INSTRUCTIONS

FOR THE CARE & RUNNING OF THE

20 H.P. ROLLS-ROYCE CAR.

DECEMBER 1922

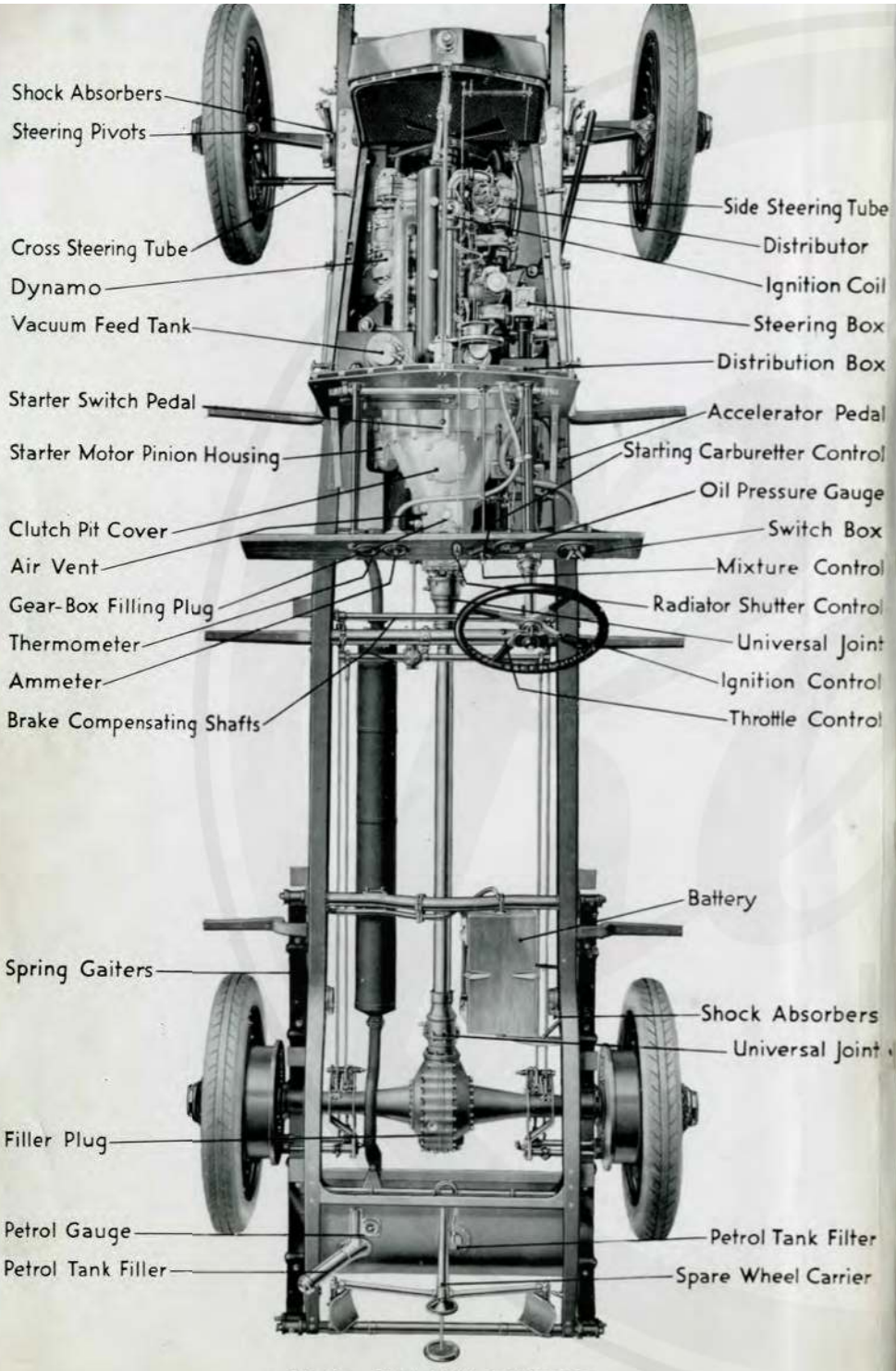

FIG. 1. PLAN VIEW OF CHASSIS.

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FOR THE CARE AND RUNNING OF THE

20 H.P.
ROLLS-ROYCE CAR

Liable to Alteration without Notice

December, 1922

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THE instructions contained in this book have been arranged with the object of facilitating reference thereto by condensing in the first two chapters all essential driving and upkeep details. Consequently, it should be an owner's first care to make himself familiar with the matter contained in these chapters. Subsequent chapters cover, in a more detailed and technical manner, the various units or components of the chassis, and reference should be made to these chapters if difficulties arise, or if there are any details referred to in Chapters I. and II., on which further information is required.

Such an arrangement of the book—while rendering unavoidable slight repetition here and there—has only been adopted after careful consideration of the needs of the average driver, and will, it is hoped, prove of interest and service to all owners and drivers of the 20 H.P. Rolls-Royce Car.

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

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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.

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, automatic advance, forced lubrication, cooling by pump circulation, Rolls-Royce automatic expanding carburetter.
Electrical Equipment	12-volt Rolls-Royce dynamo, starter motor, and other units. 45-50 ampere-hour battery.
Clutch	Single dry plate.
Gearbox ..	Three-speed and reverse, central control.
Back Axle ..	Spiral bevel drive, full floating, road wheels entirely carried on axle tubes.
Brakes	Internal expanding, both hand and foot brakes being of same diameter, side by side, and operating on the same drums on rear wheels.
Road Springs ..	Semi-elliptic, front and rear.
Wheels	Dunlop detachable wire wheels, with 32″ by 4½″ straight-side cord tyres.
Wheelbase ..	129″.
Track	54″.
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—2,305 lbs.

CHAPTER I.

Starting of Engine and Running the Car.

Starting of Engine—Petrol Feed—Running the Car—Gear Changing—Use of Charging Switch—Starting Engine by means of Ignition Switch only—Ignition Switch—Use of Magneto—Use of Radiator Shutters—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.

For service abroad, however, where a customer feels that he must have an additional ignition, a magneto can be fitted which acts purely as a standby.

It is of the utmost importance that no attempt should be made to connect up both the magneto and battery high-tension leads simultaneously to the plugs, as this will result in neither ignition working. The magneto system can only be brought into service by disconnecting the battery high-tension wires from the plugs and replacing them by the magneto high-tension wires, as more fully described later in this chapter.

In order to facilitate starting the engine from "all 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 vaporize the mixture by exhaust heat, results in the car being available for service very quickly after starting up, even in the coldest weather.

Starting of Engine. To start the engine, first check that the change gear lever is in "neutral," close radiator shutters by moving control lever on instrument board, then switch on the ignition by moving right-hand thumb lever on 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 lever on the fitting on instrument board to position marked "Starting." Now depress the small pedal situated low down in the centre of the dashboard; this closes the main switch between battery and starting motor, and the latter will start up the engine. As soon as the engine commences to run regularly, move throttle control lever on steering column about halfway up its quadrant and turn back starter carburetter control lever to position marked "Running."

With a very cold engine, it is advisable to start up by hand, in order to avoid the heavy discharge current from the battery. For this purpose 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 on the ground.

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 well-known vacuum 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 in opposite phase—it will click "home" when in the correct position through the medium of a concealed helical spring.

If the service tank on the dash be inadvertently emptied during a run, it can be replenished after the rear tank has been filled by cranking over the engine for a few revolutions, both main and starting carburetter throttles being closed meanwhile. In order to save the battery, this cranking should preferably be done by means of the starting handle, especially if the engine is cold. A depression will thereby be induced in the induction pipe, which will draw up petrol from the main tank into the service tank.

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 deceleration of 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 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, relative to the driver, for each of the three forward speeds and the reverse is as follows:—

1st gear.—To engage first gear from neutral, the lever should be pulled gently across the car towards the driver until clear of the concealed "gate," and then pulled backwards.

2nd gear.—To engage second gear from first gear, the lever should be pushed forward to neutral and at the same time firmly but gently pressed sideways away from the driver to pass it through the gate, after which it can be pushed forwards into second gear.

3rd gear.—To engage third gear (direct drive) from second, the lever should be pressed sideways away from the driver and pulled right back.

Reverse.—To engage reverse from neutral, the lever should be pulled sideways towards the driver, and then pushed forwards.

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 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 level is in the neutral position. The clutch must then be again withdrawn 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.

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 impossible.

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

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

Starting Engine by means of Ignition Switch only. If the engine is stopped temporarily by switching off the ignition, it can generally be restarted (after switching on again) by moving the ignition control lever smartly over its extreme range, from the fully advanced to the fully retarded positions. This causes the "make-and-break" mechanism to act, and a spark to jump across the plug gap in the cylinder which is next due for firing, which has had a compressed charge left unignited when the engine slowed down after switching off. Obviously, *all* the cylinders will be full of "mixture," but only one is in the correct position for firing.

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. Where a magneto is fitted, as is sometimes requested for use in overseas countries, this is arranged to be very quickly put into service should the necessity arise. The magneto high-tension wires are disconnected from the plugs when the battery ignition is being used and secured to special studs on the cylinder head cover to keep them out of the way and earthed until required. In addition, there is a permanent "earthing" wire—which is so marked with a label—connected from the low-tension terminal of the "make-and-break" to one of the screws securing the distributor cover to the magneto itself. In order to change over from battery to magneto ignition, the following procedure is necessary:—

(1) Remove battery ignition fuse marked No. 3 in distribution box.

(2) Attached at both ends to the magneto itself will be found a wire carrying a metal label marked "Permanent Earth Wire cutting out Magneto." At its upper end this wire is attached to one of the two screws securing the high-tension distributor, and at its lower end it is secured to the terminal on the cover of the "make-and-break" mechanism. Disconnect this wire at its lower end from the connection on the "make-and-break" cover, and then secure the end of the wire so removed under the same screw as secures its upper end.

(3) Disconnect from the sparking plugs the high-tension battery ignition wires (each being marked **B**), and replace them with those from the magneto, each of which is marked **M**. The battery high-tension wires should then be secured to the studs from which the magneto wires have been taken. Both sets of high-tension wires are numbered 1 to 6, to correspond with the cylinders.

The magneto ignition system is then ready for service, the thumb lever on the switchbox being used for switching "on" and "off" in the same way as for the battery ignition.

Owing to the fact that the type E.O.6 magneto which is provided 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 procedure detailed in paragraphs (1), (2) and (3) above must be reversed, special care being taken to see that the labelled magneto "earthing" wire is connected up again to the low-tension terminal on the "make-and-break" cover, leaving one end under the holding-down screw of the distributor cover.

Use of Radiator Shutters. A thermometer is arranged on the instrument board to indicate the water temperature of the engine. The normal working temperature should be between 70° C. and 90° C., and therefore, when starting the engine, it was pointed out that the shutters should be closed. They should remain so until the water temperature reaches 70° C.

When driving, it is not necessary to continually 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 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 easily to open or close the shutters. When the lever is at the bottom of the quadrant, the shutters are fully closed.

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.

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.

CHAPTER II.

Periodical 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 thereby largely eliminated, 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 certain order, with due regard to the relative location of the various items on the chassis.

These notes are succeeded by others covering the periodical 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.

Price's Motorine "B" for the engine in summer, and Motorine "C" in the winter.

Price's Amber "B" Gear Oil in gearbox and back axle.

Price's Amber "B" Gear Oil should always be used in the oil gun.

Hoffmann Ball-bearing Grease, manufactured by Alex. Duckham and Co., Ltd., Phœnix Wharf, Millwall, E., for ball bearings and wheel hubs.

A thin, good quality oil for the starter motor pinion.

Arrangements have been made whereby Rolls-Royce, Ltd., can supply promptly any quantity of the above oils (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.

Lubrication by Means of the Oil Gun.

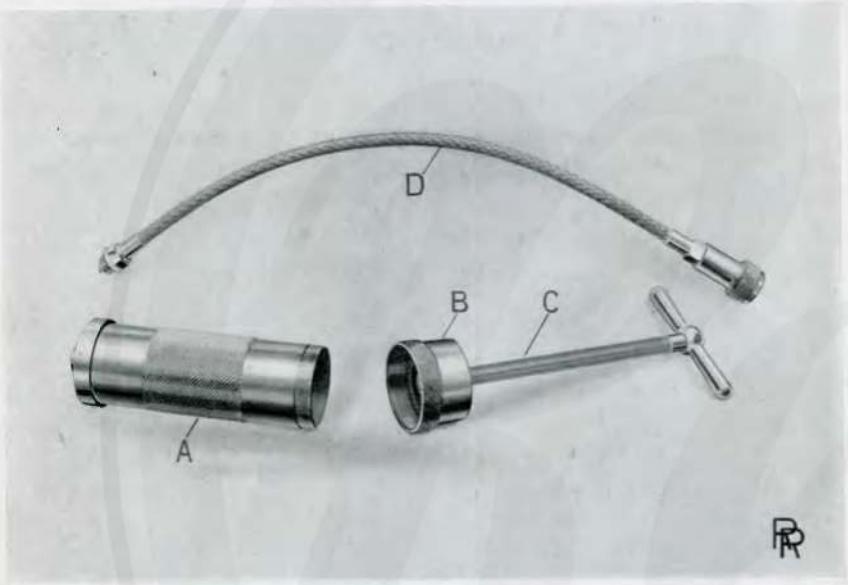

FIG. 2. OIL GUN OPENED FOR FILLING.

The oil gun is shown dismantled for filling (Fig. 2). 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 may 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 **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, 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. 2. The leather will then be suitably 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.

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

When using the oil gun, it should be borne in mind that lubricant is injected under great pressure, with very little effort on the part of the operator. Consequently, there is a danger in some cases of oil reaching points where it is harmful—as, for instance, when oiling the brake gear on the back axle, excess of oil may get on the brakes and reduce 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.

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.

Every 500 Miles, or Weekly.

LUBRICATION.

PARTS TO BE LUBRICATED.	No. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Forward ends of Front Springs	2	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Front Spring Shackles	4	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Cross Steering Tube (both ends)	2	Oil Gun ...	Gear Oil. Screw down until oil exudes.
Side Steering Tube (both ends)	2	Oil Gun ...	Gear Oil. Screw down until oil exudes.
Front Shock Absorber Connections	2	Oil Gun ...	Gear Oil. Screw down until oil exudes.
Steering Pivots ...	2	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Universal Joints at both ends of Propeller Shaft	2	Oil Gun ...	Gear Oil. Inject half a gun-full into each joint.
Forward ends of Rear Springs	2	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Rear Spring Shackles	4	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Rear Shock Absorber Connections	2	Oil Gun ...	Gear Oil. Screw down until oil exudes.
Water Pump Bearing and Gland	1	Screw-down Lubricator	Grease. Screw down lubricator one turn. Refill when necessary.
Steering Box ...	1	Oil Can ...	Engine Oil. Inject a few drops in lubricator.

Also every 500 Miles, or Weekly.

Inspect level of acid in battery cells (see page 43).

Every 1,000 Miles, or Fortnightly.

