SUPPLEMENTARY INSTRUCTIONS FOR INCORPORATING OVERDRIVE ON "SECOND" AND "THIRD" GEARS

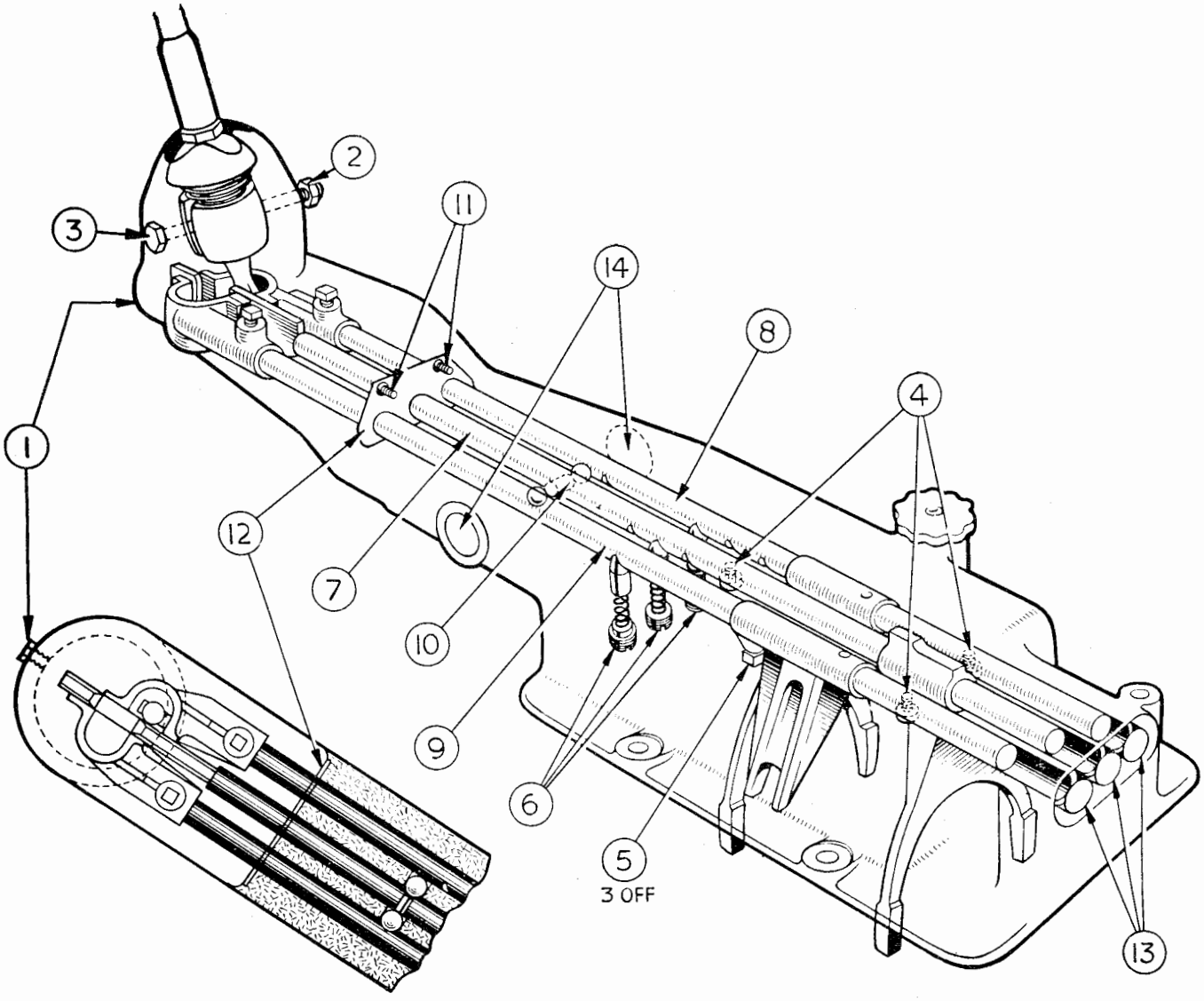

Fig. 40 **Ghost view of Top Cover Assembly.**

(**iii**) Withdrawing the pivot bolt (3) to enable the change speed lever assembly to be withdrawn.

Caution. When withdrawing the change speed lever assembly, ensure that the anti-rattle spring and retainer, which is located on the spherical part of the lever, is retained for re-assembling.

(**d**) Remove the three wire locked stop screws (4).

(**e**) Unscrew and remove the three wire locked screwed taper pins (5) securing the forks to the selector shafts.

(**f**) Remove 1st and 2nd speed selector shaft retaining screw (6), spring and $\frac{3}{8}$" locking ball and slide this selector shaft rearwards clear of the casting to enable the removal of the selector fork.

(**g**) Remove " Reverse " selector fork and shaft (9) carrying out the procedure as in (**f**) above, excepting that the shaft is positioned by a plunger, spring, distance piece and retaining screw instead of the ball, spring, and retaining screw.

(**h**) Remove 3rd and " Top " speed selector shaft (7) and fork, carrying out the procedure used in (**f**) above.

SUPPLEMENTARY INSTRUCTIONS FOR INCORPORATING OVERDRIVE ON "SECOND" AND "THIRD" GEARS

NOTE. It is important that no attempt is made to move more than one selector shaft at a time otherwise damage will be caused to the bores of the top cover and difficulty will be experienced in removing the shafts.

(**i**) Finally shake out the interlock balls from the casing.

(**j**) Remove the existing isolator switch.

(**k**) Remove the two $\frac{1}{4}$" UNF setscrews (11) from the oil sealing ring cover plate (12), enabling the plate and three rubber sealing rings to be removed.

(**l**) It being very difficult to remove the welch plugs (13 and 14) without damaging them, it is desirable to replace the old plugs with new ones when re-assembling the new top cover.

Top Cover Assembly—Fig. 40—To Assemble. Assemble the new selector forks into the new top cover by reversing the dismantling procedure, observing the following :—

(**a**) Ensure before fitting the centre selector shaft that the interlock pin is positioned in the end of the shaft. (See 10).

(**b**) After fitting and moving the centre shaft to the " Neutral " position, feed the two interlock balls into position from either side. (See 10).

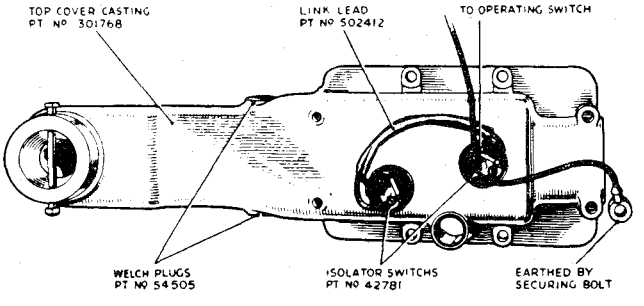

Fig. 41 **Top Cover showing Isolation Switches.**

Isolator Switches. The isolator switches, Fig. 41 (Part No. 42781), are not included in the top cover assembly (Part No. 502411) and will therefore be required.

Switch Adjustment. Fig. 42. It is important when moving the gear lever to an engaged position, that the switch contacts close at a precise point during the lever's movement.

The correct time for contact closure is when :—

(**a**) Synchronisation is complete.

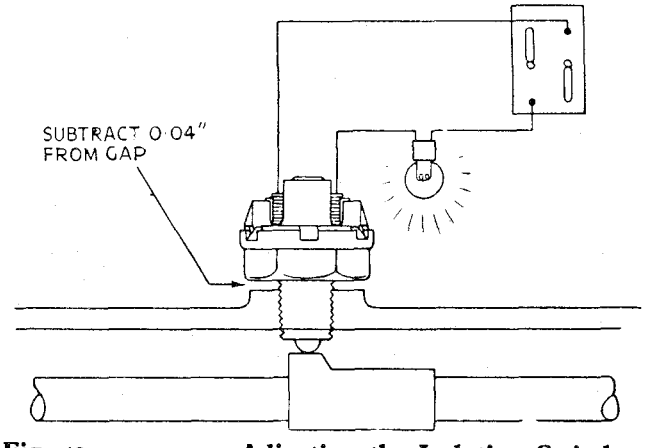

Fig. 42 **Adjusting the Isolation Switches.**

(**b**) The synchro sleeve begins to cover the dog teeth of the driving gear.

NOTE. Failure to obtain these conditions will result in noisy and difficult gear changing.

To obtain correct switch adjustment proceed as follows :—

(**a**) Move the gear lever until " Second " gear is fully engaged.

(**b**) Wire a bulb in series with the switch contacts and connect to a battery. (Fig. 42).

(**c**) Screw the switch into the rear switch boss (Fig. 42), until the contacts close. (Indicated by the bulb lighting.)

SUPPLEMENTARY INSTRUCTIONS FOR INCORPORATING OVERDRIVE ON "SECOND" AND "THIRD" GEARS

(**d**) Measure with feeler gauges the gap between the switch and boss, that is, the amount the switch would have to be screwed down to be fully home.

(**e**) From this dimension subtract .040″ and make up the remainder with paper packing washers, Part No. 502146.

Example. If the gap measured .090″ the subtraction of the .040″ would leave .050″. By selection (the washers vary in thickness) obtain a pack which measures .050″.

(**f**) Disconnect the switch and remove it from the top cover.

(**g**) After installing the washer-pack over the screwed portion of the switch, screw the switch securely into the top cover.
Repeat the procedure with the "Third" and "Top" isolator switch.

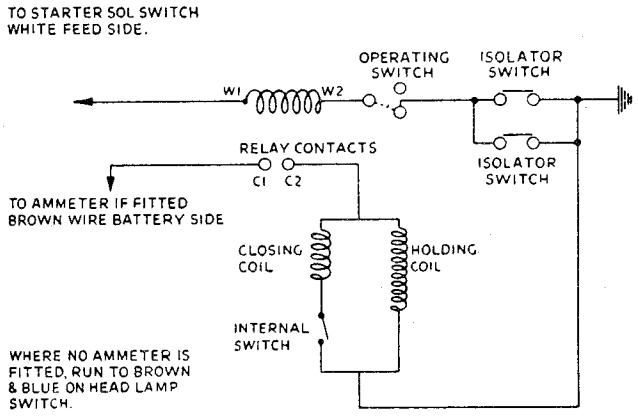

Fig. 43 **Wiring Diagram.**

Wiring. The switches are wired in parallel (Fig. 43) and the necessary link lead from switch to switch is obtainable under Part No. 502412.

One of the link wires is connected to earth (Fig. 41). The remaining link wire is connected through a snap connector to one side of the operating switch.

Top Cover Conversion Pack—Part No. 503219. The following is a list of the parts included in the pack to convert the old type cover assembly, part No. 502078 to 502411.

1	Top Cover Casting	301768
1	1st and 2nd Selector Fork	110753
1	Top and 3rd Selector Fork	110754
2	Welch Plugs	54505
1	Isolator Switch	42781
6	Packing Washers	502146
1	Link Lead	502412
3	Welch Plugs	104449

Overdrive Kit—Part No. 501803 for R.H.
Part No. 502104 for L.H.

These kits may be used either:

(**a**) Where a car is to be fitted with overdrive on all gears and is already fitted with a top cover (Part No. 502411).

(**b**) To convert cars fitted with the old type overdrive unit (Serial No. 22/1275/—, in which case either:—

(**i**) A complete new top cover assembly, Part No. 502411, may also be required, or

(**ii**) A top cover conversion Pack, No. 503219.

EI

Service Instruction Manual

F1

REAR AXLE

SECTION F

REAR AXLE

INDEX

ILLUSTRATIONS

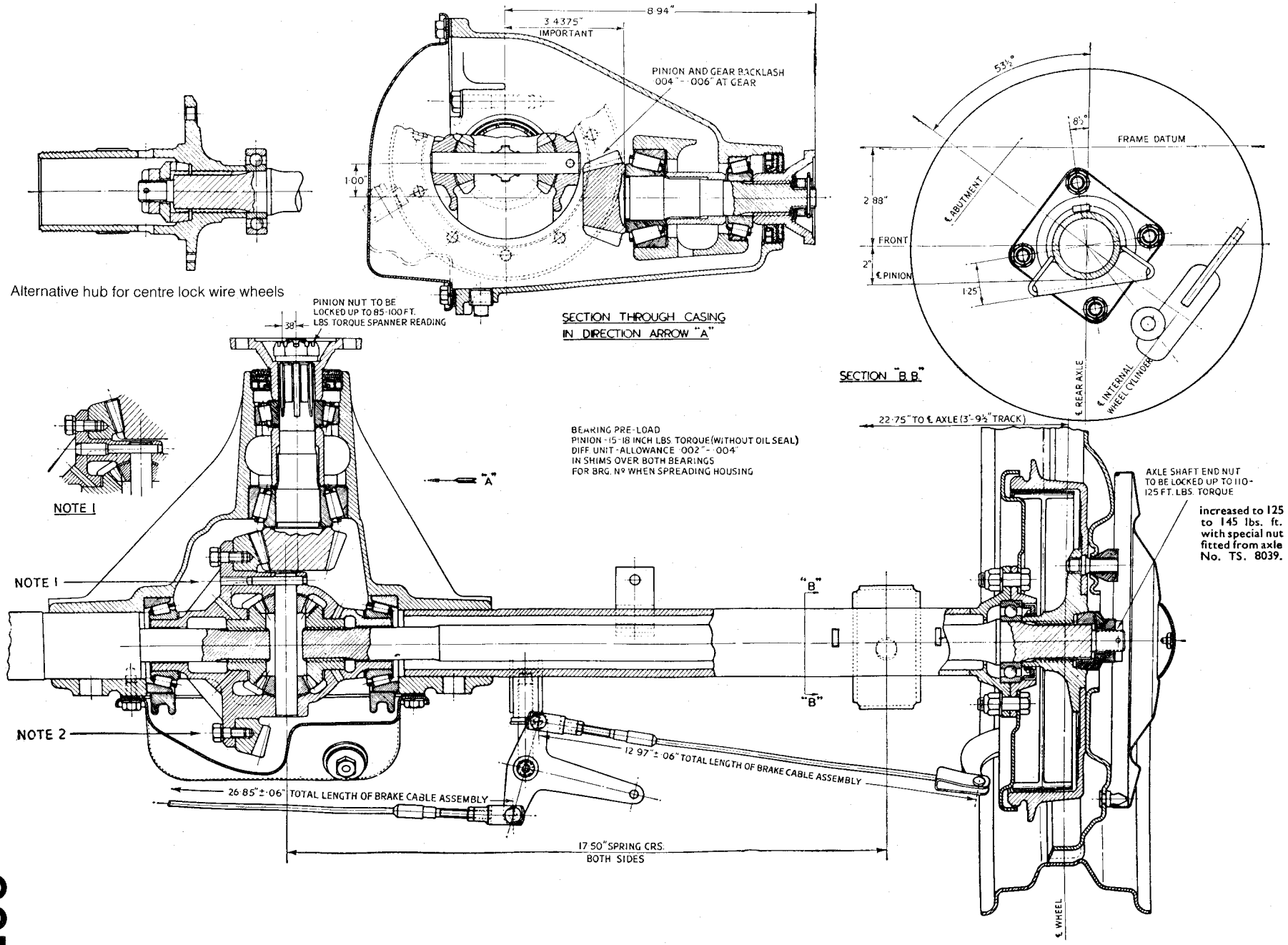

Fig. 1 **Axle arrangement.** **(For Notes 1 and 2 See page 4).**

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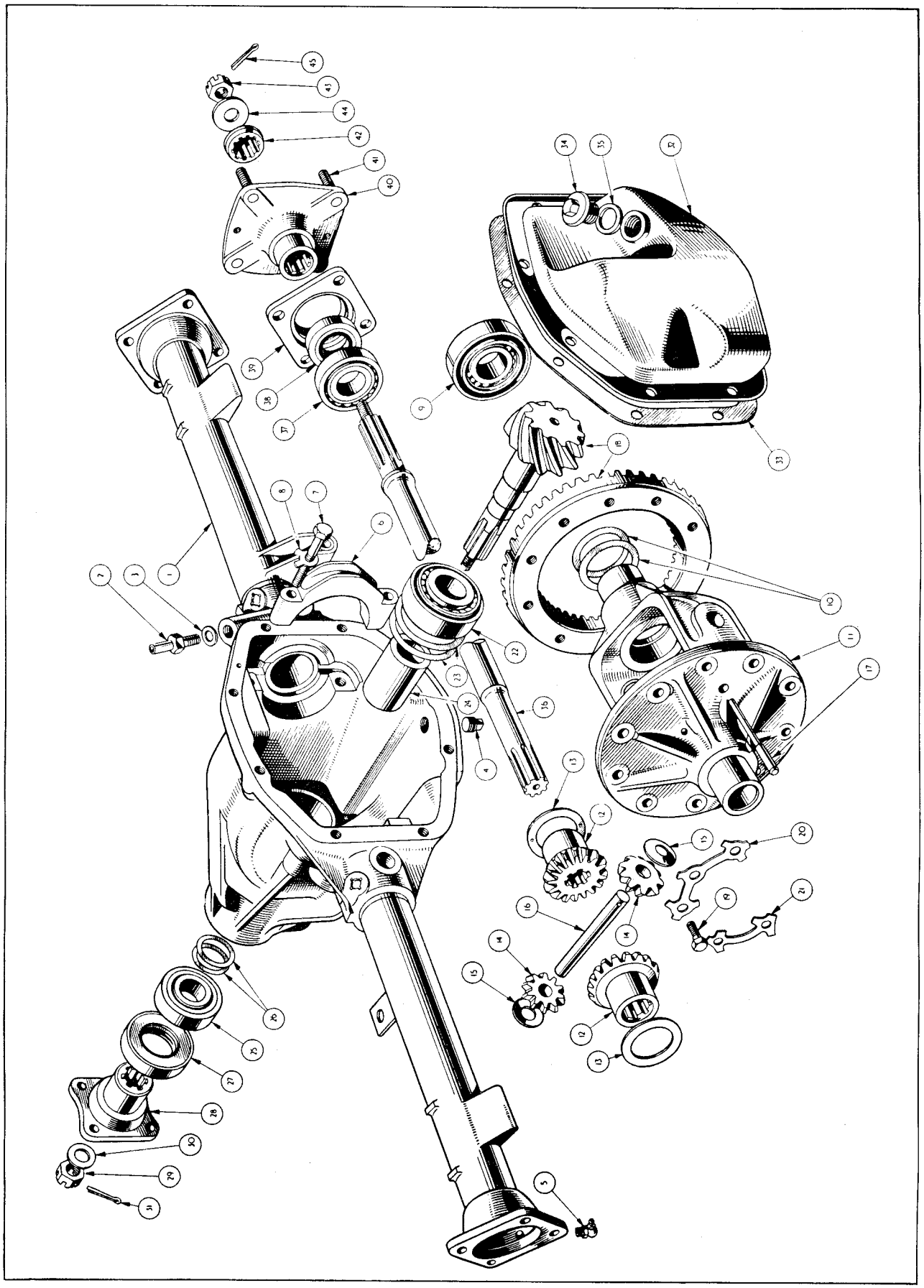

Exploded view of axle details.

Fig. 2

NOTATION FOR REAR AXLE EXPLODED VIEW (FIG. 2)

Ref. No.	Description	Ref. No.	Description
1.	Axle casing assembly	23.	Pinion head bearing ring shim.
2.	Breather.	24.	Pinion bearing spacer.
3.	Fibre washer.	25.	Pinion tail bearing.
4.	Drain plug.	26.	Pinion shaft shims.
5.	Grease nipple.	27.	Pinion shaft oil seal.
6.	Bearing cap.	28.	Pinion driving flange.
7.	Bearing cap setscrew.	29.	Castellated nut.
8.	Tab washer.	30.	Washer.
9.	Differential bearing.	31.	Cotter pin.
10.	Shims.	32.	Rear cover.
11.	Differential casing.	33.	Joint washer.
12.	Sun gear.	34.	Oil filter plug.
13.	Thrust washer.	35.	Washer.
14.	Planet gear.	36.	Rear axle shaft.
15.	Thrust washer.	37.	Hub bearing.
16.	Cross pin.	38.	Hub oil seal.
17.	Locating pin. (See note 1 page, 4).	39.	Bearing housing.
18.	Crown wheel and pinion.	40.	Hub assembly.
19.	Crown wheel bolt. (See note 2, page 4).	41.	Wheel stud.
20.	Tab washer.	42.	Splined collar.
21.	Tab washer.	43.	Castellated nut.
22.	Pinion head bearing.	44.	Washer.
		45.	Cotter pin.

See also Fig. 35.

DATA

Crown wheel run out	Not more than .003″
Backlash between crown wheel and pinion	.004″ — .006″
Distance from ground thrust face on pinion to centre of crown wheel	3.4375″
Pinion bearing pre-load, measured without oil seal	15 — 18 in. lbs.
Pre-load for differential bearings	Allowance for .002″ to .004″ shims, spread over both bearings
Diameter of differential bearings	2.8446″ — 2.8440″
Later production cars	2.8460″ — 2.8450″
Pinion nut tightening torque	85 — 100 lbs. ft.
Hub securing nut tightening torque	110 — 125 lbs. ft.
	125—145 lbs. ft. with special nut fitted to axle No. TS.8039 onwards.

1. GENERAL DESCRIPTION (Fig. 1)

The rear axle is of the hypoid semi-floating type with shim adjustment for the differential bearings and for the endwise location of the pinion in relation to the crown wheel. The axle sleeves are pressed into the centre casing and each sleeve is located by four pegs.

The centre casing is a casting which accommodates the differential cage and the attached crown wheel, together with the hypoid pinion. A detachable pressed steel cover, at the rear of the centre casing, allows access to the differential unit and crown wheel, the removal of this cover clears the way for the dismantling of the axle. The hypoid pinion is mounted on two taper roller bearings which are separated from one another by a tubular spacer. The pinion's endwise relation with the crown wheel is adjusted by means of shims inserted

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between the " head " bearing outer ring and the casing. Preloading of bearings is adjusted by means of shims between the spacer and tail bearing.

The differential casing contains two sun and two planet wheels and also carries the crown wheel, which is bolted in position by ten bolts passing through the casing and into tapped holes in the back of the wheel itself.

NOTE 2: Fig. 1. The crown wheel is attached to the differential casing by bolts locked by tab washers. The crown wheel showed a tendency to work loose after exacting rally acceleration and reversing gear tests and to obviate this possibility the $\frac{5}{16}$" UNF attachment bolts were replaced by $\frac{3}{8}$" UNF in axles numbered TS.4731 onwards.

The two planet wheels are mounted on a cross spindle, this spindle being provided with a hole at one end and located by a pin passing through the hole and the differential casing.

NOTE 1: Fig. 1. The locating pin used has a " stepped " shape but this is to be changed in the near future to the "parallel" type pin as shown in the main illustration. Incorporated in axle No. TS.6260 onwards.

The axle shafts are splined at both ends. The inner end fitting into the sun wheels and the outer extremity accommodating the wheel bearing and hub. The hub is secured to the splined end of the axle shaft by means of a splined taper collar, a shaped washer and a castellated nut.

The wheel bearing is accommodated in the axle sleeve and a housing which is bolted to the flanged end of each axle tube. The inner portion of the wheel bearing is gripped between the hub and a flange on the axle shaft.

The differential casing is mounted on two taper roller bearings, the position of these being adjusted by means of shims interposed between them and the casing itself. The disposition of these shims decides the crown wheel and pinion depth of engagement and the thickness of these the amount of pre-loading.

2. TO REMOVE HUBS

(**a**) Remove the nave plate.

(**b**) Withdraw the split pin from end of axle shaft. Partly release the torque on the castellated hub securing nut.

(**c**) Jack up the car, remove the castellated nut, the road wheel and by the withdrawal of the two countersunk setscrews remove the brake drum.

(**d**) Remove the washer and the splined taper collar from the axle shaft.

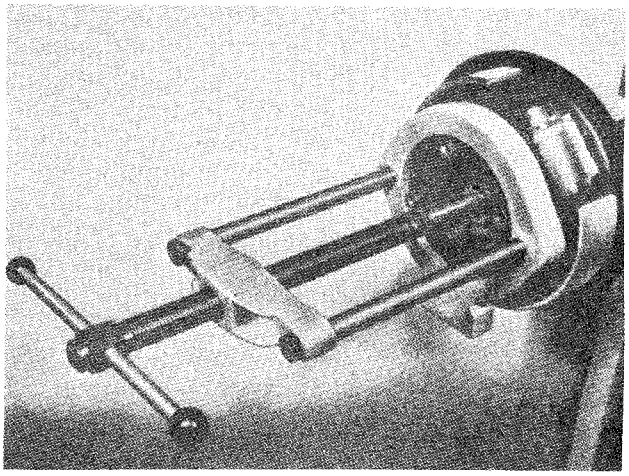

Fig. 3 **Hub removal utilising the Churchill tool No. S 132/2.**

(**e**) Fit the Churchill hub removing tool No. M86 or S132/2 and withdraw the hub from the shaft (Figs. 3 and 6).

An alternate method is to withdraw the half shaft with the hub in position (see page 5), this method necessitates the removal of the brake backing plate and the severing of the hydraulic and hand brake connections.

3. TO REPLACE HUBS

The replacement of the hubs is the reversal of the removal but the following notes should be considered.

The axle shafts of the later production cars provided an interference fit with the hub splines. To facilitate the replacement of the hubs—the Churchill hub replacing Tool No. S125 was introduced (see Fig. 5). Should the axle shafts be out of the axle casing it will still be necessary to use the hub replacing tool or a fly press.

4. TO REMOVE HUBS (Centre lock type) (Fig. 35)

(a) Jack up the car and remove the hub cap by tapping the lugs with a copper faced mallet. Remove the road wheel.

(b) Remove the split pin through the aperture in the barrel of the hub.

(c) Remove the hub securing nut from the axle shaft. It may be necessary to replace the wheel and lower the car when torque is applied to the nut. After removing the nut withdraw the washer and splined collar.

(d) By inserting a screwdriver blade into the cut of the split tapered collar, the collar will expand and allow it to be withdrawn from the hub.

(e) Remove the two countersunk brake drum securing screws and withdraw the brake drum.

(f) Fit the Churchill hub removing Tool No. S132 and remove the hub. It should be remembered that the hubs have right or left-hand threads and care must be exercised when selecting the removal rings. (See Fig. 4.)

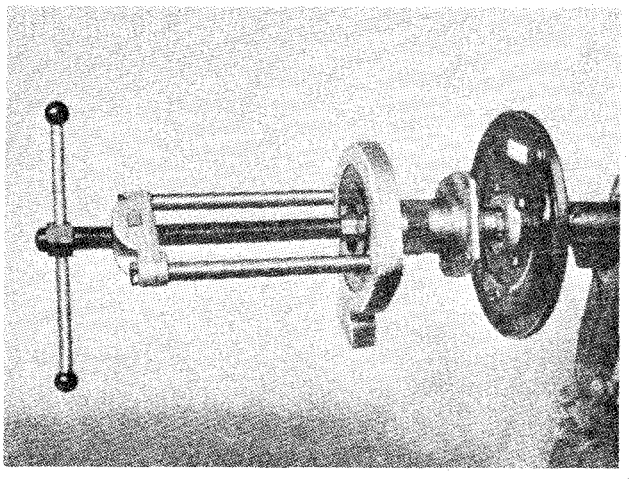

Fig. 4 **The removal of the knock on type hub utilising the Churchill Hub Removing Rings S132 with the S4221 frame and slave ring. Shown with brake assembly removed for photographic purposes.**

An alternate method of hub removal is to remove the axle shaft complete as described on this page. This necessitates the severing of the hand brake and hydraulic connections and removing the brake backing plate.

5. TO REPLACE HUBS (Centre lock type) (Fig. 35)

The replacement of the hubs is the reversal of their removal. However the following points should be noted.

(a) The axle shafts of later production cars provide an interference fit with the hubs. To facilitate the replacement of the hubs the Churchill hub replacing Tool No. S125 was introduced and is illustrated in Fig. 5.

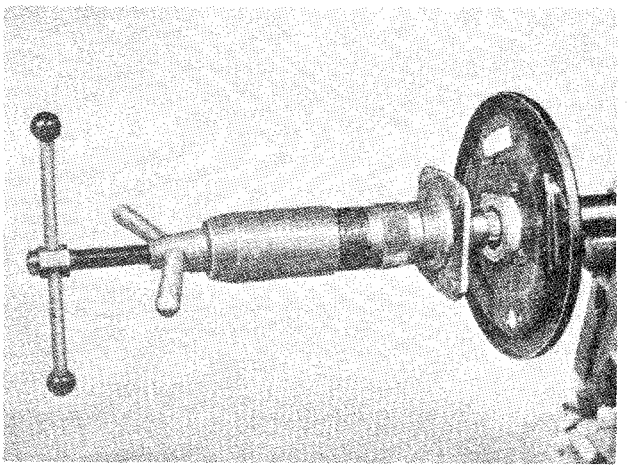

Fig. 5 **The replacing of the knock on type hub utilising the Churchill Hub Replacing Tool No. S125. Shown with brake assembly removed for photographic purposes.**

(b) When the axle shafts are out of the casing it is still necessary to use the hub replacing tool or a fly press.

6. TO REMOVE AXLE SHAFT

(a) Jack up car and remove road wheel.

(b) If the car is equipped with wire wheels remove the split tapered collar by inserting a screwdriver blade into the cut of the ring. It can now be drawn off the barrel of the hub.

(c) Withdraw the two countersunk brake drum securing screws and remove the brake drum.

(d) Drain the hydraulic system, disconnect the pipe line and the hand brake cable at the wheel cylinder.

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(e) Remove the four bolts and nyloc nuts which secure the brake backing plate and the bearing housing to the axle flange.

(f) Withdraw the axle shaft assembly from the axle casing together with the brake backing plate assembly.

(g) Grip the axle in the protected jaws of a vice and utilising the aperture in the barrels of the centre lock hub, remove the split pin. Remove the castellated nut, washer and splined taper collar. Remove the hub with the Churchill hub remover, Tool No. S132. (See Fig. 4).

(h) To remove the disc wheel hub, first remove the split pin at the axle end followed by the castellated nut, washer and splined taper collar. Remove the hub with the Churchill hub remover, Tool No. M86 (Fig. 6) or S132/2 (Fig. 3).

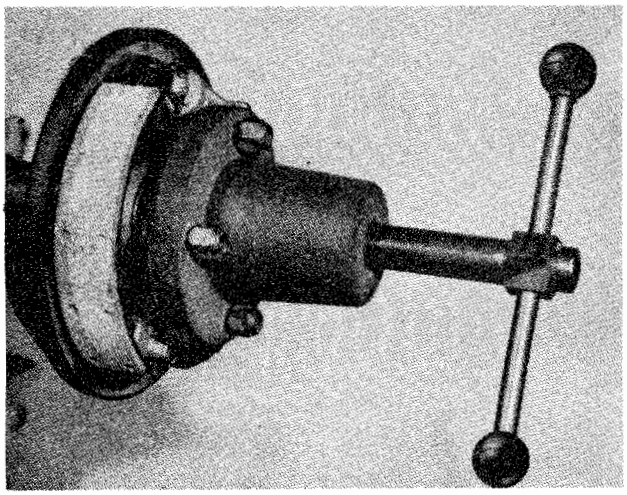

Fig. 6 **Hub removal utilising the Churchill tool No. M86.**

The extraction of each hub will release the oil seal and bearing housing but leave the hub bearing on the axle shaft.

(i) Remove the hub bearing from the shafts, utilising the Churchill Tool No. S4615 Codes 8 and 10. (See Fig 7.)

(j) The oil seal can now be drifted out of the bearing housing if it is seen to be unserviceable.

7. TO REPLACE AXLE SHAFT

The replacement of the axle shaft is the reversal of their removal. However the following points should be noted.

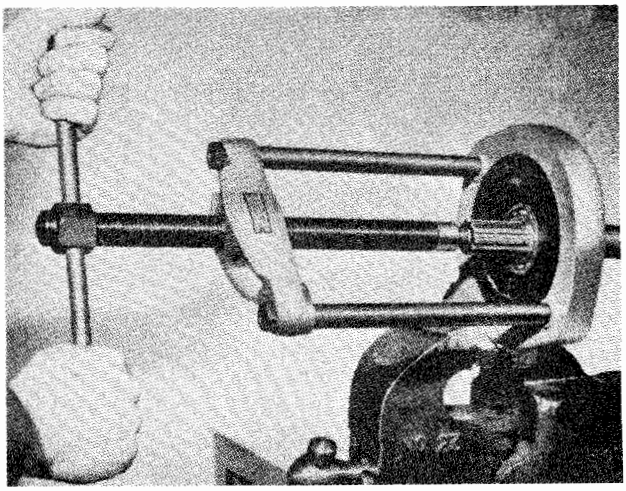

Fig. 7 **Removing hub bearing utilising Churchill Tool No. S4615 Codes 8 and 10 with S4221 frame and slave ring.**

(a) The replacement of the hub oil seal is shown in Fig. 8, utilising Churchill Tool No. M29.

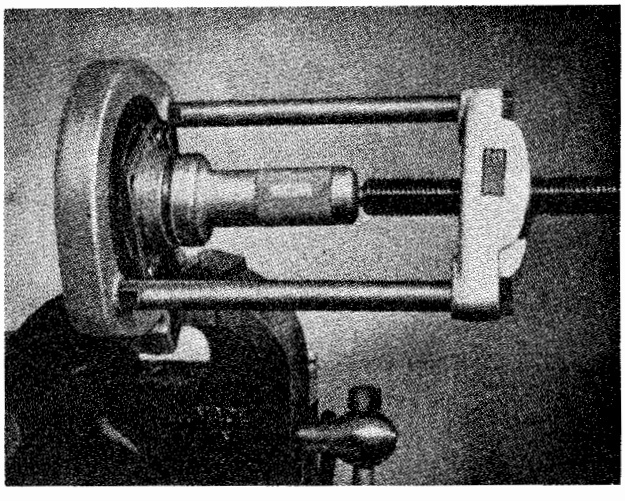

Fig. 8 **Replacing hub oil seal utilising Churchill Tool No. M29.**

(b) Replacement of the hub bearing is illustrated in Fig. 9, using Churchill Tool No. M92.

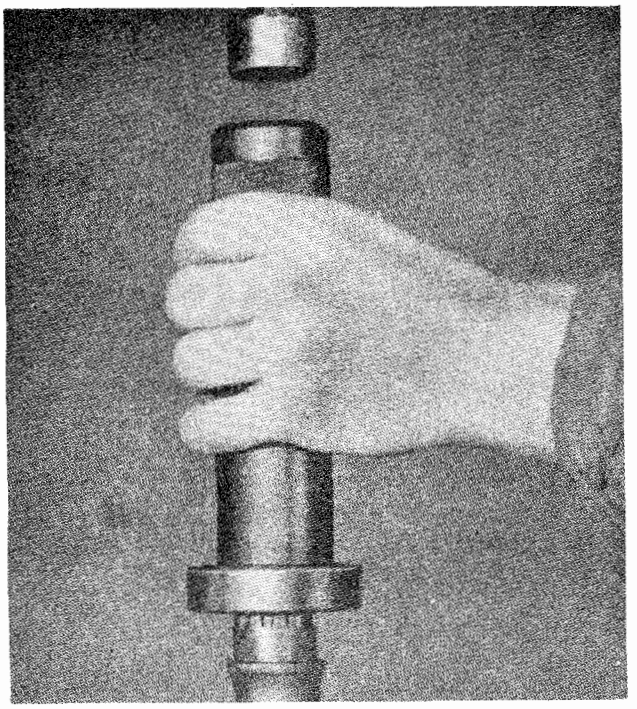

Fig. 9 **Replacing wheel bearings utilising Churchill Tool No. M92.**

(c) On later production cars the axle shaft provided an interference fit with the hub and it is necessary to replace the hub, utilising the Churchill hub replacing Tool No. S125.

(d) On completion of the replacement operations it will be necessary to bleed the brakes.

8. TO REMOVE AXLE

NOTE : As the axle has to be tilted it may be desirable to drain off the oil.

(a) Jack up car and remove road wheels.

(b) Detach propeller shaft from pinion flange by the removal of four bolts and nyloc nuts.

(c) Disconnect hand brake cable from the compensator lever.

(d) Drain the hydraulic system and disconnect the line at the front end of the flexible hose. (See Brake Section.)

(e) Remove the brake drums after withdrawing the two countersunk setscrews. If wire wheels are fitted the split taper ring will have to be removed first, this can be effected by inserting the blade of a screwdriver into the split to expand the ring which can then be drawn off the hub.

(f) First disconnect the Bundy Tubing and the hand brake cables at the wheel cylinders and then remove the bolts and nyloc nuts securing the brake back plate to the axle casing.

The hubs, together with the half shafts, oil seals, bearings and brake backing plate, can now be removed from the axle. These can be dismantled as described on page 5.

(g) Remove the axle check straps by first removing the four nuts and lock washers.

(h) Remove the nyloc nuts from the " U " bolts securing the axle to the road spring and swing the shock absorber arm (attached to the spring plate) clear. The " U " bolts may now be removed from the axle.

(i) Lift the axle clear of the spring and move it to the left, allow the right-hand side to be lowered when the axle end is clear of the right-hand spring. By moving the axle to the right it can be withdrawn from the chassis. (Fig. 10.)

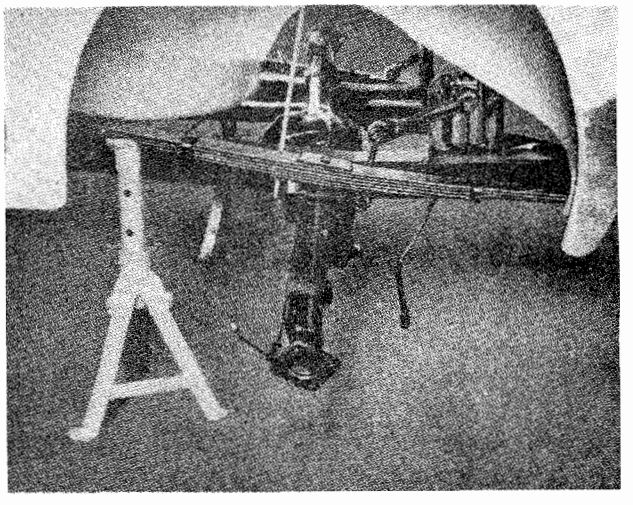

Fig. 10 **Axle being removed from car.**

9. TO REPLACE THE AXLE

If a replacement axle is being fitted it will be necessary to remove the complete brake assemblies at the axle ends.

