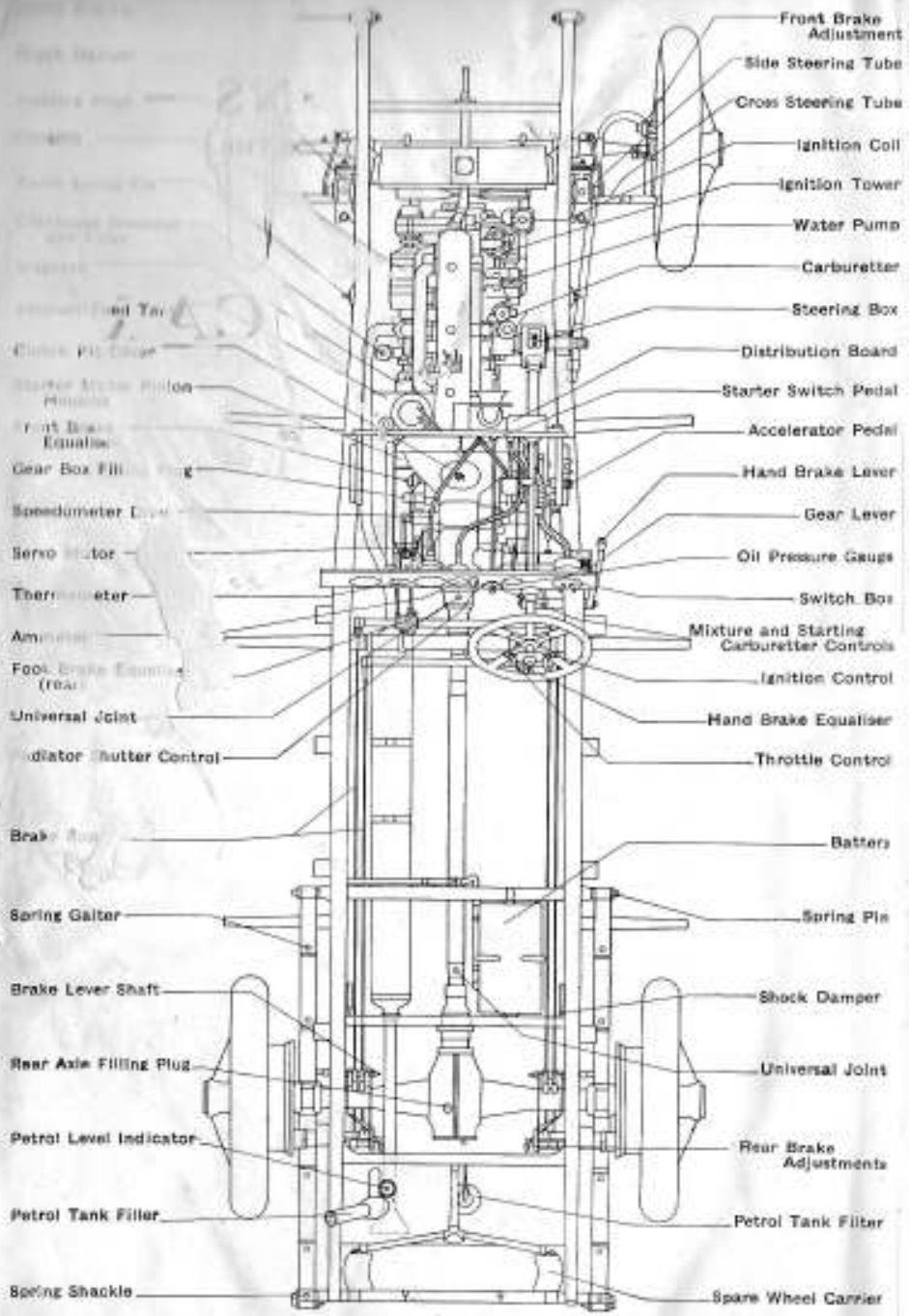

FIG. 1
PLAN VIEW OF CHASSIS.

INSTRUCTIC

FOR THE CARE AND RUNNING O

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ROLLS-ROYCF

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Incorporating the Instructions contained in Editions
November, 1925,
April, 1927,
and Number 7.

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(Printed October, 1924)

(21 H.)

tructions contained in this book have been rranged to facilitate reference by condensing all esse driving and upkeep details in the first two chapt

Subsequent chapters cover, in a more detailed and technical manner, the various units or components of the chassis.

In connection with certain proprietary components, viz., the battery, wheels and tyres, and the Klaxon horn, separate instructions provided by the respective makers of these articles will be found incorporated as pamphlets at the end of the book.

A set of special spanners and tools is supplied with the chassis. It is most desirable that these should be used when effecting any adjustment, as otherwise vital parts may be seriously damaged.

ROLLS-ROYCE LIM

London Office and Showroom:

14 & 15, Conduit Street, London,

TELEGRAMS: "ROLHEAD, PICCY, LONDON."
TELEPHONE: MAYFAIR 6201 (7 LINES).
CODES USED: A B C (5TH EDITION), BENTLEY'S, MARCONI, MOTOR TRADE, WESTERN UNION.

London Repair Depôt:

Claremont Road, Cricklewood, N.W.2

TELEGRAMS: "SILVAGOST, CRICKLE, LONDON."
TELEPHONES: GLADSTONE 4222-3-4-5.

Registered Office and Works - - - DERBY

TELEGRAMS: "ROYCAR, DERBY."
TELEPHONE: 1320 DERBY (6 LINES).

CONTENTS.

Contents—*continued.*

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INDEX OF ILLUSTRATIONS

THE ROLLS-ROYCE SYSTEM OF PERIODIC INSPECTION.

Our interest in the Rolls-Royce Cars does not end at the moment when the owner pays for, and takes delivery of, the car. Our interest in the car never wanes. Our ambition is that every purchaser of a Rolls-Royce Car shall continue to be more than satisfied.

With this end in view, there are on the staff of Rolls-Royce Ltd. experts whose sole duty it is to call, by appointment, on the owners or drivers of Rolls-Royce Cars, with a view to ascertaining whether they are satisfied with their cars.

These calls can be made at the owner's residence, not only in Great Britain, but also in certain countries abroad.

A consultation between the owner or driver, or both, and one of these inspectors is invariably of benefit to users of Rolls-Royce Cars, and these visits have been highly appreciated in the past by both owners and drivers.

THE SECRET OF SUCCESSFUL RUNNING.

Before a Rolls-Royce chassis is sold it is very carefully tested and adjusted by experts. It will run best if no attempt be made to interfere unnecessarily with adjustments.

An owner would do well to instruct his driver as follows :—

Lubricate effectively, in strict accordance with the advice given in this book, and do not neglect ***any*** part.

Use only those oils which are recommended by Rolls-Royce Ltd., who have made prolonged and searching tests of oils. Considerable harm and expense may result from the use of unsuitable oils.

Inspect all parts regularly, but take care not to alter any adjustments unless really necessary.

LEADING PARTICULARS OF CHASSIS.

Engine	... ...	Six cylinders, 3" bore, 4½" stroke, 3,127 c.c. 21·6 H.P. on R.A.C. rating. Unit construction with gearbox, three-point suspension, monobloc with detachable head, overhead valves operated by pushrods, Rolls-Royce battery ignition with automatic advance, magneto provided as a stand-by, forced lubrication, cooling by pump circulation, Rolls-Royce automatic expanding carburetter.
Electrical Equipment		12-volt Rolls-Royce dynamo, starter motor, and other units. 50 ampère-hour battery.
Clutch	... ...	Single dry plate.
Gearbox	... ...	Four-speed and reverse, side control; speedometer and brake servo-motor drives incorporated.
Back Axle	...	Spiral bevel drive, full floating, road wheels entirely carried on axle tubes.
Brakes	... ...	Internal expanding, servo operated, on all four wheels. Independent hand brake operating on rear wheels.
Road Springs	...	Semi-elliptic, front and rear.
Wheels	... ...	*Either*, Dunlop detachable wire wheels, with 32" by 4½" straight-side cord tyres, *or*, Dunlop detachable well-base wire wheels, with Dunlop cord, wired type tyres, 5¼" for 21" rim, *or*, 6" for 20" rim, *depending on date of Chassis.*
Wheelbase	...	129".
Track	... ...	56".
Petrol Tank	...	14 gallons capacity, at rear of chassis. Vacuum feed.
Weight	... ...	Chassis complete with tyres, battery, petrol, oil and water, but excluding spare wheel, lamps and other accessories—approximately 2,600 lbs.

CHAPTER I.

Starting the Engine and Running the Car.

Starting the Engine—Petrol Feed—Running the Car—Gear Changing—Use of the Brakes—Use of Charging Switch—Ignition Switch—Use of Magneto—Use of Radiator Shutters—Overheating—Slow Running—Water Level in Radiator—Frost.

The power unit consists of a six-cylinder engine, not overstressed as regards its power output, and therefore having a reasonable compression, ensuring freedom from pre-ignition troubles and giving a long period of running without decarbonising becoming necessary.

The sparking plugs have been placed in the cylinder head in such a position as to give the maximum advantage from the point of view of ignition, and be free from oiling up and detonating troubles. Rolls-Royce Ltd. have designed and manufactured a special battery ignition, which incorporates an automatic advance, and is so distinctly advantageous over ordinary magneto ignition as to have led them to adopt it as standard in preference to a magneto.

A magneto is provided, however, but it is intended for use solely as a stand-by in case of failure of the battery ignition system. Such a failure is found to be very rare and confined to failure of the battery itself, due, probably, to careless use in tropical climates, or to neglect of the battery makers' instructions. These instructions will be found at the end of this book.

It is not possible to use both battery and magneto ignition systems simultaneously, and no attempt must be made to do this. The magneto ignition can be brought into service only by releasing the catch which normally holds its drive coupling out of engagement, replacing the battery high tension lead with that from the magneto, and removing the battery ignition fuse marked No. 3 from the distribution box, as more fully described later in this chapter.

In order to facilitate starting the engine from cold and to enable the car to be run almost immediately afterwards, a small high velocity jet carburetter is provided for starting purposes only, which, in combination with a hot-spot on the induction system to vaporise the mixture by exhaust heat, results in the car being available for service very quickly after starting up, even in the coldest weather.

Starting the Engine. To start the engine, first check that the change gear lever is in neutral, close the radiator shutters by moving the control lever on the instrument board, then switch on the ignition by moving the right-hand thumb lever on the switchbox to position marked **I** (Ignition); retard the ignition and close the throttle by bringing both the levers on the steering column to their bottom positions; next open the starting carburetter by pushing the lever on the instrument board to the position marked **Starting** or **On,** and set the mixture control lever over to **Strong.** Now depress the small pedal situated low down in the centre of the dashboard; this closes the main switch between battery and starter motor, and the latter will start up the engine. As soon as the engine commences to run regularly, move the throttle control lever on the steering column about half-way up its quadrant and turn back the starter carburetter control lever to the position marked **Running** or **Off.**

The starting carburetter should not be used for more than half a minute before changing over to the main carburetter, and it should only be used when the engine is cold.

Excessive use may lead to failure of the cylinder lubrication owing to dilution of the oil by petrol.

When the engine has warmed slightly the mixture control should be set half-way between **Strong** and **Weak.**

A starting handle is carried in the tool kit. After use, it should be removed from the bracket and returned to the tool kit, otherwise it may drop out and become lost.

Difficult starting may be due to dampness in the H.T. distributor caused by condensation. The distributor should be removed under such circumstances and wiped out with a clean dry rag. The rotor should also be wiped dry. This trouble is only likely to arise when the car has been standing. The warmth of the engine will prevent such condensation normally.

It will be noticed that while the working pressure indicated on the oil gauge is only 15 to 20 lbs. when the engine is thoroughly warmed up, the gauge will show a considerably higher reading with the engine cold, due to the greater viscosity of the oil at low temperatures. The pressure will, however, fall to normal as soon as the oil becomes warmer.

Petrol Feed. The petrol feed is arranged on the system by which the vacuum induced in the inlet pipe of the engine raises the petrol from the main tank situated at the back of the car to a small service tank on the engine side of the dash, whence it flows by gravity to the carburetter float chamber.

There is a needle-type stop valve on the service tank to cut off the feed to the carburetter float chamber when the car is not in service. To open this valve, lift it and rotate it in a clockwise direction; to close, merely rotate it in the opposite direction—it will click home when in the correct position.

If the main fuel supply be exhausted during a run it should be observed that the service tank will also have been emptied, and after filling the main tank the service tank must also be recharged before the engine can be started. This can be done by cranking over the engine for a few revolutions, both main and starting carburetter throttles being closed meanwhile. A depression will thereby be induced in the induction pipe, which will draw up petrol from the main tank into the service tank.

Certain chassis are provided with a main tank which normally holds two gallons of petrol in reserve. Use can be made of this reserve by turning the knurled knob of the valve on the tank from the position **M** (main) to the position **R** (reserve). Normally, it should stand at **M**, when, with the tank full, twelve gallons will be available. If the car be run with the valve in the **M** position until it stops through lack of petrol, the vacuum feed tank will have been emptied and must be re-primed, as explained above, after turning the valve to the **R** position.

Running the Car. When driving the car, the ignition lever should, normally, be advanced about three-quarters along its quadrant, and the throttle lever set to a position at which the engine will run as slowly as possible without risk of stopping when the clutch is withdrawn. For country driving, however, the throttle lever may with advantage be moved to its lowest position, when the throttle will be closed, and the engine can be used as a brake to assist in decelerating the car when it is required to slow up. Under these circumstances it must be borne in mind that the engine will stop if the accelerator pedal is released and the clutch withdrawn. Consequently, the throttle lever must be restored to its slow-running position when the necessity for such operations appears likely to arise.

The amount of advance on the battery ignition system is controlled partly by hand, as previously indicated, and partly automatically by means of a centrifugal governor operating on the distributor drive. This is capable of meeting 90 per cent. of the conditions due to varying road speeds, leaving only extreme conditions to be met by moving the hand control on the steering column.

Gear Changing. The position of the gear lever for each of the four speeds and the reverse is shown in Fig. 2. When reverse is required, the button upon the top of the lever must be depressed. This releases a catch, and enables the lever to be moved into the gate marked **R**.

When changing up, it must be borne in mind that in order to bring the gear wheels into silent engagement, a perceptible pause must be made with the gear lever in the neutral position and the clutch withdrawn. This will give the clutch shaft time to slow down until the gears to be engaged are rotating at

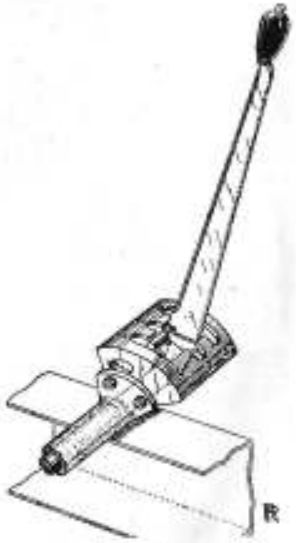


FIG. 2.
PERSPECTIVE VIEW OF GEAR LEVER GATE.

a relative speed approximately equal to that which will obtain when they are in mesh. The lever can then be moved into the required position without effort or noise, the clutch re-engaged and the accelerator pedal depressed.

When changing down the converse is the case, *i.e.*, the speed of the clutch shaft requires to be *increased* before engaging a lower gear. This can be done by double-clutching, which consists in quickly letting in the clutch and speeding up the engine while the gear lever is in the neutral position. The clutch must then be withdrawn again and the gear lever moved into the next lower gear position. It is better to speed up the clutch shaft in this manner rather too much than too little, as the period which must necessarily elapse before the gear is engaged will result in a slight decrease of the clutch shaft speed, and the driver is able to feel the way into the gear and make a good change. On the other hand, if the engine is not speeded up sufficiently, either the gear will be missed or a noisy change effected.

When manœuvring the car, no attempt must be made to engage reverse gear after moving forwards until the car has come to a standstill. Conversely, forward speed must not be engaged after using reverse until backward movement of the car has ceased.

Use of the Brakes. The hand brake is released by pressing the thumb upon the button on top of the lever and simultaneously pulling the lever backwards to release the pawl; the lever should then be moved forwards.

When the car is left standing, the hand brake should be pulled on, and subsequently, when again preparing to drive the car, it is advisable to engage the gear *before* releasing the hand brake. Such a course is recommended because, if the car is standing on even a slight decline, release of the hand brake might cause the car to move forwards or backwards, and render engagement of the required gear difficult.

Drivers should cultivate the habit of always releasing the brakes when actually turning a corner. The retarding power of the Rolls-Royce four-wheel brakes is so great that there should be no necessity for brake application under such circumstances if the speed is properly suited to the road conditions, and further, the road surface may be

different just round the bend, becoming loose and slippery. The conditions then present if the brakes are applied all favour a serious skid. Further notes on the use of the brakes will be found on pages 110 to 112.

The foot brake, which operates on all four wheels, may be used continuously in descending hills without danger of burning out. There is absolutely no need to use the hand and foot brakes alternately, as is the practice with brakes of less adequate design. Moreover, the hand lever only actuates brakes on the rear wheels, its primary use being to hold the car when standing.

Use of Charging Switch. The position marked **I & C** (ignition and charging) on the switchbox for the thumb lever indicates that the ignition is on, and that the dynamo is charging the battery. In town driving, one should always have the switch in this position while the engine is running, but for long, fast country runs it is desirable to use some discretion as to how long the switch should be in this position. Generally speaking, a good rule, if running under daylight conditions, is to run for the first quarter of the journey, charging, then switch over to the position marked **I** (ignition only), and run for the next half of the journey, and for the final quarter switch back to **I & C**.

Whenever the lamps are in use, and engine is running, always have the switch in the position marked **I & C**.

Ignition Switch. This should always stand at the off position when the car is not running. To avoid unauthorised use of the car, a lock is provided on the main switchbox, which, when locked, prevents either of the switch elements being moved.

Use of Magneto. The magneto is of a special type, having no high tension distributor, but a single high tension lead, the terminal of which is fitted to the centre of the battery ignition distributor in place of that from the standard ignition coil when required. The magneto is arranged to be put into service very quickly should the necessity arise, the following operations being performed in the order named:—

(1) Remove the battery ignition fuse marked No. 3 from the distribution box, inserting same in the dummy fuse holder (**Y**, Fig. 7, page 44) in the cover.*

(2) Pull out the high-tension terminal (**Tb**, Fig. 10, page 53) of the battery ignition from the distributor and replace with the high-tension magneto lead (**Tm**), which is carried in a special holder on the ignition tower when not in use. Insert the battery H.T. lead in the holder.

(3) Press down the catch (**H**, Fig. 11, page 55) projecting from the magneto drive shaft and turn the shaft gently by hand until the teeth are felt to engage.

The engine is then ready for running on the magneto, the thumb lever on the switch box being used for switching on and off in the same way as for the battery ignition.

Owing to the fact that the magneto is capable of giving a good spark when retarded, no attempt should be made to start the engine on the magneto ignition, either by hand or by the starter, without first fully retarding the ignition. Also, when running on this ignition it will be necessary, in order to obtain the best results, to use the ignition lever as the engine speed increases or falls off.

When changing back from magneto to battery ignition, the operations detailed in the preceding paragraphs (1), (2) and (3) must be reversed, the magneto drive being disconnected by sliding the shaft towards the rear against the pressure of an internal spring until it is felt that the catch is holding the engaging teeth clear of each other, when it will be possible to rotate the shaft by hand.

It is important that this uncoupling of the drive should be effected before running again on the battery ignition.

Use of Radiator Shutters. A thermometer is arranged on the instrument board to indicate the water temperature of the engine. On certain chassis it incorporates contacts which close and complete an electrical circuit when the temperature of the water approaches boiling point. This lights a lamp behind a small red window on the instrument board, warning the driver that the temperature conditions of the engine require adjustment of the radiator shutters.

* This is not necessary if the battery is entirely disconnected and/or removed from the car (see Warning, page 50).

The normal working temperature should be between 70° C. and 90° C., and therefore, when starting the engine, the shutters should be closed. They should remain so until the water temperature reaches 70° C.

When driving, it is not necessary continually to readjust the shutters. So long as the temperature is somewhere between 70° C. and 90° C., the engine will be in a reasonable condition as regards jacket temperature. The temperature should be taken by reference to the thermometer, not by waiting until the warning lamp lights. The latter indicates a temperature condition which must be avoided.

The fitting for controlling the opening of the shutters is arranged on the left-hand side of the driver on the instrument board, in a position which enables him to open or close the shutters with ease.

On all occasions when the engine is stopped, the shutters should be closed in order to preserve the high temperature of the jacket water as long as possible.

Under night driving conditions, the instrument board lamp must be used to check the thermometer reading.

Overheating. On long ascents which call for full throttle it is often preferable to change into a lower gear and reduce the throttle opening, to prevent boiling of the water. Also the mixture lever should be moved a little towards **Strong.**

Adjustment of the fan-belt may be necessary, and this should receive attention.

Slow Running. Faulty slow running of the engine may be due to the low speed jet of the carburetter being choked. This can be cleared easily and quickly by raising the low speed jet needle valve with the fingers and simultaneously opening the throttle to race the engine momentarily, as explained on page 92.

Water Level in Radiator. The water level in the radiator should be inspected frequently, and maintained between $3\frac{1}{2}$" and $4\frac{1}{2}$" from the top of the filling spout. Loss of water may be due to running unwittingly with the radiator shutters closed, which would result in boiling.

Frost. When there is any possibility of the car being exposed to low, frosty temperatures, with the engine not running, it is of vital importance that the water system should be drained by opening the drain tap on the water pump. Also, after a frost and before attempting to start, or even move, the engine again, hot water should first be poured over the water pump, as otherwise damage may be caused to the pump rotor by the presence of particles of ice within the casing. Warm water can be used with advantage for re-filling the radiator. (See page 134 for particulars of anti-freezing mixtures.)

CHAPTER II.

Periodic Lubrication and Attention.

It is very important that careful attention should be given to the lubrication of the chassis and this work carried out in a thorough manner. Mysterious squeaks and rattles will be largely eliminated thereby and satisfactory running assured. The matter is greatly facilitated by the provision throughout the chassis of oil-gun type lubricators, an oil gun being supplied in the tool kit.

The tabulated lubrication notes in this chapter are arranged in a definite order, with due regard, as far as possible, to the relative location of the various items on the chassis.

These notes are followed by others covering the periodic operations and adjustments which are necessary.

Reference to the plan view of the chassis in Fig. 1 will be found of assistance in locating the parts mentioned in the notes.

Lubricants Recommended.

Engine.	*Either*, Price's Motorine "C," *or*, Wakefield's "XL."
Gearbox and Back Axle.	Price's Amber "A," with which should be mixed up to 10 per cent. of Price's Motorine "C" in cold weather.
Hydraulic Shock Dampers.	Wakefield's Castrol "F" only.
Ball Bearings.	Hoffmann Ball-bearing Grease, manufactured by Alex. Duckham & Co., Ltd.

Arrangements have been made whereby Rolls-Royce Ltd. can supply promptly any quantity of the above lubricants (from one-gallon cans to forty-gallon barrels) at current retail prices, which include free delivery in London of any quantity. In the country, orders for five gallons and upwards are delivered free to the nearest railway station. Quotations will be submitted on application.

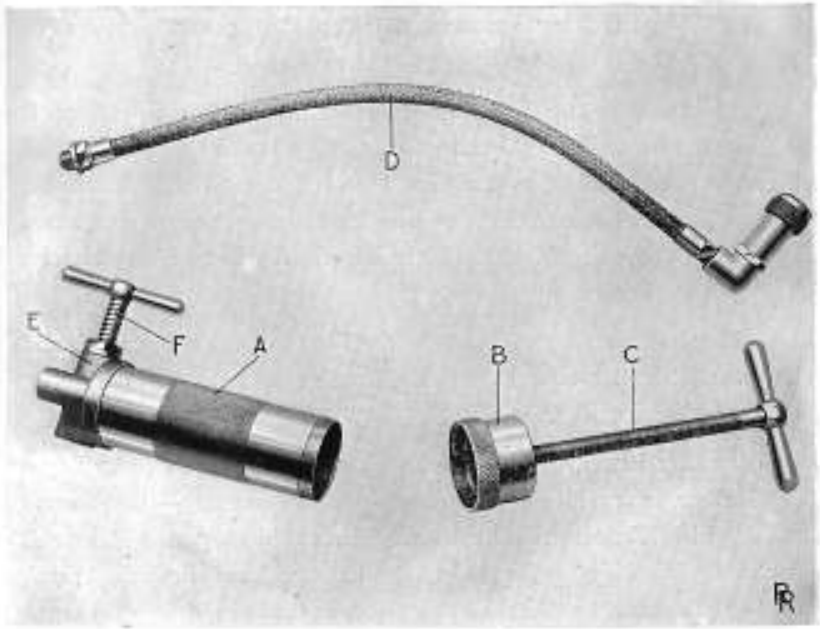


FIG. 3. OIL GUN OPENED FOR FILLING.

Lubrication by Means of the Oil Gun.

The oil gun is shown dismantled for filling (Fig. 3). It consists of a barrel, **A**, on to which screws the cap **B**. The rod **C**, carrying a cup leather, is threaded into the cap, therefore when this rod is screwed down by means of the handle, oil will be expelled from the barrel under considerable pressure.

The flexible connection **D** is fitted with a valve, which is closed by a spring except when the connection is screwed on to one of the chassis adapters or lubricators. Consequently, no oil can be expelled through the connection until this is in position on a lubricator.

In addition, each lubricator on the chassis has a ball non-return valve, which is opened by the valve in the flexible connection when this is screwed on.

Only *engine or gear oil* should be used in the oil gun. This is inserted by unscrewing and removing cap **B**, together with rod **C**, and filling the barrel.

To facilitate re-entry of the cup leather into the barrel, the cap **B** is formed with an internal diameter equal to that of the barrel, and before replacing this cap it should be screwed down the rod as far as possible, as shown in Fig. 3. The leather will then be contracted by the cap, and, on replacement of the latter, will enter the barrel freely. The gun is then ready for use.

Owing to the arrangement of the valve in connection **D**, care should be taken that this is screwed well home on a lubricator, otherwise the gun will not work.

A smaller barrel, **E**, also fitted with a screwed rod, **F**, carrying a cup leather, is provided for increasing—when necessary—the pressure under which lubricant may be delivered from the oil gun. This small barrel, or intensifier, is located in the passage from the main barrel, **A**, to the connection **D**, and is therefore automatically kept charged with lubricant from the main barrel, provided that rod **F** is unscrewed after use.

Normally the large barrel only should be used by screwing down the handle of rod **C**, the intensifier handle being unscrewed. The pressure thus obtained is quite sufficient for most bearings, but when difficulty is experienced in forcing lubricant through, the pressure may be increased by first unscrewing the main handle two turns, and then screwing down the intensifier handle. The latter should afterwards be unscrewed and the handle **C** screwed down about five complete

turns in order to recharge the intensifier barrel, the gun being meanwhile disconnected from any lubricator.

Except where otherwise stated, the number of turns of the oil gun handle mentioned in these notes refers to the handle of the rod **C**.

It is important that the intensifier should be used with great care and considerable restraint, because the extremely high pressure which can be generated with it may easily cause permanent deformation and injury to certain parts. Such care is particularly necessary where the bearing to be lubricated has a blind end, *i.e.*, the shaft terminates within the bearing and the bush has a blank end into which oil is forced, as in the case of the bearings at the ends of the brake actuating shafts on the rear axle. In such circumstances oil pressure reacts between the end of the shaft and the blank end of the bush, the shaft acting like a piston, and forces may be generated which will damage brackets or supports carrying the parts mentioned.

The intensifier should not, therefore, be used on such bearings, but only the ordinary handle, a pause being made after each screwing-down movement in order to give oil time to pass between bearing and shaft.

The intensifier should only be used when absolutely necessary, and as little as possible on any bearing. It will be found frequently that operation of the ordinary handle will be sufficient if a little more time is taken over the work, the handle being screwed down more slowly.

Over-liberal use of the oil gun on lubricators adjacent to the brake drums may result in oil getting on the brakes and reducing their effectiveness.

The oil gun must, therefore, be used in a manner suitable for the bearing being lubricated, as indicated in the following tabulated lubrication notes.

Caps are provided on the chassis lubricators, which must be removed before fitting the oil gun connection, and afterwards replaced with care.

Daily.

Crankcase Oil. The engine oil level indicator situated on the left-hand side of the crankcase should be inspected **daily,** and the quantity of oil maintained at about three-quarters of a gallon, as shown by the indicator finger. The engine should never be run with less than half a gallon of oil. The oil filler is on the left-hand side of the engine, the cap being provided with a bayonet joint.

Water in Radiator. The radiator water level should be inspected **daily.** It should stand between $3\frac{1}{2}$" and $4\frac{1}{2}$" from the top of the filler spout (see page 134).

Every 500 Miles.

LUBRICATION.

PARTS TO BE LUBRICATED.	NO. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Front Spring Shackles	4	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Rear ends of Front Springs	2	Oil Gun ...	Gear Oil. Screw down two or three turns.
Cross Steering Tube (both ends)	2	Oil Gun ...	Gear Oil. Screw down two or three turns.
Side Steering Tube (both ends)	2	Oil Gun ...	Gear Oil. Screw down two or three turns.
Front Shock Damper Connections	2	Oil Gun ...	Gear Oil. Screw down three or four turns.
Friction Shock Damper Leathers	2	Oil Can ...	Engine Oil. Apply a few drops to exposed edges of leathers.

Every 500 Miles—*continued.*

PARTS TO BE LUBRICATED.	NO. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Steering Pivots ...	2	Oil Gun ...	Gear Oil. Screw down until oil exudes. Carefully wipe off excess oil.
Universal Joints at both ends of Propeller Shaft	2	Oil Gun ...	Gear Oil. Inject one charge of the intensifier into each joint.
Forward ends of Rear Springs	2	Oil Gun ...	Gear Oil. Screw down two or three turns.
Rear Spring Shackles	4	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Rear Shock Damper Connections	2	Oil Gun ...	Gear Oil. Screw down three or four turns.
Steering Box ...	1	Oil Can ...	Engine Oil. Inject a few drops in spring-lid lubricator.*
Water Pump Bearing and Gland	1	Screw-down Lubricator	Grease. Fill lubricator cap and screw right home.

* If Steering Box Cover has a filling plug, see page 36.

Also every 500 Miles.

Inspect level of acid in battery cells. This is most important. (See Battery Makers' instructions at end of book.)

Every 1,000 Miles.

LUBRICATION.

(After the first 1,000 miles' running with a new car the engine crankcase should be drained, the filter cleaned, and fresh oil added as described on page 68.)

PARTS TO BE LUBRICATED.	NO. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Brake Cam and Lever Shafts on Axles	10	Oil Gun ...	Gear Oil. Oil sparingly where shafts enter drums.
Brake Connection Jaws under Rear Axle	8	Oil Can ...	Engine Oil. Inject a few drops on to jaws.
Jaws of Brake Ropes (front and rear)	12	Oil Can ...	Engine Oil. Inject a few drops on to jaws.

Every 1,000 Miles—*continued.*

PARTS TO BE LUBRICATED.	NO. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Ball Joints of Front Brake Pull Rods	4	Oil Can ...	Engine Oil. Remove leather stockings and inject a few drops into sides of sockets.
Jaws of Brake Rods between Balancing Lever and Equalisers (front and rear)	4	Oil Can ...	Engine Oil. Inject a few drops on to jaws.
Jaws of Brake Rod from Servo to Equaliser	2	Oil Can ...	Engine Oil. Inject a few drops on to jaws.
Joints of Coupling Rods from Servo to Balancing Lever	4	Oil Can ...	Engine Oil. Inject a few drops on to joints.
Fulcrums of Brake Actuating Levers on Servo Shaft	2	Oil Can ...	Engine Oil. Inject a few drops on to joints.
Servo Shaft	1	Oil Can ...	Engine Oil. Inject a few drops into oil hole.
Servo Engaging Levers	1	Oil Can ...	Engine Oil. Inject only one or two drops into oil hole in boss of outer lever.
Fulcrum of Balancing Lever	1	Oil Can ...	Engine Oil. Inject a few drops into oil hole.
Joints of Links between Cross Shaft and Servo	2	Oil Can ...	Engine Oil. Inject a few drops on to joints.
Jaws of Rod from Pedal to Cross Shaft	2	Oil Can ...	Engine Oil. Inject a few drops on to jaws.
Bearings of Pedal Shaft	1	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of pedal bosses.
Clutch Pedal Connections	2	Oil Can ...	Engine Oil. Inject a few drops on to jaws.
Accelerator Pedal ...	1	Oil Can ...	Engine Oil. Inject a few drops into small lubricator.
Fulcrum of Hand Brake Lever	1	Oil Gun ...	Gear Oil. Screw down until oil exudes from end of bearing.

Every 1,000 Miles—*continued.*

PARTS TO BE LUBRICATED.	NO. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Jaws of Rod from Hand Brake Lever to Equaliser	2	Oil Can ...	Engine Oil. Inject a few drops on to jaws.
Hand Brake Pawl Connections	4	Oil Can ...	Engine Oil. Inject a few drops on to each joint.
Reverse Catch of Gear Lever	3	Oil Can ...	Engine Oil. Inject a few drops on to each joint.
Cam of Battery Ignition Contact Breaker	1	—	Smear a trace only of engine oil on cam surface.
Spring Gaiters ...	12	Oil Gun ...	Engine Oil. Screw down three or four turns on each lubricator.

Also every 1,000 Miles.

Front Friction Shock Dampers. The links of the front *friction* shock dampers should be disconnected and the setting of the dampers checked. It should be such that a weight of 25 lbs. suspended on the end of the lever just causes this to move. (See page 123.)

Every 2,000 Miles.

LUBRICATION.

Engine. When the engine is warm, remove the split cotter of the drain plug in the bottom of the crankcase, unscrew this plug, and drain out all the oil. The oil filter should then be removed for cleaning by unscrewing the ring of nuts which will be found surrounding the drain plug. The filter gauze can be removed from its carrier plate by unscrewing the central nut. The gauze should be thoroughly cleaned with a brush dipped in paraffin.

When replacing the filter, care must be taken that the joint washer is in position; also that the drain plug is replaced with its aluminium washer, and locked by means of a split cotter (see page 70).

Pour three-quarters of a gallon of fresh oil into the crankcase through the filler.

Every 2,000 Miles—*continued.*

PARTS TO BE LUBRICATED.	NO. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Rear Friction Shock Dampers	2	Oil Gun ...	Gear Oil. Screw down a few turns on each lubricator.
Brake Equalisers ...	3	Oil Gun ...	Gear Oil. Screw down about six turns on each lubricator.
Clutch Trunnion ...	1	Oil Can ...	Engine Oil. Remove clutch pit cover and inject a few drops into oil hole of trunnion.
Clutch Levers ...	4	Oil Can ...	Engine Oil. Remove clutch pit cover and inject a few drops to lubricate fulcrum pins.
Clutch Withdrawing Shaft	1	Oil Can ...	Engine Oil. Inject a few drops into open end of shaft.
Starter Motor Bearing	1	Oil Can ...	Engine Oil. Inject a few drops in lubricator.
Dynamo Bearings ...	2	Oil Can ...	Engine Oil. Inject a few drops in lubricators.
Dynamo Drive Coupling	1	Oil Can ...	Engine Oil. Inject a few drops into oil hole.
Front Engine Support	1	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearing.
Battery Ignition Governor	1	Oil Can ...	Engine Oil. Inject a few drops in lubricator on low-tension rocker casing.
Steering Column ...	1	Oil Can ...	Engine Oil. Lift cover of thrust race on column, and inject a few drops into race.
Steering Box ...	1	—	Gear Oil. Remove plug and fill to mouth of plug orifice.*
Control Mechanism	—	Oil Can ...	Engine Oil. Lubricate numerous joints on steering box, steering wheel, carburetter, instrument board, radiator shutters, etc.

* If Steering Box Cover has a Spring Lid Lubricator, see page 33.

Also every 2,000 Miles.

1.—Remove wheels, grease interiors and hubs, and replace.

2.—Test steering joints and shock damper connections for play, and adjust if necessary (see Chapter IX.).

3.—Remove dynamo and starter motor end covers, clear away any dust, and inspect brush gear (see pages 43 and 48).

4.—Inspect L.T. make-and-break contacts of battery ignition. Set gaps to ·017" to ·021" (see page 54).

5.—Remove and clean carburetter air valve and chamber. Use no lubricant on these parts (see page 90).

6.—Remove rocker cover, and test tappet clearances with ·003" feeler gauge when engine is cold (see page 78).

7.—Remove and clean sparking plugs. Set gaps to ·020" (see page 57).

8.—Adjust brakes if necessary (see page 102 *et seq.*).

9.—Test fan belt for tightness, and adjust if necessary (see page 136).

