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OVERSEAS TECHNICAL CORRESPONDENCE COURSE

Section 7 LIGHTING



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INTRODUCTION

Vehicle lighting, particularly the lighting on production cars, receives a great deal of attention from the Design and Development Departments and also from the user and the press. Contrary to some people's professed views the standard of road illumination, both close and distant is far better to-day than it has ever been. The high concentration of motor vehicles by night in densely populated urban areas has tended to throw the matter of lighting into high relief and the motor engineer will be well advised to make himself conversant with the subject.

Most lamps, particularly side and tail lamps, are subject to fairly constant changes in design, especially as to outline, in order to meet the styling requirements and the search for individuality by the vehicle manufacturer. This may, and sometimes does work to the detriment of the engineer in service and also to the storekeeper in regard to stocking and interchangeability of such lamps; in both cases there is nothing much to be done about it.

However, as shown in the illustrations, the range of such lamps for current production cars is quite limited.

Headlamps, and the range of different sizes and patterns, inevitably give rise to a good deal of controversy both as to the changing form of the lamp body, the lens and the bulb.

Whilst there is a great deal to be said in favour of the earlier "Stem Fixing" lamps it is inevitable that with new and radically changing body styles the flush-fitting type of headlamp has come to the fore; also the method of mounting these lamps provides a very fine directional adjustment and accessibility.

The idea that the lamp designer is one who should "never have been let out" is erroneous. His problems are many and varied. Everyone wishes to see as well at night as they can in daylight, and just as obviously, they must not be dazzled by any approaching vehicle. Also they must have visibility to drive at any speed they wish, and the light must not throw back rays from wet and shiny road surfaces.

These are only a few of the lamp designer's problems, and he might well be justified in expecting some help and support from the motor engineer in educating the user to the changing conditions, rather than the criticism which his most successful efforts frequently evoke.

According to the lamp designer his declared objective is to enable the vehicle user :—

1. To see the road direction.
2. To see that the way ahead is clear.
3. To keep his right place on the road.
4. To yield comfortable conditions and a sense of well being.

He could have added that since the vehicle user ranged from the man with his little family saloon travelling at forty m.p.h. to the high speed motorist who expected to be able to do eighty to a hundred miles an hour it wasn't going to be too easy.

However in due time a comprehensive range of headlights were evolved. Starting with an accurate and uniform method of focusing the lamp bulb, i.e. the pre-focused bulb, developing the old lamp glass into a lens, improving the reflecting surface and then assembling the components in a rigid, dust proof unit, optically correct in relationship to each other, he produced the *Light Unit*. Next came a range of lamp sizes and bulbs to suit the requirements of the vehicle, and ultimately, to obtain the very long range illumination required by the high speed driver, he introduced various cowling and reflecting devices, and special Long Range Driving Lamps.

The anti-dazzle problem is common to all, and has been largely solved by special lens design and dipping arrangements. Finally he had to face the fact that unless the whole arrangement was correctly set up and maintained on the vehicle, and also intelligently used, his efforts were seriously handicapped.

The motor engineer will do well to ponder the fact that every single detail appertaining to modern lamps and light distribution has been carefully, deliberately, and scientifically worked out to achieve its purpose.

As to the lighting circuits themselves, the simplicity of the circuits, the sizes of cables, the colouring and the great amount of economy achieved in installing the not inconsiderable number of circuits is a subject well worth careful study.

The vast majority of lighting troubles in service are concerned with the lamp bulbs themselves, or with defective earth connections. Occasionally instances of poor lights arise through voltage loss or "voltage drop" at such points as "snap connections" and switch contacts which may "weather" or corrode; but the most frequent cause of such troubles is the renewal installation of undersized cables and the fitting of incorrect lamp bulbs.

The localising of the more obscure but infrequent wiring troubles probably calls for more electrical *horse sense* than most faults, and for this reason a full and careful study of lighting trouble diagnosis is recommended.

Lamp bulbs themselves may be regarded to some extent as "consumable," or at least their lighting efficiency falls off in the course of time and usage. The most frequent cause of premature bulb failures, however, results from excessive vibration, or else interference with the voltage regulators, particularly by raising the voltage setting when excessive brilliance is obtained only at the sacrifice of longevity.

Another point of importance with lamp bulbs is that if the correct beam of light with maximum effect and minimum dazzle is to be obtained, it is essential, firstly that the bulb filament and locating plate are correctly positioned, and also that bulbs of the correct "rating and light emission" are fitted, and this can only be assured by fitting the manufacturers' specified lamp bulbs.

As may be realised, the size, power and positioning of lamps on the modern vehicle is governed either by regulation or recommendation. Numerous efforts have been and are still being made to obtain international agreement on such matters, but, so far, only a limited amount of success has been attained in this direction, hence the variety of headlamp lenses and bulbs.

The part to be played by the motor engineer in his position as *the expert* is to see that the customer gets the best out of his lighting, and, incidentally, do what useful business he may be able, in the way of selling lamp bulbs and special purpose lamps where some useful purpose may be served by so doing.

A proper understanding of the subject is the first requisite.

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Obligatory Lighting

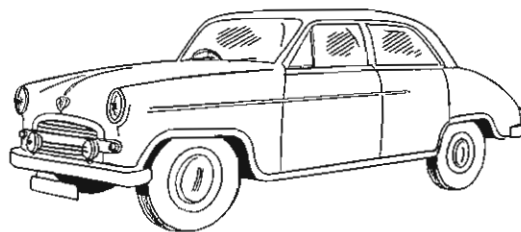
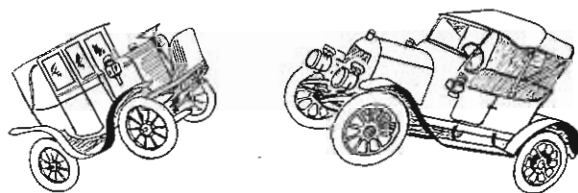
We shall not attempt to trace the history of vehicle lighting from the early days of the carriage to the modern motor vehicle. However, the distinction which existed from the very beginning, that which can be summed up as "see" and "be seen," is still prevalent to-day.

In England, the carriage lamp became the "obligatory" lamp or side-lamp; it enabled the vehicle "to be seen." In other words it merely indicated the position on the road.

As the speed of vehicles increased, it became imperative "to see" as well as "to be seen" and so we have progressively seen the introduction of headlights, long-range driving lights, passlamps, fog lights, in fact all the additional "extras" considered so necessary to modern motoring.

For "extras" they are in the eyes of English law, and optional at that; side and rear lamps, together with rear number plate illumination still constitute the only "obligatory lighting" for vehicles in the British Isles.

It is with this lighting that we shall concern our-



selves at the moment. We shall start with a review of modern side lights; carry on with rear lighting, including stop-tail, number plate lamps, and reflectors; and then show how the circuits for this lighting appear on the average vehicle.

MODERN SIDE LIGHTS

Here you see just a few examples of modern Lucas side-lamps. There are various shapes, sizes and mountings which conform to the constructional requirements of the particular vehicle.

The 488 for instance is used on cars where stem or spigot fixing is not convenient. It is a flush fitting lamp, consisting of a strongly moulded rubber body



encasing a fluted glass and chromium-plated rim. The 489 is similar in construction but with a smaller glass. The rim and glass assembly of these lamps is removable by inserting a coin or screwdriver between the rim and rubber base.

The LD109 on the other hand is of more conventional design and spigot mounted. The rim is located by a single screw to facilitate bulb replacement.

The 516 is a streamlined lamp, specially designed to match the contours of the car body.

The 545 is one of our latest side-lamps. It is provided with a bulb-holder suitable for taking a double filament bulb. One filament gives the normal side-light; the other is used as a "flashing indicator."

The bulbs used in the above lamps are as follows:

Lamp 488 No. 361, a 12-volt, double filament bulb with a rating of 18/6 watts. The 6 watt filament serves as the side-light, whilst the 18 watt is used for many applications as a "flasher" direction indicator.

The 489 is fitted with a No. 222 bulb. This is a single contact type rated at 12 volt 4 watt.

Both the *L545* lamp and the *516* take the same bulb, No. 222. Where the *L545* is used as a flasher and side-light combined, the No. 316 double filament bulb is used.

The *LD109* model employs bulb No. 207 — a 12-volt bulb rated at 6 watt.

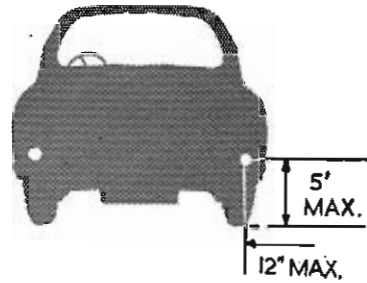
SIDE-LAMP INSTALLATION

Side-lamps are positioned on British vehicles to conform to the "Lighting Regulations" in force in Great Britain.

The regulations concerning the positioning of these lamps on cars and light-commercial vehicles state:—

1. Both lamps must be fitted at equal height and not exceeding five feet from the ground.
2. The lamps must be fixed so that no part of the vehicle or its equipment extends laterally on the same side as the lamp more than twelve inches beyond the centre line of the lamp. Mirrors and direction indicators in the operating position are excluded when making this measurement.