It is not necessary to remove the hubs, for these can be removed with the half shafts and brake backing plates.

The axle must be tilted during the fitting operations and filling the axle with oil should be delayed until the axle has been fitted to the car.

The fitting is the reversal of the removal. For the bleeding of the hydraulic system see " Brakes—Section R."

10. TO DISMANTLE

(**a**) Drain oil.

(**b**) Remove wheel securing cones (wire wheel hubs only). This enables the brake drum securing screws to be removed and the drums withdrawn.

(**c**) Remove split pins (as shown in Fig. 11)

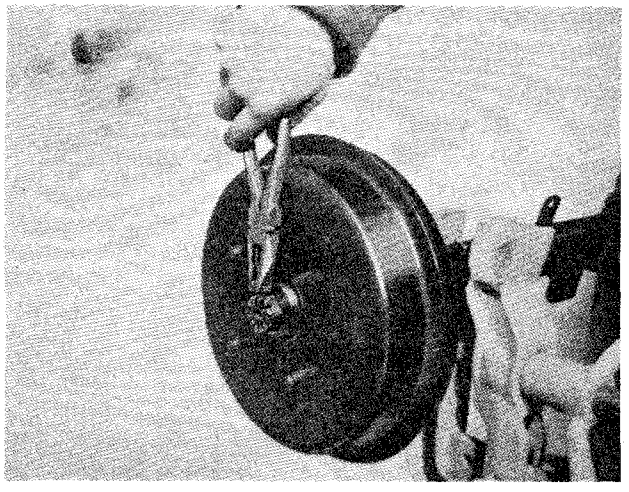

Fig. 11 Removing split pin from hub securing nut.

and hub securing nuts. Preventing the hubs from rotating by means of a road wheel, the conical washers can then be removed and the hubs, complete with their splined tightening cones, withdrawn with a suitable tool or press. Churchill Tool No. M86 or S132/2.

NOTE: Some difficulty may be experienced in the slackening of the nuts due to rotation of the hubs, but since the axle is going to be completely dismantled the hubs can be removed at a later stage, which means that the half shafts, hubs, brake backing plates, etc., must be removed as an assembly.

(**d**) Remove brake shoes and return springs.

(**e**) Withdraw the brake backing plates after removal of the eight bolts, spring washers and nyloc nuts, four from either back plate. Further dismantling of the brake backing plates only require the removal of the hydraulic wheel cylinders and anchor blocks, the latter being secured by spring washers and two nuts, the former can be withdrawn provided the hydraulic connections, rubber dust sealing boots, etc., have been removed.

(**f**) The half shafts can now be withdrawn from the axle casing, the bearing housings tapped off the bearings and the bearings withdrawn with a suitable puller. (As shown in Fig. 7.) The grease seal can then be tapped out of the bearing housings.

NOTE: If the hubs have not been previously withdrawn due to difficulties in slackening the hub nuts mentioned in (**c**) they can now be slackened by gripping the axle shaft in the vice, and the hubs then pressed off the axle shafts with a suitable tool or press.

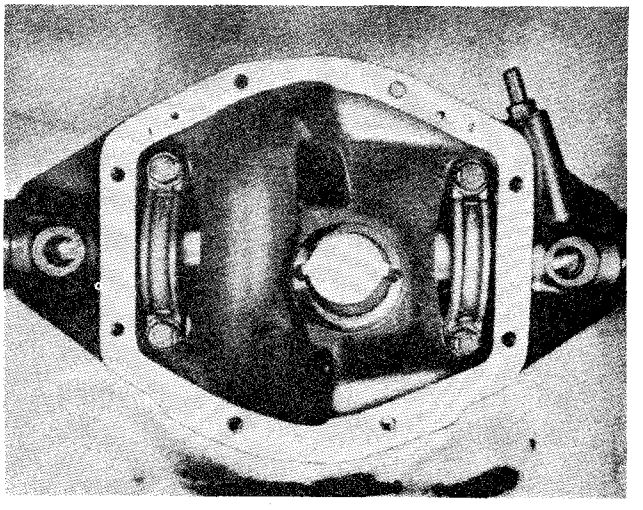

Fig. 12 Identification numbers on bearing caps and axle casing. Note also the tops of washers laying in groove of bearing cap.

(g) Remove axle centre casing cover and joint after withdrawal of eight setscrews.

(h) Remove the differential bearing caps, noting the markings stamped on the top of these and the correspondingly abutting portions of the casing. The existing relation between the caps and casing must be retained when re-assembling. Fig. 12 shows example of markings.

(i) Apply axle casing spreader as shown in Fig. 13, and lift differential assembly

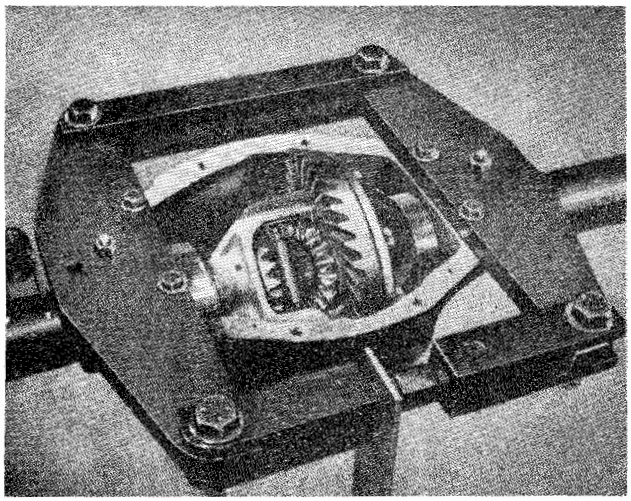

Fig. 13 Casing spreader in position. Churchill Tool No. S101.

out of the axle centre casing. " Spreading " should be limited to that required to just free the assembly in the casing.

(j) Suitably identify the respective outer portion of the differential bearings with their inner races. The interrelation of the component parts of these races must be retained when re-assembling the rear axle.

(k) Remove the crown wheel from its mounting flange after the withdrawal of the ten fixing bolts, leaving further dismantling of the differential unit until a later stage.

(l) After removal of split pinned flange nut as shown in Fig. 14, and having removed the flange, drive the pinion out through the casing with a hide faced hammer. Lay aside the shims which are fitted between the spacer

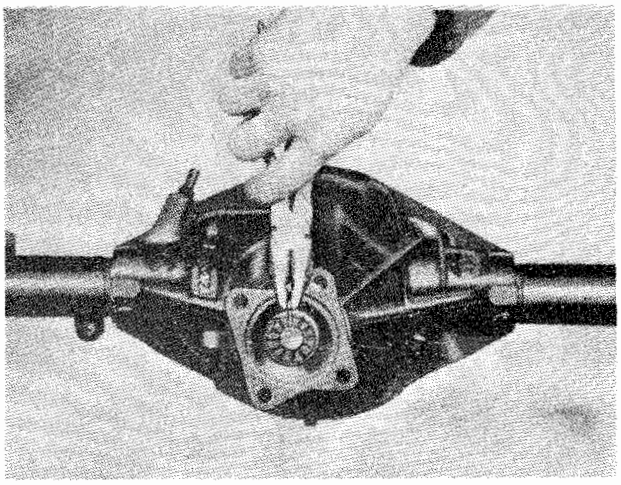

Fig. 14 Removing split pin from driving flange securing nut.

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and tail race for possible use when re-assembling. Remove pinion head bearing inner cone as shown in Fig. 15.

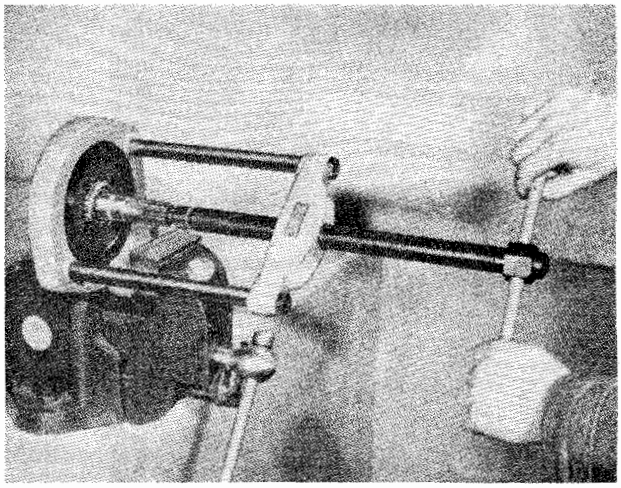

Fig. 15 Removal of pinion head bearing utilising Churchill Tool No. TS1 and S4221 frame with slave ring.

(m) Drive out the pinion outer rings as shown in Fig. 16. The removal of the outer ring of the tail bearing will also eject the oil seal and tail bearing inner cone. The ejection of the head bearing outer ring will uncover the shims fitted between this and the casing.

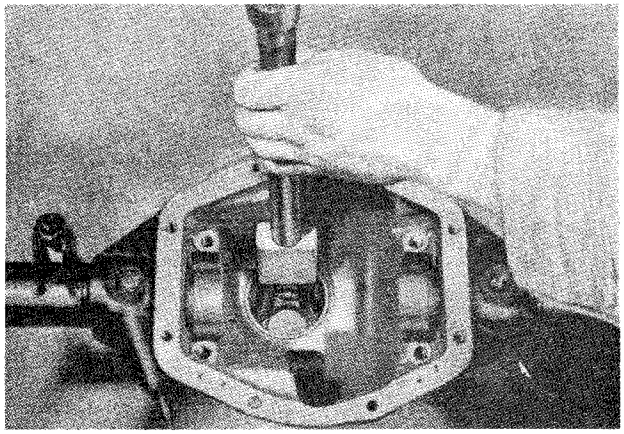

Fig. 16 Driving out pinion bearing outer rings utilising Churchill Tool No. 20SM FT71.

These shims should be laid aside with the component parts of this bearing as a guide when re-assembling.

(**n**) Replace the differential assembly in the axle casing and release the tension from the axle casing spreader.

(**o**) Check the " run out " of the crown wheel mounting flange; this should not exceed .003″ (Fig. 17). The crown wheel itself can be checked on a surface table with the aid of a set of feeler gauges. Having satisfactorily completed these checks, the differential assembly can be removed from the axle casing and dismantled as follows:

(**i**) Drive out the cross pin locating pin and withdraw the cross pin.

(**ii**) Rotate the sun wheels which will in turn rotate the planet wheels until the planet wheels with their respective thrust washers are opposite the cut away portions of the crown wheel carrier from which they can easily be withdrawn.

(**iii**) Remove the sun wheels and their thrust washers, so completing the dismantling of the rear axle.

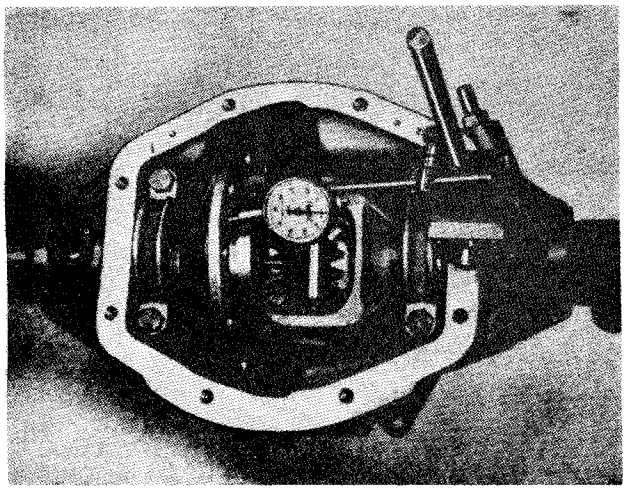

Fig. 17 Checking the run out of the crown wheel mounting flange utilising a D.T. 1.

11 TO RE-ASSEMBLE

All parts must be examined carefully and a decision should be made as to which items require renewal. Where it is found necessary to replace the crown wheel or pinion for any reason the gears must be replaced as a pair, as they are "lapped" together in manufacture.

The first consideration, after replacing damaged or worn parts, must be the correct interrelations between the crown wheel and pinion. The assembled relation of these two gears must very closely approximate that used when the gears where "lapped" together after heat treatment during manufacture.

The datum position of the pinion with relation to the crown wheel is specified as 3.4375″ from the ground thrust face on the back of the pinion to the centre line of the differential bearings. It is also important that not only should this datum position be achieved, but that sufficient bearing preload should be arranged to ensure the maintenance of the specified relations in service.

Having cleaned the abutment faces and bearing housings thoroughly, and removed any excrescences from these surfaces, the following procedure for re-assembly is recommended.

(**i**) Fit the outer rings of the pinions two bearings, pulling them into place with a special tool. (Fig. 18).

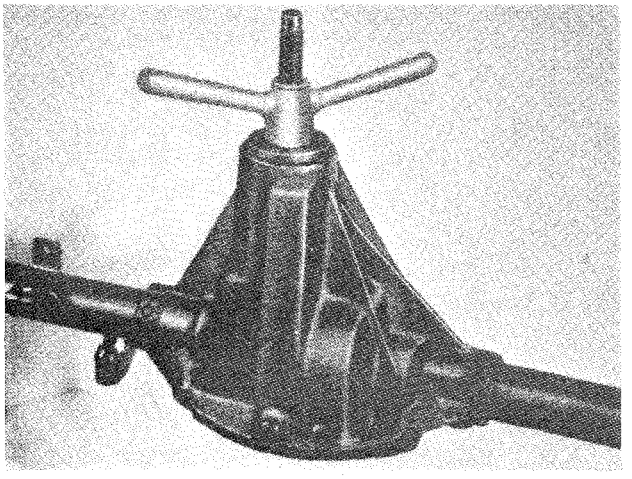

Fig. 18 **Fitting pinion bearings outer rings utilising Churchill Tool No. M70.**

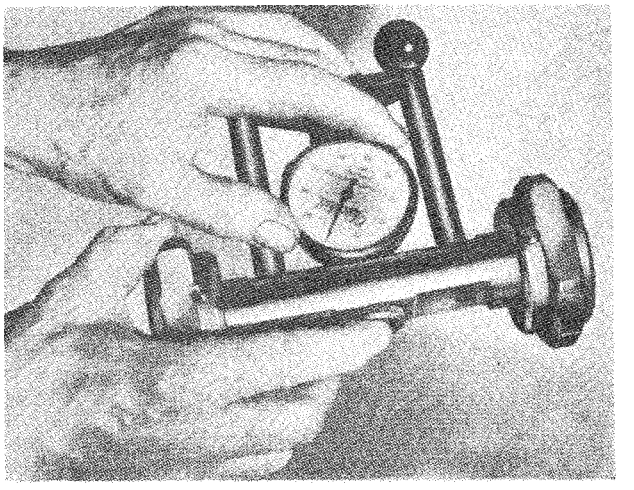

Fig. 20 **Utilising the " button ", the Pinion Setting Gauge (Churchill Tool No. M84) is set to zero.**

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(ii) Fit the dummy pinion (M.84), the pinion bearing inner cones and install into the axle centre casing ; tightening the flange nut progressively until the correct pinion pre-load of 15—18in. lbs. is obtained.

(iii) Install the pinion setting gauge in the axle centre casing (Fig. 19), (after zeroing the dial with a ground button held firmly on the gauge plunger, Fig.20) and tighten bearing caps. This gauge is used to assess the shim thickness which is required under the pinion head bearing outer ring, to bring the pinion into its correct datum position mentioned earlier. Due to the fact that the bearing inner cones are a slide fit on the dummy pinion and a press fit on the actual pinion to be used, bearing expansion will undoubtedly take place in the latter case. A pack of shims .002"—.003" below the gauge reading will be required to allow for this expansion and thus ensure the pinion is in its correct datum position.

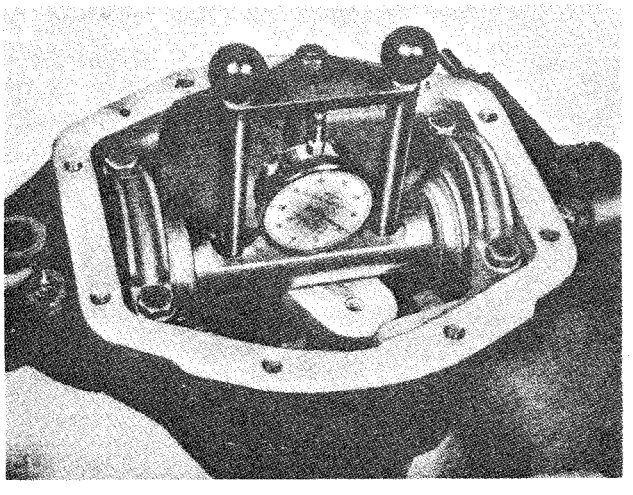

Fig. 19 **Pinion setting gauge, Churchill Tool No. M84 assembled to axle centre casing.**

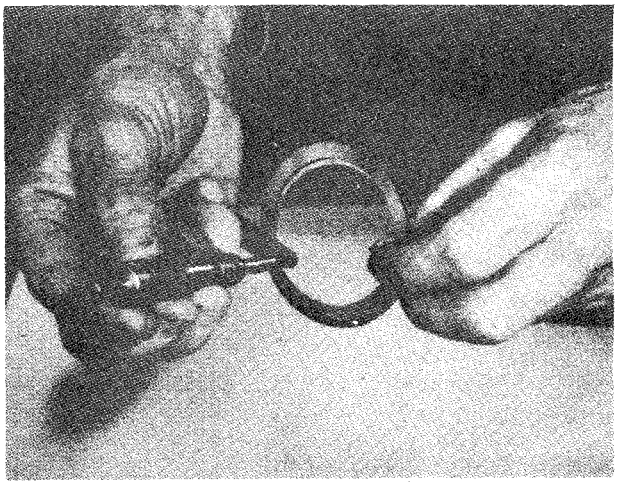

Fig. 21 **Measuring the shim pack.**

(iv) Although the packing shims are supplied to nominal thicknesses, the dimensions should be measured with a micrometer gauge. It is important that no damaged shims are used and that they are thoroughly cleaned before measurement. (Fig. 21.)

(v) Remove the pinion setting gauge, dummy pinion and pinion bearing outer rings.

(vi) Insert the measured pack of shims on the pinion head bearing outer ring abutment face (Fig. 22) and replace the pinion bearing outer rings, pulling them into place with the special tool shown in Fig. 18.

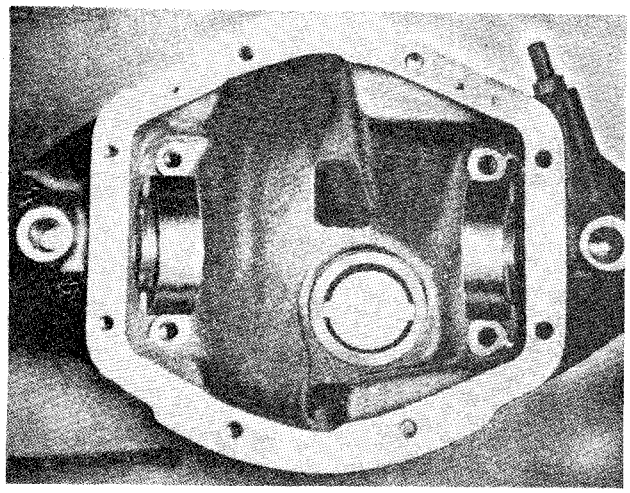

Fig. 22 **Shims placed in position on outer ring abutment face.**

(vii) Press the pinion head bearing inner cone on to the pinion shaft (Fig. 23).

(viii) The bearing spacer is fed on to the pinion shaft with the chamfer outwards as shown in Fig. 24. The shims previously removed when dismantling the axle are placed in position on the pinion and the assembly fitted into the axle centre casing. The thickness of shims fitted will probably have to be adjusted to provide the correct pre-load figure.

(ix) The inner cone of the pinion tail bearing is tapped into position on the pinion and up against the shims on the distance collar.

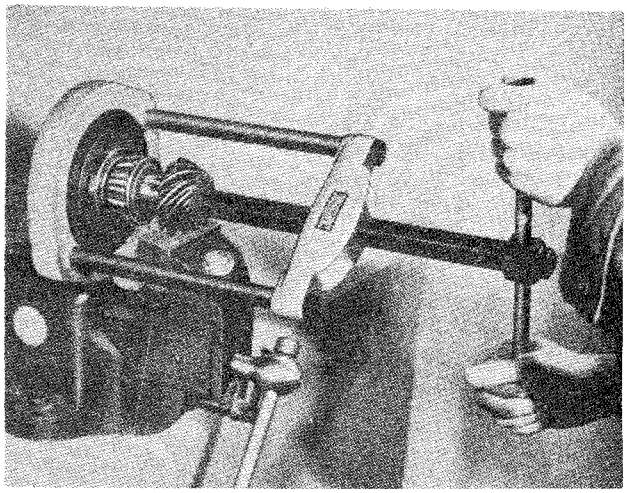

Fig. 23 **Pressing the pinion head bearing on to the pinion shaft utilising the Churchill Tool No. TS1 and S4221 frame with slave ring.**

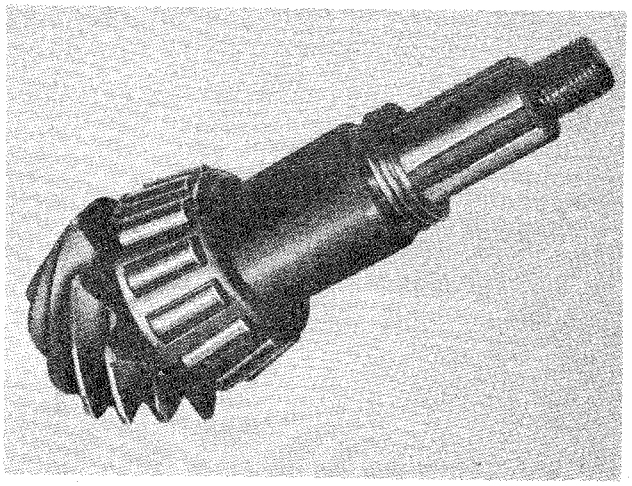

Fig. 24 **Showing the pinion bearing spacer chamfer pointing outwards, followed by the previously used shim pack.**

(x) The driving flange is fitted on the end of the pinion shaft and firmly secured with the castellated nut and plain washer to a tightening torque of 85—100 lbs. ft. THE OIL SEAL IS NOT FITTED UNTIL THE BEARING PRELOAD HAS BEEN CHECKED AS DESCRIBED IN THE NEXT OPERATION.

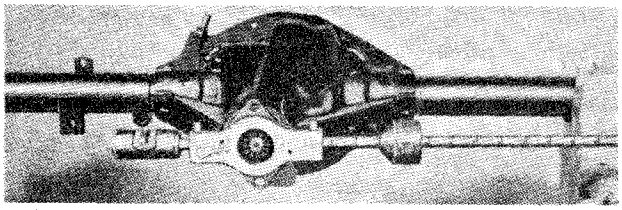

Fig. 25 **Testing the pre-load of the pinion bearing utilising the Churchill Tool No. 20SM. 98 Note: The oil seal is not fitted at this juncture.**

(**xi**) The fixture shown in Fig. 25 is now applied and the pre-load of the bearings checked. The correct pre-load should fall between 15—18 in. lbs. If the pre-load is inadequate shims must be withdrawn, whereas if an excessive figure is obtained additional shims must be fitted.

(**xii**) When the correct pinion pre-load is obtained remove driving flange and fit the oil seal (Fig. 26), after which the

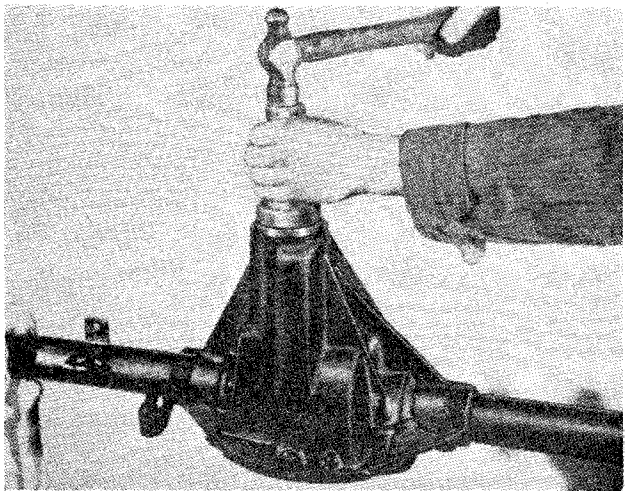

Fig. 26 **Fitting pinion housing oil seal utilising Churchill Tool No. M100.**

flange should be replaced, the castellated nut tightened to the correct torque and split pinned.

(**xiii**) The differential assembly bearings are now fitted without, as yet, installing any packing shims. A suitable driver such as that which is shown in Fig. 27 should be used for driving the bearings on to the crown wheel carrier.

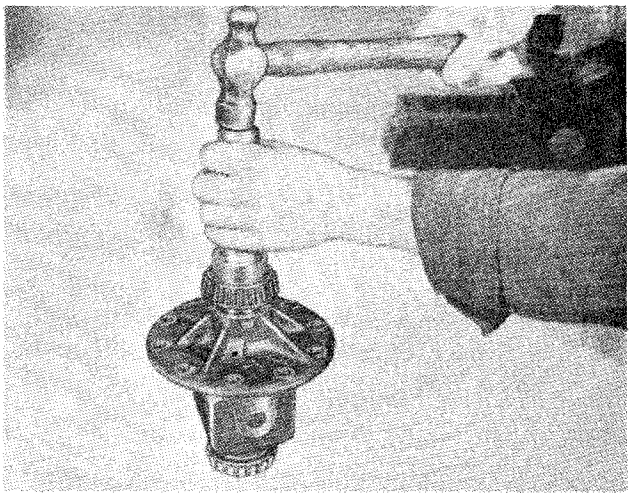

Fig. 27 **Fitting differential bearings utilising the Churchill Tool No. M89 to the differential casing.**

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(**xiv**) The axle bearing seats are carefully cleaned and any excresences removed. The differential casing is positioned and the bearing caps, fitted with regard to the identification markings, are tightened down and then slackened off a $\frac{1}{4}$ turn. This will prevent the bearings tilting but allow sideways movement. A dial indicator gauge is mounted on the axle centre casing with the plunger resting on the crown wheel mounting flange (Fig. 28). The assembly is forced away from the dial gauge and then the indicator set to zero. The assembly should then be

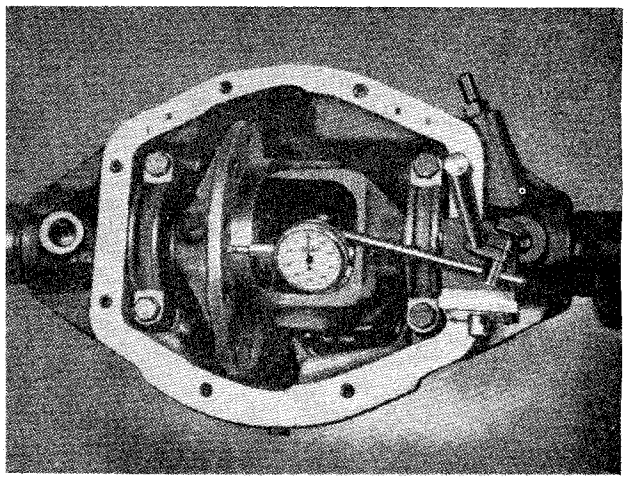

Fig. 28 **Ascertaining the total end float of the differential casing without the crown wheel fitted. The caps should be tight and then slackened $\frac{1}{4}$ turn.**

levered in the opposite direction until the taper roller bearings go hard home. The reading on the dial gauge (.062″ for example) will indicate the total side float of the crown wheel carrier and should be noted for later reference.

(**xv**) The crown wheel carrier is now removed from the axle centre casing so that the sun gears, planet gears and thrust washers can be assembled, the cross pin being used to locate the two planet gears with their respeceive thrust washers temporarily in position (Fig. 29). Subsequently, the planet gears are

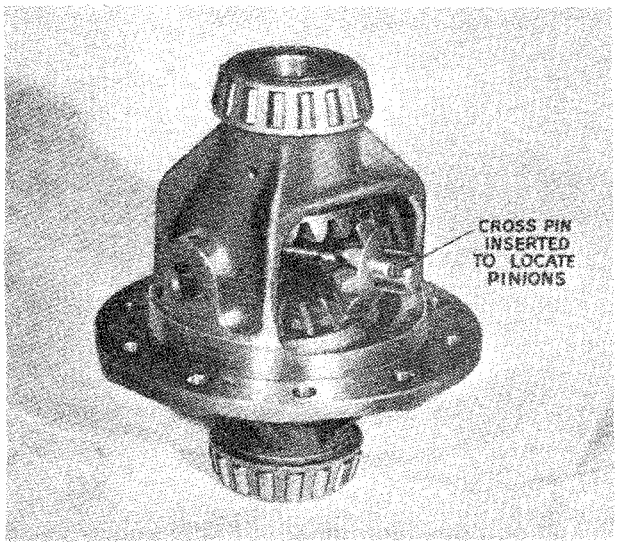

Fig. 29 Location of planet gears for entry into the differential casing.

rotated round the sun wheel through 90 degrees, the cross pin being withdrawn to allow the gears to assume their normal fitted position, and the cross pin finally fitted and secured by its locking pin, this pin being located by "centre popping."

(**xvi**) The crown wheel is fitted to the crown wheel carrier, the fixing bolts thoroughly tighten to 22—24 lbs. ft. and secured with their respective locking plates.

NOTE: The crown wheel attachment bolts were increased in diameter from $\frac{5}{16}$″ to $\frac{3}{8}$″ at rear axle No. TS.4731.

The crown wheel is checked for flush fitting against the flanged face of the carrier with a feeler gauge, thus ensuring that the crown wheel goes right home and also that there can be no question of casting distortion. The maximum permissible run out of the crown wheel and crown wheel mounting flange is .003″. The flange can be checked before the fitting of the crown wheel by rotating it on its bearings, using a dial indicator, the crown wheel itself on a surface table with the aid of feeler gauges.

(**xvii**) The differential assembly is installed in the casing in a similar manner to operation (**xiv**), but in this instance the D.T.I. plunger bears against the back of a crown wheel fixing bolt (Fig. 30).

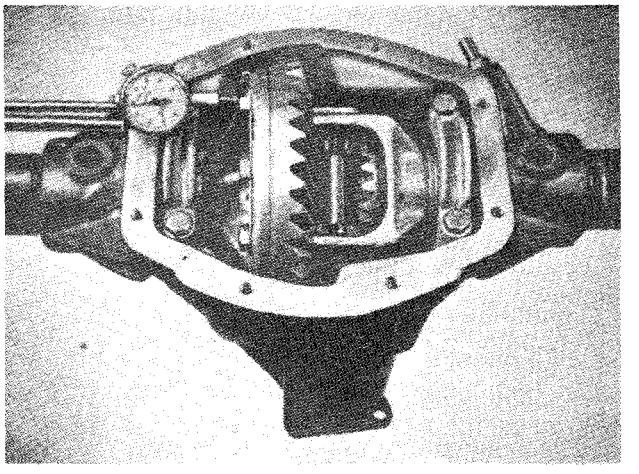

Fig. 30 Ascertaining the depth of engagement between crown wheel and pinion.

(**xviii**) The assembly is now forced away from the dial gauge until the teeth on the crown wheel go fully home with those on the pinion. The dial gauge is now set to zero and the assembly levered towards the dial gauge. Let this dimension be .045″.

(**xix**) The side float of the assembly measured in the last operation, less the crown wheel and pinion backlash specified, will indicate the shim thickness required on the crown wheel side. The backlash is specified as between .004″ and .006″ and an average figure of .005″ should be used for this calculation giving .040″ to be fitted on the crown wheel side.

(**xx**) To obtain the thickness of the shims required between the other differential bearing and casing, the figure arrived at in previous operation, *i.e.*, .040″, should be subtracted from the total side float measured in operation (**xiv**), plus an allowance of .005″ to provide the necessary degree of bearing pre-load. This gives a total shim thickness of .067″ and thus shims on two bearings will be .040″ already estimated and .067″ — .040″ = .027″ on the other side.

(**xxi**) Having decided the thickness of shims required behind each differential bearing, these bearings are extracted with the special tool shown in Fig. 31. The

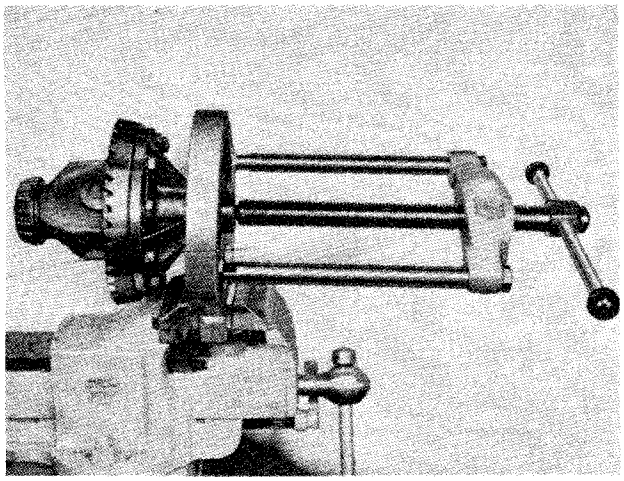

Fig. 31 Removal of the differential bearing utilising the Churchill Tool No. S103 and S4221 frame.

respective shim packs are measured with a micrometer gauge after ensuring that the shims are clean and undamaged and allocated to their respective sides of the crown wheel carrier.

(**xxii**) As each bearing is extracted, the two portions of each must be laid aside for refitting in the same relation and position as that used during initial assembly. Failure to fit these bearings in their original positions will upset the measurements made in previous operations.

(**xxiii**) Having fitted the two packs of shims in their respective positions the bearing inner cones are driven on to the carrier with a suitable sleeve tool as shown in Fig. 27 and the outer rings applied.

(**xxiv**) The differential assembly is now fitted into the axle centre casing and, owing to the pre-loading of the bearings, a certain amount of casing spreading is desirable to complete this operation. THE CASING SPREADER SHOWN IN FIG. 13 SHOULD BE USED AND THE SPREADING OF THE CASE LIMITED TO THAT JUST REQUIRED TO ENABLE THE DIFFERENTIAL ASSEMBLY TO ENTER THE CASING.

(**xxv**) The bearing caps are then fitted in their respective positions so that the number stamped on the caps coincide with those stamped on the axle casing, tightening them to their correct torque of 34—36 lbs. ft.

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(**xxvi**) The pinions and crown wheel backlash is checked with a dial gauge as shown in Fig. 32, and should be .004″—.006″: an average should be taken of several teeth.

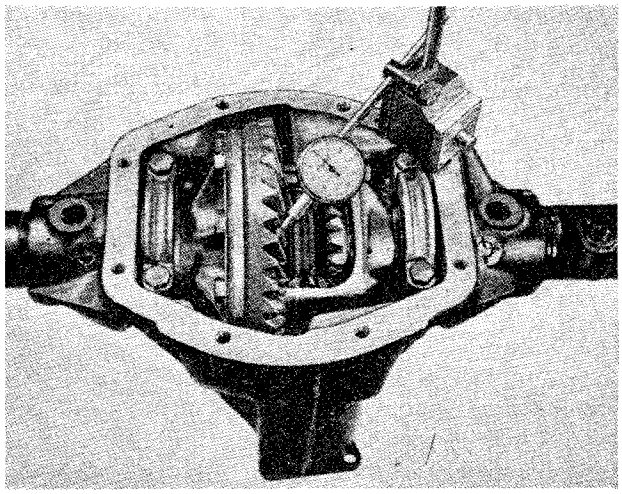

Fig. 32 Checking the back lash of the differential unit utilising a DTI.

Should the backlash be incorrect, the transfer of shims from one side of the differential carrier to the other will be necessary. If the backlash is too great, then a shim or shims will have to be taken from the side opposite the crown wheel and the same shims added to the crown wheel side, always maintaining

the same overall total. Should the backlash be insufficient, then the reverse procedure must be adopted.

(**xxvii**) A tooth marking test should now be carried out, and to enable this to be done a few teeth should be painted with a suitable marking compound. The pinion should be rotated backwards and forwards by the driving flange, over the marked teeth on the crown wheel, and the markings compared with the diagram (Fig. 33), and the instructions on this diagram regarded.

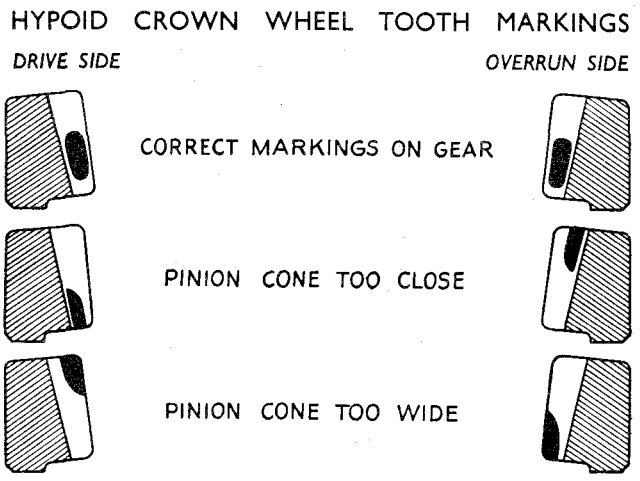

Fig. 33 **Crown wheel tooth markings.**

(**xxviii**) A new axle cover packing is fitted, together with the cover itself, and the latter secured with the eight setscrews.

(**xxix**) Drive the wheel bearings on to their respective axle shaft (Fig. 9), and assemble to the axle unit.

(**xxx**) The grease seals should now be tapped into the bearing housings (Fig. 8), and the assemblies fitted to each axle sleeve, followed by the brake backing plate and shoe assembly.

(**xxxi**) The four bolts are fitted through each bearing housing and brake backing plate, ensuring that both these items assume their appropriate relation with the axle sleeve, the nuts are screwed into position and firmly tightened.

(**xxxii**) The hubs are next fitted by means of a special tool or press (Fig. 34), and secured by the splined hub tightening cones, conical washers and hub securing nuts. A substantial spanner will be required to tighten the castellated securing nut. (A tightening torque of 110—125 lbs. ft. is specified. After axle No. TS.8039 the torque was increased to 125—145 lbs. ft. when a nut of a different material was introduced.) Having thoroughly tightened up this nut, the hole in the axle shaft is lined up with one of the slots in the castellated nut and the split pin is fitted.