10.—See that starter motor switch contains sufficient oil. Refill with engine oil if necessary (see page 51).

Every 5,000 Miles.

Carburetter Float Chamber. The float chamber cover should be unscrewed, the float removed, and the chamber wiped out with a piece of *clean, damp washleather*. The float should be shaken to discover if any petrol has leaked into it (see page 95).

Before replacing the cover the threads should be carefully cleaned and oiled, and it must be tightened by hand only.

Petrol Filters. The petrol tank filters, the filter on the petrol inlet to the vacuum tank, and also that in the float chamber or on the dashboard (whichever is provided), should be removed and cleaned (see pages 82 to 85).

Petrol Tank. The drain plug at the bottom of the petrol tank should be *released* a turn or so (not *removed*) to allow any water which may have accumulated to escape (see page 86).

Front Friction Shock Dampers. On chassis having front friction shock dampers, the links of these should be disconnected by removing the split cotters and caps at their bottom ends, after taking off the gaiters. The central adjusting nut and locknut should be unscrewed and the leathers removed. These must be cleaned and soaked in engine oil for a night.

The shock dampers should afterwards be adjusted so that a weight of 25 lbs. suspended on the end of the lever will just cause this to move (see page 123).

Water Cooling System. It is advisable to drain out the radiator and water system thoroughly, a tap being provided for this purpose just below the water pump. Clean soft water should be used for refilling, and the level should stand between $3\frac{1}{2}$" and $4\frac{1}{2}$" from the top of the filler spout (see page 134).

Fan. A few drops of engine oil should be injected into the lubricator of the fan **A**, and, on some chassis (**B**, Fig. 39). Also, the Whittle belt should be removed, scraped with a blunt knife, smeared with engine oil on the back (not on sides), and replaced.

Gearbox. When the gearbox is warm, inspect level of oil by removing plug from filler spout located on near side of the box. If necessary, add more gear oil through this filler spout until the level stands at its mouth. The oil should first be heated to reduce its viscosity and enable it to find its correct level.

The appearance of froth at the mouth of the filler spout may give a false impression as to the amount of oil in the gearbox.

When the car is new, all the oil should be drained out after the first 5,000 miles' running and replaced with fresh oil. A drain plug is located on the lower side of the gearbox. (See page 116.)

Back Axle. The plug at the bottom of the axle casing communicates with the interior through a standpipe which projects inside the casing to act as an oil level indicator.

The plug should be removed for testing the oil level when the axle is warm, and one should not be deceived by the appearance of a small quantity of oil, which is possibly only what has lodged in the standpipe.

If necessary, gear oil, which has been thoroughly warmed, should be poured in through the filler plug at the top of the casing, until oil just commences to flow from lower plug-hole.

In replacing the plugs, it should be noticed that their washers are in position.

When the car is new, all the oil should be drained out after the first 5,000 miles' running and replaced with fresh oil. For this purpose the standpipe must be removed. (See page 118.)

Clutch Shaft. The clutch-pit cover should be removed and crankshaft turned until an oil-hole on the clutch shaft is visible (**N**, Fig. 30). Into this a few drops of engine oil should be injected.

Excess of oil at this point will cause clutch trouble.

Bonnet Fasteners and Locks. The bonnet fasteners and locks should be carefully oiled, in order to prevent these parts from squeaking and rattling.

Every 10,000 Miles.

Gearbox. The drain plug should be removed when the gearbox is warm and all the oil drained out. The plug of the filler spout should be removed at the same time.

Fresh oil should then be added up to the mouth of the filler spout (see page 116).

On no account must paraffin, petrol or other oil solvent be used for washing out the box.

Back Axle. All the oil should be drained out when the axle is warm by removing the standpipe, and fresh oil should be added, after replacing the standpipe, until it commences to flow out of the bottom plughole (see page 118).

Crankcase Breather Pipe to Carburetter. The pipe which connects the carburetter air inlet to the crankcase should be removed and its gauze cleaned (see page 96).

Hydraulic Shock Dampers. On chassis having hydraulic shock dampers, the oil level in these should be inspected and more oil added if necessary (see page 125).

Every 20,000 Miles.

The brake servo adjustment should be tested as described on page 107, and the clearance readjusted if necessary.

CHAPTER III.

Electric Lighting, Starting, and Ignition System.

General — Dynamo — Distribution Box — Switchbox — Ammeter — Starter Motor—Starter Motor Drive—Starter Motor Switch—Battery Ignition — Magneto Ignition — Firing Order of Cylinders — Sparking Plugs — Klaxon Horn and Connections — Addition of Electrical Apparatus—Battery Connections—Electrical Fault Location.

General. The equipment comprises a dynamo, distribution box with fuses and automatic cut-out, switchbox, ammeter, a 12-volt 50-ampère-hour accumulator in container, a starter motor with foot-operated oil-immersed switch, a motor Klaxon horn with push-button at head of steering column, and battery ignition, consisting of non-trembler coil with ballast resistance, and combined low-tension contact breaker and high-tension distributor, and the necessary wiring encased in metal tubing.

Incorporated with the battery ignition is a governor, which effects automatic control of the battery ignition timing.

A magneto is provided as a stand-by.

The whole of this equipment, with the exception of the ammeter, battery, Klaxon horn, magneto, and electrical conductors, is of Rolls-Royce manufacture.

On certain chassis, contacts are provided on the instrument board thermometer, which close when the temperature of the cooling water approaches boiling point, and light a bulb located behind a small red window on the instrument board.

The practical wiring diagram (Fig. 4) shows these units in their approximate relative positions, with their electrical connections, the various wires being indicated in colours, to correspond with those of their actual coverings.

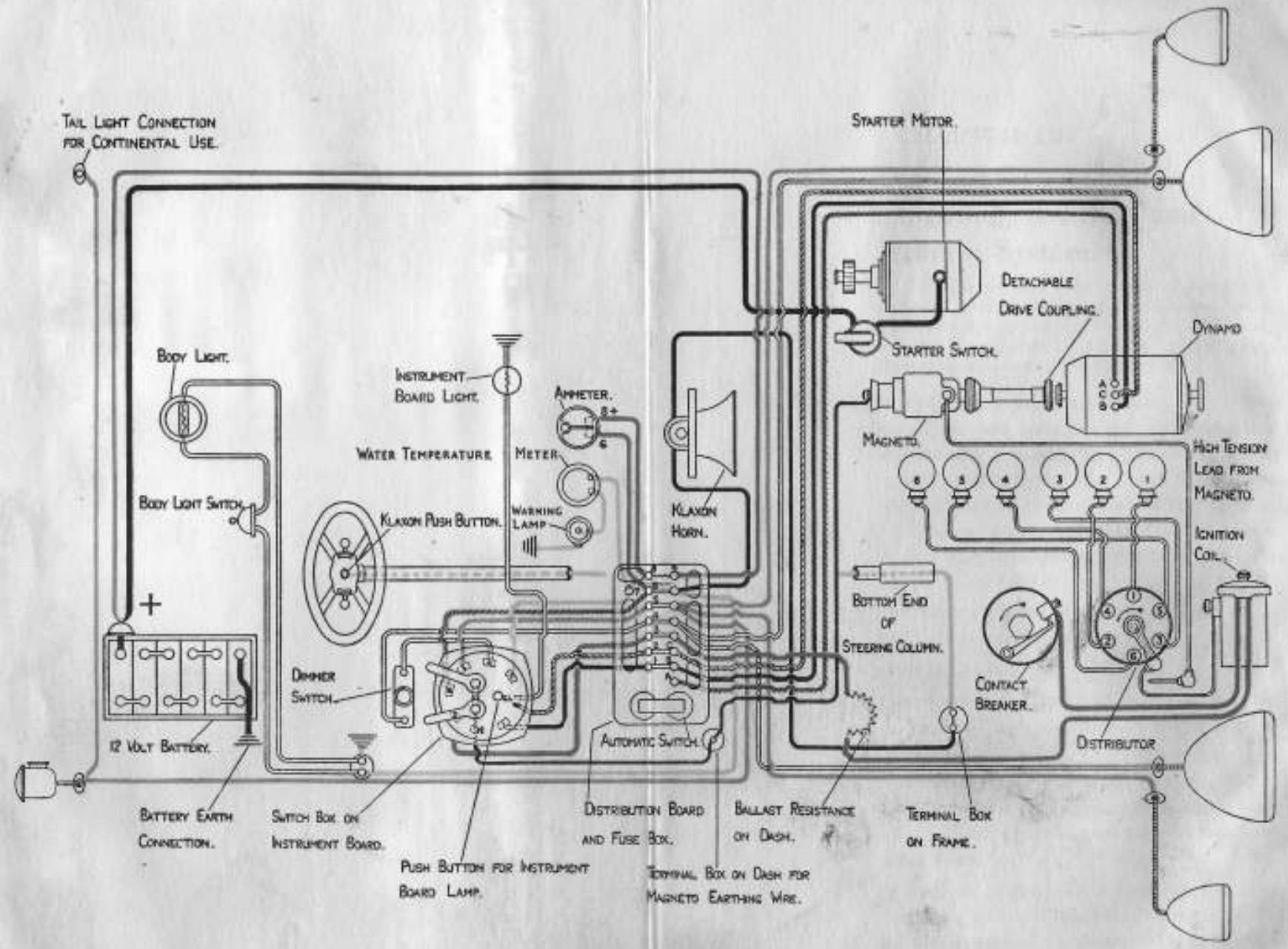


Fig. 4. Practical Wiring Diagram.

(On some Chassis two black wires pass up steering column and one terminal of Klaxon is earthed. Certain Chassis are not provided with Water Temperature Warning Lamp.)

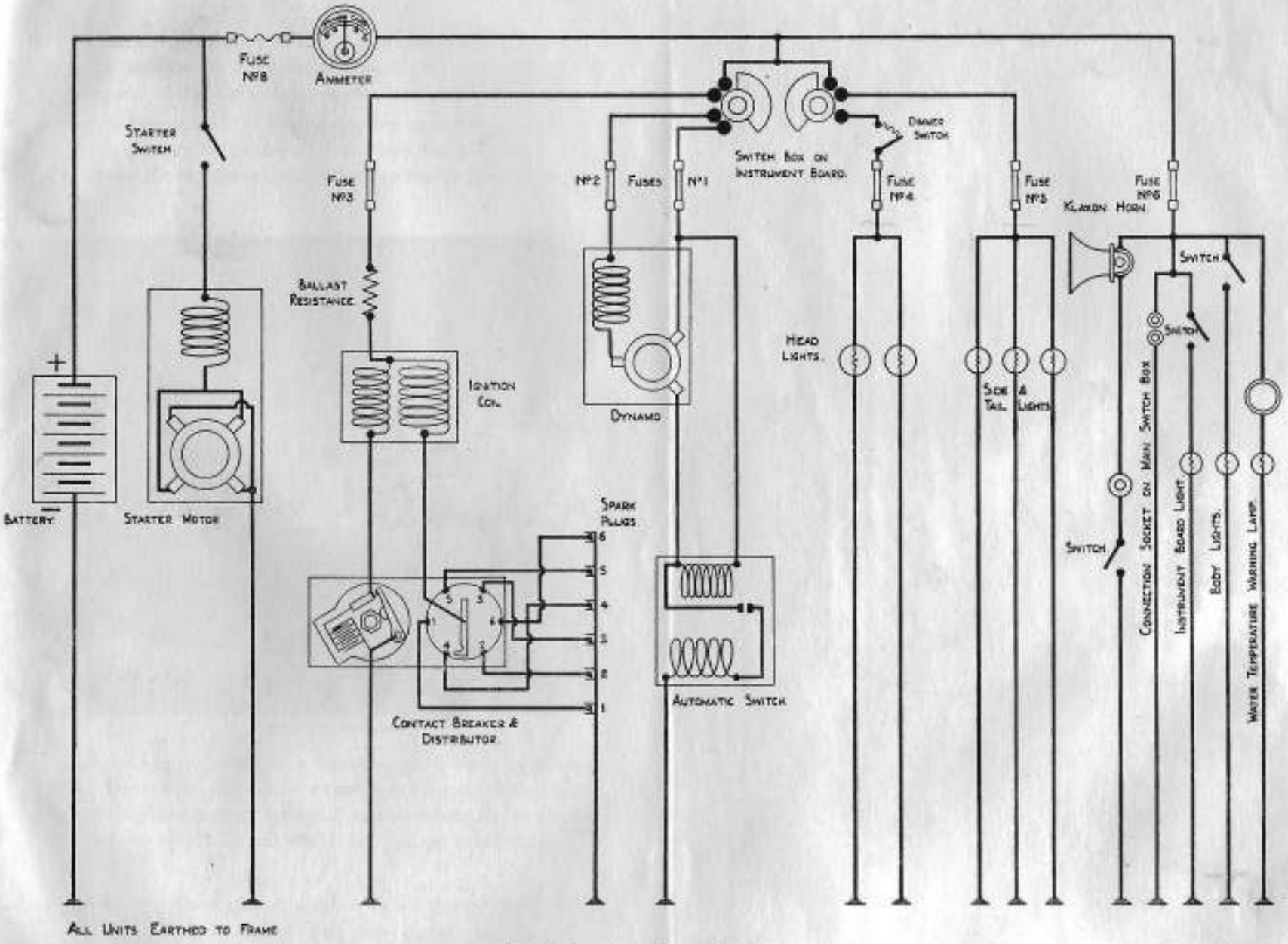


Fig. 5. Technical Wiring Diagram.
(Magneto omitted.)

The technical diagram (Fig. 5) is a simplified diagram of the battery circuits, which is the electrical equivalent of the actual circuits, the magneto connections being, in this case, omitted.

It will be seen that the electrical system is earthed on the negative side of the battery to the chassis frame, and that all hand-switching is done in the positive leads, with the exception of that of the Klaxon horn.

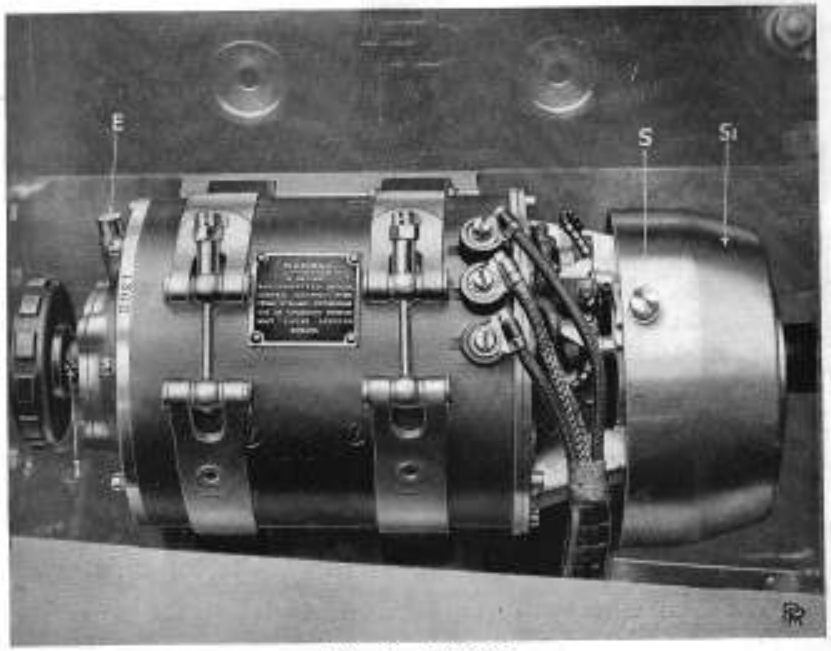


FIG. 6. DYNAMO.

Before doing any work on a chassis which is likely to involve the electrical system, it is advisable to remove the chassis frame connection from the negative battery terminal, and so render the whole system dead, but do not disconnect whilst any charge or discharge current is passing.

Dynamo. The dynamo, which is shown in position in Fig. 6, is positively driven from the engine (in line with the magneto) at one-and-a-half times engine speed. It is of the single field winding and third brush type, which, when connected to a battery,

is so controlled by armature flux distortion as to cause it to generate a relatively large current at moderate speeds, but one which falls off suitably in magnitude as the speed is increased.

The positive terminal of the field winding is brought up, via a cartridge type fuse in the distribution box, to the switchbox for switching purposes. The negative end of the field winding is connected to the third brush, which is narrower in width than the main brushes. The arrangement involves the use of three leads between the dynamo and distribution box, the actual leads being coloured as follows :—

Lead.	*Colour.*	*Corresponding letter on Dynamo.*
Negative	Red and black	... A
Positive	Black	... B
Field	White and black	... C

When, for any reason, the dynamo is removed from the chassis, care should be taken that it is not replaced with reversed residual magnetic polarity, which may result from an electrical test, such as running the dynamo as a motor with wrong connections from an independent battery.

Should the dynamo be replaced thus, though there is a probability of its being corrected by the chassis battery, there is danger in the process of the cut-out contact points being damaged by the arcing which may occur there.

To be sure of avoiding this, see that the charging switch is off before running the engine after the dynamo has been replaced.

The distribution box cover should now be removed.

Accelerate the engine and hold the cut-out contacts together by hand for a moment, during which the charging switch should be put on. This will allow the battery to determine the dynamo polarity correctly in the first instance, and eliminate the possibility of damage to the contacts.

The bearings require little attention. When the chassis is overhauled, however, or the dynamo removed, they should be cleaned out and re-greased with only sufficient grease to occupy the spaces between balls and cage. Any excess is only melted out by heat, and may get on the commutator, or between the brushes and brush holders, causing brush sluggishness.

There is provision for additional lubrication at each bearing in the form of a small oil cup, one being shown at **E** (Fig. 6) and the other at **S**, the latter being normally within the cover **S1**.

A little engine oil should be injected at each lubricator every 2,000 miles, as directed on page 36. At the same time a few drops of oil should be injected into the oil-hole **I** to lubricate the drive coupling.

Also every 2,000 miles the dynamo end cover **S1** should be removed, so exposing the commutator and brushes. Deposits of brush dust, moisture or oil should be removed by suitable means, and note taken of any appreciable wear of the brushes.

Premature failure or excessive wear, however, indicates some definite fault in the machine, which should be returned for correction. In normal circumstances the brushes should last until the chassis is returned for general overhaul.

In the event, however, of a new set of brushes being required, application should be made to Rolls-Royce Ltd.

When new brushes have been fitted, it is advisable that arrangements be made for the machine to run for two hours on load under bench conditions, and the initial bedding of the brushes assisted by scraping their working surfaces, though in time correct bedding will take place naturally in any case.

When it is necessary to run the engine with the dynamo end cover, **S1**, removed, the latter may be held clear of the magneto drive shaft by turning it until a hole is found, by which it may be secured on the lubricator by means of the lubricator cap **S**, as shown in Fig. 6.

When it is necessary to disconnect the wires from the dynamo, care must be taken to ensure their correct replacement, which is facilitated by the colouring and lettering adopted. The same remarks apply to the disconnection of dynamo wires at the distribution box.

Distribution Box. The distribution box containing the cut-out, or automatic charging switch, together with a series of fuses, is shown with the cover removed in Fig. 7. The cut-out and fuses are easily accessible on removing the cover.

The cut-out is operated when the dynamo speed rises high enough

for the dynamo to be excited up to battery voltage, because its shunt coil is connected across the main terminals of the dynamo. This closes the cut-out contacts, which make connection, via the cut-out

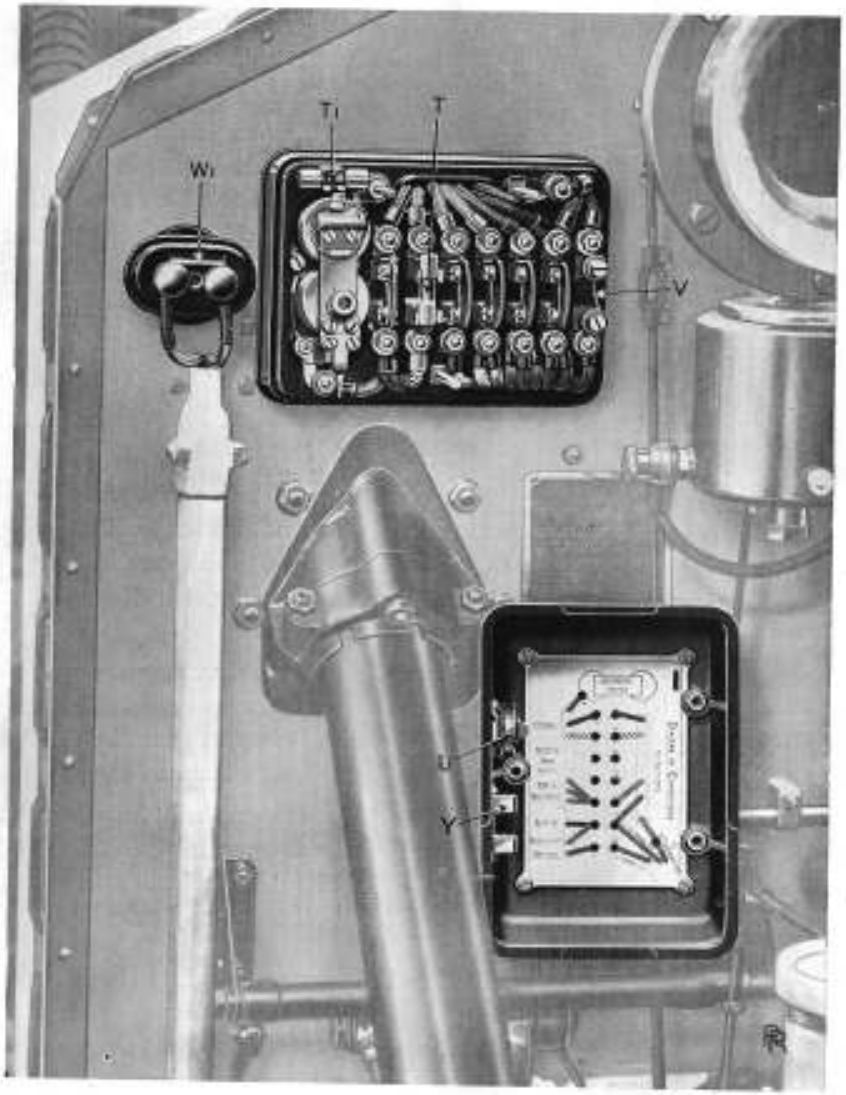


FIG. 7.
DISTRIBUTION BOX, WITH COVER REMOVED, AND BALLAST RESISTANCE.

series coil, between the negative (dynamo) terminal, through the chassis frame to the battery negative, and thus allows the main charging current to flow from the dynamo positive terminal through the battery to the chassis frame, returning through the series coil and the contacts to the negative terminal of the dynamo.

The series coil is so connected that, when carrying the charging current, it assists the shunt coil in holding the contacts firmly together.

When the dynamo slows down, and its voltage falls below that of the battery, the current reverses through the series coil, and the effect of the shunt winding becomes neutralised, which results in the contacts falling apart.

The automatic cut-out is carefully adjusted by Rolls-Royce Ltd. in the first instance, and should only be touched in exceptional circumstances.

In the unlikely event of burning at the contacts, causing the cut-out to fail to break, and thus allowing the battery to discharge through the dynamo, turn off the charging switch immediately, and inspect the cut-out contacts. Such a failure would be indicated by the ammeter showing an unexpected discharge current. It may be necessary to clean the contacts with the aid of some fine glass-paper, after which carefully remove grit.

The fuses in the distribution box, with exception of the battery emergency fuse **V** (Fig. 7), and dynamo field fuse **T**, which is of the cartridge type, are all of a single strand of 30 S.W.G. copper wire. Spare wire of this size is provided on a reel **U**, in the inside of the box cover.

The emergency fuse **V** should be three strands of this wire, neatly twisted together, and is only intended to be an emergency protection against dead earths on the wiring.

The cartridge type field fuse contains a No. 38 S.W.G. tinned copper fuse wire, and affords protection against damage to the dynamo, automatic cut-out, lamp bulbs, ignition ballast resistance and coil, in the event of the battery not being properly connected to the system, or to the dynamo in the event of dirty or gritty cut-out contacts.

Three spare cartridge type field fuses are supplied with each

chassis, one of these being clipped to the distribution box, as shown at T1.

The dynamo cannot be excited or connected to the system if this fuse is removed or melted.

Special care should be taken that all fuses are gripped firmly in their holders, as a loose contact may in itself cause the fuse to melt or prevent the dynamo from exciting.

Be certain particularly that the emergency fuse is in order.

Switchbox. Carried on the right-hand end of the instrument board, this unit includes :—

(*a*) Lamp switch.

(*b*) Ignition and charging switch.

(*c*) Push-button for dash lamp.

(*d*) Socket for inspection lamp plug.

(*e*) A lock which can be locked and the key withdrawn with the switches in only two positions :—

(1) When both ignition and lamp switches are at the off position.

(2) When ignition is at the off position, but the lamp switch is at the **S** and **T** position.

Do not try to lock the switch in other positions.

The switches (*a*) and (*b*) are operated by thumb levers, and the various combinations controlled by each are clearly indicated by letters as follows :—

OFF.—No circuits in action.

S and **T.**—Side and tail lamps on.

H, S and **T.**—Head, side and tail lamps on.

I.—Ignition on (battery or magneto, as the case may be).

I and **C.**—Ignition on, and connections closed to enable the dynamo to charge the battery. The switch in this position connects up the positive field and positive armature connections to the positive terminal of the battery, via the ammeter and emergency fuse in the distribution box, and therefore, when the dynamo is running, permits excitation of the dynamo field.

This is the position of the switch recommended for ordinary running.

Ammeter. The ammeter is a moving coil instrument with a central zero and 20-ampère range.

Electrically, it is so connected as to indicate all current passing in or out of the battery, except the heavy current for the starter motor, a needle deflection to the right indicating charge, and left discharge. Thus the dynamo output, less the current required to operate the battery ignition, is exactly indicated if no other consuming apparatus be switched on; and, if the dynamo be off, the current being consumed by the lamps, etc., together with that for the ignition, is shown. If both dynamo and lamps or other apparatus be on, the reading gives the balance in or out of the battery.

Should the ammeter not show any charging current with the charging switch on, lamps off, and dynamo running, confirm that the battery connections are sound, by inspection, and by trying the head lamps with the charging switch off, and if no irregularity be found, inspect the fuses, and replace with spare fuse wire or cartridge fuse provided as necessary.

In the unlikely event of no charging now taking place, the fault must lie in the dynamo or dynamo connections, and it will be necessary to inspect these carefully. One cause of failure to charge would be the existence of a break on the field positive or armature positive leads from switchbox via distribution box to dynamo; another, want of freedom of dynamo brushes in their holders, preventing them from properly making contact with the commutator.

An unnoticed reversal of the ammeter connections causes the charge and discharge indications to be reversed.

Starter Motor. The starter motor is shown at **A** in Fig. 9. The Bijur pinion engages with teeth on the engine flywheel in the usual manner, the gearing being totally enclosed, and giving a reduction ratio between motor armature and engine crankshaft of 8·4 : 1.

The motor bearings, like those of the dynamo, require little attention. When the chassis is overhauled, however, or the starter motor removed, they should be cleaned out and re-greased with only sufficient grease to occupy the spaces between balls and cage. Excess of grease may lead to trouble with the brush gear.

There is provision for additional lubrication at the driving end, in the form of a small oil cup (**B**, Fig. 9). Oil every 2,000 miles, as directed on page 36.

At the same time, the motor end cover should be removed, exposing the commutator and brushes. Deposits of brush dust should be suitably removed.

Should faulty running of the motor develop which is not traceable to the battery, it is possibly due to faulty contact of the brushes on the commutator, which may in turn be due to want of freedom of the brushes in their holders. Such want of freedom may result from bearing grease having found its way to the brush holder.

Ordinarily, the brushes will last a very long time. In the event, however, of replacements becoming necessary, application should be made to Rolls-Royce Ltd.

When new brushes have been fitted, it is important, by means of fine glass-paper drawn to and fro round the commutator, with its rough side in contact with the brush, to secure proper bedding. After this, it is well to run the motor light on six volts for ten minutes before replacing in the chassis.

When replacing the starter motor in the chassis, it is important to be sure that clean and sound electrical connection of cable to motor is reobtained, owing to the heavy current which this has to carry. This also applies to electrical connection of the motor carcase to the crankcase.

The starter should never be used unless the ignition advance lever has been fully retarded on its quadrant.

Starter Motor Drive. Normally, the starter motor drive should need no attention. If, on the other hand, it be found that operation of the switch causes the pinion to engage and the motor to turn without rotating the flywheel, or only rotating it sluggishly, this is probably due to slipping of a small cork friction clutch which is incorporated with the drive. To cure the trouble it will be necessary to remove and dismantle the drive and probably renew the friction washers.

Having first disconnected the negative battery terminal from the

chassis frame, it is preferable to remove the motor complete with the drive.

To do this the crankcase oil filler spout must be removed and the motor cable disconnected.

After unscrewing and withdrawing the four long set-screws and detaching the rear end cover, the motor should be withdrawn forwards as far as possible. The rear end must then be canted upwards, when the complete unit can be taken out.

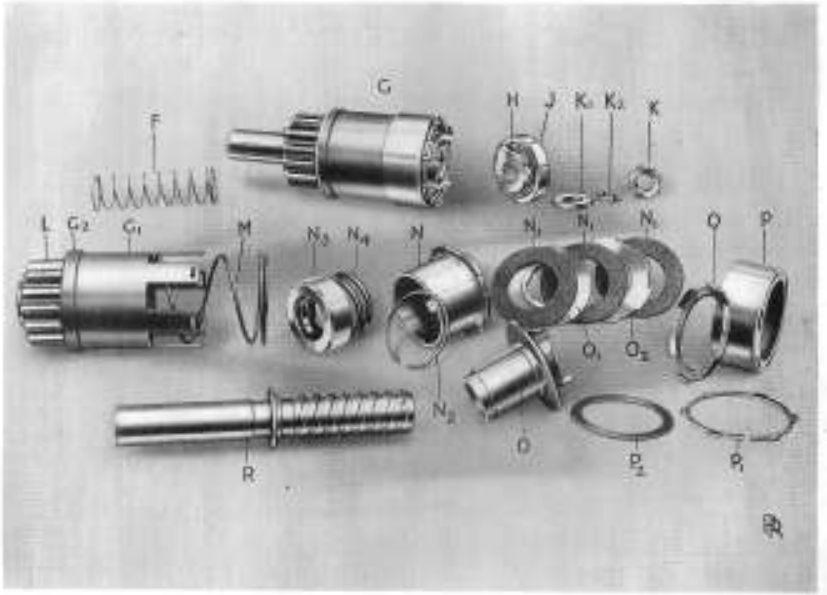


FIG. 8. STARTER MOTOR DRIVE
(Chassis GFN, GLN, GEN and GVO).

Two different types of drives are provided, the one having a single cork friction washer and the other three such washers. The latter type is only provided on chassis having the letters GFN, GLN, GEN and GVO as part of their serial numbers, and may be recognised by the fact that it is secured on the armature shaft by a plain hexagon nut locked by a tab washer, the single-washer type being secured by a castellated nut and split cotter.

It should be particularly noticed that the castellated nut has a left-hand thread whereas the plain nut is provided with a right-hand

thread. If difficulty be experienced in removing this nut, the spanner should be given a sharp tap with a hammer.

A complete drive of the three-washer type is shown at **G** in Fig. 8, and a similar type of drive is also shown dismantled in the lower part of the illustration. Similar remarks apply to the removal and dismantling of both types.

After removing retaining nut **K**, the stop **H** with the ball bearing **J** in position should be pulled off the shaft, followed by the complete drive and spring **F**.

The first operation, when dismantling, consists of the removal of retaining ring **P1** with pliers and screwdriver. Cap **P** can then be lifted off followed by ring **Q**, beneath which is fibre washer **P2**. (The latter is not provided with the single-washer drive.)

The engaging nut **O**, with its friction plate, the cork washers **N1**, the metal washers **O1** and **O2**, and the member **N**, housing the buffer spring **N4**, and bush **N3**, together with the shaft **R**, will then be pushed from the casing **G1** by spring **M**.

The cork friction washers, **N1**, should be examined, and if these be found damaged, they must be discarded and the new ones supplied with the spares used instead.

Normally, there should be no need to remove the buffer spring **N4** from the member **N**, but if it be considered desirable to do so for inspection or other purposes, removal is effected by making use of the shaft **R** and nut **O** to compress the spring **N4**.

To do this, the friction washers **N1**, **O1**, and **O2**, together with member **N**, must be assembled on the sleeve of nut **O**. Shaft and nut should then be screwed together by hand until bush **N3** is seen to be pressed clear of the locking ring **N2**. The latter can then be removed.

When reassembling the drive, the shaft **R** and nut **O** can be utilised in a similar manner to compress the buffer spring for replacement of spring ring **N2**.

If the pinion **L** should have been removed from casing **G1**, care must be taken to see that the fibre washer is in position in the casing before replacing the pinion.

The various parts can then be built into the casing **G1** as follows :—

(1) Fit coil spring **M** into casing **G1**.
(2) Fit shaft **R** into pinion.
(3) Assemble on engaging nut **O**, in the order stated, cork washer **N1**, externally serrated plate **O2**, cork washer **N1**, internally serrated plate **O1**, cork washer **N1**, member **N** containing the parts **N2**, **N3**, and **N4**.
(4) Fit resulting assembly into casing, screwing shaft lightly into engaging nut.
(5) Replace ring **Q** with washer **P2**.
(6) Fit cap **P**.
(7) Fit locking ring **P1**. If this should have been damaged in removal, the ring which is supplied in the spares should be utilised.

Replacement of cap **P**, which involves compressing the spring **M**, will be facilitated if the assembly be mounted vertically on two wood blocks, the pinion being downward, and the blocks being so arranged that the weight of the unit and the reaction of compressing the spring is taken on the rounded end, **G2**, of the casing.

Before replacing the drive on the armature shaft, the latter should be carefully wiped clean and smeared with a little oil. The bore of the drive shaft must also be quite clean.

The drive with the spring **F** can then be replaced on the shaft, followed by the stop **H**, with its bearing **J**, and the plain washer, **K1**. A new tab washer, **K2**, is provided in the spares for locking the nut **K**.

When replacing the motor, care must be taken to see that all joint faces are clean. The motor must be steadied by hand while refitting the end cover, and the four long set-screws tightened evenly and gradually.

A clean and sound electrical connection of cable to motor must be assured.

A paper washer should be used for making the joint between filler spout and crankcase.

Starter Motor Switch. This switch is shown at **F** (Fig. 9). It is situated on the left rear engine foot. Its working contacts are oil-immersed, and it is foot-operated. The switch should be kept full of ordinary engine oil, a plug, **D**, being

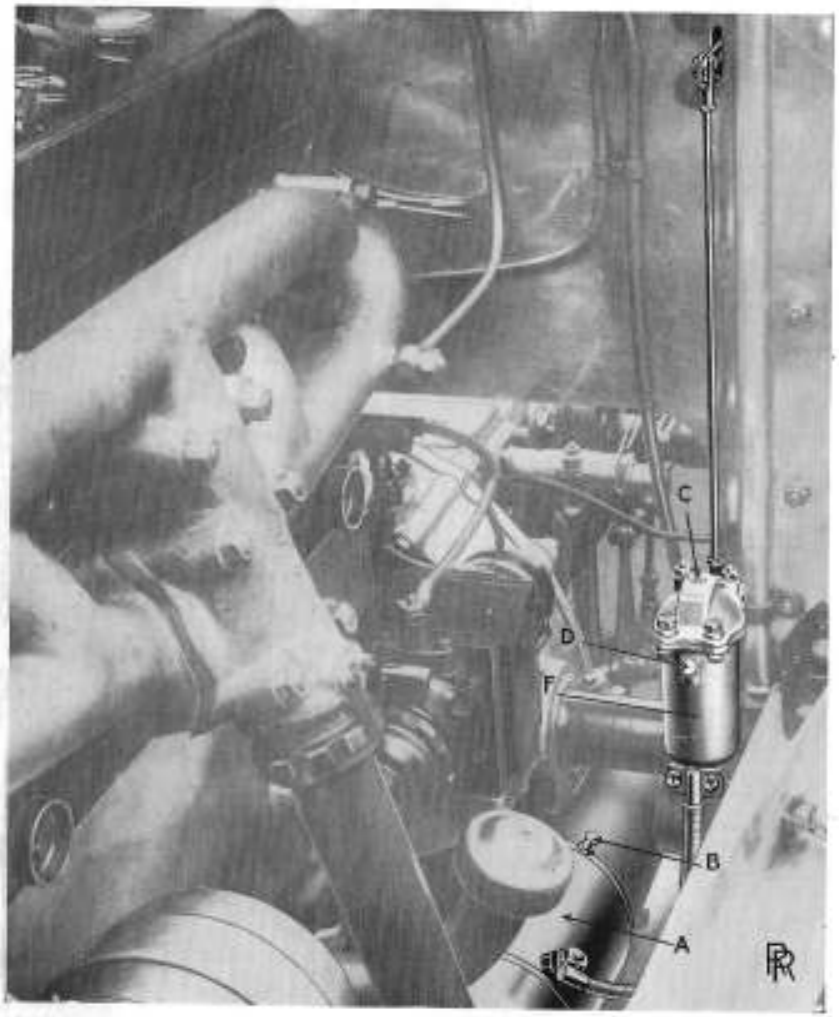


FIG. 9. STARTER MOTOR AND SWITCH.

provided for filling purposes. A spring-loaded ball, **C**, on the top of the switch permits lubrication of the control lever. Oil every 2,000 miles, when lubricating the control mechanism as directed on page 36.