LUBRICATION.

PARTS TO BE LUBRICATED.	No. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Brake Actuating Shafts on Axle	4	Oil Gun ...	Gear Oil. Use sparingly, or oil may get on brake surfaces.
Brake Lever Shafts on Axle	2	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Brake Connection Jaws on Axle	8	Oil Can ...	Engine Oil. Inject a few drops on to jaws.
Jaws of Brake Ropes	8	Oil Can ...	Engine Oil. Inject a few drops on to jaws.
Spring Gaiters ...	12	Oil Gun ...	Gear Oil. Screw down three or four turns on each lubricator.
Bearings on Pedal Shaft	1	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of pedal bosses.
Pedal Connections ...	8	Oil Can ...	Engine Oil. Inject a few drops on to jaws and spring connections
Accelerator Pedal ...	1	Oil Can ...	Engine Oil. Inject a few drops into small spring lubricator.
Hand Brake Lever and Connections	3	Oil Can ...	Engine Oil. Inject a few drops in oil hole of lever boss and on ends of pull rod.
Hand Brake Pawl Connections	4	Oil Can ...	Engine Oil. Inject a few drops on to bearings of pawl and pawl lever.
Cam of Contact Breaker	1	—	Smear a trace of engine oil on cam surface.

Every 2,000 Miles, or Monthly.

LUBRICATION.

PARTS TO BE LUBRICATED.	No. OF POINTS.	HOW LUBRICANT IS APPLIED.	LUBRICANT AND QUANTITY.
Rear Shock Absorbers	2	Oil Gun ...	Gear Oil. Screw down a few turns.
Hand Brake Equalizer	1	Oil Can ...	Engine Oil. Remove plug in equalizer casing and inject oil.
Foot Brake Equalizer	1	Oil Can ...	Engine Oil. Remove plug in equalizer casing and inject oil.
Clutch Trunnion ...	1	Oil Can ...	Engine Oil. Remove clutch pit cover.
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.
Front Engine Support	1	Oil Gun ...	Gear Oil. Screw down until oil exudes from ends of bearings.
Steering Box	—	—	Gear Oil. Remove cover and smear oil on screw.
Control Mechanism	—	Oil Can ...	Engine Oil. Lubricate numerous joints on steering box, steering wheel, carburetter, instrument board, radiator shutters, etc.

Also every 2,000 Miles, or Monthly.

1.—Remove wheels, grease interiors and hubs, and replace (see page 87).

2.—Test steering joints and shock absorber connections for play, and adjust if necessary (see page 77).

3.—Test fan belt for tightness, and adjust if necessary (see page 85).

4.—Remove dynamo and starter motor end covers, clear away any dust, and inspect brush gear (see pages 29 and 34).

5.—Inspect cut-out contacts, and clean if necessary (see page 32).

6.—Inspect L.T. " make-and-break " contacts, and clean if necessary. Set gap to ·018" to ·020" (see page 36).

7.—Remove and clean carburetter air valve. Use no oil on this part (see page 65).

8.—Remove rocker cover, and test tappet clearances with ·004" feeler gauge (see page 58).

9.—Remove and clean sparking plugs. Set gaps to ·030" (see page 38).

10.—Adjust brakes if necessary (see page 69).

Every 5,000 Miles, or Half-yearly.

LUBRICATION.

Engine. When the engine is warm, remove the engine under-shield, take out the drain plug in bottom of the crankcase, 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 fibre joint washer is in position; also that the drain plug is replaced with its fibre washer.

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

Gearbox. When the gearbox is warm, inspect level of oil by turning tap, which will be found on right-hand side of gearbox. If necessary, add more gear oil through the filler plug. The oil should first be heated to reduce its viscosity and enable it to find its correct level, the tap being left open as oil is poured in.

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.

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 fibre 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 75).

Starter Motor Drive. The plug in the starter motor pinion housing (see Fig. 7) should be removed and a little thin machine oil injected.

Starter Motor Switch. This should be filled up with engine oil through the small plug-hole provided (see Fig. 7), by means of the oil can or a syringe.

Clutch Shaft. The clutch-pit cover should be removed and engine turned until an oil-hole on the clutch shaft is visible. Into this a few drops of engine oil should be injected. Excess of oil at this point will cause clutch trouble (see Fig. 22).

Fan Bearings. A few drops of gear oil should be injected with a syringe into the fan hub (see Fig. 28).

Wheel Bearings. The small screw should be removed from the centre of each road wheel and a few drops of gear oil injected with the syringe (page 87).

Every 10,000 Miles.

Engine. After 10,000 miles, the cylinder head should be removed for decarbonising. Full particulars regarding this operation will be found in Chapter V. (page 53).

Gearbox. The drain plug should be removed when the gearbox is warm and all the oil drained out. Fresh oil should then be added up to the overflow tap (see page 75).

Back Axle. All the oil should be drained out when the axle is warm by removing the standpipe, and fresh oil should be added until it commences to flow out of the plug-hole (see page 75).

CHAPTER III.

Electric Lighting, Starting, and Ignition System.

General — Dynamo — Switchbox — Distribution Box — Ammeter— Starter Motor—Starter Motor Switch—Battery Ignition—Magneto Ignition—Sparking Plugs—Klaxon Horn Connection—Battery Connections—Electrical Fault Location.

General. The equipment comprises a dynamo, distribution box with automatic cut-out, switchbox, and ammeter, a 12-volt 45-ampere-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 low-tension "make-and-break" and high-tension distributor, the whole, with the exception of the battery, ammeter, and Klaxon horn, being of Rolls-Royce manufacture.

The practical wiring diagram (Fig. 3) shows these units in their approximate relative position, with their electrical connections, the various wires being indicated in colours, to correspond with those of their actual coverings.

The technical wiring diagram (Fig. 4) is a simplified diagram, which is the electrical equivalent of the actual circuits.

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

Before working on any part of the system, it is important to remove the chassis frame connection from the negative battery terminal, which renders the whole system dead, but do not disconnect whilst any charge or discharge current is passing.

Dynamo. This machine is shown in Fig. 5. 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.

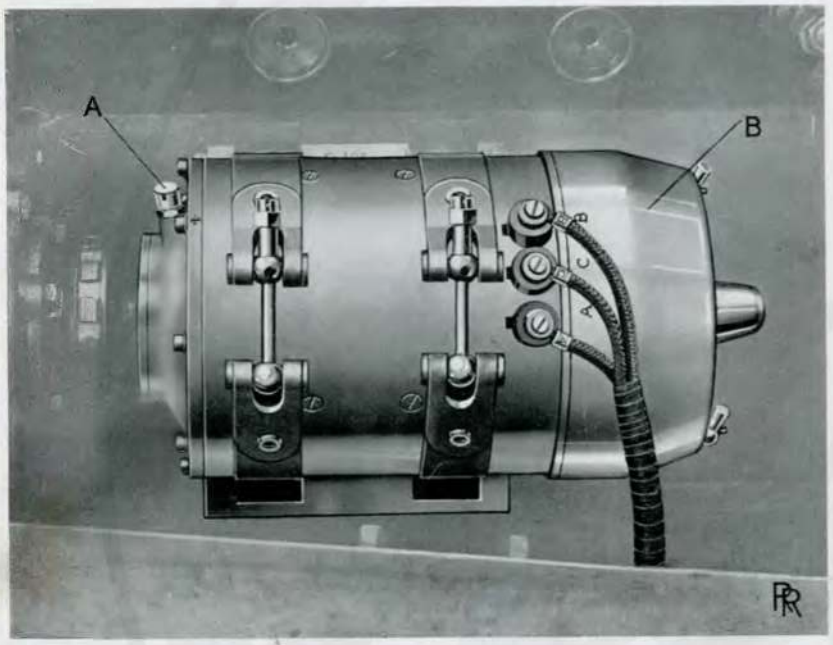

FIG. 5. DYNAMO.

The positive terminal of the field winding is brought up to the switchbox via the distribution box 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 thus replaced, though there is a possibility 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 there occur.

To be sure of avoiding this, on first running the engine, after the components have been replaced, the distribution box cover should be removed and the cut-out contacts held together by hand for a moment, during which the engine should be accelerated and the charging switch put on.

This will ensure the dynamo polarity in relation to the battery being made correct in the first instance, and eliminate the possibility of damage to the contacts.

The dynamo bearings require little attention. When the chassis is overhauled, however, or the dynamo removed, they should be cleaned out and regreased 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.

There is provision for additional lubrication at each bearing in the form of a small oil cup, one being shown at **A** (Fig. 5), and the other being within the cover **B**. Oil every 2,000 miles.

At intervals the dynamo end cover **B** should be removed, exposing the commutator and brushes. Deposits of brush dust or moisture should be suitably removed, and the amount of wear of the brushes inspected. A spare set of brushes is provided with each chassis. Should it become necessary to fit these, 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. The dynamo should then be allowed to run with the charging switch in its " off " position for several miles.

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

Switchbox. Carried on the right-hand end of 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 key withdrawn with switches in only two positions :—

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

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

No attempt must be made to force the lock to act when in other positions, or the mechanism will be strained.

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

S and **T.**—Side and tail lamps " on."
H, S and **T.**—Head, side, and tail lamps " on."
I.—Ignition system " on."
I and **C.**—Ignition system " on," and connections closed to enable dynamo to " charge " the battery. This means the switch in this position connects up the positive field and positive armature connections to the positive terminal of battery through the ammeter and an emergency fuse carried in the distribution box, and therefore, when dynamo is running, permits excitation of dynamo fields.
OFF.—No circuits in action.

Distribution Box. This contains the cut-out, or automatic charging switch, together with a series of fuses. It is shown with the cover removed in Fig. 6. The cut-out and fuses are easily accessible on removing the cover of the distribution box. The cut-out is operated when the dynamo speed rises high enough for the dynamo to be excited, 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 series

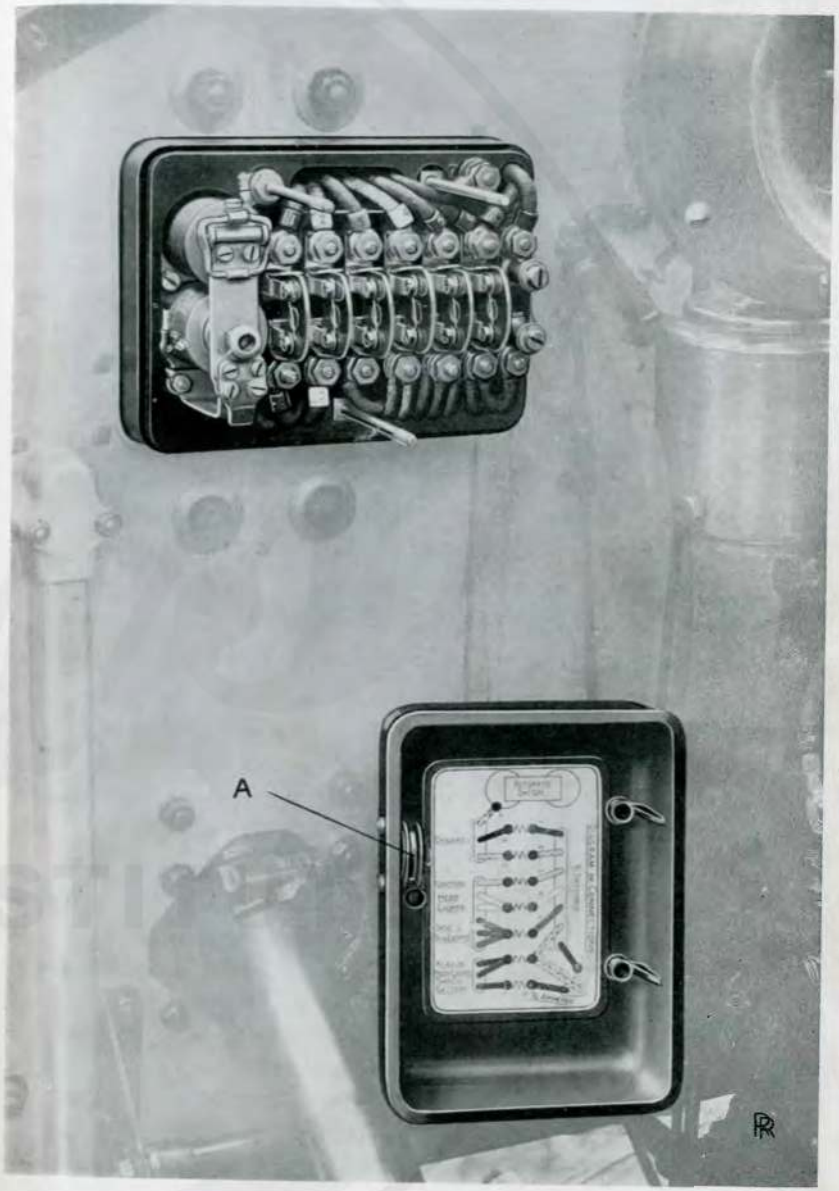

FIG. 6. DISTRIBUTION BOX WITH COVER REMOVED.

coil, between the negative (dynamo) terminal, through "earth," 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 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 allow the battery to discharge through the dynamo, turn off charging switch immediately, and inspect 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 the exception of the main battery emergency fuse on the extreme right, are all of a single strand of 30 S.W.G. copper wire. Spare wire of this size is provided on a little reel (**A**, Fig. 6) on the inside of the box cover. The emergency fuse should be three strands of this wire neatly twisted together. This fuse is only intended to be an emergency protection against "dead earths" on the wiring.

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.

Ammeter. This is a moving coil instrument with a central zero and 20-ampere 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 is

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 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 if necessary replace with spare fuse wire provided.

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 carefully to inspect these. 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.

The lighting of lamps or operation of any other part of the electrical system *direct from the dynamo*, due to battery being either intentionally or unintentionally disconnected, *e.g.*, by removal or failure of emergency fuse, must be avoided. In these circumstances, no current will be indicated by the ammeter, but the lamps or other apparatus may be damaged by excessive voltage.

If the charge and discharge indications of ammeter are reversed, it means that the ammeter connections have been wrongly made.

Starter Motor. The starter motor is shown at **A** in Fig. 7. The Bendix 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 regreased 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. 7). Oil every 2,000 miles.

At intervals, 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. A spare set is, however, provided with each chassis, and should it become necessary to utilise these, 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 re-obtained, owing to the heavy current which this has to carry. This also applies to the electrical connection of motor carcase to crank-case.

Lubrication of the Bendix drive should be effected every 5,000 miles by removing the large hexagon plug **C** (Fig. 7), and by means of a syringe, injecting a small quantity of *thin* oil. The use of thick oil will cause the Bendix to fail to operate. In case of such a failure, first inject paraffin, then use thin oil sparingly.

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

Starter Motor Switch. This switch is shown at **F** (Fig. 7). 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**, is provided for filling purposes.