The maximum wattage of the bulbs should not exceed 7 watts.



Sidelamps — maximum bulb rating 7 watts.

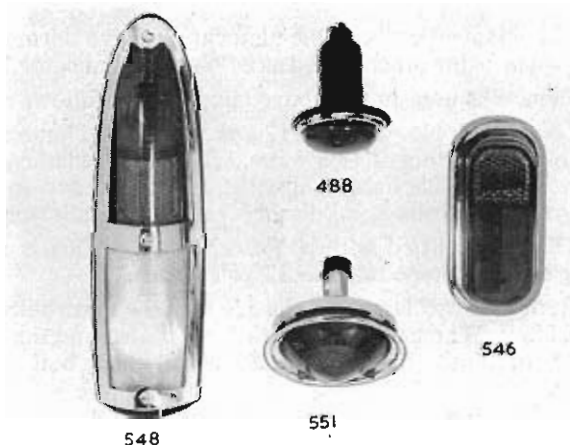
STOP TAIL LAMPS

Nearly all our car tail lamps are combined in one assembly with a stop lamp, the latter being operated by the brake pedal.

The picture shows a cross-section of the lamps we produce to-day. Let us examine their main constructional features.

The 488 is the same lamp as the side-lamp we have already shown you, but fitted with a red lens.

One of the latest developments in rear lamp design is seen in the 546 lamp. A Reflex reflector is moulded into the actual lens itself, forming the top section of the unit. The centre section houses a double filament bulb which provides the normal tail and stop lights. A "flasher" direction indicator bulb can be fitted in the bottom section. This one unit thus fulfils three functions.



The 551 lamp, too, embodies many recent design features. The moulded Diakon reflector, $1\frac{1}{2}$ " in diameter, is situated in the centre of the lens, with a clear surround. The rim is pressed onto the conical shaped lens, and the assembly fitted to a metal backplate which contains the bulbholder. To prevent the ingress of water, seating rubbers are fitted between the lens and the backplate, and also behind the backplate. A double filament bulb provides the tail and stop lamp lighting.

The 548 is the largest of our combined rear-lamps. It is approximately $11" \times 3"$ and provides a reverse lamp in addition to the reflector and stop-tail lights.

This lamp consists of a die-cast baseplate into which are sealed two diakon windows, a red one at the top for the stop-tail light and a clear one at the bottom for the reverse lamp. The centre section contains a red reflex.

Although the clear window is provided, the reverse lamp is an optional extra, and a separate bulbholder assembly is available.

When the reverse lamp is not required, a flat steel plate is fitted over the aperture in the base plate.

The following bulbs are commonly fitted to these lamps:—

The 488 model takes the No. 361, a 12-volt double filament bulb with a 6/18 watt rating.

The 546 lamp is fitted with a No. 361 bulb serving as the stop-tail light and a separate "flasher" indicator bulb No. 221 12 volt 18 watt.

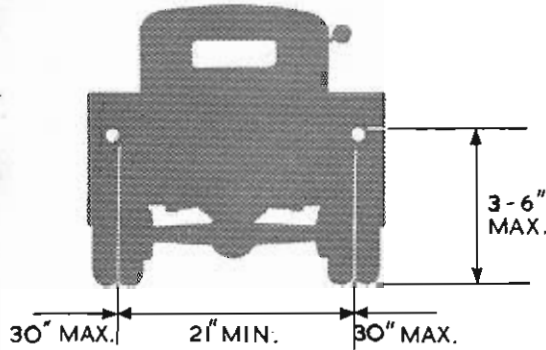
The 551 lamp employs a No. 380 12 volt bulb, which contains a 21 watt flasher or stop-light filament and the normal 6 watt tail light filament.

Two bulbs are used in the 548 lamp: the No. 380 rated at 6/21 watt (12 volt) and No. 382 containing a single 21 watt filament for the reverse light.

REAR LIGHT INSTALLATION

Rear lamps must be positioned on British vehicles according to the "Lighting Regulations" which are enforced in Great Britain.

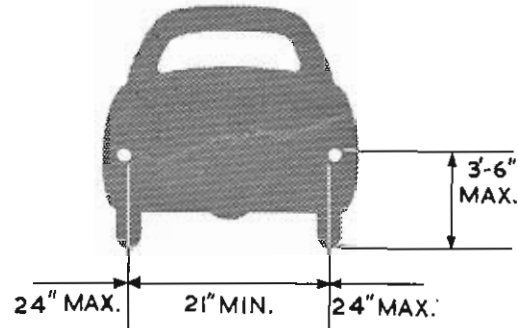
The specified measurements are clearly visible in the



Goods Vehicles (over 30 cwt.) Rear Lamps — must not be more than 3 feet 6 inches from extreme rear.

two illustrations, and we need only add that "extreme rear" should be taken to mean the rear of the vehicle when the tail board, luggage grid or any other adjustable fixture is extended.

The bulb rating for rear-lamps should not be less than 6 watts.



Private Cars, Goods Vehicles under 30 cwt., Three-wheel Cars and Trailers Rear Lamps — must not be more than 30 inches from the extreme rear.

REFLEX REFLECTORS

Reflectors, which in the British Isles formerly came within the category of "extras" are now legally enforced. They provide most effective supplementary rear lighting, contributing greatly to road safety.

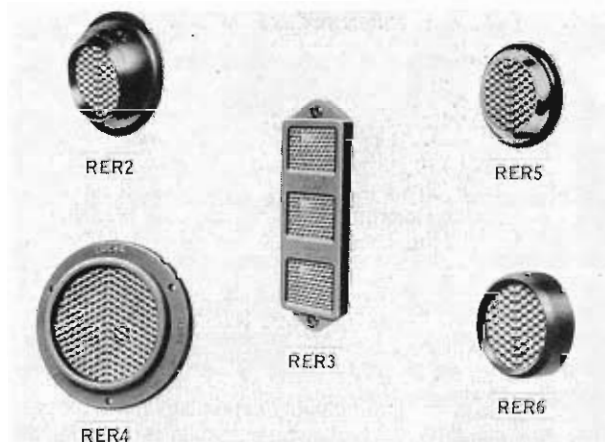
All Lucas reflectors are formed by prisms moulded in Diakon. This formation provides an extremely efficient reflecting surface, so good in fact, that tests prove that in a headlight beam, reflectors are visible at a thousand feet or more, showing up as brightly as an ordinary rear lamp.

We show you here some of the reflectors we have designed to meet the requirements of all types of vehicles.

The R.E.R.4 is a large model suitable for fitting to commercial vehicles. The strip type R.E.R.3 is also designed for this purpose. Both these models can be obtained with amber coloured reflectors for fitting to the sides of the vehicle.

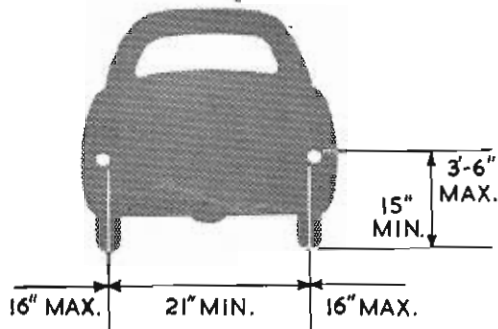
The other three types are all suitable for fitting to cars and motor-cycles. They are provided with a single self-tapping fixing screw, and designed for mounting on number plates, rear mud-wings, etc. The design of the R.E.R.2 makes it suitable for fitting to curved surfaces.

And here we must make an extremely important point concerning the positioning of all reflectors. Their fitting is controlled by the "Road Transport Lighting Regulations" and these should be carefully studied. The reflected light is cut down considerably if the reflector is not mounted in the correct position and, even more important, at the correct angle.



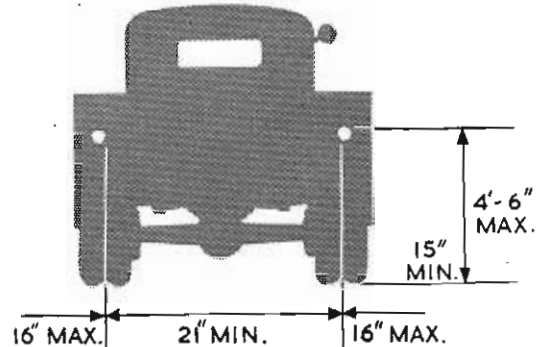
REFLECTOR INSTALLATION

These two illustrations show the specified positioning for reflectors.



Reflectors on Private Cars, Goods Vehicles under 30 cwt., Three-wheel Cars and Trailers must not be more than 30 inches from the extreme rear.

We will stress once more that to be properly effective reflectors must be fitted in the vertical plane and facing squarely to the rear.



Reflectors on Goods Vehicles over 30 cwt. must not be more than 30 inches from the extreme rear.