In order to avoid burning or sticking of the switch contacts the operating pedal must always be *fully* depressed when starting the engine.

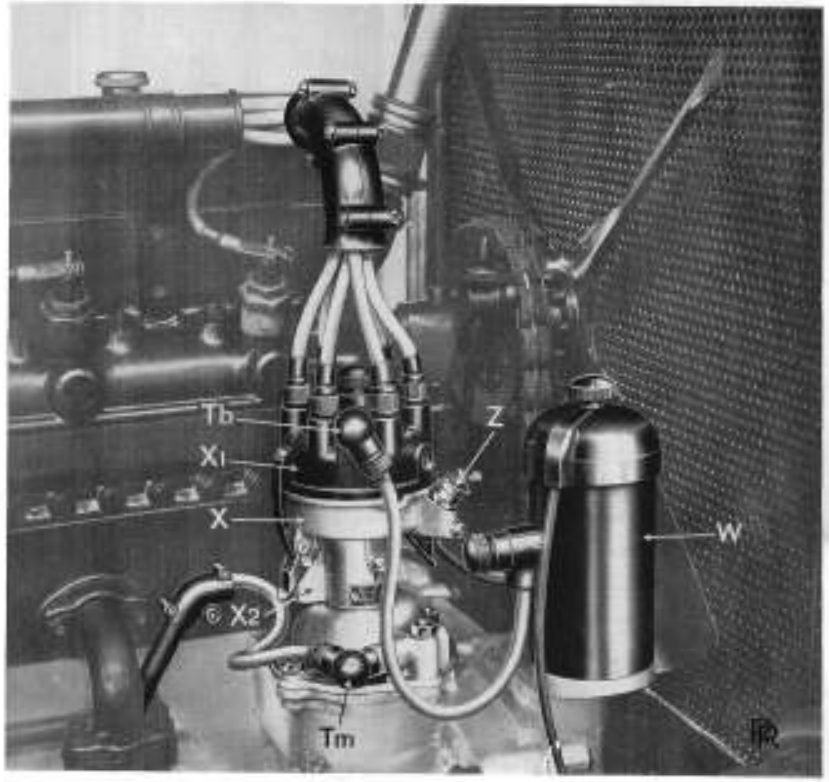


FIG. 10. IGNITION COIL AND DISTRIBUTOR.

Battery Ignition. The battery ignition is in a very accessible position, as shown in Fig. 10, and consists of a non-trembler ignition coil **W**, and combined low-tension contact breaker **X** and high-tension distributor **X1**.

A ballast resistance **W1** (Fig. 7) is arranged on the dash, connected in series with the low-tension winding of the coil. Its function is to limit the current taken by the coil at slow speed, or if the ignition switch be accidentally left on while the engine is stopped. It also

secures practical equality of intensity of secondary spark at all speeds.

A condenser connected across the contact points is located in a pocket **X2** of this apparatus, the condenser case and the main body of the contact breaker unit being together in direct electrical connection with the chassis frame.

The insulated terminal of the condenser is connected to the insulated contact, and they are brought out together to the insulated terminal to which the external low tension connection is made.

In setting the points the maximum gap opening should be from ·017" to ·021".

The low-tension rocker arm may require lubrication at long intervals. The rocker arm should be removed and a little grease smeared on the pivot pin.

A few drops of engine oil should be injected into lubricator **Z** (Fig. 10) every 2,000 miles, as directed on page 36, in order to lubricate the centrifugal ignition timing mechanism. In addition, the oil so injected serves to maintain an oil seal arranged at the base of the ignition tower to protect the contacts from oily vapour from the crankcase, which is liable to cause pitting.

The high-tension distributor requires no attention beyond an occasional wiping of the interior with a clean, dry rag.

If the timing of the battery ignition should have been deranged, due, for instance, to removal of the cam operating the low-tension rocker, it can be re-set by reference to the flywheel markings which can be seen on removal of the clutch pit cover.

To carry out this operation the engine should be cranked by hand until No. 1 piston is at the commencement of its firing stroke, as indicated by the T.D.C. (top dead centre) mark. A little further rotation will reveal the letters B.L.I. (battery, late ignition) on the flywheel periphery. The flywheel should be set so that this B.L.I. mark registers with the mark on the casing.

With the ignition lever fully retarded, it is then necessary that the low-tension contacts should be just breaking, the high-tension distributor blade being meanwhile in a position which will bring it opposite No. 1 terminal of the distributor. A convenient method

of determining precisely when the break takes place is by reference to the ammeter. With the ignition switched on, and someone watching the ammeter, the cam should be slowly rotated on the taper of its shaft in the normal direction of rotation until the required peak breaks contact as indicated by the reading of the ammeter. The screw securing the cam should then be tightened.

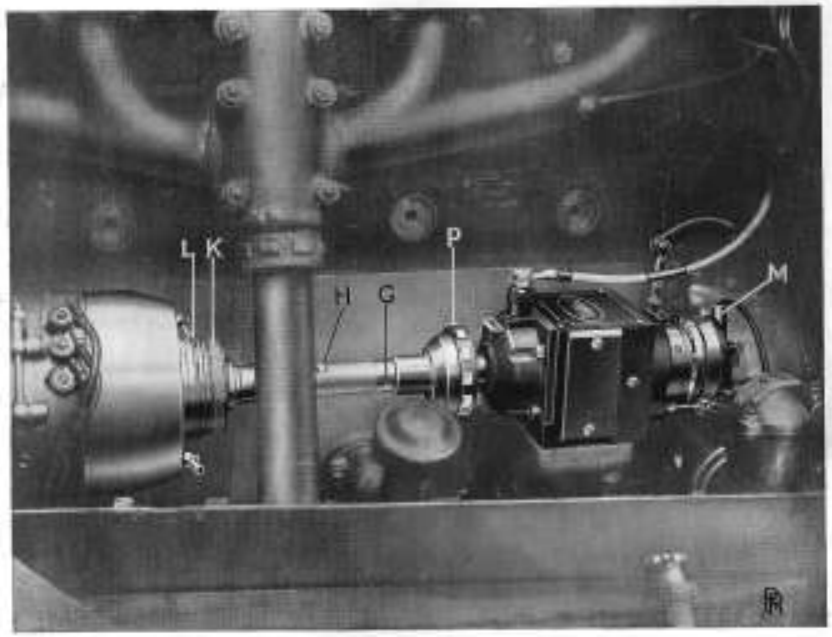


FIG. 11. MAGNETO.

Magneto Ignition. A special magneto (type R.O. 1) is fitted as a stand-by, and is shown in Fig. 11. It is provided with oil-holes, and two or three drops of oil should be added occasionally when the magneto is in use. Excess of oil, however, must be carefully avoided, as it will interfere with the working. An oil-hole is also provided in the drive shaft, as shown at **G**, and a drop or two of oil should be inserted occasionally, when using the magneto, to lubricate the rear coupling.

A gauge for setting the contacts is provided on the magneto spanner.

The drive is carried by serrated couplings from the dynamo shaft, the forward coupling being quickly detachable by hand, in order to avoid running the magneto save when it is required for ignition purposes. A tooth is omitted from this coupling, and the shaft is pressed forward by an internal spring, the coupling being normally held out of engagement by means of a catch shown at **H** in Fig. 11. The catch is released by pressing it inwards, when the shaft should be turned by hand until the serrated coupling is felt to be in engagement. The omitted tooth ensures that the timing is correct.

No high-tension distributor is provided on the magneto. It is arranged to deliver two high-tension sparks per revolution, and a single high-tension lead conveys these to the battery ignition distributor. The lead is fitted with a terminal which is interchangeable with that of the lead from the coil, and is normally carried in a holder on the ignition tower, as shown at **T**m in Fig. 10. Thus, to put the magneto into service it is only necessary to engage the drive coupling as described, and change over these two high-tension terminals. It must be remembered that the magneto ignition is provided, not as an alternative ignition, but as a stand-by, to ensure reliability. The characteristics of its application to the engine are not such as will give as good power performance as the battery ignition, and this must not be expected. Usually, therefore, the magneto will only be used when there is no battery connected to the system, in which case, as elsewhere explained, there will be no supply of current. Should, however, circumstances call for use of the magneto in spite of the presence of the battery, it is then important to remove ignition fuse No. 3 from the distribution box and so independently cut off the supply that would otherwise go to the battery ignition in the on position of the switch. A dummy fuse holder is provided in the distribution box cover, as shown at **Y**, in Fig. 7, for the reception of fuse No. 3 when this is removed from its working position.

The magneto coupling should not be left in engagement when the battery ignition is being utilised. It is easily disengaged by pulling the shaft rearwards by hand until the catch is felt to be holding it against the pressure of the internal spring. It will then be possible to turn the shaft freely.

Should it become necessary to remove the magneto from the engine

at any time, this should be done, if possible, without disturbing the rear drive coupling, which would necessitate re-timing of the magneto. The forward coupling is easily demountable by unscrewing the knurled cover **K** (Fig. 11), but before doing this, catch **H** should be depressed to clear the cover. The spring locking ring **L** should then be removed and the cover unscrewed (right-hand thread). The magneto is held on its bracket by two set-screws, and after removing these, detaching the earth wire **M**, and disconnecting the control mechanism, the magneto, complete with its shaft, can be removed.

If the rear coupling must be detached, this should be done with the magneto in position and the drive engaged. A special spanner is provided in the tool kit for unscrewing the cap **P** (right-hand thread). When the magneto is removed, care must be taken not to lose the spring which is arranged within this coupling, and when the latter is reassembled, this spring must be in its correct position.

When re-timing the magneto, reference should be made to the timing markings on the flywheel by removing the clutch pit cover. The crankshaft should be turned until the T.D.C. (top dead centre) mark registers with the timing mark on the flywheel casing. In this position the low-tension contacts should just be breaking when the ignition lever is fully retarded.

Firing Order of Cylinders. The firing order of the engine is 1, 4, 2, 6, 3, 5, No. 1 being the front cylinder.

Sparking Plugs. The sparking plugs should be removed and cleaned every 2,000 miles, and the width of the gaps checked, as directed on page 37. These should be ·020".

Klaxon Horn and Connections. An instruction pamphlet concerning the care and adjustment of the Klaxon horn is inserted at the end of this Instruction Book. A small junction box on the frame near the foot of the steering column enables the connection to the Klaxon button on the centre of the steering wheel to be broken when required.

Addition of Electrical Apparatus. If current consuming apparatus be installed additional to that provided on the car, this must on no account be connected to the system at one of the terminals of the ammeter.

Under such circumstances the new apparatus and additional wires are only protected by the comparatively heavy emergency fuse, consequently a short-circuit on the new system is likely to burn out the wiring and expose the whole car to the risk of fire.

The only point at which any new apparatus should be connected is the No. 7 terminal, either that in the switchbox or in the distribution box, whichever may be more convenient.

When connected at either of these points the added apparatus and wires are protected by No. 6 fuse.

Battery Connections. The necessary care must be taken to secure clean and sound electrical connections of the clip-on type of cable terminals to the projecting battery lugs, and also in replacing connections in the terminal box on the sides of the battery box. To clean terminals, use paraffin (not abrasives), and afterwards again vaseline thoroughly. To remove corrosion, use a solution of ammonium carbonate in the first instance, applying this with a rag.

When disconnecting the cable terminals from the battery terminal posts, care should be taken not to use force if these are found to be tight, as this is likely to damage the battery. The clip-on terminals should be opened slightly with a screwdriver, and removal will be found to be quite easy.

It is of great importance not to attempt to light lamps or operate any part of the electrical system direct from the dynamo, the battery being either intentionally or unintentionally disconnected, e.g., by removal of the battery or failure of the emergency fuse. In these circumstances, though no current is indicated by the ammeter, the voltage of the system rises above normal.

Considerable protection of consuming apparatus other than lamp bulbs is afforded by the cartridge type field fuse in the dynamo field circuit, which will melt when the voltage is excessive, and save also the dynamo and cutout from damage, but it will be understood that it is impossible to arrange this fuse to be a universally infallible protection without introducing the possibility of its failing in normal running.

In order to provide against such damage, when, for instance, the battery is removed or disconnected and the car is being run on the magneto, a plate is fixed on the battery box cover, and also on the dynamo, on which the following instructions appear :—

WARNING.

If battery disconnected, detach central (exciting) wire from dynamo, otherwise use of charging switch may cause serious damage.

The central wire is marked "C," and when disconnected should be secured under one of the thumb screws which hold the dynamo rear end cover in position. The dynamo and cutout portion of the system is then inoperative should the switch be inadvertently moved to the charge position.

Electrical Fault Location. An electric torch hand-lamp should be carried when much night running is being done, in addition to an inspection lamp with a plug which may be connected to the switchbox.

In case of faulty operation, proceed to investigate as follows :—

(1) Failure of any part of the system separately may be due to a blown fuse in the distribution box.

(2) Failure or incorrect operation (see under Battery Connections) of the system may be due to the fusing of the emergency battery fuse (V, Fig. 7) due to an earth.

Repeated failure of a properly fitted fuse indicates a fault on the system.

If dynamo does not charge, this may be due to :—

(1) Brushes sticking, due probably to oiliness. Clean brushes and holders with rag moistened with petrol.

(2) Melting of dynamo armature or dynamo field fuse, which latter may be due to :—

(*a*) Dirty cut-out contacts, which clean.

(*b*) Discontinuity or bad contact in dynamo battery circuit. See that lights are in order and examine battery terminal connections.

(*c*) Sticking dynamo negative brushes.

If, with the fuses intact, and the lights in order, the ignition :—

(*a*) Misses.

(1) First confirm right condition of sparking plugs.

(2) Assure correct condition of contact breaker points, and adjust gap '017" to '021", if necessary.

(3) If missing still continues, test ignition circuit as below.

(*b*) Fails.

(1) With battery ignition switched on, see by ammeter, while engine is cranked, that coil is taking current intermittently. If no current, test with a small voltmeter (to frame) availability of battery voltage on ballast resistance terminals then at coil terminals.

If, with battery in order, starter motor is sluggish or does not turn, examine commutator and brushes. Clean oily brushes and holders with a rag moistened with petrol. If motor turns without turning engine, examine Bijur drive (see page 48).

If battery will not retain charge :—

(1) Ascertain that no circuit is left switched on.

(2) Test each individual cell with a small voltmeter, with all lights on.

(3) See that no cell of the battery leaks acid.

CHAPTER IV.

Care of Battery.

Use of Charging Switch—Care of Battery under Running Conditions—Failure of one or more Cells—Charging in Garage from External Source—Use of Starter.

Use of Charging Switch. If the car is used in circumstances which require frequent use of the starter and lights, it will be found quite necessary to keep the charging switch on whenever the engine is running.

The current generated by the dynamo falls off with increasing speed, so that the danger of overcharging by long fast runs in the daytime is much reduced. **When, however, the battery is known to be fully charged and the car is running at a moderate speed only, it would generally be advisable for the charge to be switched off.**

It is important that the battery should be kept fully charged, but not overcharged at a high rate of current, as this may cause the temperature limit of 100° F. to be exceeded, and the cells may suffer, due to evaporation from the electrolyte and by disintegration of the plates.

Care of Battery under Running Conditions. The top of the battery should always be kept clean and, as far as possible, dry ; attention should be given immediately to the least sign of corrosion occurring on the terminals.

Keep the terminals and connections well greased, clean on their surfaces in contact and firmly screwed up, but do not use abrasives for cleaning, *i.e.*, file, emery-paper, sand-paper (see also under " Battery Connections," page 58).

Do not allow metal tools or other metal to short circuit any terminals of the cells.

Do not inspect the battery with the aid of a naked light, and on no account disconnect any of the battery terminals or connections when any charge or discharge current is passing, for such a course incurs risk of an explosion, destructive to one or more cells, and involving personal risk.

A useful adjunct in connection with keeping the top of the battery free from acid is a small sponge, which should be used in conjunction with a bowl of water and ammonia to remove acid from the top of the battery.

Do not short the battery to see if it is charged.

See that vent-plug passages are kept clear.

A battery should not be allowed to continue discharging when the voltage of any cell has fallen below 1·8 (except momentarily for the purpose of tracing a faulty cell, as described on page 59 and below).

Such a discharge may occur if there is an earth in the wiring system, or if the ignition switch be left on in error and the platinum contacts of the make-and-break happen to be left in contact.

Always, when taking leave of the car, make a practice of checking that the ammeter does not show any discharge current.

It is most important that the battery should not be allowed to stand with its terminal voltage below 10·8, as this will shorten its life.

It is of even greater importance to keep all plates always well covered with electrolyte.

Failure of one or more Cells. If, when the battery is supplying current, its voltage becomes low prematurely, it may be due to one or more cells having become faulty.

This condition is best ascertained by the use of a small voltmeter, with which each cell should be tested independently, whilst the head lamps are lighted, and the faulty cell or cells located.

Ordinarily, it may be expected that all six cells will work together in much the same condition.

In such a case of failure, the makers of the battery should be consulted.

It should be understood, however, that failure is considered *most unlikely* within a period of three years' service, if proper care be taken of the battery.

Charging in Garage from External Source. A direct current is necessary.

If the supply be alternating, suitable rectifying apparatus must be used. There are two or three reliable types of rectifier on the market which are capable of supplying to a six-cell battery a direct current of from 2 to 6 ampères. The charging current must necessarily be supplied through a suitable switch and a variable resistance, or set of lamps, preferably carbon filament, suitably arranged to act as a variable resistance.

If the source of current be a direct current public supply main, it should be confirmed that the resistance is in the main showing the higher potential to earth, before connecting up the battery for charging purposes.

For this purpose, take a lamp of supply main voltage, earth one terminal to water pipes or gas pipes, and connect the other terminal to each charging terminal in turn.

With the minimum possible resistance in the circuit, the lamp should light more brightly on that terminal supplied through the resistance. Otherwise, the mains feeding the board require interchanging.

In the absence of the necessary experience, an electrical expert should be consulted.

It is possible to charge the battery in position on the car, making use of a flexible lead and two-pin plug which fits the socket on the switchbox.

The other ends of the flexible lead must be connected to the charging board terminals in such a way that the chassis ammeter indicates charge when the current is switched on. The chassis charging switch should be left off.

Another method of securing correct direction of current is to place the plug pins in contact with pole-finding paper, and arrange that the polarity shown is in agreement with that at the plug socket,

the positive being on the right; but whichever way it is done, be certain that the direction is correct.

The number of lamps in circuit, or the variable resistance, must be suitably adjusted to allow of the flow of the required charging current, which should not exceed 6 ampères, and should be reduced as the charge proceeds to about 3 ampères at the finish, when all plates should be gassing.

Avoid overcharging the battery, either in quantity or time, except at trickle rate, as described below.

Charging in the garage from an external source, with the battery in position on the car, is strongly recommended where conditions of running are such that a heavy demand is made on the battery, for instance, where much night-running is done.

Where it is a frequent occurrence for the car to be parked for long periods in the dark, it would be advantageous to use small consumption side lamp bulbs, i.e., BAS. 10 12/14 volts, 6 watts only.

When a suitable direct current supply is available, we recommend in any case that it be made a rule always to leave the battery on charge at trickle rate (about half an ampère) when the car is in the garage, as such a procedure will assist in keeping the battery in thoroughly good condition.

Use of Starter. It is necessary to use the starter intelligently. If the engine does not start reasonably quickly, it is necessary to look for the cause, not to continue to use the starter until the whole of the battery output has been used up.

Careful use of the starter, as explained above, will minimise deterioration of the battery.

If the engine is warm and the battery is known to be fully charged, the starter may be used several times in succession, without appreciably affecting battery life.

If, on the other hand, the starter appears to be sluggish in its action, and such sluggishness is traceable to the battery, no attempt should be made to use the starter until the battery has been thoroughly charged and brought to such a condition that it is gassing freely in all the cells.

N.B.—For instructions regarding initial charge of battery, density of electrolyte, etc., see pamphlet at end of book.

CHAPTER V.

Engine Lubrication System.—Removal of Cylinder Head.

Crankshaft — Connecting Rods — Oil Pump and Relief Valve — Valve Rockers, Push Rods and Tappets—Camshaft—Oil Sump Filter —Oil Level Indicator—Oil Pressure—Dismantling Oil Pump and Relief Valve—Removal of Cylinder Head for Decarbonising—Removing Rocker Cover and Shaft—Removing Exhaust and Inlet Manifolds—Removing Cylinder Head—Cleaning Pistons and Head—Grinding in the Valves — Replacing Cylinder Head — Reassembling — Adjusting Tappets.

The engine oiling system is illustrated diagrammatically in Fig. 12.

A gear-type pump is located on the right-hand side of the crankcase lower half, and is driven by skew gearing from the water-pump driving shaft.

A gauze filter is arranged in the crankcase lower half, through which the pump draws its supply.

Oil is delivered to all the crankshaft and connecting rod bearings at from 15 to 20 lbs. per square inch pressure by a pipe which runs inside the upper half crankcase, the connection to this pipe being outside the crankcase, on the right-hand side.

Crankshaft. From the internal pipe, three leads are taken to the two end and the centre main crankshaft bearings respectively.

The crankshaft journals and the crankpins are bored for lightness and to act as oil conduits, the ends of the holes being plugged with caps, and the crankpin and crank journal holes being in communication through the medium of smaller holes drilled through the webs and plugged at their outer ends.

The three main bearings to which oil leads are carried have circumferential oil grooves, communicating with the oil-feed pipes,

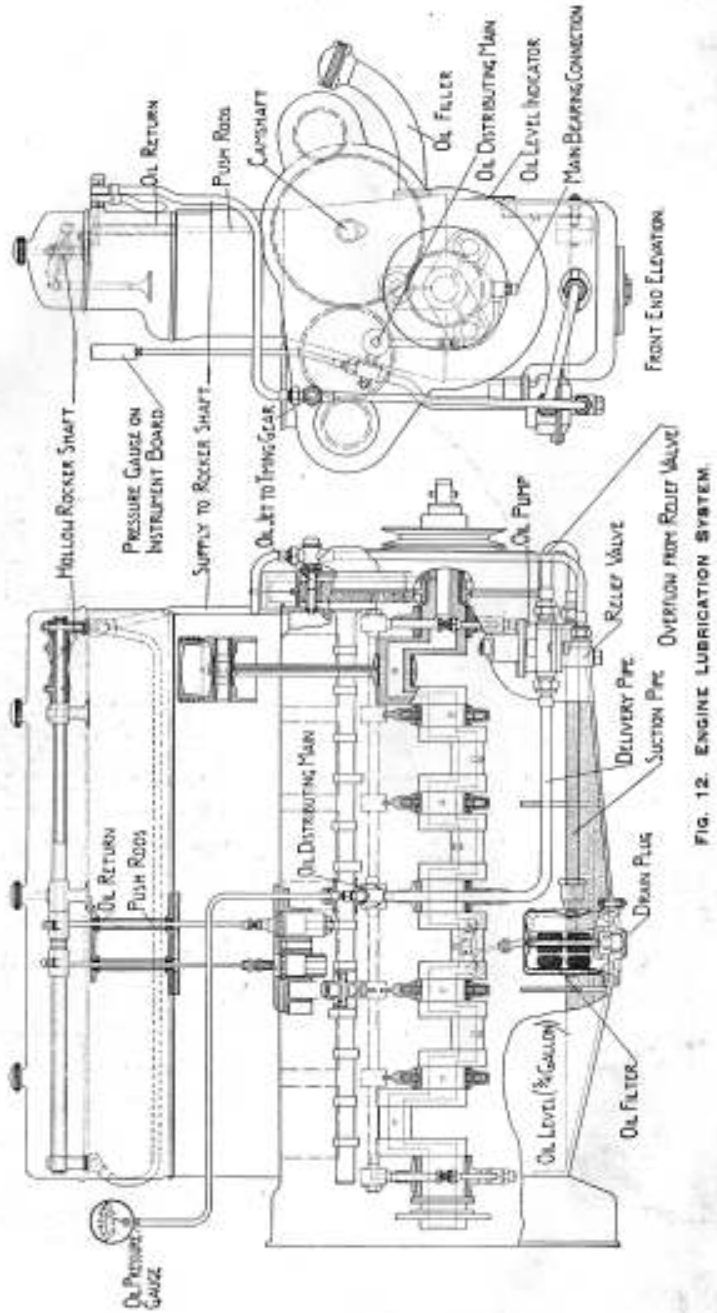


FIG. 12. ENGINE LUBRICATION SYSTEM.

radial oil-holes being drilled in the crank journals to register with these grooves. Oil is thereby conveyed to the interior of the crankshaft, whence it finds its way to the four other main bearings and the crankpin bearings through further radial holes in the crankshaft at these points.

Connecting Rods. The big ends of the connecting rods are grooved internally, the groove registering with a radial hole in the crankpin. Each connecting rod is fitted with an oil pipe, communicating, at the lower end, with this oil groove, and, at the upper end, with the gudgeon-pin bearing bush.

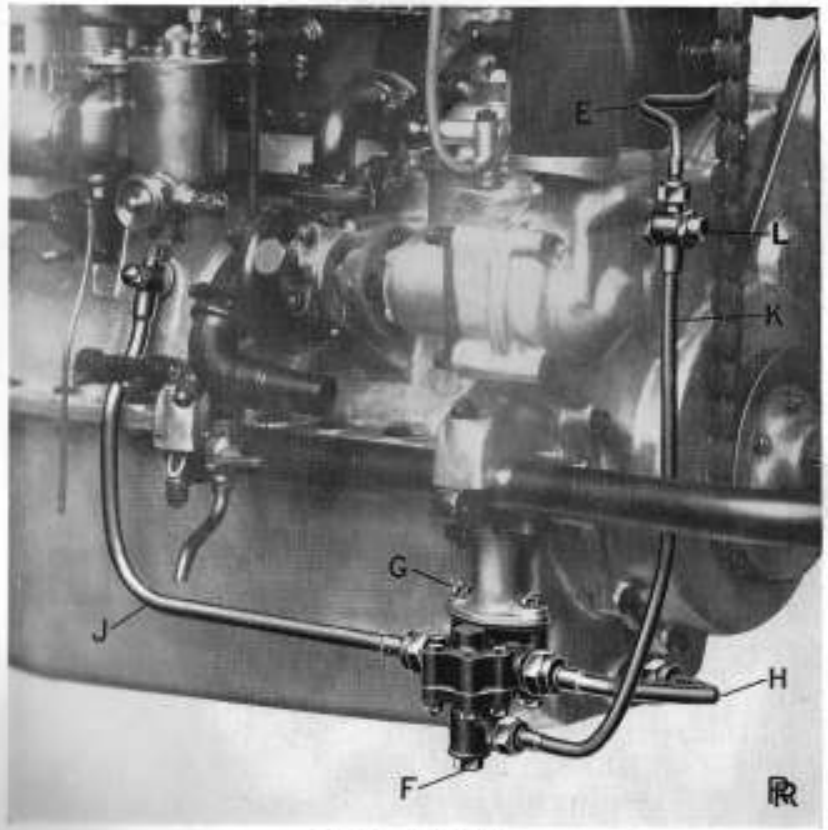


FIG. 13. OIL PUMP.

Thus all the main crankshaft bearings and all the connecting rod bearings are supplied with oil under pressure.

Oil Pump and Relief Valve. The oil pump is shown in position on the engine in Fig. 13. Oil is drawn from the filter through pipe **H**, and delivered to the crankcase oil conduit through pipe **J**, the latter also being connected to the instrument board pressure gauge. Incorporated with the pump is a relief valve. The released or overflow oil is taken by a pipe, **K**, to the timing gear wheels, a connection, **L**, on the timing gearcase being provided with a jet which sprays oil on to the gear teeth.

Valve Rockers, Push Rods, and Tappets. From connection **L**, a pipe, **E**, is taken to the cylinder head, for feeding oil into the hollow rocker shaft.

For this purpose, the front bracket of the shaft is drilled, and communicates through an oil-hole in the head with a union on the left-hand side, to which pipe **E** is connected.

The rocker shaft is drilled radially where each rocker works to lubricate the bearings of the latter. The rocker arms are also drilled, the holes running through the bearing bushes. By this means oil is fed on to the push-rod ball ends and the ends of the valve stems.

Each valve guide is provided with a felt packing gland, held in position by the spring, which prevents excess of oil from percolating down the valve guides.

Oil is returned from the rocker casing to the crankcase through the push-rod tunnels and valve tappets.

Camshaft. The camshaft is carried in seven bearings, that at the front end being a ball journal, and the others plain gun-metal bearings. The latter are formed with recesses and oil-holes on their sides, which are designed to catch oil splashed in the crankcase and convey it to the bearing surfaces.

Oil Sump Filter. The oil filter is carried in the bottom of the lower half crankcase.

When required to be removed for cleaning, it is necessary to drain the oil from the crankcase in the first place.

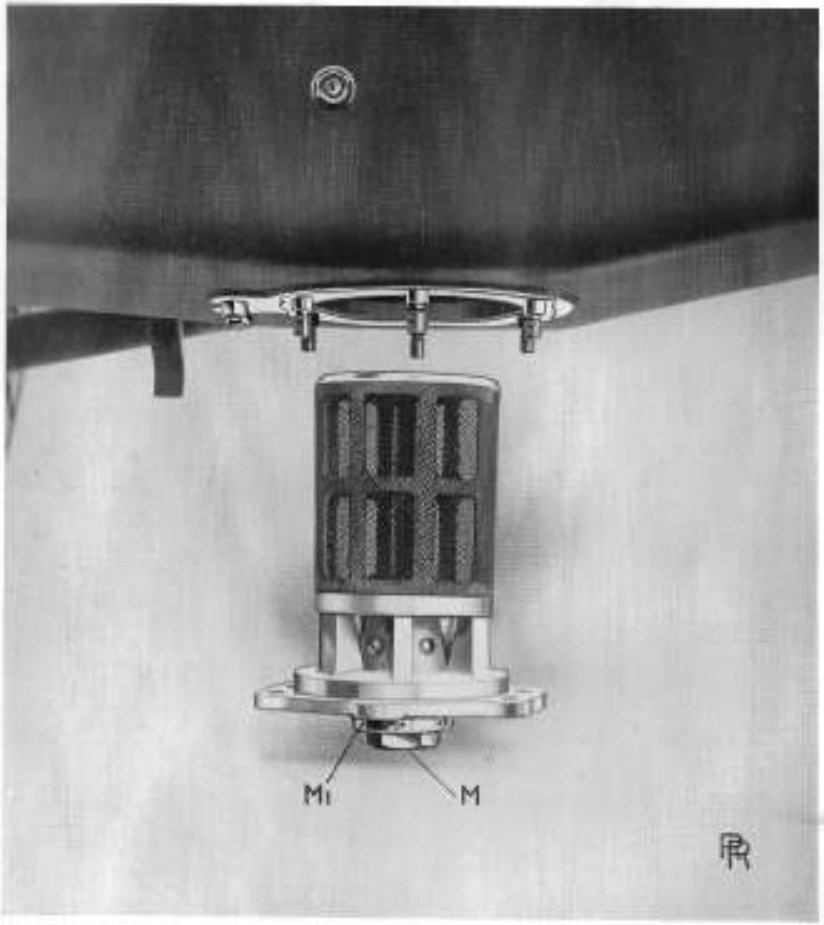


FIG. 14. OIL SUMP FILTER REMOVED.

For this purpose a plug (**M**, above) is provided in the filter supporting plate, which should be unscrewed, after removing its split cotter, and the oil allowed to drain out.

The six nuts which hold the filter in position should then be unscrewed, when the filter can be removed downwards, as shown.

The gauze should be cleaned by brushing with a stiff brush, dipped

in paraffin, and not by wiping with a fluffy cloth, which is liable to leave particles clinging to the gauze.

When replacing, it should be noticed that the joint washer is in position between filter-flange and crankcase. An aluminium washer is fitted on the drain plug. When the latter is screwed up it should be locked by means of a split cotter passed through one of the holes (**M**1, Fig. 14), whichever may happen to register with a hole through the plug.

Oil Level Indicator. On the lower half crankcase will be found a small pointer, with a dial marked in fractions of a gallon. This pointer is operated by a float within the crankcase, and indicates the quantity of oil in the engine.

The amount of oil should be maintained at three-quarters of a gallon as nearly as possible, by the addition of oil through the filler by means of a filter funnel when necessary.

The engine should never be run with less than half a gallon of oil in the crankcase.

Oil Pressure. On starting the engine from cold, a high oil pressure will be indicated, but this need not cause alarm, as the gauge is arranged to carry the overload, and the pressure will fall to about 15 to 20 lbs. when the engine becomes warmed.

On no account should the car be run with the gauge showing less than 7 lbs. pressure. Such a low pressure, which may be accompanied by fluctuations of the pressure gauge needle, may be due to one or more of several causes.

In the first place, it should be ascertained that there is sufficient oil in the sump by referring to the oil level indicator.

If this is found to be in order, the trouble may be due to a particle of foreign matter having lodged on the relief valve seating and prevented the valve from closing, or the filter may require cleaning. If the latter is the cause, then it will be necessary to drain the crank-chamber for removing and cleaning the filter, as described under "Oil Sump Filter."

After this operation, the correct quantity of fresh oil having been added to the crankcase, it may sometimes be found that the oil pressure fails to build up on next running the engine. This will probably be

due to the presence of air in the suction and delivery pipes of the oil pump.

A convenient method of releasing this trapped air is to slacken off the nut which holds the upper end of pipe **J** (Fig. 13) to the crank-case while the engine is running, care being taken to tighten it again after a few seconds.

Failure of the oil pressure may also be due to air leaks in the suction pipe from filter to oil pump.

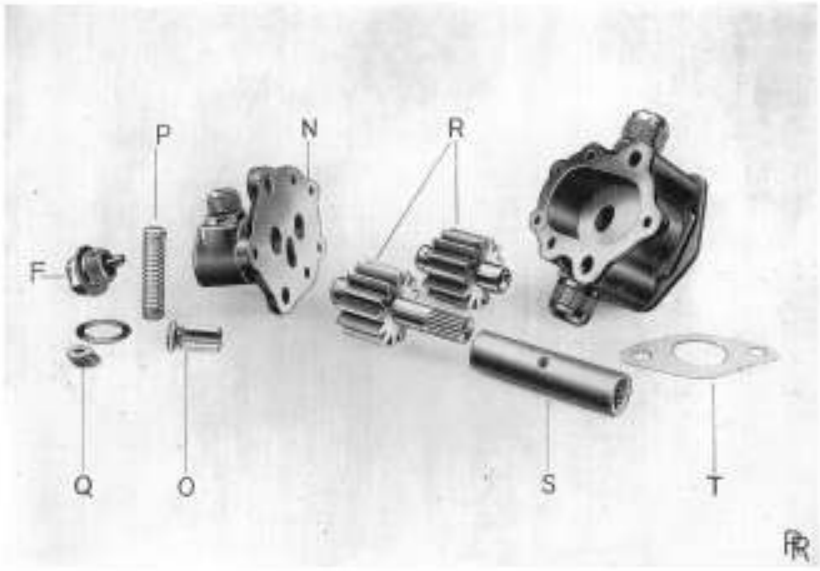


FIG. 15. OIL PUMP DISMANTLED.

Dismantling Oil Pump and Relief Valve. The relief valve is easily removed by unscrewing plug **F**, as shown in Figs. 13 and 15. Care must be taken that the valve **O** and spring **P** (above) do not drop out when removing the plug in question.

It will be noticed that plug **F** is fitted with adjustment washers, **Q**, which have been added to bring the spring pressure on the relief valve to the correct amount to maintain the required oil pressure.

These adjustment washers must not be modified or left out when replacing the parts.

After cleaning the valve and its seat, the parts can be replaced, and the plug **F** screwed up, taking care that the aluminium washer is not omitted.

Should it be required to dismantle the oil pump for cleaning or inspection, the three oil unions should be disconnected, and the two nuts **G** (Fig. 13) unscrewed. The pump, complete with its hollow drive shaft, **S** (Fig. 15), can then be removed. By unscrewing the small bolts securing the casing cover **N**, the latter may be removed, and the gear wheels **R** taken out.