(**xxxiii**) The brake drum is next fitted to each hub and secured thereto by means of the two countersunk grub screws.

(**xxxiv**) Fit wheel securing cones (wire wheel hubs only). Fig. 35.

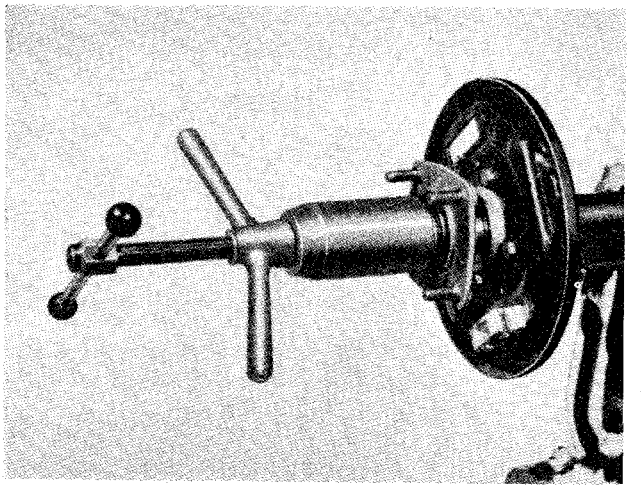

Fig. 34 **The replacing of the disc wheel type hub utilising the Churchill Hub Replacing Tool No. S125.**

12. SERVICE DIAGNOSIS

Rear axle noise is usually apparent as a hum in moderate cases or as a growl in very severe cases.

Noises from the rear wheel bearings, propeller shaft bearing or tyres is often diagnosed as rear axle troubles.

Always ascertain that the noise attributed to the rear axle does actually emanate from that unit before dismantling parts.

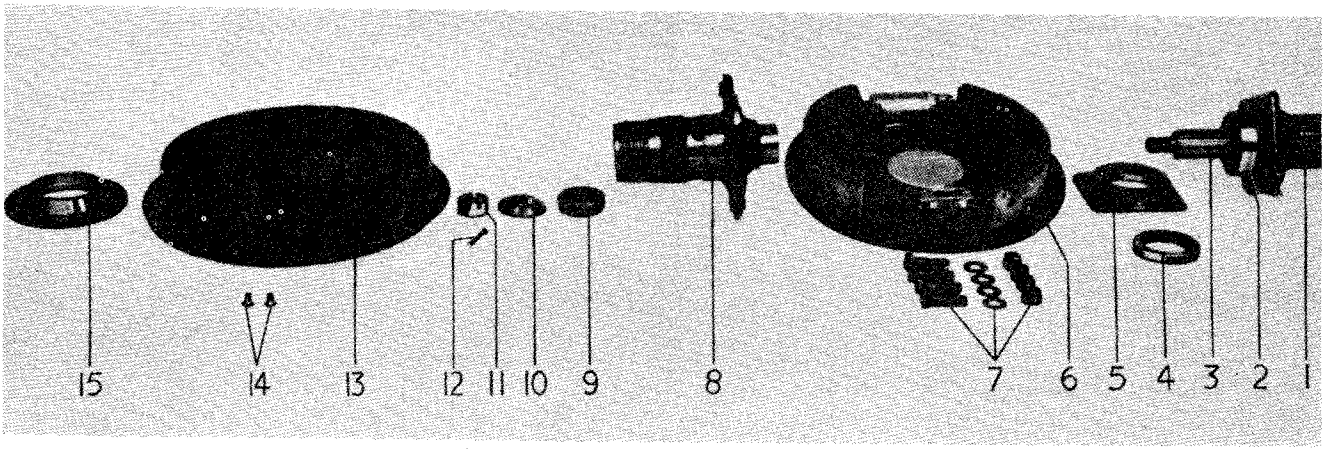

Fig. 35 "Knock on" type hub.

1. Axle casing.
2. Hub bearing.
3. Axle shaft.
4. Oil seal.
5. Seal and Bearing Housing.
6. Brake assembly.
7. Fixing bolts for brake backing plate and seal / bearing housing.
8. Hub "knock on" type.
9. Splined taper collar.
10. Washer.
11. Castellated nut.
12. Split pin.
13. Brake drum.
14. Counter sunk screws.
15. Taper collar.

F1

CAUSE	REMEDY
1. Axle Noise	
(a) Inadequate or improper lubrication.	(a) Drain, flush casing out with flushing oil and replenish with correct grade of oil. See "General Data" Section A.
(b) Teeth broken off gears.	(b) Replace damaged parts.
(c) Contact of crown wheel and pinion not correctly adjusted.	(c) Noise during coasting; move the pinion away from crown wheel. Noise during driving; move the pinion toward the crown wheel. Do not move the pinion more than .004" when making these adjustments.
2. Lubricant Leakage	
(a) Leakage in general.	(a) Reduce level of oil if overfull. Clean out breather.
(b) Leakage at hub.	(b) Clean out breather. Renew oil seal if leakage persists.
(c) Leakage at pinion head.	(c) Clean out breather. Renew oil seal if leakage persists.
3. Axle Knock	
(a) Splines on axle shafts or in differential gears badly worn.	(a) Replace worn parts.
(b) Splines on hub shell or centre of wire wheel badly worn.	(b) Replace worn parts.
(c) Incorrect shimming of planet gears in differential unit.	(c) Replace present ones in use with thicker ones.

Service Instruction Manual

G

FRONT SUSPENSION AND STEERING

SECTION G

FRONT SUSPENSION AND STEERING

FRONT SUSPENSION

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STEERING

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TELESCOPIC STEERING UNIT

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FRONT SUSPENSION AND STEERING

ILLUSTRATIONS

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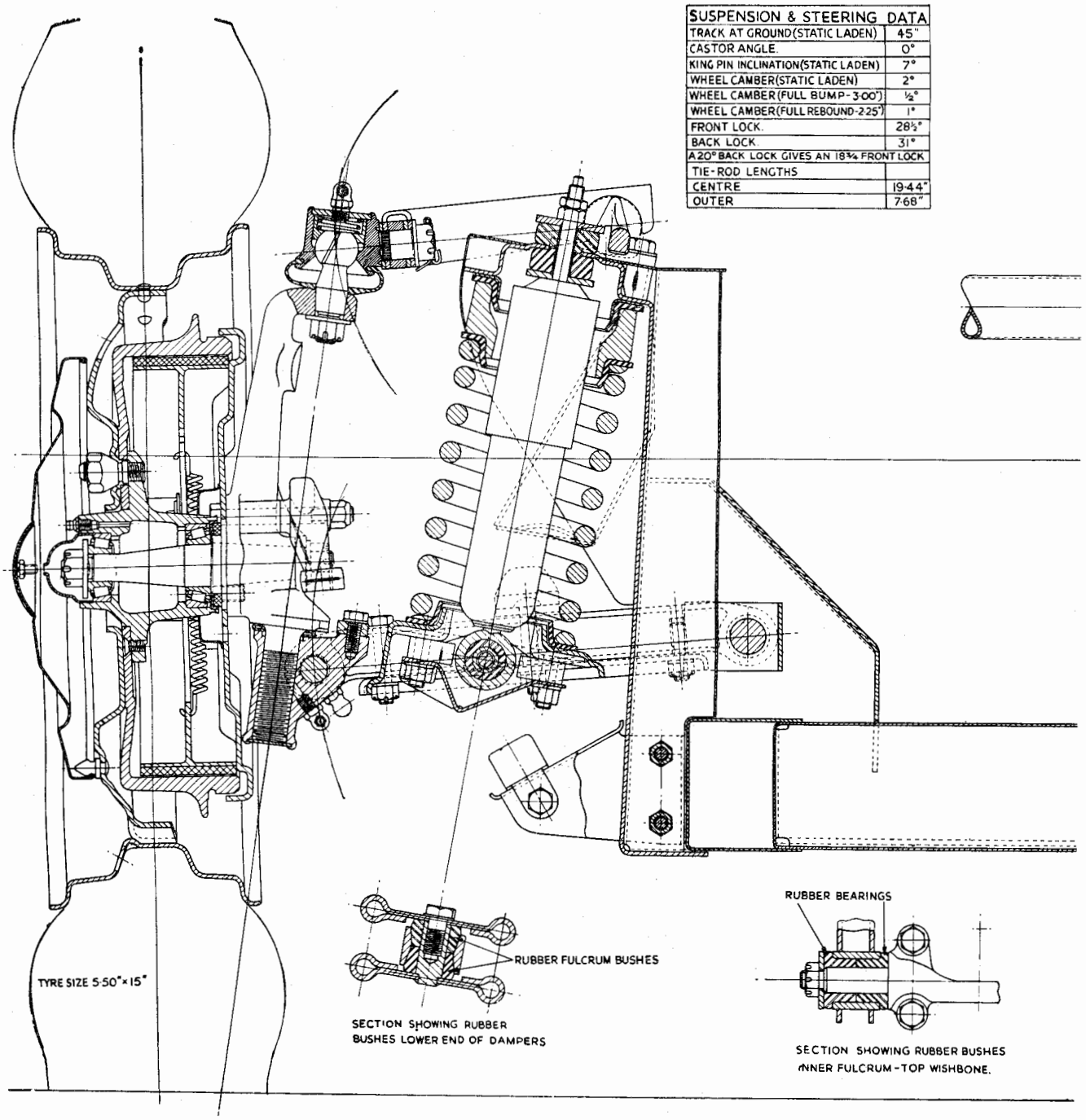
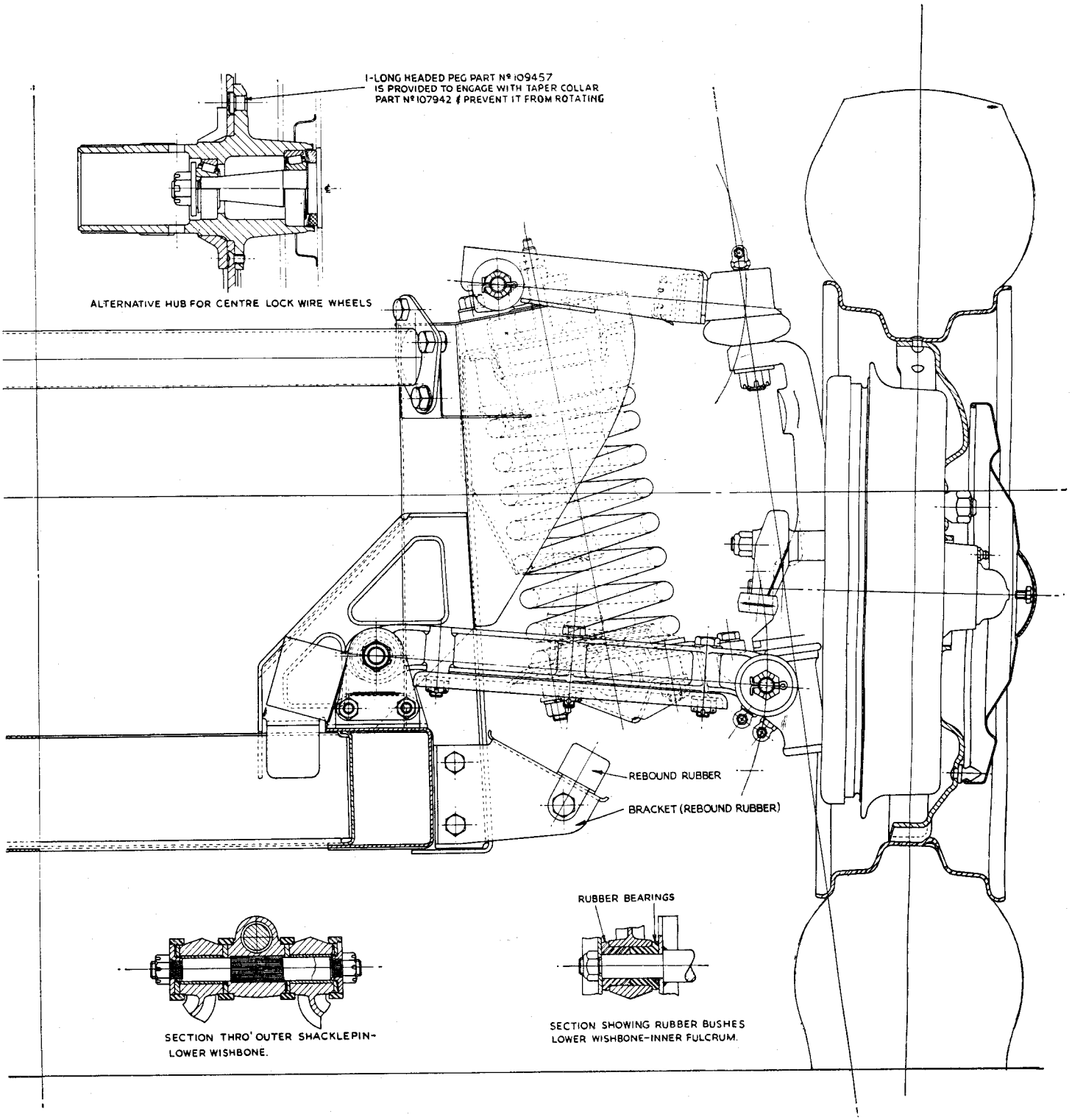


Fig. 1 Front Suspension Arrangement.


1-LONG HEADED PEG PART Nº 109457 IS PROVIDED TO ENGAGE WITH TAPER COLLAR PART Nº 107942 & PREVENT IT FROM ROTATING
ALTERNATIVE HUB FOR CENTRE LOCK WIRE WHEELS
REBOUND RUBBER
BRACKET (REBOUND RUBBER)
RUBBER BEARINGS
SECTION THRO' OUTER SHACKLEPIN-LOWER WISHBONE.
SECTION SHOWING RUBBER BUSHES LOWER WISHBONE-INNER FULCRUM.

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FRONT SUSPENSION AND STEERING

1. FRONT SUSPENSION DATA

Track at Ground (Static Laden)	45″
Castor Angle	Nil
King Pin Inclination (Static Laden)	7°
Wheel Camber (Static Laden)	2°
Wheel Camber (Full Bump 3″)	½°
Wheel Camber (Full Rebound 2.25″)	1°
Turning Circle	32′
Back Lock	31°
Front Lock	28.5°
A 20° Back Lock gives an 18.75° Front Lock.	
Front Wheel Alignment	Parallel to ⅛″ toe in
Length of Centre Tie Rod	19.44″
Length of Outer Tie Rod	7.68″
End Float of Lower Outer Shackle Pin Assembly	.004″ to .012″

2. DESCRIPTION (Fig. 1)

The two front suspension units are of wishbone construction. Road shocks are absorbed by low periodicity coil springs, each of these springs are controlled by a double acting telescopic shock absorber fitted inside the coil spring.

The upper wishbones are rubber bushed at their inner ends to a fulcrum pin which is attached to the spring housing, they are shaped to form a "U" and the outer ends are interlaced to accommodate a distance piece and are secured together by the screwed shank of a ball joint. This joint is fitted to, and provides the axial movement for, the upper end of the vertical link. The inner ends of the lower wishbone arms are rubber bushed on each side and are attached to the fulcrum pin mounted on the upperside of the chassis frame. The fulcrum is steadied at its extremities by two support brackets.

The outer ends of the wishbone arms, bushed with a Clevite bearing, are mounted on either end of a shackle pin. The shackle pin is splined centrally to fit transversely into the manganese bronze trunnion which is threaded to accommodate the lower end of the vertical link.

Each bushed end of the wishbone arms is located sideways on the shackle pin by means of a white metal covered steel thrust washer, bearing on the screwed trunnion on the inside and on the outer side against a steel washer which is secured by a split pinned castellated nut. During production the outer lower ends of the wishbone arms are assembled to the shackle pin to give an end float of .004″ to .012″. The need for adjustment should only occur when the front suspension units have been disturbed. Road dirt and weather are excluded from the grease lubricated bearings by special oil resisting rubber seals.

The screwed trunnion at the lower end and the ball joint at the upper end of the vertical link provide the bearings for the pivoting of the road wheels. Road dirt and weather are excluded from these bearings by a rubber gaiter interposed between the vertical link and the ball joint assembly at its upper end, at the lower end a circular rubber seal is fitted between the trunnion and the link. The thread of the trunnion is sealed off by a disc let into the lower end of the threaded bore. The steering lock stop consists of an eccentric roller bolted to the upper side of the trunnion and abuts against a machined face on the vertical link.

The vertical link, which couples the upper and lower wishbone arms as previously described, is a carbon steel stamping and carries the stub axle shaft, the brake backing plate and the steering lever.

The stub axle is of manganese molybdenum steel, which is mounted as a press taper fit in the vertical link, is secured by a split pin locked castellated nut.

The brake backing plate, with the brake shoes and hydraulic wheel cylinders attached, is secured to a machined flange on the vertical link by two setscrews with a lock plate at the lower two points and two bolts of unequal length at the upper two points. The longer of these bolts passes through the front bore of the brake plate, the vertical link, a distance piece and the steering lever and is secured by a nyloc nut; the shorter bolt is similarly secured and utilises the lower bore.

The front hub is mounted on a pair of opposed taper roller bearings carried on the stub axle shaft. The inner bearing abuts against a projecting shoulder on the vertical link and its outer ring against a flange machined in the hub. The outer ring of the

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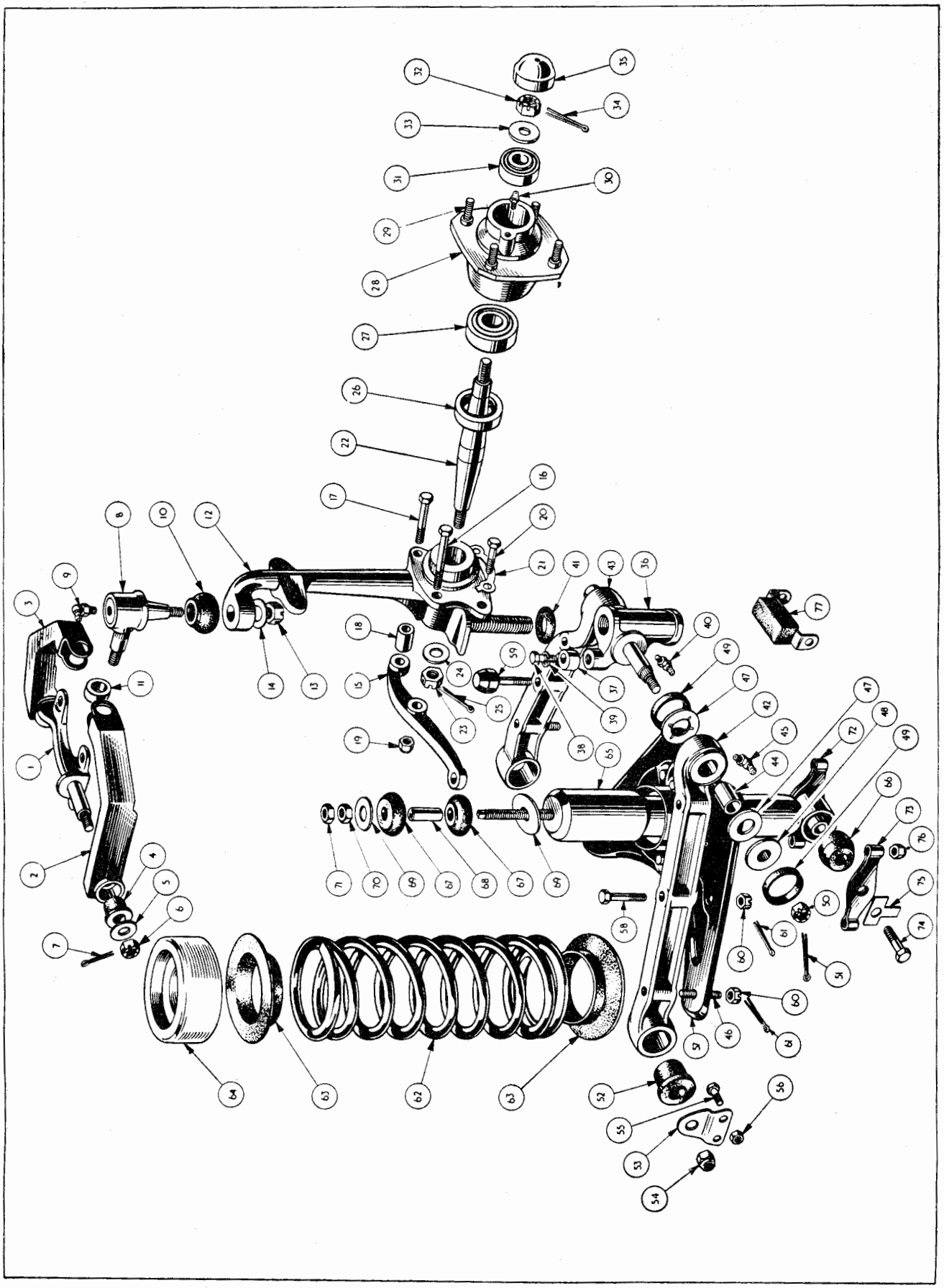

Exploded details of L.H. Front Suspension Unit.

Fig. 2

NOTATION FOR FIGURE 2

Ref. No.	Description
1.	Inner Upper Fulcrum Pin.
2.	L.H. Front Upper Wishbone Arm.
3.	R.H. Front Upper Wishbone Arm.
4.	Rubber Bush.
5.	Plain Washer.
6.	Castellated Nut.
7.	Split Pin.
8.	Upper Wishbone Ball Joint Assembly.
9.	Grease Nipple.
10.	Rubber Gaiter.
11.	Upper Wishbone Distance Piece.
12.	Vertical Link.
13.	Castellated Nut.
14.	Plain Washer.
15.	Steering Lever.
16.	Bolt.
17.	Bolt.
18.	Steering Lever Distance Piece.
19.	Nyloc Nut.
20.	Setscrew.
21.	Locking Plate.
22.	Stub Axle.
23.	Castellated Nut.
24.	Plain Washer.
25.	Split Pin.
26.	Oil Seal.
27.	Front Hub Inner Bearing.
28.	Front Hub.
29.	Wheel Stud.
30.	Grease Nipple, fitted up to Commission No. TS.5348.
31.	Front Hub Outer Bearing.
32.	Castellated Nut.
33.	"D" Washer under nut.
34.	Split Pin.
35.	Grease Retaining Cap.
36.	Bottom Trunnion.
37.	Steering Lock Stop.
38.	Bolt for Steering Lock Stop.
39.	Spring Washer.
40.	Grease Nipple.
41.	Oil Seal.
42.	L.H. Front Lower Wishbone Arm Assembly.
43.	R.H. Front Lower Wishbone Arm Assembly.
44.	Bush for Wishbone Arm.
45.	Grease Nipple.
46.	Spring Pan Studs
47.	Thrust Washer.
48.	Lock Washer.
49.	Grease Seal.
50.	Castellated Nut.
51.	Split Pin.
52.	Rubber Bush.
53.	Support Bracket.
54.	Nyloc Nut.
55.	Bolt.
56.	Nut.
57.	Lower Spring Pan Assembly.
58.	Bolt.
59.	Bump Rubber.
60.	Castellated Nut.
61.	Cotter Pin.
62.	Front Road Spring.
63.	Rubber Washer.
64.	Packing Piece.
65.	Shock Absorber.
66.	Lower Rubber Mounting.
67.	Upper Rubber Mounting.
68.	Metal Sleeve.
69.	Washer.
70.	Nut.
71.	Lock Nut.
72.	Shock Absorber Bracket and Fulcrum Pin.
73.	Shock Absorber Bracket.
74.	Setscrew.
75.	Tab Washer.
76.	Nut.
77.	Rebound Rubber.

outer bearings bears against the flange machined in the hub and the inner cone of the race against a "D" washer, all are secured to the stub axle by a castellated nut and split pin. These bearings are adjusted by the castellated securing nut but are not pre-loaded.

Provision is made against the loss of grease by fitting a felt washer between the vertical link and inner bearing.

3. MAINTENANCE

The maintenance necessary is largely confined to periodical greasing (see Lubrication Chart in General Data Section "A".

The hub bearings are not pre-loaded and it will be necessary to ensure this condition is attained when carrying out adjustments (see page 7).

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As a precautionary measure it is most desirable to check that an end float of .004″ to .012″ in the lower outer wishbone arm attachment to the shackle pin is maintained. Each arm is adjusted independently. Apart from damage at this point, tightness at this point can appreciably affect the ride of the car (see page 12, para. xii).

Front wheel alignment of parallel to $\frac{1}{8}$″ toe in should be checked if the front wheel alignment is in doubt (see below).

4. FRONT WHEEL ALIGNMENT

The track should be between parallel and $\frac{1}{8}$″ toe in.

The outer tie rods are adjustable for length and usually to give the correct track the distance between the centres of the ball joint assembles will be 7.68″.

If the wheel alignment is in doubt and a check is to be made it will be necessary to satisfy the following initial requirements :

(**a**) Tyre pressures are correct for all tyres.

(**b**) The amount of wear on both front tyres must be the same.

(**c**) The front wheels are true and in balance.

(**d**) The checking floor must be level.

(**e**) The car is in the static laden condition.

5. TO ADJUST FRONT WHEEL ALIGNMENT

(**a**) With the car satisfying the initial requirements, set the front road wheels in the straight ahead position and push the car forward a short distance.

(**b**) Check the alignment of the wheels with a Dunlop Optical Gauge or similar instrument.

(**c**) If only a fractional correction is necessary it can be made on the outer tie rod on the opposite side to the steering box.

(**d**) To carry out this adjustment it is first necessary to loosen the two lock nuts and turn the tube to shorten or lengthen the tie-rod assembly. Lock the tube by the two nuts and move the car forward half a revolution of a wheel and check, and make a further adjustment if necessary.

(**e**) If an appreciable amount of maladjustment has to be corrected, check first the length of the outer tie-rods. Should these lengths be equal make the necessary correction to both. When they are found to be of unequal length first correct the rod nearest the steering box to 7.68″ and then make any adjustment to the further one. After making such adjustments it is a wise precaution to measure the length and if found to differ greatly from 7.68″ the front suspension should be checked for accidental damage.

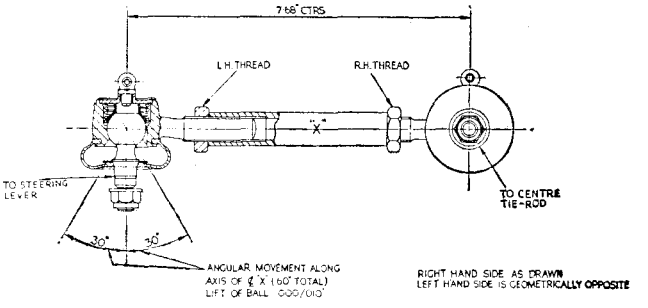

Fig. 3 **Outer Tie Rod Assembly.**

6. STEERING LOCK STOPS

The steering lock stop consists of an eccentric roller mounted on each bottom trunnion by means of a setscrew and lock washer.

It is most important that the steering lock stops come into action before the conical peg of the rocker shaft follower reaches the end of its cam path. This movement is not more than 33° either side of the mid point of the cam and will allow the steering wheel to travel approximately $2\frac{1}{4}$ turns from lock to lock.

The correct adjustment of the lock stops should allow a "Back lock" of 31° and a "Front lock" of $28\frac{1}{2}$°.

When checking this adjustment it is necessary to satisfy the following initial requirements.

(**a**) The tyre pressures must be correct for all four tyres.

(**b**) The testing ground must be flat.

(**c**) Car must be in the static laden condition.

7. TO SET STEERING LOCK STOPS

(**a**) Select a space of level ground and run the car gently forward so that the front wheels run on to the Churchill Turning measure and the back wheels on to blocks as high as the Churchill gauge (Fig. 4).

This will ensure that the car maintains its level.

(**b**) Measure the wheel movement from the straight ahead position.

(**c**) Adjust the eccentric roller by first loosening the setscrew and then turn the roller itself.

(**d**) When the correct degree of adjustment is attained, tighten down the setscrew so that the roller will remain in contact with the vertical link.

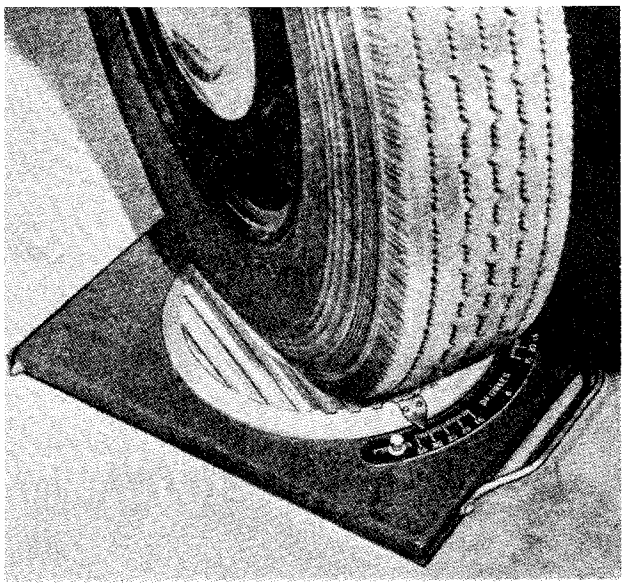

Fig. 4 Showing Use of Wheel Turning Measure for setting Steering Lock—V.L. Churchill Turning Measure Tool No. 121U.

NOTE: If it is impossible to obtain the correct lock positions by adjustment of the steering lock stop, this condition will indicate either a damaged steering drop arm, steering lever, or in rare cases, a fault in the steering unit. Where such difficulties do arise steps must be taken to diagnose the cause and necessary replacements fitted.

8. TO REMOVE FRONT HUB AND STUB AXLE

(**a**) Jack up the front of the car, remove nave plate and road wheel.

(**b**) Remove grease retaining cap and grease nipple from end of hub. Grease nipples were discontinued after Commission No. TS.5348.

(**c**) Withdraw split pin and remove castellated nut and washer from end of stub axle.

(**d**) Remove hub, utilising Churchill Hub Removing Tool No. M.86 or S.132.

(**e**) The outer hub bearing can be removed when the hub is released from the hub remover.

(**f**) Remove the four nuts, spring washers and bolts securing the hub grease catcher to the brake backing plate.

(**g**) Remove the inner wheel bearing from the stub axle, followed by the grease seal.

(**h**) The stub axle can be removed from the vertical link if so desired by the removal of the split pin, castellated nut and plain washer from the inner side of the vertical link.

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9. TO REPLACE FRONT HUB AND STUB AXLE

(**a**) Fit the stub axle to the vertical link and secure with the plain washer, castellated nut locked by a split pin on the inner side of the vertical link.

(**b**) Seat the grease seal on its spigot of the vertical link with the felt pad towards the centre of the car, followed by the inner wheel bearing.

(**c**) Place the hub grease catcher in position in such a manner that the shaped end of the pressing is below the vent hole in the brake backing plate. Secure grease catcher to backing plate with four screws, spring washers and nuts.

(**d**) Fit the hub and outer bearing followed by the "D" aperture washer and attach castellated nut.

Adjustment of the Front Hubs

These front wheel bearings should **not** be pre-loaded.

(**e**) The castellated nut should be tightened to a torque loading of 10lbs. ft. and then slackened off $1\frac{1}{2}$ to 2 flats according to the position of the split pin hole.

The hub bearings are now considered to be correctly adjusted and the castellated nut can be locked with the split pin.

(**f**) Fit the grease retaining cap and grease nipple to hub, and grease hub.

(**g**) Replace road wheel and nave plate. Remove lifting jack from under front of car.

10. TO REMOVE FRONT SHOCK ABSORBER

(**a**) Jack up the car, place supporting stands under the chassis frame and remove lifting jack. Remove road wheel.

(**b**) Partially compress the front road spring by placing a small lifting jack under the spring pan.

(**c**) Remove the lock nut and nut from upper end of shock absorber, followed by a plain washer and upper rubber mounting.

(**d**) Detach the rebound rubber and its bracket from the side of the chassis frame after removing the nuts, lock washers and two long bolts.

(**e**) Remove the lifting jack from below the spring pan.

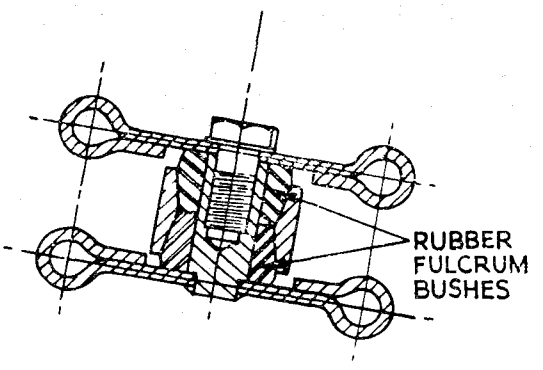
(**f**) Remove the four nuts and lock washers from the underneath and centre of the spring pan. After withdrawing the rebound rubber abutment plate the shock absorber can be withdrawn through the spring plate.

(**g**) After removing the shock absorber from the car, its lower attachment brackets can be removed. Lift the tabs of the locking plate and remove the setscrew followed by one bracket and a rubber bush.

(**h**) The second bracket is removed from the shock absorber together with the rubber bush, the latter can be withdrawn from the fulcrum pin of the bracket assembly.

11. TO FIT SHOCK ABSORBER

(**a**) Examine all rubber bushes to ascertain that they are in good order. Also ensure that the fulcrum pin is securely welded to the shock absorber attachment bracket.



SECTION SHOWING RUBBER BUSHES. LOWER END OF DAMPERS.

Fig. 5 Section showing Rubber Bushes at lower end of Dampers.

(**b**) Press a rubber bush on to the fulcrum pin attachment bracket and feed this assembly, bush first, into the eye of the shock absorber. Press a second rubber bush on to the protruding fulcrum pin.

(**c**) Position second attachment bracket with the tab washer and secure with the setscrew. Turn over tab of washer.

(**d**) Place a large plain washer in position on the upper end of the shock absorber followed by a rubber mounting (spigot uppermost) with the metal sleeve in its centre.

(**e**) Feed the shock absorber assembly through the spring pan in such a manner that the two attachment brackets locate on the studs of the spring pan assembly and at the same time the upper attachment will pass through the spring abutment on the chassis frame. It may be necessary to compress the road spring by placing a jack under the lower wishbone assembly.

(**f**) Attach the second rubber mounting (spigot downwards) to the upper end of the damper which is protruding through the chassis frame, threading it on to the metal sleeve and followed by the plain washer and securing nut.

(**g**) Tighten this nut sufficiently to nip the plain washers and metal sleeve and lock with a second nut.

(**h**) Place the rebound rubber abutment plate in position on the lower attachment studs (welded to the spring pan) with the apex of the wedge pointing towards the centre of the car. Secure with nuts and lock washers.

(**i**) Utilising two long bolts, nuts and lock washers secure the rebound rubber and its bracket to the chassis frame.

(**j**) Remove the lifting jack from under the lower wishbones and replace the road wheel.

(**k**) Jack up front of car to remove support stands, finally remove jack.

12. TO REMOVE FRONT ROAD SPRING

(**a**) Remove front shock absorber as described on page 8.

(**b**) Withdraw the split pins from the castellated nuts on the underside of the lower wishbones. Remove the centre nut and bolt from the front wishbone arm and the bump rubber assembly from the rear wishbone arm. Feed two guide pins into the vacant holes.

(**c**) Place a small lifting jack under the spring pan, with a suitable packing between jack and pan to prevent damage to the shock absorber attachment studs on the latter.

(**d**) Remove the four remaining nuts securing the spring pan to the wishbone arms and lower jack, easing the guide pins through the wishbone arms.

(**e**) The spring can be withdrawn from its upper abutment together with rubber washers and distance piece.

An alternative method is to utilise the Churchill Tool, No. M50 in the following manner :—

(**a**) Carry out operation (**a**) and (**b**) as previously described.

(**b**) Remove the fly nut, bearing and plate from the threaded rod of the Churchill Tool followed by the "C" washer.

(**c**) Feed the rod, notched end first, through the spring pan and upper shock absorber abutment, to the protruding end fit the "C" washer.

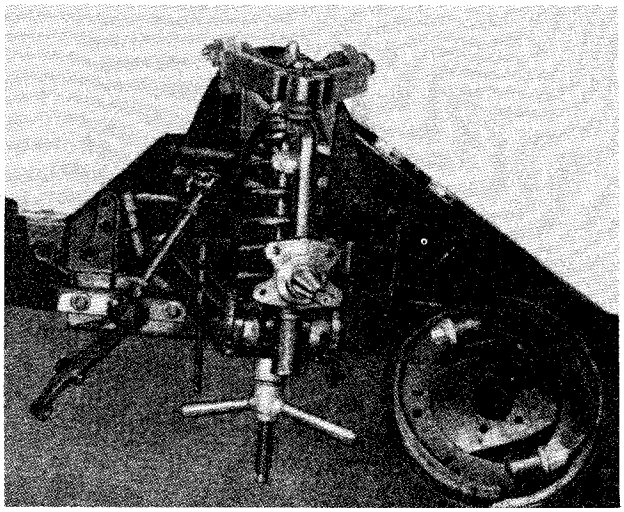


Fig. 6 Front Road Spring being removed, utilising the Churchill Tool No. M.50.

(**d**) Feed the plate on to the threaded portion of the rod protruding from the spring pan in such a manner that the bearing seat is downwards, ensure too that the holes in the block locate on the studs of the spring pan.

(**e**) Feed bearing on to threaded rod followed by the fly nut, tighten to compress spring a small amount.

(**f**) Remove the four remaining nuts securing the spring pan to the wishbone arms.

(**g**) By slowly unscrewing the fly nut the spring pan can be lowered down the guide pins.

(**h**) When all tension is released from the road spring the guide pins and the "C" washer can be removed from the upper end of the shaft.

(**i**) Withdraw the Churchill Tool from the suspension unit together with the spring pan, spring, rubber washers and distance piece.

13. TO FIT ROAD SPRING

(**a**) Attach the rod of the Churchill Tool No. M50 to the spring abutment bracket of the front suspension unit and fit the guide pins through the centre holes of the lower wishbone arms.

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(**b**) Assemble the alloy distance piece (spigot downward) on the road spring with a rubber washer interposed between, and position a second rubber washer on the spring's lower extremity.

(**c**) The spring and distance piece assembly is offered up to the front suspension unit followed by the spring pan, the latter located on the guide pins.

(**d**) Fit the plate to the threaded rod of the Churchill Tool in such a manner that the bearing will seat in its recess and the studs of the spring pan in their recesses. Follow with the bearing and fly nut.