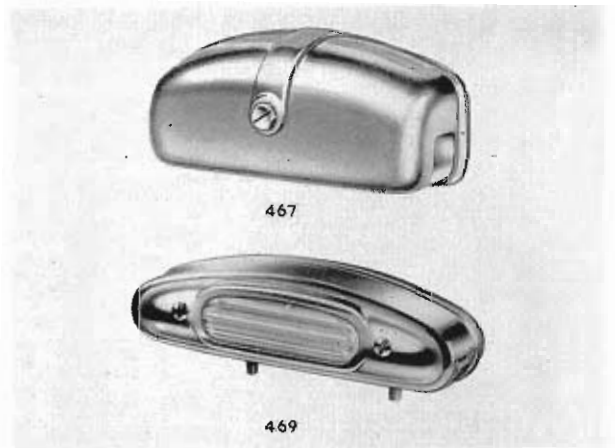
NUMBER PLATE ILLUMINATION

These are two of the most popular number plate lamps — the only remaining units in the 'obligatory' category.

The 467 is designed purely for number plate illumination and is installed with ONE, either 4 or 6 watt filament miniature bayonet cap (MBC) type bulbs.

No. 469 is intended for the larger cars. In addition to giving ample number plate illumination by two similar bulbs to those just described, this lamp also carries an 18 watt bulb which will provide a reversing light when required.

Let us now consider the circuit arrangement for the side and rear lighting.



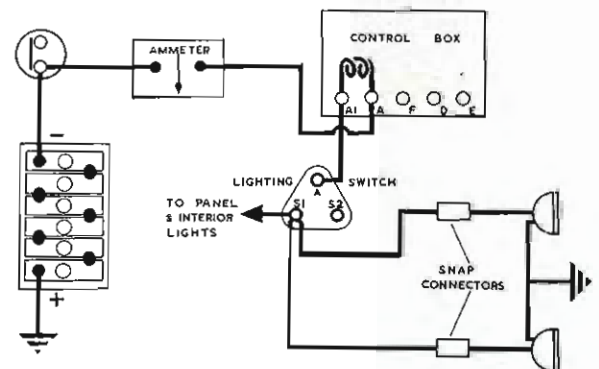
TYPICAL SIDE-LAMP CIRCUIT

On modern cars, both side lamps are fed in parallel from the S1 terminal of the main lighting switch. (Many of you will remember the earlier type combined ignition and lighting switch with this terminal marked "T").

You will notice too that the lighting switch obtains its feed via the LOAD TURNS of the voltage regulator in the control box. The complete circuit, therefore, would be as follows:—From the battery, usually via an ammeter, to terminal "A" of the control box, then through the load winding to A1, feeding the lighting switch at terminal "A". The circuit continues across the switch through both bulb filaments to earth, being completed via the vehicle chassis to the battery earth.

Notice particularly the "Snap Connectors." These are of great significance in servicing and trouble shooting work with which we shall deal later.

It will be found throughout the lighting circuits that extensive use is made of single and multiple snap connectors in order to reduce the lengths of cables necessary.

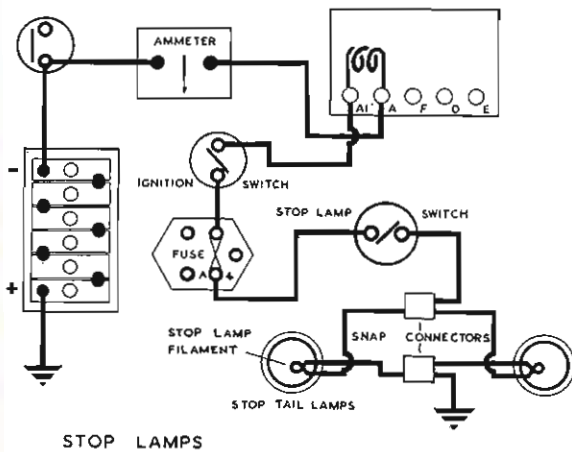
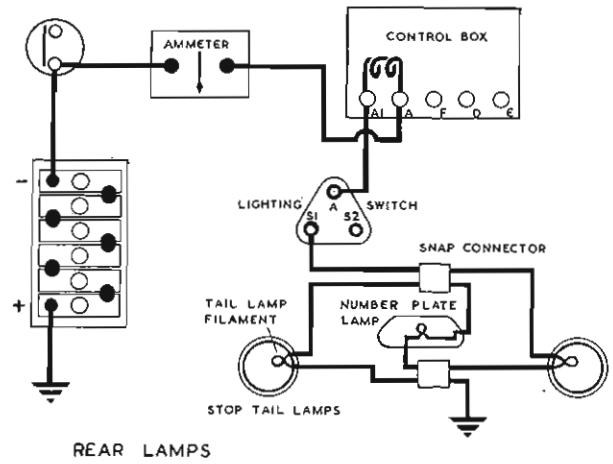


SIDE LAMPS

REAR LIGHTING CIRCUIT

The rear lighting is also fed from the S1 terminal of the main lighting switch. Let us follow the circuit from this point. A single cable leads direct to a double snap connector. Feed cables branch off to the tail lamp bulb filaments in the stop tail lamps and another to the number plate lamp.

Earth return cables are looped from all the lamps to one snap connector and then earthed to the chassis.



STOP LAMP CIRCUIT

As the stop lamps are usually part of the tail lamp assembly we have included the circuit here. These lamps usually carry double filament bulbs, one 4 or 6 watt filament for the rear light and either an 18, 21 or 24 watt filament for the stop lights with which we are concerned in this diagram.

The circuit is simple enough as you can see. The stop lamp filaments are fed from the A4 fuse via a separate stop lamp switch actuated by the brake linkage.

Feeding from the A4 circuit means that the lamps are master controlled by the ignition switch with a fuse in circuit.

In Part 2 overleaf we shall consider lighting which, while not being "obligatory" in the legal sense, is of paramount importance to all road users. We shall begin with the main headlamp lighting.

Headlamps

DAZZLE

We shall approach the subject of headlamp lighting by way of the problem it inevitable poses. In so doing, we hope to convey the sense which lies behind the development of the modern Lucas headlamp unit.

With headlamps becoming necessarily more and more powerful as the speed of vehicles increased, a problem arose which, in recent years, has been causing concern in all countries where night driving is widespread.

How do we provide adequate lighting of the road for fast driving and at the same time use this light when passing oncoming vehicles so as not to cause discomforting dazzle? What sort of *safe* compromise can we strike between poor headlights which scarcely enable the driver to see, and those which light the way brilliantly, yet blind the approaching driver? For safety depends upon *both* drivers being able to see.



DIP AND SWITCH METHOD

The only effective answer at present appears to be a really efficient dipping system.

The method we show you here, known generally as the "Dip and Switch Method," has been employed for many years on British vehicles. The off-side light, that nearest the oncoming driver is switched off, and the other "dipped" downwards and directed towards the nearside curb.

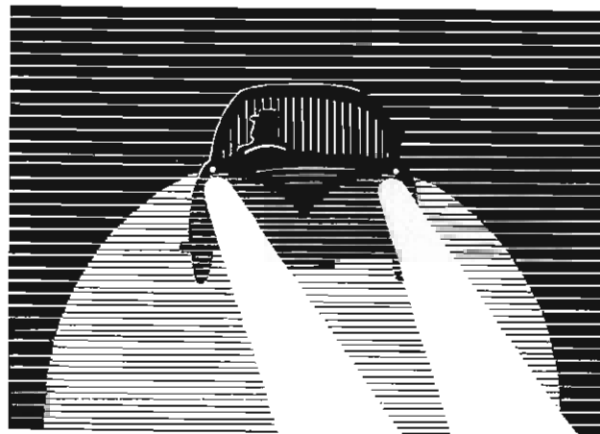
The snag in this is obvious enough: the approaching driver is safeguarded but the driver dipping his lamps is suddenly left with less than half his road lights. The difference between the main and dipped light is considerable.

DOUBLE DIPPING

The introduction of the Lucas double dipping system overcame this disadvantage. Both lights remain on, dip filaments in the headlamp bulbs providing adequate illumination of the road in the dipped position. So good is this light, that speeds of 40-50 m.p.h. can be maintained with perfect safety.

The use of PRE-FOCUS BULBS and the BLOCK PATTERN LENS reduces the dazzle of the approaching motorist to an absolute minimum.

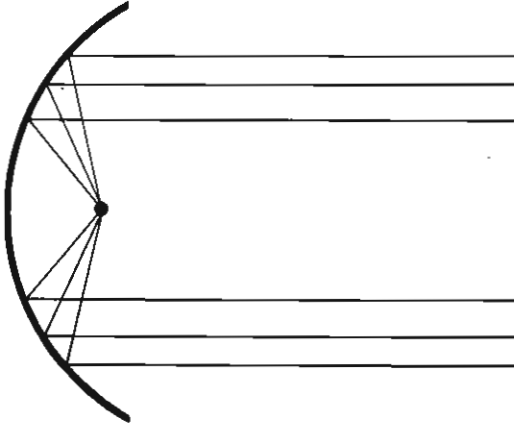
But perhaps we are going a little too quickly; some of these terms may need explaining.



OPTICAL PRINCIPLES

For you to appreciate the double dipping system fully, let us consider for a moment the optical principles involved.