When reassembling, care should be taken that a suitable paper joint washer, **T**, is fitted between the pump flange and crankcase facing. All nuts should have a spring locking washer beneath them.

***Removal of Cylinder Head for Decarbonising.** When decarbonising becomes necessary it is best to drain old oil from the crankcase, preferably when the engine is hot. For this purpose the drain plug should be taken out. The oil sump filter can then be removed, cleaned, and replaced, as described on page 68.

It will be necessary to drain the water system, for which purpose a drain tap is provided on the water pump at the right-hand side of the engine.

Before undoing any electrical connections, the negative earthing terminal of the battery should be disconnected from the frame.

On no account should petrol, benzole, or other highly inflammable liquid be used for cleaning down the engine, as this practice has resulted in cars being destroyed by fire.

The upper radiator water pipe and the Klaxon horn should be removed, push-on terminals being provided on the latter, which must be disconnected.

The ignition wires should be disconnected from the plugs and the H.T. distributor moulding removed. The wires complete in their tube can then be removed by unscrewing the nuts which hold the tube brackets to the cylinder head.

* If it is not convenient to return the car to the makers when this operation becomes necessary, Messrs. Rolls-Royce Ltd. will always be pleased to send a skilled mechanic to assist in the work on receipt of a request to this effect, the expense of doing so being borne by the owner.

Removing Rocker Cover and Shaft. The rocker cover can be removed after unscrewing the three knurled nuts.

The rocker shaft is carried in seven pedestals, each having a stud running up its centre and through the shaft. The seven nuts of these studs should be removed, together with the single small nut which secures the base of the front pedestal to the head for making an oil-tight connection. The shaft, complete with rockers and pedestals, can then be lifted off.

The twelve valve push rods should be withdrawn from the cylinders.

Removing Exhaust and Inlet Manifolds. The union on the inlet pipe, connecting the latter by means of a copper pipe with the vacuum petrol feed tank, should be disconnected.

After unscrewing the exhaust pipe union nut with the special spanner provided in the tool-kit, and removing the

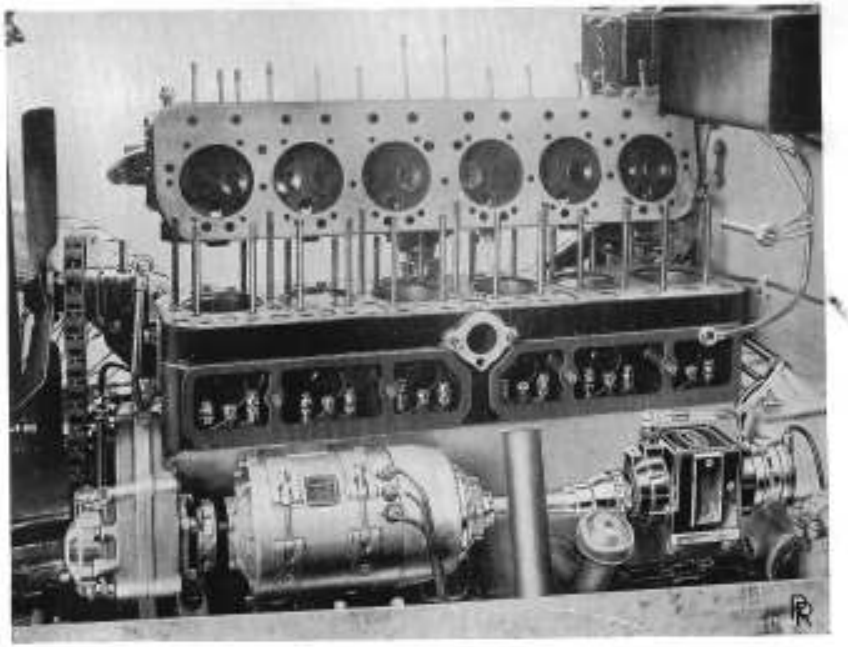


FIG. 16. CYLINDER HEAD REMOVED FOR DECARBONISING.

sixteen nuts which secure the manifolds to the cylinder block, the manifolds can then be withdrawn as a unit.

On no account should any attempt be made to disconnect the hot spot junction between the two pipes, as this has been carefully set by the makers to align the flange faces.

Removing Cylinder Head. On the left-hand side of the cylinder head are two unions, that at the rear being the water jacket thermometer connection, and the front one being the oil supply pipe to the valve rockers. Both these unions require disconnecting.

The thermometer must be withdrawn clear of the head, a coil being arranged in the connecting tube to provide flexibility for this purpose. Great care is necessary, however, as injury to the thermometer or its tube would render the apparatus useless.

The head is held in position by thirty-one long studs, running from the crankcase and through the cylinder block. In order to avoid straining the head, the thirty-one nuts of these studs should be released gradually, commencing with those in the centre, and working outwards towards the end ones.

This operation should be repeated several times, only turning each nut slightly each time.

With all nuts and washers removed, it should be possible to lift off the head. This operation is best performed by two people, one standing on either side of the engine. If the head be found difficult to remove, it should be lightly tapped with a wood mallet on either side. This will probably be found sufficient to free the joint.

The head must be raised evenly or it will bind on the studs.

The joint gasket should be removed and discarded, a new one being used when the head is replaced.

Cleaning Pistons and Head. When scraping the aluminium piston heads, great care should be taken not to score these. Only a blunt rounded tool should be used, and applied with very moderate pressure.

Before scraping the cylinder head, all the valves should be removed. To effect this, the valve spring must be compressed, carrying with it the washer **A** (Fig. 17), the valve meanwhile being held on its seat.

A special tool is provided in the kit for this purpose. It consists of a screw clamp, the clamp being formed with a ring for the reception of the valve spring washer. The point of the screw should engage the head of the valve and on tightening the screw the spring will be compressed. The split conical washers **B** will then fall out, and the valve can be removed. The felt packing washer **C**, and gland **D**, should also be removed.

Carbon deposit can now be scraped from the head.

Grinding in the Valves. Each valve should be ground in the seat where it has been working.

A good quality grinding paste should be used, the valve being rotated backwards and forwards with the special tool provided and raised from its seat occasionally. Only a light pressure should be applied, or valve and seat will become scored.

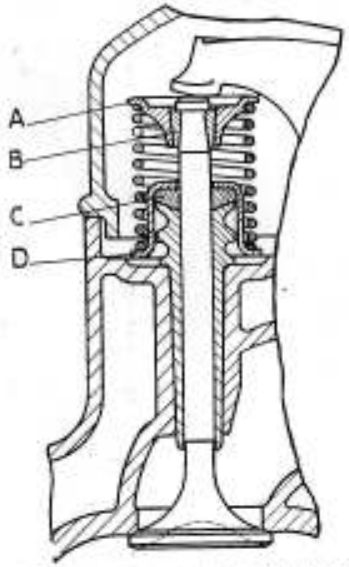


FIG. 17. SECTION THROUGH VALVE GUIDE.

After this operation, the cylinder head and valves should be well washed in paraffin to remove every trace of grinding compound, valve guides and ports being syringed through with paraffin.

The valves, springs, and washers can then be replaced, the special

tool being used to compress the springs. Care must be taken that the felt packing washers and glands are in position, and that the valves are replaced in the seatings from which they were removed and in which they were ground.

The valve guides should be lubricated with a little engine oil.

Replacing Cylinder Head. Before replacing the head, the joint faces should be carefully wiped to remove all particles of foreign matter. A new joint gasket should be utilised, and placed on the cylinder block and the head carefully lowered in position.

Too much emphasis cannot be laid upon the necessity for exercising care in tightening the nuts which secure the head.

These should be screwed down very gradually, commencing with those at the centre of the head and working outwards towards the two ends. This process should be repeated several times, the nuts being turned only a comparatively small amount at each stage. By this means the pressure on the joint faces will be evenly distributed and the joint rendered sound.

Reassembling. Before replacing the rocker shaft, all the valve tappet heads must be screwed down as far as possible by releasing the lock-nut **B** (Fig. 18), and screwing the head **A** into the tappet. This will avoid the risk of bending the push rods as the rocker shaft is secured in position.

In order to facilitate replacement of the push rods in their original positions, they are numbered 1 to 12 commencing from the front of the engine.

The rockers themselves are also marked, but it should not be necessary to remove these from their shaft.

The push rods should then be arranged in their correct positions in the tappet heads, and the rocker shaft replaced.

Each pedestal of the rocker shaft is recessed around its stud-hole for a spherical washer, and it should be observed that these are in position before putting on the nuts.

The inlet and exhaust manifolds should be replaced with a *new* copper-asbestos gasket for each joint face, those for the two end inlet pipe connections being smaller than the others, and the sixteen nuts must be tightened gradually and evenly. The exhaust pipe can then be

connected up, and also the oil supply union to the head. There are two aluminium joint washers, one on either side of this union, and it should be seen that these are in place.

A similar type of union is adopted for the vacuum feed pipe coupled to the inlet manifold, and similar care should be exercised in its replacement.

The water jacket thermometer should be replaced. When refitting the upper radiator water pipe, it should be observed that the packing pieces of the clips are in position.

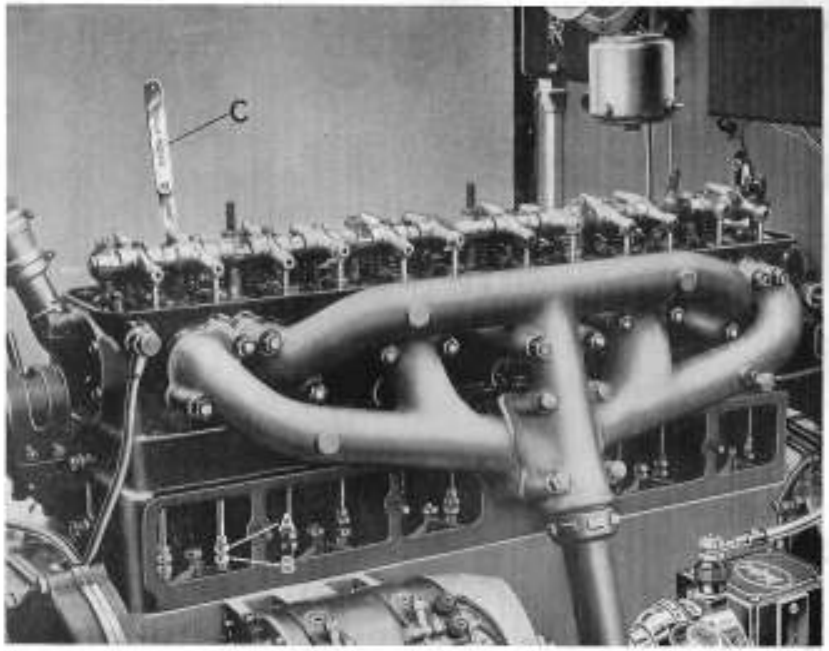


FIG. 18. ADJUSTING THE TAPPETS.

Adjusting Tappets. Access to the adjustable valve tappets is obtained by removing the two covers on the left-hand side of the engine. In Fig. 18 these covers are shown removed for adjusting the tappets.

The tappet head, **A**, is screwed into the tappet, and locked with a nut, **B**. On releasing this nut, the tappet can be screwed in or out as may be required.

With the engine cold, and the valve roller on the base of the cam, there should be ·003" clearance, measured between valve stem and rocker. A feeler gauge is provided in the tool-kit, and is shown at **C** in position for measuring the tappet clearance.

Before commencing to adjust a tappet, it should be ascertained that that particular tappet roller is well away from the cam, which is best done by turning the crankshaft by hand until the valve has opened and closed, and then cranking round half a revolution beyond this point.

As each tappet is adjusted, its lock-nut should be tightened up.

When checking the tappet clearances every 2,000 miles, as directed on page 37, the rocker cover should be removed, and a feeler gauge used as described. It is not sufficient merely to remove the tappet covers and estimate the clearance by lifting each push rod.

After replacing the tappet covers, the rocker cover, the Klaxon horn and high-tension ignition leads, filling up the radiator with water, and adding the correct quantity of oil to the crankcase, the car should be ready for running once more.

It is very important that the cylinder head nuts should be tightened again after the engine has done sufficient running to become thoroughly warmed. In order to do this the valve rocker shaft must be removed.

It will subsequently be necessary to re-set the tappet clearances as already described, owing to the fact that the joint gasket will have become further compressed, with a consequent reduction of the tappet clearances.

It is advisable to repeat this inspection of the clearances during the next few hundred miles of running, readjusting if necessary.

Further, if the car should have been returned to the makers for decarbonising, or any other purpose involving removal of the cylinder head, it is very desirable, afterwards, that the owner should inspect the tappet clearances when he has run the car a certain amount.

In spite of the fact that the car will have been carefully tested by the makers after overhaul, the amount of running involved may have been insufficient to ensure that the joint gasket has entirely settled down.

CHAPTER VI.

Petrol Feed System and Carburation.

Action of Vacuum Feed System—Failure of Supply—Petrol Filters—Petrol Tank with Reserve Supply—Petrol Level Indicator—Action of the Carburetter—Cleaning the Air Valve—Faulty Adjustment of Carburetter—Setting of the Jets—Mixture Control—Slow Running—Starting Carburetter—Float Feed Mechanism—Crankcase Breather Pipe to Carburetter—Dismantling the Carburetter.

Action of Vacuum Feed System. The working of the automatic petrol feed will be understood by reference to Fig. 19. This illustrates the vacuum tank on the dashboard, and shows its internal working parts.

The apparatus consists of two chambers, one within the other, these being in communication through the medium of a non-return or drop valve situated at the base of the inner chamber.

The outer chamber is fitted with an air vent, and is connected to the carburetter float chamber through a spring-controlled needle valve and pipe. This valve is opened by raising it vertically, and then rotating it as far as it will go in a clockwise direction.

The inner chamber is connected to the main petrol tank by means of a pipe running along the inside of the left-hand chassis frame member, and has another connection to the engine induction pipe. A float within this chamber is coupled to a spring-loaded toggle arm, carrying two valves, one in the induction pipe connection and the other controlling the air vent to the inner chamber. The object of this toggle arm is to ensure that one valve shall be fully open when the other is quite closed, without any appreciable intermediate period.

The float is arranged to be self-draining, hence a slightly leaking float will not impair the functioning of the apparatus.

Assuming that the engine is running and that the float has just operated to close the induction pipe valve and open the air vent, then petrol within the inner chamber will gravitate into the outer chamber through the drop valve until the level in both chambers is alike.

Continued running of the engine will lower the level until the weight of the float on the toggle arm operates the latter to close the air vent and open the induction pipe connection.

The induction pipe depression or suction is then transmitted to the inner chamber and causes the drop valve to close, because atmospheric pressure exists in the outer chamber, its air vent being always open. Petrol is then drawn from the main tank and fills up the inner chamber until the float again operates to reverse the position of the two valves and repeat the cycle.

During the suction period, the engine has, of course, to run on fuel contained in the outer chamber, which is made of ample capacity to meet this demand.

When the engine is idling the depression in the induction pipe is considerable, but the amount of mixture taken by the engine from the carburetter is, of course, at a minimum. Consequently, the suction period of the vacuum feed is liable to upset smooth idling of the engine owing to the fact that the air which it then draws from the inner chamber is heavily carburetted, and an over-rich mixture results. To obviate this, certain chassis are provided with a spring-controlled piston valve in the pipe between the induction pipe and the inner chamber which, under such circumstances, automatically restricts the passage to the induction pipe and extends the suction period. By this means the change in quality and quantity of the idling mixture is rendered negligible. As the main engine throttle is opened the spring returns the piston valve towards its open position.

Failure of Supply. To fill the vacuum tank when it has been emptied, due to running out of petrol or draining for cleaning, close the main throttle, see that the starting carburetter control is in the closed position, then use either the starter motor to turn engine for a few seconds, or crank by hand; the vacuum produced in the induction system will then draw petrol from the main tank.

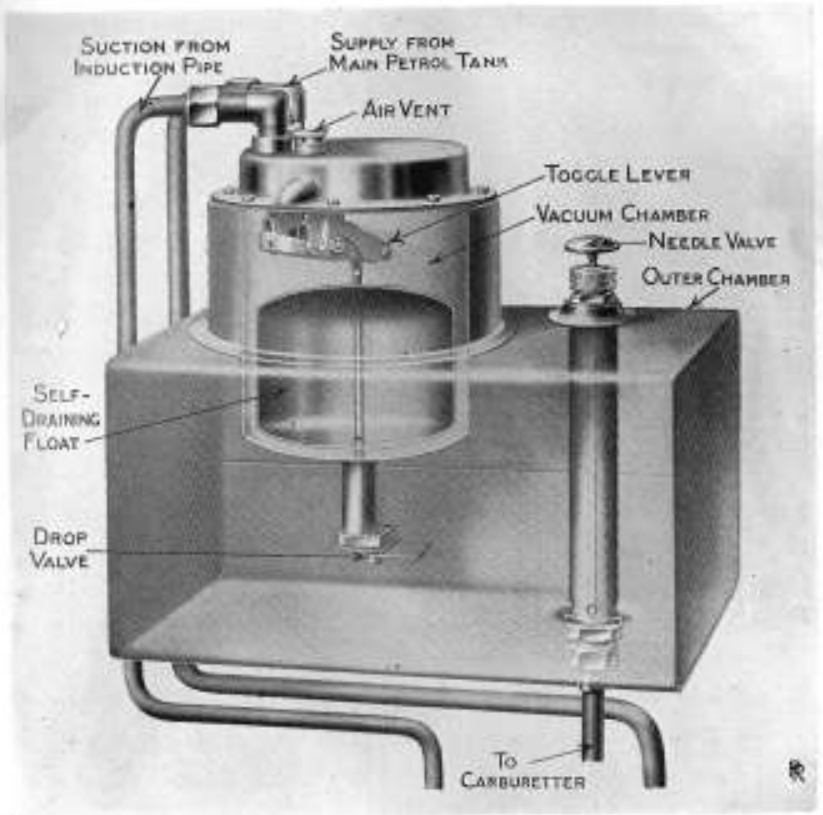


FIG. 19. VACUUM FEED TANK.

Its presence can be checked by opening the needle valve on the vacuum tank and removing the plug on the float chamber cover. The end of the float needle will then be exposed. This may be raised with the fingers and should cause flooding.

Should cranking the engine with the throttle closed not have the desired effect, it may be due to foreign matter on the drop valve, or to the fact that the valves are dry owing to the vacuum tank having been standing empty for a considerable time.

Under these circumstances, the petrol supply pipe should be removed and a little petrol syringed into the inner tank to wash away sediment from the drop valve and moisten the valves.

This should result in the apparatus functioning correctly. If it does not, the inner tank should be removed and the drop valve inspected.

The two unions should be disconnected, and the screws which hold the inner chamber in position removed. Care should be taken not to damage the joint washers when lifting out the inner chamber. To avoid doing so, a knife or similar instrument should be run round between the washer and the outer tank facing.

With the inner chamber removed, the drop valve can be inspected and cleaned if necessary. It occasionally happens that a black deposit forms on the valve, which prevents it from closing properly. This should be carefully cleaned off.

Petrol Filters. A small conical filter gauze is located on top of the inner chamber at the junction of the main petrol supply pipe, and irregularity in the working of the vacuum feed may be due to choking of this filter with foreign matter.

It should be removed every 5,000 miles, as directed on page 37, by disconnecting the main supply pipe, and carefully cleaned.

The gauze must be replaced with the cone pointing upwards.

A filter is also arranged between the vacuum feed tank and the carburetter float chamber.

On some chassis this is incorporated on the float chamber itself, as shown in Figs. 24 and 25, and on others is replaced by a filter mounted on the front of the dashboard, under the steering column, and shown dismantled in Fig. 20. These filters should be removed and cleaned every 5,000 miles, as directed on page 37. Before doing so, the valve on the top of the vacuum feed tank must be turned off.

The float chamber filter is removed by unscrewing the large nut **A**, Fig. 25, when the filter gauze, **B**, may be withdrawn and cleaned. The plugs, **C** and **S**, Figs. 24 and 25, should also be removed and cleaned of any sediment or water which may have accumulated. When replacing this filter, great care must be taken that the joint

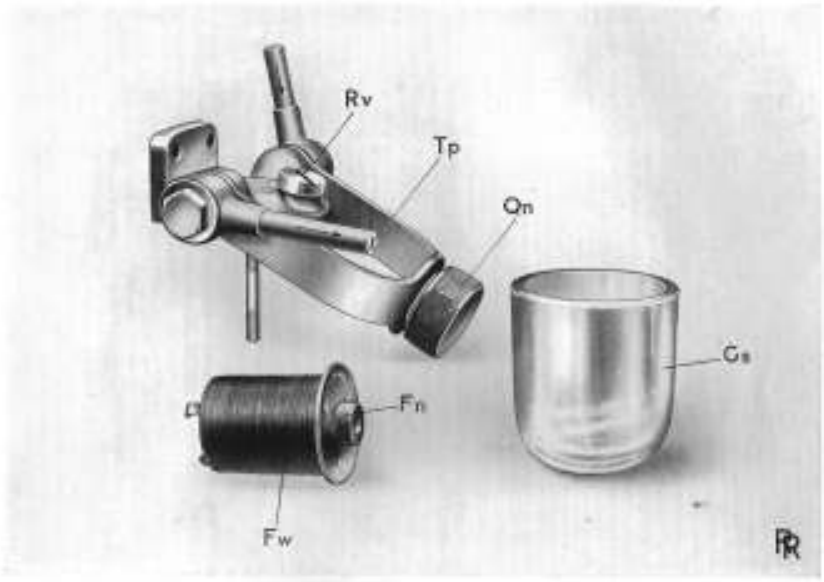


FIG. 20. DASHBOARD FILTER DISMANTLED.

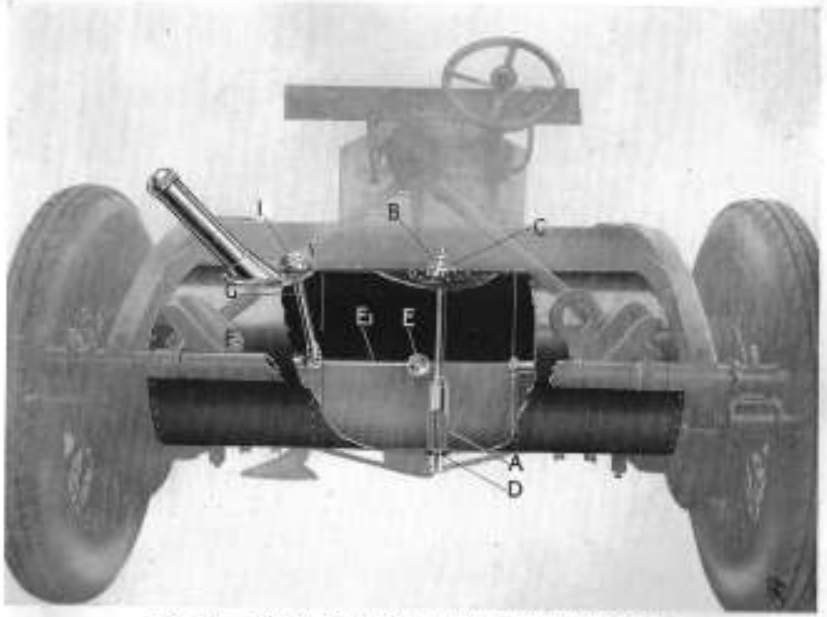


FIG. 21. PETROL TANK FILTER AND LEVEL INDICATOR.

faces are clean, as these make a metal-to-metal joint, no washers being used.

The dashboard filter is of the type in which the fuel is caused to flow between adjacent metal washers having small protuberances on their faces resulting in very small clearances being formed between the washers when they are clamped together.

To dismantle the filter for cleaning, the knurled nut **Q**n, Fig. 20, should be released, and the stirrup, **T**p, swung forward as shown, care being taken to hold the cover or sump, **G**s, or this will fall out.

The filter element, **F**w, can then be removed by releasing the knurled nut, **F**n, and withdrawing the element downwards. It should be cleaned by shaking and washing it in petrol. The sump, **G**s, should also be cleaned.

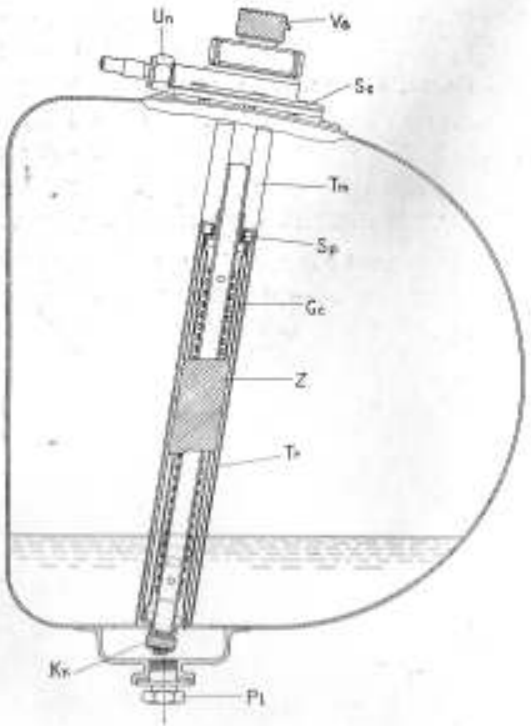


FIG. 22. PETROL TANK FILTERS.

After replacing the parts and turning on the petrol supply again, the valve, **R**v, should be unscrewed a turn or so to release any entrapped air.

A filter is also provided in the main petrol tank, that shown in Fig. 21 being the type fitted to chassis having the float chamber filter, and that shown in Figs. 22 and 23 applying to chassis having the dashboard filter.

These filters should also be cleaned every 5,000 miles, as directed on page 37.

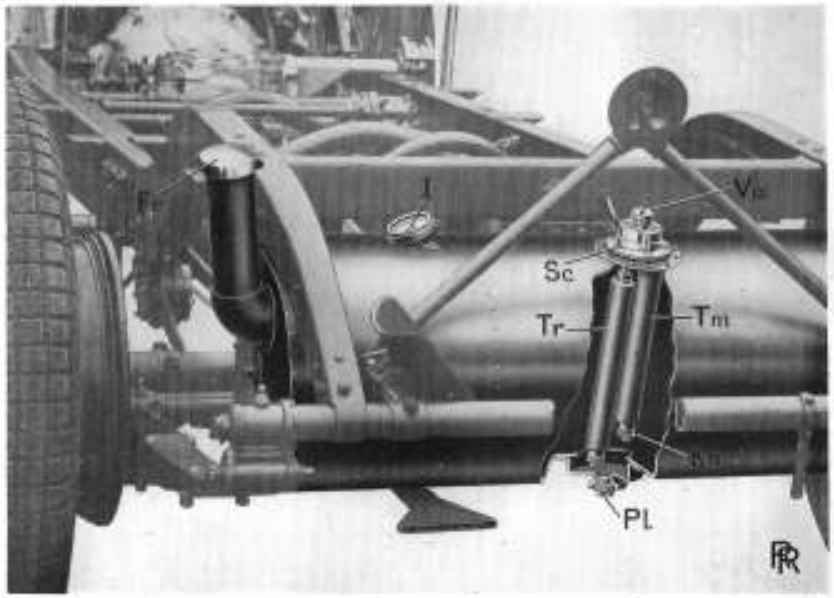


FIG. 23. PETROL TANK.

Referring to Fig. 21, to remove the filter, the union, **B**, must be disconnected and the four screws **C** taken out. The filter may then be lifted out, care being taken not to damage the leather joint washer. The filter gauze is retained in position by a brass split cotter, **D**.

Referring to Figs. 22 and 23, two independent filters are provided, that enclosed within tube, **T**m, being on the main supply, and that within the tube, **T**r, on the reserve supply. In Fig. 22 the reserve

filter is shown in section in order to make clear how removal of the gauze is effected for cleaning.

The detail arrangements of both filters are identical.

To remove them for cleaning, the union, **U**n, must be disconnected, and the five screws, **S**c, removed. The two filters may then be lifted out of the tank.

Each gauze is retained in position by a knurled nut, **K**n, which is prevented from coming adrift by a brass split cotter. After removal of the latter, and unscrewing the knurled nut, the gauze may be removed, care being taken not to lose the small coil spring, **S**p, which is arranged on top of the gauze carrier, **G**c. This can now be removed and the gauze, **Z**, cleaned.

When cleaning filter gauzes care must be taken not to damage them, for they are of a very fine mesh and somewhat fragile. Cloth of a fluffy nature should not be used, as particles of fluff are liable to be left adhering to the gauze. The best plan is to wash the gauze in petrol or paraffin, using a brush.

When replacing in their tubes the filters shown in Figs. 22 and 23, care must be taken that the spring **S**p is in position on each. The knurled nuts **K**n are intended for turning with the fingers only, and on no account must any tools be used on them. After they are replaced, brass split cotters must be fitted in the holes provided.

When replacing the assembly in the tank care must be taken to see that the leather joint washer is sound and properly in position.

It is further advisable every 5,000 miles, as directed on page 37, to release the drain plug (**P**l, Figs. 22 and 23) located at the bottom of the tank. It need not be *removed*, only *released* a turn or so, to allow any accumulation of water to escape, afterwards being securely re-tightened.

The precaution is especially necessary when touring on the Continent.

Petrol Tank with Reserve Supply. The petrol tank shown in Fig. 23 is provided with a reserve supply of two gallons. Its total capacity is fourteen gallons.

Use can be made of the two gallons reserve by turning the knurled knob **V**a so that its indicator points to the letter **R**. Normally,

it should stand at the position marked **M** (main), when, with the tank full, twelve gallons will be available.

If the car be run with the valve in the **M** position until it stops through lack of petrol, the vacuum feed tank on the dashboard will have been emptied, and the mere act of turning the valve to the **R** position will not be sufficient to re-prime this tank.

The engine must also be given a few turns by hand or by means of the electric starter motor, as explained on page 80, with the main throttle and the starting carburetter controls in the closed position.

Owing to the large area and fine mesh of the filters no inconveniences are likely to arise from filling up direct from a pump, adequate filtering arrangements usually being incorporated in these. When filling from an ordinary two-gallon can it is advisable to make use of a filter funnel.

The large filler spout is closed by a screwed cap **F**r, which is adapted for turning with the hands only. A suitable air vent is provided in the end of this spout. The cap should be screwed on tightly in order to utilise the friction locking plate which is fitted inside it.

Petrol Level Indicator. A float-operated level indicator is contained in the main tank and shown in Fig. 21. The float **E** is carried by an arm, **E**1, to which is secured a crown wheel, **F**. This engages with a pinion mounted on a spindle which is housed within the tube **G**. At its upper end this spindle carries a finger which registers with a dial plate, **I** (Figs. 21 and 23), graduated in gallons. As the float rises or falls, the spindle is rotated and indicates on the dial the contents of the tank.

Action of the Carburetter. The carburetter is of the Rolls-Royce automatic expanding type, provided with two jets adjustable by a single lever under the driver's control.

Each of these jets is located in a Venturi tube, the smaller one always being in action, and the larger one being automatically brought into action by an increase, beyond a certain value, in the depression existing within the carburetter, due to an increase of engine speed or throttle opening, or both.

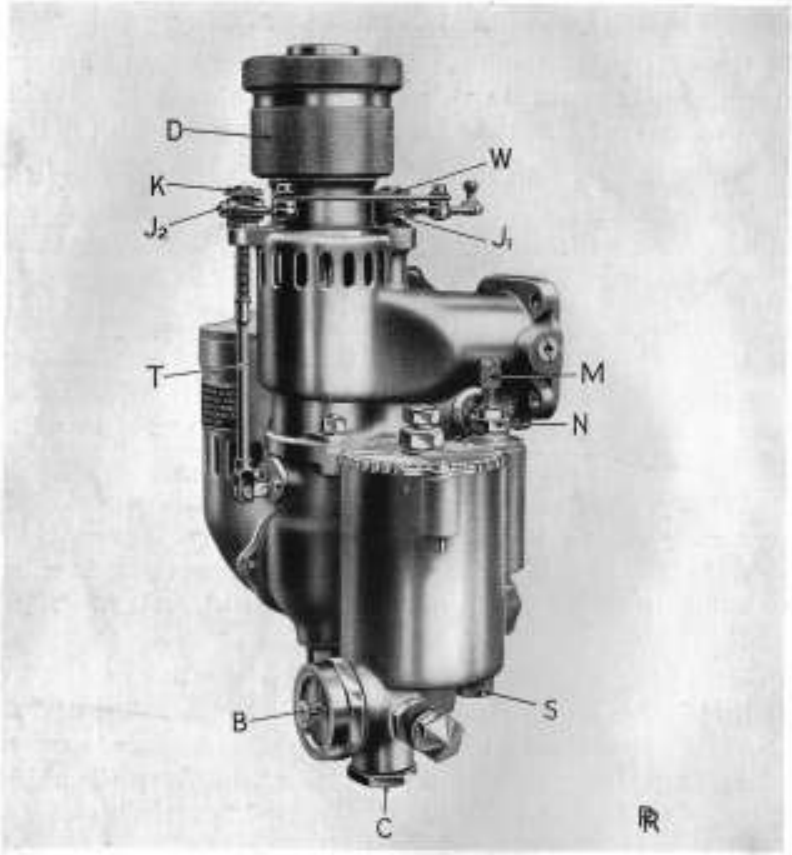


FIG. 24. CARBURETTER.

The complete carburetter is shown in Fig. 24, and in Fig. 25 it is shown with certain parts removed.

The outlets of the jets are regulated by taper needle valves, that for the small or low-speed jet being shown at **W** (Fig. 24), and the control for the large or high-speed jet needle at **T**.

The automatic expanding effect is attained by the provision of a suction-operated piston working in a cylinder, **D** (Figs. 24 and 25), located above the high-speed jet.

The cylinder **D** and piston **E** are shown removed for cleaning in

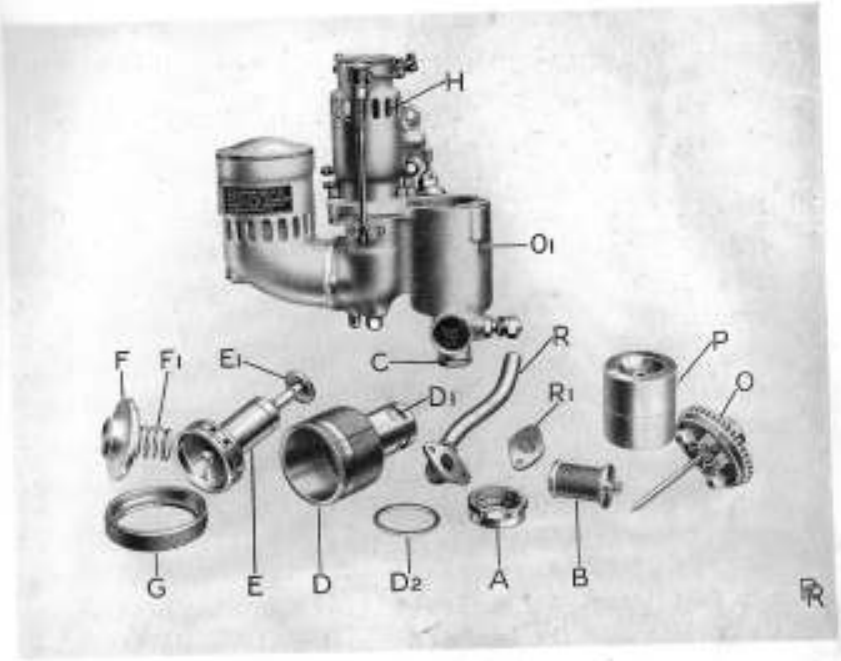


FIG. 25. CARBURETTER, WITH CERTAIN PARTS DISMANTLED.

Fig. 25. The cap **F** carrying the spring **F1** fits over the top of the cylinder, and is retained by the knurled nut **G**.

Increased depression in the carburetter raises the piston **E** against the spring **F1**, carrying with it a diaphragm **E1**, which fits into, and, in its lowest position, blanks off the larger choke tube. The lifting of this diaphragm admits air past the high-speed jet.

More movement of the piston not only opens the high-speed choke tube still further, but also admits air by uncovering the ports **D1**, the air gaining admission through ports **H** in the carburetter, thereby counteracting the tendency for the mixture to become over-rich at increased air velocity.

The various adjustments should on no account be altered, the carburetter having been carefully set by the makers in the first instance.

The mixture control lever, which operates on both jets simultaneously, provides ample range to suit ordinary variations in

running conditions, such as different atmospheric temperatures and different fuels, including the use of benzole or benzole-petrol mixtures.

Cleaning the Air Valve. The air valve and cylinder should be removed every 2,000 miles, and carefully wiped with a piece of clean dry cloth, as directed on page 37.

No oil should be used on the valve or its cylinder.