(**e**) The fly nut of the tool is turned to compress the spring. Ensure that, when the spring pan closes to the wishbone arms that it is located on the attachment studs at the inner ends of the wishbone. Secure and lock washers and castellated nuts and fit two bolts with castellated nuts and lock washers at the trunnion end of the wishbone arm.

(**f**) When the spring pan is secured to the wishbone arms the Churchill Tool can be removed and the guide pins withdrawn from the wishbone arm.

(**g**) The spring pan is finally secured to the wishbone arms by a nut, bolt and lock washer at the front arm and a bump rubber assembly at the rear arm.

Lock all six nuts with split pins.

(**h**) The shock absorber can now be fitted as described on page 8.

14. TO REMOVE AND DISMANTLE FRONT SUSPENSION UNIT

Before dismantling the units, suitably mark the components so that they can be returned to their relative positions.

Carry out instructions as detailed for "To Remove Front Hub and Stub Axle," page 7, and "To remove Front Road Spring," page 9, then proceed as follows :—

(**a**) Drain the hydraulic system and disconnect the flexible hose as described in Brakes, Section " R." Remove the grease catcher by removing four nuts and bolts. Release the tabs of the locking plates and withdraw the lower two of the four bolts securing the brake backing plate to the vertical link, followed by the upper two bolts. These bolts pass through the vertical link and distance pieces and thence through the steering lever, on the withdrawal of these bolts it will be necessary to hold the steering lever and collect the bushes. Alternately the brake plate can be removed from the vertical link without draining the system. (Fig. 7).

(**b**) Remove the nyloc nuts from the ends of the lower wishbone fulcrum pin, followed by the nuts, bolts and lock washers securing the fulcrum pin support brackets to the chassis frame. The support brackets can now be removed.

(**c**) Remove the split pins from the outer ends of the lower shackle pins. Remove the castellated nuts, grease seals and washers from both ends of the shackle pin.

(**d**) The wishbone arms can now be removed and the thrust washer and grease seal withdrawn from the shackle pin.

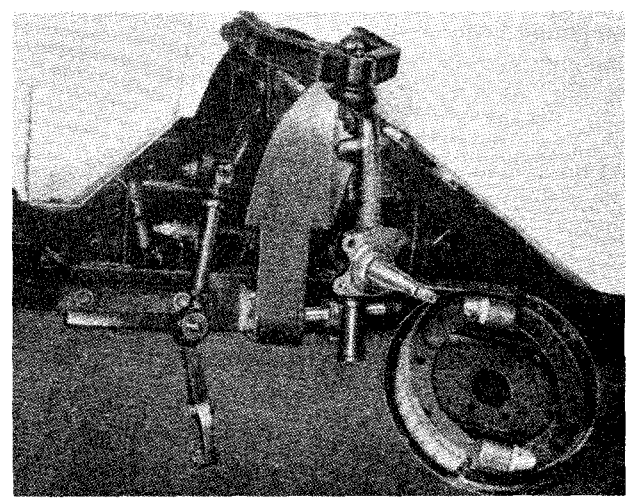


Fig. 7 The Front Suspension Unit partially dismantled.

(**e**) Remove the two bolts, nuts, plain and locking washers, followed by the two setscrews and spring washers, from the upper fulcrum pin.

(**f**) The front suspension unit can now be lifted away from the car.

(g) Withdraw the split pin from the castellated nut securing the ball joint assembly to the upper wishbone arm. Remove the castellated nut and withdraw the ball joint assembly from the wishbone arms, collecting the distance piece as the ball joint is moved.

(h) Withdraw the split pin and remove the nut and plain washer securing the ball joint assembly to the vertical link and withdraw ball joint.

(i) Withdraw the split pins from the castellated nuts at the outer ends of the upper inner fulcrum pin. Remove the large diameter plain washers and the outer rubber bushes.

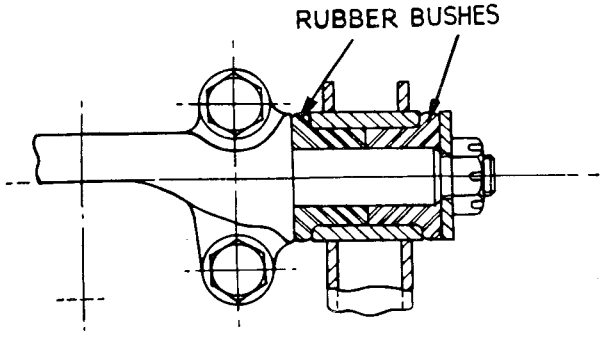
(j) The wishbone arms can now be removed and the second rubber bush withdrawn from the fulcrum pin.

(k) Remove the steering stop screw from the lower end of the vertical link and detach the bottom trunnion assembly from the vertical link and collect the oil seal situated between the vertical link and the trunnion assembly.

15. TO ASSEMBLE AND REPLACE FRONT SUSPENSION UNIT

Assembly is made with strict regard to the markings on certain parts to ensure that they are returned to the same relative position.

(i) Fit a rubber bush to each end of the upper fulcrum pin.



SECTION SHOWING RUBBER BUSHES.
INNER FULCRUM-TOP WISHBONE.

Fig. 8 A section showing the rubber bushes of the Upper Wishbone Inner Fulcrum.

(ii) Feed the fulcrum pin into the upper wishbone arm, press the second rubber bush into the wishbone and fit the large plain washer followed by the castellated nut. This nut should be left loose at this juncture.

(iii) While similarly fitting the second wishbone arm ascertain that the other ends of the arm are positioned correctly to receive the ball pin assembly and distance piece. With the ball pin assembly toward the operator the wishbone flange on the right overlaps the one on the left. This applies to both left and right suspension units.

(iv) Feed through the upper attachment of the ball joint assembly with the distance piece between the wishbone arms and secure with the plain washer and castellated nut locked by the split pin. Tighten castellated nuts of inner upper fulcrum pins and lock with split pins.

(v) Fit the ball pin taper into the vertical link with the rubber gaiter in position and secure with the plain washer and castellated nut. Fit split pin in nut.

(vi) Offer up the inner upper fulcrum pin to the chassis frame and secure by bolts with a plain washer under its head and a lock washer with the nut at the points near the centre line of the car. Setscrews and lock washers are used for the attachment points nearer the ball joint assembly.

(vii) Ascertain that the shackle pin of the bottom trunnion assembly is mounted centrally. This pin is a press fit in the body of the casting and is prevented from turning by the imbedding of the splines, it can be centralised by the use of a press or gentle tapping with a copper faced mallet.

(viii) Fit the rubber sealing ring to the lower end of the vertical link followed by the bottom trunnion assembly, which is a screw fit on the vertical link. The trunnion is screwed home and then turned back approximately one turn so that the shackle pin lies parallel to the fore and aft line of the car but between the base of the vertical link and the chassis frame.

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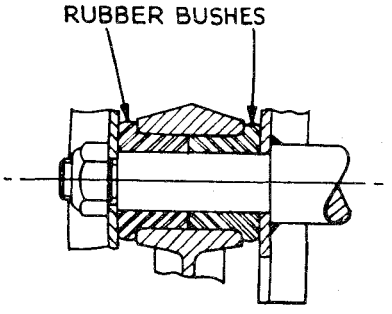
(ix) Feed the locking washer and steering lock stop bush on to the steering stop securing bolt and attach to the bottom trunnion assembly. The bolt is left finger tight at this juncture.

(x) Fit two rubber bushes to the inner lower fulcrum pin situated on the upper face of the chassis frame, one to each side.

(xi) Fit two thrust washers to the shackle pin, one to each side, followed by the grease seal.

(xii) The lower wishbone arms are now fitted over the rubber bushes on the inner fulcrum pin and on to the shackle pin simultaneously. Fit a second pair of rubber bushes on to the inner fulcrum pin (and into the lower wishbone arm) followed by the support bracket, the two holes of which are lowermost. Secure with the nyloc nut but do not fully tighten at this juncture.

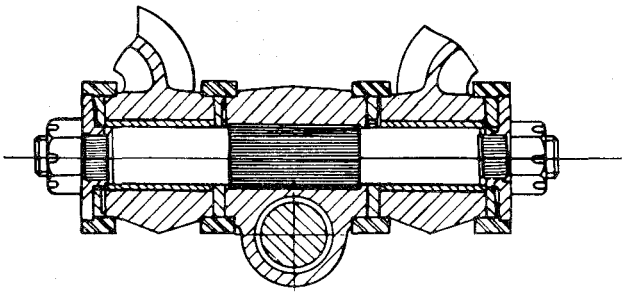


SECTION SHOWING RUBBER BUSHES LOWER WISHBONE–INNER FULCRUM.

Fig. 9 Section showing Rubber Bushes at Lower Wishbone—Inner Fulcrum.

(xiii) Secure the support brackets to the brackets welded to the chassis frame utilising bolts, nuts with lock washer. Tighten the nyloc nuts of the inner lower fulcrum pins until they are solid.

(xiv) Fit to both ends of the shackle pin at the outer end of each wishbone arm, a thrust washer followed by a special lock washer (collar inwards) followed by the rubber grease seals. These lock washers are prevented from rotating by self cutting splines. Feed on the castellated nuts to the ends of the shackle pin and obtain the necessary end float before locking with the split pin.



SECTION THRO' OUTER SHACKLEPIN-LOWER WISHBONE.

Fig. 10 A section through Outer Shackle-pin and lower wishbone bearings. End float in these bearings must be .004″ to .012″.

(xv) It is essential to have .004″ to .012″ end float for the outer boss of each lower wishbone arm. As it is not possible to ascertain the end float by the usual method owing to the presence of the rubber grease seals, the following procedure is suggested.

(a) Equal tightening should be applied to the two castellated nuts and continued until the assembly is solid.

(b) The nuts should then be turned back $1\frac{1}{2}$—2 flats according to the position of the split pin hole and then split pinned.

(c) The wishbone arms should then be lightly tapped outwards to displace the lock washers (now a splined fit to the shackle pin) and this should be carried out alternately on each arm to avoid altering the relationship of the shackle pin and trunnion.

(d) This method will give the recommended end float but as a final precaution the assembly should be checked for freedom of movement over its full range of operation before fitting the road spring.

Apart from damage at this point, tightness will affect the ride of the car.

(**xvi**) Attach the rod of the Churchill Tool No. M.50 to the spring abutment bracket and the guide rods through the centre of the lower wishbone arms.

(**xvii**) Assemble the alloy distance piece (spigot downward) on the road spring with a rubber washer interposed, fit a second rubber washer to the lower extremity of the road spring.

(**xviii**) The spring and distance piece assembly is offered up to the front suspension unit followed by the spring pan, the latter being located on the guide pins. It will be found that the rod of the Churchill Tool No. M.50 protrudes downward from the unit. Fit the plate to this rod in such a manner that the clamp bearing will seat in the recess and the studs of the spring pan fit into their recesses.

(**xix**) The fly nut of the tool can now be turned to compress the spring. Ensure that, as the spring pan closes to the wishbone, it is located on the attachment studs. Attach the lock washers and castellated nuts to the studs and fit the two bolts, lock washers and castellated nuts adjacent to the bottom trunnion assembly.

(**xx**) When the spring pan is secured to the wishbone arms the Churchill Tool can be removed.

(**xxi**) Remove the guide pins from the centre holes and fit the bump rubber assembly to the rear wishbone arm and secure with a lock washer and castellated nut. Fit bolt, lock washer and castellated nut to vacant hole in front wishbone arm. Lock all six nuts with split pins.

(**xxii**) Fit the shock absorber as described on page 8.

(**xxiii**) Ensuring that the taper bore of the vertical link and the taper of the stub axle are perfectly clean, feed axle into link and secure with plain washer, castellated nut and lock with a split pin.

(**xxiv**) Place the brake backing plate in position on the vertical link and secure by the lower bolt holes first, utilising two short setscrews and a locking plate. Through the upper holes of the brake backing plate feed the longer of the two remaining bolts, on to the shank of these bolts protruding inwards through the plate and vertical link feed a distance piece (one to each bolt). Selecting the correct steering lever, it must point forward and downward when fitted, fit this also on the protruding bolts and secure with two nyloc nuts. Finally tighten the lower pair of setscrews and turn up tabs of locking plate.

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(**xxv**) Check that the length of outer tie-rod is correct and then connect the outer tie-rod to the steering arm and secure with the nyloc nut with plain washer.

(**xxvi**) Connect the flexible hose to the hydraulic line as described in "Brakes Section R".

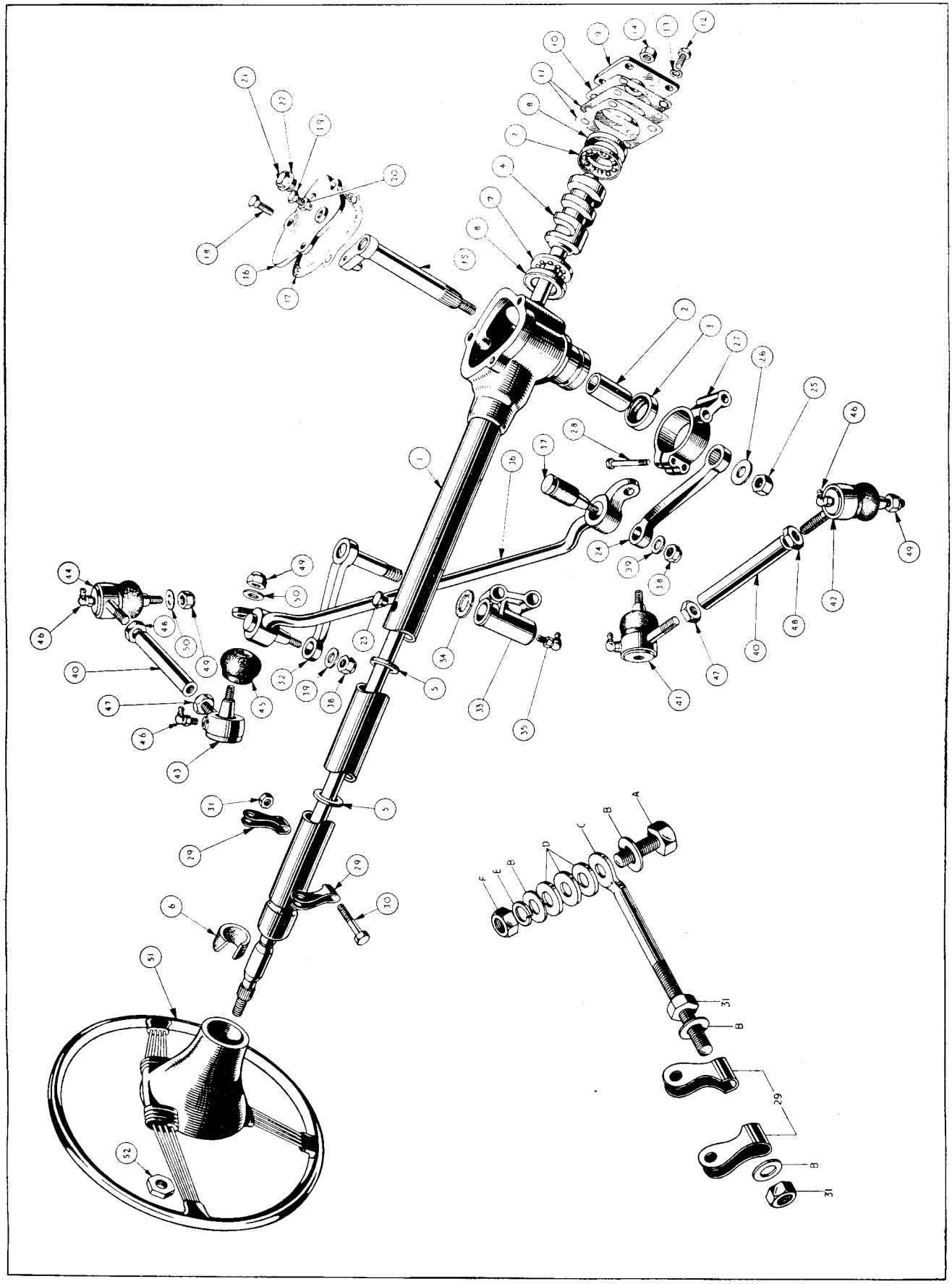
(**xxvii**) Fit the hub bearings and hub as described on page 7.

(**xxviii**) Bleed the hydraulic system if the system has been drained and adjust brakes.

(**xxix**) Fit road wheels, nave plate and remove jacks.

(**xxx**) Check front wheel alignment as described on page 6.

(**xxxi**) Set the steering lock stop (see page 6).



Exploded view of Steering Details.

Fig. 11

STEERING

NOTATION FOR FIGURE 11

Ref. No.	Description	Ref. No.	Description
1.	Outer Tube and Box Assembly.	30.	Bolt.
2.	Rocker Arm Bush.	31.	Nut.
3.	Rocker Arm Oil Seal.	32.	Idler Lever
4.	Inner Column and Cam.	33.	Idler Bracket.
5.	Rubber Ring.	34.	Oil Seal.
6.	Felt Bush.	35.	Grease Nipple.
7.	Inner Column Ball Cage.	36.	Centre Tie-rod.
8.	Ball Cage Race.	37.	Silentbloc Bush and Fulcrum Pin.
9.	End Cover.	38.	Nyloc Nut.
10.	Joint Washer.	39.	Plain Washer.
11.	Adjusting Shims.	40.	Tie-rod.
12.	Bolt.	41.	R.H. Inner End Assembly.
13.	Lock Washer.	42.	R.H. Outer End Assembly.
14.	End Plate Gland Nut.	43.	L.H. Inner End Assembly.
15.	Rocker Shaft Assembly.	44.	L.H. Outer End Assembly.
16.	Top Cover.	45.	Rubber Gaiter.
17.	Joint Washer.	46.	Grease Nipple.
18.	Bolt.	47.	R.H. Threaded Lock Nut.
19.	Rocker Shaft Adjusting Bolt.	48.	L.H. Threaded Lock Nut.
20.	Lock Nut.	49.	Nyloc Nut.
21.	Oil Filler.	50.	Plain Washer.
22.	Washer.	51.	Steering Wheel.
23.	Rubber Plug.	52.	Steering Wheel Nut.
24.	Drop Arm.	A.	Bolt
25.	Nut.	B.	Plain Washer
26.	Lock Washer.	C.	Tie Rod
27.	Trunnion Bracket.	D.	Thick Washers
28.	Bolt.	E.	Lock Washer
29.	Steering Column Clamp.	F.	Nut

Fitted in place of 30 after Comm. No. TS. 1390. See page 20.

GI

1. TYPE AND DESCRIPTION

The steering gear is of the cam and lever type with a ratio of 12 to 1. The rocker shaft travel should be limited to 33° either side of the mid point of the cam by the steering lock stops and this will allow the steering wheel to travel approximately $2\frac{1}{4}$ turns from lock to lock. The cam takes the form of a spiral, whilst the lever carries a conical shaped peg which engages in this cam.

As the conical peg does not reach the bottom of the spiral cam the depth of engagement can be adjusted. This is effected by a hardened steel setscrew mounted on the top cover, the screw when turned clockwise contacts the lever's upper face and holds the conical peg in engagement with the cam.

The steering gear is a self contained and oil tight unit. The cam attached permanently to the inner column which in turn is mounted on caged ball bearings immediately above and below the cam, with a graphite impregnated bearing at its other end.

The lever, to which the conical shaped peg is attached, is an integral part of the rocker shaft assembly and the latter is mounted in a plain bearing, the bore has an oil seal fitted at its lower extremity. The shaft which protrudes through the case is splined to receive the drop arm.

The stator tube which carries the control wires of the electric horn and flashing indicators is held in position by the bottom cover plate, a gland nut and an olive, the latter also provides an oil tight seal.

The unit is attached to the chassis frame by a trunnion bracket at its lower end and braced in the body of the car to the facia panel.

2. MAINTENANCE

An oil filler is provided in the form of a rubber plug, which is located on the steering column at approximately 12″ from the steering box.

A high pressure oil should be used for replenishment. (See Lubrication Chart for Recommended Lubricants.)

The felt bush in the top of the column outer tube is graphite impregnated and should, therefore, require no additional lubrication. If owing to extreme climatic conditions a "squeak" should develop in the bush, extra lubrication should be by colodial graphite. Oil should not be used since it tends to make the bearing "sticky."

An occasional check for tightness should be made to the steering drop arm, the ball joints and also the steering box securing bolts.

Adjustment of the steering box can be affected in two ways, firstly by shims interposed between the steering box and its end cover, and secondly by a setscrew mounted in the top cover.

3. ADJUSTMENT OF STEERING BOX

Means of adjustment to take up wear is provided at two points, both of which are accessible with the steering column in position.

The **FIRST** means of adjustment is made by adding to, or taking from, the shim pack located between the end cover and the steering box. (See Note).

The thickness of the shim pack controls the amount of "float," or pre-load, of the inner column.

While a slight amount of pre-load is permissible, in no circumstances must there be any end float.

The second means of adjustment is by a hardened setscrew and locknut, situated on the top cover plate.

This screw controls the amount of lift in the rocker shaft and is adjusted with the rocker shaft in the centre of the box, that is, the straight ahead position.

The cam gear, which is integral with the inner column, is similar in shape to a spiral cam, having a greater diameter at its centre than at its extremities.

When adjusting the rocker shaft it will be noticed that at the extremities of the arc through which the rocker shaft moves, a certain amount of lift can be felt, and as the shaft moves to the centre, the amount of lift is progressively reduced.

The correct adjustment of the rocker shaft is when on turning the steering wheel from lock to lock, a very slight resistance is felt at the centre of the travel.

The point of resistance should correspond with the straight ahead position of the steering.

NOTE : The adjustment of the rocker shaft should only be made after ensuring that **NO** end float exists in the inner column.

4. TO REMOVE CONTROL HEAD FROM STEERING WHEEL

(**a**) Disconnect the horn and flasher control wires at the "snap connectors" situated on the wing valance. Suitably identify these wires for subsequent reconnection if the colouring is not distinguishable.

(**b**) Slacken off the gland nut which secures the stator tube to the end cover of the steering box.

(**c**) Slacken the three grub screws which are situated radially in the steering wheel hub.

(**d**) Withdraw the control head and stator tube from the steering column.

(**e**) The stator tube can now be withdrawn from the control head. These components are a slide fit just below the control head.

5. TO FIT CONTROL HEAD AND STATOR TUBE TO THE STEERING WHEEL

(**a**) Place the steering wheel in the straight ahead position. This position can be checked by inspecting the alignment of all four wheels.

(**b**) Feed the stator tube, with the anti-rattle springs in position, into the inner column of the steering unit with the tube slot uppermost and at the 12 o'clock position. Allow approximately 1 inch of tube to protrude from the end cover of the steering box.

(c) Fit the brass olive to the protruding stator tube and secure with the gland nut. Loosen nut back one turn, this is retightened in a later operation.

(d) Feed the wires from the short tube of the control head into and through the stator tube now in the steering unit. With the flasher control lever of the head at 12 o'clock ensure that the vertical lever of the stator tube plate is at the 6 o'clock position. Failure to observe this point will mean that the flashing indicators will not cancel correctly.

(e) Secure the control head in the boss of the steering wheel by tightening the three grub screws situated radially in the steering wheel hub. Do not move the steering wheel during this operation.

(f) Tighten the gland nut to secure the stator tube to the steering box end cover and reconnect wires according to the colours or identification marks.

6. TO REMOVE STEERING WHEEL

(a) First remove the stator tube and control head as described on page 16.

(b) Remove the steering wheel securing nut. If it is so desired the wheel and the top of the inner column can be "centre popped" for identification and simplified replacement.

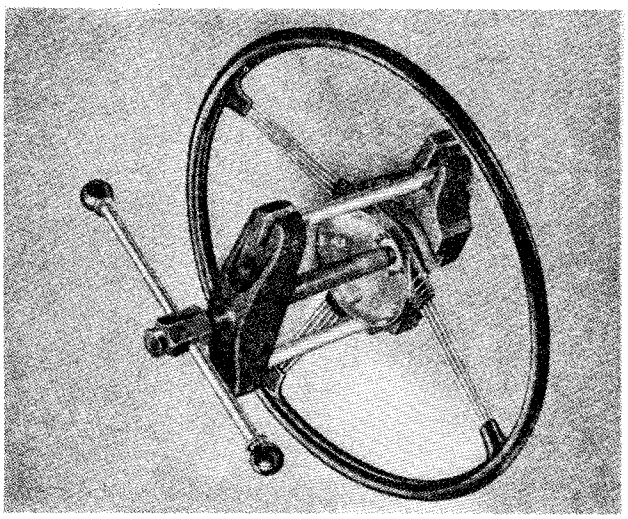


Fig. 12 Removing the Steering Wheel, utilising the Churchill Tool No. 20SM.3600.

(c) Utilising the Churchill steering wheel remover Tool No. 20SM.3600 remove the wheel (Fig. 12).

7. TO FIT STEERING WHEEL

(a) Place the car on level ground and set the wheels in the straight ahead position.

(b) Feed the steering wheel on to the inner column of the steering unit in such a manner that the two horizontal spokes lie across the fore and aft axis of the car. If on dismantling the column and wheel previously the components have been "pop marked" it is merely necessary to align the "pops."

(c) Fit the securing nut and tighten down.

(d) Fit stator tube and control head. (See page 16.)

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8. TO REMOVE STEERING UNIT

(a) Disconnect battery lead and jack up front of car. Place stands securely under frame and remove jacks.

(b) Remove front bumper and front apron as described in "Body Section N."

(c) Remove the road wheel nearest to the steering column.

(d) Using a suitable lever remove the centre tie-rod from the drop arm of the steering unit.

(e) Remove the control head from the centre of the steering wheel as described on page 16.

(f) Remove the steering wheel as described on this page.

(g) Loosen the clamp securing the column to the facia panel by slackening off the two nuts on the lower support stay (this is a nut and bolt on early production cars) (Fig. 11) and the two nuts securing the clamps to the anchor bracket. (See page 20.)

(h) Remove the clip from the rubber draught excluder.

(i) Withdraw the two bolts securing the steering unit trunnion bracket to the chassis frame.

(j) The steering unit may be drawn forward and downward through the draught excluder.

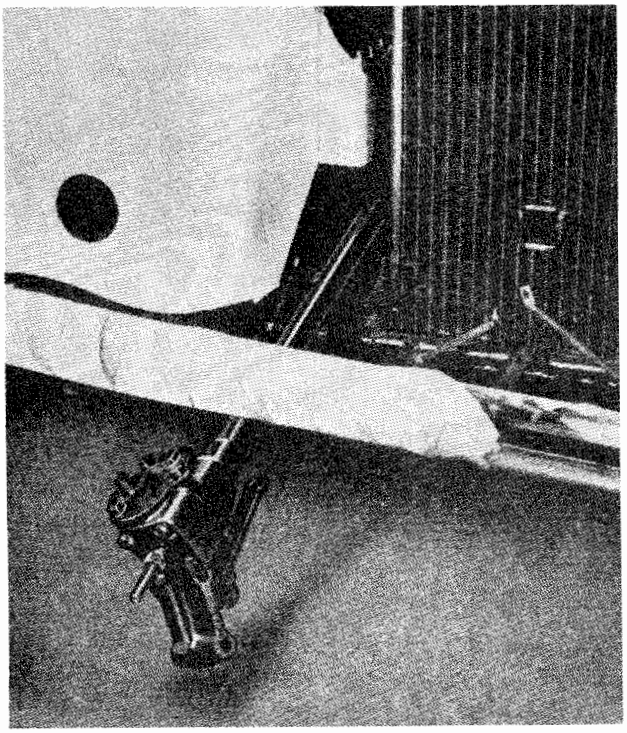

Fig. 13 The Steering Unit being removed from the front of the car. For the purpose of this illustration the bumper has not been removed. Note the wrapping on the bumper bar to prevent wing damage.

(**k**) After the removal of the steering unit the drop arm can be detached from the rocker shaft, utilising a suitable puller (Churchill Tool No. M.91) when the securing nut and lock plate have been first removed.

(**l**) Slacken off the two pinch bolts securing the trunnion bracket and withdraw it from the steering unit.

9. TO FIT STEERING UNIT

(**a**) Adjust the end float of the inner column and the rocker shaft for depth of engagement (see page 16).

(**b**) Fit the trunnion bracket so that the chassis mounting points are forward. Do not fully tighten these two bolts at this juncture.

(**c**) Attach the drop arm to the splined end of the rocker shaft in such a manner that the scribe lines on these components align and appear to be continuous. Position lock plate and tighten securing nut, lock this nut with the plate by turning its edge over the "flat" machined on the drop arm and another part of the lock plate over the nut.

(**d**) Place screw clip on draught excluder and feed the column of the steering unit upwards from the front of the car, through the draught excluder and clip and under the facia panel. Position the trunnion bracket in the chassis bracket and attach with two bolts and lock washers, the longer bolt also accommodates the stiffening bracket for the bumper and is fitted to the lowermost hole, the shorter of the two bolts utilises the upper hole. Leave both bolts loose at this juncture.

(**e**) Secure the column to the mounting bracket under the facia panel by tightening the two nuts on the lower support stay (this was a nut and bolt on early production cars) and the nuts securing the clamps to the anchor bracket. (See page 20).

(**f**) Tighten the two bolts securing the trunnion bracket to the chassis frame and finally the two bolts of the trunnion bracket to the steering unit.

(**g**) Fit the centre tie-rod to the drop arm and secure with the nyloc nut and plain washer.

(**h**) Tighten the draught excluder clip.

(**i**) Fit the steering wheel as described on page 17.

(**j**) Fit the control head and stator tube (see page 16).

(**k**) Fill steering box with high pressure oil recommended in "General Data Section A."

(**l**) Fit front apron and front bumper as described in "Body Section N."

(**m**) Replace road wheel, jack up car to remove stands and lower car to ground. Reconnect battery.

10. TO DISMANTLE STEERING UNIT

(**a**) Remove nut and lock plate and utilising a suitable puller (Churchill Tool No. M.91) remove the drop arm. On no account must the drop arm be removed by hammer blows as this may seriously damage the conical pin on the rocker shaft and also the cam of the centre column.

(**b**) Slacken off the two pinch bolts attaching the trunnion bracket to the body of the rocker shaft housing, and remove bracket.

(c) Remove cover and joint washer after withdrawing the setscrews of the steering box cover. Allow the oil to drain away.

(d) Withdraw the rocker shaft whilst protecting the rocker shaft oil seal with a thin cylinder of shim steel.

(e) Remove the setscrews and lock washers securing the end cover to the steering box, followed by the shims and joint washer.

(f) The lower bearing race and ball cage can now be removed allowing the cam to be withdrawn, together with the upper ball cage and rubber rings attached to the inner column.

(g) The split felt bush situated in the top of the outer case can now be withdrawn.

(h) The upper bearing race can be drifted out from the steering box.

(i) Drift out the bearing bush and oil seal of the rocker shaft.

11. TO ASSEMBLE STEERING UNIT

(a) Feed the rocker shaft bearing bush into the outer column and box assembly and press into position.

(b) Slide the trunnion bracket into position on the rocker shaft housing. The chassis mounting points should point forward and downward. The two bolts should be tightened just sufficiently to keep the bracket in position at this juncture.

(c) Fit the upper ball race to the steering box. Feed the inner column with the rubber rings and ball cage in position into the box.

(d) Place the second ball cage in position on the lower bearing face of the cam followed by the race.

(e) Locate a fresh joint washer together with the old shim pack on the end cover and fit to the steering box, utilising four bolts and lock washers.

(f) Check for end float. See "Adjustment of Steering Box," page 16. All float **must** be eliminated but a small amount of pre-loading is permitted. End float is adjusted by the removal or addition of shims interposed between the steering box and the end cover. Their removal decreases the end float whilst the addition of these shims increases the end float.

(g) Press the oil seal into the lower extremities of the rocker shaft body.

(h) Feed the rocker shaft into its bore through the top of the steering box and allow the conical pin to settle in the groove of the cam.

Whilst this shaft is being fitted it is essential that the oil seal lip is protected from damage, otherwise oil leaks will result.

(i) Withdraw the adjusting screw in the top cover to ensure that its shank does not bear down on to the rocker shaft lever when the cover is secured to the unit. Secure cover with three setscrews and lock washers, utilising a new joint washer.

(j) Ensure that the mounting bracket is in position as described in operation **(b)**, for this cannot be fitted when the drop arm is attached to the rocker shaft. Position the drop arm on the splined rocker shaft so that the scribe lines align ; secure with nut and lock plate, the edge of the latter is turned up to secure nut and drop arm.

(k) Having removed **all** end float as described in operation **(f)** adjust the depth of engagement of the rocker shaft and the cam by means of the screw mounted in the top cover. The screw is turned clockwise to increase the depth of engagement or anti-clockwise to reduce the depth. The engagement is said to be correct when slight resistance is felt when the rocker shaft is in the straight ahead position.

(l) Fit the graphite impregnated bush to the upper end of the outer column. The steering wheel securing nut is loosely attached to the inner column for safe keeping.

12. REMOVAL AND REPLACEMENT OF DROP ARM

It should be noted **that it is not possible to remove the drop arm of the steering unit without first removing the unit from the car.** This sequence is covered under "To remove Steering Unit," page 17.

The drop arm must only be removed by a special puller, Tool No. M.91 is recommended, a hammer must not be used since any blow would be transferred to the hardened conical pin in the rocker shaft lever which would in turn indent the cam gear and damage the unit.

The drop arm should only be replaced when the trunnion bracket is in position on the rocker shaft housing. The arm is set in such a manner that it will point rearwards and downwards and the scribe line on the end of the rocker shaft will align with that on the drop arm and appear to be continuous.

Should there be an absence of scribe lines on these components the rocker shaft must be set in the straight ahead position and the drop arm fitted so that it is offset 3° to the left of a line passing through the centre of the rocker shaft parallel to the centre line of the column (see Fig. 14).

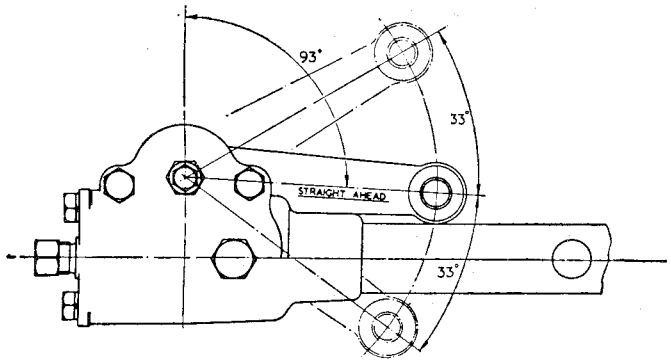

Fig. 14 Diagrammatic view of angular position of the Drop Arm.

13. TO REMOVE IDLER UNIT

(a) Jack up the car and place stands securely under the chassis frame, remove the jacks and remove the road wheel nearest to the idler unit.

(b) Remove nyloc nut and plain washer and utilising a suitable lever disconnect the centre rod from the idler lever.

(c) Remove the two bolts from the chassis frame brackets, lift out idler unit.

(d) The idler unit can be further dismantled by unscrewing the lever and fulcrum assembly from its bracket body. The oil seal can now be removed from the base of the fulcrum pin.

14. TO FIT IDLER UNIT

(a) Ensure that the lever and fulcrum pin have full movement, this is allowed by screwing the pin into its housing and unscrewing one full turn ; ensure also that the grease seal is in good condition and that the unit is fully greased.

(b) Offer up the unit to its bracket welded to the chassis frame and secure with two bolts and lock washers.

(c) Attach centre tie-rod to the idler lever and secure with nyloc nut and plain washer.

(d) Fit road wheel, jack up car, remove stands and lower car to ground.

15. STEERING COLUMN BRACING

To provide greater steering column stability, the nut and bolt fixing for the column attachment clamps at the facia panel were replaced by a tie-rod. This tie-rod is attached at its inner end to the facia-battery box stay and grips the column clamps at its outer end by two nuts and plain washers. Cars with Commision No. TS. 1390 onwards are fitted with this tie-rod.

The rod is attached to the facia stay by a $1\frac{1}{8}$" long bolt. The bolt with a thin plain washer under its head is fed through the eye of the tie-rod with the off set uppermost, three thick plain washers are now fitted to the bolt. This assembly is offered up to the underside of the facia stay and held in position by a nut with a plain and lock washer.

An additional support bracket, clamped to the steering column by two nuts and bolts and to the front suspension unit by a third nut and bolt, was introduced at Commission No. TS. 5777. This bracket is situated between the front suspension unit and the steering box. To remove the column it will be necessary to loosen the two clamping bolts and re-tightening them on replacement of the column.

16. TELESCOPIC (ADJUSTABLE) STEERING UNIT

(a) Description (Fig. 15)

This unit is very similar to the normal equipment apart from three main features :—

(b) Steering Unit

(i) The inner column is of similar length, but its steering wheel attachment splines are of a much greater length.

(ii) The outer column is shorter than the normal equipment to allow the increased length of the inner column splines to be utilised.

(iii) The distance of the steering wheel from the driver can be increased by $2\frac{1}{2}$" inches.

(c) Steering Wheel

The steering wheel is the three equi-distance spoke type and is a slide fit on the splines of the inner column, it is held at its maximum point of extension by a circlip fitted in an annular recess machined at the top of the splines. (See Fig. 16.)

The lower length of splines, between the underside of the steering wheel and the top of the outer column is covered by a telescopic metal shroud.

This metal shroud is supported at its smaller (bottom) end by a spigotted bakelite washer and positioned at its upper end under the steering wheel locking sleeve by a plated steel cup washer.

The steering wheel hub consists of a steel internally splined sleeve as its centre, with a cast aluminium surround. The lower end extruding portion of the steel insert is split, threaded and is provided with an externally tapered flange to accommodate aluminium steel lined locking sleeve.

An internal taper, corresponding to that on the lower extension of the steering wheel hub, is machined at the bottom of the locking sleeve bore. When the locking sleeve is screwed to the hub insert, a chuck action is developed, thus locking the steering wheel to the external splines on the inner column.