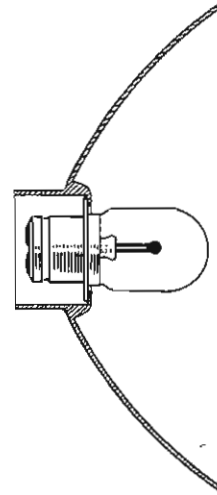
If a pin-point of light were placed at the exact focus of a parabolic reflector, in theory we should obtain a perfectly parallel beam of light. No light rays would be reflected above the horizontal.



PRE-FOCUS BULB ARRANGEMENT

But a bulb filament can never be merely a pin-point. It must have a certain substance to enable it to carry sufficient current and to make it mechanically strong.

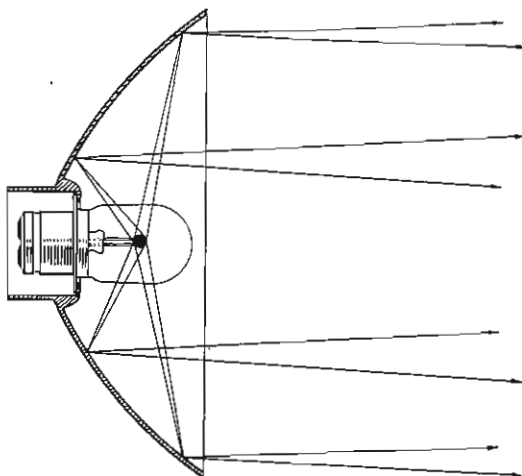
Not all the incandescent area of the filament then, can be at the exact focal point of the reflector, although by using what we call a PRE-FOCUS bulb with a locating flange we can achieve what is, for all practical purposes, an accurate positioning.



THE DAZZLE RAYS

Arising from what we have just said, the beam produced by such a bulb and reflector combination must necessarily be slightly divergent; some light rays are reflected above the horizontal. These are the ones which cause dazzle.

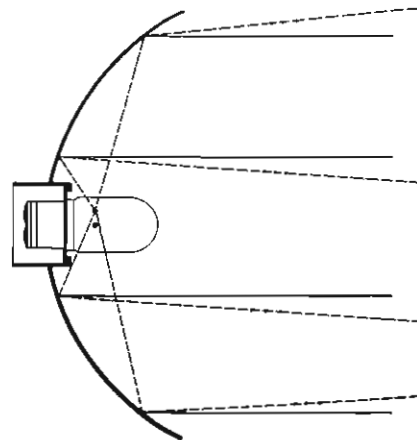
You can see from the illustration that it is not only the rays which strike the lower half of the reflector that are projected upwards; a proportion of the light striking the upper areas is similarly affected.



DIPPED BEAM REFLECTION

A second or DIP filament situated above the filament we have so far discussed, i.e. displaced from the focus of the reflector, and actually offset from the axis of the bulb, would produce a "dipped beam" whose main concentration would fall below the horizontal.

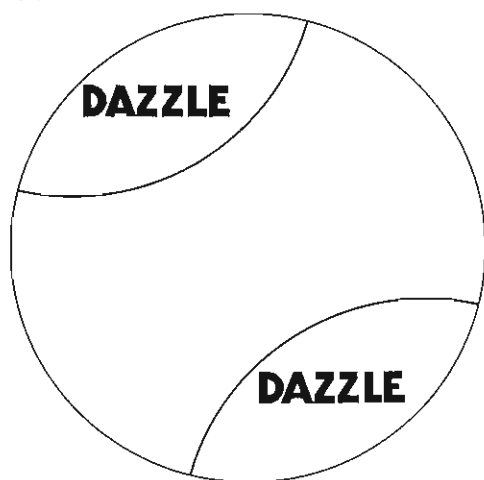
But this dip filament would still give rise to some upwards reflected light as you can see by the dotted lines at the top and bottom of the reflector. Light rays emitted from the filament, striking these upper and lower areas, will inevitably be reflected above the main concentration of the beam. This means that no matter how the dipped beam is set or directed, some light will rise, causing dazzle to the approaching driver.



DAZZLE POINTS

To re-direct these upwards reflected rays so that they are projected below the horizontal line, groups of prisms are moulded into a special glass known as a Block Lens. The dazzle points, where the two prism groups must be formed, are indicated here.

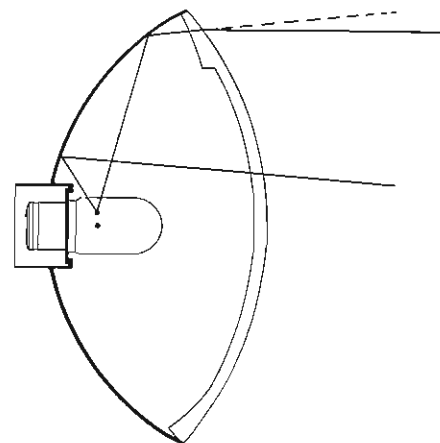
(You will see later how the actual positioning varies according to the lighting regulations of a particular country.)



PRISMATIC CONTROL — DIPPED BEAM

You can see here what the effect is as far as the Dip filament is concerned: light rays formerly rising above the horizontal are now refracted or bent downwards to the horizontal so that they fall within the main concentration of the dipped beam.

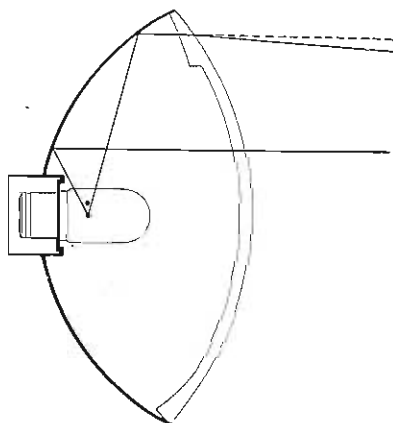
A similar group of prisms is situated in the lower area of the glass to control the other dazzle-producing rays in the same way.



PRISMATIC ACTION OF DIPPED BEAM

PRISMATIC CONTROL — MAIN BEAM

The prisms also control the light rays of the main beam — i.e. the rays emitted by our first filament at the focus of the reflector. Light which was previously projected upwards and wasted is now brought into the beam, adding to its intensity.

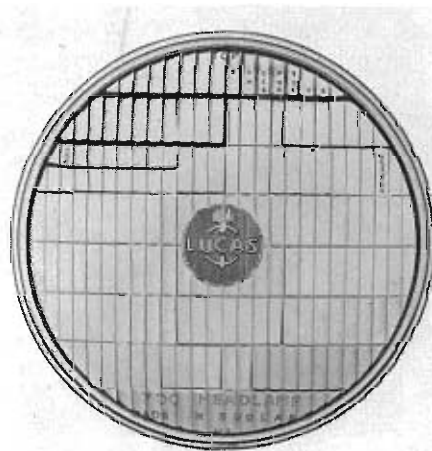


PRISMATIC ACTION OF MAIN BEAM

BLOCK LENS

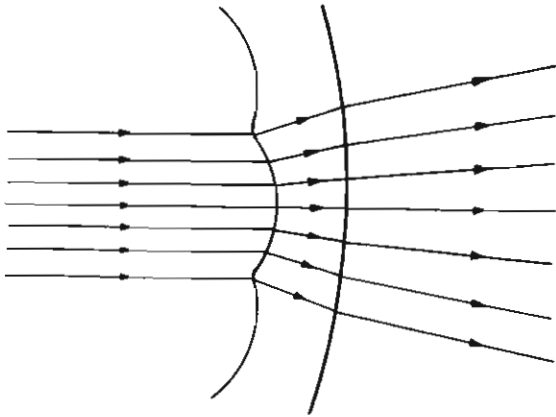
Here is a photograph of the actual lens with the grouping of the prisms clearly marked. They control the rays, then, in the vertical direction. But what about the horizontal spread of the beam?

This is taken care of by the vertical flutes moulded into the lens.



HORIZONTAL CONTROL

Here you see the effect of these flutes. There is sufficient light-spread at good intensity to give enough light for cornering — the light intensity should be such that it is *not* the controlling factor on the speed of cornering.



LIGHT IMAGE

This is the pattern of light produced by the main filament of one block lens light unit. The screen is approximately 25 feet from the lamp. Notice the intense spot in the centre of the beam; this will give a long driving light. There is also good sidespread immediately in front of the lamp and at a little distance ahead. This ensures safe illumination of the sides of the road, enabling the driver to position himself accurately, and to pick out pedestrians and cyclists with ease.



MAIN BEAM LIGHTING

This is how the main beam lighting appears from behind the wheel. The road is illuminated for a length of over 170 yards. The brick pillars are 17 yards apart and 8 feet high. This will give you an idea too of the "low top" of the beam.

A LAMP ASSEMBLY

The moulded lens containing the prism and flute combination is rolled into a dustproof assembly with the reflector. This protects the reflector surface, ensuring long life to the light unit.

The pre-focus bulb is inserted from the rear of the assembly, thus making replacement possible in service.



This long range light enables the driver to see the contour of the road — he can also anticipate any sudden changes in direction, a realisation which brings with it an added sense of security. The road a little distance in front of the vehicle is also brightly and evenly lit, making it possible for the driver to proceed according to the state of the surface.