It is advisable when replacing these parts to re-fit the cylinder to the carburetter without the air valve, the latter being replaced afterwards.

Care should be taken when replacing the cylinder **D** to see that the metal washer **D2** is in position, and its joint faces are perfectly clean.

It must be emphasised that great care is necessary when handling these parts, as they have been machined to fit very accurately, and any slight distortion is liable to impair the working of the carburetter.

Faulty Adjustment of Carburetter. Examination of cars which have been in the hands of users has shown that in some cases the setting of the carburetters has been altered, with detriment to the running and economy.

There is no reason why carburetters should require readjusting, unless some new parts are supplied and fitted to the carburetter, or some alterations made to the engine.

Particular attention is drawn to the fact that great care is taken in accurately adjusting and setting the carburetter, the makers having installed at their works for this purpose scientific apparatus which enables them to be certain the carburetter setting is quite correct before the car leaves the works.

Users are therefore cautioned against interference with the makers' setting.

Setting of the Jets. If the adjustment of the jet needles has been upset for any reason, it can be restored in the following manner :—

With the mixture control lever set half-way along its quadrant and the clamping screws **J1** and **J2** (Fig. 24) of the jet needle levers

slack, each of the knurled nuts **K** and **W** should be turned until the line filed across them registers with the line across the end of the corresponding screwed spindle, the end of the spindle being at the same time flush with the end of the nut.

The clamping screws **J1** and **J2** should then be tightened, and the makers' setting will have been restored.

If, owing to damaged and replaced parts, it becomes necessary to re-set the jets with no guide in the form of the markings referred to, it is strongly recommended that the makers should be consulted, and this work not attempted without their advice or assistance.

In the event, however, of circumstances rendering such a course impossible, or very inconvenient, proceed as follows :—

With the mixture control lever set half-way along its quadrant and the clamping screw **J1** slack, the knurled nut **W** should be turned in a clockwise direction until its lower side just commences to lift away from the facing against which it normally rests.

The low-speed jet will now be fully closed, the tapered part of the needle resting on the mouth of the standpipe.

A preliminary setting can then be obtained by rotating the nut **W** in an anti-clockwise direction through approximately one complete turn. The clamping screw **J1** should then be tightened.

In the case of the high-speed jet it is not practicable to obtain a preliminary setting in this way because the tapered portion of the high-speed jet needle is arranged to pass freely inside the bore of its standpipe. This is done in order to protect these parts from damage which otherwise might result if the nut **K** were turned to force the taper of the jet needle into the standpipe.

Consequently, no visible indication is available to show precisely when the high-speed jet is fully closed, and it will be necessary to discover its approximate position by running the engine.

It will be possible to start up the engine after setting the low-speed jet needle as described, and this should now be done, the mixture control lever being set half-way along its quadrant.

If, when the throttle is opened moderately by means of the lever on the steering wheel, the engine pops back through the carburetter,

and possibly stops, the mixture is too weak, and if black smoke comes from the exhaust, and the engine misses fire and perhaps stops, the mixture is too rich.

To weaken the high-speed jet setting, the screw **J2** should be released and nut **K** turned in a clockwise direction; and to strengthen it, nut **K** must be turned in an anti-clockwise direction.

Having arrived at a preliminary setting for the high-speed jet in this way, and with the mixture control lever again set half-way along its quadrant, the throttle should be opened by means of the lever on the steering wheel until a speed is reached at which the automatic piston valve is on the point of lifting but has not actually lifted. Movement of this can be observed by looking through the air ports in the carburetter.

The clamping screw **J1** of the low-speed jet needle should then be slackened, and the knurled nut turned in a clockwise direction until the engine speed becomes slightly reduced.

The clamping screw should then be tightened, and the mixture control lever moved first over to strong and then to weak. If in *both* of these positions the engine hesitates, or even possibly stops in the weak position, then the adjustment of this jet is fairly correct.

To test the high-speed jet setting, the accelerator pedal should be depressed momentarily, and the lever again tried in both its extreme positions. In either position a distinct loss of power should be experienced. If these variations do not occur, or occur in only one of the extreme settings of mixture strength, the settings should be varied accordingly by slackening the clamping screw and turning the high-speed knurled nut in a clockwise or anti-clockwise direction, according as the mixture requires weakening or strengthening respectively.

The foregoing will only provide an approximate or trial setting.

When the car is taken on the road for final adjustment, the driver should bear in mind that the high-speed jet comes into operation at about four miles per hour on top gear on the level. Consequently, any sign of too rich or too weak a mixture below this speed is an indication that the low-speed jet requires adjustment.

At speeds above four miles per hour, the high-speed jet has an increasing influence over the mixture.

The best all-round setting of the jets is one in which movement of the mixture control lever to either of its extreme positions will, at any speed, cause a distinct loss of power and possibly miss-firing. Steady running and good power at all speeds should be obtained with the lever set half-way on its quadrant.

Mixture Control. It will be readily gathered from the preceding notes that a considerable and very useful range of mixture strength is within the driver's control under running conditions.

Utilised in a proper manner, very economical running can be obtained.

When starting the engine from cold, especially in cold weather, the mixture lever should be moved over to **Strong** before changing from the starting to the main carburetter.

As the engine warms up, it will be found that the lever can be moved towards the half-way position, until, with a well-warmed engine and normal touring conditions, it can be taken a few notches towards **Weak.**

A weak mixture burns more slowly than a normal one, and to get the best power from such a mixture, the ignition needs to be well advanced. Consequently, the most economical running is obtained when the ignition lever is fully advanced and the mixture control set as far towards **Weak** as the conditions allow without seriously reducing the power available.

If, on the other hand, weakening of the mixture is carried too far, then, apart from the probability of miss-firing and popping in the carburetter, similar road conditions will call for a bigger throttle opening, and the economy desired be thereby nullified.

Under severe conditions, such as a long ascent which calls for full throttle, too weak a mixture may cause overheating. So the control lever may with advantage be set a little **Strong** under these circumstances.

Slow Running. The best slow running will be obtained with the mixture control set two or three notches **Strong.** If difficulty is experienced in getting the engine to run slowly, this may be due to the flow of petrol past the low-speed jet needle being restricted by the presence of foreign matter.

To remove this, the jet needle should be raised with the fingers by lifting knurled nut, **W** (Fig. 24), and the throttle simultaneously opened to race the engine momentarily.

If this effects a cure, it would be advisable to clean the petrol filters, as these are probably dirty (see page 82).

The trouble may also be due to sticking of the carburetter air valve (see page 90), or faulty tappet adjustment (see page 77).

Starting Carburetter. A special auxiliary jet and expanding choke tube is incorporated in the carburetter for starting purposes only.

This jet can be regulated by means of the knurled screw **M** (Fig. 24), which carries a taper needle running into the jet. Turning this screw in a clockwise direction reduces the jet opening, and in an anti-clockwise direction increases it.

Should occasion arise to re-set this jet adjustment, the screw should be turned with the fingers in a clockwise direction until it is felt that the needle is entirely closing the jet. It should then be rotated in the opposite direction for about one-and-a-half complete turns. This will give a setting at which the engine can be started. Then, with the engine running, the screw may be turned to weaken or strengthen the mixture slightly as may be required.

It is important that the setting of the needle valve should not be such as to provide an over-rich mixture. Although an average setting is one-and-a-half turns from the closed position as stated, this may be reduced to one-and-a-quarter turns in warm weather. On the other hand, in very cold weather, it may be increased to one-and-three-quarter turns, but must be again reduced when the weather becomes warm.

Adjustment of the starting carburetter should only be performed when the engine is cold.

The variable choke or throat of this small carburetter consists of a suction-operated piston, which is lifted against gravity and automatically adjusts the choke area to suit the engine speed.

Access to this throat is obtained by unscrewing the cap **N**, which may then be lifted out with the jet needle. It is advisable occasionally

to remove and carefully wipe the piston, but no oil should be used on it.

As the successful working of this small carburetter is dependent on an air-tight induction system it is essential that the main throttle should be fully closed when starting the engine.

When changing over to the main carburetter, the throttle should be moderately opened and the starting carburetter lever turned to the **Running** or **Off** position, where it should always remain, except for starting. If the engine hesitates and tends to stop, the starting carburetter should be opened again and the main throttle closed until the temperature conditions of the engine are suitable for steady running on the main carburetter.

Cases have arisen of piston seizure which have been traced to excessive use of the starting carburetter. It should be appreciated that the object of the starting carburetter is to facilitate starting when the engine is quite cold, the mixture it provides under such conditions being on the rich side. Consequently, excessive use of the starting carburetter, or its use with a hot engine, is liable to cause liquid petrol to be drawn into the cylinders and wash away the engine oil.

Further, if used with a hot engine, starting may be difficult, due to the over-rich mixture.

The starting carburetter should not be used for more than half a minute before changing over to the main carburetter, and not used at all with a hot engine, in which circumstances starting will be found quite easy on the main carburetter only.

Float Feed Mechanism. The float chamber should be cleaned out every 5,000 miles, as directed on page 37, by unscrewing the cover **O** (after raising the catch **O1**, if such be fitted), and removing the float **P**, Fig. 25. The interior of the float chamber should be wiped out with a piece of clean, damp wash-leather.

No provision is made for flooding the carburetter by agitating the float needle, as this is never necessary. The starting carburetter is provided to supply a suitably rich mixture for starting purposes.

If flooding occurs, it is probably due to foreign matter having lodged on the needle valve seating, and steps should be taken accordingly.

Crankcase Breather Pipe to Carburetter. In order to reduce the emission of oil fumes from the engine, a pipe is carried from the crankcase to the carburetter air inlet.

This pipe is shown removed at **R** in Fig. 25.

A small gauze, **R1**, is arranged between the pipe flange and the carburetter, which in course of time may require cleaning. It should be removed and cleaned every 10,000 miles, as directed on page 39.

Dismantling the Carburetter. Normally it should not be necessary to dismantle the carburetter to a further extent than that already mentioned. On the other hand, it sometimes occurs that the jet needles become sticky in operation, due to sediment and impurities in the fuel, and the correct functioning of the carburetter is impaired.

Under such circumstances the carburetter should be removed bodily from the engine for dismantling.

The plugs below both jet needles should then be removed and cleaned of sediment. At the same time it should be ascertained that the spring plunger below the high-speed jet needle is working quite freely. The upward pressure of this spring is relied upon to open the high-speed jet, and its freedom of movement is therefore of great importance.

After removing the air valve and its chamber, two countersunk set-screws near the low-speed jet needle should be unscrewed. The jet needle can then be carefully lifted out.

The high-speed jet needle is removed by taking out the pin from the jaw at the lower end of control rod **T** (Fig. 24) and unscrewing the two countersunk set-screws which secure the bearing of the operating lever to the side of the carburetter. The jet needle may then be lifted out.

It is advisable to clean both jet needles carefully in paraffin. The jets themselves should also be cleaned out by using a small wooden stick and a piece of rag soaked in paraffin.

There should be no need to separate the two parts of the carburetter body, but if this be done, it is of vital importance to remove the air valve and its chamber first of all, and also the low-speed jet needle.

The latter will almost certainly be damaged if left in position when the carburetter body is divided.

WARNING.—On no account should the engine be kept running for any appreciable period with the car in a closed garage. There is then a grave danger of people in the garage being asphyxiated owing to the presence of poisonous gases in the exhaust.

Consequently, particular care should be taken always to fling the garage doors wide open before starting the engine.

CHAPTER VII.

Care and Adjustment of the Four-Wheel Brakes.

General Description — Possible Variations — Adjustments — Adjustment of Rear Brakes—Adjustment of Front Brakes—Adjustment of the Servo—Lubrication—Oil on Brakes—Use and Abuse of the Brakes.

General Description. The Rolls-Royce four-wheel braking system comprises a servo motor of the dry, disc-clutch type, which is equally available when the car is moving backwards or forwards. Further, even should the servo be out of action, the rear pedal-operated brakes still provide a reasonable braking capacity.

Pressure on the pedal applies the rear brakes direct in the usual manner and also engages the servo. The effect of the latter is distributed between the front and rear brakes, being therefore added to the direct pedal effort in the case of the rear brakes. With the leverages provided, this results in only about one-third of the total braking being imposed on the front wheels, which, in combination with the fact that—when the car is moving forwards—greater weight is thrown upon the front axle during braking, renders it very improbable that the front wheels can ever be locked.

The equalising of the servo pull to front and rear brakes respectively is effected by a special "T"-shaped balancing lever. A separate equaliser is provided for both pairs of front and rear brakes to ensure even braking on both sides of the car.

A diagrammatic representation of the whole system is shown in Fig. 26, a more detailed view of the servo and its connections being given in Fig. 29.

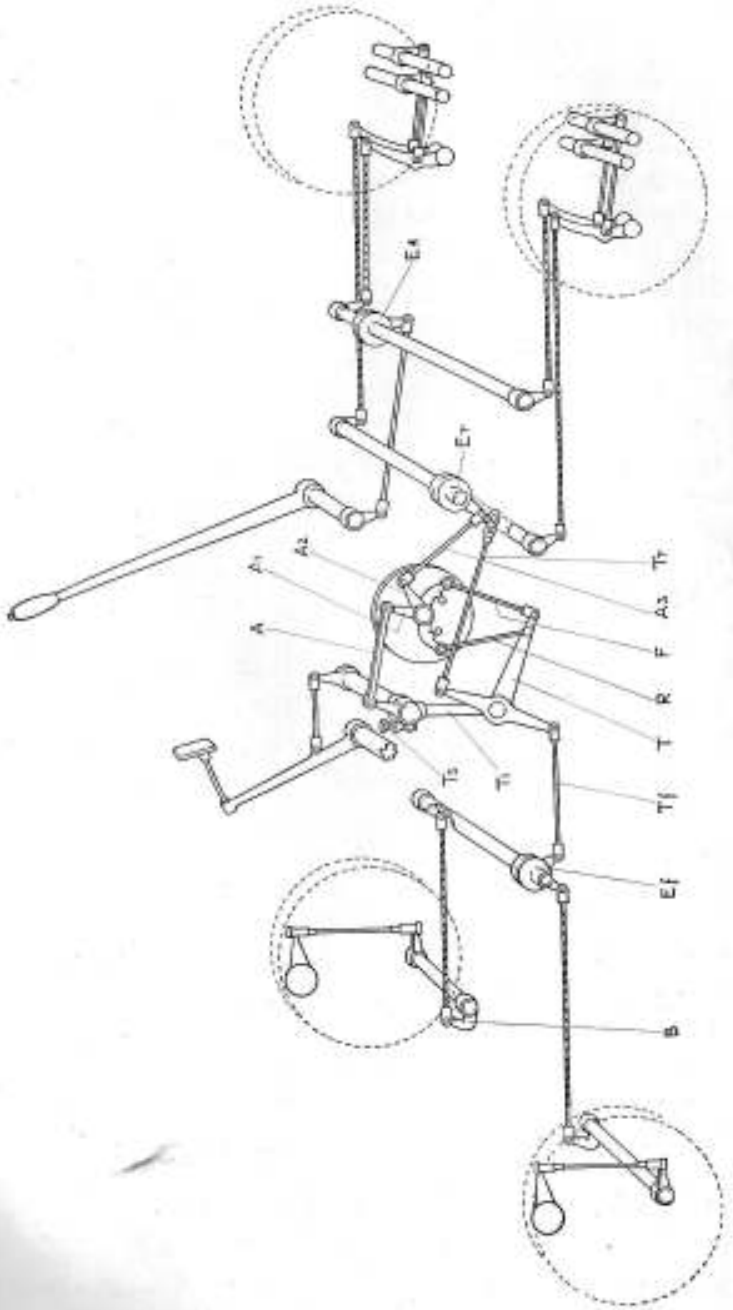


FIG. 26. DIAGRAM OF ROLLS-ROYCE FOUR-WHEEL BRAKE SYSTEM.

A shaft operated by the pedal passes through the gearbox, and on the near-side extremity of this shaft is mounted a lever coupled by the links **A** with a lever **A1** on the servo motor shaft. The lever **A1** has inclined teeth or cams formed on the face of its boss, these teeth engaging similar teeth formed on the boss of another lever, **A2**. From the latter a rod **A3** actuates the rear brakes through the medium of the equaliser **Er**.

The driven member of the servo carries two stops engaging one or other of two levers mounted freely on the shaft. From each of these levers coupling rods, **F** and **R**, are carried to the " **T** "-shaped balancing lever **T**, rod **F** operating the brakes from the servo when the car is moving forwards, and rod **R** when it is moving backwards.

From the balancing lever **T**, rod **Tr** operates the rear brakes through the equaliser **Er**, its connection to the latter consisting of a slotted fork, which permits direct operation of the rear brakes by the pedal when the car is standing without affecting the servo or the front brakes. The other arm of balancing lever **T** is coupled by a link **Tf** to the front brake equaliser **Ef**, from which ropes are carried to the levers **B** mounted on the front axle.

In order to prevent noisy contact of the front brake shoes with their drums, the suspension link **T1** of the balancing lever **T** is hinged to the gearbox through a friction device, which damps the free movement of the link.

For this purpose the link is provided with a boss, which is split on one side and tightened on to the bearing by a bolt and spring. The latter may be seen at **Ts** in Figs. 26 and 29.

The setting of this spring should not be altered.

Initial movement of the foot pedal engages the servo, owing to the inclined teeth riding upon one another and tending to separate the two levers. Further movement of the pedal causes both levers to move together, and actuates the rear brakes in the ordinary way.

These movements occur whether the car is standing or moving forwards or backwards, and result in the rear brakes being applied immediately the pedal is operated without any lag for the servo to take up its duty.

The degree of braking available without the servo assistance enables

a driver to shunt the car in awkward places with perfect assurance that his brakes will respond without delay to the pedal movement.

When the car is running, in either direction, the servo actuates the front brakes and also adds its effort to the direct pedal effort on the rear brakes, operating through the medium of the " **T** "-shaped balancing lever, the long arm of which is pulled upwards by one or other of the coupling rods depending on the direction of movement of the car.

The hand brake operates on an entirely independent set of shoes working in the rear wheel brake drums, a similar type of equaliser (**Eh**, Fig. 26) being employed. In order to avoid choking up of the ratchet teeth by grit, small stones or other foreign objects, the teeth are arranged pointing downwards.

To release the ratchet pawl, the button on the extremity of the hand lever should be depressed.

Possible Variations. As already mentioned, the leverages are so proportioned that of the total braking effort about two-thirds goes to the rear brakes, and the remaining one-third to the front.

This distribution, though independent within reasonable limits of any maladjustment on the part of the user, depends, nevertheless, upon the condition of the brakes themselves. For instance, if oil should reach the rear brakes, and so reduce their co-efficient of friction, a greater proportion of the braking would be thrown upon the front wheels, which is not desirable.

Conversely, if the front shoes become oily, the balance of distribution will be upset in the other direction.

It is therefore very necessary that oil should be kept from the brake surfaces, particularly in the case of the rear brakes.

Precautions to be observed in this connection are :—

(*a*) Periodically and regularly to check that the oil escape holes in the brake covers are clear.

(*b*) To fill the axle box only when it is warm after running, and to warm the oil before pouring it in.

(*c*) To use the oil gun on lubricators adjacent to the brake drums with great care.

(*d*) To clean off surplus oil from the front brake drum covers after lubricating the steering pivots.

Adjustments. The only points in the system where any adjustment is provided or is necessary are the following :—

(1) Rear Brakes ... The threaded rods coupled to the cam operating levers below the ends of the rear axle.

(2) Front Brakes ... A serrated adjustment on the cam operating shafts.

(3) Servo ... ... A serrated adjusting nut on the end of the servo shaft.

These adjustments are dealt with in detail in the succeeding paragraphs.

It is very important to observe that under no circumstances should adjustment be attempted at any other points, for instance, by altering the lengths of other brake rods or any of the ropes. These are all carefully determined during the erection of the chassis, with a view to utilising to the best advantage the lengths of the various levers, taking into consideration the total movement of such levers from when the brakes are new until the facings are completely worn out.

Any alterations to the lengths of these rods or ropes will virtually shorten the lengths of some of the levers, and will interfere with the correct functioning of the system.

Adjustment of Rear Brakes. Indication that adjustment of the rear brakes is required is readily observed by noting the pedal travel necessary to take up the clearance between shoes and drums.

The pedal should be comparatively lightly depressed with the hand, the floorboard being meanwhile removed and the servo engaging mechanism watched. It is also advisable during this operation to jack up one of the rear wheels and get someone to turn the wheel and to indicate when the brakes are applied.

Measuring from the top edge of the pedal towards the dash, the first $\frac{1}{4}$" of movement will be required to take up the servo clearances ; a further $1\frac{1}{4}$" of movement should just apply the rear brakes, this further movement corresponding to about $\frac{3}{8}$" of movement of the brake ropes.

Adjustment of the rear brakes is imperative when the total pedal movement with light hand operation exceeds 3".

As in the case of the foot brake, so with the hand brake there should be about $\frac{3}{8}$" of travel of the cables before the shoes come into contact with the brake drums. This will be found to correspond approximately with a movement of the brake lever from its fully off position to the third or fourth notch of its quadrant.

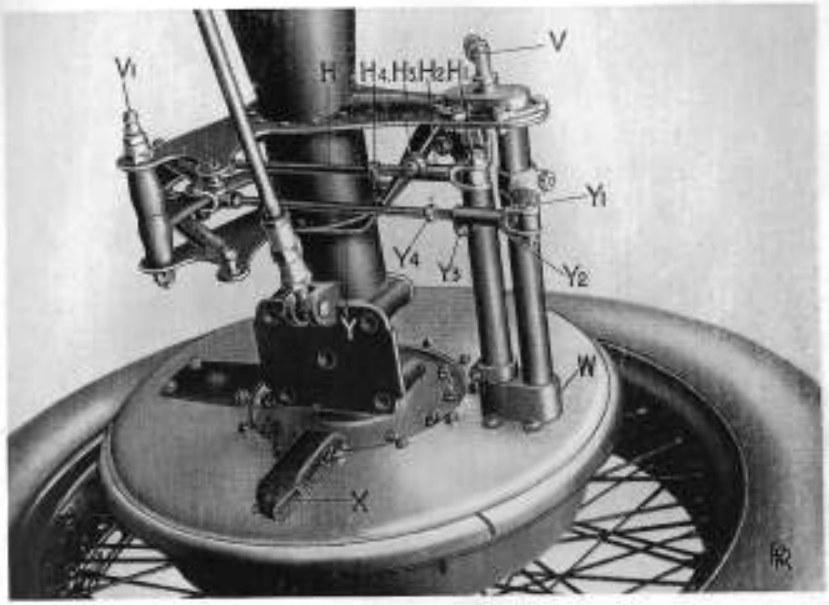


FIG. 27.
REAR WHEEL BRAKE ADJUSTMENT
(Viewed from Below).

The method of adjustment is similar for both hand-operated and rear foot-operated brakes, and is illustrated above. This is a view looking from the underside of the axle.

The outside rods, **Y**, actuate the foot brake shoes, and adjustment is effected by removing the bolt **Y1** from the jaw **Y2**, this bolt being secured by a castellated nut, slackening the small nut **Y3**, and screwing the jaw further on to the rod **Y**, to an extent depending on the amount of adjustment required.

It is important that the amount of adjustment made to the corresponding rod at the other end of the axle should be the same.

A convenient method of checking this is to measure the distance between the collar **Y4** and the jaw **Y2**.

Before replacing the bolts **Y1** in the jaws, attention should be turned to adjustment of the hand brake, if any is required.

All adjustment for the hand brake is made on the inside rod **H** and the corresponding rod at the other end of the axle.

The adjustment is effected in a similar manner to that of the foot brake, but it should be noticed that the bolt **H1** of the hand brake jaw **H2** cannot be removed until jaw **Y2** is disconnected.

Care should be taken that the distance bush, which fits the eye of each lever, is in position before replacing the jaw and bolt.

The adjustment of both brakes should be finally checked by measuring the travel of the cable, as already described, when the pedal or hand lever is moved from the off position to a point where the shoes just touch the drums.

The distance must be the same for both cables of each brake.

After replacing the jaw bolts and their nuts, split cotters should be fitted to these, and the small nuts, **H3** and **Y3**, tightened up.

The amount of adjustment provided is so proportioned that when all has been utilised (jaws **H2** and **Y2** being against the collars **H4** and **Y4** respectively), it is a sign that the brake shoes require re-covering, and the makers should be consulted.

On no account should further adjustment be attempted, as, for instance, by shortening the brake ropes or interfering with adjustments within the brake drums. Such a course might result in serious injury to the drums and shoes.

Adjustment of Front Brakes. It should be borne in mind that the correct pedal travel is in no way an indication that the front brakes are correctly set, because these are entirely servo operated and their adjustment will not influence the pedal travel.

The only indication that they require adjustment (apart from an observed decrease in the front braking) is excessive movement at the end of the levers **B**, Fig. 28, on the front axle. When lightly pressed rearwards by hand the movement of this lever should

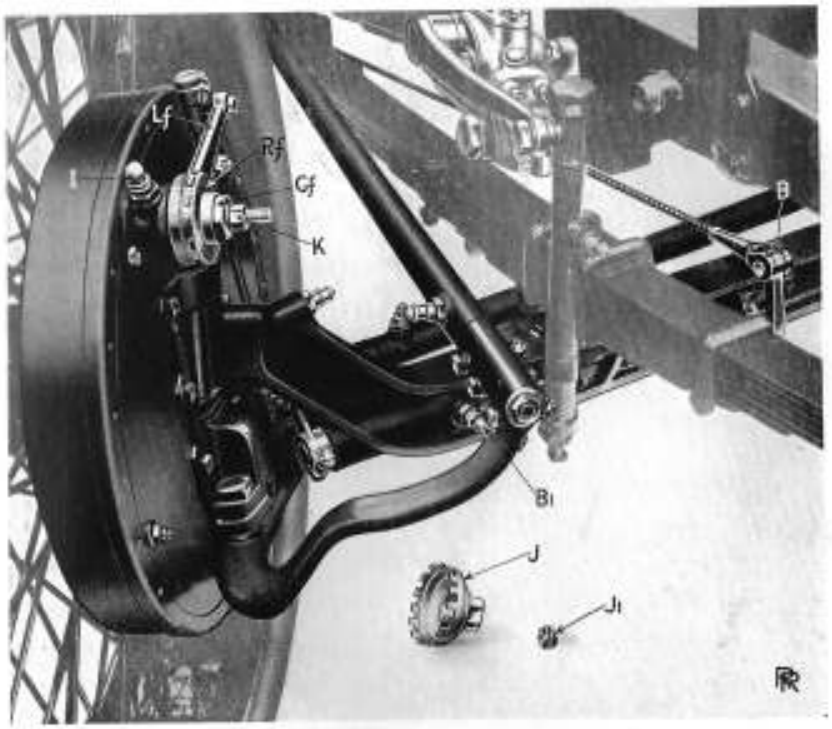


FIG. 28. FRONT WHEEL BRAKE ADJUSTMENT.

be $\frac{5}{8}$" measured at the centre of its jaw pin for correct adjustment. If appreciably more movement than this is required, it will be necessary to utilise the adjustment provided. This is shown above. To effect an adjustment proceed as follows:—

Remove the split cotter of the castellated nut **J1**, and unscrew the latter. The cover **J** may then be removed, exposing the serrated adjustment. As this cover also acts as a locking piece, it will be found convenient to mark the position of engagement of its teeth with those on the member **Rf** before removing it.

The nut **Gf** should be unscrewed sufficiently to permit the serrated member **Rf** to be moved clear of similar serrations on the lever **Lf**. These two sets of teeth are marked respectively with an arrow and figures 0, 1, 2, 3, 4 and 5. If the brakes are being adjusted for the first time the arrow will point to 0.

Having noted the relative position of these serrated parts, they may be disengaged by tapping the lever **Lf** away from the wheel, carrying with it the serrated member **Rf**. While holding the latter in the hand, the lever should then be tapped towards the wheel again, when the serrations will be disengaged.

The cam operating shaft, and with it member **Rf**, should next be turned by means of a spanner on the hexagon **K** of the shaft until the parts can be re-engaged one serration further towards the on position of the cam operating shaft than before; that is, after the first adjustment the arrow will point to 1.

Finally, re-tighten the nut **Gf**, re-fit the cover **J**, which also acts as a locking piece for this nut, and replace the castellated nut **J1**, fitting a split cotter to the latter.

If any difficulty is experienced in getting the teeth of cover **J** to engage with those on member **Rf**, the cover should be rotated slightly and tried in different positions.

The brake clearances should be tested again after adjustment by measuring the movement of levers **B**, as described. This movement must not be less than $\frac{3}{8}$" at the centre of the pin, otherwise the brakes may drag.

Particular care must be taken that each front brake is adjusted a like amount.

It should be observed that when the five teeth of adjustment have been utilised, this is an indication that the shoes require new facings.

On no account should further adjustment be attempted by, for instance, interfering with the lengths of any of the brake rods or ropes.

Apart from testing for the need of adjustment of the front brakes, it is important to test from time to time that the shafts and joints on the axle are free by pushing down the levers **Lf** with the hand, or by moving levers **B** similarly.

The mechanism should feel free, and be returned sharply to the off position by the pull-off springs.

If any tightness is found, the cause must be investigated and removed, otherwise there is a danger of the brakes dragging and becoming damaged.

Adjustment of the Servo. The servo is of the dry, disc-clutch type, and should run 20,000 miles without the need of any adjustment.

If adjustment is necessary, it is effected by screwing up the nut **Z** (Fig. 29).

This nut is locked by 25 rounded serrations formed on its face, which engage similar serrations on a washer, which is secured against rotation relative to the shaft. The depth of these serrations

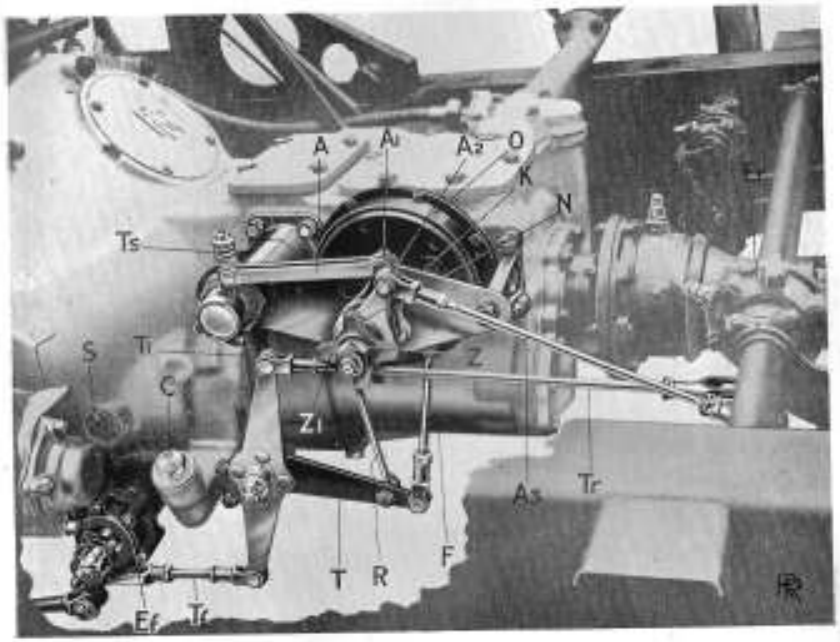


FIG. 29. THE SERVO MOTOR AND ITS CONNECTIONS.

is carefully proportioned to give the correct clearance of the servo, the nut being turned so that the teeth lightly ride over each other and engage again.

On no account should force be used in this operation, as such treatment would nullify the object of the teeth, namely, to ensure the correct clearance with very little trouble.

After effecting adjustment in this way, care should be taken to see that the serrations are in proper engagement.

The adjusting nut should not be screwed up more than one serration—that is, $\frac{1}{25}$ of a turn—without testing the servo adjustment.

To test the servo adjustment the pedal should be depressed lightly by hand, as when testing the rear foot brake adjustment. But in this case it should only be depressed sufficiently to engage the servo without appreciably compressing the buffer springs, **Z**1 (where these are provided), and just short of moving the lever **A**2 rotationally.

The pedal travel should then be not less than $\frac{1}{4}$" measured at the top of the pedal towards the dash.

It must be realised that this movement is entirely due to the servo clearance, and does not alter the rear brake clearances. Hence, lever **A**2 is not moved rotationally, as mentioned.

Another method of testing for the correct servo clearance is by measuring the gap on the straight or axial sides of the inclined teeth between levers **A**1 and **A**2.

It should be possible to insert a ·025" feeler gauge at this point when the servo is engaged lightly.

After adjustment, the servo clearance should always be checked again by one or both of the methods explained.

Emphasis is laid on this point, as obviously a dragging servo, due to abuse of the adjustment provided, would result in dragging of the brakes on all wheels.

Lubrication. The bearings of the brake cam and operating shafts on both front and rear axles are provided with lubricators to take the oil gun.

Four of these will be found on the front axle, as shown in Fig. 28 at **B**1 and **I** (same on other side), and six on the rear axle, as shown in Fig. 27 at **V**, **V**1, and just above the boss **W** (same on other side).

Gear oil should be injected into these every 1,000 miles, as directed on page 33. The intensifier should not be used on lubricators **V**, and care must be taken to oil sparingly in the case of the lubricators on the bosses **W** on the rear axle, and

I on the front axle. These being located on shafts which enter the brake drums, there is a risk of oil reaching the brake surfaces if too much is used.

In this connection it should be observed that spouts are arranged on the brake covers just below the rear axle, as shown at **X** in Fig. 27, in order, as far as possible, to drain away oil, which otherwise might reach the brake surfaces. These spouts should be inspected frequently and kept clear of any obstruction. In the case of the front brakes, a drain hole will be found in the covers beneath each brake cam shaft, which must also be kept clear.

After lubricating the steering pivots, as directed on page 33, care must be taken to clean off all excess oil thoroughly, as this will run down the outside of the brake drum covers, and is liable to work into the drums (see page 122).

Other points of the brake mechanism requiring periodic attention, as directed on pages 33, 34 and 35, are shown in certain of the illustrations.

The rear foot brake equaliser is shown at **E**r in Figs. 26 and 29, and that for the hand brake equaliser at **E**h in Fig. 26.

The front brake equaliser is seen at **E**f in Figs. 26 and 29.

The lubricator for the pedal fulcrum will be found on the shaft which carries the brake and clutch pedals.

In addition, there is a number of joints and links of the rods and levers which must be oiled with the oil can every 1,000 miles, as instructed on pages 33, 34 and 35.

Two such points are on the servo shaft in the form of oil holes, one of which is shown at **N** in Fig. 29, and the other is located just behind the servo supporting plate at **K**. Only a drop or two of oil should be inserted at these points.

Excess of oil at the hole **N** must be carefully avoided, as it may result in oil working through the servo shaft to the friction surfaces.

In this connection it should be noted that drain holes are drilled around the servo as shown at **O**. Drain passages will also be found at the back of this member. It is important that all these should be kept free from obstruction and oil, the servo being designed to function with no oil on its friction surfaces.

Oil on Brakes. If, owing to overfilling of the axle casing, too liberal use of the oil gun on lubricators adjacent to the brake drums, omission to wipe excess oil off the brake drum covers after lubricating the steering pivots or choking up of the oil drain channels referred to, the brakes become oiled up and ineffective, it will be necessary to remove the hubs (see pamphlet, "Care of Dunlop Wheels," at end of book).

The brake coverings should then be well cleaned by scrubbing with a stiff brush dipped in petrol, and the drums wiped clean on the insides.

Use and Abuse of the Brakes. Although in the layout of the brake system every care has been taken to ensure, for a given pedal pressure, a constant retarding effect on the wheels distributed in a constant ratio between the front and rear wheels, a factor which remains very far from constant and outside the control of automobile designers is the adhesion between the tyres and the road.

As is well known, this factor varies greatly, being best on dry, firm roads, and worst on wet or loose-surfaced roads.

It is therefore very necessary for a driver to use his brakes with due regard to the conditions of the road, especially when rounding a curve or corner.

Violent braking under such circumstances—whether only the rear wheels are braked or all four—is far more likely to produce a skid than when the car is proceeding along a straight road.

This is due to the fact that a locked wheel ceases to have any tendency to proceed in its normal direction of rolling, and may be comparatively easily induced to move sideways. Further, a wheel which is braked almost to the limit of its adhesion to the road, that is to say, which is on the point of skidding, is much more easily deflected from its normal course.

When rounding a corner heavy side stresses are set up due to centrifugal force, and the conditions then present, if the rear wheels are locked or heavily braked, all favour a serious rear skid.

Such a skid, with a little skilful driving, may usually be corrected.

A front wheel skid, however, is incomparably more dangerous, as it is insidious and difficult to detect at the outset, and cannot be corrected so long as the front wheels are locked, there being then no steerage-way on the car.