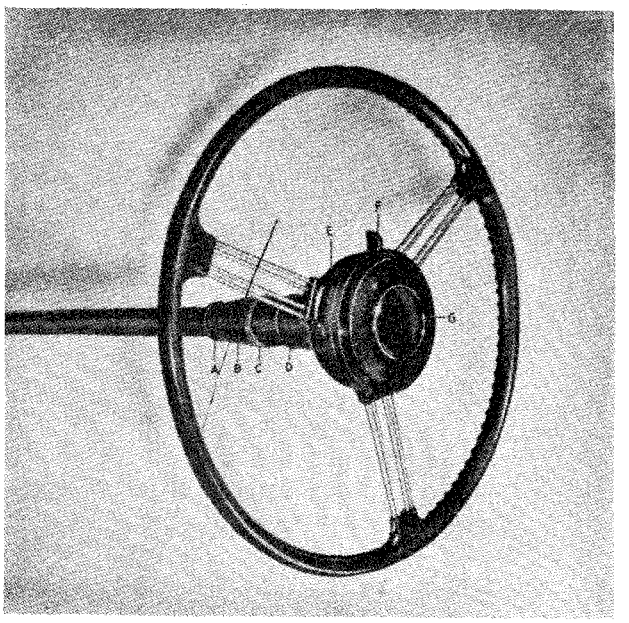

Fig. 15 The Telescopic (adjustable) Steering Unit.

A Spigotted Bakelite Washer.
B Metal Telescopic Shroud.
C Plated Steel Cup Washer
D Locking Sleeve
E Telescopic Steering Wheel
F Flasher Control
G Control Head

G

The length of these splines permit the range of adjustment, and the circlip mounted in its annular groove limits the upwards movement. The telescopic metal shroud covers and protects the splines at all points of adjustment.

(d) The Control Head

The control head mounted in the steering wheel centre is similar to the normal equipment with the exception of the stator tube. This consists of a short tube with indents at its lower end to form a key, and a longer tube with a slot at its upper end. The two tubes telescope together, the indents engaging with the slot provided.

The purpose of this key and slot is two fold, firstly to prevent rotation with the steering wheel and secondly to provide telescopic action as the steering wheel is adjusted on its splines.

17. TO FIT THE TELESCOPIC (ADJUSTABLE) STEERING UNIT AND STEERING WHEEL

(**a**) With the exception of the steering wheel the fitting of this unit does not differ from that of the normal equipment. Follow the sequence given in "To Fit Steering Unit" (see page 18, operations **(a)** to **(h)**).

(**b**) Ensuring that the car is on level ground and the road wheels are aligned in the straight ahead position, thread the bakelite washer, spigot uppermost, over the splines of the inner column and locate it on the top of the outer column. Slightly grease the splines.

(**c**) Fit the telescopic metal shroud on to the steering column placing the smaller diameter downwards to engage the spigot of the bakelite washer. The large diameter end of the metal shroud fits into the metal cupped washer, the plane side of which abuts against the locking sleeve.

(**d**) With the three spokes of the steering wheel forming a "Y" and ensuring that the locking sleeve is loosened, position the wheel on the splines of the inner column so that the lowermost spoke is pointing vertically downwards.

(**e**) Push the wheel down to its fullest extent and tighten locking sleeve. This will uncover an annular groove in the upper end of the inner column. The circlip can now be fitted (Fig. 16).

(**f**) Fit the control head as described in "To fit Control Head to Telescopic Steering Wheel" (page 23).

(**g**) The work can be completed as described in "To fit Steering Unit" (page 18, operations **(k)** and **(l)** inclusive).

18. TO REMOVE TELESCOPIC (ADJUSTABLE) STEERING WHEEL AND STEERING UNIT

(**a**) Proceed as described under "To remove Steering Unit" (page 17, operations **(a)** to **(d)** inclusive).

(**b**) Remove the control head and stator tube as described under "To remove Control Head" (on this page).

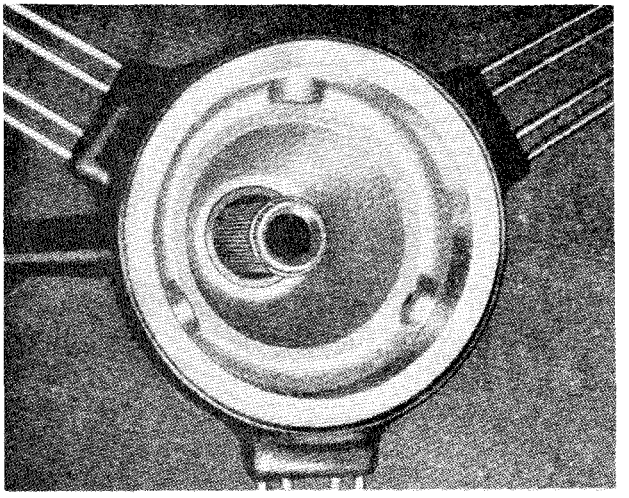

Fig. 16 The circlip in position on the inner column of the steering unit.

(**c**) Loosen the clamping nut of the steering wheel hub and lower the wheel to its fullest extent. The hub and inner column may be "pop marked" for simplified replacement.

(**d**) Remove the circlip from its annular groove situated at the top of the inner column.

(**e**) Loosen the hub clamp to allow the steering wheel to be drawn from its column and at the same time hold the metal shroud assembly.

(**f**) Remove the cupped washer from the top of the metal shroud, followed by the shroud and bakelite washer from the top of the outer column.

(**g**) Proceed with operation **(g)** and onwards as detailed in "To remove Steering Unit" (page 17).

19. TO REMOVE CONTROL HEAD FROM CENTRE OF TELESCOPIC STEERING WHEEL

The sequence for removal is similar to that of the normal equipment other than the stator tube need not be released by loosening the gland nut and olive at the end cover of the steering box.

20. TO FIT CONTROL HEAD AND STATOR TUBE TO TELESCOPIC STEERING WHEEL

The procedure is the same as fitting the normal equipment but it may be considered necessary to apply a smear of grease to the upper (slotted) end of the stator tube to ensure freedom of movement. It must be pointed out that over greasing at this point may lead to corrosion of the rubber insulation of the electrical harness and cause short circuiting.

The electrical harness protruding from the stator tube must be free to allow a portion to be drawn into the tube when the steering wheel is adjusted to a higher position.

21. STEERING STIFFNESS

If after greasing all points of the steering, stiffness persists, the following procedure is recommended.

(**a**) Jack up the front of the car and turn the steering wheel from lock to lock. A very slight resistance should be felt when the steering is almost in the straight ahead position. If this stiffness is appreciable and extends to a distance either side of the straight ahead position, the rocker shaft adjusting screw situated in the steering box top cover is bearing too heavily on the lever head of the shaft. The screw should be unlocked and slackened off by a fraction of a turn and then relocked. Should this fail to improve the condition further investigation must be carried out.

(**b**) Loosen off completely the nuts of the steering column tie situated under the facia panel, followed by the two nuts securing the clamps to the anchor bracket. If the column moves more than $\frac{1}{4}$" from its clamped position, reposition by slackening the bolts securing the steering box to its mounting bracket and the mounting bracket to the chassis frame.

(**c**) Move the steering unit to its correct position. Secure the mounting bracket to the chassis and the steering unit to the mounting bracket.

(**d**) The clamp attachments to the anchor bracket should be made finger tight and the two clamps brought together round the steering column in such a manner that the column is not displaced. Tighten the jam nuts up to the clamps and finally tighten the nuts of the clamp to anchor bracket attachment.

(**e**) If stiffness still persists remove the centre tie-rod from the drop arm by removing the nyloc nut and plain washer and so isolate the steering unit from the suspension unit. Check the inner column for pre-load by loosening the four bolts attaching the end cover from the steering box. Should the movement of the steering wheel become easier shims must be placed between box and end cover.

Remove the control head and steering (described on pages 16 or 20) followed by the felt bearing situated at the top of the column. Check the inner column relative to the outer column, if column appears to be displaced, it can be assumed that the inner column is bent and must be replaced.

(**f**) If the stiffness is traced to the ball joint assemblies, isolate the joint by removing the outer tie-rods from the steering levers. The offending ball joint can now be located and corrected.

(**g**) Should no stiffness be traced, the car must be jacked up and the upper and lower bearings of the vertical link examined.

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ASSESSMENT OF ACCIDENTAL DAMAGE

The following illustrations are necessary for the assessment of accidental damage.

It is suggested that the suspect components are removed from the car as described in this Section, cleaned and laid on a surface plate for measuring.

The measurements taken should be compared with those shown in the appropriate illustration and a decision made as to its condition.

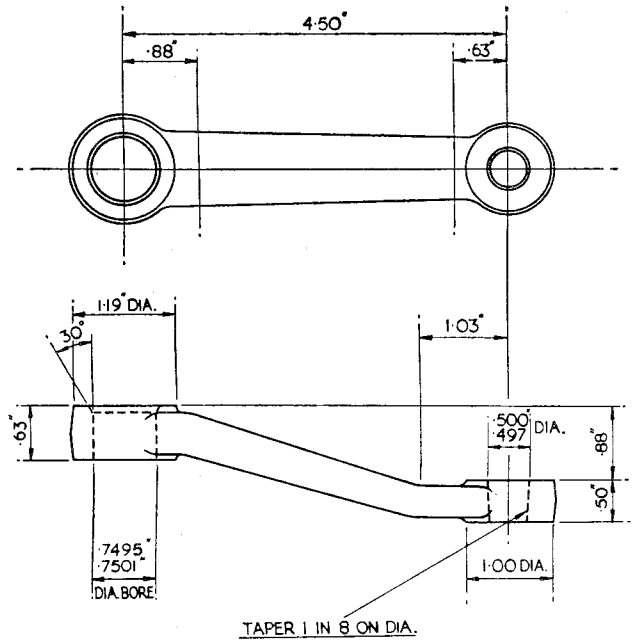

Fig. 17 The Idler Lever R.H.S. and L.H.S. are identical.

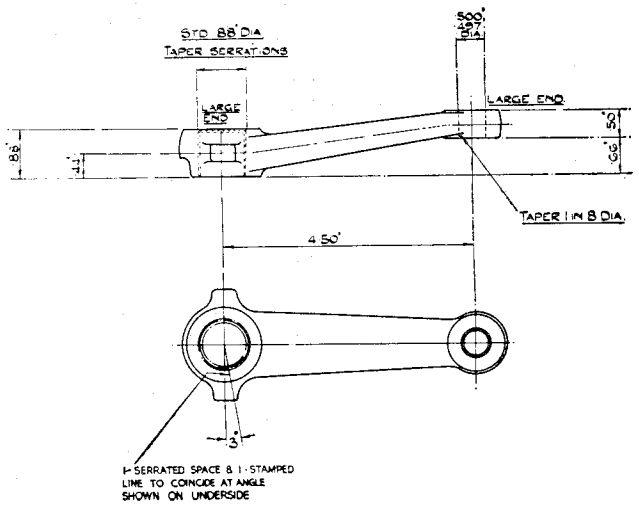

Fig. 18 The Steering Drop Arm R.H.S. L.H.S. is symmetrical but opposite handed.

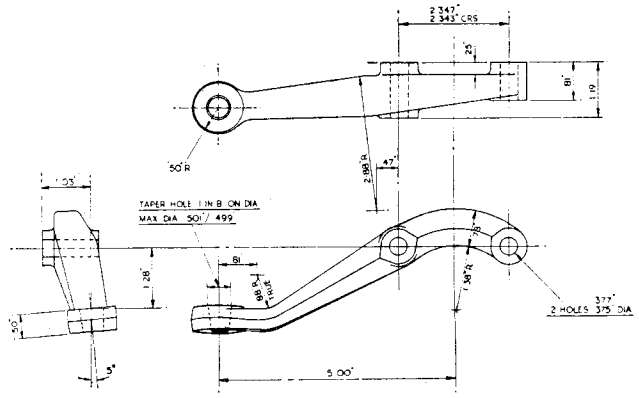

Fig. 19 The Steering Lever R.H. L.H. is symmetrical but opposite handed.

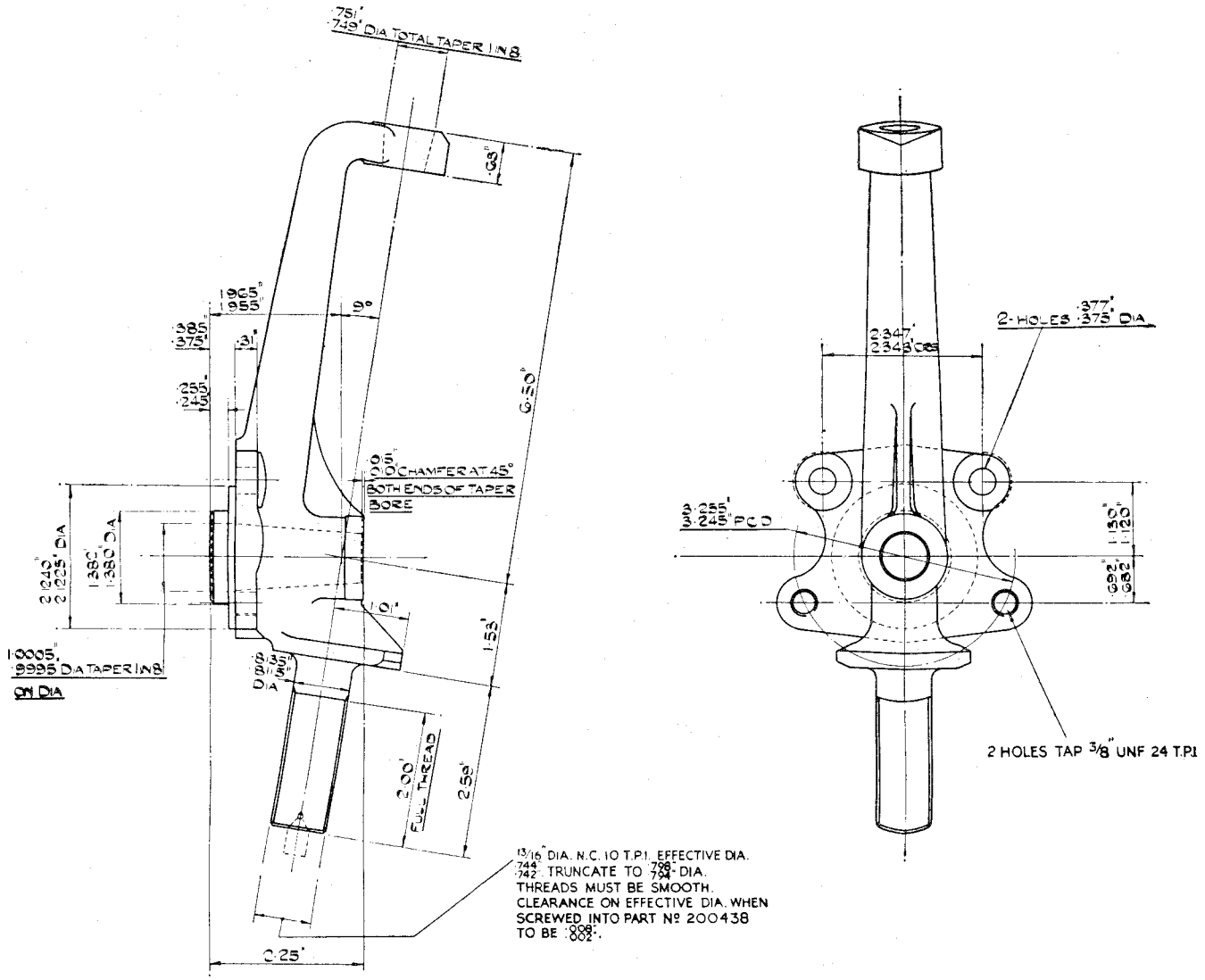

Fig. 20 **The Vertical Link.**

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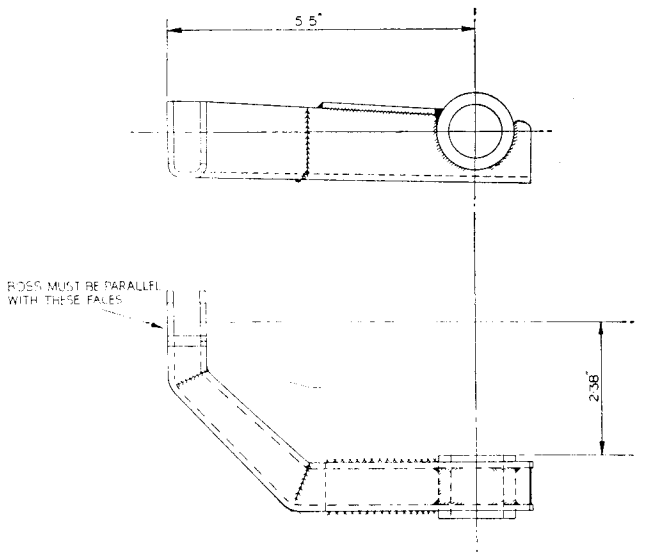


Fig. 21 R.H. front and L.H. rear upper wishbone.

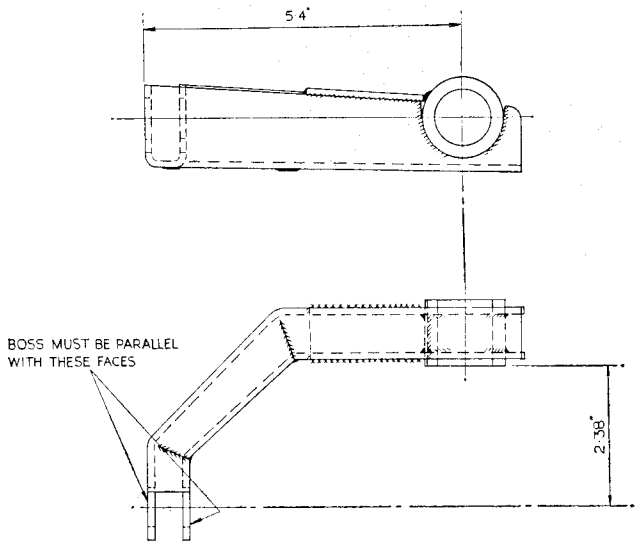


Fig. 22 L.H. front and R.H. rear upper wishbone.

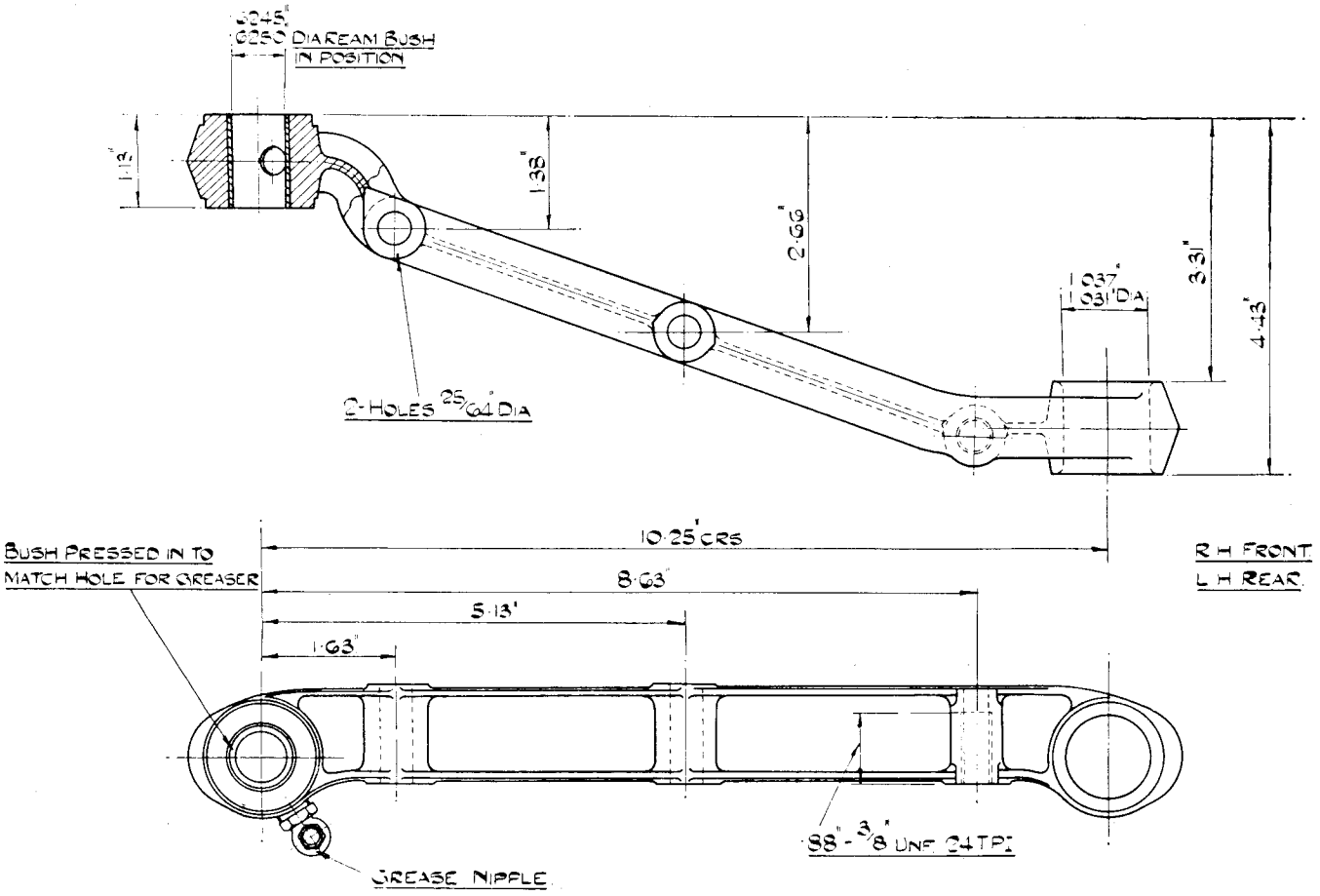


Fig. 23 The R.H. front and L.H. rear Lower Wishbone. The R.H. rear and L.H. front are symmetrical but opposite handed.

Service Instruction Manual

H

ROAD SPRINGS AND SHOCK ABSORBERS

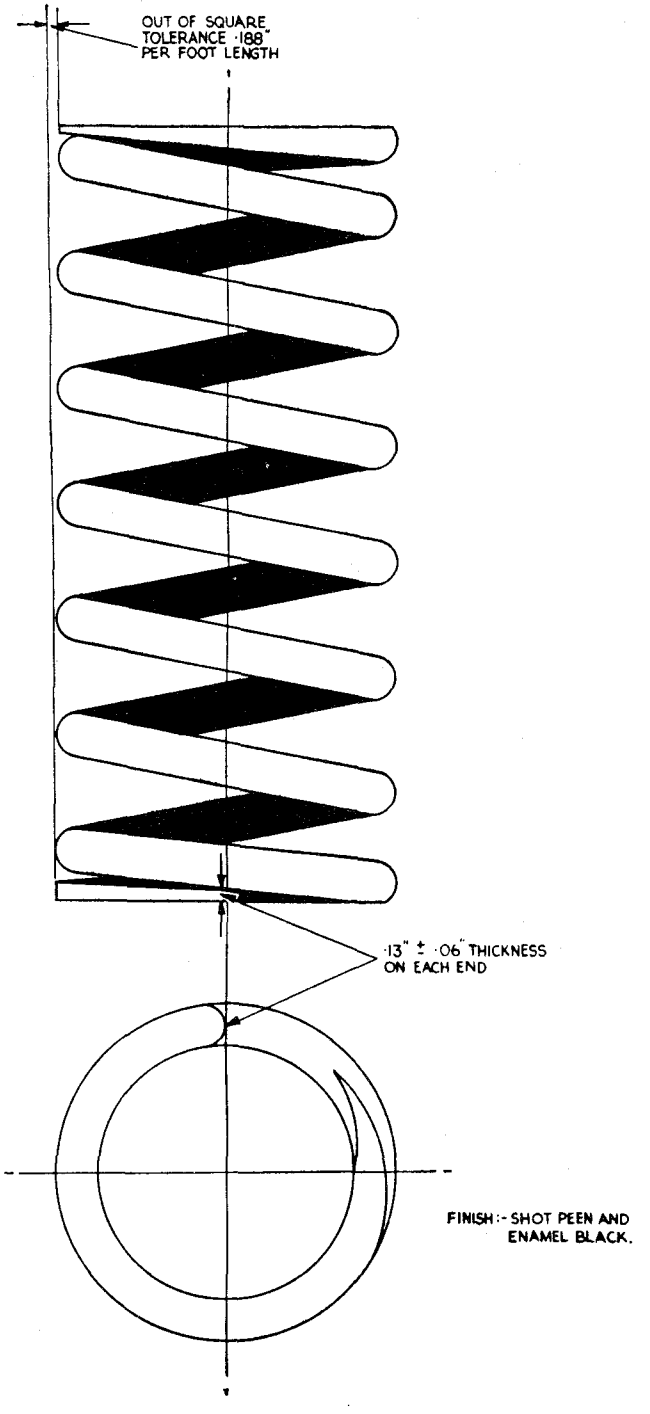
SECTION H

ROAD SPRINGS AND SHOCK ABSORBERS

INDEX

ILLUSTRATIONS

ROAD SPRINGS AND SHOCK ABSORBERS



SPRING DATA			
		COMPETITION	
ITEM	DIMENSION	ITEM	DIMENSION
WIRE DIA.	·50" ± ·002"	WIRE DIA.	·52" ± ·002"
NUMBER OF WORKING COILS	6¾	NUMBER OF WORKING COILS	6½
MEAN DIA. OF COILS	3·5" ± ·020" ·010"	MEAN DIA. OF COILS	3·5" ± ·020" ·010"
RATE *	310 LB/IN.	RATE *	380 LB/IN.
FREE LENGTH	9·75" (APPROX)	FREE LENGTH	9·19" (APPROX)
FITTED LENGTH	6·75" ± 3/32"	FITTED LENGTH	6·75" ± 3/32"
SOLID LENGTH	4·13" 4·26" MAX	STATIC DEFLECTION	2·44"
STRESS AT SOLID	151,000 LB/□"	FITTED LOAD *	925 LB.
HAND OF HELIX	RIGHT	SOLID LENGTH	4·16" 4·29 MAX
FITTED LOAD *	925 LB.	STRESS AT SOLID	148,000 LB/□"
STATIC DEFLECTION	3·0" APPROX.	HAND OF HELIX	LEFT
MATERIAL	SILICO MANGANESE GROUND BAR	MATERIAL	SILICO MANGANESE GROUND BAR

GENERAL DATA			
ITEM	DIMENSION	ITEM	DIMENSION
MAX. WHEEL BUMP	3·0"	MAX. WHEEL BUMP	3·0"
MAX. WHEEL REBOUND	2·25"	MAX. WHEEL REBOUND	2·25"
SPRUNG LOAD AT WHEEL	540 LB.	SPRUNG LOAD AT WHEEL	540 LB.
LEVERAGE	·585"	LEVERAGE	·585"
STATIC WHEEL DEFLECTION	5·1"	STATIC WHEEL DEFLECTION	4·15"
WHEEL RATE	106 LB/IN.	WHEEL RATE	130 LB/IN
PERIODICITY	83 OSC/MIN.	PERIODICITY	92 OSC/MIN.
WAHL FACTOR	1·213	WAHL FACTOR	1·223
STATIC STRESS	80,000 LB/□"	STATIC STRESS	71,600 LB/□"
STRESS AT MAX. BUMP	140,800 LB/□"	STRESS AT MAX. BUMP	138,000 LB/□"
LADEN HEIGHT AT WHEEL	± ⅛"	LADEN HEIGHT AT WHEEL	± ⅛"
CLEARANCE FROM CHOC-A-BLOC AT MAX. WHEEL BUMP	·37"	CLEARANCE FROM CHOC-A-BLOC AT MAX WHEEL BUMP	·34"

* IMPORTANT

Fig. 1 **Front Road Spring. For illustration purposes only the Competition Spring is shown. This spring has a left-hand helix.**

FRONT SPRING

1. DESCRIPTION

The low periodicity coil spring used in the front suspension of this car is illustrated in Fig. 1. This illustration also gives the data of both the normal road spring and the competition spring. This competition spring can easily be distinguished from the normal type, for it has a left-hand helix. Damping action is provided by a direct acting telescopic type shock absorber, mounted centrally through the coil spring.

2. MAINTENANCE

Very little maintenance should be required during the lifetime of the car. There is no lubrication required, and the only possible maintenance would be to replace the rubber washers, or to check the spring against the data given in Fig. 1.

3. TO REMOVE OR REPLACE

These operations are fully covered in the "Front Suspension, Section G" of this manual.

REAR ROAD SPRINGS

1. DESCRIPTION (Fig. 2)

Semi-elliptical laminated springs are used which have their location point with the axle below and forward of the centre, so that the longer end of each spring is fitted toward the rear of the car.

The forward fulcrum of the spring has a silentbloc bush and is mounted on a bolt protruding from the outer side of the chassis frame. The attachment is completed by a "D" washer and split pinned castellated nut. The rear fulcrum is a shackle assembly utilising split rubber bushes interposed between the pins, the spring or the chassis frame. The attachment is completed by nuts and lock washers situated between the spring and the chassis frame.

2. MAINTENANCE

The only lubrication required is that for the spring leaves, on no account must the rubber or silentbloc bushes be lubricated. Over lubrication of the spring leaves should be avoided. After the springs have been cleaned, brush the blades at their edges with engine oil, this will allow sufficient oil to penetrate between the leaves and provide inter-leaf lubrication.

Lubrication of spring blades is chiefly required at the ends of the leaves where one presses upon the next and where the maximum relative motion occurs.

The clips should be inspected and any looseness corrected by pinching the "ears" closer to the spring. Failure to keep these clips tight often causes "knocks" at the rear of the car.

3. TO REMOVE REAR ROAD SPRING

(a) Jack up the body at the rear of the car sufficiently to take the weight off the road spring.

(b) Remove the rear wing stay situated behind the rear wheel between the chassis and wing itself.

(c) Holding the hexagon of the shock absorber-link remove the nyloc attachment nut.

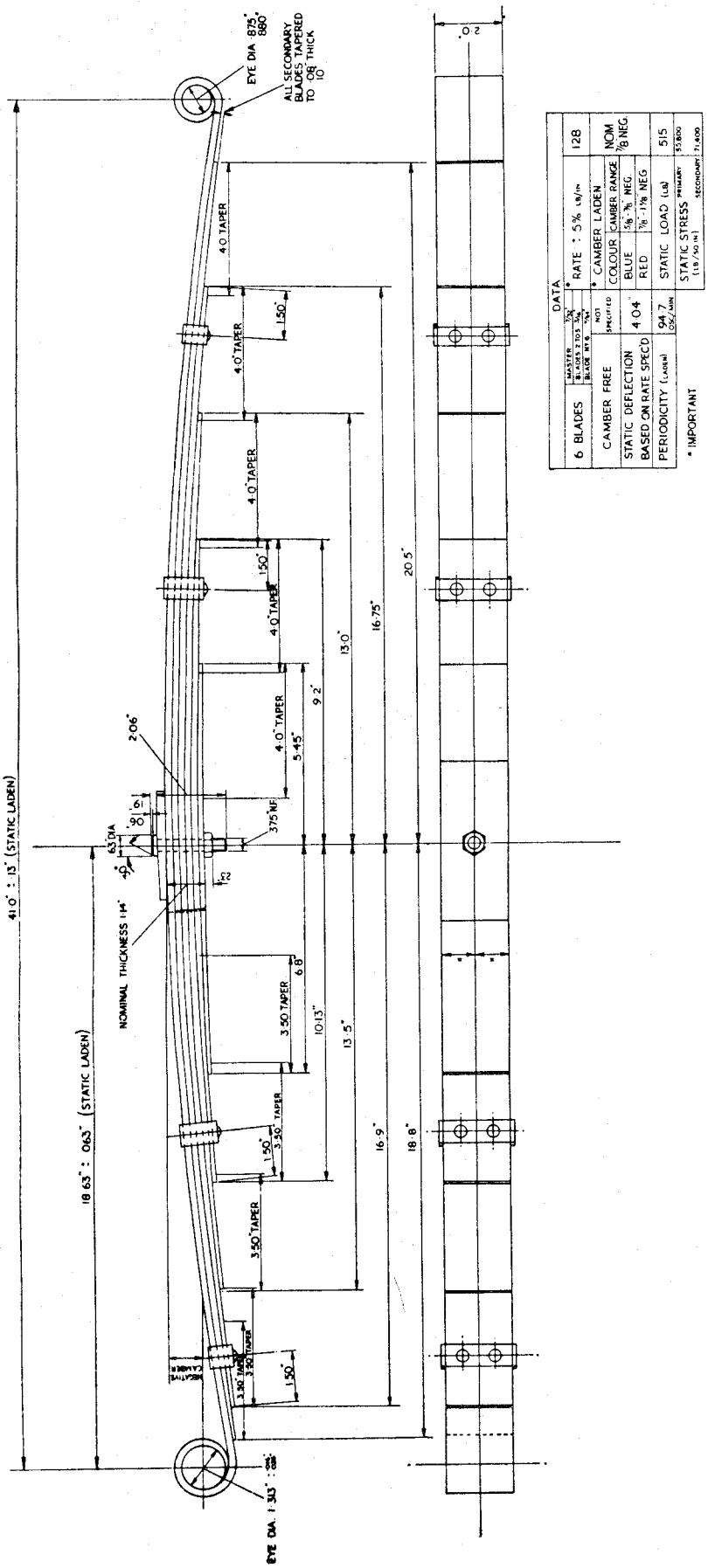
(d) Remove the two nuts and lock washers, followed by the plate of the shackle assembly at the rear end of the spring. Withdraw the plate and pin assembly and collect the rubber bushes from the spring eye and the chassis bracket.

(e) Screw a $\frac{5}{16}''$ × 24 UNF bolt into the head of the forward fulcrum bolt to a depth of $\frac{1}{2}''$. Withdraw the split pin to remove nut and "D" washer. Utilising a lever under the head of the $\frac{5}{16}''$ UNF bolt, the fulcrum bolt can now be withdrawn from the spring and chassis frame.

(f) Supporting the spring by a small jack remove the four nyloc nuts of the two "U" bolts attaching the spring to the axle, remove the "U" bolts and the spring plate from the shock absorber link.

(g) The road spring and the supporting jack is now removed from under the car to a bench.

(h) The silentbloc bush can now be removed from the forward eye of the spring.



DATA

6 BLADES	MASTER	32"	RATE ± 5% LB/IN	128
	BLADES 2 TO 5	3/4"		
	BLADE NO 6	1/4"		
CAMBER FREE	NOT SPECIFIED		CAMBER LADEN	NOM 7/8 NEG.
			COLOUR	CAMBER RANGE
STATIC DEFLECTION BASED ON RATE SPECD	4.04"		BLUE	15/16" - 7/8" NEG.
			RED	7/8" - 1 1/16" NEG
PERIODICITY (LADEN)	94.7 CYC/MIN		STATIC LOAD (LB)	515
			STATIC STRESS (LB/SQ IN)	PRIMARY 55,800
				SECONDARY 71,400

* IMPORTANT

Fig. 2 Rear Road Spring.

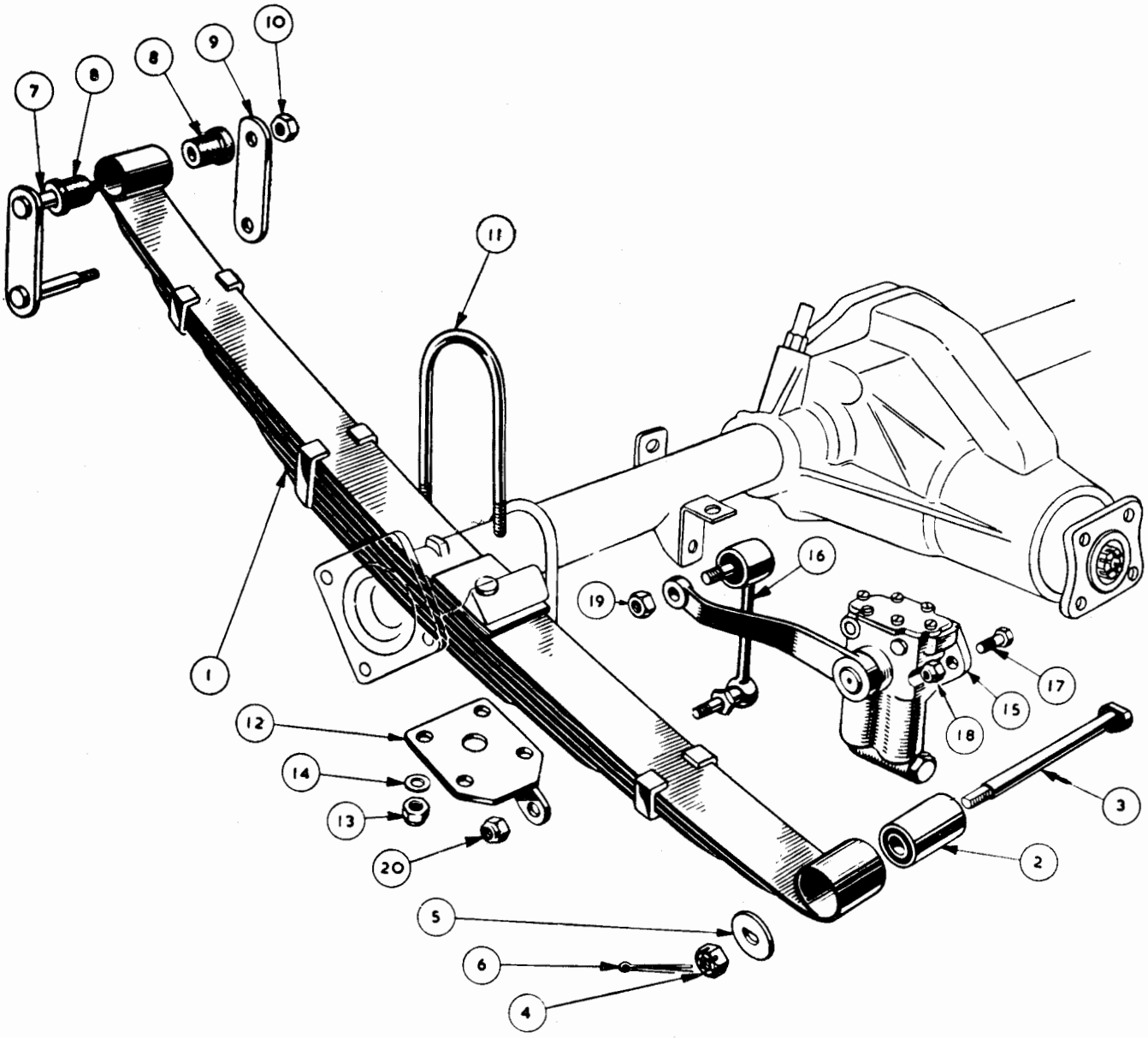


Fig. 3. Exploded Rear Suspension Details.