This main beam lighting gives sufficient light straight ahead to enable speeds of up to 55 m.p.h. to be maintained with safety in average conditions. This limit has been set because the vast majority of drivers hardly ever exceed this speed, and, as we are necessarily working with a limited amount of light, an excess in the centre to allow faster driving might mean less at the sides of the road.



DIPPED BEAM LIGHTING

Both head lamps are now dipped, but notice that the light has relatively not decreased in intensity. These dipped beams provide adequate light for passing the oncoming vehicle with safety and comfort.

If both headlamps are correctly set, the approaching driver will be subjected to little or no dazzle.

And here we would like to make two very important points. In the first place, the approaching driver will of course be aware of two headlamps. If he happens to glance directly at them he will see two lights — but they are only sources of light: they do not dazzle. On looking directly ahead again, there is no sudden, urgent need for re-focusing of the eyes, no dangerous "black" period that we experience after the eyes have really been "dazzled."

The other point is this: you will appreciate that if both vehicles are equipped with block lens light units and the beams dipped, the whole breadth of the road surface between the vehicles is illuminated, without dazzling either of the drivers.



This avoids any possible misjudgment of the width of the vehicle.

LIGHT UNITS AND BULBS — LENS DESIGN

It may be appreciated that the desired results from double dip lighting will only be obtained if the bulb and light unit combination is correct.

Both light units and bulbs vary in accordance with the lighting regulations of different countries.

Broadly speaking, we can divide these into three distinct groups according to different areas: right-hand drive countries, left-hand drive, and continental.

The continental sphere has to be sub-divided, special lighting regulations being in force in France. In order to meet International Regulations not covered by the standard pattern lens and also to provide driving lights with special characteristics for racing work, a number of variations to the standard Block Lens are sometimes fitted. Any of those illustrated may be found on vehicles from time to time.

F700 LIGHT UNIT

This is the F700 light unit used in right-hand drive areas. It is the present standard unit fitted by British car manufacturers to vehicles for the home market.

The prism arrangement is suitable for beams dipping to the left.



CORRECT BULBS

The correct bulb is the 354 for 12 volt units with a rating of 42/36 watt (the main filament value is given first, the dip filament second). The No. 356 bulb, exactly similar in appearance, is used for 6 volt applications, its wattage being 45/35 watt.

Notice that the main filament is axial and that the dip filament is above it and to the side.

The single slot in the flange precludes the possibility of incorrect fitting.

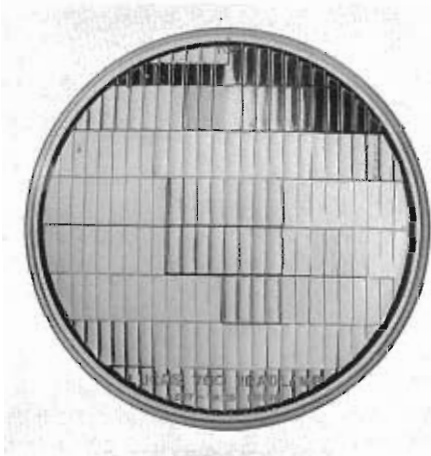


F700 UNIT — LEFT-HAND DRIVE

The F700 unit for left-hand drive countries, including the U.S.A. has the prism groups moulded into the opposite side of the lens, i.e. top right and bottom left. Also, the dip filament, in the pre-focus bulb is positioned so as to give deflection of the beam to the right.

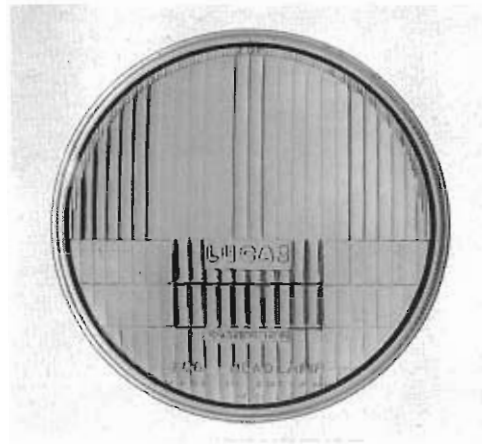
The bulb numbers are :—

12 volt	No. 355	42/36 watts.
6 volt	No. 387	45/35 watts.



F700 CONTINENTAL

This special F700 block lens light unit has been designed for use in European countries. The prisms are concentrated in the centre of the lower half of the lens, thus giving the necessary vertical dip.



BULBS FOR THE CONTINENT

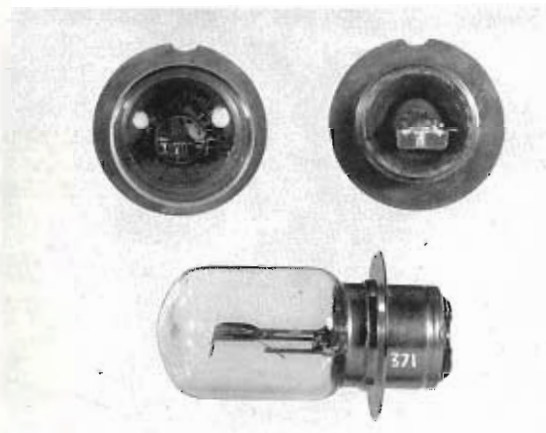
The correct bulbs for use with the continental unit are :—

12 volt	No. 370	45/40 watts.
6 volt	No. 378	45/40 watts.

Both bulbs are of the pre-focus type but with a hooded dip filament.

A similar bulb No. 371 with a yellow envelope, may also be fitted for touring in France.

This is the bulb recommended for any of the F700 light units when touring the continent.

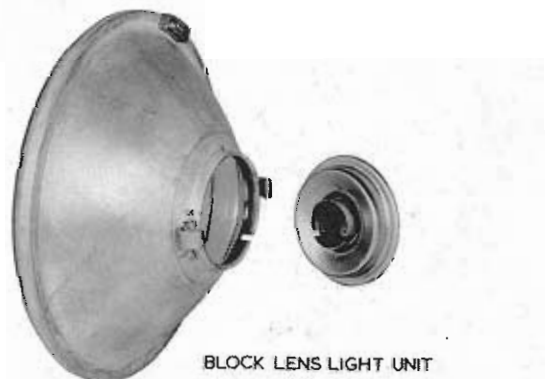


SPECIAL UNIT FOR FRANCE

Where the visit is of a more permanent nature, both light units and bulbs must comply with the French regulations.

We show you here a suitable Lucas unit. The lens used is still the CONTINENTAL F700, but the reflector is fitted with the special holder to take the three pin bulb legal for France.

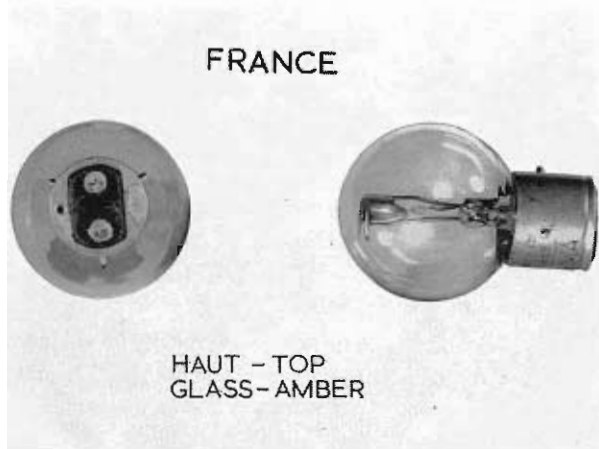
FRANCE



BLOCK LENS LIGHT UNIT

THE THREE PIN BULB

This bulb, No. 372, has a hooded dip filament, a yellow glass envelope and three pin fixing. The bulb must be correctly inserted in the holder and for this reason it is marked "haut" — "top."



LE MANS UNIT

This "Le Mans" light unit was specially designed for fast driving on the continent. Again you will notice the prisms are in the centre for vertical dipping.

Models of the unit are made to take either the British pre-focus bulb or the French bulb you've just seen.



P700

A later design block lens, the P700, has a clear centre, giving a longer beam. This does enable us to drive faster along the straight, but remember that with a given amount of light we can't increase the intensity of the beam centre without losing something at the sides.

Notice the hood attached to the centre piece. Apart from enhancing the appearance of the lens, this does of course serve a useful purpose. With the clear glass centre, some rays are projected upward at about 45°. These rays would tend to produce a slight glare immediately in front of the vehicle which would affect the driver, particularly in misty conditions. The driver of an approaching vehicle however would in no way be troubled. The hood suppresses this tendency to glare.



Lenses are made for right hand, left hand and continental application, the positioning of the prisms varying as in the "F" range.

The bulbs used in the previous range can also be fitted to this "P" range.

The P700 is *not* permissible at present in the U.S.A.

J700

The last light unit we have to show you is the J700. Again you'll notice the clear centre of the lens and the hood over the bulb. A lens is produced for both left and right hand drive.

The specified bulb is the No. 404, a 12-volt pre-focus type with a 60 watt main filament and a 36 watt dip filament.

This unit is *not* permissible in the U.S.A.