The first intimation which a driver usually has that the front wheels are locked is the fact that the car will not respond to movement of the steering wheel, but continues straight ahead.

In fact, on a greasy road a driver may not realise that the front wheels are locked until he attempts to steer the car.

The only course then is to release the foot brake, when steerage-way will usually be recovered.

It requires some presence of mind to do this, the first impulse being to put more pressure on the pedal.

Drivers should cultivate the habit of always releasing the brakes when actually turning a corner. The power of retardation provided is so great that there is no necessity for the full power of the brakes to be used on a turn.

Therefore, it is necessary to use the brakes with the greatest discretion when the car is rounding a curve, and with due consideration for the state of the road.

Experienced drivers will know that this applies to any form of braking, but with four-wheel brakes—with their increased powers of retardation—it will be obvious that still more care is necessary.

Also, one should remember that following traffic may not possess the rapid retarding powers of the Rolls-Royce with four-wheel brakes. Therefore drivers should continually keep themselves aware of the presence of any overtaking vehicle in order that the latter may be warned in time to prevent a rear collision if the Rolls-Royce car has to be heavily braked.

As far as possible the brakes should not be suddenly and violently applied. If they are, the rear wheels will certainly be locked and the power of the brakes thereby greatly reduced. Pressure should be applied to the pedal steadily, and so adjusted that the rear wheels are just short of skidding.

The maximum braking will then be available.

When stopping the car by means of the foot brake, this should be eased off when the car comes to rest, in order to avoid any shock or jerk to the passengers. It is found that this shock is most pronounced when the car is proceeding at quite slow speeds, and is then brought to a sudden standstill.

The hand brake should be used for holding the car when stationary.

Apart from the comfort of passengers and the safety and convenience of other road users, it must not be forgotten that the practice of braking heavily and frequently will inevitably make itself felt in the matter of tyre wear and cost of renewals.

The latter should not be greater with four-wheel brakes than with only rear wheel brakes.

If it is found to be so, then the fact can be taken as an indication that the driver is habitually taking too great an advantage of the retarding abilities which the brakes provide.

The foot brakes are capable of being used continuously on the longest descents without overheating or damage.

Special consideration has been given in the design both of the servo and of the brake drums to the provision of adequate means of cooling the friction surfaces. There is no need to use foot and hand brakes alternately on a long hill.

If chains are fitted to the rear wheels for driving on snow and ice, it is necessary also to equip the front wheels similarly. If this is not done, the front wheels will certainly be locked by application of the foot brakes due to the greater adhesion of the rear wheels.

No chains must be fitted to the off side front wheel. If only two sets of chains are available, these must be arranged on the off side rear and near side front wheels respectively.

CHAPTER VIII.

Clutch and Transmission.

Clutch Adjustment—Dressing of Clutch Friction Surfaces—Lubrication of Clutch Mechanism—Gearbox—Universal Joints—Back Axle.

A part sectional elevation of the clutch is shown in Fig. 30.

It is of the single dry-plate type, the fabric **O** being secured to the flywheel and clutch ring members respectively, thereby enabling the clutch plate **P** to be kept as light as possible.

Four levers, **R**, are provided for clutch withdrawal purposes, their ends being pressed inwards on operation of the clutch pedal by the sliding sleeve **D**, actuated through a ball thrust bearing and trunnion.

Owing to these and other features, operation of the clutch is very smooth and light, and gear-changing is greatly facilitated.

Clutch Adjustment. No adjustment is provided for spring pressure, the springs being proportioned to render this unnecessary in the life of the clutch.

An adjustment is provided, however, to ensure an equal outward movement being imparted to the clutch ring **E** by each of the four levers on withdrawal. This takes the form of four tappets, **F**, abutting the ends of levers **R**, and locked by nuts **G**.

Normally, it should be possible to raise the clutch pedal with the fingers about $\frac{1}{8}$" when the footboards are in position. If, owing to bedding down of the fabric, this is not possible, clutch slip may occur owing to the clutch being prevented by the footboards from proper engagement.

Under these circumstances, the clutch-pit inspection cover **H** should be removed, and, after slackening lock-nuts **G**, the tappet

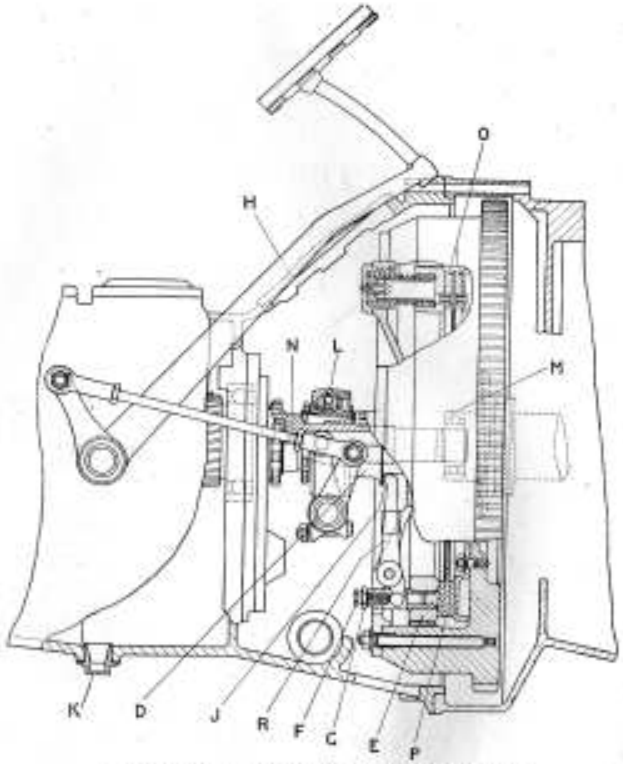


FIG. 30. PART SECTIONAL VIEW OF CLUTCH.

screws **F** should be unscrewed until there is ·020" clearance, measured with a feeler gauge, at the point **J**, i.e., between the inner ends of the levers and the withdrawal sleeve **D**.

During this operation, the pedal must, of course, be in a position corresponding with that which it occupies when raised against the lower side of the footboards, the latter being removed to gain access to the clutch pit.

A convenient method of ensuring this is to prop up the pedal lightly by means of a piece of wood between it and the dashboard before removing the footboards.

It is of vital importance that this clearance should be equal for each of the four levers, the pedal not being moved during the adjustment.

When the necessary clearances have been obtained, the nuts **G** should be locked with care.

Dressing of Clutch Friction Surfaces. Should it be considered that the clutch is operating harshly, the setting of the clutch levers should be verified, as described in the preceding section.

If the trouble persists with these adjustments correctly set, then it is possible that the friction surfaces are in need of a slight degree of lubrication.

The best form of lubricant is a mixture of half engine oil and half paraffin. This should be applied in the following manner :—

(1) Remove the clutch pit inspection cover.

(2) On turning the engine by means of the starting handle, four small holes at 90° will be observed in the rim of the flywheel. Inject with a syringe (if available), or otherwise with the oil can, about an eggcupful of the lubricant into the four holes (one-quarter of the amount into each hole), whilst the clutch pedal is depressed.

(3) Start engine and operate the clutch repeatedly, taking care to slip it a reasonable amount in order to distribute the lubricant thoroughly over the surfaces.

(4) Inject a second eggcupful of lubricant as before, and repeat the former process of operating and slipping the clutch. Any excess of lubricant will escape through a drain hole in the clutch casing.

(5) Replace the inspection cover.

Lubrication of Clutch Mechanism. The various joints and bearings of the clutch-striking mechanism should be lubricated periodically with an oil can, as directed in Chapter II.

There is an oil-hole, **L**, in the clutch trunnion, into which a few drops of oil should be inserted for the lubrication of the ball thrust bearing every 2,000 miles, as mentioned on page 36.

The clutch shaft, which is hollow, is spigotted at its forward end in the crankshaft on a ball bearing shown dotted at **M**.

Provision is made for the lubrication of this bearing by means of a small hole, **N**, through one side of the clutch shaft. A few drops only should be inserted every 5,000 miles, as directed on page 39.

It is very important not to over-oil at this point, as excess of oil will find its way on to the clutch surfaces and cause trouble.

The bearings of the hollow clutch withdrawing shaft should be lubricated every 2,000 miles by injecting engine oil into the open end of the shaft **S** (Fig. 29), as directed on page 36.

The fulcrum pins of the levers **R** should also be lubricated every 2,000 miles, as directed on page 36.

Gearbox. The gearbox is of the usual sliding type, the two main shafts being supported in three bearings each. The extra bearings contribute largely to the permanent silence of the gears, and, in the case of the third motion shaft, relieve the spigot bearing of much of its load.

Lubricant is inserted into the box by unscrewing the filler plug shown at **C** (Fig. 29).

It is very necessary that the oil should be well warmed before introduction, in order to reduce its viscosity. It is also important that the filling-up should be done when the gearbox is warm after running, as otherwise a false level will be obtained.

Oil should be poured in until the level reaches to the mouth of the filler spout.

The oil level should be inspected every 5,000 miles, as directed on page 38.

Every 10,000 miles all oil should be drained out by removing plug **K** (Fig. 30), and fresh oil inserted, as directed on page 39.

A worm-driven connection is provided on the gearbox for the speedometer, the drive ratio being suited for the speedometer which is supplied.

Universal Joints. The propeller shaft universal joints are enclosed, and provided with oil gun lubricators.

The driven portion of the forward joint is mounted on serrations of the propeller shaft, so that it can slide in order to permit of plunging movement.

As the work which these joints have to perform is heavy and

continuous, the importance of their careful lubrication cannot be overestimated.

As directed on page 33, it is recommended that one charge of the intensifier barrel of the oil gun should be injected into each joint every 500 miles, gear oil being used.

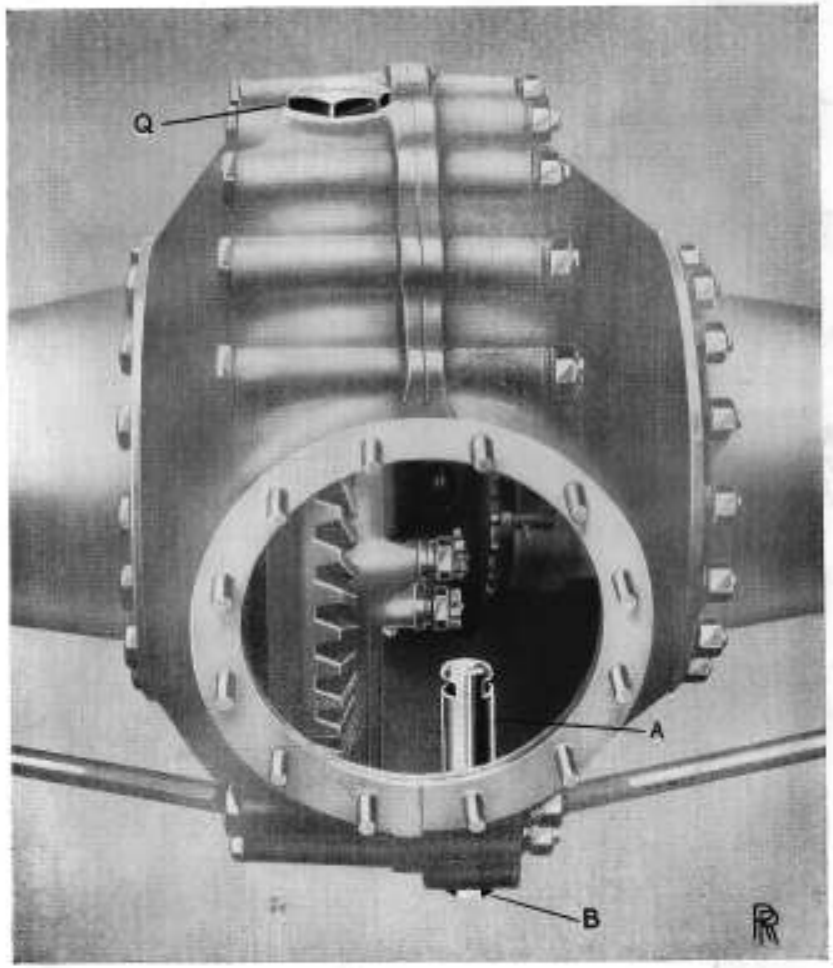


FIG. 31. OIL LEVEL PIPE IN BACK AXLE CASING.

Back Axle. The back axle is of the full floating type, the road wheels being mounted solely on extensions of the axle tubes.

The final drive is by spiral bevel gears.

In connection with lubrication of the axle, a point to be borne in mind when adding oil is that the oil level is determined by a stand pipe which projects the required height into the box, and is normally closed at its bottom end by a plug.

This pipe is shown at **A** (Fig. 31), and the plug at **B**. The latter should be removed during filling, which, as in the case of the gear-box, should be done when the axle is warm after running.

On removing the plug, a little oil may run out, but it should not be inferred from this that there is sufficient oil in the casing, as such oil is probably only what has been trapped in the standpipe.

Warm oil should be poured in through plug-hole **Q** until it just commences to run out of the lower hole, and the plugs carefully replaced.

The oil level should be checked every 5,000 miles, as directed on page 38.

The oils recommended for use in the back axle are given on page 28.

Every 10,000 miles all the oil should be drained out and replaced with fresh oil, as directed on page 39.

To do this standpipe **A** must be removed by unscrewing the serrated nut into which plug **B** is screwed. A locking washer is arranged with its tab bent into a serration of this nut. This tab must first be bent clear, when the nut can be unscrewed with the special spanner provided.

When replacing it a new locking washer must be used, and its tab bent into a serration.

CHAPTER IX.

Steering, Shock Dampers, and Road Springs.

Steering Column and Box—Steering Arms and Joints—Steering Pivots—Front Friction Shock Dampers—Front Hydraulic Shock Dampers—Rear Friction Shock Dampers—Shock Damper Connections—Road Springs.

Steering Column and Box. Steering is by worm and nut, a double ball thrust bearing being carried on the column a short distance below the steering wheel.

If it be found, after a considerable time, that a slight rattle develops in the steering and a certain amount of backlash is present, this may be due to the need of adjustment of the ball thrust bearing.

To do this, the serrated locking ring on the column must be released with the special spanner provided, and the knurled housing screwed down, the fingers only being used in the latter operation. The lock-nut should then be re-tightened.

The cover which encloses the ball thrust bearing should be lifted with the fingers every 2,000 miles, and a few drops of engine oil injected into the thrust bearing, as directed on page 36.

Where a spring-lid lubricator is fitted on the cover of the worm-and-nut mechanism casing, a few drops of engine oil should be injected through this lubricator every 500 miles, as directed on page 33. Where a filling plug is provided, this should be removed every 2,000 miles, as directed on page 36—preferably when the box is warm—and the level of oil inspected. If necessary, gear oil should be poured in until it is on the point of overflowing from the plug orifice.

Steering Arms and Joints. The steering gear should be examined regularly every 2,000 miles, as directed on page 37, to see that all bolts are tight, joints in good adjustment, and well lubricated.

It should be noticed particularly that the steering arms are tight on the stub axles, and that all the nuts and bolts securing them are tight.

If any nuts are found loose, and only being retained by their split cotters, the latter should be removed, the nuts screwed up tightly, and new cotters fitted.

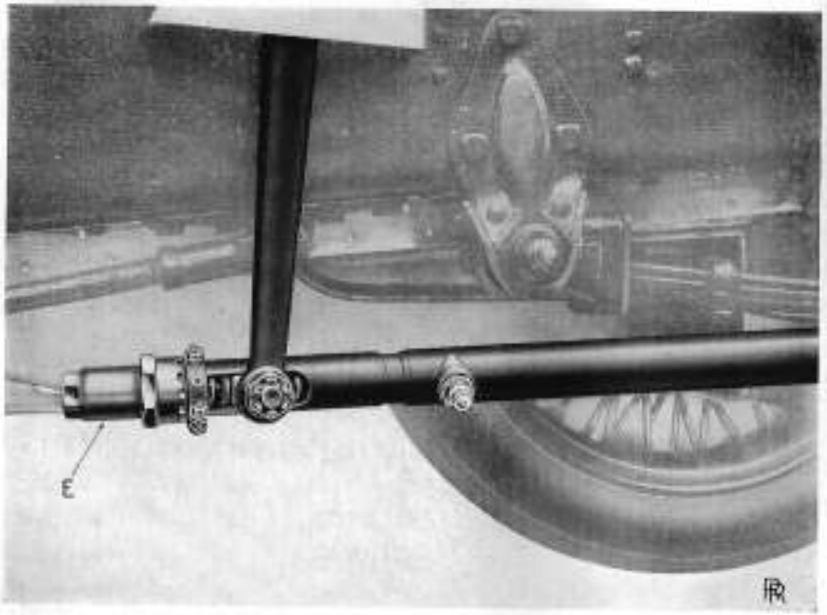


FIG. 32. REAR END OF SIDE STEERING TUBE.

The ball joints of both side and cross steering tubes are provided with oil gun lubricators, and gear oil should be freely injected every 500 miles, as directed on page 32.

The joint at the rear end of the side steering tube is shown in Fig. 32.

The bearing pads of the ball are spring loaded, being self-adjusting within certain limits, and means are provided for restoring the original

setting. This should not normally require attention except when the car is undergoing a general overhaul, but the correct setting is important. It is as follows: When the cap **E** is unscrewed a nut and lock-nut will be seen. These are screwed on a stem formed integral with one of the bearing pads. The face of the inner nut should stand ·006" away from the end of the guide through which passes the stem.

In addition to being tightened against one another, these nuts are further locked by means of a washer with tabs bent against flats of the hexagons.

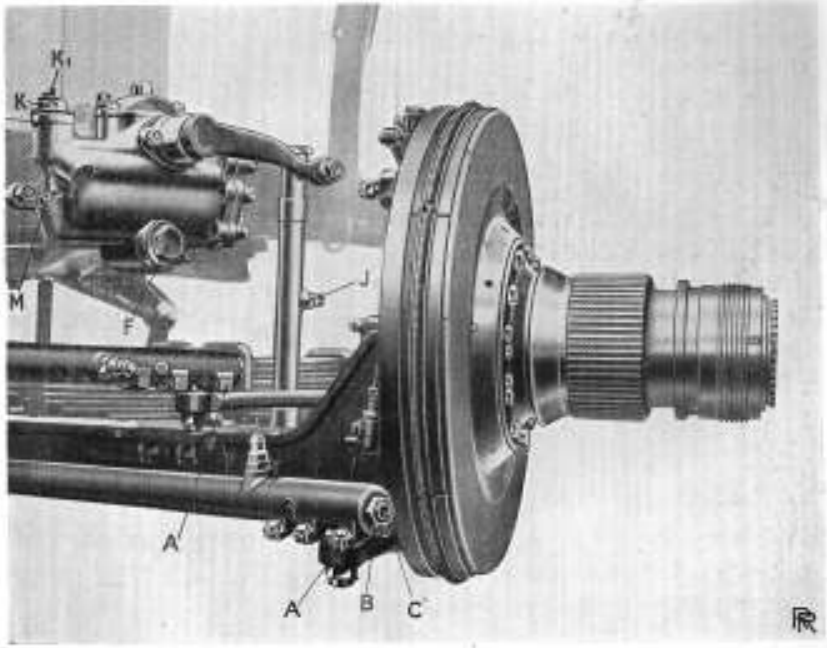


FIG. 33. CROSS STEERING TUBE.

In setting the clearance of ·006" these tabs must first be bent clear and the nuts then released.

The clearance is conveniently set by first screwing the inner nut lightly up to the guide and then unscrewing it approximately one-eighth of a turn.

It should afterwards be locked by means of the lock-nut and tab-washer, and the cap **E** should finally be replaced.

On cars which are not fitted with the cap **E** at the end of the tube, the joint is entirely self-adjusting and needs no attention beyond regular lubrication.

The joints provided at the forward end of the side steering tube and at either end of the cross steering tube, respectively, are all three similar in design, and on the majority of chassis are spring loaded.

To adjust them, the bolt **A** (Figs. 33 and 34), which is fitted with a castellated nut, should be slackened, and the lock-nut **B** unscrewed.

The screw **C** must now be turned in a clockwise direction with the key provided until just tight, and afterwards turned *back* one-eighth of a turn.

The bolt **A** should then be re-tightened and fitted with a split cotter, and nut **B** screwed up.

When the joints are correctly adjusted, it should be possible to partially rotate the side and cross steering tubes with the hand without undue effort, and at the same time no slackness should be present in any of the joints.

Steering Pivots. Gear oil should be forced into the steering pivots freely every 500 miles with the oil gun, as directed on page 33.

The lubricator of one pivot is shown at **D** (Figs. 34 and 35).

It is preferable during this operation that the axle should be jacked up, in order to give the oil a better chance of reaching the loaded surfaces of the pivot pin.

Care must be taken not to over-lubricate at these points, because, as mentioned on page 109, excess oil, which runs down the outsides of the brake drum covers, is liable to find its way into the drums and reduce the effectiveness of the brakes. Any such excess oil must therefore be carefully wiped off after lubrication.

The nuts which secure the steering levers to the stub axles should be inspected at intervals to see that none is loose and retained by the split cotter alone.

Front Friction Shock Dampers. Certain chassis are fitted with friction shock dampers on the front axle, as shown in Fig. 34.

It is of the utmost importance that the loading of these dampers should be maintained. This should be such that a weight of 25 lbs. suspended on the end of the arm will just

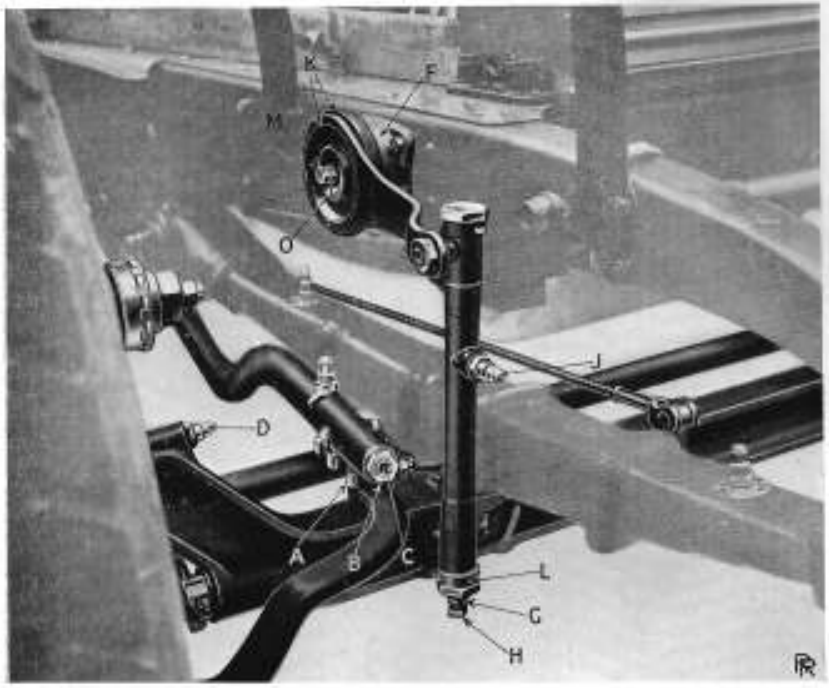


FIG. 34.
FRONT FRICTION SHOCK DAMPER AND FRONT END OF SIDE STEERING TUBE.

cause it to move. The adjustment must be checked every 1,000 miles, as directed on page 35, for which purpose it is necessary to disconnect the damper from the axle.

This is most conveniently done by removing the split cotter at the lower end of the link and unscrewing the cap **L**. The link may then be pulled off the ball.

If adjustment is found to be necessary, it is effected by releasing

the lock-nut **M** and screwing up the nut **O** the required amount, afterwards re-tightening the lock-nut.

It will afterwards be necessary to readjust the joints of the connecting link as described on page 125.

Every 500 miles, as directed on page 32, a little engine oil should be applied with the oil can to the edges of the leather covers at **K**. This will keep them in a soft and pliable condition. Every 5,000 miles, as directed on page 38, they should be removed, cleaned and soaked overnight in engine oil. To do this, the link should be disconnected at the lower end, as described, and the central nut

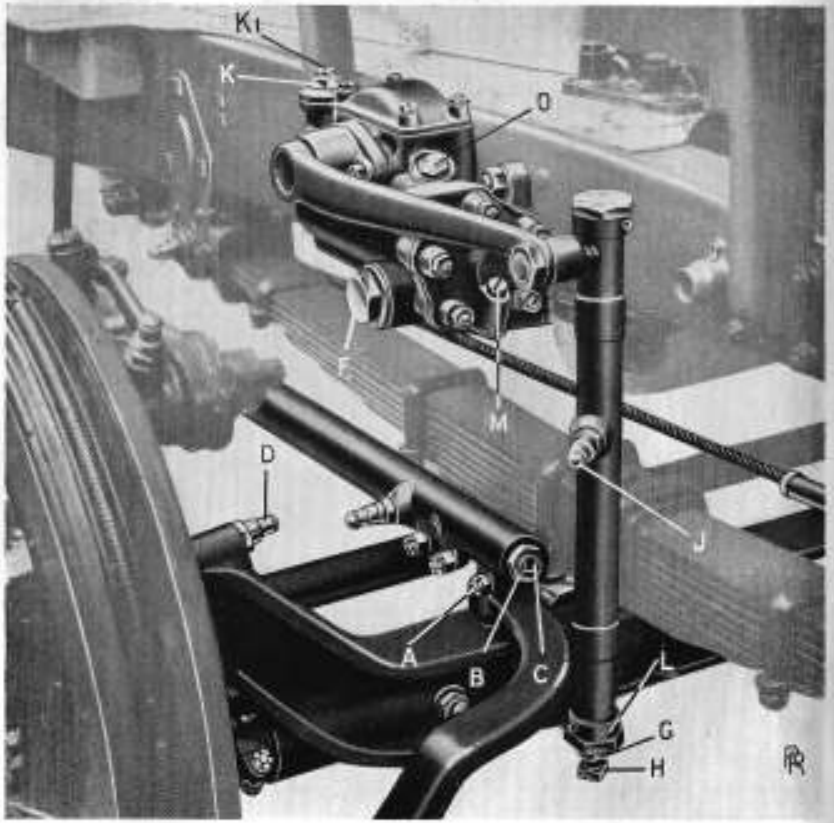


FIG 35.
FRONT HYDRAULIC SHOCK DAMPER AND FRONT END OF SIDE STEERING TUBE.

and lock-nut removed. Care must be taken that the central bolt and the coil spring under its head do not fall inwards.

Hydraulic Shock Dampers. Certain chassis are fitted with Rolls-Royce hydraulic shock dampers either on the front axle or on both front and rear axles, as shown in Figs. 33, 35 and 36.

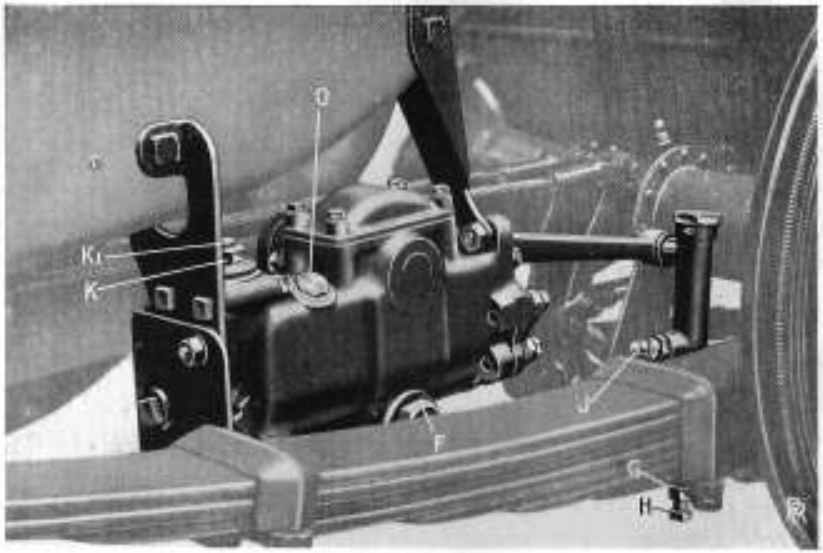


FIG 36. REAR HYDRAULIC SHOCK DAMPER.

Unless it is obvious that the effectiveness of the shock dampers has become reduced, or undue leakage of oil is apparent, no attention whatever will be necessary for 10,000 miles of running, with the exception of lubrication and adjustment of the joints of the connecting links as described later.

After 10,000 miles running, it is necessary to inspect the oil level in the shock dampers as directed on page 39.

For this purpose a filling plug, **O**, is provided, arranged at such a height in the casing as to control the maximum oil level.

As it is of vital importance that only perfectly clean oil of the

correct brand should be used, the following precautions must be observed :—

(*a*) Before attempting to remove the plug **O**, both the plug and the shock damper casing adjacent to it must be cleaned very carefully with a brush dipped in paraffin, in order to avoid the possibility of dirt entering the hole when the plug is removed.

(*b*) Only Wakefield's Castrol " F " oil must be used, and, before inserting this, it should be filtered through a fine gauze. Filtering is greatly facilitated if the oil be first warmed to about 75° C.

The importance of such cleanliness cannot be over-emphasised. A very small particle of foreign matter in the oil may lodge under one of the valves and impair the effectiveness of the shock damper.

The plug **O** can then be removed with a box spanner, and the oil level restored, if necessary, to the bottom of the plug hole. When replacing the plug, care must be taken that its washer is in position.

Each shock damper consists of a piston operating in a cylinder which is maintained full of oil, the latter being displaced from one end of the cylinder to the other, past spring-loaded valves. The loading of the valves is such that greater resistance is offered to movement of the piston corresponding with downward movement of the axle relative to the frame than to upward movement of the axle.

In order to ensure that the working chambers shall be maintained full of oil, each end of the cylinder is provided with a ball valve controlling a passage which leads to an oil reservoir, the valves being located beneath screws **M**.

If there should be any shortage of oil in the working chambers, movement of the piston will cause one of these valves to lift and admit more oil from the reservoir, the oil passing through a gauze filter carried by the plug **F**.

As the presence of any air bubbles in the oil within the working chambers seriously impairs the effectiveness of the shock damper, special means are adopted to expel such air. Located at the highest point of the pressure system is a very small hole, normally closed by a ball valve, which communicates with the upper part of the oil reservoir.

Any air present in the oil is easily expelled through the hole, but the size of the latter is too small to allow any appreciable quantity of oil to pass. The ball valve prevents air being drawn back into the working chambers.

In spite of these precautions, however, the effectiveness of the shock dampers may be impaired owing to insufficient oil or to the presence of dirt in the oil.

This will be apparent by an increased liveliness of the front springing, and also, possibly, by the development of peculiarities in the steering.

In such circumstances, and assuming ample oil is present in the reservoir, the ball-controlled air leak should be inspected.

This is located in the cap **K**, which also houses the spring of the high pressure valve.

It will be necessary to remove this cap **K**, but before doing so, great care must be taken to cleanse the cap and adjacent parts with a brush and paraffin, as in the case of plug **O**, to avoid the possibility of dirt getting into the shock damper. The plug **K1** should first be unscrewed, and then the cap **K**, care being taken not to lose the ball valve in the latter.

The small hole below the ball should then be inspected to see that it is clear, and the parts carefully cleaned.

When replacing the cap **K** care must be taken to see that the spring just beneath it is seated properly on the high pressure valve.

Washers are arranged beneath the parts **K** and **K1**, and must be replaced.

As it is so very important that the shock dampers should be maintained always full of oil, evidence of any undue leakage should at once be reported to Rolls-Royce Ltd.

Rear Friction Shock Dampers. Certain chassis are provided with rear shock dampers of the multi-plate friction type, totally enclosed in oil-tight casings, and situated inside the chassis frame members.

Oil gun lubricators are fitted to the casings, and gear oil should be injected every 2,000 miles, as directed on page 36.

Shock Damper Connections. The connecting links of front and rear shock dampers are similar in design, therefore the notes which follow apply to both.

In order to lubricate the ball and socket joints, gear oil should be injected freely through the lubricators by means of the oil gun every 500 miles, as directed on pages 32 and 33.

The adjustment of the joints should be tested frequently.

If adjustment is found to be necessary, it is effected by releasing the lock-nut **G**, and screwing up the set-screw **H** until the looseness disappears.

The bearings of both upper and lower joint balls are adjusted simultaneously by this operation.

When the adjustment is correct, it should be possible to rotate the connecting link slightly by hand, but no slackness should be present.

Road Springs. The road springs are encased in leather gaiters fitted with oil gun lubricators.

Engine oil should be injected through these every 1,000 miles, three or four turns being given on each lubricator as directed on page 35.

The shackles and pins are also fitted with oil gun lubricators, and require careful lubrication every 500 miles, as directed on pages 32 and 33.

It is advisable to inspect all spring bolts and clips occasionally to see that these have not worked loose.

CHAPTER X.

Water Cooling System.

Water Pump — Re-packing Pump Gland — Water Temperature Warning Lamp — Overheating — Radiator Shutters — Water Level in Radiator—Mascots—Frost—Fan.

Water Pump. The centrifugal water circulating pump is fitted with a special double packing gland designed to facilitate lubrication, and thereby reduce wear, and also to reduce the possibility of leakage.

On some chassis the gland is as shown in Fig. 37, while on others a self-adjusting gland is provided, as shown in Fig. 38.

A screw-down greaser is provided with each type for lubricating the gland and bearings.

It should be screwed down two or three turns every 500 miles, as directed on page 33, and refilled when empty.

Re-packing Pump Gland. Referring to Fig. 37, the pump is shown removed from the engine, with the gland dismantled for re-packing.

If leakage occurs at the gland, the knurled cap **J** should be screwed *by hand, no tools being used*, in an anti-clockwise direction viewed from the radiator, the thread being left-handed.

When the cap has been screwed up as far as possible and leakage still occurs, the gland will require re-packing, for which purpose the system must be drained by opening tap **K**, and the pump removed bodily.

To do this, the inlet and outlet pipes at **L** and **M** respectively must be disconnected, and the cap holding the pump to the crankcase bracket removed. The pump can then be withdrawn, the serrated end of the shaft being a sliding fit in the coupling.

The cap **J** should then be unscrewed by turning it in a clockwise direction, and bearing **E** removed.

The packing **F** is divided into two portions by the ring **G**, into which grease is fed by the lubricator.

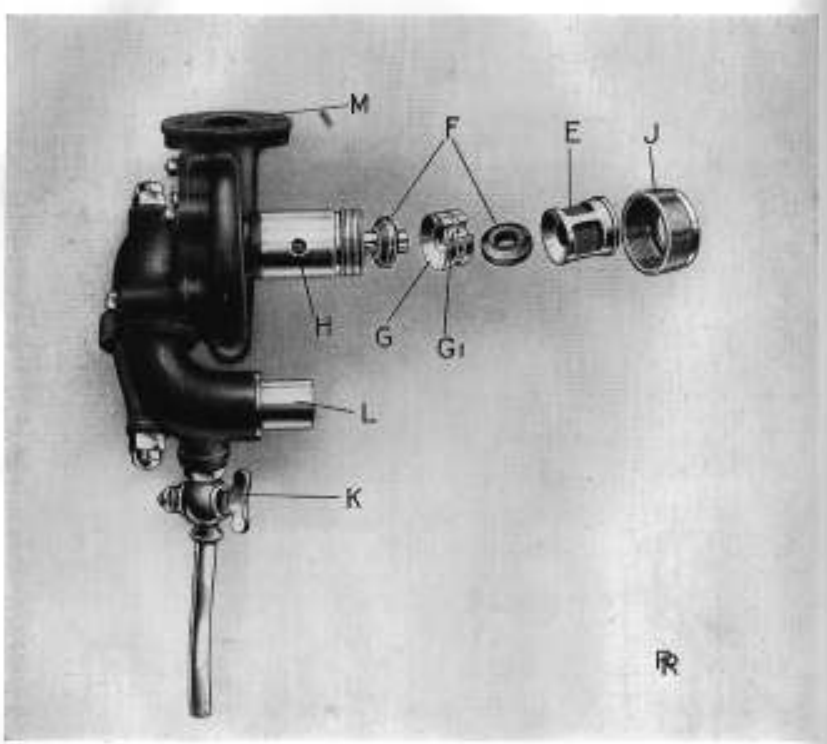


FIG. 37. WATER PUMP WITH GLAND DISMANTLED.

If the bearing **E** is found to be pressed in as far as its flange will allow, then one or both of the packings will require to be renewed.

Under these circumstances, application must be made to Rolls-Royce Ltd. for new packing rings, as these are of a special type and material.

When reassembling the gland it must be seen that the slot, **G1**, in the ring, **G**, registers with the lubricator hole **H**.

When replacing the pump, a "Dermatine" washer should be fitted on the outlet flange, and care must be taken that the pump is correctly located in its bracket before tightening the holding-down cap and the outlet flange set-screws, otherwise there is a danger of the pump and the outlet pipe being strained.