NOTATION FOR FIGURE 3.

Ref. No.	Description	Ref. No.	Description
1.	Rear Road Spring	12.	Right Hand Shock Absorber Plate Assembly.
2.	Silentbloc Bush.	13.	Nyloc Nut.
3.	Front Attachment Bolt.	14.	Plain Washer.
4.	Castellated Nut.	15.	Shock Absorber.
5.	"D" Washer.	16.	Shock Absorber Link.
6.	Split Pin.	17.	Attachment Bolt.
7.	Shackle Pin and Plate Assembly.	18.	Attachment Nut.
8.	Rubber Bush.	19.	Nut for Link Upper Attachment.
9.	Shackle Plate.	20.	Nut for Link Lower Attachment.
10.	Nut.		
11.	"U" Bolt.		

4. TO FIT REAR ROAD SPRING

(**a**) Press the silentbloc bush into the forward eye of the road spring and ensure that the eight split rubber bushes are in good condition.

(**b**) Offer up the spring, short end forward, to a position above the rear shackle bracket of the chassis frame and below the axle. Support the spring on a small jack and attach spring plate loosely to the shock absorber link.

(**c**) Fit the "U" bolts over the axle either side of the spring and through the spring plate, secure with four nyloc nuts.

(**d**) Secure shock absorber link to spring plate.

(**e**) Feed the front attachment bolt from inner side of the chassis frame through its support tube into the silentbloc bush of the road spring and allow the machined flat on its head to bed against its abutment on the inner side of the chassis frame. Secure the fulcrum bolt on its outer side by a "D" washer and castellated nut locked by a split pin.

(**f**) Fit the two rubber half bushes to the road spring rear eye—one from each side. Press a second pair of half bushes into the shackle eye on the chassis frame.

(**g**) Press the shackle pins of the shackle assembly through the rubber bushes and after positioning the inner shackle plate on the pin extremities, between the shackle assembly and chassis side member, fit and secure the two nuts and lock washers.

(**h**) Replace the rear wing stay, positioning it behind the rear wheel in the wing valance and chassis bracket provided and securing with bolts, nuts, plain and lock washers.

(**i**) Remove the jacks from under the body of the car.

5. REAR ROAD SPRING OVERHAUL

The better procedure to adopt when dealing with a road spring which has settled badly or where blades have broken is to fit a replacement.

The only provision the Spares Department make for these springs, other than complete replacements, is the supply of the master blade.

The spring, on being removed from the chassis, should be laid on a surface plate and measured, the measurements taken should be compared with those given in Fig. 2 and a decision made as to its condition.

6. TO DISMANTLE REAR ROAD SPRING

(**a**) Drift out the silentbloc bush from the forward eye of the master blade.

(**b**) Gripping the spring in a vice, prise open the clips sufficiently to allow the removal of the leaves.

(**c**) Remove the centre bolt and dismantle the spring.

(**d**) Clean and examine the blades for cracks or breakages. Damage is most likely to occur toward the centre hole of each blade.

(**e**) Examine centre bolt for damage and wear.

7. TO ASSEMBLE REAR ROAD SPRING

(**a**) Grease the blades with a graphite grease, particularly at the ends where one blade contacts the one above.

(**b**) Feed the leaves on to the centre bolt and utilising a press or vice compress the assembly sufficiently to attach the nut of the centre bolt.

(**c**) Tap the clips over with a hammer and an anvil so that they grip the blades firmly. Failure to ensure complete tightness will result in "knocks" when the car is in use.

(**d**) Press the silentbloc bush into the forward eye of the master blade and ensure that it does not become contaminated with grease.

H

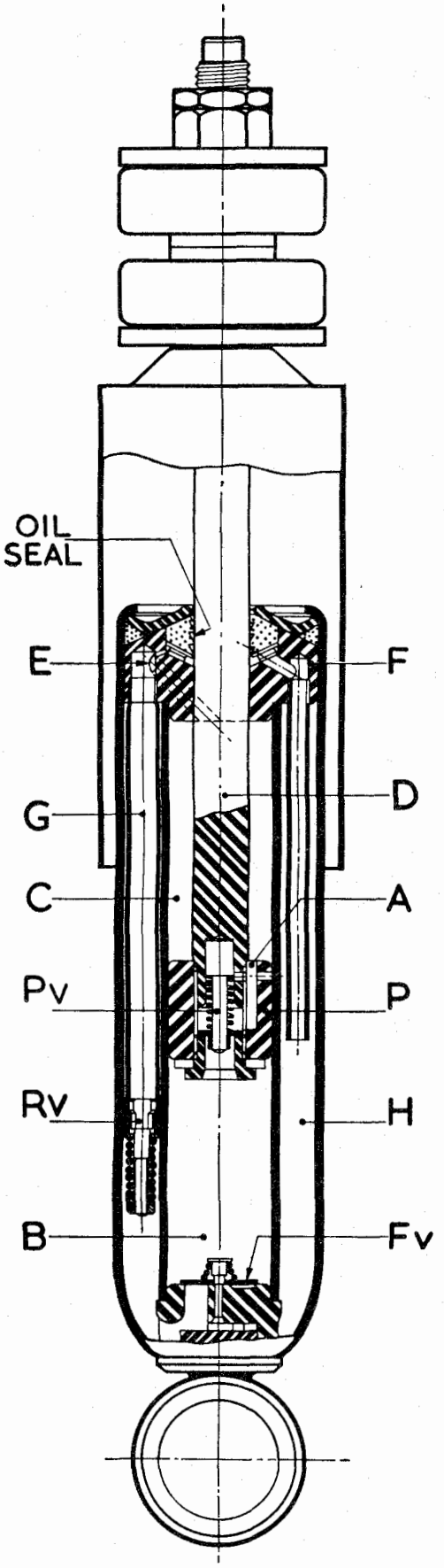


Fig. 4 The Front Shock Absorber.

FRONT SHOCK ABSORBER

1. DESCRIPTION

A telescopic type shock absorber is fitted, utilising a stem fixing at the top with rubber bushes, large diameter steel washers and lock nuts. At the lower end it is first attached to a fulcrum pin bracket with rubber bushes interposed between shock absorber eye and fulcrum pin, the bracket assembly is secured to the lower side of the spring pan. The body of the shock absorber is in the centre of the coil spring.

2. MAINTENANCE

The shock absorber is a sealed unit and requires no topping up. If it is found to be unserviceable it must be replaced.

The only maintenance that can be required is the renewal of the rubber mountings. This is detailed in the "Front Suspension, Section G" under "To remove front shock absorber."

NOTATION FOR FIGURE 4

A. Port in Piston.
B. Portion of Cylinder below Piston.
C. Portion of Cylinder above Piston.
D. Piston Rod.
E. Port in Piston Rod Guide.
F. Piston Rod Guide.
Fv. Foot Valve.
G. Foam Tube.
H. Oil Reservoir.
P. Piston
Pv. Piston Valve.
Rv. Rebound Valve.

---

3. OPERATION OF THE TELESCOPIC SHOCK ABSORBER (Fig. 4)

This shock absorber operates by the one-way circulation of oil. By this method of circulation the oil moves all the time the unit is in operation thus keeping the unit cool under the most arduous conditions of service. The valve gear is simple, of robust construction, and is self cleaning.

On the bump stroke, the oil pressure opens the piston valve (Pv) against the spring load and oil passes through the ports (A) in the piston (P) from the lower to the upper portion of the cylinder (B to C). The excess oil

volume equal to the displacement of the piston rod (D) passes through the ports (E) in the piston rod guide (F), down the anti-foam tube (G) and into the reservoir (H) by way of the rebound valve (Rv).

On the rebound stroke, however, the piston valve (Pv) closes and oil passes through the ports (E) in the piston rod guide (F), down the anti-foam tube (G), opens the rebound valve (Rv) against the spring load and passes into the reservoir (H). At the same time the foot valve plate (Fv) lifts and oil is recuperated to the lower part of the cylinder (B). General slow speed damping is accomplished by bleed orifices built into the valve mechanism.

The maximum load of compression (bump) is 200 lbs. and on extension (rebound) 500 lbs.

4. TO REMOVE OR REPLACE FRONT SHOCK ABSORBER

This is detailed in the "Front Suspension, Section G" under this heading.

REAR SHOCK ABSORBER

1. DESCRIPTION (Fig. 5)

The shock absorber body is attached to the brackets welded to the upper sides of the chassis frame and linked to the rear axle by an arm, splined to the shock absorber spindle, and a connecting link to a plate assembly mounted on the underside of the road spring.

The body has two equal sized cylinders accommodating steel pistons which are reciprocated through short connecting rods and are coupled to the crank plate which is attached to the spindle.

When the axle moves relative to the car (this movement is allowed by the road spring) the arm is moved up or down, and as it is splined to a spindle, the latter rotates. The spindle is a splined fit in the crank plate, this plate being coupled by means of connecting rods to the pistons, in which are situated lightly loaded recuperating valves. The pressure is built up in one cylinder or the other and since the cylinders are connected by ports in the body to the valve chamber, this pressure is dependent on the valve setting.

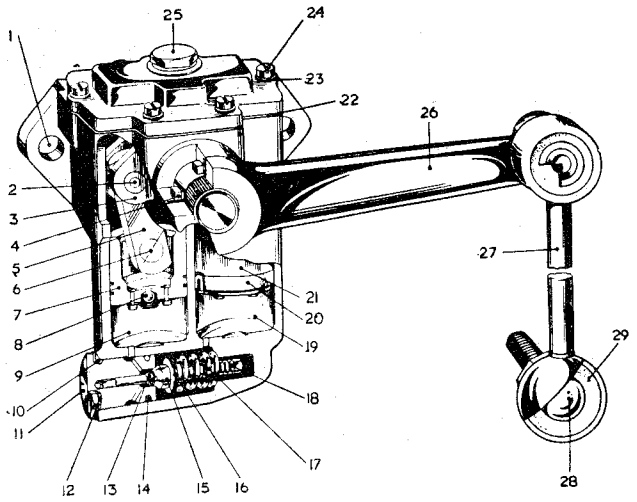


Fig. 5 **The Rear Shock Absorber.**

NOTATION FOR FIGURE 5

Ref. No.	Description
1.	Mounting Holes.
2.	Crank Pin.
3.	Crank Plate.
4.	Oil Seal.
5.	Connecting Rod.
6.	Piston Pin.
7.	Compression or Bump Piston.
8.	Recuperating Valve.
9.	Compression or Bump Cylinder.
10.	Ring Seal.
11.	Valve Screw.
12.	Valve Screw Washer.
13.	Rebound Valve.
14.	Ring Seal.
15.	Compression Valve.
16.	Compression Washer.
17.	Compression Spring.
18.	Rebound Spring.
19.	Rebound Cylinder.
20.	Rebound Piston Seal.
21.	Rebound Piston.
22.	Gasket.
23.	Shake Proof Washer.
24.	Lid Screw.
25.	Filler Plug.
26.	Arm.
27.	Connecting Link.
28.	Ball End Bolt.
29.	Rubber Cushion.

HI

The unit is filled to the base of the filler plug boss which prevents over filling and maintains the necessary air space essential to satisfactory operation. The working mechanism is completely submerged in oil which is prevented from leaking along the spindle by means of oil seals.

2. MAINTENANCE

The damper requires very little attention but the fluid level should be checked every 15,000 miles. It should be topped up to the lower reaches of the filler boss and only with Armstrong Shock Absorber Oil No. 624 should be used, the guarantee of this particular component becomes void if any other oil is used.

Every precaution must be taken to ensure that no lubrication is given to the rubber mountings of the connecting link.

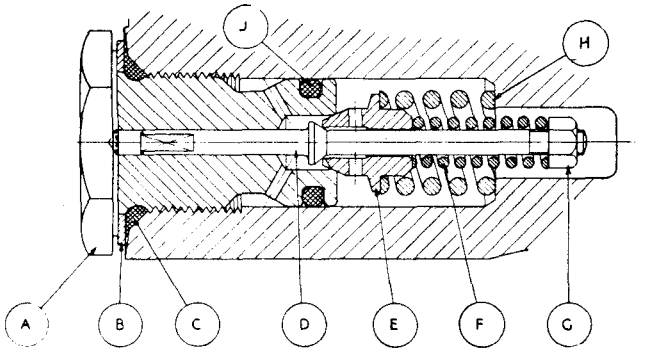


Fig. 6. Sectional view of Rebound and Compression Valve of Rear Shock Absorber.

A Valve Screw
B Valve Screw Washer
C Ring Seal
D Rebound Valve
E Compression Valve
F Rebound Valve Spring
G Rebound Valve Spring Nut
H Compression Spring
J Ring Seal

3. VALVE OPERATION

To accomplish general damping of the car springs, a small bleed is built into the valve. This operates both on compression (axle moving up) and on rebound (axle moving down). As bumps become more severe on compression, pressure builds up in the compression cylinder and blows the compression valve off its seat at a pre-determined pressure controlled by the outer spring.

As the speed of the rebound increases, pressure is built up in the rebound cylinder and blows the rebound valve off its seat at a pre-determined pressure controlled by the inner spring.

It will be clear that by suitable selection of springs in the valve, any range from zero to a maximum rating of the shock absorber can be obtained in either direction.

4. TO REMOVE REAR SHOCK ABSORBER

(**a**) Jack up the rear of the car and remove the road wheel nearest to the shock absorber to be removed.

(**b**) Remove the nyloc nut and plain washer from the connecting rod attachment to the spring plate. It may be necessary to hold the hexagon on the inner side of the spring plate.

(**c**) Remove the nut and lock washer from the upper joint of the connecting link. Utilising a suitable extractor, remove the link from the shock absorber arm, this is a taper fit. Remove the connecting link from between chassis frame and spring.

(**d**) Remove the bolts and nyloc nuts securing the body of the shock absorber to its bracket on the chassis frame and withdraw the shock absorber and connecting link.

5. TO FIT REAR SHOCK ABSORBER

(**a**) Remove the connecting link from the shock absorber arm.

(**b**) Offer up the shock absorber to its bracket on the chassis frame in such a manner that the body faces outwards and the arm points rearwards. Secure with two bolts and nyloc nuts.

(**c**) With the spherical knuckle of the connecting link lowermost, offer up the link to the shock absorber arm and spring plate, the link should be positioned between the road spring and chassis frame, with the nuts away from the centre line. Holding the hexagon of the lower attachment bolt secure the link to the spring plate with a nyloc nut and plain washer.

(**d**) Utilising a nut and lock washer secure the connecting link to the shock absorber arm.

(**e**) Fit road wheel and remove jacks.

Service Instruction Manual

FRAME UNIT

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SECTION J

FRAME UNIT

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ILLUSTRATIONS

FRAME UNIT

1. DESCRIPTION. Fig. 1.

A rigid structure is provided, the frame side members being formed by opposed steel pressings welded together, giving tubular type side members of rectangular section.

Welded at the front and rear ends of the side members are two tubular cross members. The front tube is $1\frac{1}{8}$" diameter and is supported by the steering unit and idler unit mounting brackets welded to the side members. The rear tube of $1\frac{3}{4}$" diameter is welded between the two side members. A second tube, just forward of the rear one, protrudes through the side members and to it the rear road spring shackle brackets are welded.

The centre of the frame is braced by channel sectioned steel pressings forming a rigid cruciform structure and stiffened at its centre by heavy gauge plates. This structure carries the gearbox and handbrake mounting brackets.

At the front end but a little to the rear of the tubular cross member, the frame is braced by opposed steel pressings welded together and forming a rigid box section cross member. This member forms the lower points of attachment for the front suspension and engine mountings. It is built up to form the upper abutments for the front road springs and this upper structure is braced by a detachable tubular cross member and by supports to the two side members.

Welded in position approximately half-way along the inner side of each side member are the jacking brackets. To each cruciform member is welded an outrigger body support bracket, these brackets pass through and are supported by the side members. There are four such brackets.

The complete frame is protected from corrosion by rust proofing.

2. THE ASSESSMENT OF ACCIDENTAL DAMAGE

For this purpose reproduction drawings of the chassis frame giving the necessary dimensions are given as Fig. 1.

Even when a car has suffered only superficial damage it is possible that the frame members have been displaced which will result in the road wheels failing to track correctly and it is recommended that the frame is checked for squareness.

It is possible to check the frame dimensionally to a satisfactory degree of accuracy without first removing the body. For clarity the chassis frame only is shown in the illustrations of this section.

Details of checks for "twist," "cradling," "squareness," and "bowing," are given in this section. By carrying out these checks in the order mentioned a great deal of work is eliminated.

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FRAME UNIT

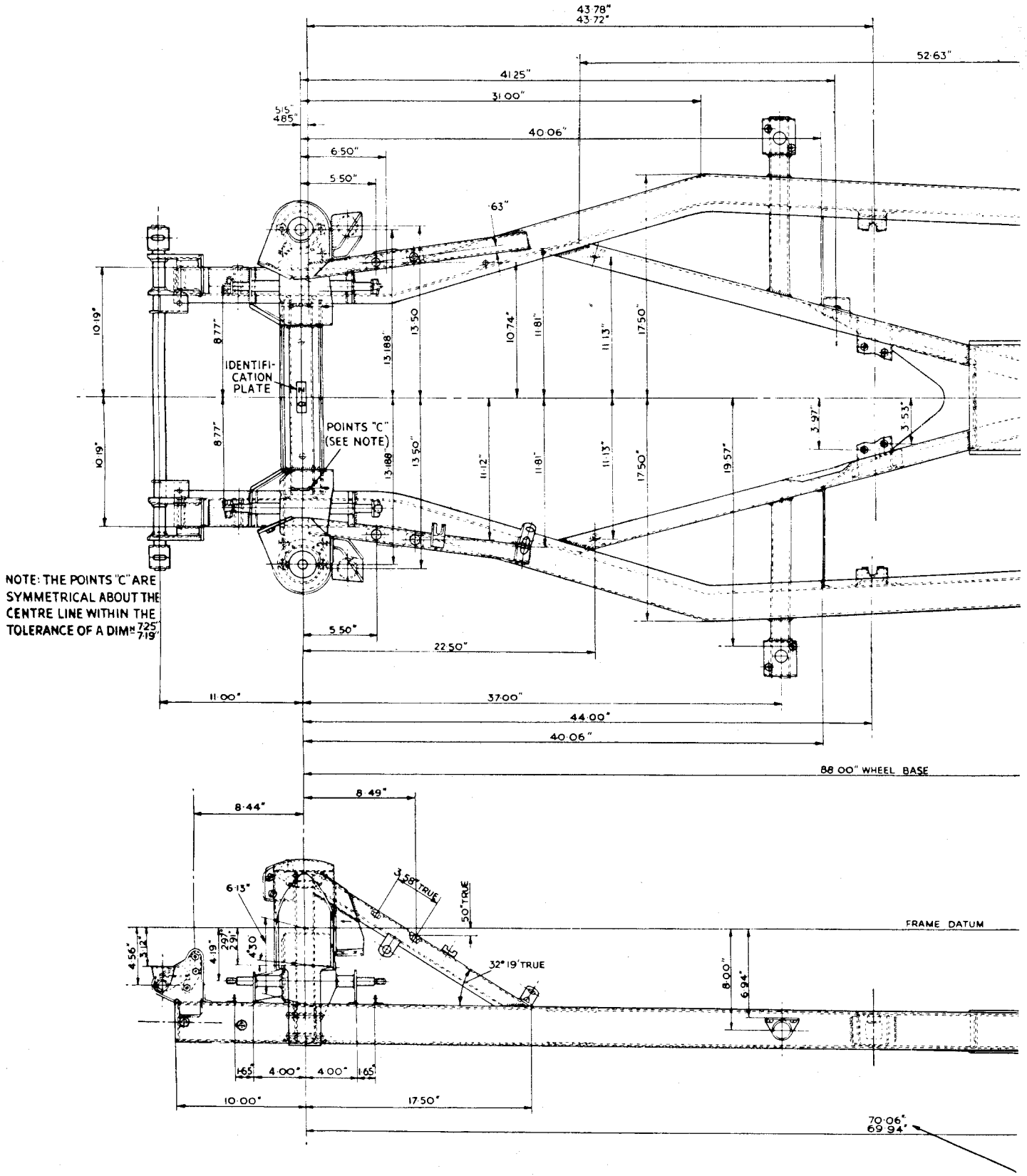
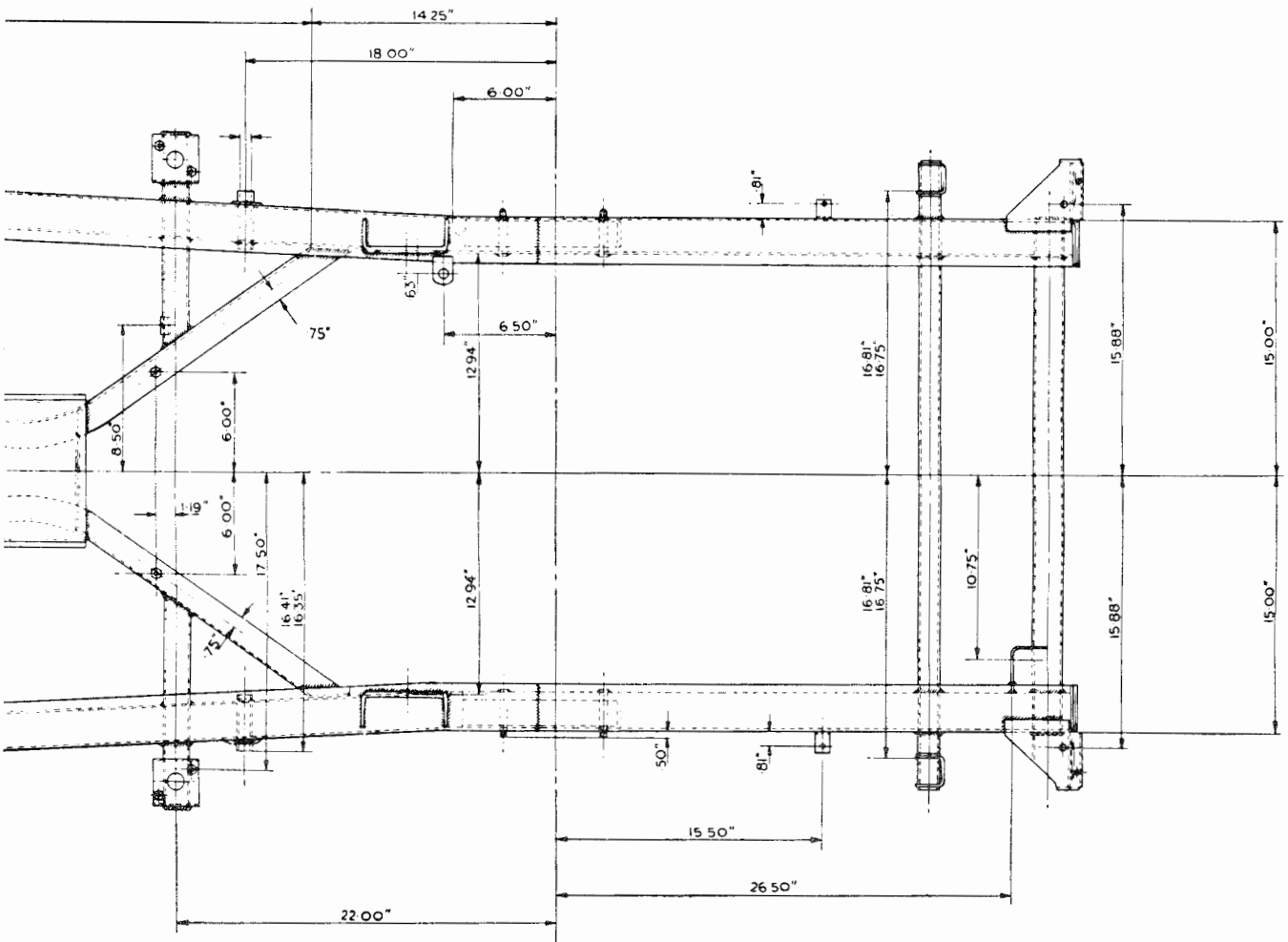
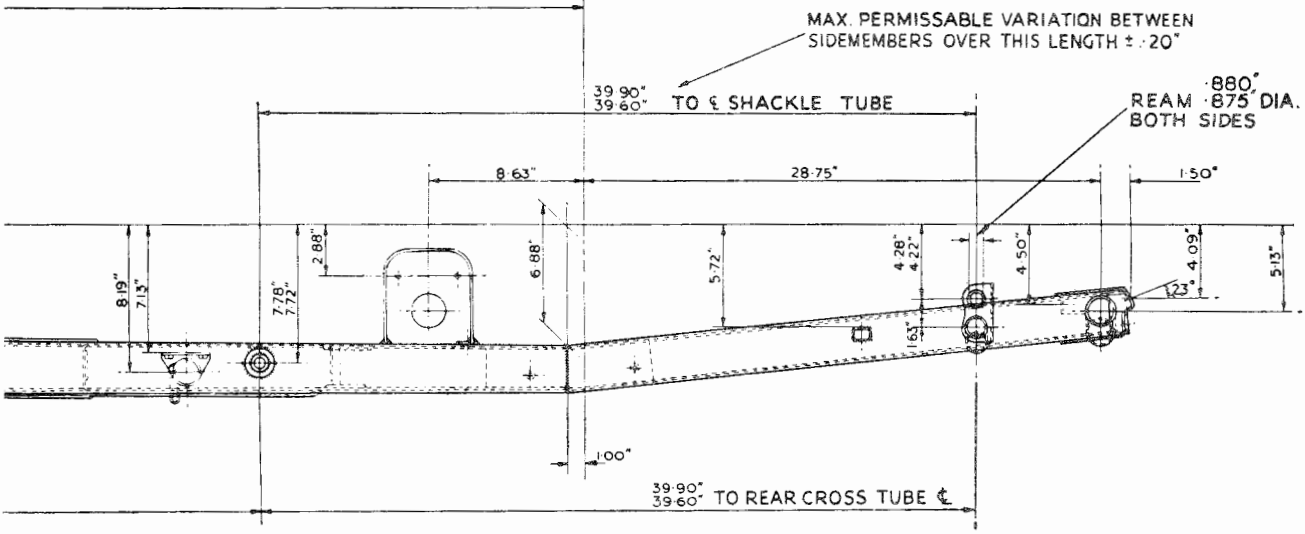


Fig. 1 {Plan view of Frame Unit.
Side view of Frame Unit.

FRAME UNIT





MAX PERMISSABLE VARIATION BETWEEN SIDEMEMBERS OVER THIS LENGTH ± .10"

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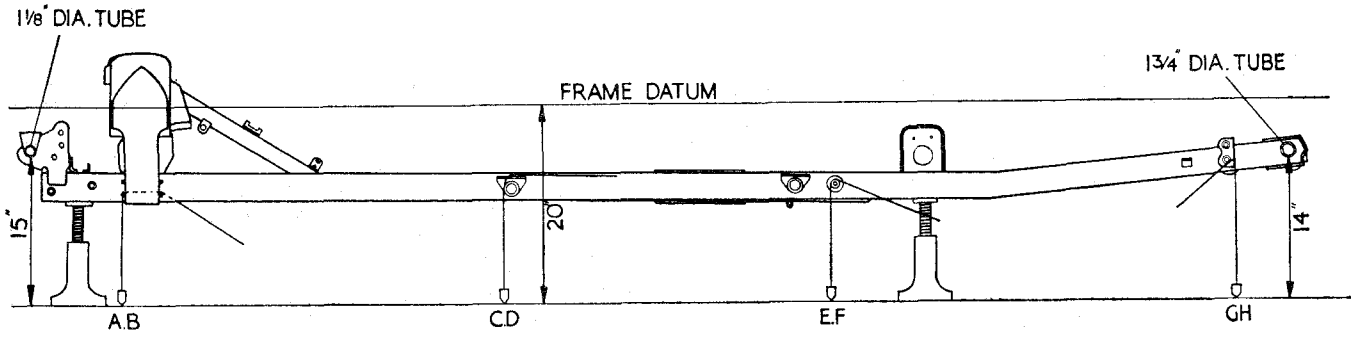

Fig. 2 The car prepared for the assessment of accidental damage, in particular the assessment of "cradling" (for clarification purposes only the chassis frame is shown).

3. PREPARATION OF CAR (Fig. 2)

(a) Select a clean level floor space and jack up the car, utilising four screw jacks. It is suggested that two jacks are placed near the front box section cross member and the second two under the side members at the rear.

Remove all four road wheels.

(b) Adjust the rear jacks until the straight portion of the rearmost tubular cross member is 14″ from the ground, measured as close to the side member as is practical.

(c) Adjust the two front jacks similarly until the foremost tubular cross member is 15″ from the ground, measured as close to the steering and idler mounting brackets as possible.

(d) Remove the front rebound buffer and bracket from each side of the chassis frame by withdrawing two bolts, nuts and lock washers.

(e) Through the lower bolt hole pass the plumb bob cord from front to rear. Mark the floor directly under the plumb bob pointer. This operation is repeated on the other side of the chassis frame and so creates points A and B (Fig. 3).

(f) From inside the car adjacent to the front door posts raise the carpet and remove the most forward body securing bolts from the forward outrigger body supports.

(g) Pass the plumb bob cord from below through the bolt hole. Mark the floor immediately below the plumb bob pointer. The operation is repeated on the other side and so creates points C and D (Fig. 3).

(h) Withdraw the split pins to remove the castellated nuts and "D" washers from the rear road spring front fulcrum pins.

(i) Pass the cord of the plumb bob over the fulcrum pin in such a manner that the bob hangs in front of the pin. Mark the floor immediately below the plumb bob pointer. This operation is repeated on the other side of the chassis and creates the points E and F (Fig. 3).

(j) Thread the cord of the plumb bob from the rear and through the lower jig hole in the rear road spring shackle bracket. Mark the floor immediately below the plumb bob pointer. This operation, when repeated on the other side of the chassis frame, creates points G and H (Fig. 3).

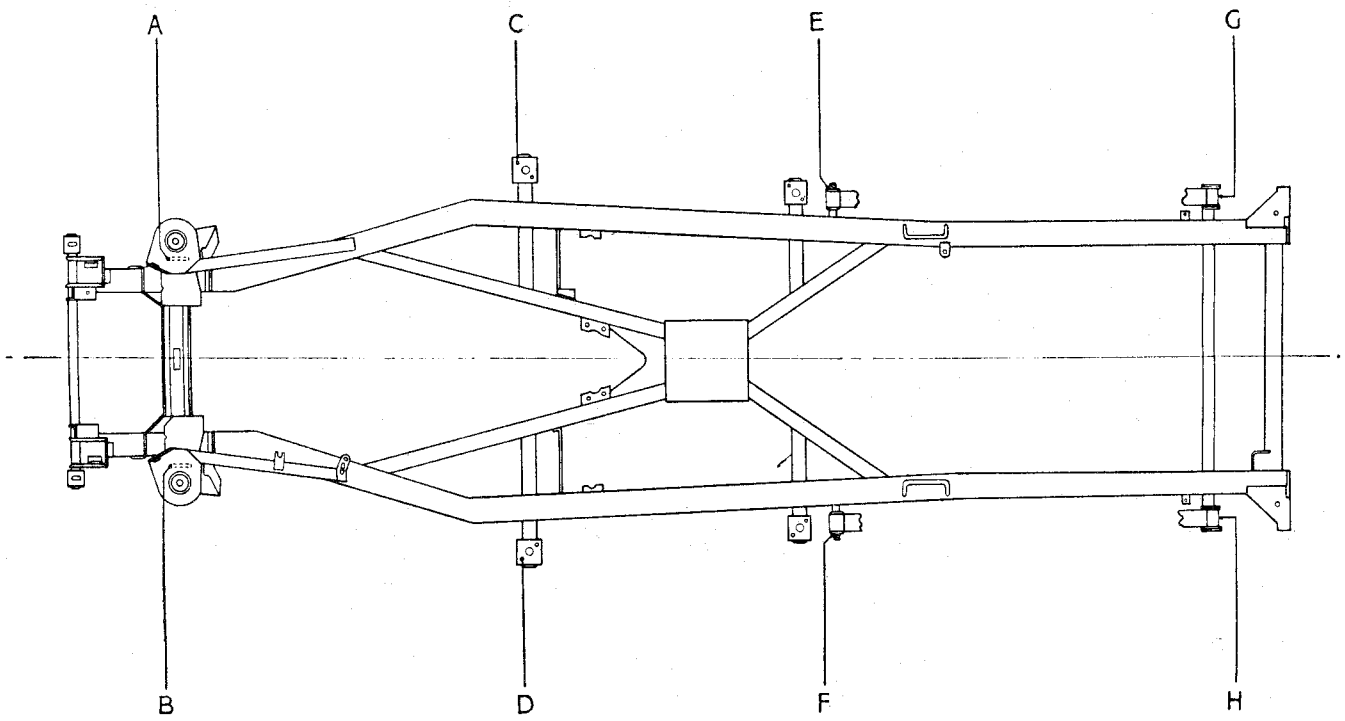

Fig. 3 **Illustrating the eight points of the chassis which are generated on the floor below.**

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4. CHECKING THE SIDE MEMBERS FOR TWIST

If, by adjusting the screw jacks under the chassis frame as described in "Preparation of Car" page 3 operation **a**—**c**, it is found to be an impossibility to bring the front cross member and the straight portions of the rear cross members parallel to the ground, the frame can be considered to be "twisted."

5. CHECKING SIDE MEMBERS FOR CRADLING

(**a**) Having prepared the car as detailed in "Preparation of Car" page 3 operations **a**—**c**, it is now standing with the datum line parallel to the ground and this line is 20″ from the ground (Fig. 2).

(**b**) Referring to Fig. 1 it will be observed that all dimensions are given from this datum line and by simple subtraction of these dimensions from 20″ it is possible to calculate their height above the ground.

As an example, when checking the position of one of the front "out rigged" body supports, the dimension given is 6.94″ from the top of the support to the datum, therefore if we subtract 6.94″ from 20″ the result will be 13.06″ which should be the distance between the top of the support and the floor.

(**c**) Measure the height above the ground at several points and subtract the dimensions obtained from 20″. By comparing the results with the drawing dimensions, it will be possible to determine whether the frame is true.

(**d**) (**i**) When the difference is greater than the drawing, the chassis frame is "bowed" downward.

(**ii**) When the difference is less that the drawing the chassis frame is "bowed" upwards.

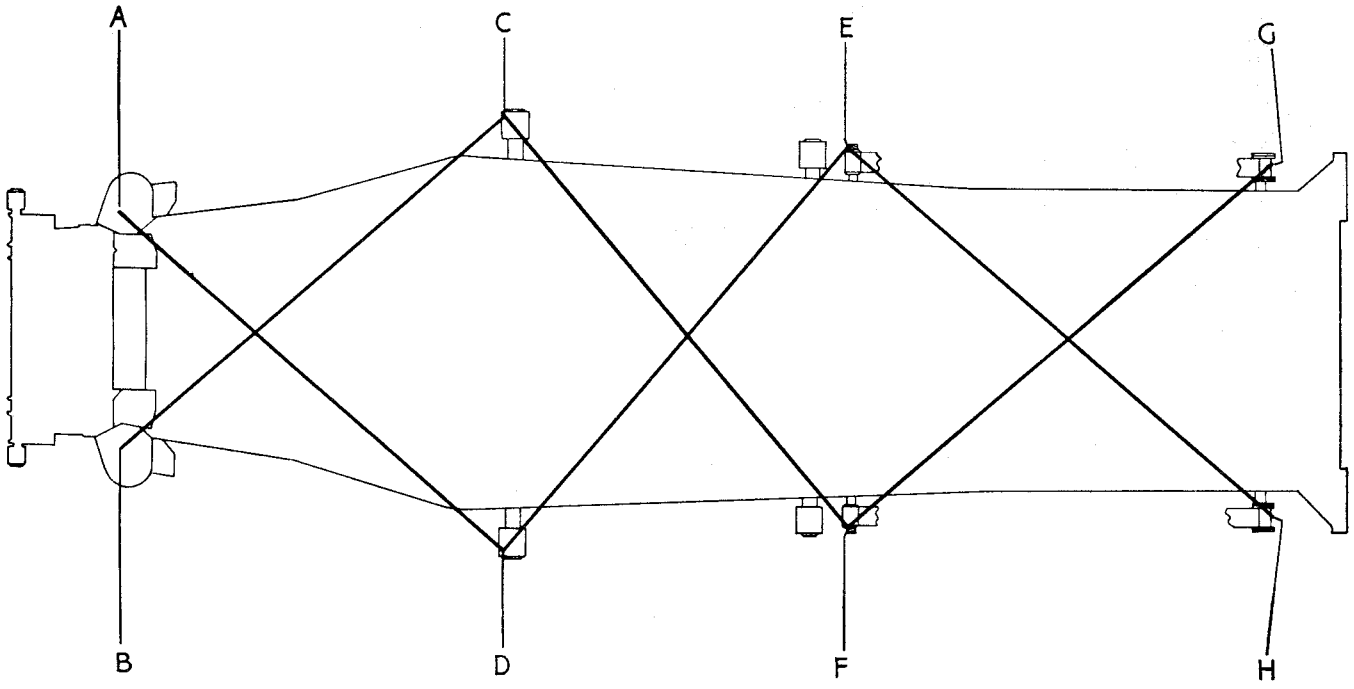

Fig. 4 **Utilising the eight generated points for the assessment of frame "squareness."**

6. CHECKING SIDE MEMBERS FOR SQUARENESS (Fig. 4)

(**a**) It is assumed that the car has been prepared and the eight points generated on the floor below. Replace the road wheel and rebound rubber bracket. The car is now moved so that the position of the markings can be examined.

(**b**) Utilising a suitable measure ascertain the lengths of the diagonals AD, BC, CF, DE, EH, and FG.

(**c**) If the chassis frame is square the length AD will equal BC, CF will equal DE and EH will equal FG.

(**d**) (**i**) When BC, DE, and FG are of greater length than AD, CF and EH respectively the left hand (BH) side member is forward of the right hand (AG) side member.

(**ii**) When AD, CF and EH are of greater length than BC, DE and FG respectively the right hand (AG) side member is forward of the left hand (BH) side member.