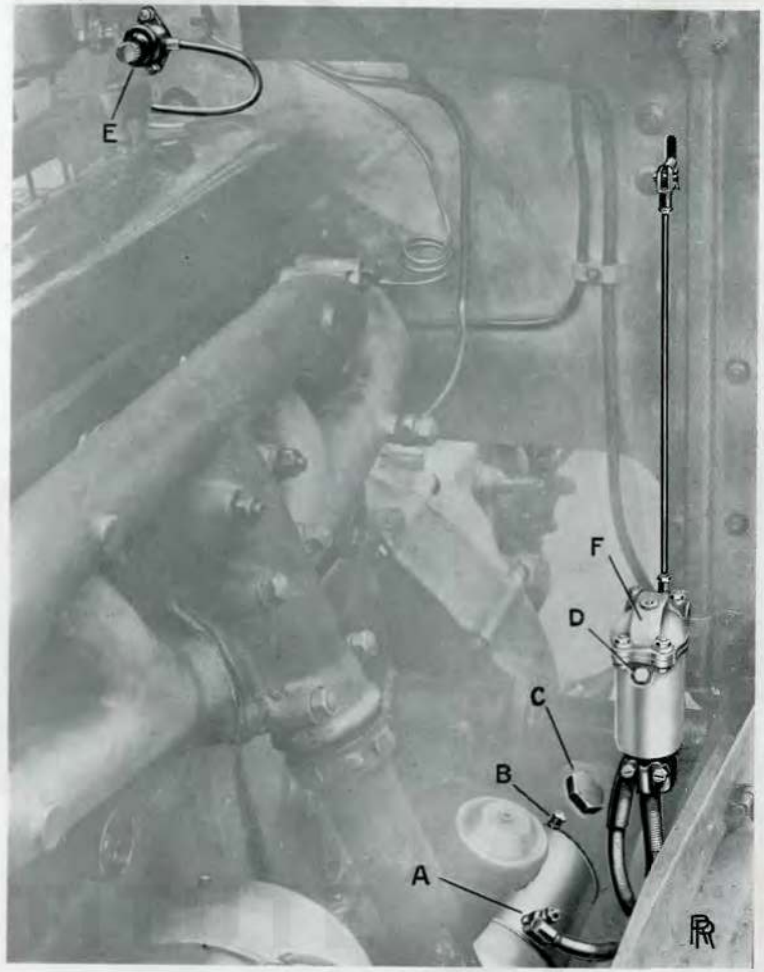

FIG. 7. STARTER MOTOR AND SWITCH.

Battery Ignition. In Fig. 8 is shown the very accessible position of the small non-trembler ignition coil **A**, its ballast resistance **B**, also the combined low-tension "make-and-break" **C**, and high-tension distributor **D**, the latter being shown removed. The function of the ballast resistance is to limit the current taken by the coil at slow speeds 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 break is located in a pocket, **E**, in this apparatus. The insulated contact and the insulated side of the condenser are brought out to the insulated spring terminal to which the external low-tension connection is made. It is desirable

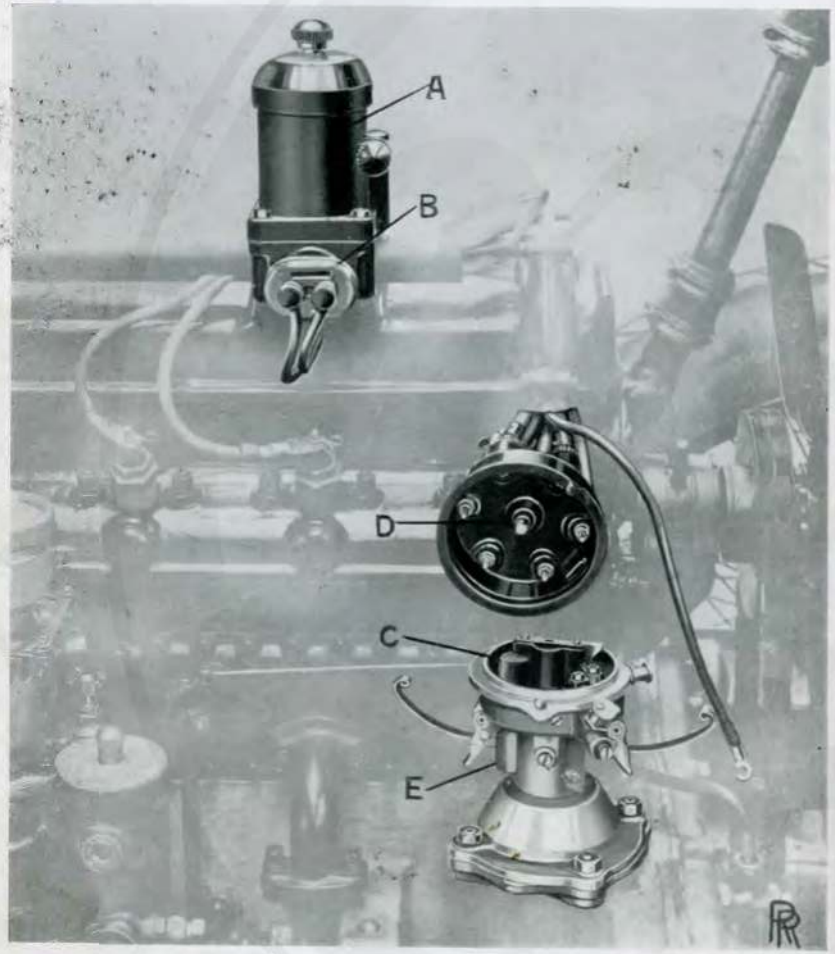

FIG. 8. IGNITION COIL AND DISTRIBUTOR.

occasionally to touch up the platinum points of the low-tension "make-and-break" with a very fine file, but take care not to remove platinum unnecessarily. In setting the points, the maximum gap opening should be from ·018" to ·020".

A small terminal box is provided on the dash, to enable the battery ignition system to be disconnected from the supply of current when it is necessary to remove the valve rocker cover. This is shown at **E** in Fig. 7.

Magneto Ignition. An E.O. 6 type magneto is fitted, when required, as a standby. It is provided with oil-holes, and two or three drops of oil should be added occasionally.

Excess of oil must be carefully avoided, for it will interfere with the working of the magneto.

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

Although the magneto is driven by means of serrated couplings, the coupling at the magneto end is arranged with an uncut space, so that it is only possible to connect up the magneto in one position to its drive if at any time it is necessary to take the magneto off the engine.

Before touching the magneto, if it is required to remove it, it is essential that the engine should be turned by hand until the red marked tooth on the large distributor gear wheel of the magneto is in the centre of the observation glass under the large brass cap on the top of the magneto. By unscrewing the cover of the coupling adjacent to the magneto on the driving shaft by means of the special spanner provided, the thread being right hand, and disconnecting central rod joint, the magneto is ready for removal after undoing the clamping nuts which hold it down to its bracket.

If the engine has been rotated by an oversight whilst the magneto is out of position, when it would be possible to be a complete turn of the magneto spindle wrong for timing, it can be retimed as follows:—

No. 1 distributing plate should be visible through the window in the front of the magneto when the No. 1 or front-end piston of the engine is in its firing position. Correct timing can then be obtained by noting the exact moment when the low-tension platinum points break contact, which must occur when the top dead-centre mark (1 and 6) on the flywheel is opposite to the top centre mark in the gearbox opening when the ignition lever is fully retarded.

Sparking Plugs. The sparking plugs should be removed and cleaned every 2,000 miles, and the width of the gaps checked. These should be ·030". Smaller gaps will impair the slow running of the engine.

Klaxon Horn Connection. 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.

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 side 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.

Electrical Fault Location. In case of faulty operation, proceed to investigate as follows :—

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

(2) Failure of the whole system may be due to the fusing of the emergency battery fuse (extreme right), due to an earth.

Repeated failure of properly fitted fuse indicates fault on system.

If dynamo does not charge :—

(1) This may be due to dynamo armature or dynamo field fuse blowing.

(2) Examine for dirty cut-out contacts.

If, with fuses intact, battery ignition :—

(*a*) Misses.

(1) First confirm right condition of sparking plugs.

(2) Assure correct condition of contact breaker points, and adjust gap ·018" to ·020".

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

(*b*) Fails.

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

If with battery in order, motor is sluggish or does not turn, examine commutator and brushes.

If battery will not retain charge :—

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

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

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

CHAPTER IV.

Care of Battery.

Initial Charge of Battery if received Unfilled with Acid—Use of Charging Switch—Care of Battery under Running Conditions—Inspection and Renewal of Electrolyte—Testing for Condition of Charge—Failure of one or more Cells—Charging in Garage from External Source—Use of Starter—Battery out of Commission—Despatch of Battery—Battery Stored or Despatched Unfilled.

Initial Charge of Battery if received Unfilled with Acid.

First examine the battery and see that terminals and connections are properly greased to prevent corrosion, which may generally occur on the positive terminals of the cells.

Fill each cell carefully with best brimstone sulphuric acid of density 1280 to half an inch above the tops of the plates, taking care not to spill acid on the top of the battery.

If it be necessary to prepare the acid electrolyte, obtain best brimstone battery sulphuric acid, free from contamination of iron or arsenic, having a density of about 1840, and pour it slowly into distilled water in a leaden or non-metallic vessel, stirring meanwhile with a glass rod until a density of 1280 is secured when the mixture is quite cold (60° F.). Never pour water into the acid, but always acid into water, and do this very slowly, in order to avoid an excessive rise of temperature. Allow the mixture to cool to 60° F. (15° C.) before use. Use clean glass, earthenware, or leaden vessels for acid, but on no account use any other metal vessel.

Leave the battery for about twelve hours to allow the plates to soak, then restore the levels with acid of the same density.

Now charge the battery at a rate of 3½ to 4 amperes for sixty hours at least, but in any case until all plates, both positive and negative,

gas freely, voltmeter and hydrometer readings showing no increase during three hours. The charging rate may be reduced overnight, but the time extended accordingly. If the charge cannot be carried out in one period, an interval of rest should not exceed the immediately preceding period of charge at the specified rate, nor should it exceed twelve hours as a maximum. If, during the charge, the electrolyte temperature approaches 100° F. (38° C.), interrupt or reduce rate of charge, but extend time accordingly. It is most important that during the life of a battery this temperature should never be exceeded.

The first charge and all subsequent charges of a battery removed from the car should be carried out with the stoppers removed.

During this first charge, watch the acid density in each cell, using a syringe hydrometer. The density should not be allowed to exceed 1285. If it does, withdraw some acid and replace with distilled water, allowing time for mixing. Ordinarily, the acid in the hydrometer must be allowed to return to the cell from which it was drawn. In order to facilitate the use of various hydrometers when determining the density of the electrolyte, we give below a conversion table of principal readings required :—

Density or Specific Gravity.	*Twaddell's Hydrometer Degrees.*	*Baumé Degrees (approx.).*
1170	34	21
1200	40	24
1225	45	26·5
1265	53	30
1270	54	30·5
1275	55	31
1280	56	31·5
1285	57	32
1350	70	37·5
1840	168	66

The battery should now be allowed to discharge through resistances or lamps to 10·8 volts (current passing) at the rate of about 5 amperes. Then recharge immediately at this rate until all plates again gas freely (*i.e.*, charging for at least fifteen hours).

The battery is then in good condition for being placed on the car and connected up to the electrical system. It should be well packed

in its box so that it cannot move, and the cable terminals should be greased.

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 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 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 be kept fully charged, but be 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 immediately be given 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 38). Do not allow metal tools or other metal to short circuit across 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 normally 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 39; or when desired to store or despatch battery unfilled, as described on page 46).

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.

Inspection and Renewal of Electrolyte. The levels of electrolyte in the cells should be inspected frequently and maintained to well cover the plates by the frequent addition of distilled water. Use a syringe-type hydrometer to take densities, which should be 1265 to 1275 for fully charged condition. If, in these circumstances, the densities are low, give a special charge if possible from an external source (see later, page 44), at the normal charge rate (5 amperes), until the density has remained constant in every cell for three hours. If still below 1265, it is important to remove some electrolyte and replace with electrolyte of about 1350 density, until the required increase is secured, after which, again pass charging current for a short while. Unless acid has been lost by spilling, such replacement should *never* be required. As far as possible, arrange to make changes in the electrolyte just previous to charging.

Every twelve months, or, at most, two years, the acid electrolyte should be renewed. Charge the battery fully, empty out the old acid, allow to drain, then immediately replace with new acid of density 1265 to 1275.

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 indication of the condition of the battery. For voltmeter readings to be of any value, a battery must be discharging a moderate current, *e.g.*, lighting the head lamps, at the time the readings are taken.

If the battery is in ordinarily good working order, and care is taken to keep the densities, when in a fully charged condition, round about 1270, as already described, the state of charge of the battery will be very well indicated by density readings taken with the syringe hydrometer. If the readings are 1200 to 1225, the battery may be considered to be half discharged. If the readings are down to 1170, the battery must be considered in a completely discharged condition.

Failure of one or more Cells.

If, when the battery is supplying current, its voltage becomes prematurely low, it may be due to one or more cells having become faulty. This condition is best ascertained by the use of the pocket 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 two 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. 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, then, before connecting up the battery for charging purposes, it should be confirmed that the resistance is in the main showing the higher potential to earth. For this purpose, take a lamp of supply main voltage, earth one terminal to water pipes or gas pipes, and connect the other terminal in turn to each charging terminal. Then, with the minimum possible resistance in 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 two-pin plug (as previously mentioned, under the " Ammeter " section, page 32), which fits the socket on the switchbox. The connections of the other end of the flexible wire to which the plug is attached to the charging board 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 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, 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 amperes, and should be reduced as the charge proceeds to about 3 amperes 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 recommended where conditions of running are such that a heavy demand is made on the battery.

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 ampere) when the car is in the garage, as such a procedure will assist in keeping the battery in thorough condition.

Use of Starter.

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.

Battery out of Commission. If it is desired at any time to put the battery out of use, it is preferable to store the battery in a fully charged condition in a cool, dry place, and give it a freshening charge at half-rate at least once a month until all plates gas freely, topping up with distilled water if necessary.

Despatch of Battery. If the battery is to be despatched by rail 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. Then 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.

Battery Stored or Despatched Unfilled. If it is not possible in storing the battery to give it the necessary freshening charges, or if the battery is to be despatched a long way, or if not desired to send it at owner's risk, the best procedure, which is not, however, as good as keeping the battery in a charged condition, is as follows:—

(1) Fully charge the battery.
(2) Empty out electrolyte and replace with pure distilled water.
(3) Allow battery to discharge slowly through resistances until it shows about one volt per cell.
(4) Remove terminals, clean, regrease, and store or despatch these separately.
(5) Empty out water and allow battery to drain.
(6) For storage, place in a cool, dry place, with vent plugs well tightened up.
(7) To put the battery again into commission, it should preferably be treated in the same way as a battery received unfilled (page 40), except that particular care should be paid to the density, which is likely to finish higher than in an ordinary first charge.

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—Removing Rocker Shaft—Removing Exhaust and Inlet Manifolds—Removing Cylinder Head—Cleaning Pistons and Head—Grinding in the Valves—Replacing Cylinder Head—Re-assembling—Adjusting Tappets.