FOCUSING AND TRACKING

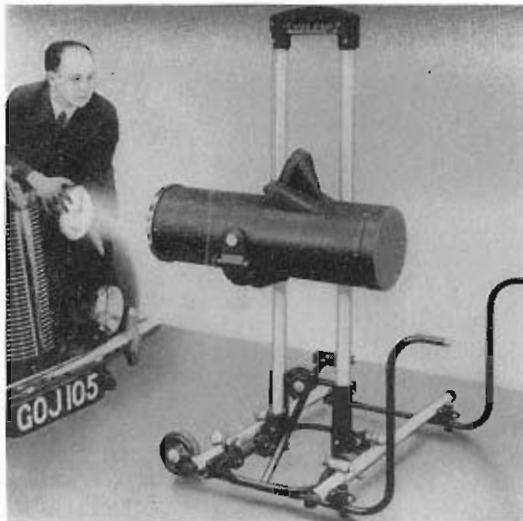
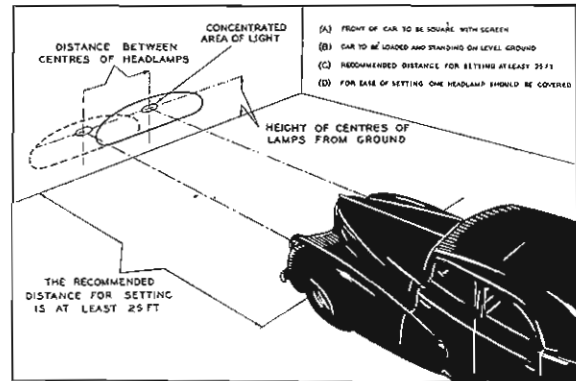
No matter how good the actual head lamps are, they will never do their job as intended unless they are correctly set. The two terms usually associated with this process are "focusing" and "tracking."

The latest bulbs, as we have said, are automatically focused in the reflector by the positioning flange and notches. Earlier types are usually adjustable in the bulb holder. In such cases, the focusing adjustment should always be carried out before the alignment or "tracking" of the lamps.

HEADLAMP SETTING

Our picture shows one method of setting lamps. A screen is used, set square to the vehicle and at least 25 feet from it. The car should be loaded and standing on level ground. Mark the lamp height and the distance between the centres on the screen. The setting operation is eased, as we suggest, by covering one headlamp. Make sure that the MAIN BEAM lighting is switched on.

Then adjust the lamps so that the beams fall on the screen as we have illustrated. Notice that just over half of the main concentration of light falls below the horizontal line.



THE BEAM SETTER

This "Beamsetter" greatly simplifies headlamp setting.

The apparatus is first positioned in accordance with the track of the vehicle wheels by means of a light ray and screen.

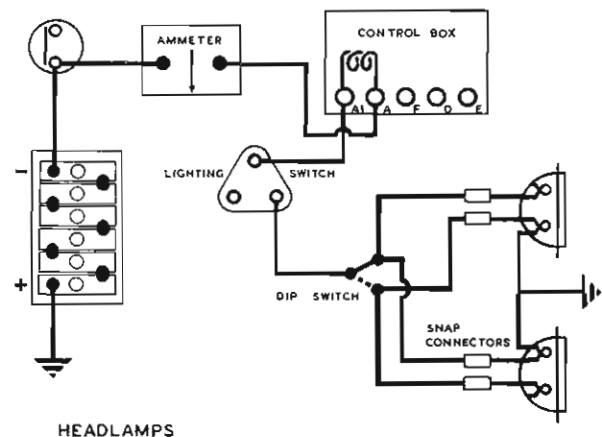
Each lamp beam is then directed in turn through the condenser lens of the apparatus and the position of maximum light intensity read off on a candle power scale. The reading is dependent on the intensity of light falling on a photo-electric cell.

HEADLAMP WIRING CIRCUIT

The headlamps are supplied with current from the lighting switch S2 terminal. The latter is connected via a cable to the dip switch, carrying battery current to either the main or dip filaments in both headlamps, depending upon the switch position.

Earth leads from each lamp are attached to any suitable point on the chassis, thus closing the circuit with the battery earth.

The circuit from the battery to the lighting switch is the same as for the side and rear lighting, current again passing via the load turns of the voltage regulator, thus compensating the headlight load.



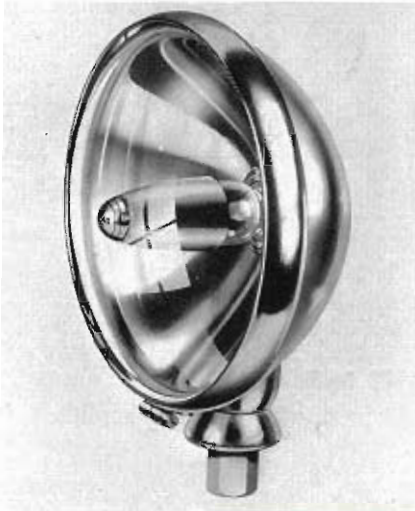
Auxiliary Lights

AUXILIARY LIGHTING

Auxiliary lights, such as long-range driving lamps, fog lamps and reversing lamps are to-day widely fitted by motorists as "extras." But the great majority of the motoring public is rapidly realising that these so-called 'extras' are well-nigh indispens-

SLR700

This long-range driving lamp, the SLR700, is intended for use in conjunction with the car's normal headlamps for fast night driving. The specially designed conical bulb shield and clear lens have the effect of condensing all the light power into a thin "pencil" beam of great intensity — in fact 100,000 candle power are projected in advance of the headlamps — a searching beam which makes fast driving safe.

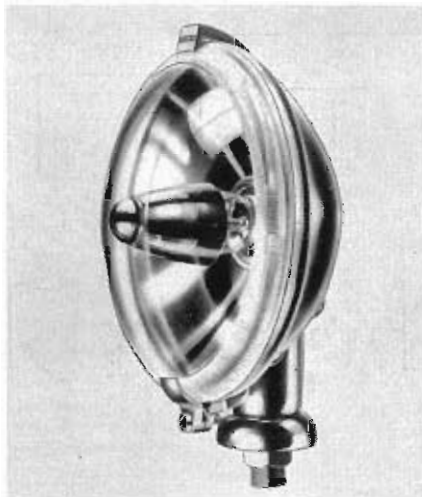


SLR 576

This SLR 576 is a development of the 700. It is much smaller in size — less than 6 inches in diameter — but is remarkably efficient, producing a long, concentrated driving beam of 80,000 candle power.

Its size and shallow body make it ideal for fitting to cars where frontal space is limited.

The 576 should also be fitted so that it is automatically extinguished when the headlamps are dipped.



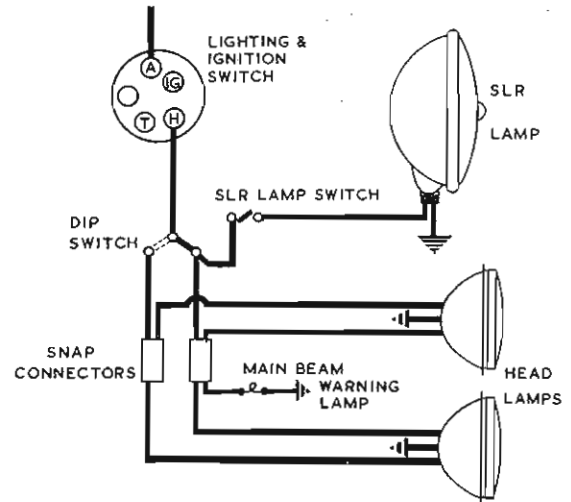
able to modern motoring.

Such additional lamps afford a convenient choice of lighting to cope with any possible combination of traffic, weather and speed.

They bring added safety and comfort to night driving.

SLR CIRCUIT

The SLR should always be fitted as we show in this diagram. The feed is taken from the MAIN beam side of the dip switch and then via a separate switch to the lamp. Thus the SLR is only operative when the main beams are in use. On dipping the headlights, the lamp is also extinguished. This of course is done to avoid dazzling an oncoming driver.



SFT700

One of our most popular fog lamps, the SFT700, incorporates the block pattern lens. This lens, in conjunction with the special reflector, pre-focus bulb and bulb shield, produces a flat-topped beam with exceptionally wide side-spread and without upward or backward glare. It gives an ideal light for driving in fog.



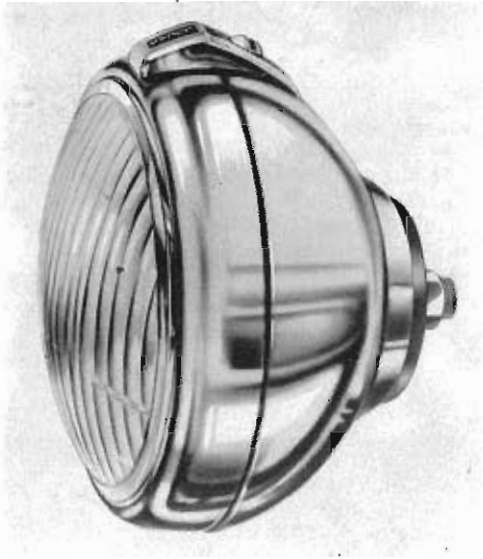
462 RANGE

The 462 models are the smallest fog lamps we make, having a diameter of 5".