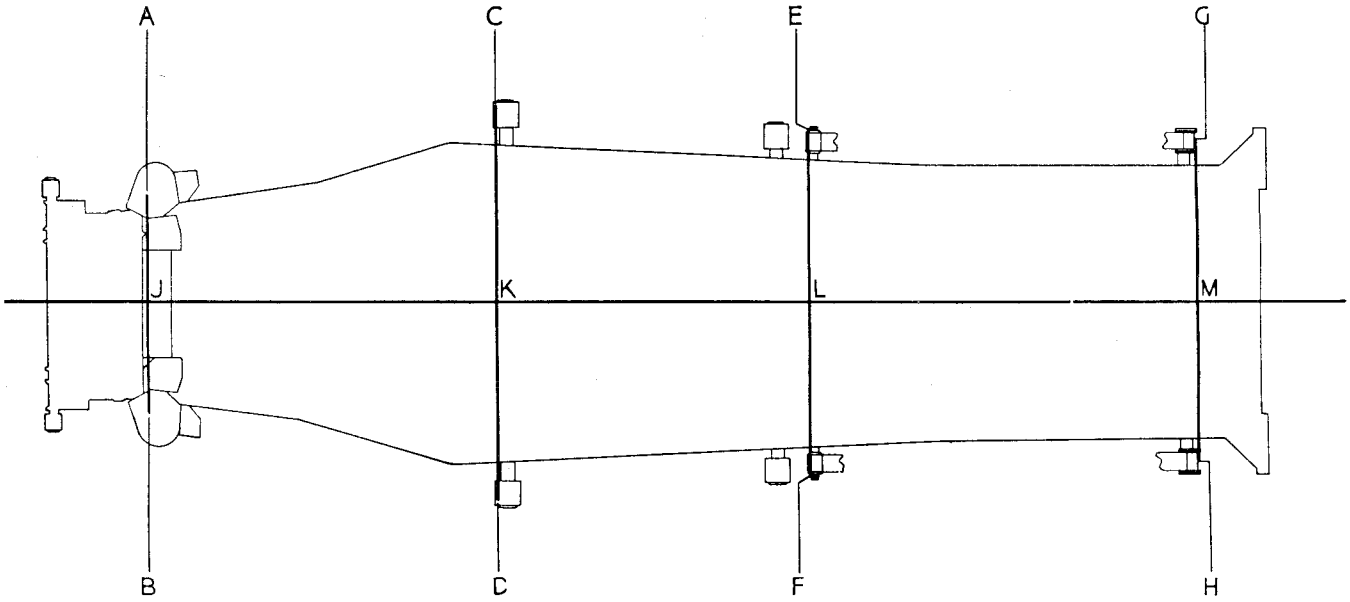

Fig. 5 **Utilising the eight generated points for the assessment of "bowing."**

7. CHECKING THE SIDE MEMBERS FOR BOWING (Fig. 5)

(**a**) Having gained access to the points generated on the floor beneath the car, join the points A to B, C to D, E to F and G to H.

(**b**) Accurately determine the mid-points of the lines AB, CD, EF and GH. Call these points J, K, L and M respectively.

(**c**) With a suitable straight edge join point J to point M.

(**d**) (**i**) If this line passed through points K and L the side members are correctly aligned.

(**ii**) When the points K and L lay to the right of the line JM the side members are "bowed" to the right.

(**iii**) When the points K and L lay to to the left of the line JM the side members are "bowed" to the left.

J

Service Instruction Manual

PROPELLER SHAFT

K

SECTION K

PROPELLER SHAFT

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ILLUSTRATIONS

PROPELLER SHAFT

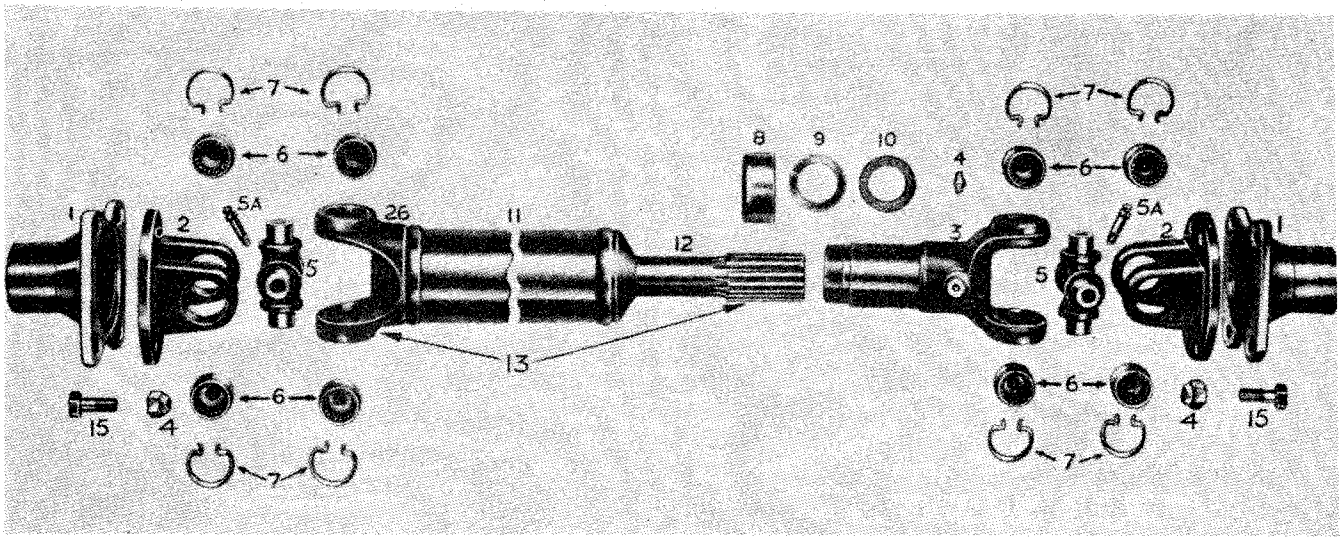

Fig. 1 Propeller Shaft Details.

NOTATION FOR FIG. 1			
Ref. No.	Description	Ref. No.	Description
1	Companion Flange.	8	Dust Cap.
2	Flange Yoke.	9	Steel Washer.
3	Sleeve Yoke Assembly.	10	Cork Washer.
4	Nipple for Splines.	11	Tube.
5	Spider Journal Assembly (less Nipple).	12	Splined Stub Shaft.
5A	Nipple for Journal Assembly.	13	Propeller Shaft Assembly.
6	Bearing Race Assembly.	14	Simmonds Nut.
7	Snap Ring.	15	Flange Attachment Bolts.

K

1. DESCRIPTION

The propeller shaft and universal joints fitted to this model are the Hardy Spicer Series 1300, the tube diameters being 2", and the overall length of the assemblies being 2' $4\frac{9}{16}$".

Details of these propeller shafts are as shown in exploded form in Fig. 1.

When the rear axle rises and falls, with the flexing of the springs, the arc of the axle's travel necessitates variations in the length of the propeller shaft which is provided for by the fitting of a sliding spline at the front end of the assembly. The splined end of the propeller shaft is shown under Notation 13 in Fig. 1.

A universal joint is supplied at each end, consisting of a central spider having four trunnions, four needle roller bearings and two yokes as can be appreciated by a study of Fig. 1.

2. LUBRICATION

Each spider is provided with an oil nipple and there is one fitted on the sleeve yoke assembly (3) to lubricate the sliding spline. After dismantling and before re-assembly, the inside splines of the sleeve yoke should be liberally smeared with oil.

Each of the two journal assemblies are provided with an oil nipple which should be lubricated each 5,000 miles in accordance with the lubrication recommendation made in the summary in " General Data " Section.

If a large amount of oil exudes from the oil seals, the joint should be dismantled and new oil seals fitted.

3. MAINTENANCE INSTRUCTIONS

To test for wear

Wear on the thrust faces is located by testing the lift in the joint by hand.

Any circumferential movement of the shaft relative to the flange yokes indicates wear in the needle roller bearings and/or the sliding splines.

4. REMOVAL OF PROPELLER SHAFT

(**a**) Jack up one rear wheel clear of the ground to enable the propeller shaft to be rotated.

(**b**) Remove nuts from bolts at both flange yokes engaging first gear, as necessary to hold the shaft from turning when slackening nuts.

(**c**) Tap out bolts and remove propeller shaft assembly.

5. TO DISMANTLE PROPELLER SHAFT

Before commencing to dismantle propeller shaft see if "arrow" location marks are visible when the parts are clean. If no markings are visible, re-mark to ensure correct re-assembly.

Having unscrewed the dust cap (8, Fig. 1), pull sleeve yoke assembly (3, Fig. 1) off shaft. Clean enamel from snap rings and top of bearings races. Remove all snap rings by pinching ears together with a suitable pair of circlip pliers and subsequently prising out these with a screwdriver. If ring does not snap out of groove readily, tap end of bearing race lightly inwards to relieve the pressure against ring. Holding joint in left hand with splined sleeve yoke lug on top, tap yoke arms lightly with a soft hammer as shown in

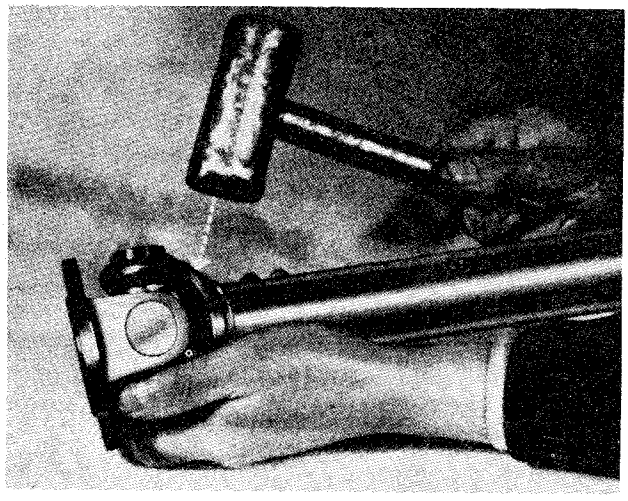

Fig. 2 **Tapping Tube Yoke to release Bearing.**

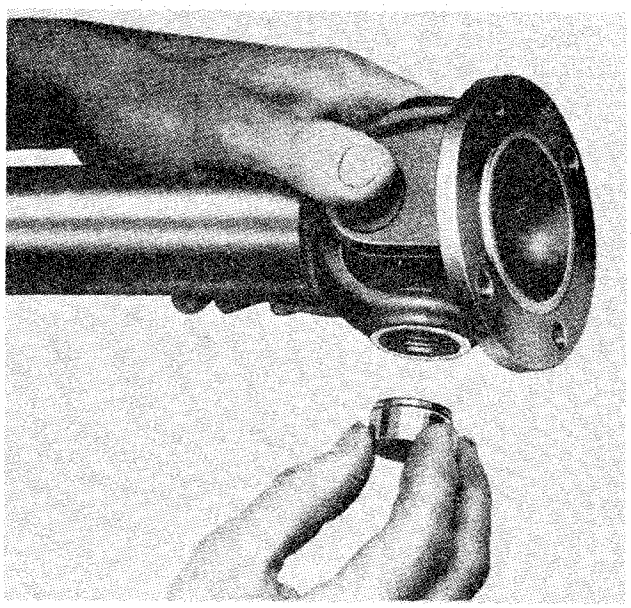

Fig. 3 **Removing Bearing.**

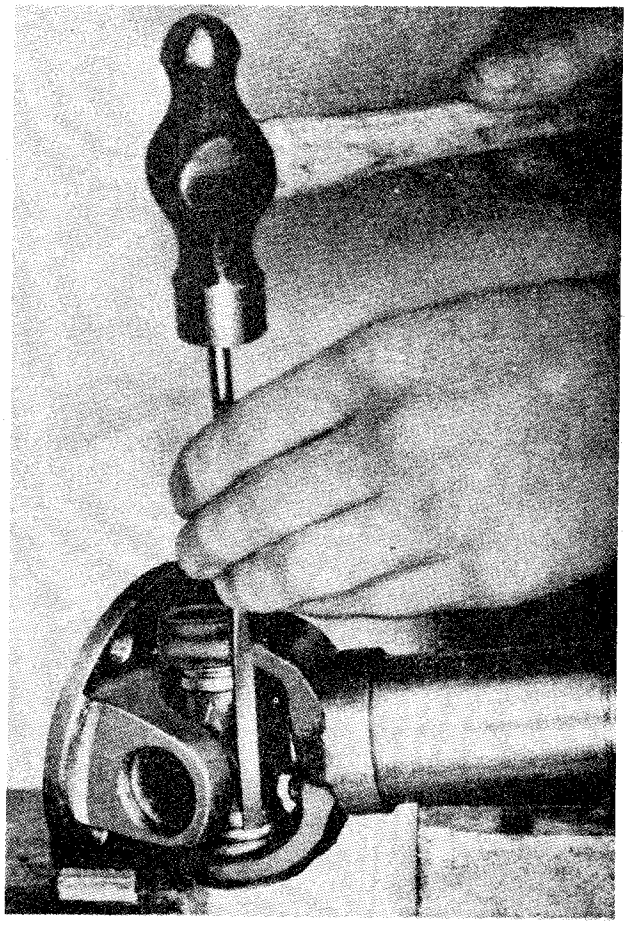

Fig. 4 **Removing Bearing Race with Special Punch.**

Fig. 2. Top bearing should begin to emerge, turn joint over and finally remove with fingers as shown in Fig. 3.
If necessary tap bearing race from inside with small diameter bar, as shown in Fig. 4, taking care not to damage the bearing race. This operation will destroy the oil seal and necessitate fitting replacement parts when re-assembling, keep joint in this position whilst removing bearing race, so as to avoid dropping the needle rollers.
Repeat the operation described in previous paragraph for opposite bearing. The splined sleeve yoke can now be removed as shown in Fig. 5.
Rest the two exposed trunnions on wood or lead blocks, then tap flange yoke with soft hammer to remove the two remaining bearing races.

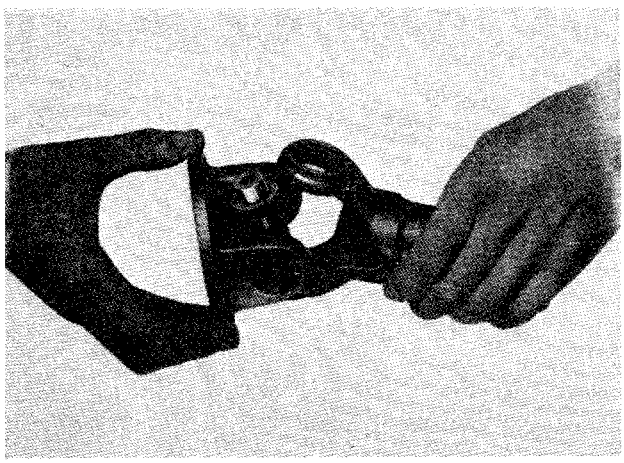

Fig. 5 **Removing the Yoke.**

6. TO EXAMINE AND CHECK FOR WEAR

The parts most likely to show signs of wear after long usage are the bearing races and spider trunnions. Should looseness in the fit of these parts, load markings, or distortion be observed, they must be renewed complete, as no oversize journal bearing races are provided. It is essential that bearing races are a light drive fit in the yoke.
In the rare event of wear having taken place in the yoke cross hole, the holes will most certainly be oval, and such yokes must be replaced.
In the case of wear of the cross holes in a fixed yoke, which is part of the tubular shaft assembly, only in cases of absolute emergency should this be replaced by welding in a new yoke. The normal procedure is to replace by a complete shaft assembly. The other parts likely to show signs of wear are the splines of the sleeve yoke, or splined stub shaft. A total of .004″ circumferential movement, measured on the outside diameter of the spline, should not be exceeded.
In the event of the splined stub shaft requiring renewal this must be dealt with in the same way as the fixed yoke, *i.e.*, a replacement tubular shaft assembly fitted.

7. TO ASSEMBLE

See that the trunnion assemblies are well lubricated with one of the oils recommended. Assemble needle rollers in bearing recess, smearing the walls of the races with vaseline, or lubricant, to retain the rollers in place.
It is advisable to replace cork gaskets and gasket retainers (oil seals) on the trunnions using a tubular drift as shown in Fig. 6. The spider journal shoulders should be shellacked prior to fitting retainers to ensure a good oil seal. Ensure that the trunnions are clean and free from shellac before fitting needle rollers.

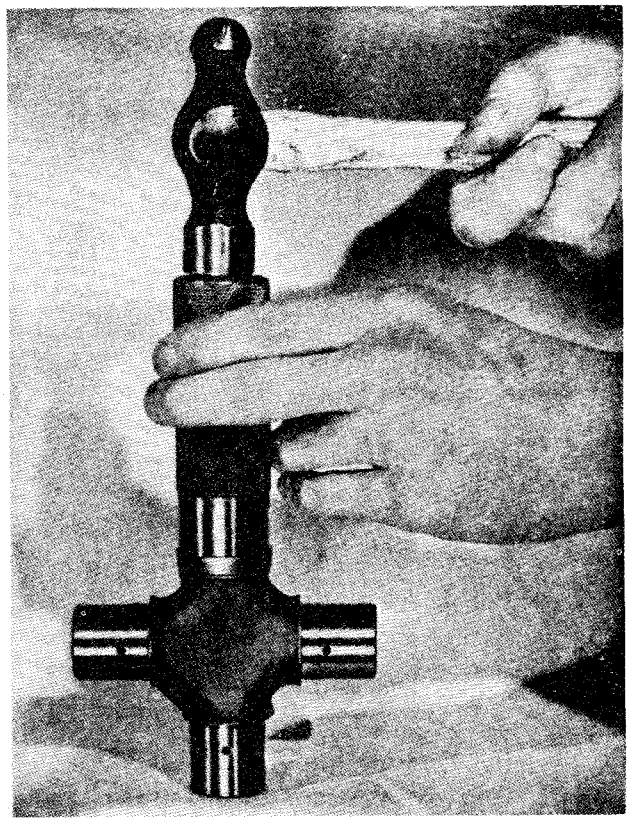

Fig. 6 **Fitting New Oil Seals.**

KI

Insert spider in flange yoke. Then using a soft-nosed drift about $\frac{1}{32}$" smaller in diameter than the hole in the yoke, tap the bearing into position. It is essential that bearing races are a light drive fit in the yoke holes. Repeat this operation for the other three bearings.

Refit snap rings with a suitable pair of circlip pliers, ensuring that rings engage properly with their respective grooves. If joint appears to bind after assembly, tap lightly with a soft hammer, thus relieving any pressure of the bearings on the ends of the trunnions.

WHEN REPLACING SLIDING JOINT ON SHAFT BE SURE THAT SLIDING AND FIXED YOKES ARE IN THE SAME PLANE AND ARROW MARKINGS COINCIDE. A single universal joint does not transmit uniform motion when the driving and driven shafts are out of line, but when two joints are used as in the case of a propeller shaft, and are set in correct relation the one to the other, the errors of one are corrected by the discrepancies of the other, and uniform motion is then transmitted. Hence the importance of re-engaging the splines correctly when they have been taken apart.

8. TO FIT PROPELLER SHAFT

Wipe companion flange and flange yoke faces clean, to ensure the pilot flange registering properly and joint faces bedding evenly all round. Insert bolts, and see that all nuts are evenly tightened all round and are securely locked. Dust cap to be screwed up by hand as far as possible. Sliding joint is always placed towards front of vehicle.

Service Instruction Manual

WHEELS AND TYRES

L

SECTION L

WHEELS AND TYRES

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ILLUSTRATIONS

WHEELS AND TYRES

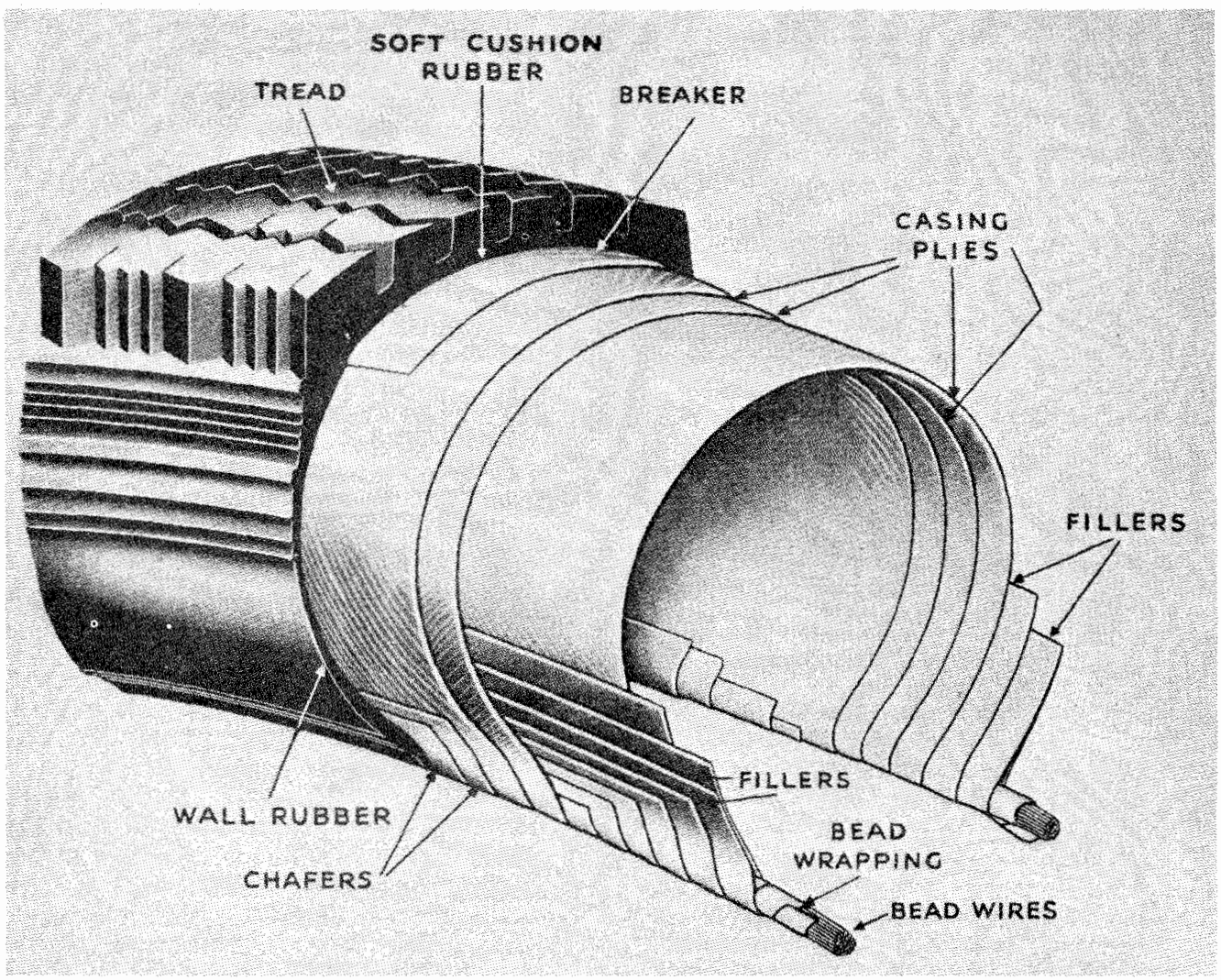

Fig. 1 Tyre Construction.

Construction of Tyre

One of the principal functions of the tyres fitted to a car is to eliminate high frequency vibrations. They do this by virtue of the fact that the unsprung mass of each tyre—the part of the tyre in contact with the ground—is very small.

Tyres must be flexible and responsive. They must also be strong and tough to contain the air pressure, resist damage, give long mileage, transmit driving and braking forces, and at the same time provide road grip, stability, and good steering properties.

Strength and resistance to wear are achieved by building the casing from several plies of cord fabric, secured at the rim position by wire bead cores, and adding a tough rubber tread (Fig. 1).

Part of the work done in deflecting the tyres on a moving car is converted into heat within the tyres. Rubber and fabric are poor conductors and internal heat is not easily dissipated. Excessive temperature weakens the tyre structure and reduces the resistance of the tread to abrasion by the road surface.

Heat generation, comfort, stability, power consumption, rate of tread wear, steering properties and other factors affecting the performance of the tyres and car are associated with the degree of tyre deflection. All tyres are designed to run at predetermined deflections, depending upon their size and purpose.

Load and pressure schedules are published by all tyre makers and are based on the correct relationship between tyre deflection, tyre size, load carried and inflation pressure. By following

the recommendations, the owner will obtain the best results both from the tyres and the car.

Tyre Pressures:

Correct tyre pressures for 5.50″—15″ are :
Front 22 lbs. Rear 24 lbs.

Note.—Pressures should be checked when the tyres are cold, such as after standing overnight, and not when they have attained normal running temperatures.

Pressures shown are for normal motoring when sustained high speeds are not possible.

Special Pressures for High Speed Motoring

(a) For touring at sustained speeds in excess of 85/90 m.p.h., pressure in front and rear tyres should be increased by 6 lb. per sq. in.

(b) For predominantly and regularly high speed touring of continental type, pressures in front and rear tyres should be increased by 8 lbs. per sq. in.

Tyres lose pressure, even when in sound condition, due to a chemical diffusion of the compressed air through the tube walls. The rate of loss in a sound car tyre is usually between 1 lb. and 3 lbs. per week, which may average 10% of the total initial pressure.

For this reason, and with the additional purpose of detecting slow punctures, *pressures should be checked with a tyre gauge applied to the valve not less often than once per week.*

Any unusual pressure loss should be investigated. After making sure that the valve is not leaking the tube should be removed for a water test.

Do not over-inflate, and do not reduce pressures which have increased owing to increased temperature. (See " Factors Affecting Tyre Life and Performance," page 3).

(a) **Valve Cores and Caps**

Valve cores are inexpensive and it is a wise precaution to renew them periodically.

Valve caps should always be fitted, and renewed when the rubber seatings have become damaged after constant use.

(b) **Tyre Examination**

Tyres on cars submitted for servicing should be examined for :—

Inflation pressures.
Degree and regularity of tread wear.
Misalignment.
Cuts and penetrations.
Small objects embedded in the treads, such as flints and nails.
Impact bruises.
Kerb damage on walls and shoulders.
Oil and grease.
Contact with the car.

Oil and grease should be removed by using petrol sparingly. Paraffin is not sufficiently volatile and is not recommended.

If oil or grease on the tyres results from over-lubrication or defective oil seals suitable correction should be made.

(c) **Repair of Injuries**

Minor injuries confined to the tread rubber, such as from small pieces of glass or road dressing material, require no attention other than the removal of the objects. Cold filling compound or " stopping " is unnecessary in such cases.

More severe tread cuts and wall rubber damage, particularly if they penetrate to the outer ply of the fabric casing, require vulcanised repairs. The Dunlop Spot Vulcanising Unit is designed for this purpose and it is also suitable for all types of tube repairs.

Injuries which extend into or through the casing, except clean nail holes, seriously weaken the tyre. Satisfactory repair necessitates new fabric being built in and vulcanised. This requires expensive plant and should be undertaken by a tyre repair specialist or by the tyre maker.

Loose gaiters and " stick-in " fabric repair patches are not satisfactory substitutes for vulcanised repairs and should be used only as a temporary " get-you-home " measure if the tyre has any appreciable tread remaining. They can often be used successfully in tyres which are nearly worn out and which are not worth the cost of vulcanised repairs.

Clean nail holes do not necessitate cover repairs. If a nail has penetrated the cover the hole should be sealed by

a tube patch attached to the inside of the casing. This will protect the tube from possible chafing at that point.
If nail holes are not clean, and particularly if frayed or fractured cords are visible inside the tyre, expert advice should be sought.

1. FACTORS AFFECTING TYRE LIFE AND PERFORMANCE

(a) Inflation Pressures

Other things being equal there is an average loss of 13% tread mileage for every 10% reduction in inflation pressure below the recommended figure. The tyre is designed so that there is minimum pattern shuffle on the road surface and a suitable distribution of load over the tyre's contact area when deflection is correct.
Moderate under-inflation causes an increased rate of tread wear although the tyre's appearance may remain normal. Severe and persistent under-inflation produces unmistakable evidence on the tread (Fig. 2). It also causes structural failure due to excessive friction and temperature within the casing (Figs. 3 and 4).
Pressures which are higher than those recommended for the car reduce comfort. They may also reduce tread life due to a concentration of the load and wear on a smaller area of tread, aggravated by increased wheel bounce on uneven road surfaces. Excessive pressures overstrain the casing cords, in addition to causing rapid wear, and the tyres are more susceptible to impact fractures and cuts.

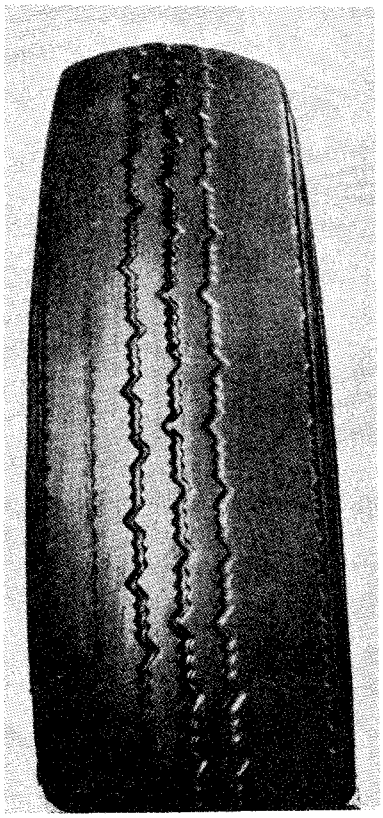

Fig. 2 **Excessive Tyre Wear due to persistent under-inflation.**

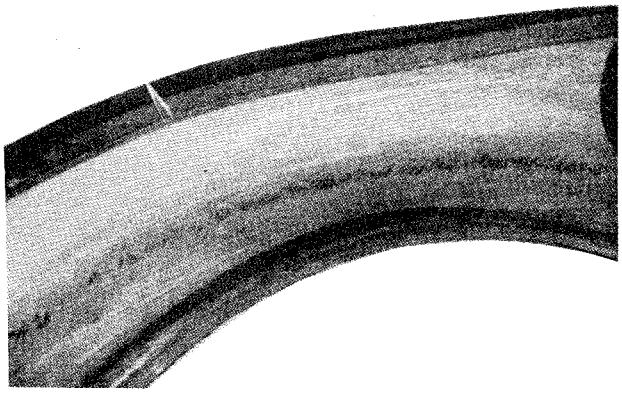

Fig. 3 **Breaking up of Casing due to over-flexing and heat generation.**

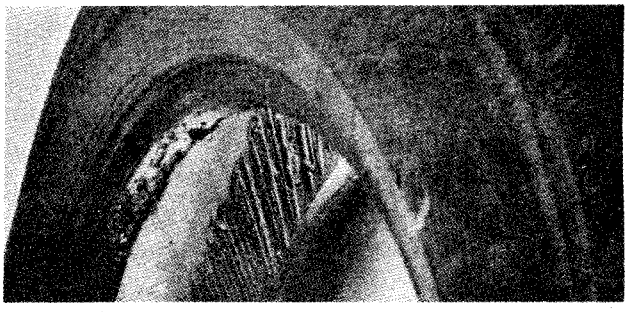

Fig. 4 **Running deflated destroyed this Tyre.**

(b) Effect of Temperature

Air expands with heating and tyre pressures increase as the tyres warm up. Pressures increase more in hot weather than in cold weather and as the result of high speed. These factors

are taken into account when designing the tyre and in preparing Load and Pressure Schedules.
Pressures in warm tyres should not be reduced to standard pressures for cold tyres. " Bleeding " the tyres increases their deflections and causes their temperatures to climb still higher. The tyres will also be under-inflated when they have cooled.

(c) Speed

High speed is expensive and the rate of tread wear may be twice as fast at 50 m.p.h. as at 30 m.p.h.
High speed involves :—

(i) Increased temperatures due to more deflections per minute and a faster rate of deflection and recovery. The resistance of the tread to abrasion decreases with increase in temperature.
(ii) Fierce acceleration and braking.
(iii) More tyre distortion and slip when negotiating bends and corners.
(iv) More " thrash " and " scuffing " from road surface irregularities.

(d) Braking

" Driving on the brakes " increases rate of tyre wear, apart from being generally undesirable. It is not necessary for wheels to be locked for an abnormal amount of tread rubber to be worn away.
Other braking factors not directly connected with the method of driving can affect tyre wear. Correct balance and lining clearances, and freedom from binding, are very important. Braking may vary between one wheel position and another due to oil or foreign matter on the shoes even when the brake mechanism is free and correctly balanced.
Brakes should be relined and drums reconditioned in complete sets. Tyre wear may be affected if shoes are relined with non-standard material having unsuitable characteristics or dimensions, especially if the linings differ between one wheel position and another in such a way as to upset the brake balance. Front tyres, and particularly near front tyres, are very sensitive to any condition which adds to the severity of front braking in relation to the rear.
" Picking up " of shoe lining leading edges can cause grab and reduce tyre life. Local " pulling up " or flats on the tread pattern can often be traced to brake drum eccentricity. (Fig. 5.) The braking varies during each wheel revolution as the minor and major

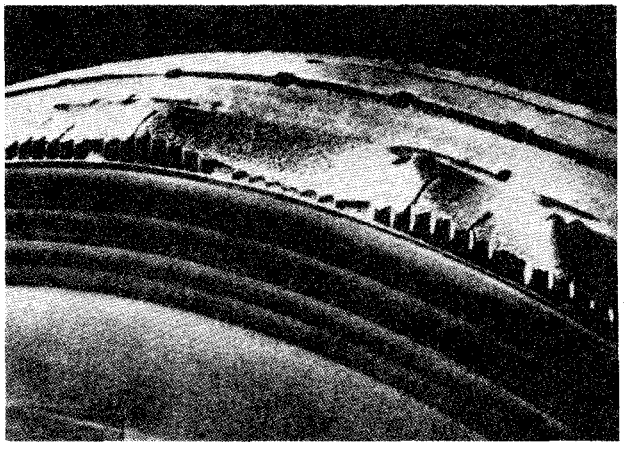

Fig. 5 **Local excessive wear due to Brake Drum Eccentricity.**

axes of the eccentric drum pass alternately over the shoes. Drums should be free from excessive scoring and be true when mounted on their hubs with the road wheels attached.

(e) Climatic Conditions

The rate of tread wear during a reasonably dry and warm summer can be twice as great as during an average winter.
Water is a rubber lubricant and tread abrasion is much less on wet roads than on dry roads. Also the resistance of the tread to abrasion decreases with increase in temperature. Increased abrasion on dry roads, plus increased temperatures of tyres and roads cause faster tyre wear during summer periods. For the same reasons tyre wear is faster during dry years with comparatively little rainfall than during wet years.
When a tyre is new its thickness and pattern depth are at their greatest. It follows that heat generation and pattern distortion due to flexing, cornering,

driving and braking are greater than when the tyre is part worn. Higher tread mileages will usually be obtained if new tyres are fitted in the autumn or winter rather than in the spring or summer. This practice also tends to reduce the risk of road delays because tyres are more easily cut and penetrated when they are wet than when they are dry. It is therefore advantageous to have maximum tread thickness during wet seasons of the year.

(f) Road Surface

The extent to which road surfaces affect tyre mileage is not always realised.

Present day roads generally have better non-skid surfaces than formerly. This factor, combined with improved car performance, has tended to cause faster tyre wear, although developments in tread compounds and patterns have done much to offset the full effects.

Road surfaces vary widely between one part of the country and another, often due to surfacing with local material. In some areas the surface dressing is coarser or of larger " mesh " than in others. The material may be comparatively harmless rounded gravel or more abrasive crushed granite or knife edged flint. Examples of surfaces producing very slow tyre wear are smooth stone setts and wood blocks but their non-skid properties are poor.

Bends and corners are severe on tyres because a car can be steered only by misaligning its wheels relative to the direction of the car. This condition applies to the rear tyres as well as to the front tyres. The resulting tyre slip and distortion increase the rate of wear according to speed, load, road camber and other factors. (Fig. 6.)

The effect of hills, causing increased driving and braking torques with which the tyres must cope, needs no elaboration.

Road camber is a serious factor in tyre wear and the subject is discussed on page 8.

An analysis of tyre performance *must* include road conditions.

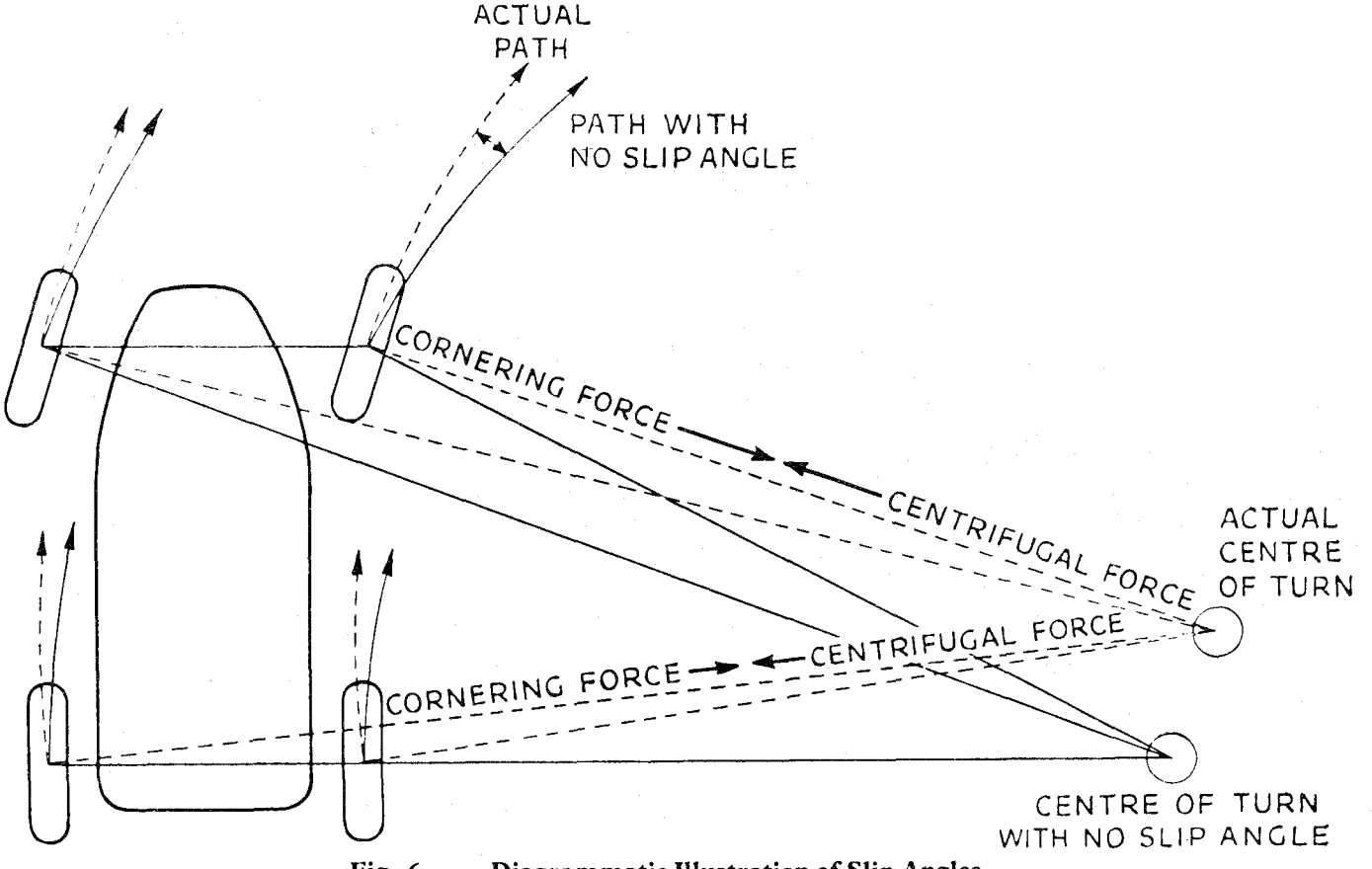

Fig. 6 Diagrammatic Illustration of Slip Angles.