The engine oiling system is illustrated diagrammatically in Fig. 9. A gear-type pump is located on the right-hand side of the crankcase lower half, and 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 at from 15 to 20 lbs. per square inch pressure to 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, 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.

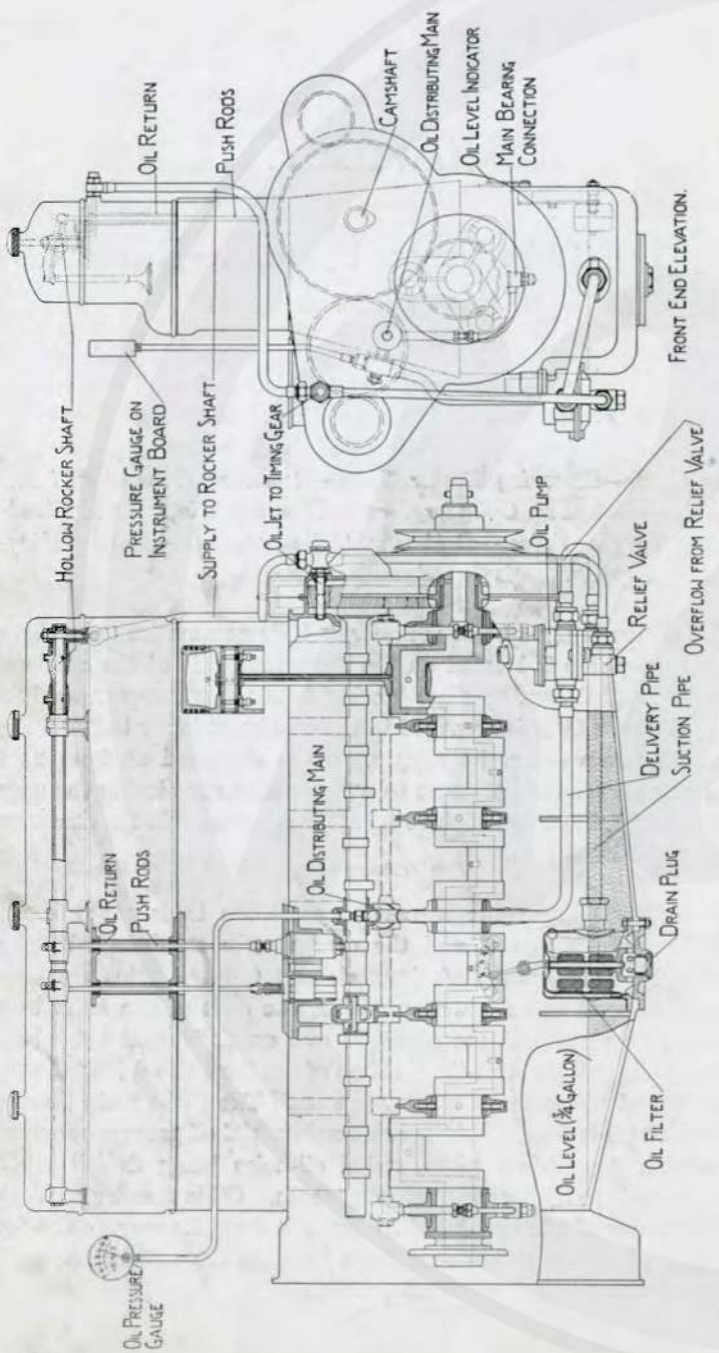

FIG. 9. ENGINE LUBRICATION SYSTEM.

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.

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. 10. Oil is drawn from the filter through pipe **A**, and delivered to the crankcase oil conduit through pipe **B**, the latter also being connected to the instrument

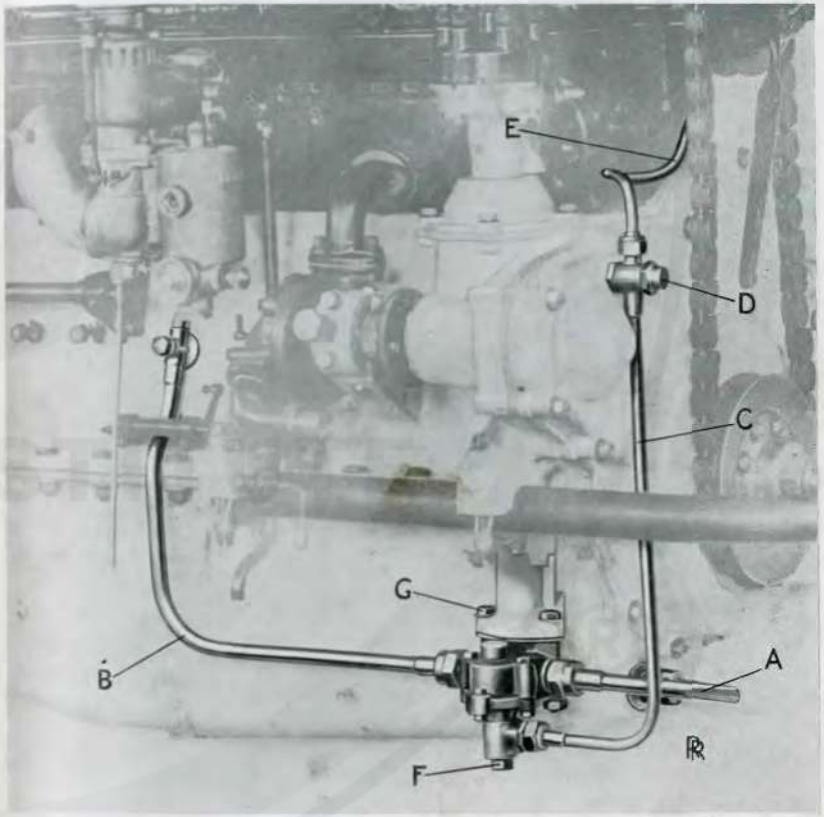

FIG. 10. OIL PUMP.

board pressure gauge. Incorporated with the pump is a relief valve. The released or overflow oil is taken by a pipe, **C**, to the timing gear wheels, a connection, **D**, 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 **D**, 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

FIG. 11. OIL SUMP FILTER REMOVED.

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 first to drain the oil from the crankcase. For this purpose a plug is provided in the filter supporting plate, which should be unscrewed, 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 in Fig. 11. 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 red fibre joint washer is in position between filter-flange and crankcase. A fibre washer is also fitted on the drain 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, and the engine should never be run with less than half a gallon.

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

Dismantling Oil Pump and Relief Valve. The relief valve is easily removed by unscrewing plug **F**, as shown in Figs. 10 and 12. Care must be taken that the valve **B** and spring **C** (Fig. 12) do not drop out when removing the plug in question. It will be noticed that plug **F** is fitted with adjustment washers, **D**, 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.

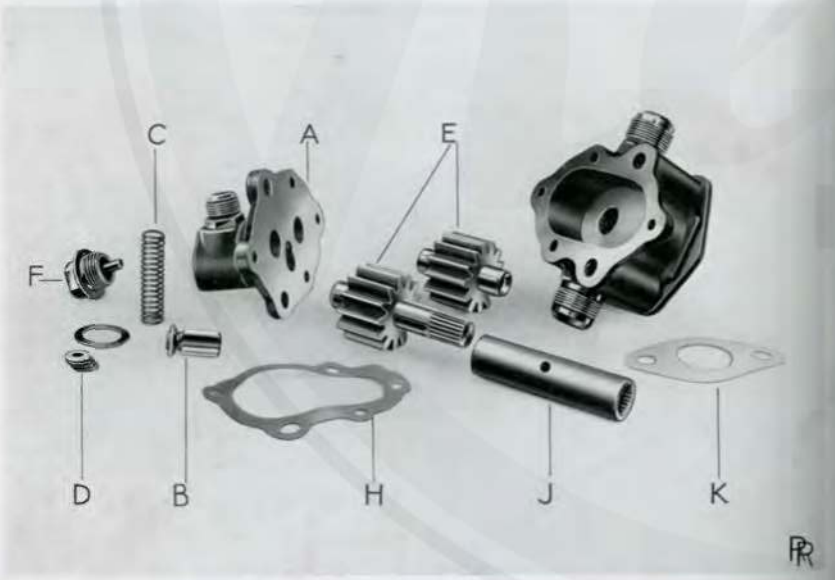

FIG. 12. OIL PUMP DISMANTLED.

After cleaning the valve and its seat, the parts can be replaced, and the plug **F** screwed up, taking notice that the fibre 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. 10) unscrewed. The pump, complete with its hollow drive shaft, **J** (Fig. 12), can then be removed. By unscrewing the four small bolts securing the casing cover **A**, the latter may be removed, and the gear wheels **E** taken out. When reassembling, care should be taken that a suitable paper joint washer, **H**, is arranged between cover **A** and the casing, and also that a paper joint washer, **K**, 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. The engine should not need decarbonising before about 10,000 miles have been covered. When this time arrives, it is best to drain old oil from the crankcase, preferably when the engine is hot. For this purpose the engine undershield should be removed, and the drain plug taken out. The oil sump filter can then be removed, cleaned, and replaced, as described on page 51.

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.

Access to this is obtained by removing the battery-box cover.

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

Removing Rocker Cover. A small terminal box is situated on the dash adjacent to the Klaxon horn (shown at **E**, Fig. 7). The cover of the box should be removed, and the terminal within it disconnected. This separates the low-tension lead to the "make-and-break" from the electrical system. The front end of this low-tension lead is connected to a terminal on the "make-

and-break " casing, which may be disconnected by pulling the terminal outwards against the action of an internal spring. The spring clips securing the high-tension distributor moulding should now be released, and the sparking plug terminals disconnected. The three knurled screws which hold on the rocker cover should be removed, when the cover, complete with the coil and high-tension wires, can be lifted off.

Removing Rocker Shaft. 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 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 and damaging the joint gasket, 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

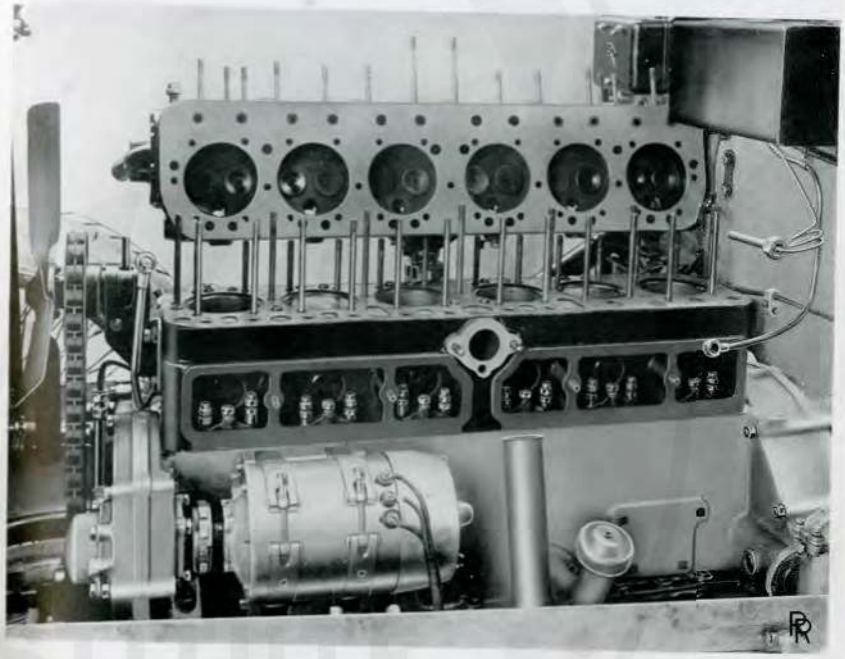

FIG. 13. CYLINDER HEAD REMOVED FOR DECARBONISING.

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 placed aside until required.

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 spring must be compressed, carrying with it the washer **A** (Fig. 14), the valve meanwhile being held on its seat. 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.

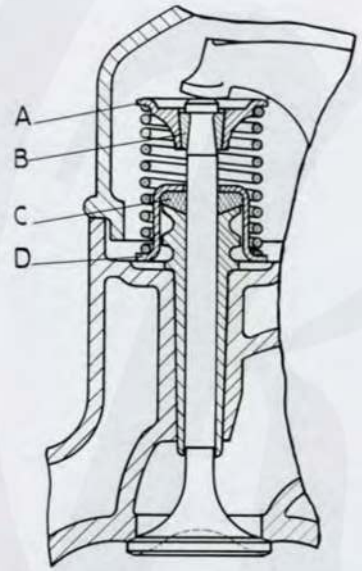

FIG. 14. SECTION THROUGH VALVE GUIDE.

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 a screwdriver, only a light pressure being applied, or valve and seat will become scored.

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, care being taken that the felt packing washers and glands are in position, and that the valves are replaced in the seatings from which they were remove

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 and the gasket should be carefully wiped to remove all particles of foreign matter. The gasket may then be 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.

Re-assembling. The push-rods should be replaced in the tappets before replacing the rocker shaft. 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 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 fibre 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 re-fitting the upper radiator water pipe, it should be observed that the packing pieces of the clips are in position.

Adjusting Tappets. The valve tappets are provided with adjustable heads, access to which is obtained by removing the two covers on the left-hand side of the engine. In Fig. 15 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.

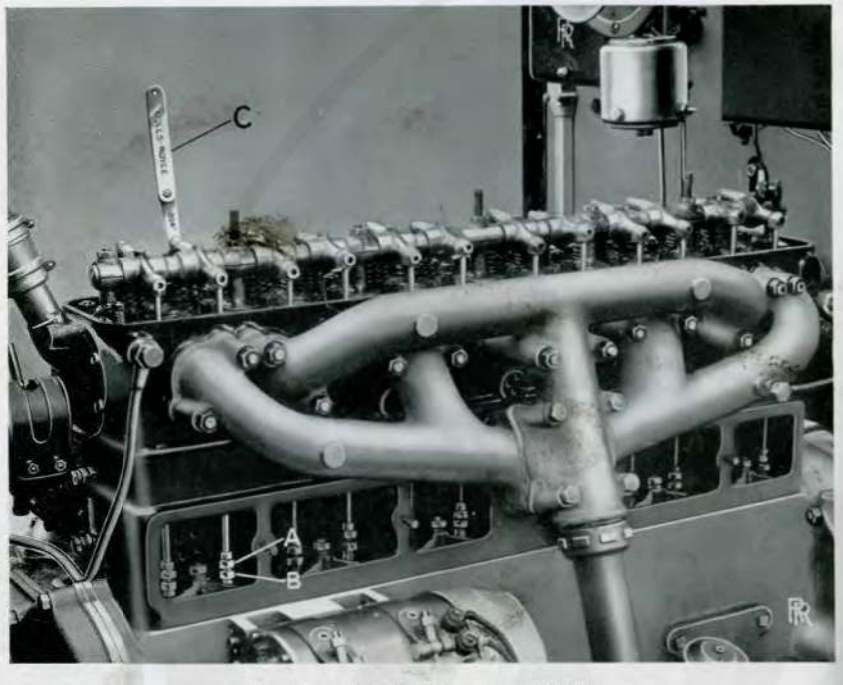

FIG. 15. ADJUSTING THE TAPPETS.