They are fitted with the block pattern lens and produce the characteristic 'flat-topped' beam.

The WFT462 shown here is designed with a fixing bolt in the back of the lamp, enabling it to be mounted directly on to the front of the vehicle, or on to a vertical or suspended bracket.

The model in this range with the usual spigot fixing is the FT462.



SFT576

Another attractive foglamp, the SFT576 has been designed for use with the SLR576 long-range driving lamp. Like the larger 700 foglamp we've just shown you, it has a wide-spread beam, sharply cut off at the top — a most effective light in fog.

Fitting presents no difficulties, thanks to the shallow body and the 6" diameter.



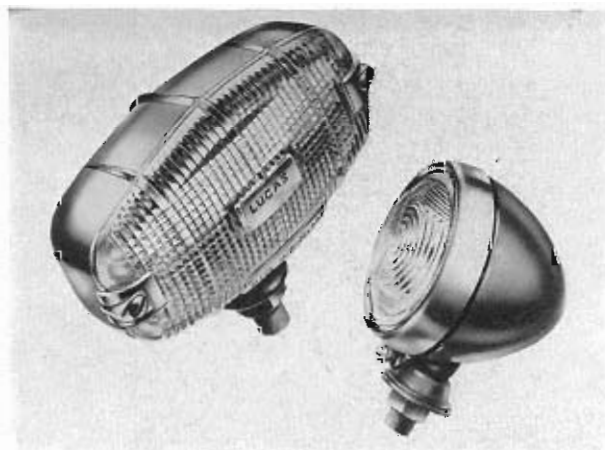
494 AND 511 REVERSE LAMP

These two auxiliary lamps have been designed expressly as reversing lights and provide ample illumination to the rear.

The model 494 on the left is roughly oval in shape and is styled to blend with the tail lines of modern cars. A wide, even distribution of light is assured by the ribbed construction of the glass.

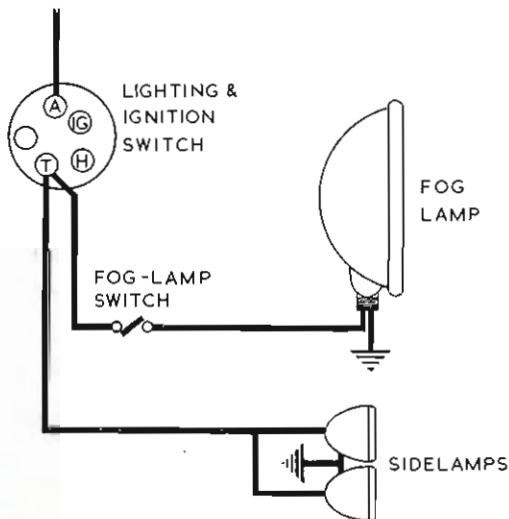
The mounting is external, by stem and "ball-joint" fixing. The other lamp, the 511 model, is suitable for fitting to the majority of cars — it is only 3½" in diameter and spigot mounted.

The bulb usually fitted in both these lamps is the No. 221 12 volt 18 watt or the No. 317 6 volt 18 watt. The maximum permissible bulb rating in Great Britain is 24 watt.



FOGLAMP CIRCUIT

Fog lamps are normally connected in the sidelamp circuit, either from snap connectors in the feed wire or as we show here direct from the lighting switch. They are of course also controlled by a separate switch.



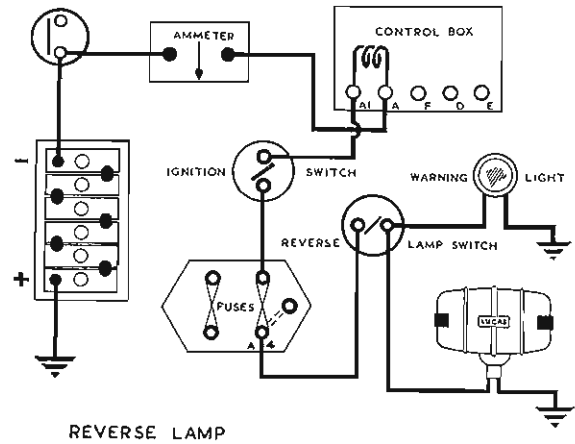
REVERSE LAMP CIRCUIT

A reverse lamp should always be fed from the A4 fuse terminal. Current passes from the battery, through the meter and then via the load turns of the voltage regulator.

Terminal A1 then feeds the ignition switch. When this is in the "ON" position, current passes through the A4 fuse to one side of the reverse lamp switch, which is normally situated near the gear box selector mechanism. When reverse gear is selected, this switch is closed and the reverse light operates.

Vehicles fitted with a reverse lamp that is not controlled by the gear change lever must have a warning light in circuit. This, as you can see, is fed from the lamp side of the reverse lamp switch.

The standard switches most suitable are models PS7 and PS15. When the 494 or 511 reverse lamps are supplied as accessory kits, either one or the other of these switches is included.



LIGHTING REGULATIONS

We stress once more that Regulations affecting the British Isles concerning the positioning, dimensions and bulb wattage of all lamps are contained in the latest "Road Transport Lighting Act."

They specify among other things the height of the lamps from the ground, the distance from the outer edge of the vehicle, the dimensions of the glass or lens, the type of glass, the colour of the light, etc.

It is recommended that these lighting regulations should be studied in order to understand clearly the correct positioning of all lights.

Maintenance

MAINTENANCE POINTS

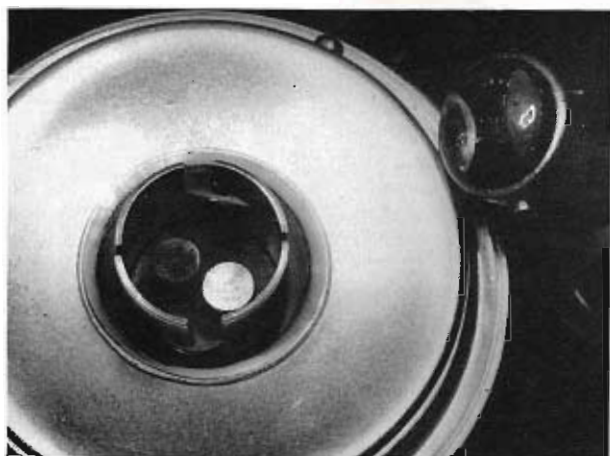
1. Faulty bulbs.
2. Bad earths.
3. Bad contacts.
4. Faulty wiring.

When individual lights are poor or out of action, these points should be checked.

BAD EARTHS

Bad earths are a frequent cause of poor lights and even complete failure.

A check should be made with a voltmeter between the lamp body and a good earth on the vehicle. A voltage reading indicates a faulty earth. The voltmeter should read zero if the earth connection is good.



FAULTY WIRING

Our picture shows a test being made with a voltmeter to see if there is voltage at the bulb holder. No voltage reading with the lights switched on indicates a break in the feed wire.

If this is the case, the circuit should be checked with a voltmeter at every point in the feed, i.e. control box A and A1 terminals, lighting switch, dip switch and any cable junction such as a snap connector. These tests will localise the fault. A broken wire or dirty connection can then usually be found by eye when the voltage readings have been taken.

FAULTY BULBS

If a bulb filament is broken, make sure that the fault is due to normal wear and tear and not the result of vibration caused by a loose lamp fixing or faulty bulb holder.

Don't forget too that in the category "faulty" we include bulbs of the incorrect type, unsuitable wattage and wrong voltage.



DIRTY CONTACTS

Dirty contacts, either at the bulb holder or the bulb will always cause trouble. Frequently, contacts are blackened by sparking between the holder and bulb contacts, due to a loosely fitting bulb. What's more, if sparking occurs, the bulb holder springs will over-heat and lose their tension, thus making permanent contact impossible for instance over a rough road surface.

The only real cure if the bulb holder contacts are badly blackened or discoloured is to change the holder.



LIGHT LIFT

One of the main troubles associated with lighting in service is that of "Light Lift". This is the term used to express the rise in the light intensity of the headlamps when the engine speed is increased quickly.

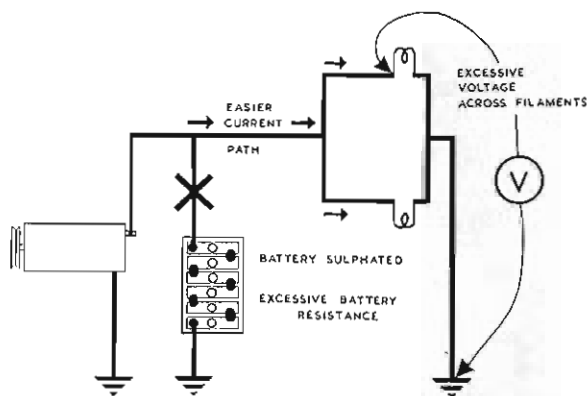
This fault is of course the exception rather than the rule, but it is one which in many cases is difficult to remedy. For this reason we intend to go into it at some length.