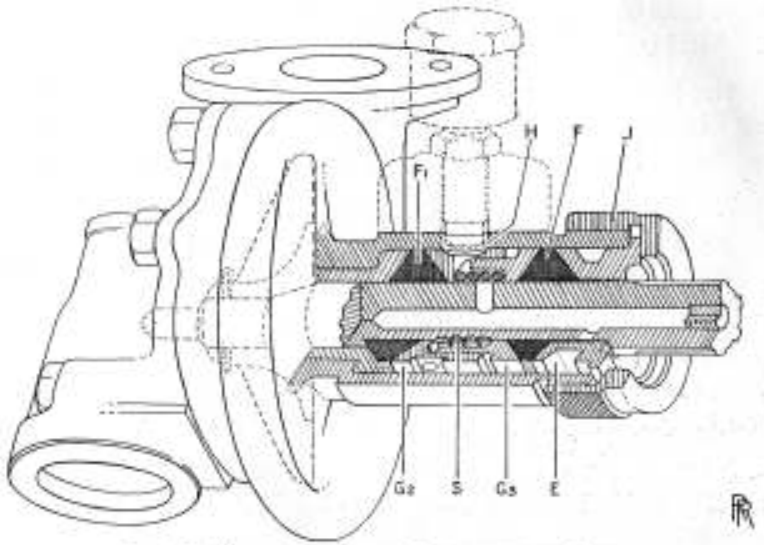


FIG. 38. WATER PUMP WITH SELF-ADJUSTING GLAND.

A sectional view of the pump having a self-adjusting gland is shown in Fig. 38. The ring (**G** in Fig. 37), which divides the gland packing, is itself divided into two, **G2** and **G3**.

Between these parts is a coil spring, **S**, which maintains pressure on both halves of the packing, thereby automatically taking up wear and bedding-down of the packings, and rendering the gland self-adjusting.

It is improbable that any leakage or other trouble will be experienced over long intervals of running—provided always that the gland be properly and regularly lubricated, as instructed on page 129.

It is considered advisable, however, to give details regarding renewal of the packings.

Each packing, **F** and **F1**, consists of an equal length of six-ply asbestos yarn.

Before use the yarn must be well dried, then soaked in melted tallow and the excess squeezed off.

The pump gland itself and the gland parts must be well warmed —by, for instance, immersion in boiling water—before insertion of the packing.

The inner packing, **F1**, is then wound on the shaft in one piece and pressed down by means of the chamfered ring, **G2**, with the assistance of a piece of tube that will fit over the shaft.

The spring, **S**, and the other half, **G3**, of the ring are then put in, and followed by the outer packing, **F**, wound on in a similar manner to the inner packing, being pressed down by the bearing **E** and a piece of tube over the shaft.

When the packings have been compressed as far as possible by hand, the nut, **J**, should be put on and tightened *by hand only, no tools being used*. The pump is then ready for re-fitting.

Subsequently, after a certain amount of running has taken place, it will probably be found necessary to hand-tighten the gland nut **J** a little further.

It is important to observe that :—

(*a*) an equal length of packing, namely about 20", must be used in each half of the gland.

and (*b*) when replacing the divided ring, the part **G2**, which is drilled with oil holes, must be inserted first.

Water Temperature Warning Lamp. The connections of the instrument board warning lamp provided on certain chassis are shown in the electrical diagrams, Figs. 4 and 5.

As explained on page 26, the lamp is arranged to become illuminated when the temperature of the cooling water approaches boiling point.

Overheating. Overheating may be due to one or more of the following causes :—

(*a*) The fan belt may need adjustment (see page 136).

(*b*) The hand ignition control may be too much retarded (see page 22).

(*c*) The continued ascent of a long steep gradient under adverse circumstances at full throttle and too high a gear. There will be less tendency to overheating if the gear is changed to the next lower and the throttle opening is reduced.

(*d*) The petrol mixture may be incorrect.

(*e*) The adjustment of the radiator shutters may have been neglected.

Radiator Shutters. The engine must not be allowed to run in too cool a condition, because it will not then be running efficiently.

The best working temperature lies between 70° and 90° C.

In order to enable the driver to adjust this temperature to meet varying road conditions, shutters are provided on the radiator which are controlled from the instrument board.

There is also a thermometer fitted in the cylinder water jacket which indicates the jacket temperature on a gauge on the instrument board.

When starting from cold, the shutters should be closed until the water reaches the minimum temperature of 70° C.

When driving, it is not necessary to readjust the shutters as long as the temperature is somewhere between 70° and 90° C., as any temperature between these two extremes represents a reasonable condition for the engine.

The temperature should always be regulated with reference to the thermometer readings, by day or night. The red warning lamp, where such is provided, must be regarded as an emergency warning indicating that some attention is required.

On all occasions when the engine is stopped, the shutters should be closed in order to preserve the high temperature of the jacket water as long as possible.

The joints of the shutter control mechanism should be lubricated with the oil can every 2,000 miles, as directed on page 36.

Water Level in Radiator. The contents of the radiator should be inspected daily and more water added if necessary.

The level should stand between 3¾" and 4½" from the top of the filler spout.

If it is often found necessary to add water, the system should be inspected for leaks. Loss of water has also been traced to forgetfulness on the part of the driver to open the radiator shutters, which has caused boiling, although the driver has been unaware of it at the time.

Every 5,000 miles, as directed on page 38, the system should be thoroughly drained by opening the tap situated just below the pump, and refilled with clean, soft water, a strainer always being used.

Mascots. A heavy or cumbersome mascot should not be carried on the radiator filler cap, as it is liable to cause fracture of the joint between the filler spout and the top of the radiator.

A special mascot of a distinctive type, and designed exclusively for use on Rolls-Royce cars, can be obtained at an extra cost on application to the makers.

Frost. In very cold weather, the general rule should be to empty all the water out of the car when it is not in use, if it is to stand in a place where water may freeze.

When the car is again required, hot water should be poured in to melt any ice there may be in the system, and *hot water should also be poured over the pump* to melt the ice which may have cemented the impeller and casing together. Be sure all is thawed *before turning the crankshaft.*

A suitable anti-freezing mixture may be prepared by adding 1¼ gallons of trimethylene glycol, ethylene glycol or an approved compound to the system. This provides a mixture containing about 30 per cent. of anti-freezing compound and lowers the freezing point to about 5° F. or –15° C.

Glycerine must not be used, either pure or commercial. Many anti-freeze mixtures now on the market are largely, or in part, glycerine.

When it is decided to use such a mixture the water system must be drained and the glycol thoroughly mixed with an equal quantity of water before being added to the radiator. A further 1¼ gallons of soft water will then be needed to fill the system. The rubber connections must be carefully examined and replaced if unsound, as glycerine has a searching action which is likely to open cracks in perished rubber.

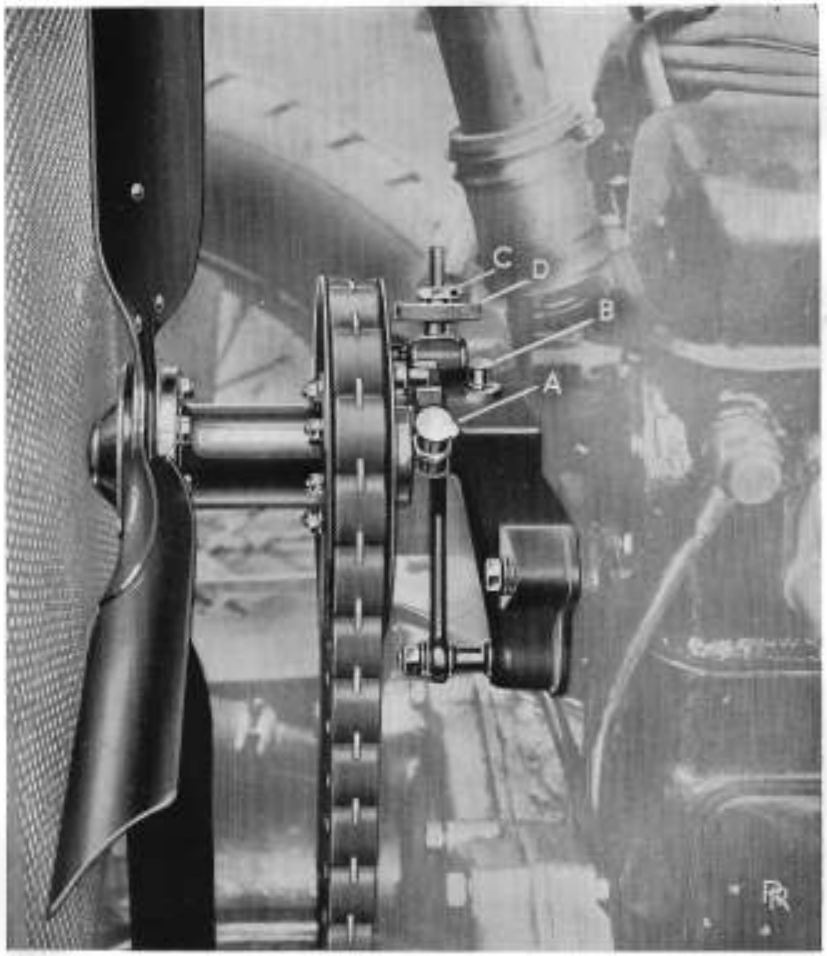


FIG. 39. FAN BELT ADJUSTMENT

If plain water only is used, and the climate is extremely cold, it is best to keep the engine running when exposed standing out of doors; it is also good practice to throw a rug over the radiator when the car is at rest. The fan belt may be dispensed with, provided the water does not boil.

Fan. A spring-lid lubricator is provided on the fan bracket as shown at **A** (Fig. 39) for lubrication of the fan ball bearings. Certain chassis also have a lubricator, **B**, for the trunnion.

A few drops of engine oil should be injected every 5,000 miles, as directed on page 38.

The tension of the belt should be tested every 2,000 miles, as directed on page 37. It should be kept only gently tight.

Adjustment is effected by slackening the hexagon lock-nut **C** with a spanner and screwing down the knurled nut **D** with the fingers until the required belt tension is obtained, afterwards securely re-locking with a spanner by means of nut **C**.

When all the adjustment has been utilised, a link must be removed from the belt, and adjusting nut **D** screwed back a suitable amount.

CHAPTER XI.

Rolls-Royce School of Instruction.

A Drivers' School of Instruction is maintained by Messrs. Rolls-Royce Ltd. for the benefit of drivers of Rolls-Royce cars.

Only those who are engaged to drive Rolls-Royce cars can be accepted for instruction.

The School is intended for men who are experienced drivers, but who require tuition in Rolls-Royce methods to ensure that the car in their charge be kept in the best possible manner.

The School is of great benefit to those having old type Rolls-Royce cars who intend getting a new chassis, as all the new parts are carefully demonstrated to the pupils.

The instruction classes are divided into three distinct sections, dealing respectively with:—

(*a*) the 40-50 H.P. "Phantom" type of car;
(*b*) the 40-50 H.P. "Silver Ghost" type; and
(*c*) the 20-25 H.P. Rolls-Royce car.

A pupil is instructed solely on the car of the type of which he will eventually take charge.

The course occupies twelve days, which may commence on any Monday morning, continuing until the following Saturday week.

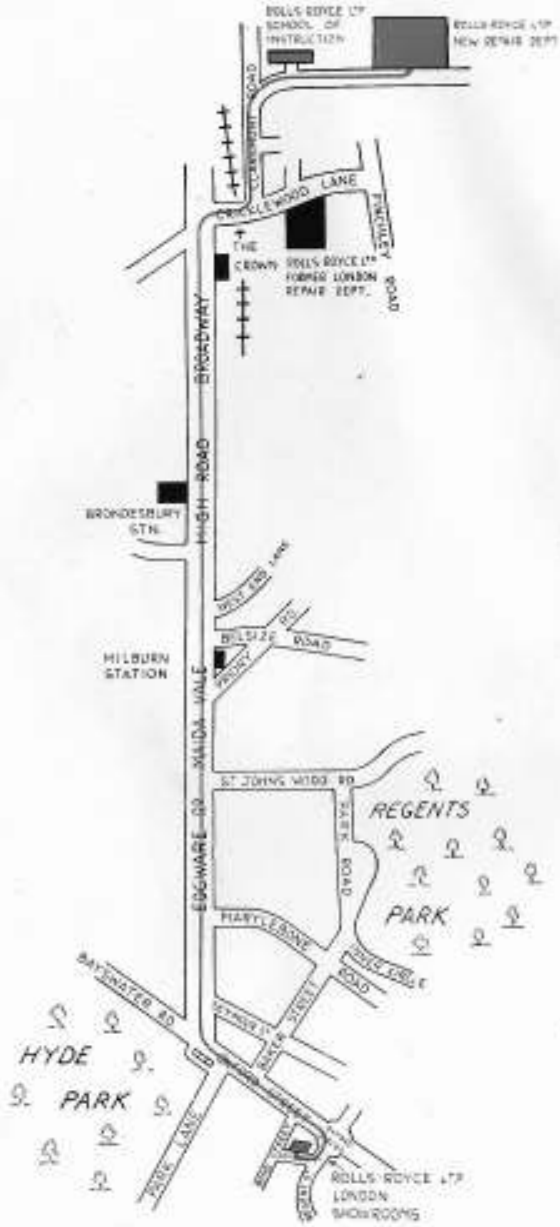
Under exceptional circumstances a shorter course can be arranged, but our experience has been that we would advise owners to allow their drivers to take the full course.

Units of each chassis are available, which are carefully explained to the pupils.

Other driving instruction includes the handling of the car, both in traffic and on the open road, and the proper observance of road courtesies, signs and signals.

Where a car is to be owner-driven, Rolls-Royce Ltd. will be pleased to afford facilities for the owner to receive a course of instruction, which, as far as possible, will be arranged to suit his convenience.

Forms giving the conditions under which men are received in the School of Instruction will be forwarded to customers on application to Rolls-Royce Ltd., 14-15, Conduit Street, London.



MAP SHOWING LOCATION OF ROLLS-ROYCE LONDON REPAIR AND SERVICE DEPOT.

BUS ROUTES—Services 16a, 68, 31, Marble Arch to "The Crown"; Service 68, Oxford Circus to "The Crown."

TUBE ROUTES—Hampstead and Highgate Line to Golders Green, thence by tram to Cricklewood Broadway.

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INSTRUCTIONS

FOR THE CARE OF

DUNLOP WHEELS AND TYRES

ON THE

ROLLS-ROYCE 20 H.P. CAR

For the convenience of Rolls-Royce owners who use their cars on the Continent, the Dunlop Rubber Co., Ltd., supplies lists giving names of all Continental firms which carry stocks of Dunlop Tyres. Application should be made to the Dunlop Rubber Co., Ltd., Fort Dunlop, Erdington, Birmingham.

THE DUNLOP RUBBER CO., LTD.

FORT DUNLOP

ERDINGTON :: BIRMINGHAM

AND

BRANCHES THROUGHOUT THE WORLD

(56 11)

Reprinted and revised October, 1934.

Care of Dunlop Wheels and Tyres.

Removal of Wheel—Care of Wheels—Lubrication of Wheel Bearings—Removing and Dismantling Front Hubs—Reassembling and Replacing Front Hubs—Removing and Dismantling Rear Hubs—Reassembling and Replacing Rear Hubs—Tyre Equipment—Replacement Tyres—Spare Tyre—Fitting and Removal Instructions for Straight-Side Tyres—To Remove Tyre—To Fit Tyre—Fitting and Removal Instructions for Wired Type Tyres on Well-base Rims—Special Note—To Remove Tyre—To Fit Tyre—Care of Tyres—Inflation of Tyres—Cuts—Mileage and the Modern Tyre—Speed—Acceleration—Braking—Tyre Wear and Noise—Important—Balancing Front Road Wheels.

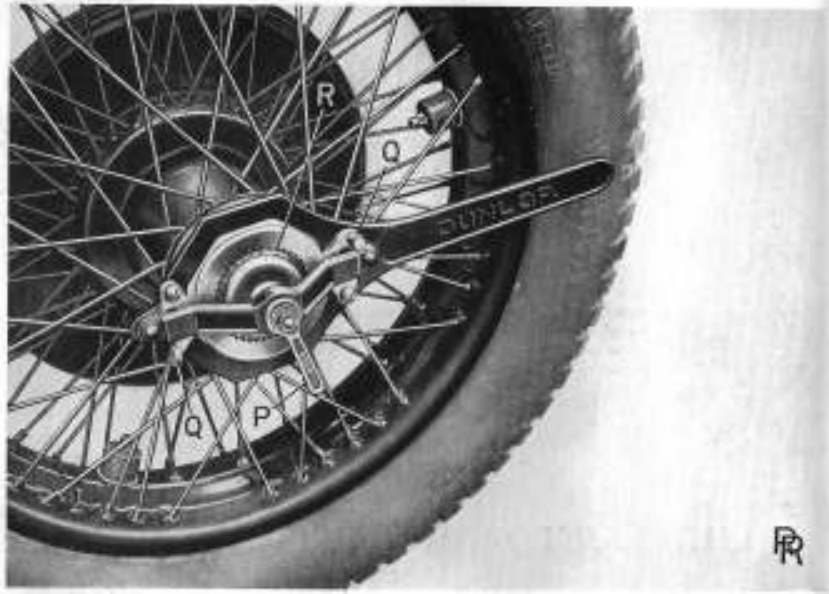


FIG. 1. REMOVING DETACHABLE WHEEL.

Removal of Wheel. Dunlop detachable wire wheels are fitted, and a special spanner is provided in the tool-kit for removing and replacing them.

In Fig. 1 the spanner is shown in position on a wheel.

Before using the spanner, the central screw **P** must be unscrewed as far as possible. After jacking up the car, the spanner can be placed in position by pressing the levers **Q** to clear the shoulder on the hub nut. On releasing these levers, it should be noticed that they correctly fit into the groove provided for the purpose.

Screw **P** should then be turned until the serrations of the locking plate **R** are seen to be clear of those on the hub nut. The latter can then be turned in an anti-clockwise direction and the wheel withdrawn.

The thread of the hub and nut is right-handed for all wheels.

When replacing a wheel, care must be taken that the engaging surfaces, serrations and threads of both hub and wheel are free from road grit and other foreign matter. Preferably, they should be slightly greased.

The hub nuts must be tightly screwed up by means of the special spanner, and the use of the mallet in conjunction with it, to ensure absolute tightness.

The locking plate should now be allowed to come forward by turning the small lever **P** in an anti-clockwise direction, in order that its serrations shall engage those of the hub nut.

It should be observed that when jacking up a rear wheel care is necessary that the head of the jack is arranged in the proper position. It should be immediately beneath the axle, between the two "U" bolts which secure axle and spring together.

Care of Wheels (*Important*). Every 2,000 miles hub nuts should be tested for tightness with the spanner.

On no account should the car ever be run with a wheel even slightly loose, as this will cause irreparable damage to the serrations and screw threads.

It is necessary to try each hub nut periodically with the spanner, and tighten if necessary. In order to tighten the hub nut, it is necessary for the locking plate to be forced back by means of rotation of the small lever **P** until its serrations are disengaged from those of the hub nut.

Care must be taken when driving close to a high curb to avoid catching the projecting spokes of wire wheels. Very serious damage may thus be done to the wheel.

Lubrication of Wheel Bearings. The wheel bearings are filled with ball-bearing grease in the first instance, and should run a long period without attention.

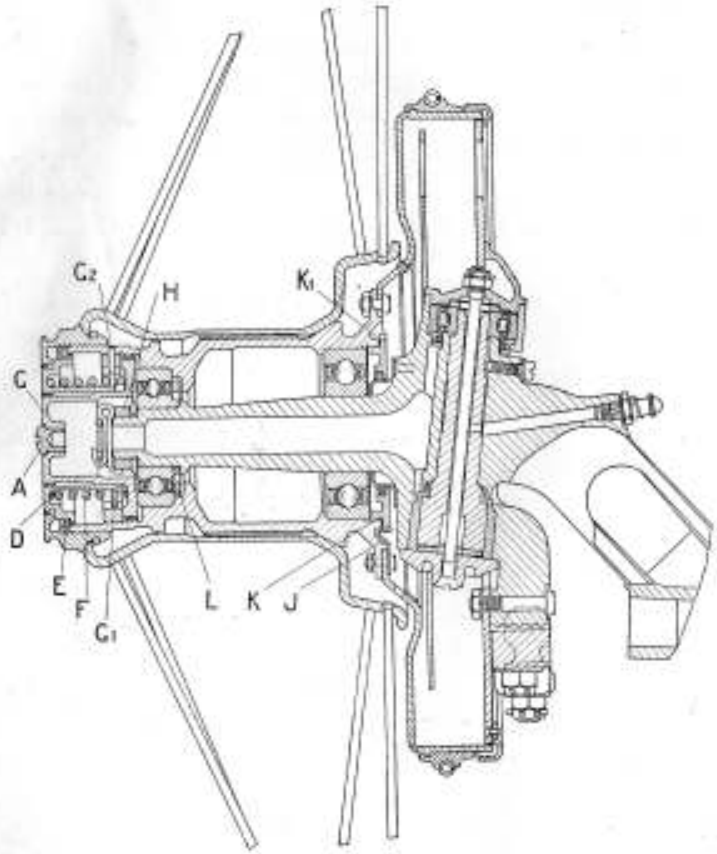


FIG. 2. SECTION OF FRONT HUB.

Removing and Dismantling Front Hubs. A section of the front hub is given in Fig. 2. To remove the hub, after removing the wheel, the screw **A** must first be taken out and replaced with the special tool **B**, shown in position in Fig. 3. Nut **C** should then be screwed up until the locking plate **D** is pressed inwards, clear of the split ring **E**. The latter can then be removed

by inserting a screwdriver or other suitable tool through one of the slots on the edge of the hub.

The nut **C** should then be slackened and the stud **B** unscrewed, allowing the locking plate **D** to be pressed out by the large coil spring **F**. This spring can then be removed.

The cap **G** must next be removed.

It is secured by the nut **G1**, which is locked by a spring ring **G2**. After removing the latter, the nut can be unscrewed with the special spanner provided, the thread being right-handed.

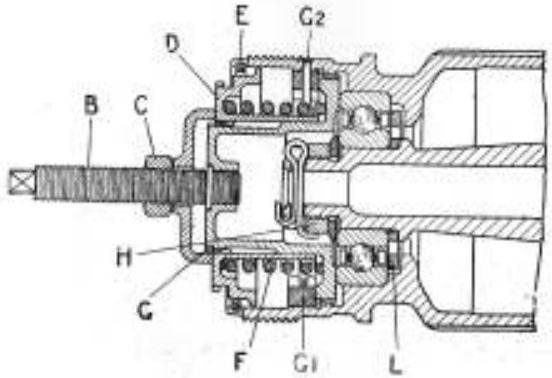


FIG. 3. TOOL IN POSITION FOR REMOVING LOCKING RING.

With the cap **G** removed the stub axle nut **H** will be exposed.

This has a left-handed thread for the near side of the axle, and a right-handed thread for the off side.

After removing the split cotter, nut **H** should be unscrewed, when the hub, together with its ball-bearings, may be withdrawn from the axle.

If any difficulty is experienced in this operation owing to the ball races being a little tight on the axle, a wheel should be temporarily mounted on the hub and a better purchase on the latter thereby obtained.

The small outer ball-bearing can be removed with a hard wood drift passed through the inner bearing.

To remove the latter, the locking piece **J** must be removed and the cap **K** unscrewed.

It has a left-handed thread for the near side wheel, and a right-handed thread for the off side wheel. The large ball-bearing can then be taken out.

A joint washer, K1, is arranged between the flange of the cap **K** and the hub.

It is important to see that the front hubs fit their axles without looseness or excessive end play, as undue slackness might cause a breakage through the shocks that would result.

The ball races should be cleaned and carefully examined for signs of rust or deterioration. If the races or balls are rusty, they must be discarded.

Reassembling and Replacing Front Hubs. When reassembling the hub, the ball races should be packed with Hoffmann ball-bearing grease, and about one-half to three-quarters of a pint (approximately one-half to three-quarters of a pound) of grease wiped round so that it forms an annulus on the inside of the hub shell about $\frac{3}{8}$ in. thick.

All internal parts should also be smeared with grease.

The large race should be replaced first, followed by the retaining cap **K** and its joint washer K1, the cap **K** being filled with grease in order that the latter may be forced into the ball race as the cap is screwed on. The locking piece **J** must then be refitted.

Next, the hub should be pressed lightly on the axle and safety washer **L** put into position, followed by the small ball race.

The axle nut **H** must then be tightly screwed up and locked with a split cotter.

It is important at this stage to test the hub for end play, by temporarily attaching a wheel, if necessary. There should be at least ·010" end play before cap **G** is secured by its nut, because all end thrust which may be imposed on the wheel under running conditions is taken by the small outer bearing, and none should fall on the large inner bearing.

Finally, cap **G** should be filled with ball-bearing grease and secured by its nut G1, the spring locking ring G2 being carefully refitted.

With locking plate **D** in position, the spring **F** should be compressed by means of the tool **B**, and the split ring **E** replaced.

Owing to the "handing" of the various screw threads, as described, it is, of course, vitally important that the hubs should not be changed over by mistake when replacing them.

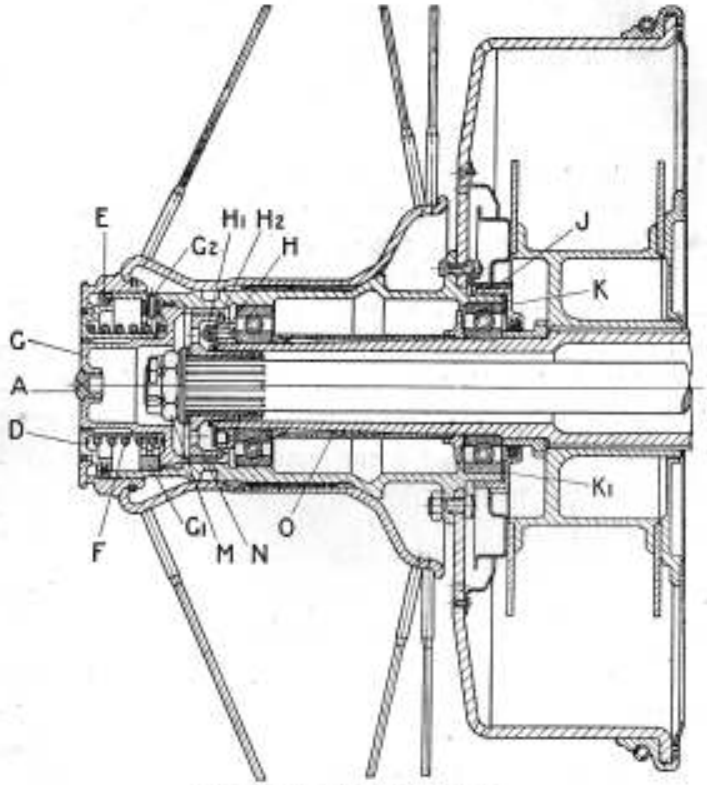


FIG. 4. SECTION OF REAR HUB.

Removing and Dismantling Rear Hubs. A section of the rear hub is given in Fig. 4. To remove the hub, the screw **A** must first be taken out and replaced by the special tool **B**, shown in position in Fig. 5. Nut **C** should then be screwed up until the locking plate **D** is pressed inwards clear of the split ring **E**. The latter can then be removed by inserting a

screwdriver or other suitable tool through one of the slots on the edge of the hub.

The nut **C** should then be slackened and stud **B** unscrewed, allowing the locking plate **D** to be pressed out by the large coil spring **F**. This spring can then be removed.

The cap **G** must next be removed.

It is secured by the nut **G1**, which is locked by a spring ring **G2**. After removing the latter, the nut can be unscrewed with the special spanner provided, the thread being right-handed.

With the cap **G** removed, the axle shaft nut **M** will be exposed.

The split cotter must be withdrawn, and this nut can then be unscrewed, the thread being right-handed.

To slide off the driving dog **N**, there is provided in the tool-kit a screwed rod which should be screwed into one of the threaded holes in the driving dog and the latter withdrawn.

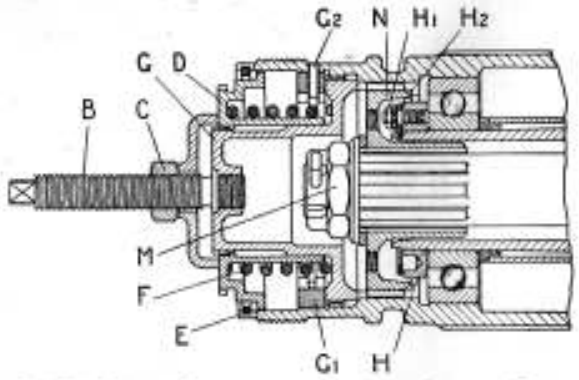


FIG. 5. TOOL IN POSITION FOR REMOVING LOCKING RING.

The axle tube nut **H** will then be visible. To remove this, the three small nuts **H1**, which secure the locking plate **H2** in position, must be unscrewed, and the locking plate removed. Then, with the special spanner provided, nut **H** can be unscrewed, this having a left-handed thread for the near side wheel, and a right-handed thread for the off side wheel.

With this nut removed, the hub is free to be drawn off the axle

tube, together with its ball-bearings. It may be found convenient temporarily to attach a wheel for this purpose.

To remove the ball-bearings, the locking piece **J** must be removed, and cap **K** unscrewed.

It has a left-handed thread for the near side wheel and a right-handed thread for the off side wheel.

The ball-bearings, together with the distance piece **O**, can then be removed, passing them through the inner end of the hub.

It should be noticed that the ball races are a good fit both on the axle tube and also within the hub shell.

The races should be cleaned and carefully examined for signs of rust or deterioration. If the races or balls are rusty, they must be discarded.

Reassembling and Replacing Rear Hubs. When reassembling the hub, the ball races should be packed with Hoffmann ball-bearing grease, and about one-half to three-quarters of a pint (approximately one-half to three-quarters of a pound) of grease wiped round so that it forms an annulus on the inside of the hub shell about $\frac{3}{8}$" thick.

All internal parts should also be smeared with grease.

The outer bearing should be placed in position in the hub first, and followed by the distance piece **O**, arranged with its flange towards the inside of the wheel.

The inner race should next be replaced, and the retaining cap **K** filled with grease in order that the latter may be forced into the ball race as the cap is screwed on.

The cap **K**, together with its joint washer **K1**, should then be screwed up tightly until the locking piece **J** can be put into position to lock it.

The hub may now be pushed home on the axle tube, nut **H** screwed up tightly, and the locking plate **H2** secured in position with its three small nuts **H1**.

Next, the driving dog **N** should be pushed on to the axle shaft. There are two washers between this part and its retaining nut, one being a distance washer which has a bore equal to the maximum

diameter of the shaft, and the other a plain washer fitting on the screwed end of the shaft. The large bore washer should be replaced first, and it must be seen that this fits on the serrated portion of the shaft projecting through the driving dog. After fitting the smaller washer, the nut **M** can be tightened up and fitted with a split cotter.

The cap **G** should next be filled with ball-bearing grease and secured by means of its nut **G1**, the spring locking ring **G2** being carefully refitted.

The special tool **B** must be used to compress the spring with the locking plate **D** in position, in order to replace the split spring ring **E**.

Owing to the "handing" of the various screw threads, as described, it is, of course, vitally important that the hubs should not be changed over by mistake when replacing them.

Tyre Equipment.

Some chassis are provided with Dunlop straight-side 32" × 4½" cord tyres, and others with Dunlop wired type tyres, either 5¼" for 21" or 6" for 20" well-base rims.

No security bolts or bolt valve plates are provided. Such devices are unnecessary, and indeed may be definitely harmful with either of these types of tyres.

Replacement Tyres. When ordering new outer covers or inner tubes, the type and size should be specified. It should be noted that the straight-side tyre requires a tube with a short type valve, centrally located. The tube for a well-base tyre, on the other hand, has the valve located to one side. These two inner tubes are not interchangeable.

Spare Tyre. Owing to the ease with which either type of tyre can be fitted or removed, in combination with their large size and high quality, there is no necessity to carry more than one spare tyre, which will be fitted, of course, to the spare wheel. It is only necessary to carry as spares one or two inner tubes of the correct type.

Fitting and Removal Instructions for Straight-Side Tyres.

To Remove Tyre. A special tool, Fig. 6, is supplied in the tool-kit to assist in the removal and refixing of the detachable side flange, which is a feature of the ordinary straight-side rim. The tool should not be confused with a tyre lever; it is not intended for use with the tyre, as it is one of the outstanding advantages of the normal pressure straight-side tyre that the tyre does not need a lever of any description either for removal or fitting.

FIG. 6. SPECIAL TOOL FOR REMOVING SIDE FLANGE OF WHEEL.

After deflating the tyre and removing the locking plate at the joint of the side flange, the pointed end **S** (Fig. 6) of the tool should be inserted in the slot **U** near the joint in the side flange (Fig. 7). The end of the flange should then be lifted out of its recess by pushing the tool downwards. When the end is lifted out, the whole of the flange may be sprung off by hand. After it has been removed, the

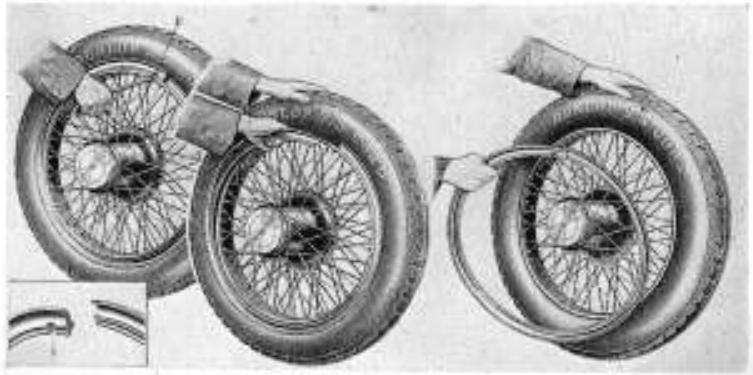


FIG. 7. REMOVING THE SIDE FLANGE.

tyre valve should be pushed up clear of the rim, and it is then a perfectly easy matter to slide off both cover and tube together.

To Fit Tyre. The tyre should first be placed on the rim, care being taken that the valve corresponds to the hole provided; then one end of the detachable flange should be inserted in the recess at a point diametrically opposite the valve, and pushed down as far as it will go. The remainder of the flange can be put into position by using the reverse end of the tool to that employed in the removal operation. To effect this, insert the lip **T** (Fig. 6) of the tool in the recess at a point **V** (Fig. 8), just over half-way round

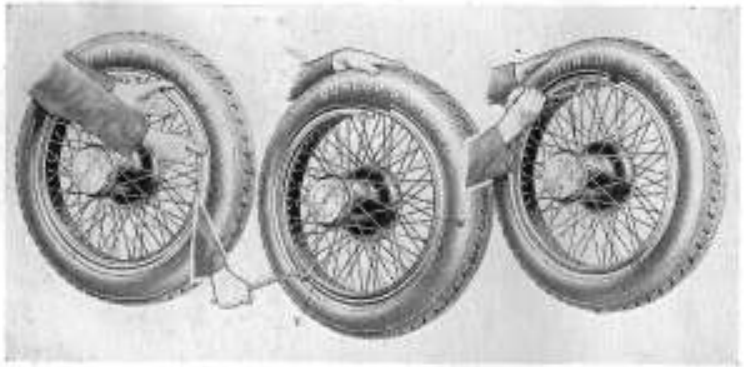


FIG. 8. REFIXING THE SIDE FLANGE.

the rim from the flange end that has already been inserted, and lever the flange home at this point by a sharp thrust of the tool, making quite sure that it is seated at **W** (Fig. 8) before withdrawing. To complete the operation, insert the tool once again, this time close to the end of the flange which is still detached, and snap it into place by another sharp thrust. Finally, the flange should be tapped lightly by the lever in various places round the circumference, to ensure that it is properly bedded. The tyre should be inflated before tightening the nuts of the side flange locking plate, and care should be taken to replace the spring washers under these nuts.

Fitting and Removal Instructions for Wired Type Tyres on Well-base Rims.

Special Note. *Inextensible* wires are incorporated in the edges of wired type tyres. Therefore, do not attempt to stretch the wire edges of the tyre cover over the rim edge.

Force is entirely unnecessary and may be dangerous, as it merely tends to damage the cover edges and serves no helpful purpose.

Fitting or removing will be quite easy if the wire edges are carefully adjusted into the rim base; if it is not found to be easy, the operation is not being correctly performed.

To Remove Tyre. Remove all valve parts, and push both cover edges into the base of the rim at the part diametrically opposite the valve, then lever the cover edges near the valve over the rim edge.