With the engine cold, and the valve roller on the base of the cam, there should be ·004" clearance, measured between valve stem and rocker. A feeler gauge is provided in the tool-kit, and is shown in position for measuring the tappet clearance at **C**. 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 locknut should be tightened up.

When checking the tappet clearances periodically, as directed on page 24, 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 low-tension ignition leads, and filling up the radiator, the car should be again ready for running.

CHAPTER VI.

Petrol Feed System and Carburation.

Action of Vacuum Feed System—Failure of Supply—Petrol Filters—Petrol Level Indicator—Action of the Carburetter—Setting of the Jets—Mixture Control—Starting Carburetter—Float Mechanism and Petrol Feed.

Action of Vacuum Feed System.

The working of the automatic petrol feed will be understood by reference to Fig. 16. 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. This 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 an 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.

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

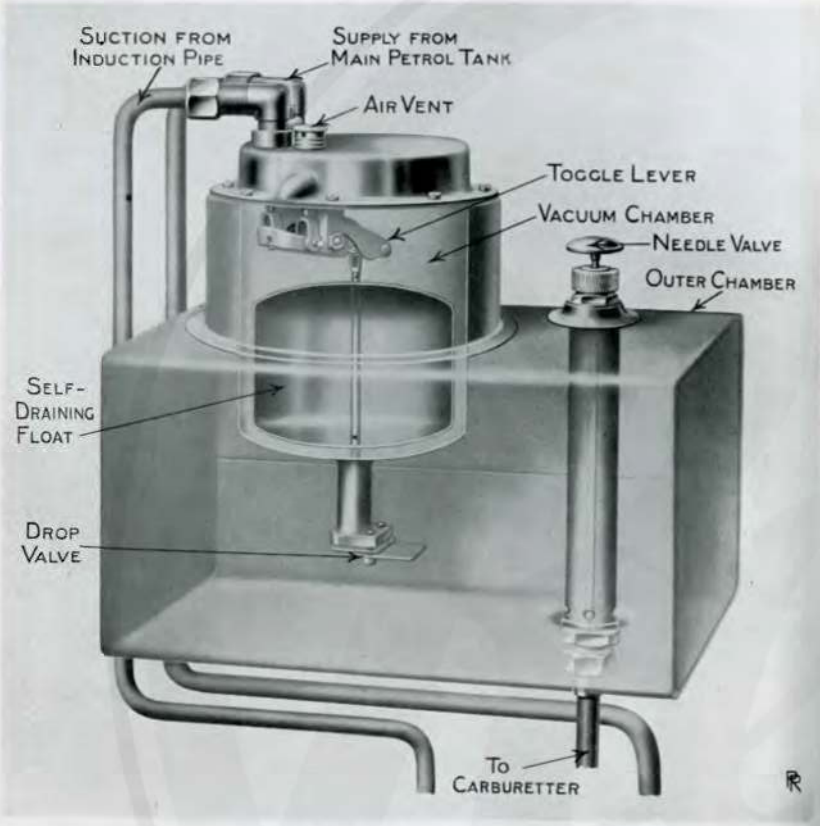

FIG. 16. VACUUM FEED TANK.

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.

Failure of Supply. Should the vacuum tank be emptied, due to running out of petrol or draining for cleaning, there is no necessity to remove any connection for the purpose of "priming" the tank. To fill the vacuum tank, close

the main throttle, see starting carburetter control is in the closed position, then use either the starting 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. Its presence can be checked by opening the needle valve and watching for the appearance of petrol at the small inspection window provided in the carburetter float chamber. 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. To do this, 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 washer 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 by disconnecting the main supply pipe, and carefully cleaned. The gauze must be replaced with the cone pointing upwards.

A filter is also arranged on the carburetter float chamber. The carburetter is shown in Fig. 19, with certain parts removed for cleaning, among them this filter. To remove it, the large nut **A** should be unscrewed, and the filter **B** withdrawn and cleaned about every 5,000 miles. The plug **C** should also be removed and cleared of any sediment or water which may have accumulated. A further plug, **S** (Fig. 18), is arranged at the base of the float chamber, and

should also be removed and cleared of sediment. When replacing the carburetter filter, care should be taken that the joint faces are clean, as these make a metal-to-metal joint, no washers being used.

When filling the main petrol tank, a combined filter and funnel should always be used. But in case foreign matter gains access into the tank, a large filter is provided on the outlet pipe. This is illustrated at **A** (Fig. 17), which shows part of the tank broken away to reveal the filter and level indicator. This filter should be cleaned

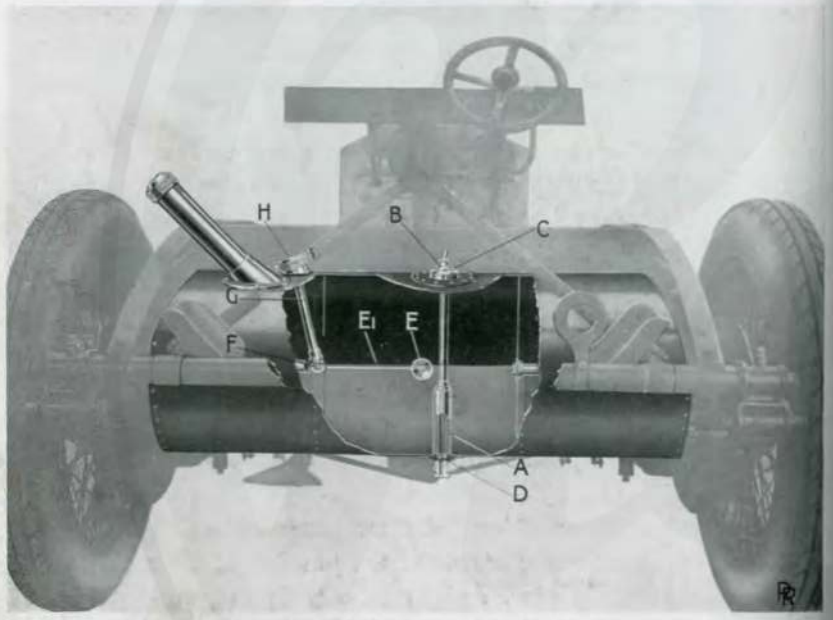

FIG. 17. PETROL TANK FILTER AND LEVEL INDICATOR.

every 5,000 miles. To remove it, the union **B** should be disconnected and the four screws **C** taken out. The filter may then be taken out, care being taken not to damage the leather joint washer. The filter gauze is retained in position by a cotter pin, **D**, which must be removed to free the gauze. Cloth of a fluffy nature should not be used for cleaning petrol filter gauzes, 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 stiff brush. When replacing this filter, check that the leather joint washer is in position.

After prolonged use, it is advisable to drain the main tank by removing the plug which is situated immediately below the filter. This will flush out any accumulation of sediment or water.

Petrol Level Indicator. A float-operated level indicator is contained in the main tank and shown in Fig. 17. The float **E** is carried by an arm, **E1**, 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, **H**, graduated in gallons. As the float rises or falls, the spindle is rotated and indicates on the dial the contents of the tank.

FIG. 18. CARBURETTER.

Action of the Carburetter. The carburetter is of the Rolls-Royce automatic expanding type, provided with two jets controlled by a single lever from the instrument board. 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. The complete carburetter is shown in Fig. 18, and in Fig. 19 it is shown with certain parts removed. The capacities of the jets are regulated by taper needle valves, that for the small or low-speed jet being shown at **W** (Fig. 18), 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

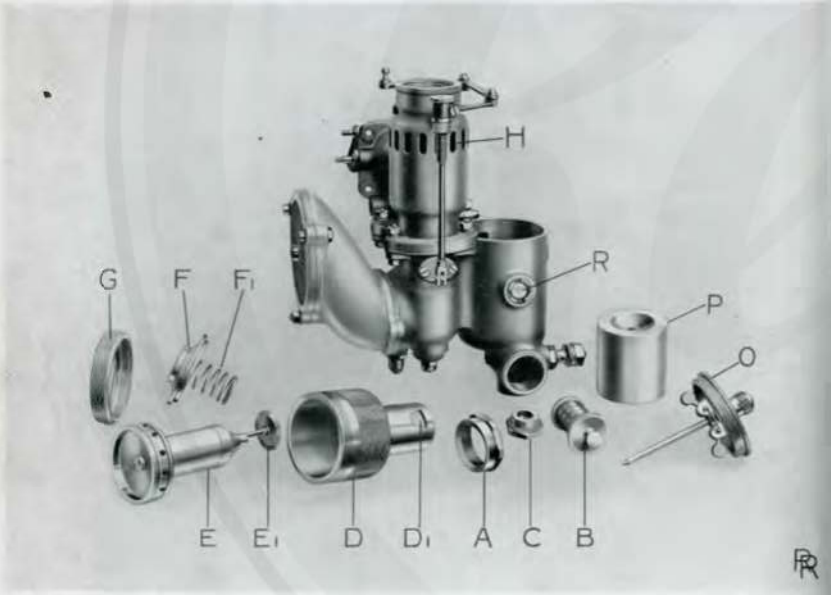

FIG. 19. CARBURETTER, WITH CERTAIN PARTS DISMANTLED.

in a cylinder, **D** (Figs. 18 and 19), located above the high-speed jet. The cylinder **D** and piston **E** are shown removed for cleaning in Fig. 19. The cap **F** carrying the spring **F**[1] 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 **F**[1], carrying with it a diaphragm, **E**[1], which fits into, and in its lowest position blanks off, the larger choke tube. Air is then admitted 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 **D**[1], 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.

The air valve and cylinder should be removed every 2,000 miles, and carefully wiped with a piece of clean dry cloth. No oil should be used on these parts.

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 **J** (Fig. 18) 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 **J** 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, the following procedure must be adopted:—With the mixture control lever half-way along its quadrant and the clamping screws **J** slack, the knurled nuts should be turned until both jets are fully closed. In the case of the high-speed jet, this will occur when its nut, **K**, is turned in a clockwise direction as far as possible, the fingers only being used in this operation, and no undue force being applied. For the low-speed jet, 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. Both jets will now be fully closed. A trial setting can then be obtained by rotating the knurled nuts in an anti-clockwise direction, one complete turn being given to that of the high-speed jet and half a turn for the low-speed jet. The clamping screws **J** should then be tightened and the engine started up.

With the mixture control lever 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 only just commences to lift. Movement of this can be observed by looking through the air ports in the carburetter. The clamping screw **J** 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 misses fire, or even possibly stops, 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. The engine should pop back and miss fire in the weak position and miss fire in the strong position. 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 probably 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." It should be borne in mind that 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.

Starting Carburetter. A special auxiliary jet and expanding choke tube is incorporated in the carburetter for starting purposes. This jet can be regulated by means of the knurled screw **M** (Fig. 18), 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 two-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 the mixture until the engine slows down slightly. 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 un-

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

Float Mechanism and Petrol Feed.

The float chamber cover, **O** (Fig. 19), should be unscrewed when cleaning the filter, and the float, **P**, removed. The float chamber can then be wiped out with a clean cloth.

A small window, **R**, is provided in the float chamber, and the petrol level is set to lie half-way across this window. No re-adjustment is necessary for different fuels, and benzole or benzole-petrol mixtures may be used if desired, the mixture control lever permitting any required variation in mixture strength without re-adjustment of the carburetter. This window also provides a convenient means of ascertaining that fuel is reaching the carburetter. "Flooding" of the carburetter by agitating the float needle is not necessary, the starting carburetter providing 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.

CHAPTER VII.

Care and Adjustment of the Brakes.

Foot Brake Adjustments—Hand Brake Adjustment—Checking and Locking the Adjustment—Re-covering Brake Shoes—Lubrication of Operating Gear—Use of the Brakes.

The brakes are of the internal expanding type, both hand and foot brakes operating on large drums on the rear wheels. The aluminium brake shoes are fabric-lined, and suitably enclosed within

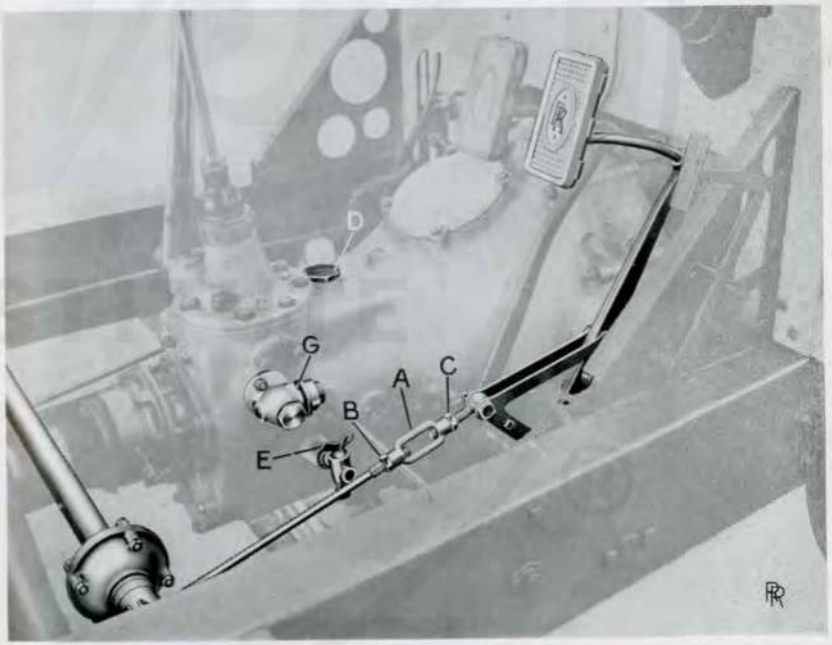

FIG. 20. FOOT BRAKE ADJUSTMENT AND GEARBOX FILLER.

the drums to protect them from dirt and oil. Compensating gears of the full bevel-differential type are provided on the operating cross shafts.

Foot Brake Adjustments. A turnbuckle adjustment for the foot brake is provided on the rod coupling the brake pedal to the compensating gear. This turnbuckle is shown at **A** (Fig. 20). Locknuts, **B** and **C**, are fitted at either end of the turnbuckle, which must, of course, be released before using the adjustment. The nut **B** has a right-hand thread, and **C** a left-hand thread. When properly adjusted, there should be from $\frac{3}{4}$" to 1" of movement on the brake cables when the pedal is lightly pressed down from its " off " position to the point where it can be felt that the shoes are just touching the drums. In the latter position there should be about $2\frac{1}{2}$" clearance between pedal and footboard. The brakes should not be adjusted too closely; less than $\frac{3}{4}$" movement of the cables, as described, will render the brakes liable to " drag."