(g) **Impact Fractures**

In order to provide adequate strength, resistance to wear, stability, road grip and other necessary qualities, a tyre has a certain thickness and stiffness. Excessive and sudden local distortion such as might result from striking a kerb, a large stone or brick, an upstanding manhole cover, or a deep pothole may fracture the casing cords. (Figs. 7 and 8.)

Impact fractures often puzzle the car owner because the tyre and road spring may have absorbed the impact without his being aware of anything unusual; only one or two casing cords may be fractured by the blow and the weakened tyre fails some time later; there is usually no clear evidence on the outside of the tyre unless the object has been sufficiently sharp to cut it. This damage is not associated solely with speed and care should be exercised at all times, particularly when drawing up to a kerb or parking against one.

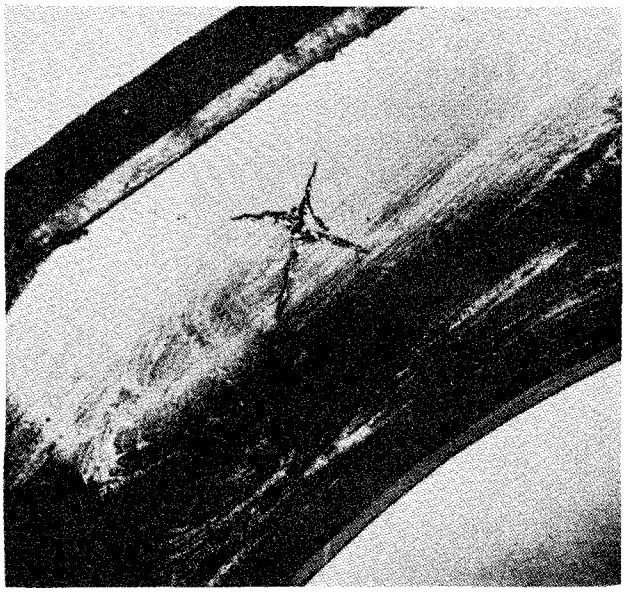

Fig. 7 Severe impact has fractured this Casing.

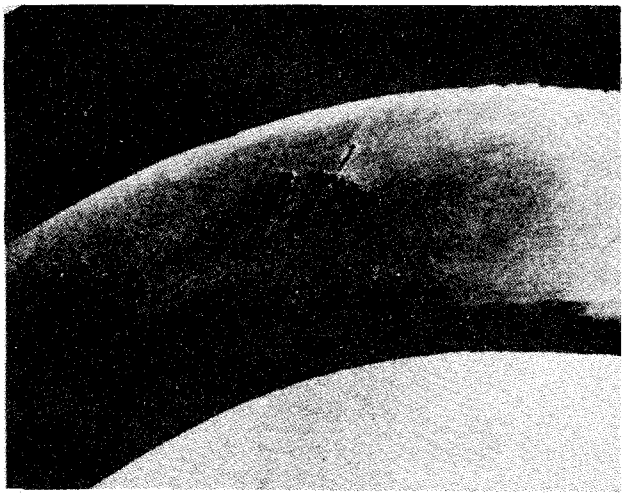

Fig. 8 A double fracture.

2. SPECIAL TYPES OF IRREGULAR TREAD WEAR

(a) **"Heel and toe" or "saw tooth" wear**

This is the condition where one end of each pattern segment or stud is more worn than the other (Fig. 9). To some extent it is latent in any non-skid pattern design and severe service conditions may cause it to develop.

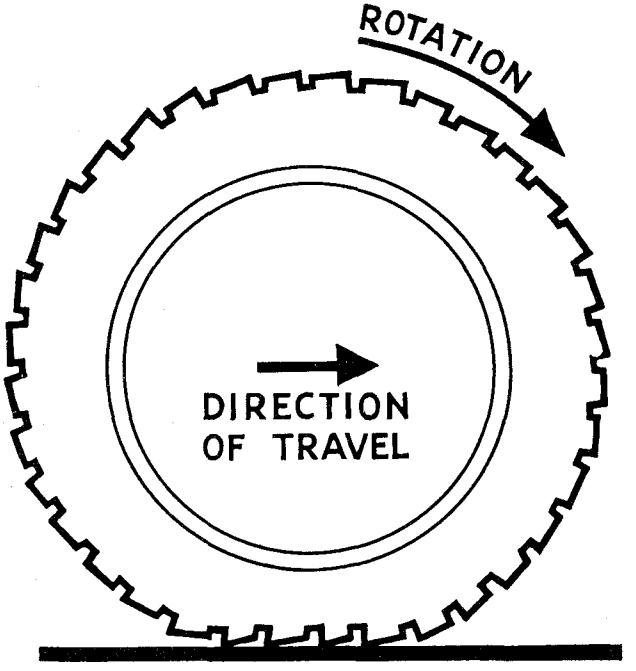

Fig. 9 "Heel and Toe" Wear.

When each successive portion of a running tyre comes under load the tread is flattened and there is limited pattern distortion and shuffle on the road surface. Additional movement is caused by braking, driving and the tyre's own rolling resistance, which acts as a constant retarding force.

On rear wheels the effects of braking and rolling resistance are offset by the effects of driving. Rear tyres usually wear evenly if they are properly maintained. Front tyres are at a

disadvantage in this respect and their pattern displacement tends to be always in the same direction.

Fig. 10 illustrates the basic cause of

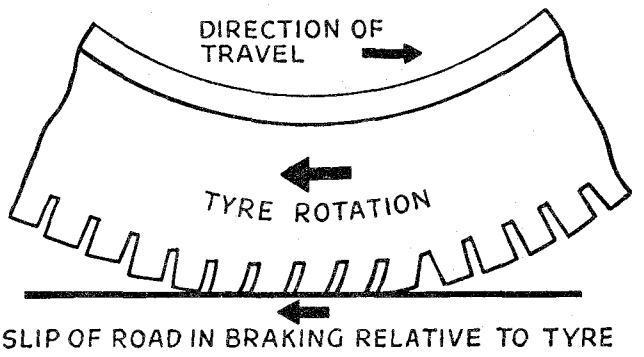

Fig. 10 **Showing the effect of braking and rolling resistance on Tyre Tread.**

" heel and toe " wear. If the tyre is assumed to be on a locked wheel and sliding forward, the abrasive road surface may be likened to a file passing across the tread. The manner in which the flexible rubber studs will be worn is clear. There is a similar but less marked effect when the tyre is revolving but trying to " hang back " under the forces of braking and rolling resistance.

Modern tyre patterns designed for use on hard road surfaces are very stable They do not consist of separate unsupported studs or blocks such as are shown in the diagram. In normal conditions " heel and toe " wear should be absent or barely noticeable but any localised forces such as from eccentric brake drums, fierce or binding brakes, incorrect brake balance and severe front braking will usually cause this type of wear to appear amongst other evidence of these troubles. An unsuitable tyre contact area and distribution of load, resulting from road camber, wheel camber, or excessive deflection, will also produce " heel and toe " wear.

Regular interchanging of tyres will prevent or reduce irregular wear (see page 11).

Fig. 11 **" Spotty " Wear due to a variety of causes.**

(b) " Spotty " Wear

Fig. 11 shows a type of irregular wear which sometimes develops on front tyres and particularly on near front tyres. The causes are difficult to diagnose although evidence of camber wear, misalignment, under-inflation, or braking troubles may be present.

Front tyres are at a disadvantage due to their fore and aft slip and distortion being in one direction. Front tyres are connected to the car through swivelling stub axles and jointed steering linkage and they are subjected to complicated movements resulting from steering, spring deflection, braking and camber. Load transference during braking causes increased loading and pattern displacement on front tyres, and adds to the severity of front tyre operation. Unbalance of the rotating assembly may also contribute to a special form of irregular wear with one half of the tyre's circumference more worn than the other half. Unbalance alone does not cause the type of " spotty " wear illustrated but the unbalance usually becomes progressively worse as the irregular or unequal wear develops.

The nature of " spotty " wear—the pattern being much worn and little

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worn at irregular spacings round the circumference—indicates an alternating " slip-grip " phenomenon but it is seldom possible to associate its origin and development with any single cause.

It is preferable to check all points which may be contributory factors. The front tyre and wheel assemblies

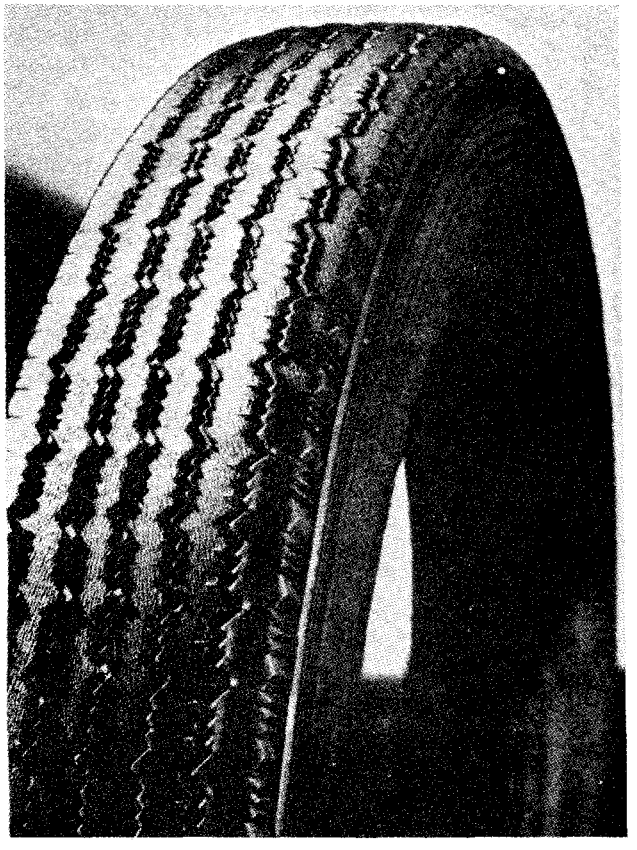

Fig. 12 **Fins and Feathers due to severe misalignment.**

may then be interchanged, which will also reverse their direction of rotation, or better still the front tyres may be interchanged with the rear tyres.

Points for checking are :—

(**a**) Inflation pressures and the consistency with which the pressures are maintained.

(**b**) Brake freedom and balance, shoe settings, lining condition, drum condition and truth.

(**c**) Wheel alignment.

(**d**) Camber and similarity of camber of the front wheels.

(**e**) Play in hub bearings, king pin bearings, suspension bearings and steering joints.

(**f**) Wheel concentricity at the tyre bead seats. S.M.M. & T. tolerances provide for a radial throw not exceeding $\frac{3}{32}$", but this may be affected by impact or other damage.

(**g**) Balance of wheel and tyre assemblies.

(**h**) Condition of road springs and shock absorbers.

Corrections which may follow a check of these points will not always effect a complete cure and it may be necessary to continue to interchange wheel positions and reverse directions of rotation at suitable intervals.

Irregular wear may be inherent in the local road conditions such as from a combination of steep camber, abrasive surfaces, and frequent hills and bends. Driving methods may also be involved. Irregular wear is likely to be more prevalent in summer than in winter, particularly on new or little worn tyres.

3. WHEEL ALIGNMENT AND ITS ASSOCIATION WITH ROAD CAMBER

It is very important that correct wheel alignment should be maintained. Misalignment causes a tyre tread to be scrubbed off laterally because the natural direction of the wheel differs from that of the car.

An upstanding sharp " fin " on the edge of each pattern rib is a sure sign of misalignment and it is possible to determine from the position of the " fins " whether the wheels are toed in or toed out (Fig. 12).

" Fins " on the inside edges of the pattern ribs—nearest to the car—and particularly on the nearside tyre indicate toe in. "Fins" on the outside edges, particularly on the offside tyre, indicate toe out.

With minor misalignment the evidence is less noticeable and sharp pattern edges may be caused by road camber even when wheel alignment is correct. In such cases it is better to make sure by checking with an alignment gauge.

Road camber affects the direction of the car by imposing a side thrust and if left to follow its natural course the car will drift towards the nearside. This is instinctively corrected by steering towards the road centre.

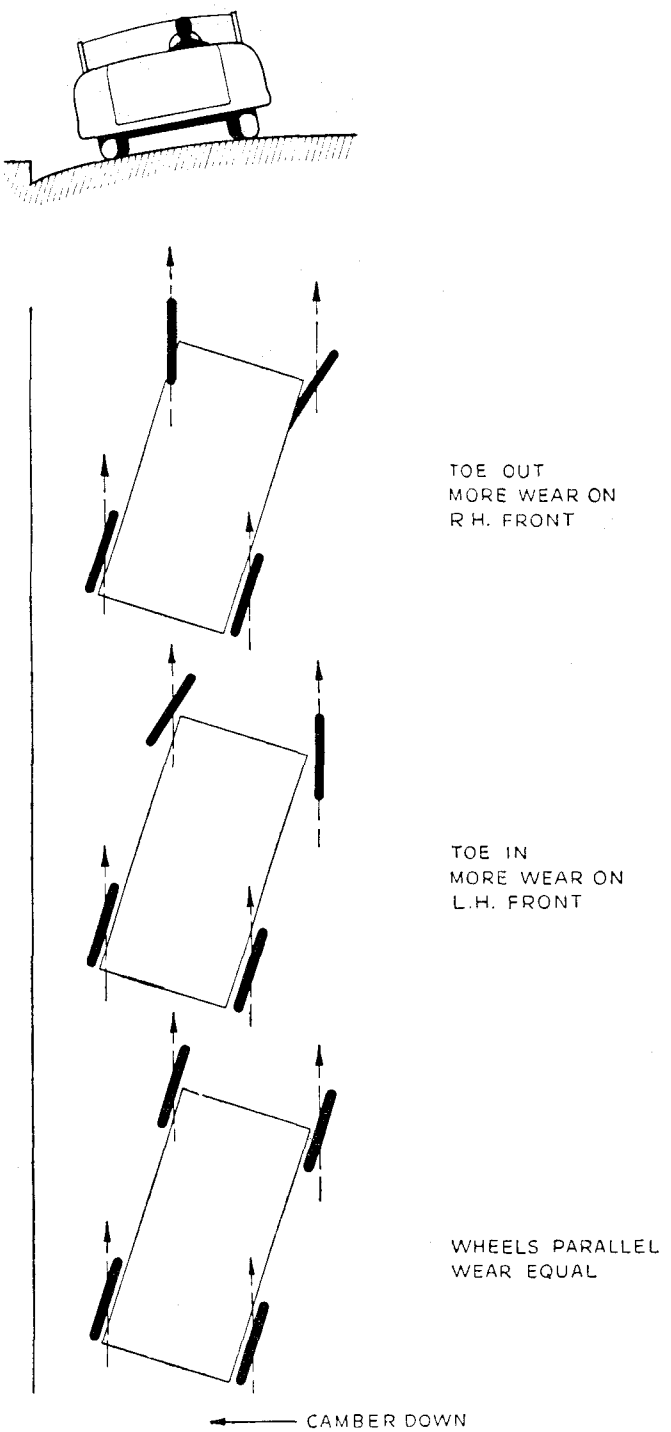

Fig. 13 Exaggerated Diagram showing effect of road camber on a car's progress.

As a result the car runs crab-wise, diagrammatically illustrated in an exaggerated form in Fig. 13. The diagram shows why nearside tyres are very sensitive to too much toe in and offside tyres to toe out. It also shows why sharp " fins " may appear on one tyre but not on the other and why the direction of misalignment can be determined by noting the position of the " fins." Severe misalignment produces clear evidence on both tyres.

The front wheels on a moving car should be parallel. Tyre wear can be affected noticeably by quite small variations from this condition. It will be noted from the diagram that even with parallel wheels the car is still out of line with its direction of movement, but there is less tendency for the wear to be concentrated on any one tyre.

The near front tyre sometimes persists in wearing faster and more unevenly than the other tyres even when the mechanical condition of the car and tyre maintenance are satisfactory. The more severe the average road camber the more marked will this tendency be. This is an additional reason for the regular interchanging of tyres.

(a) Precautions when measuring Wheel Alignment

(i) The car should have come to rest from a forward movement. This ensures as far as possible that the wheels are in their natural running positions.

(ii) It is preferable for alignment to be checked with the car laden.

(iii) With conventional base-bar tyre alignment gauges measurements in front of and behind the wheel centres should be taken at the same points on the tyres or rim flanges. This is achieved by marking the tyres where the first reading is taken and moving the car forwards approximately half a road wheel revolution before taking the second reading at the same points. With the Dunlop Optical Gauge two or three readings should be taken with the car moved forwards to different positions—180° road wheel turn for two readings and 120° for three readings. An average figure should then be calculated.

Wheels and tyres vary laterally within their manufacturing tolerances, or as the result of service, and alignment figures obtained without moving the car are unreliable.

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4. CAMBER, CASTOR AND KING PIN INCLINATION

These angles normally require no attention unless they have been disturbed by a severe impact or abnormal wear of front end bearings. It is always advisable to check them if steering irregularities develop.

Wheel camber, usually combined with road camber, causes a wheel to try to turn in the direction of lean, due to one side of the tread attempting to make more revolutions per mile than the other side. The resulting increased tread shuffle on the road and the off centre tyre loading tend to cause rapid and one-sided wear. If wheel camber is excessive for any reason the rapid and one-sided tyre wear will be correspondingly greater. Unequal cambers introduce unbalanced forces which try to steer the car one way or the other. This must be countered by steering in the opposite direction which results in still faster tread wear. When tyre wear associated with camber results from road conditions and not from car condition little can be done except to interchange or reverse the tyres. This will prevent one-sided wear, irregular wear, and fast wear from developing to a maximum degree on any one tyre, usually the near front tyre.

Castor and king pin inclination by themselves have no direct bearing on tyre wear but their measurement is often useful for providing a general indication of the condition of the front end geometry and suspension.

5. TYRE AND WHEEL BALANCE

(a) Static Balance

In the interests of smooth riding, precise steering, and the avoidance of high speed " tramp " or " wheel hop," all Dunlop tyres are balance checked to predetermined limits.

To ensure the best degree of tyre balance the covers are marked with white spots on one bead, and these indicate the lightest part of the cover. Tubes are marked on the base with black spots at the heaviest point. By fitting the tyre so that the marks on the cover bead exactly coincide with the marks on the tube, a high degree of tyre balance is achieved (Fig. 14). When using tubes which do not have the coloured spots it is usually advantageous to fit the covers so that the white spots are at the valve position.

Some tyres are slightly outside standard balance limits and are corrected before issue by attaching special loaded patches to the inside of the covers at

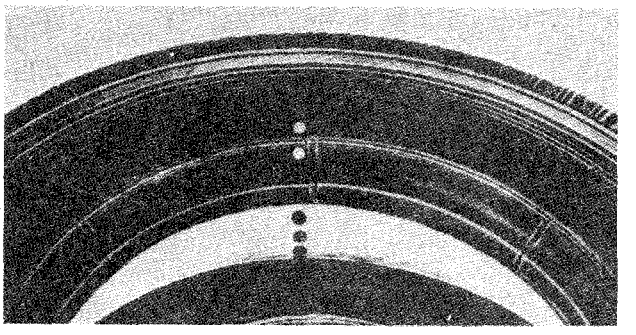


Fig. 14 **The correct relationship between Tyre and Tube.**

the crown. These patches contain no fabric, they do not affect the local stiffness of the tyre and should not be mistaken for repair patches. They are embossed " Balance Adjustment Rubber."

The original degree of balance is not necessarily maintained and it may be affected by uneven tread wear, by cover and tube repairs, by tyre removal and refitting or by wheel damage and

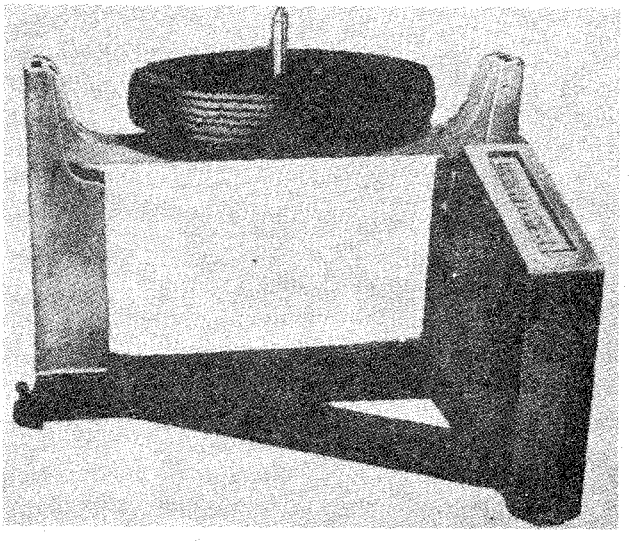


Fig. 15 **Dunlop Tyre Balancing Machine.**

eccentricity. The car may also become more sensitive to unbalance due to normal wear of moving parts.

If roughness or high speed steering

troubles develop, and mechanical investigation fails to disclose a possible cause, wheel and tyre balance should be suspected.

A Tyre Balancing Machine is marketed by the Dunlop Company to enable Service Stations to deal with such cases. This is shown in Fig. 15; a second, marketed by Messrs. V. L. Churchill Ltd., in Fig. 16.

(b) Dynamic Balance

Static unbalance can be measured when the tyre and wheel assembly is stationary. There is another form known as dynamic unbalance which can be detected only when the assembly is revolving.

eccentric wheels give the same effect. During rotation the offset weight distribution sets up a rotating couple which tends to steer the wheel to right and left alternately.

Dynamic unbalance of tyre and wheel assemblies can be measured on the Dunlop Tyre Balancing Machine and suitable corrections made when cars show sensitivity to this form of unbalance. Where it is clear that a damaged wheel is the primary cause of severe unbalance it is advisable for the wheel to be replaced.

6. CHANGING POSITION OF TYRES

There have been references to irregular tread wear and there may be different rates

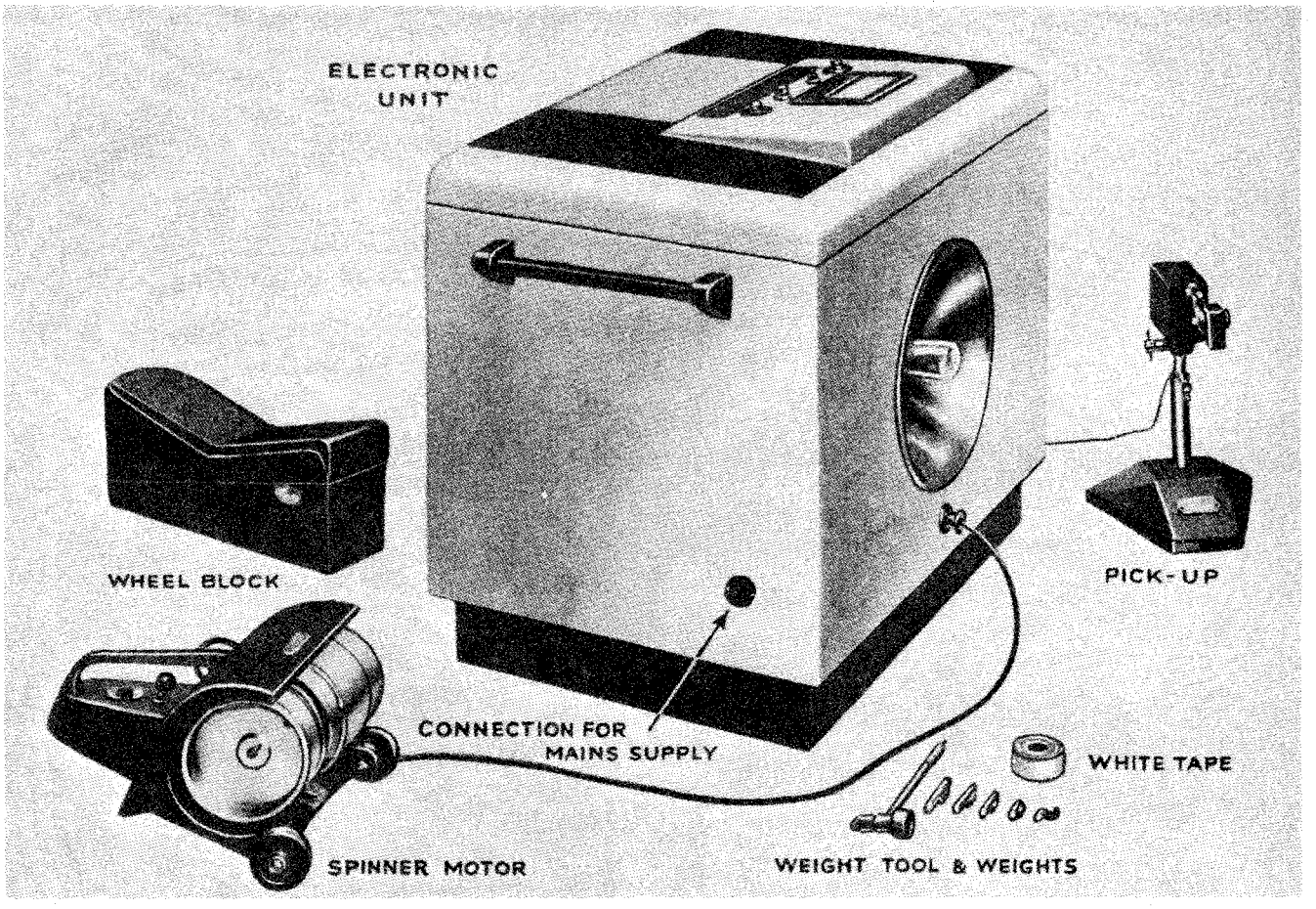


Fig. 16 Churchill 120 Electronic Wheel Balance.

There may be no heavy spot—that is, there may be no natural tendency for the assembly to rotate about its centre due to gravity—but the weight may be unevenly distributed each side of the tyre centre line (Fig. 17). Laterally of wear between one tyre and another. It has also been stated that irregular wear is confined almost entirely to front tyres and that the left-hand front tyre is likely to be more affected than the right-hand front tyre.

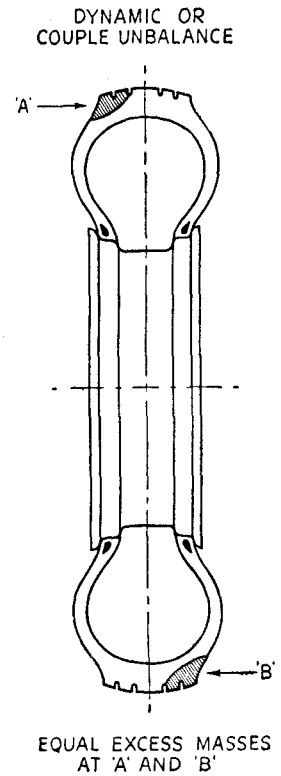


Fig. 17 **Dynamic or Couple Unbalance.**

The causes may lie in road conditions, traffic conditions, driving methods and certain features of design which are essential to the control, steering and driving of a car. Close attention to inflation pressures and the mechanical condition of the car will not always prevent irregular wear.
It is therefore recommended that front tyres be interchanged with rear tyres at least every 2,000 miles. Diagonal interchanging between left-hand front and right-hand rear and between right-hand front and left-hand rear provides the most satisfactory first change because it reverses the directions of rotation.
Subsequent interchanging of front and rear tyres should be as indicated by the appearance of the tyres, with the object of keeping the wear of all tyres even and uniform.

7. PRESSED STEEL WHEELS

S.M.M. & T. standard tolerances are—

(a) Wobble

The lateral variation measured on the vertical inside face of a flange shall not exceed $\frac{3}{32}$".

(b) Lift

On a truly mounted and revolving wheel the difference between the high and low points, measured at any location on either tyre bead seat, shall not exceed $\frac{3}{32}$".

Radial and lateral eccentricity outside these limits contribute to static and dynamic unbalance respectively. Severe radial eccentricity also imposes intermittent loading on the tyre. Static balancing does not correct this condition which can be an aggravating factor in the development of irregular wear.
A wheel which is eccentric laterally will cause the tyre to " snake " on the road but this in itself has no effect on the rate of tread wear.
At the same time undue lateral eccentricity is undesirable and it affects dynamic balance.
There is no effective method of truing eccentric pressed steel wheels economically and they should be replaced.
Wheel nuts should be free on their studs. When fitting a wheel all the nuts should be screwed up very lightly, making sure that their seatings register with the seatings in the wheel.

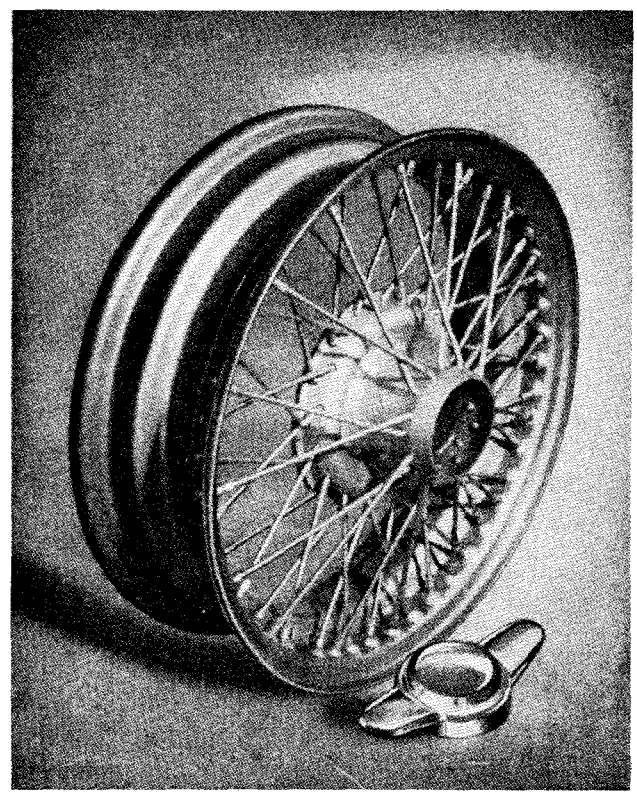


Fig. 18 **Wire Wheel and Hub Cap.**

Final tightening should be done progressively and alternately by short turns of opposite nuts to ensure correct seating and to avoid distortion.
Wheels with damaged or elongated stud holes, resulting from slack nuts, should be replaced.
Rim seatings and flanges in contact with the tyre beads should be free from rust and dirt.

8. WIRE WHEELS (Fig 18)

See "Front Suspension and Steering" Section also "Rear Axle" Section for special hubs.

(a) To Remove Wheels

(i) Jack up the car.

(ii) With a copper headed mallet tap the lugs of the hub cap in the direction stated thereon :—

UNDO—➤UNDO RIGHT SIDE — Caps fitted on right-hand side of car.

UNDO➤—UNDO LEFT SIDE — Caps fitted on left-hand side of car.

(iii) By gripping the tyre with both hands the wheel can be pulled off the hub.

(b) To Replace Wheels

(i) Lightly grease the splines of the hub, and the thread of the hub cap.

(ii) Slide wheel on to hub and secure the hub caps.

(iii) Tap the lugs of the cap with the copper headed mallet to secure the wheel.

RIGHT-HAND SIDE CAPS ARE TURNED ANTI-CLOCKWISE TO TIGHTEN. LEFT-HAND SIDE CAPS ARE TURNED CLOCKWISE TO TIGHTEN.

(iv) Remove jacks.

(c) Examination

This should be done periodically every 5,000 miles or at more frequent intervals if the car is used for competition driving or racing.
After cleaning the wheels they should be examined for faults paying particular attention to the following :—

(i) **Spokes**
Looseness can be corrected and damaged spokes replaced but care must be taken to ensure that the position of the rim relative to the hub shell is not disturbed (Fig. 19).
No undue load must be placed on any one spoke and all spokes must be under the same relative tension. The correct tension is that that will give a flexible but strong wheel. If the tension is too high the wheel will become rigid and loose its advantage over the disc wheel. Or, if too loose, undue strain will be placed on the spokes resulting in breakages.
This tension can be ascertained by drawing a light spanner or similar metal object across the spokes.
When the spokes are correctly tensioned they will emit a "ringing note", however, if the spokes are slack the "ring" will be flat.
Spoke tensioning is best carried out with the tyre and the tube removed and any protruding spoke heads filed off flush to the nipple.

Note—The building of wire wheels is a specialised trade and this Company and the wheel manufacturers advise that a wheel specialist is consulted if the condition of the wheel is in doubt.

(ii) **Hub Shells.** The splines should be examined for wear, this is often caused by looseness of the wheel on the axle hub. Excessive wear on these splines will mean the replacement of the hub shell. Rust caused by water entering from outside should be cleaned off and a smear of grease used to protect the interior of the shell and ease the fitting and removing of the wheel from the axle hub.

(iii) **Rims**

All rust should be cleaned off the exterior of the rim and the affected portion protected with enamel or similar finish. When the tyres are changed the interior of the rims can be inspected for corrosion. Particular attention must be paid to the corrosion, if it is not cleaned away the tyre will become affected.

(d) **Wheel Building (See Fig. 19)**

The spokes should be laced as shown in the illustration and particular attention must be paid to the positioning of the valve hole, failure to observe this point will mean that the valve stem of the inner tube will foul one or more spokes, resulting in insufficient clearance to connect an air line.

The hub shell, spokes and rim should be loosely assembled and the rim brought into true position relative to the hub, ensuring that the outside dish is maintained.

When this condition is reached the wheel should be mounted on a running hub, each pair of spokes should be carefully tensioned a small amount at a time, working from one pair and thence to the diametrically opposite pair. Afterwards, repeating the procedure with the opposed pairs which are located at right angles to the original pairs.

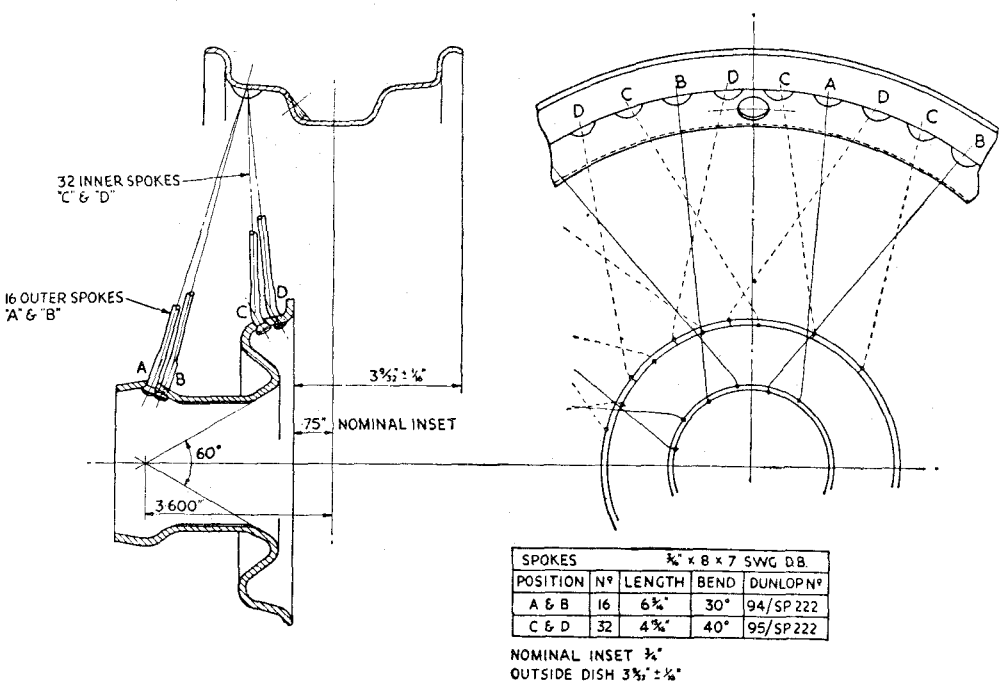
At each stage of the tensioning the truth of the wheel should be checked both for lateral (buckle) and up and down movement (gallop). Then checking any buckle or gallop by giving a slight additional or reduction of tension to the appropriate spoke or sets of spokes.

It is important that as little additional tension as possible is given when truing the wheel. The desired condition when the wheel is finally true is that each spoke should have as near as possible the same tension as its neighbour. This condition can be attained by slackening the tension of one spoke, as as well as increasing that in the opposite spoke, to position the rim correctly.

An experienced wheel builder will be able to gauge when the correct tension has been reached, either by the general feel of the spokes or by the ringing note which the spokes will give when lightly struck with a small spanner or similar metal object.

When building is complete the spoke ends should be examined to ensure that none protrude through the nipple.

Any protrusions should be filed off and the filings brushed away from the rim.



SPOKES		⅛" x 8 x 7 SWG D.B.		
POSITION	Nº	LENGTH	BEND	DUNLOP Nº
A & B	16	6¾"	30°	94/SP 222
C & D	32	4⅞"	40°	95/SP 222

NOMINAL INSET ¾"
OUTSIDE DISH 3⅜" ± 1/16"

Fig. 19 **Wheel Building Dimensions.**

Service Instruction Manual

ELECTRICAL EQUIPMENT

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SECTION M

ELECTRICAL EQUIPMENT

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