To Fit Tyre. Push one edge of the cover over the edge of the rim. It will go quite easily if the part first put on is pushed right down into the rim base.

Very slightly inflate the inner tube—do not distend it—place it in the cover, with the valve through the hole in the rim. (Take care that the valve, which is fitted in the side of the tube, is on the correct side of the rim.)

Fit the second edge of the cover, commencing at a point diametrically opposite the valve, and pushing the edge down into the base of the rim.

Small levers may be gently used to ease the last few inches over the rim edge.

FIG. 9

You cannot pull the cover edge at "A" over the rim edge until the cover edge at "B" is pushed off the rim shoulder "C" down into the well "D," then the cover edge at "A" comes over the rim easily. Remember, the cover edges are inextensible—force will only damage the cover and cannot stretch the edge.

Whilst inflating, see that the edges of the cover are seated evenly round the rim.

Care of Tyres.

Tyres constitute one of the biggest items in car maintenance. No other justification is necessary for emphasising the need for reasonable care in their selection and treatment.

It would be apparent, from the very nature of their service and constitution, that the influences governing their life are many and various—but almost invariably, be it noted, within the motorist's control, either wholly or in part.

The Dunlop Company would be only too happy to advise motorists on any problem or difficulty in connection with the use of tyres, and any enquiry addressed to any of the Company's Sales or Service Depots, or direct to Service Dept., Fort Dunlop, Birmingham, will receive prompt and careful attention.

Inflation of Tyres. The correct pressures for each type of tyre should be as follows :—

	32" × 4½" Straight-side.	5¼" for 21" Well-base.	6" for 20" Well-base.
Front tyres, open and closed cars	Per sq. in. 40 lbs.	Per sq. in. 35 lbs.	Per sq. in. 35 lbs.
Rear tyres, closed cars ...	50 ,,	45 ,,	30 ,,
Rear tyres, open cars ...	45 ,,	40 ,,	30 ,,

The nature of the material used, and the method of manufacture, do not permit the production of tyres which are always perfectly balanced throughout the whole circumference.

Consequently front tyre pressures must not be allowed to fall below the pressures specified above, because any reduction may spoil the steering at high speed, and render it heavy for traffic work, while the resultant increase in comfort will not be very noticeable to passengers in the rear seats.

The pressures being comparatively low, it is important that they should be carefully maintained if maximum tyre life is to be secured. It is therefore recommended that the pressure be tested at short intervals by means of a tester applied to the valve stem orifice.

It is a practice with some motorists to reduce the inflation pressure when the tyres get hot through running, or in hot weather.

This is wrong, and tends to create the very condition it is desired to avoid, since the lower the pressure the greater the internal friction, and consequently the greater the heat developed in the tyre itself.

An extremely hot tyre is generally evidence of too little air pressure, and should be the signal for testing the inflation with a view to remedying the deficiency. Atmospheric conditions are best disregarded entirely, since their effect is negligible.

Cuts. Any cut sufficiently deep to penetrate one or more plies of casing material is a menace to the whole structure, and, if neglected, will inevitably develop into a burst, the severity of which is out of all apparent proportion to the extent of the original damage.

The destructive processes are, however, easily explained. Practically any material manufactured from cotton—which is the basis of all tyre fabrics, however described—only retains its strength so long as it remains unbroken ; if but two or three strands are severed, the material can be torn through with little effort.

This is actually what occurs in the case of tyres, which are subjected not only to the strains of running, but to the pressure of the inflated inner tube.

The actual burst, however, is delayed owing to the resistance of the unbroken plies of the material, and in all probability, if these are protected by repairing the exterior of the cover and reinforced by strengthening the inside, serious effects would be avoided. Unfortunately, however, in many cases water is allowed to penetrate through the cut to the casing, and rapid deterioration of the surrounding material, already weakened at this point, results in its eventually giving way.

Covers should be periodically examined, and all cuts, other than superficial ones, should be cleaned out and filled with Dunlop Low Temperature Vulcanising Compound, or similar material.

Severe cuts, particularly those which penetrate the casing as well as rubber, will necessitate more extensive repairs, and such work should be placed in the hands of thoroughly competent repairers.

Mileage and the Modern Tyre.

Scientific investigations of the actual effect of the following major factors have recently been made, and the results are surprising :—

Speed. Car-owners vary greatly in the speed at which they habitually drive. The rate of tread wear at 45 m.p.h. is double that at 35 m.p.h.

Acceleration. Many motorists like to make the most of the rapid acceleration of which modern cars are capable. The effect of this on tyre wear is not susceptible to accurate measurements, but it has been proved that wheel slippage is almost always set up, causing temporarily ultra-rapid tread wear due to abrasion against the road surface.

Braking. Some owners use their cars in far more congested districts than others, where constant braking is necessary, others are in the habit of using their brakes constantly—"driving on the brakes"—whereas yet others seldom use their brakes except in an emergency.

A test vehicle was run at 35 m.p.h. and stopped every quarter of a mile; this wore off half the tread rubber in 108 miles; the same car, driven at the same speed, but stopped every mile, wore off half the tread in 3,100 miles.

The rapid improvement in car performance during the past few years has brought these particular factors into prominence.

Tyre Wear and Noise. Covers which have been used on the rear wheels and subjected to violent braking should not be used on the front, because wear may have rendered the tread somewhat irregular.

If, when new tyres have been fitted to the front, and wheels and tyres have been properly balanced, and both tyres equally and correctly inflated, it is found that the steering then possesses undesirable characteristics, other covers should be tried if possible.

IMPORTANT.

Balancing Front Road Wheels. It is most important, in view of the high speeds attainable, that the front road wheels should be balanced every time a change of tyre or wheel is found necessary.

An out-of-balance effect is usually present in the complete wheel and tyre due to :—

(*a*) the valve and its patch on the inner tube ;
(*b*) the joint of the inner tube ; and
(*c*) unavoidable irregularities in the outer cover due to movement of the material during vulcanizing.

To correct such out-of-balance, three bolts are provided, spaced at equal intervals around the wheel rim, as shown at **S**, **T** and **U** in Fig. 10, and each carries a number of washers, to fill up to the under-

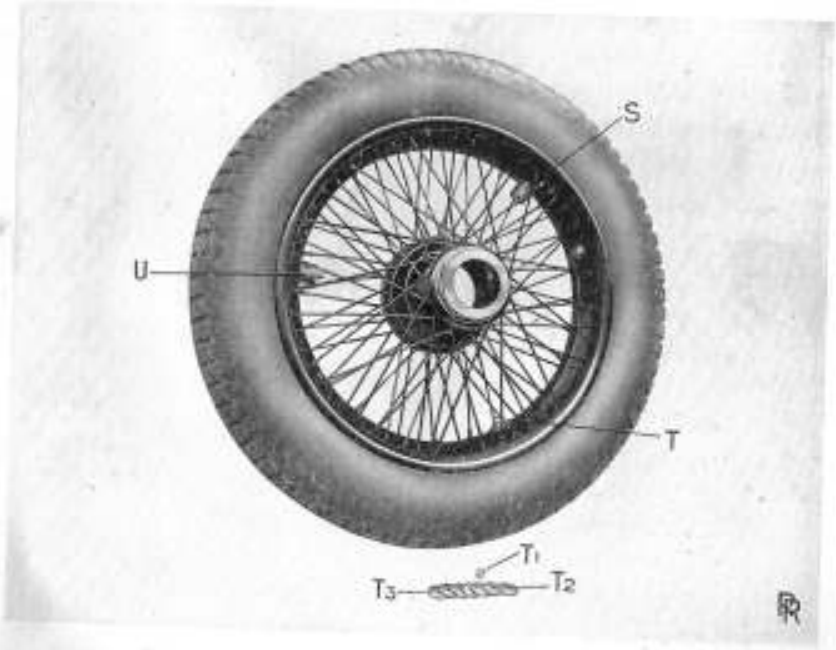


FIG. 10. WIRE WHEEL WITH BALANCE WEIGHTS.

side of the nut. These washers are of lead or bakelite, according to the out-of-balance state of the tyre.

One of the bolts, T, is shown with its cap, T1, steel retaining washer, T2, and lead or bakelite washers, T3, removed.

In addition to these, a rubber washer is arranged against the wheel rims to act as a seal against the ingress of water. This must always be followed by a special steel washer to form a firm base for the six balancing washers, T3.

To balance a wheel, all the bolts should first be arranged with a full complement of bakelite washers.

The axle being jacked up, the wheel must be turned gently and allowed to come to rest.

The lowest point of the tyre should then be marked.

The operation should be repeated, and if the original mark returns to the bottom position, one or more of the bakelite washers should be replaced with one or more lead washers on the bolt on the opposite side of the wheel.

If the mark made on the tyre is adjacent to a bolt, then one bakelite washer on each of the other two bolts should be replaced with a lead washer.

On the other hand, if no bolt should lie on the vertical centre line through the marked point on the tyre, the washers of the two bolts furthest from the mark must be altered, for instance, if the distance of one bolt from the centre line is approximately twice that of the other, two bakelite washers should be replaced by two lead washers on the bolt nearer to the centre line and one bakelite washer replaced by one lead washer on the other bolt.

This process should be continued until the wheel will remain in any position in which it may be brought to rest, the number of lead washers being kept down to a minimum consistent with good balance of the wheel.

The bakelite washers are provided to fill up the bolts to the same distance from the end, namely, approximately $\frac{3}{16}$ of an inch.

By this means uniformity in appearance and therefore neatness is obtained. Their provision also ensures that space shall always be

available for the addition of sufficient lead washers to correct any reasonable want of balance.

In addition to the lead and bakelite washers provided on the wheels themselves, a number of such washers is also supplied as spares.

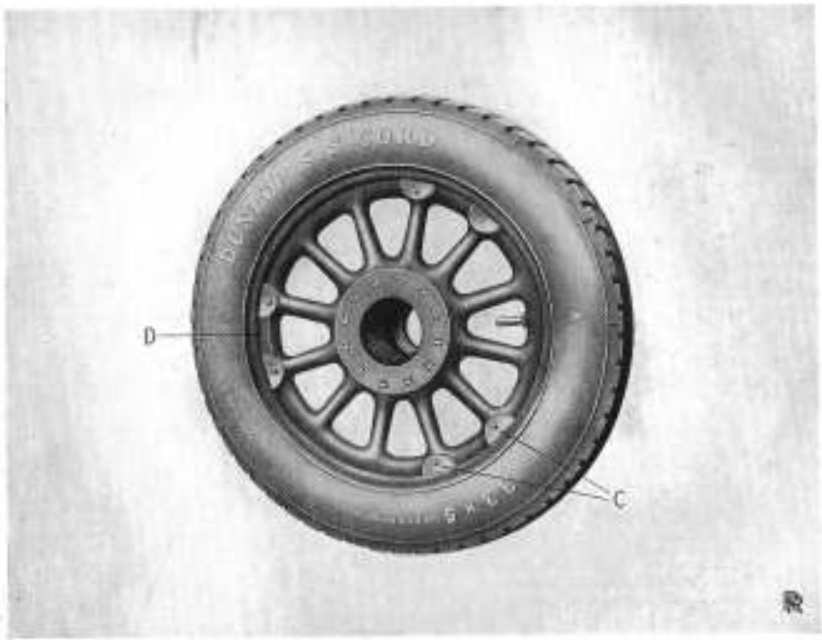


FIG. 11. STEEL ARTILLERY-TYPE WHEEL WITH BALANCE WEIGHTS.

In the case of steel artillery-type wheels, six balancing bolts are provided on the inner face of the wheel rim, as shown in Fig. 11 at C. The weights are semi-circular in shape, and made of steel or bakelite. In order to balance the valve and its patch, the two weights opposite this point are made in one piece as shown at D.

Two such double weights are provided with each wheel. A similar procedure should be adopted to balance the wheel, each bolt being filled up with washers either of steel or bakelite, or both, as required. It will usually be found that the special weights, D, must be opposite the valve, but their positions may be varied if necessary.

MAINTENANCE AND ADJUSTMENT

OF THE

KLAXON

A.S. 1 MODEL

AS FITTED ON

Rolls-Royce 20 H.P. Cars

QUOTE IN ALL CORRESPONDENCE
NUMBER FOUND ON NAMEPLATE

KLAXON LTD. WARNING SIGNALS

HEAD OFFICE:

36, Blandford St., Marylebone, London, W.1

WHERE ALL CORRESPONDENCE SHOULD BE ADDRESSED

PARIS
31, RUE DARU

BIRMINGHAM
WARWICK ROAD
GREET

Reprinted
OCTOBER 1934

1. **PLEASE NOTE.**—Klaxons are properly adjusted when fitted to cars, and it is strongly recommended that no attempt be made to improve the note by adjustment, or so-called tuning up.

2. **MAINTENANCE.**—In order that the construction and working of the Klaxon may be easily understood, a section is illustrated in Fig. 4.

It is operated by an electric motor rotating at 2,000 r.p.m., which occasionally requires lubrication. A few drops of any lubricating oil once a month (see Fig. 1) will suffice. No other attention should be necessary.

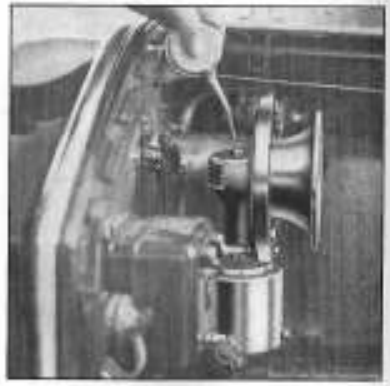


Fig. 1.

3. **FAILURE.**—It must be remembered that the Klaxon note may be affected by trouble with battery, wires or push buttons; these can be tested by applying a voltmeter to the terminals of the instrument, at the same time operating the Klaxon by pressing the button (see Fig. 2).

The voltmeter should indicate the full battery voltage.

If this is found to be correct, it is possible that the six screws securing the projector may have worked loose. Tighten them (see Fig. 3).

If still unsatisfactory, adjustment may be necessary. If so, proceed as in paragraph 5.

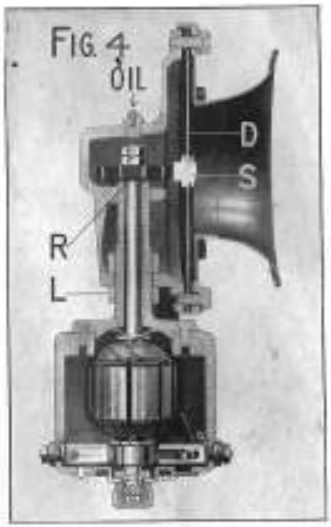
Fig. 2.

Fig. 3.

4. **OPERATION.** — Revolved by reason of its being attached to the armature shaft is the hard steel rotor **R** (see Fig. 4), which engages a hardened steel stud **S** fixed in the centre of the chrome vanadium steel diaphragm **D**.

The note emitted by the Klaxon depends on the pressure between the rotor and the stud.

The object of adjustment is to obtain the correct pressure.



5. **ADJUSTMENT.** — First loosen the lock-nut by a spanner, as shown in Fig. 5. This lock-nut can also be seen at **L** in Fig. 4. Then, after lock-nut is loose, start the current by pressing push-button. In other words, sound the Klaxon.

While it is sounding, twist the motor case until no sound is heard except the buzzing of the motor.

Continue twisting—in either direction—until note is loud and clear.

When the note is loud and clear, tighten lock-nut. Be sure to keep nut tight always.

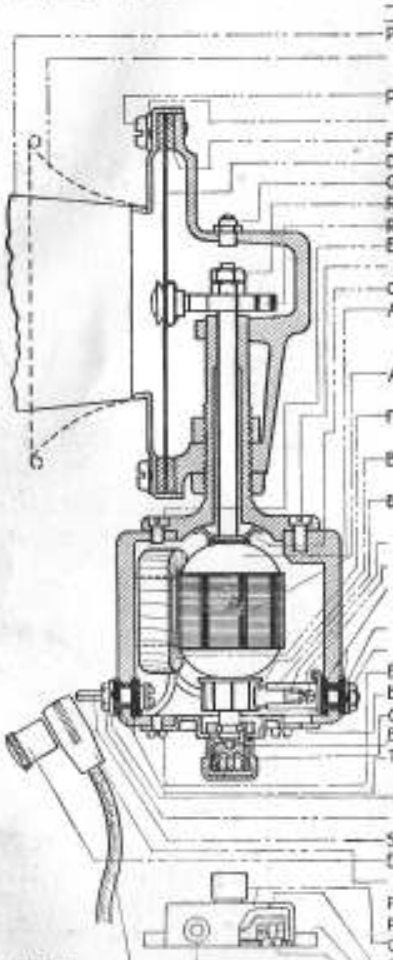
Fig. 5.

6. **GUARANTEE.**—Messrs. Klaxon, Ltd., guarantee their Warning Signals, and should the instrument be considered unsatisfactory, a call should be made to their Service Dept., at 36, Blandford Street, Marylebone, London, W.1, or Warwick Road, Greet, Birmingham, where complaints will be dealt with.

If this is not possible, the instrument should be removed from the car, labelled with the owner's name and address, carefully packed, and sent, carriage paid, to Messrs. Klaxon, Ltd., 36, Blandford Street, London, W.1, writing them at the same time, stating the nature of the complaint.

Quote the instrument number in all correspondence.

KLAXON TYPE A1. SPARE PARTS



PART NAME	REF. No.	PRICE s.	d.
PROJECTOR - LONG	EK 110	30	0
D° - SHORT	EK 104	20	0
D° - GUNB'R'L	EK 108	25	0
PROJ: SCREWS	EK 54		2
D° SPG WASHER	EK 135		1
FELT WASHER	EK 62		2
DIAPHRAGM	EK 79	4	6
OILER	EK 85	1	0
ROTOR NUT	EK 39		2
ROTOR	EK 40	3	0
E.P. SCREW - SHORT	EK 3/9		2
D° - LONG	EK 8		2
CHECK SPRING	EK 43		2
ARMATURE			
REWINDING 6 & 12 v.	EK 124	10	0
D° D° 110 v.	EK 123	15	0
ARM: COMPLETE 6 & 12 v.	EK 76	21	0
D° D° 110 v.	EK 136	25	0
FIELD COIL 6 & 12 v.	EK 125	7	0
D° D° 110 v.	EK 126	9	0
BRUSH 6 & 12 v.	EK 29	1	0
D° 110 v.	EK 157	1	3
BRUSH HOLDER 6 & 12 v.	EK 77	1	3
D° D° 110 v.	EK 169	1	3
D° LEVER	EK 22		2
D° SPRING	EK 21		2
D° FIBRE WSHR 6 & 12 v.	EK 25		1
D° MICA D° 110 v.	EK 148		2
D° SPG D°	EK 117		1
D° NUT	EK 19		2
B.P. SCREW	EK 3/8		2
BOTTOM PLATE	EK 127	5	0
CAP NUT	EK 187	1	0
BALL	EK 6		1
TERM: FIBRE WSHR 6 & 12 v.	EK 34		1
D° MICA D° 110 v.	EK 151		2
D° SPG D°	EK 118		2
D° NUT	EK 31		2
SPLIT TERMINAL	EK 30	1	0
EBONITE NUT	EK 105		6
D° SCREW	EK 102		6
PUSH COMPLETE 110 v.	EK 139	5	6
PUSH D° 6 & 12 v.	P 22	5	6
COVER & KNOB	P 20	1	6
CONTACT SPRING	P 8		3
CLAMP PLATE	P 16		3
D° D° SCREW	P 17		1
COVER BUSH	P 6		3
FLEX: WIRE. TWIN 23/36	EK 99	1	6

NOTE !!
IF THE PART YOU REQUIRE IS NOT ENUMERATED ON THE LIST ABOVE, PLEASE INDICATE BY A CROSS ON THE ILLUSTRATION AND SEND IT TO US WITH YOUR ORDER.
THE ABOVE PRICES ARE FOR BLACK ENAMEL FINISH: EXTRA FOR NICKEL PLATING PROJECTORS ETC: ABOUT 10%

INSTRUCTIONS FOR CHARGING & OPERATING

Exide

Starting, Lighting, Ignition Batteries in Ebonite Boxes

FOR

20 h.p. Rolls-Royce Cars.

Issued by

THE Chloride ELECTRICAL STORAGE COMPANY LIMITED.

For list of addresses, see next page.

No. 4,034.
(1) H.)

REPRINTED OCTOBER, 1934.

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Exide

Starting, Lighting, and Ignition Batteries, in Ebonite Boxes, for 20 h.p. Rolls-Royce Cars.

(1) Specification.

Model	20 H.P.
Description : Exide Battery type	6-XL-3-4
Specific gravity (at 60° F.) of filling in acid for first charge	1·340 / 1·260*
Specific gravity (at 60° F.) of acid when fully charged	1·280 / 1·210*
First charge current	2½ amps.
Normal charge current (see par. 15, first section)	4 ,,
Capacity when fully charged :—	
Starting—for five minutes	110 ,,
Lighting—at 3 amperes	17 hours
Voltage across terminals of battery ...	12

(2) **First Charge.**—Fill the cells with pure "Accumulator" sulphuric acid—previously diluted to 1·340 (1·260*) specific gravity, and cooled to approximately atmospheric temperature—to ½" above tops of plates.

(3) Let the cells stand for 12 hours, then add sufficient acid of the same gravity as originally used, to restore to the original level.

(4) See that the filling plugs are in position ; connect as described in par. 17 for charging from an outside source and charge as detailed below.

* For tropical climates ; see par. 23.

(*a*) When time permits it is recommended that the charge be given at 2½ amperes for not less than 96 hours (see par. 23 with reference to maximum temperature permissible).

Alternatively, the charge may be given at 4 amperes for not less than 70 hours, provided the maximum temperature permissible (see par. 23) is not exceeded.

Should the maximum permissible temperature be reached, the current must be reduced or the charge suspended. If this has to be done, the time required for the charge will be proportionately increased.

The charge should be continued until :—

(*b*) gas is freely evolved in every cell.

(*c*) the voltage across the battery and the specific gravity of the acid in every cell remain constant over 5 successive hourly readings.

(**5**) Take specific gravity readings of the acid in each cell (see par. 11) and adjust by adding distilled water if the specific gravity is above 1·285 (1·215*), or by adding acid of 1·350 specific gravity if the specific gravity is below 1·275 (1·205*). In this way, adjust until the specific gravity after correction for temperature (see par. 12) is between 1·275 (1·205*) and 1·285 (1·215*) *but only after making certain that the voltage and gravity have remained constant for at least 5 hours.*

(**6**) Adjust the level by the addition or withdrawal of acid as required until it is approximately ⅜" above the tops of the plates in each cell (when the gas bubbles have been eliminated from the electrolyte the level will fall to approximately ½" above the tops of the plates). The first charge is then complete.

(**7**) Discharge the battery through resistances or lamps at the rate of about 5 amperes until the voltage across the battery with the current passing is 10·8, then recharge at 4 amperes until all the plates again gas freely. The recharge will require approximately 15 hours. The battery is then in good condition for being placed on the car and connected up to the electrical system.

(**8**) **Batteries must be properly installed.** The battery must be well packed in its box so that it cannot move. The cable terminals should be well greased before putting the battery into service.

* For tropical climates, see par. 23.

(**9**) **Keep battery and interior of battery compartment wiped clean and dry.** Do not permit an open flame near the battery.

Keep all small articles, especially of metal, out of and away from the battery. Keep terminals and connections coated with pure vaseline, not grease. If acid has slopped, or is spilled, wipe off with a rag wet with clean water, then dry thoroughly.

(**10**) **Pure water must be added to all cells regularly and at sufficiently frequent intervals to keep the acid at the proper height.** Add water until the level is ½" above tops of plates. Never let the level of the acid get below top of plates.

Plugs must be removed to add water, then replaced and tightened after filling.

DO NOT ADD ACID, ONLY PURE WATER.

Putting acid into the cells to bring up specific gravity may do great harm, and should never be done except by an experienced battery man. Acid should only be used to make good loss from sloppage, or by leaks.

Do not add any water containing even small quantities of salts of any kind.

Distilled water, melted artificial ice, or fresh rain-water are recommended.

Use only a clean, non-metallic vessel for handling the water.

Add water regularly, although the battery may seem to work all right without it. Distilled water for "topping-up" purposes can be obtained from a chemist or Exide Service Station.

If a vent plug is left out, or loose, the acid may splash out of the cell. If a plug is lost or broken, obtain a new one at once.

In cold weather, always add the water just before charging, or running the car, so that the water and acid will be mixed, and freezing thus avoided.

(**11**) **The best way to ascertain the condition of the battery is to test the specific gravity (density) of the acid in each**

cell with a hydrometer. This should be done regularly, but not just after adding water.

A reliable specific gravity test cannot be made after adding water, and before it has been mixed by charging the battery.

Fig. 1.—Type S-1 Hydrometer Syringe.

Fig. 1 illustrates the Chloride Company's special hydrometer syringe used to test the specific gravity of the acid. To take a reading, insert the end of the rubber tube in the cell, squeeze and then slowly release the rubber bulb, drawing up acid from the cell until the hydrometer floats. The specific gravity is read on the graduated stem of the hydrometer at the point where it emerges from the acid. After testing, *the acid must always be returned to the cell from which it was taken.*

The gravity reading is expressed in "points"; thus, the difference between 1·250 and 1·275 is 25 points.

(**12**) Correct for temperature (see table under par. 13). The correction may also be obtained approximately by *adding* one point to the reading for every 2½ degrees in temperature of the acid *above* 60° F., and by *subtracting* one point for every 2½ degrees of temperature of the acid *below* 60° F. Thus, if the reading is 1·290 with acid at 50° F., the specific gravity corrected to 60° F. is four points less than the reading, or 1·286.

(**13**) **When all cells are in good order, the gravity will test about the same (within 25 points) in all.**

Specific Gravity of Acid in Cells in TEMPERATE Climates, in various states of discharge.

Actual hydrometer readings at temperatures of:

	50° F. (10° C.)	**60° F. (16° C.)**	70° F. (21° C.)	80° F. (27° C.)	90° F. (32° C.)	100° F. (38° C.)	110° F. (43° C.)
Fully Charged ...	1·284	**1·280**	1·276	1·272	1·268	1·264	1·260
Half Discharged ...	1·214	**1·210**	1·206	1·202	1·198	1·194	1·191
Fully Discharged ...	1·153	**1·150**	1·147	1·144	1·140	1·137	1·134

Specific Gravity of Acid in Cells in TROPICAL Climates, in various states of discharge.

Actual hydrometer readings at temperatures of:

	50° F. (10° C.)	**60° F. (16° C.)**	70° F. (21° C.)	80° F. (27° C.)	90° F. (32° C.)	100° F. (38° C.)	110° F. (43° C.)	125° F. (52° C.)
Fully Charged ...	1·214	**1·210**	1·206	1·202	1·198	1·194	1·191	1·186
Half Discharged	1·146	**1·140**	1·137	1·133	1·130	1·127	1·123	1·118
Fully Discharged	1·082	**1·080**	1·078	1·075	1·072	1·069	1·066	1·062

In order to facilitate the use of various hydrometers when determining the density of the acid, we give below a conversion table of principal readings required:—

Density or Specific Gravity.	*Twaddell's Hydrometer Degrees.*	*Beaumé Degrees (approx.).*
1,170	34	21
1,200	40	24
1,225	45	26·5
1,265	53	30
1,270	54	30·5
1,275	55	31
1,280	56	31·5
1,285	57	32
1,350	70	37·5
1,840	168	66

The specific gravity of the acid in fully-charged cells is between 1·275 (1·205*) *and* 1·285 (1·215*).

Specific Gravity above 1·225 (1·155*) *indicates battery less than half discharged.*

Specific Gravity below 1·200 (1·130*), *but above* 1·150 (1·080*), *indicates battery more than half discharged.*

When battery is found to be more than half discharged, use lamps sparingly until, by charging the battery, the gravity is restored to at least 1·200 (1·130*).

Specific Gravity below 1·150 (1·080*) *indicates battery completely discharged (exhausted).*

An exhausted battery is always the result of lack of charge or waste of current. If, after having been fully charged, the battery is

* For tropical climates; see par. 23.

soon exhausted again, there may be trouble somewhere else in the system, which should be located and corrected.

Such a discharge may occur if there is an "earth" in the wiring system, or if the ignition switch be left on in error and the platinum contacts of the "make-and-break" happen to be left in contact. Always, when leaving the car, make a practice of checking that the ammeter does not show any discharge current, except that required for any lights which are left on.

(14) **Specific gravity in one cell markedly lower than in the others, especially if successive readings show the difference to be increasing, indicates that the cell is not in good order.** If the cell also regularly requires more water than the others, a leaky container is indicated.

Even a slow leak may, in time, drain a cell of all its acid, and a leaky container should immediately be replaced with a good one.

If there is no leak, and if the gravity is, or becomes, 50 to 75 points below that in the other cells, a partial short-circuit or other trouble within the cell is indicated.

A partial short-circuit, if neglected, may seriously injure the battery, and should receive prompt attention.

In case of a leak or other trouble within the cell, such as a short-circuit, do not attempt to open the cell, but communicate with the nearest Exide Service Station, or The Chloride Electrical Storage Co., who will advise where the battery should be sent.

(15) **The best results, both in starting and in lighting service, will be obtained when the system is so adjusted that the battery is normally kept well charged, but without excessive overcharging.**

Too little charging is indicated by the specific gravity falling below 1·225 (1·170*) frequently, in which case either a greater proportion of the running should be done with the charging switch closed, or the battery should be given a special charge (see pars. 16 and 17).

Too much charging is indicated by the specific gravity of the acid being generally about 1·280 (1·210*), and by unusually frequent "topping-up" being required.

* For tropical climates; see par. 23.

If the car is used in circumstances which require frequent use of the starter and lights, it will be found necessary always to keep the charging switch "on" when the engine is running.

The current generated by the dynamo falls off with increasing speed, so that the danger of overcharging by long, fast runs in the day-time is much reduced. **When, however, the battery is known to be fully charged, and the car is running at a moderate speed only, it would generally be advisable for the charge to be switched off.**

Careless use of the starter will reduce the life of the battery. Careful use of the starter will make very little difference in its life, as compared with the more ordinary lighting demands. If the battery is known to be in good condition, and well up in its state of charge, the starter may be used for several times in immediate succession, with the certain knowledge that the battery is not being appreciably injured, and will turn the engine easily. If, at any time, the starter appears sluggish in its action, and such sluggishness is traceable to the battery, no attempt should be made to use the starter until the battery has had a thorough charge up again to the gassing condition.

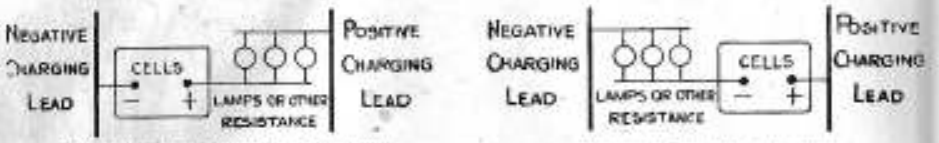
If, for any reason, an extra charge is needed, it may be accomplished by running the engine idle (par. 16), or by using "direct" current from an outside source (par. 17).

(16) **Charging in position on the Car.**—It is possible to charge the battery in position on the car, making use of a 2-pin plug which fits the socket on the switch-box. The connections of the other end of the flexible wire to which the plug is attached to the terminals must be made in such a way as to cause the chassis ammeter to indicate "charge" when the current is switched on. The chassis charging switch should be left "off."

Another method of securing correct direction of current is detailed in par. 18; it is essential that the polarity shown is in agreement with that at the plug socket, the positive being on the right.

The number of lamps in circuit, or the variable resistance, must be suitably adjusted to allow the flow of the required charging current, which should be approximately 4 amps., and should be continued until the conditions detailed in par. 21 are fully complied with. Note par. 23 *re* temperature permissible. Avoid overcharging the battery, either in quantity or time.

(17) Charging from an Outside Source.—Charging from an outside source is recommended where conditions of running are such that a heavy demand is made on the battery. If desired, the battery may be charged in position on the car.



Connections when Negative main or neither main is earthed.

Connections when Positive main is earthed.

FIG. 2.

When charging the battery, use direct current only. Connect as shown in fig. 2, taking care to connect the cells up correctly as regards polarity. If alternating current only is available, it must be converted to direct current by means of a rectifier or other device.

(18) Polarity of Mains.—The polarity may be tested by dipping the ends of the charging wires in a glass of water in which a teaspoonful of salt has been immersed. Connect a lamp (of "mains" voltage) in series with the wire to avoid trouble from short-circuits (fig. 3). Bubbles of gas will form on the **negative** wire.

FIG. 3.
Diagram of connections for polarity test.

(19) Earthed Main.—If one of the mains is earthed, it is very desirable to connect the battery on to it. The mains may be tested by connecting a wire from a water pipe or other earth to a lamp of "mains" voltage, the other wire from the lamp being connected to each of the mains in turn (fig. 4). (Be exceedingly careful not to "short-circuit" the mains when testing in this manner. Unless one has some familiarity with matters of this kind, it is preferable to call in an electrician.) If the lamp lights to full brilliancy on one main and not on the other, the main on which it does **not** light is the one which is earthed, and the battery should be connected to it. If the lamp does not light on either main, or it glows dimly on both mains, neither of the mains is earthed, and it

FIG. 4.
Diagram of connections for testing for earthed main.

is preferable under these conditions to connect the battery to the negative main.

(20) Limit the current to the proper rate in amperes (4 amperes) by connecting a suitable resistance in series with the battery. Incandescent lamps or radiator elements are convenient for this purpose. (See fig. 2.)

When charging as above, the watts taken by the lamps or elements connected in parallel (as shown in the diagram) when added together should be about 250 watts on 30 and 50 volt mains, 400 watts on 100 volt mains, or 800 watts on 200 volt mains. It is, of course, only the current taken by the lamp and not the brightness of the filaments that determines their suitability for use as resistances.

Do not allow the temperature of the acid to exceed 100° F. (125° F.*) during the charge; if it tends to do so, reduce the charging rate or stop the charge temporarily.

Continue the charge until the conditions detailed in par. 21 are fully complied with.

(21) A battery charge is complete, when, with charging current flowing at the normal charging rate (see par. 1), **all cells are gassing (bubbling) freely and evenly, and the gravity of the acid in all cells has reached a maximum: that is, has shown no further rise during five hours.** The battery is fully charged when all of the plates in all of the cells have given back all of the acid, of which the best indication is that charging will produce no further rise in gravity; the gravity has reached a maximum.

The specific gravity of the acid in fully-charged cells is between 1·275 (1·205*) *and* 1·285 (1·215*).

(22) Testing for Condition of Charge.—No voltmeter is provided on the electrical system, as this is not considered necessary, though we recommend that a small pocket voltmeter be carried. The reading of a voltmeter when the battery is on open circuit is no real indication of the condition of the battery. For voltmeter readings to be of any real value, a battery must be discharging at a moderate current, *e.g.* lighting the head lamps, at the time the readings are taken. If, with a current passing, each cell shows 1·95 to 2 volts, and the specific gravity of the acid is not less than 1·270 (1·200*) when the battery is thought to be fully charged, it is reasonable to assume that the battery is in a healthy condition.

* For tropical climates; see p. 23.

(23) Temperature Permissible.—

(a) *Temperate Climates.*—Under normal conditions, the maximum permissible temperature of the acid at any period of the charge or discharge is 110° F. (43° C.).

(b) *Tropical Climates.*—In tropical climates (places where freezing temperature never occurs are regarded as having tropical climates) the maximum permissible temperature of the acid may be increased to 125° F. (52° C.), provided the working specific gravity at the end of discharge does not exceed 1·210 *after* correction for temperature

Despatch of Battery.—If the battery is to be despatched any distance within the British Isles, first give it a full charge, then pack in a box so that the tops of the terminals are level with the top of the box. Fix narrow strips of wood across the top, but leave spaces between the strips so that the tops of the cells are plainly visible.

Label the case "CONTAINS ACID, KEEP THIS SIDE UP," and despatch at owner's risk. Before putting the battery again into use, give it a freshening charge.

(25) A battery which is to stand idle should first be fully charged. A battery not in active service may be kept in condition for immediate use by giving it a freshening charge at least once every two months, but should preferably also be given a thorough charge after an idle period before it is replaced in service.

A battery which has stood idle for more than two months should be charged at normal rate to maximum specific gravity before being replaced in service.

It is not wise to permit a battery to stand for more than six months without charging.

Disconnect the wires from a battery that is not in service, so that it may not lose charge through any slight leak in car wiring.

(26) If in doubt, consult the nearest EXIDE Service Station. Advice regarding testing, and "topping-up" with distilled water may be obtained at any EXIDE Service Station. There are 13,000 EXIDE Service Stations in the world, of which 600 are in Great Britain. Addresses may be obtained on request.

mw R. Harper
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