When all the adjustment permitted by this turnbuckle has been utilised, it should be turned back to its original position, the nuts locked, and use made of the adjustment provided on the back axle. A view of this adjustment for both hand and foot brakes is given in Fig. 21, looking from the underside of the axle. The outside rods, **A**, actuate the foot brake shoes, and adjustment is effected by removing the bolt **B** from the jaw **C**, this bolt being secured by a castellated nut, slackening the small nut **D**, and screwing the jaw further on to the rod **A**, to an extent depending on the amount of adjustment required.

The corresponding rod at the other end of the axle should be dealt with similarly. It is important that the amount of adjustment made to both these rods should be the same. A convenient method of checking this is to measure the distance between the collar A^1 and the jaw **C**.

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

Hand Brake Adjustment. All adjustment for the hand brake is made on rods **E** (Fig. 21), 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, as described in the

preceding paragraph, but it should be noticed that the bolt **F**, of the hand brake jaw **H**, cannot be removed until jaw **C** is disconnected.

As in the case of the foot brake, so with the hand brake, it is important that there should be from $\frac{3}{4}$" to 1" of movement of the cables before the shoes come into contact with the brake drums. This will be found approximately to correspond with movement of the brake lever from its fully " off " position, to the second notch of its quadrant.

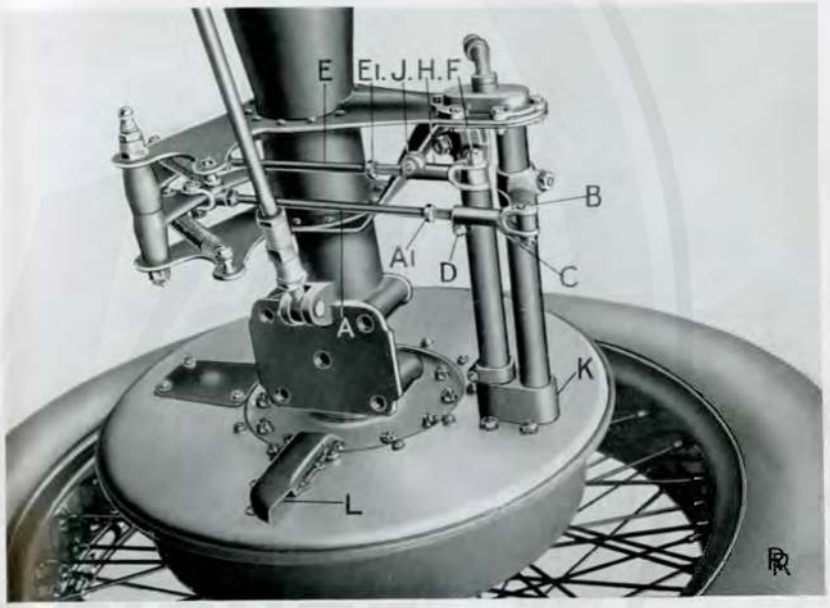

FIG. 21. BRAKE ADJUSTMENT UNDER AXLE.
(Viewed from below.)

Checking and Locking the Adjustment. 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 touch the drums. This 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, **D** and **J**, tightened up.

Re-covering Brake Shoes. The amount of adjustment provided is so proportioned that when all has been utilised (jaws **C** and **H** being against the collars **A**[1] and **E**[1] 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.

Lubrication of Operating Gear. In order to avoid the risk of oil getting on the brake surfaces, very careful use must be made of the oil gun on lubricators of bearings **K**. Excess of oil at this point may result in the effectiveness of the brakes being spoiled. Also it should be noticed from time to time that the oil drain **L** is not obstructed by dirt. This is conveniently done periodically, at the same time as attention is given to the various joints and lubricators of the brake gear.

Plugs are provided in the casings of the differential compensating gears. These plugs should be unscrewed and engine oil injected with a syringe every 2,000 miles.

Use of the Brakes. Sudden and violent application of the brakes should be avoided except in cases of emergency. The proper way to stop the car is to release the accelerator some time before the destination is reached, and use the engine as a brake. Then, on arriving near to the stopping place, the clutch may be withdrawn and the brake applied. To avoid shock to the passengers, the brake should be eased off at the moment of stopping and the hand brake applied when the car is stationary.

It is advisable on long declines to make use of the hand brake, as the foot brake is more frequently used under ordinary driving conditions. Wear on the foot brake can thereby be reduced.

CHAPTER VIII.

Clutch and Transmission.

Clutch Adjustment — Lubrication — Gearbox — Universal Joints — Back Axle.

A part sectional elevation of the clutch is shown in Fig. 22. It is of the single dry-plate type, the fabric **A** being secured to the flywheel and clutch ring members respectively, thereby enabling the clutch plate **B** to be kept as light as possible. Four levers, **C**, 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 thereby 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 **C**, 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 locknuts **G**, the tappet 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. It is of vital importance that this clearance should be equal for each of the four levers, the pedal not being moved

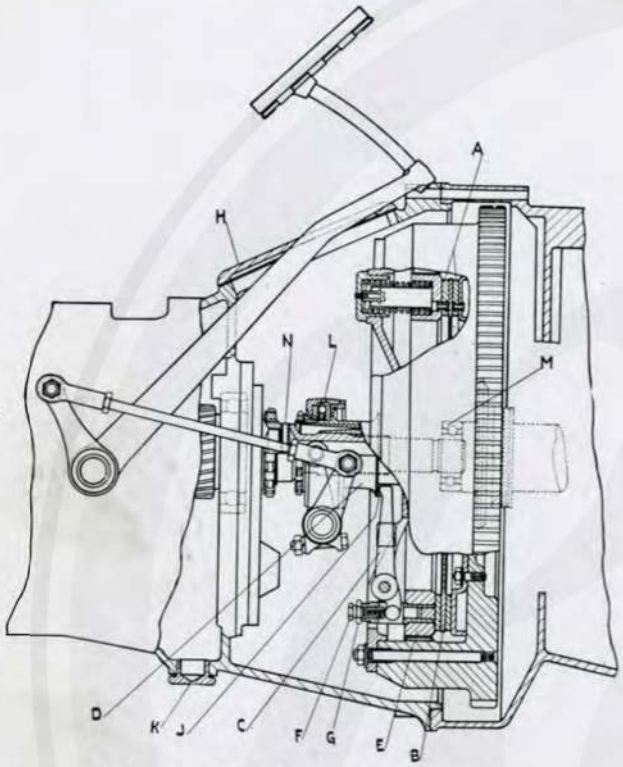

FIG. 22. PART-SECTIONAL VIEW OF CLUTCH.

during the adjustment. When the necessary clearances have been obtained, the nuts **G** should be carefully locked.

Lubrication. 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, as mentioned on page 24. 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 arranging a small tube, **N**, through one side of the clutch shaft. A few drops only should be inserted every 5,000 miles, as directed on page 26. 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 fulcrum pins of the levers **C** should also be lubricated occasionally.

Gearbox. The gearbox is of the usual sliding type, the two main shafts being supported in three bearings each. The extra bearings largely contribute to the permanency of 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 **D** (Fig. 20). 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. A level indicating tap is fitted at **E** (Fig. 20), and this should be open while filling the box.

Every 10,000 miles all oil should be drained out by removing plug **K**, and fresh oil inserted.

A worm-driven connection is provided on the gearbox for the speedometer, the drive ratio being suited for the speedometer which is supplied. This connection is shown at **G** (Fig. 20).

Universal Joints. The propeller shaft universal joints are enclosed, and provided with oil-gun lubricators. The driven portion of the forward joint is slidably mounted on serrations of the propeller shaft, 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 over-estimated. As directed on page 22, it is recommended that half a gun-full of gear oil should be injected into each joint every 500 miles.

Back Axle. The back axle is of the "full floating" type, the road wheels being entirely mounted 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 standpipe 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. 23), and the plug at **B**. The latter should be removed during filling, which, as in the case of the gearbox, 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 **C** 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.

Every 10,000 miles all the oil should be drained out and replaced with fresh oil. To do this standpipe **A** must be removed by unscrewing the serrated nut into which plug **B** is screwed. A locking washer

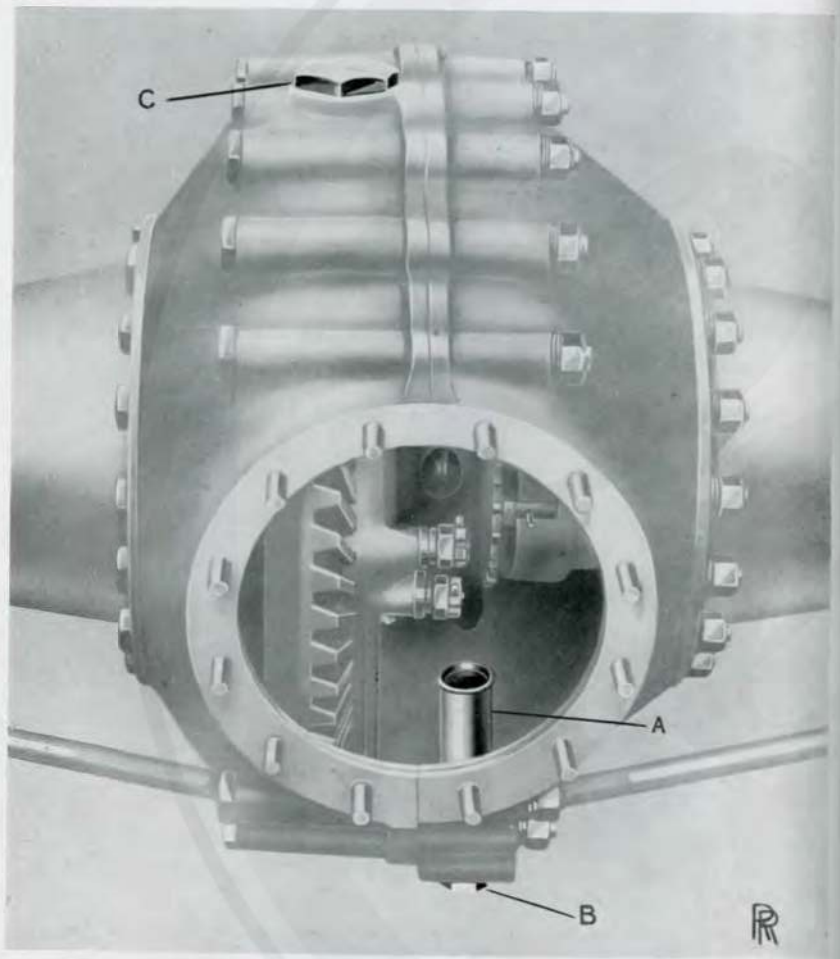

FIG. 23. OIL LEVEL PIPE IN BACK AXLE CASING.

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 Absorbers, and Road Springs.

Steering Box — Steering Joints — Steering Pivots — Front Shock Absorbers—Rear Shock Absorbers—Road Springs.

Steering Box. The steering is by worm and nut, a double ball thrust bearing being carried on the column a short distance below the steering wheel. Careful attention must be given to the lubrication of the worm-and-nut mechanism, for which purpose the housing is provided with a detachable cover and small spring lid lubricator. Every 500 miles, engine oil should be injected through this lubricator. Every 2,000 miles the cover should be removed and the worm smeared *liberally* with gear oil, the steering being turned first to one lock and then to the other during this operation in order to expose the worm.

Steering Joints. The joints of the side and cross steering tubes are of the adjustable ball-and-socket type, and are fitted with oil-gun lubricators. They should be freely lubricated with the oil gun every 500 miles, and frequently tested for slackness.

The joint at the rear end of the side steering tube is shown in Fig. 24. It is provided with " set-up " springs, one behind each bearing pad of the steering arm ball. The full pressure of these springs is restrained from falling on the ball under normal conditions by a stem formed integral with the pad and provided with a nut, which limits the movement of the pad under the influence of the spring. When passing over uneven road surfaces which tend to deflect the front wheels and jar the arms of the driver, one or other of these springs is compressed and absorbs the shock. When this joint requires adjustment, the cap **A** should be unscrewed. This will

expose a nut and locknut on the stem of one of the spring-loaded bearing pads. To take up play in the joint, the locknut should be slackened and the nut must be unscrewed until it is just clear of the shoulder against which it normally rests. This will allow the full pressure of the springs to fall on the joint ball. The nut should then be screwed up against the shoulder sufficiently to relieve the joint

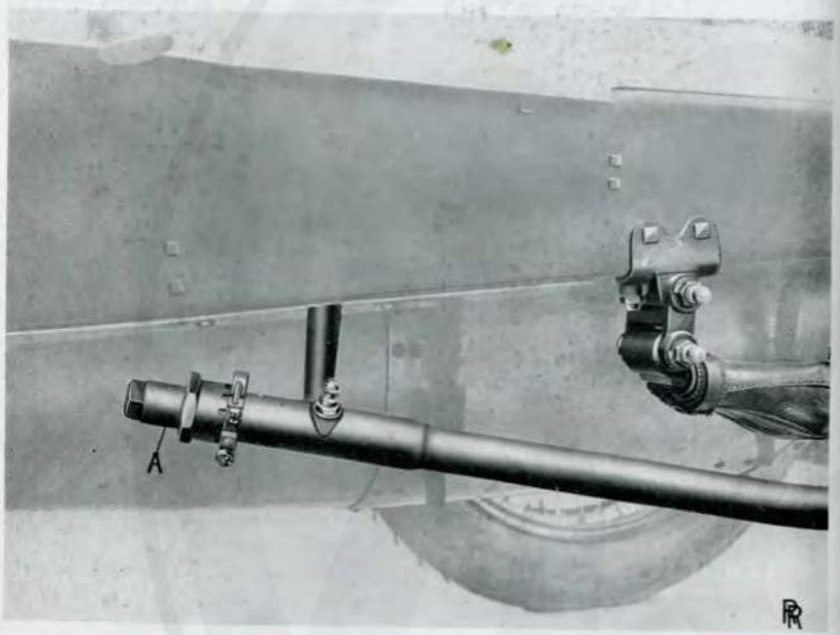

FIG. 24. REAR END OF SIDE STEERING TUBE.

ball of spring pressure without introducing any appreciable slackness. The locknut must be securely tightened, care being taken not to upset the adjustment.

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. To adjust these, the bolt **A** (Figs. 25 and 26), which is fitted with a castellated nut, should be slackened, and the locknut **B** unscrewed. The squared end **C** must now be turned in a clockwise direction 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.

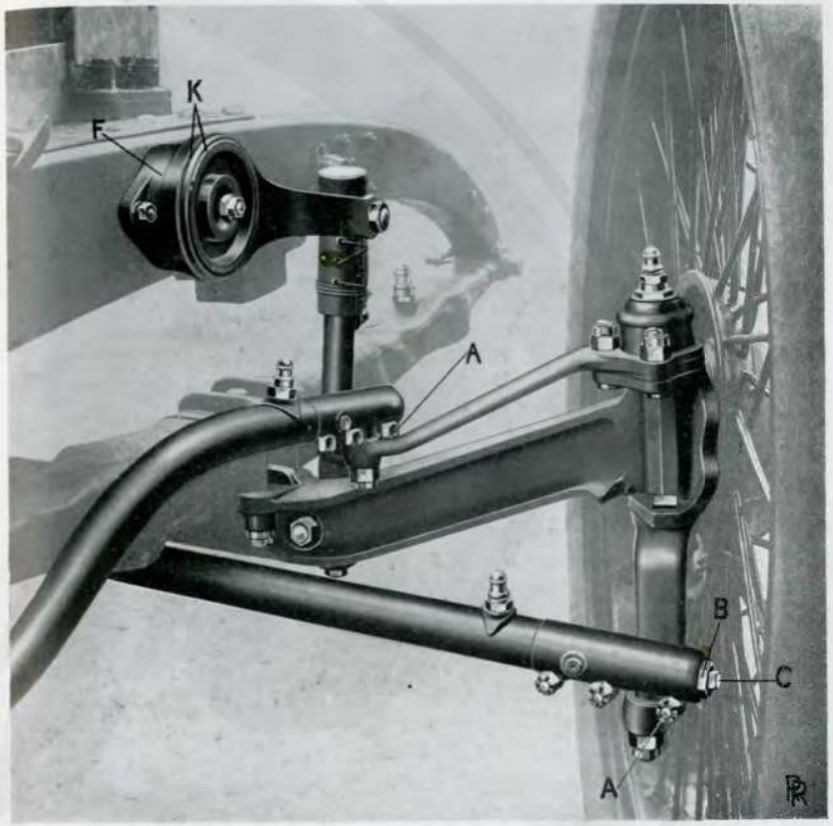

FIG. 25. CROSS STEERING TUBE AND FRONT SHOCK ABSORBER.

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. The lubricator of one pivot is shown at **D** (Fig. 26). 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. The plug **E** should be removed occasionally to drain off any water which may have accumulated.

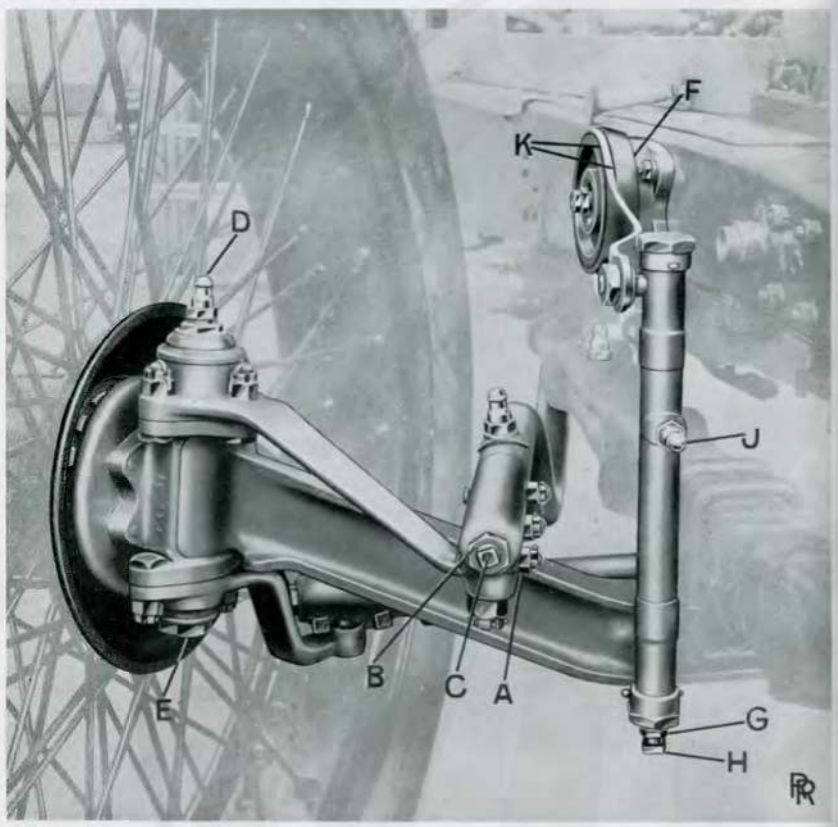

FIG. 26. STEERING PIVOT AND SHOCK ABSORBER CONNECTION.

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

Front Shock Absorbers. Friction shock absorbers are fitted, being connected to the front axle by adjustable ball-and-socket joints. One of these shock absorbers is shown at **F** (Figs. 25 and 26). The connections should be tested occasionally and adjusted if any slackness is noticed. To do this, the locknut **G** (Fig. 26) should be unscrewed, and set screw **H** screwed up 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 connection slightly by hand, but no slackness must be present. Oil should be freely injected through lubricator **J** by means of the oil gun every 500 miles.

In order to maintain the cup leathers in a soft and pliable condition, a little engine oil should be put on their edges at points **K** (Fig. 26) every 500 miles.

Rear Shock Absorbers. The rear shock absorbers are of the multi-plate "progressive" type, and are situated inside the chassis frame members, as will be seen on reference to the plan view (Fig. 1). The connections to the axle are exactly similar in design to those of the front shock absorbers, consequently similar remarks apply regarding their adjustment and lubrication.

Oil-gun lubricators are fitted on the shock absorber casings, and gear oil should be injected every 2,000 miles, as directed on page 24. No other attention should be necessary.

Road Springs. The road springs are encased in leather gaiters fitted with oil-gun lubricators. Gear oil should be injected through these every 1,000 miles. The shackles and pins are also fitted with oil-gun lubricators, and require careful lubrication every 500 miles, as directed on page 22. It is advisable occasionally to inspect all spring bolts and clips, to see that these have not worked loose.

CHAPTER X.

Water Cooling System.

Water Pump—Re-packing Pump Gland—Radiator Shutters—Frost —Fan.

Water Pump. The centrifugal water circulating pump is fitted with a special double packing gland designed with the object of facilitating lubrication, and thereby reducing wear, and also to reduce the possibility of leakage. A screw-down greaser is provided for lubricating the gland and bearings. It should be kept filled with thick grease, and given a turn every 500 miles.

Re-packing Pump Gland. In Fig. 27 the pump is shown removed from the engine, with the gland dismantled for repacking. If leakage occurs at the gland, the knurled cap **A** should be screwed in an anti-clockwise direction viewed from the radiator, the thread being left-handed. Only the fingers must be used in this operation. When the cap has been screwed up as far as possible and leakage still occurs, the gland will require repacking, for which purpose the system must be drained by opening tap **B**, and the pump removed bodily. To do this, the inlet and outlet pipes at **C** and **D** 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 its shaft being a sliding fit in the coupling. The cap **A** 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. It is important that *both* these packings should be renewed or increased, hemp and tallow being used for the purpose, and the amount of packing at both points being approximately equal.

When replacing the pump, a "Dermatine" washer should be arranged on the outlet flange, and care must be taken to see that

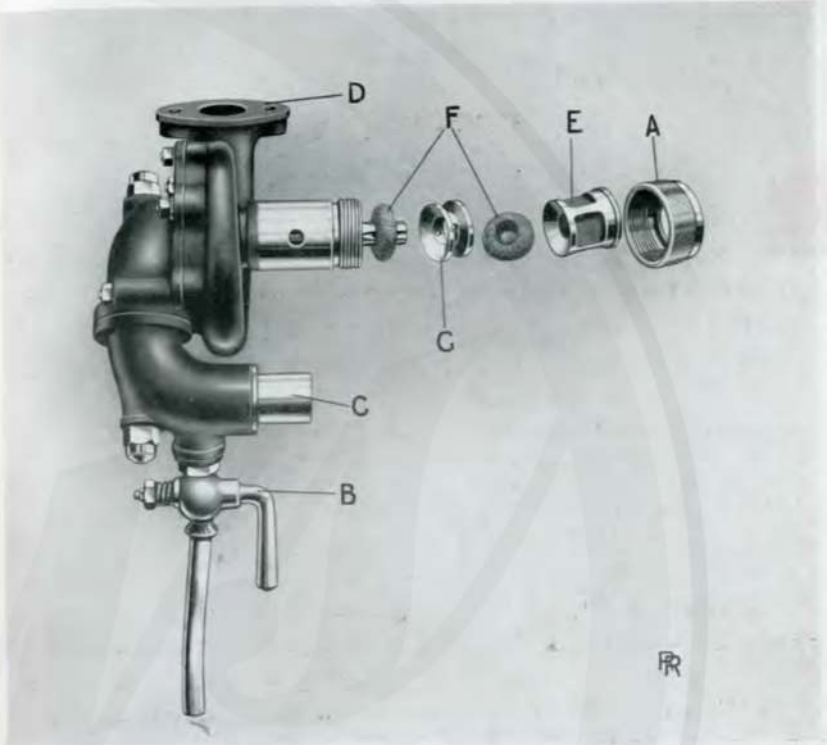

FIG. 27. WATER PUMP WITH GLAND DISMANTLED.

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.

Radiator Shutters. It is important that the cooling water should not be allowed to boil, and, on the other hand, the engine must not be allowed to run in too cool a condition, because, in the former case, water will be lost, and in the latter the engine will not 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 80°, as any temperature between these two extremes represents a reasonable condition for the engine.

When running at night, it is necessary to check that the jacket temperature is correct by using the instrument board lamp, as the presence of steam, indicating too high a temperature, might not be noticed under such conditions.

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.

Frost. When there is any likelihood of the car being exposed to a temperature below freezing point, the cooling system should be drained by opening the drain tap **B** (Fig. 27), situated on the pump inlet. Before attempting to turn the crankshaft for starting after exposure to frost, hot water should be poured over the water pump to thaw any particles of ice which may be present in the casing, and which would probably damage the impeller. Hot water should also be used for filling up the radiator.

Under extremely cold climatic conditions, an anti-freezing mixture may be used if desired. The most suitable mixture is obtained by adding 20 per cent. of denatured alcohol or methylated spirits to the water. This will lower the freezing point to about 10° F. As the alcohol will in time be reduced by evaporation, the radiator should under such circumstances be filled up when necessary with a mixture of half alcohol and half water.

If plain water be used and the weather very cold, it is best to keep the engine running when the car is left standing; it is also a good plan to throw a rug over the radiator, in addition to closing the shutters when the car is at rest.

Fan. A small hole, **A** (Fig. 28), is arranged in the boss of the fan, into which a few drops of gear oil should be injected with a syringe every 5,000 miles.

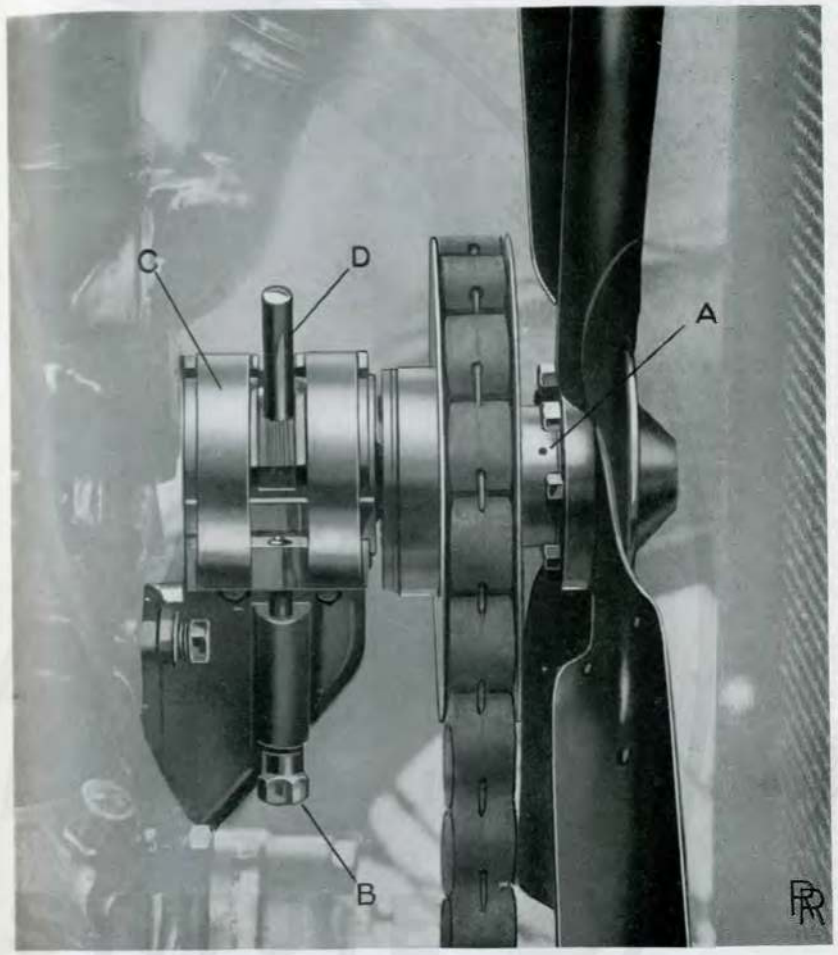

FIG. 28. FAN BELT ADJUSTMENT.

The tension of the driving belt should be tested occasionally. It should be kept only gently tight. The fan is eccentrically mounted in its housing **C**, and belt adjustment is effected by slackening the nut **B** and pushing over lever **D** until the required belt tension is obtained.

If the climatic temperature is consistently low, it may be advisable to remove the fan belt. Under such circumstances, however, one must carefully notice that the jacket water is kept within the prescribed temperature limits and not allowed to boil.

CHAPTER XI.

Wheels and Tyres.

Removal of Wheel—Care of Wire Wheels—Lubrication of Wheel Bearings—Removing and Dismantling Front Hubs—Re-assembling and Replacing Front Hubs—Removing and Dismantling Rear Hubs—Re-assembling and Replacing Rear Hubs—Tyres—Inflation of Tyres—Removing a Tyre—Refitting a Tyre—Spare Tyre—Cuts in Tyres.

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. 29, the spanner is shown in position on a wheel. Before using the spanner, the central screw **A** must be unscrewed as far as possible. After jacking up the car, the spanner can be placed in position by pressing the levers **B**

FIG. 29. REMOVING DETACHABLE WHEEL.

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 **A** should then be turned until the serrations of the locking plate **C** 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 wooden mallet in conjunction with it, to ensure absolute tightness.

Care of Wire Wheels. Every 2,000 miles the 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. Consequently, it is necessary periodically to try each hub nut with the spanner, and tighten if necessary.

Care must be taken, when driving close to a high curb, to avoid catching the projecting spokes. 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 much attention. It is advisable, however, to remove the small screw, which will be found in the centre of each hub, every 5,000 miles, and inject a small quantity of gear oil with a syringe. In the case of the rear hubs, this will also serve to lubricate the driving dogs, but due regard must be paid to the fact that an excess of oil at this point may get on the brake surfaces.

Removing and Dismantling Front Hubs. A section of the front hub is given in Fig. 30. To remove the hub, the screw **A** must first be taken out and replaced with the special tool **B**, shown in position in Fig. 31. Nut **C** should then be screwed up until the locking plate **D** is pressed inwards about $\frac{3}{16}$".

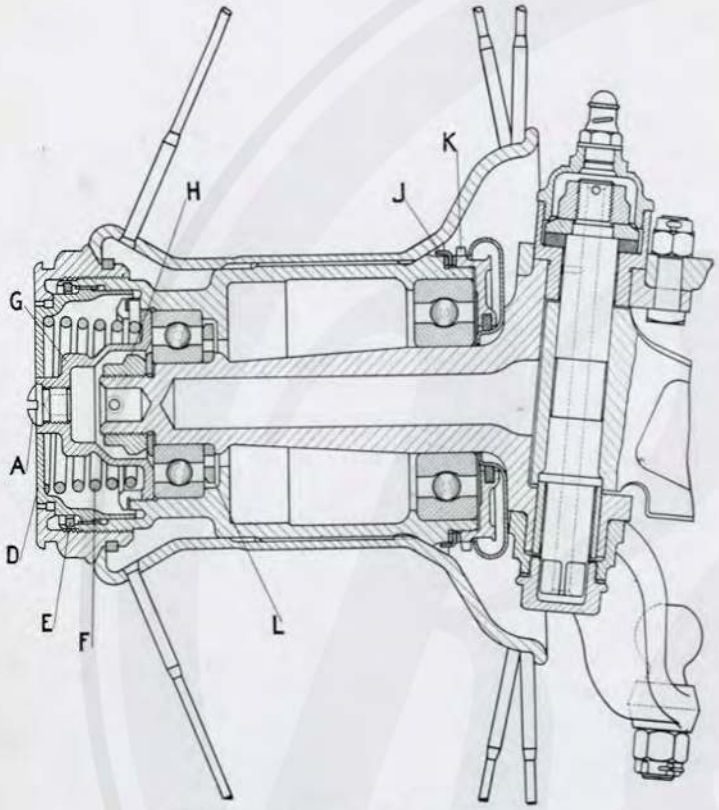

FIG. 30. SECTION OF FRONT HUB.

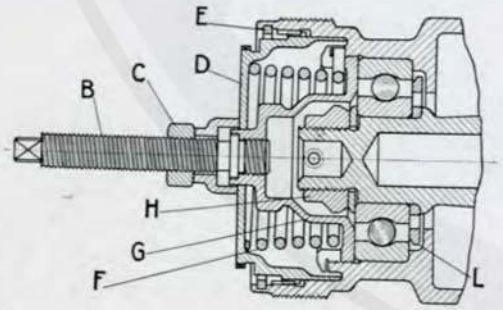

FIG. 31. TOOL IN POSITION FOR REMOVING LOCKING RING.

The split spring ring **E** 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. It will be noticed that its inner end is bent outwards and fits into slots locking the cap **G**. The latter has a left-handed thread for the off or right-hand wheel, and a right-handed thread for the near or left-hand wheel. It should be unscrewed with a box spanner, exposing the stub axle nut **H**. 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 it 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 of 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 tabs of the locking plate **J** must be bent clear of the cap **K**, and the latter unscrewed with the special spanner provided. This cap 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.

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.

Re-assembling and Replacing Front Hubs. When re-assembling the hub, the ball races should be packed with Hoffmann ball-bearing grease. The large race should be replaced first, followed by the retaining cap **K**. A new locking plate **J** must be used—being arranged between the two composition washers—and the tabs bent into position when the cap is tightly

screwed up. Next, the hub should be pressed on the axle and safety washer **L** put into position, followed by the small ball race. The axle nut 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 screwed up, 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 replaced with one of its serrations corresponding with one of those in the hub for the reception of spring **F**. With locking plate **D** in position, the spring should be compressed by means of the tool **B**, and the split spring 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.

Removing and Dismantling Rear Hubs.

A section of the rear hub is given in Fig. 32. To remove the hub, the screw **A** must first be taken out and replaced with the special tool **B**, shown in position in Fig. 33. Nut **C** should then be screwed up until the locking plate **D** is pressed inwards about $\frac{3}{16}$″. The split spring ring **E** 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. It will be noticed that its inner end is bent outwards and fits into slots locking the cap **G**. The latter has a left-handed thread for the off or right-hand wheel, and a right-handed thread for the near or left-hand wheel. It should be unscrewed with a box spanner, exposing the axle shaft nut **M**. The split cotter must be withdrawn, and this nut can then be removed. 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. 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**

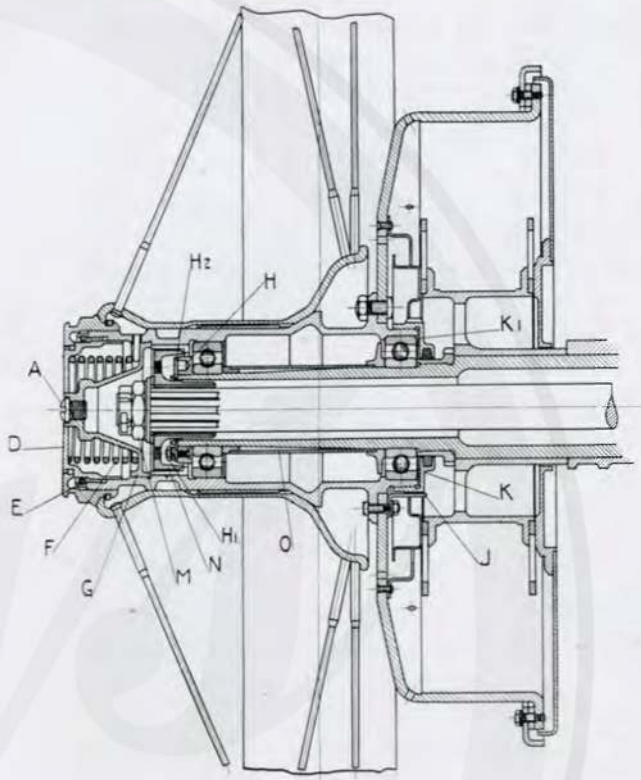

FIG. 32. SECTION OF REAR HUB.

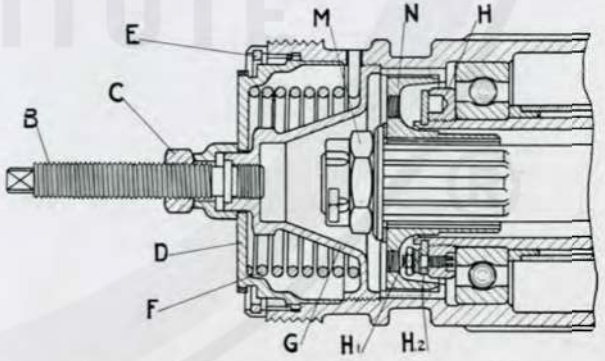

FIG. 33. TOOL IN POSITION FOR REMOVING LOCKING RING.

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 to temporarily attach a wheel for this purpose.

To remove the ball-bearings, the locking plate **J** must be removed, and cap **K** unscrewed with the special spanner provided. This cap 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.

Re-assembling and Replacing Rear Hubs. After packing the ball races with Hoffmann ball-bearing grease, the outer one should first be placed in position in the hub, 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 retaining cap **K**, with its fibre washer **K**[1], tightly screwed up until the locking plate **J** can be put into position to lock it. The hub may then be pushed home on the axle tube, nut **H** screwed up tightly, and the locking plate **H**[2] secured in position with its three small nuts **H**[1]. 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. Cap **G** should next be filled with grease and tightly screwed up, observing that the slots register to receive the end of spring **F**, which may then be replaced. The special tool **B** must be used to compress the spring with 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.

Tyres. Dunlop straight-side 32" by 4½" cord tyres are fitted. No security bolts are provided or necessary with these tyres, as they are designed to be self-retaining. A special tool (Fig. 34) is supplied in the tool-kit to assist in the removal and refixing of the detachable side flange, which is a feature of the 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 straight-side type that the tyre does not need a lever of any description either for removal or fitting.

Inflation of Tyres. The tyre pressures should be as follows:—

Front tyres	40 lbs. per sq. inch.
Rear tyres (closed cars)	50 lbs. per sq. inch.
Rear tyres (open cars)	45 lbs. per sq. inch.

It is important that these pressures should be maintained as nearly as possible. The high pressures recommended in the past result in uncomfortable riding and the early development of rattles in coachwork and chassis, with little, if any, increase in tyre mileage.

FIG. 34. SPECIAL TOOL FOR REMOVING SIDE FLANGE OF WHEEL.

On the other hand, pressures kept too low undoubtedly tend to shorten the life of a tyre. Moderate pressures are very necessary with tyres or cord foundation as supplied with the chassis. The pressures mentioned on previous page are those which have been found to give the best all-round results in both comfort and tyre economy.

FIG. 35. REMOVING THE SIDE FLANGE.

Removing a Tyre. After deflating the tyre, the pointed end **A** (Fig. 34) of the tool should be inserted in slot **P** (Fig. 35) at the gap in the side flange. 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 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.

Refitting a Tyre. The tyre should first be replaced 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 **B** (Fig. 34) of the tool in the recess at a point **R** (Fig. 36), just over halfway round 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 **Q** (Fig. 36) 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.

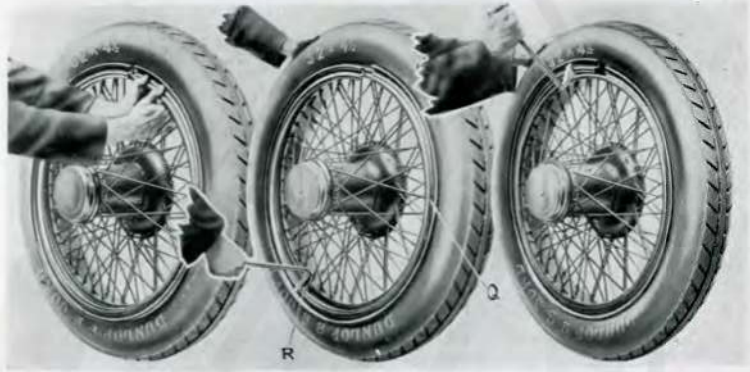

FIG. 36. REFIXING THE SIDE FLANGE.

Spare Tyre. Owing to the ease with which the straight-side tyres are removed and fitted, in combination with their large size and high quality, there is no necessity to carry more than the one extra tyre on the spare wheel. It is only necessary to carry as spares one or two inner tubes.

Cuts in Tyres. Tyres showing bad cuts should be dismounted at the earliest opportunity, and the cuts properly vulcanized. A tyre stopping can be used, temporarily, as unfilled cuts allow water to penetrate to the casing, and speedily rot the fabric.

CHAPTER XII.

Care of Bodywork.

1. A motor car should be kept in an airy, dry motor house, with a moderate amount of light, otherwise the colours will be destroyed.

2. There should be no communication between the stable and the motor house. The manure heap or pit should be avoided, as ammonia fumes are very injurious to both paint and upholstering.

3. A motor car should never under any circumstances be put away dirty. It will stain or spot unless care be taken to remove the mud before it dries on, or as soon afterwards as possible.

4. The use of petrol with the water when washing a car is most detrimental to the varnish, especially when the varnish is soft.

5. When washing a motor car, keep it out of the sun, use plenty of water, and apply, when practicable, the hose or syringe, taking care that the water is not driven into the body to the injury of the lining. When forced water is not obtainable, use for the body a large soft sponge. This, when saturated, squeeze over the panels, and by the flow down of the water the dirt will soften and harmlessly run off. Then finish with a soft chamois leather and old silk handkerchief, but it is important that all grit should be removed from the panels before leathering off; a particularly careful man would have a second sponge to use for his panels, and would on no account wash the bonnet, wings, chassis, or wheels with the same sponge or leather as he uses for the panels.

6. The same remarks apply to the underwork and wheels. Never use a spoke brush, which, in conjunction with the grit from the road, acts like sandpaper on the varnish, scratching it and, of course, effectually removing all gloss. If persisted in, it will rub off the varnish and paint down to the wood. Great attention should be paid to this point. Never allow water to dry itself on a motor car, as it will invariably leave stains.

7. Regarding the interior, when the trimming is of morocco, it should never be washed or even rubbed with a damp leather, as the dye of the skins is thereby loosened and comes off on the clothes of the occupants. When the upholstery is of cloth, a gentle rubbing with a soft brush is the best for cleaning it.

8. To remove stains or spots from the panels, a few drops of furniture polish reviver, or even linseed oil, on a dab made of woollen rags (using as little of the fluid as possible), will generally suffice. If the panels are very bad, nothing but a regular flatting-down and hand-polishing, or even re-varnishing by the coachmaker, will be effectual.

9. In cleaning brass or silver, be careful not to smear upholstery or paint with the polish. Silver should be cleaned with the best plate powder; brass may be cleaned with liquid cleaners, but great discretion should be used in the sort employed.

10. Keep a small bottle of japan always handy to paint the treads and steps worn by the feet; lay it on as thin as possible. If the treads and steps are of rubber, they should be treated with pipe-clay, which easily washes off.

11. As a general rule, a motor car retains its freshness better with moderate work than if standing for long periods in a motor house; the paint will not fade so quickly, and the lustre of the varnish will be greater.

12. A driver should be careful not to load the inside of a car with oil-cans, dirty bundles of odds and ends, or sharp-edged articles, as these do more damage to the coachwork and upholstery of a car in a few minutes than any amount of fair wear and tear. The driver should be equally careful to see that his hands and clothes are quite clean before touching the coachwork or upholstery of a car, as again much damage can be caused in a few minutes.

13. Such moving parts of the bodywork as locks, hinges, dovetails of doors, hoodstick joints, or the joints of cabriolet bodies, and windscreen joints, should be lubricated occasionally to prevent wear and eliminate squeaks.

CHAPTER XIII.

Demonstration Class.

We desire to advise customers of our Demonstration Class, which is maintained for the purpose of training drivers in the care, adjustment, and driving of a Rolls-Royce car. This class is only intended for men who have had experience in driving and maintenance of motor cars and require special instruction in the care and handling of the Rolls-Royce car. It is also of great benefit to customers with old type Rolls-Royce cars who intend getting a new chassis, as all the wiring system and the new parts are carefully demonstrated to the pupils in the class.

It is pointed out that only those who are engaged to drive Rolls-Royce cars can be accepted for instruction. The course occupies one week, commencing every Monday morning and finishing on the following Saturday at noon. The premises are well equipped, there being one car for actual driving on the road, and a chassis complete in all details, on which general instruction is given, and on which gear-changing methods are practised. There is also a fine lecture room, in which there is a complete set of units of the chassis, which are taken apart and demonstrated to the pupils. There is also a complete set of the wiring system laid out on a table, which makes it easier for the pupil to understand than if it was on a chassis. At the end of the course there is an examination, and customers are asked to allow their drivers to take part in this.

While undergoing tuition, drivers are boarded and lodged on the premises, which are specially equipped for the purpose.

In order that pupils shall not miss any of the course, which commences on Monday morning, they are requested to report at "The Welcome," Alvaston, Derby, on the Sunday night previously.

On arrival at Derby Station, if the pupils take the tram to Alvaston, anybody there will show them where "The Welcome" is situated.

We shall be pleased to forward to customers, on request, forms giving further particulars of this class.

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