REASONS FOR LIGHT LIFT

The final reason for light lift is a sudden excess of voltage across the filaments of the headlamp bulbs which increases the brilliance.

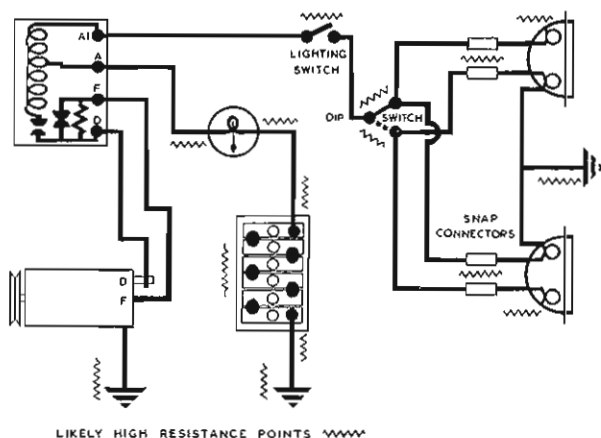
Take the simple case we show you here. The battery is sulphated, that is, in a condition where its internal resistance is comparatively high. The engine is suddenly revved and the dynamo charges. But the charge will not readily be absorbed by the battery, owing to its resistance. Instead, the generator voltage will rise directly across the bulb filaments.

Admittedly, the voltage rise is limited on modern



REASONS FOR LIGHT LIFT

vehicles by the regulator, but it is still sufficient to cause light lift, especially when you consider that with a bad battery the lights will be dim anyway when the engine is idling.



LIKELY HIGH RESISTANCE POINTS

COMPLETE CIRCUIT

But the battery is by no means the only cause of light lift. Any point in the circuit where there is excessive resistance will cause a voltage drop. Consequently, with the engine idling, the lights will not be receiving their full battery voltage. There will then be a noticeable difference when the engine is revved and the full generator voltage develops.

We have indicated many of these possible high resistance points. You see that they can be anywhere in the circuit; at terminals, at snap connectors and junction points, even in the wiring itself. There may be one main fault or a combination of minor losses which all add up to produce light lift.

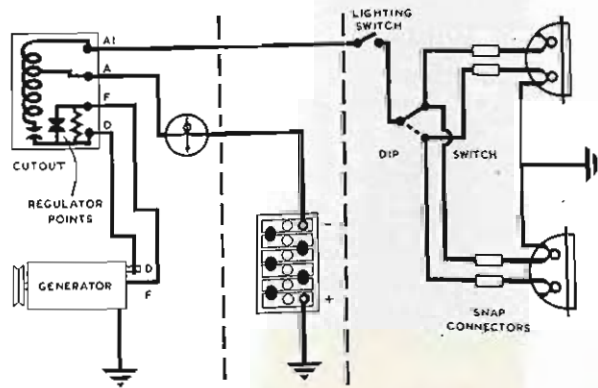
We have drawn up a test procedure which will enable you to locate all the more usual faults.

To illustrate this procedure, let us take a test case. We have a vehicle with light lift, not excessive, but noticeable. How do we proceed?

COMPLETE CIRCUIT DIVIDED INTO THREE SECTIONS

We have divided the vehicle circuit into three sections: lights and switches; battery; generator and voltage regulator.

The first move is to find out just what light lift we have in terms of volts. The rise in light intensity is visible to the eye but a reading on a voltmeter gives us a more exact idea of the problem. A comparative measurement can then also be made at the end of the tests — which makes sure the fault has in fact been cleared.



COMPLETE CIRCUIT DIVIDED INTO 3 SECTIONS

LIGHTS SECTION TEST 1 AND 2

Connect a voltmeter between earth and the end of the lighting cable as close as possible to the bulb holder. Switch on the headlights (main beam) and note the reading with the engine stationary. Then make the same test with the engine running at a good charging speed.

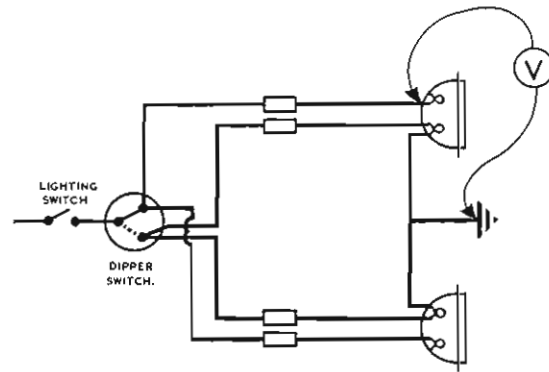
It is advisable to carry out these tests at both headlamps, just to make sure that both are affected by light lift.

Readings on our test vehicle were as follows :—

Engine stationary	11.8 volts.
Engine running	12.8 volts.

Both headlamps gave the same reading. The voltage difference, then, causing the light lift is 1 volt. For normal service purposes, 0.5 volt is considered the maximum permissible reading.

What then, in our case, is causing the higher reading?



TEST 1 HEADLIGHTS ON — ENGINE STATIONARY
TEST 2 HEADLIGHTS ON — ENGINE RUNNING



BATTERY SECTION TEST 3

The next point in the procedure is to test the battery to ensure that no abnormal condition is affecting the circuit as a whole.

We first took S.G. readings of each cell with a hydrometer and then heavy discharge readings. Results were as follows :—

S.G. Readings : 1.230, 1.230, 1.230, 1.240, 1.240, 1.230.

Discharge voltage readings over 10 seconds : 1.6v., 1.5v., 1.5v., 1.6v., 1.6v.

The battery was obviously in good condition, and could not be considered as a possible cause of the trouble.

TESTS 4, 5, 6

Tests 4, 5 and 6 concern the voltage of the battery.

First use the voltmeter to check the terminal voltage with the engine stationary; then with the engine running and finally with the engine running and full load, (i.e. engine running at charging speed).

We obtained these figures :—

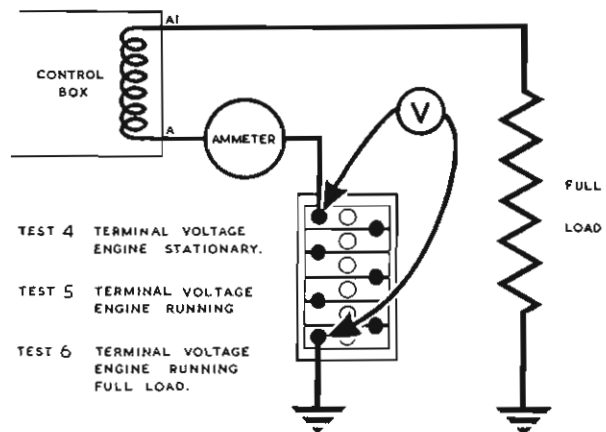
Test 4	12.5 volts
Test 5	13.5 volts
Test 6	12.5 volts

The load we switched on consisted of a fog lamp and long-range driving light in addition to the head, side and tail lights.

Test 5 reading should of course be higher than Test 4 for the set to be charging, but a difference in readings of much above 1 volt would suggest overcharging. In our case, with 1 volt difference, we felt that a further investigation was necessary — particularly as the battery was reasonably well charged.

Test 6 reading we considered normal — the 1 volt drop from Test 5 showed us that the load was not too

great for the battery. You see, too great a load on the circuit will cause the battery terminal voltage to drop to such an extent that when charging begins, light lift will inevitably result.

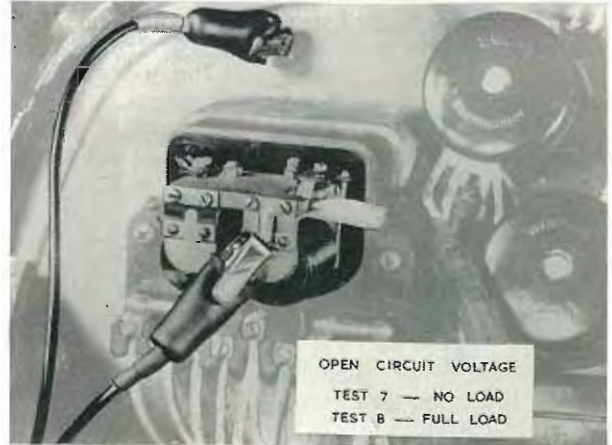


REGULATOR OPEN-CIRCUIT SETTING. TESTS 7 AND 8

We further investigated the slightly high terminal voltage obtained in Test 5 by checking the open circuit voltage of the regulator. A voltmeter was connected between the regulator frame and earth and a piece of thin, clean paper inserted between the cut out points.

The reading as we suspected was slightly high : 16.5 volts instead of between 15.6-16.2 volts. The alteration of the setting was left until the end of the test procedure, to enable us first to trace any other faults.

We next switched on the full load of head, side and tail and two auxiliary lights. The engine was revved up to the same speed as in the previous tests and the voltmeter open circuit reading again noted : 17.5 volts. Something was obviously wrong : if the regulator is working correctly the reading with full load will be below the no-load figure. The load turns should reduce the operational voltage of the regulator when a heavy discharge current is passing to the lights.



On investigating, we found that the A and A1-leads were crossed over at the regulator. This fault too was left until all the tests had been completed.

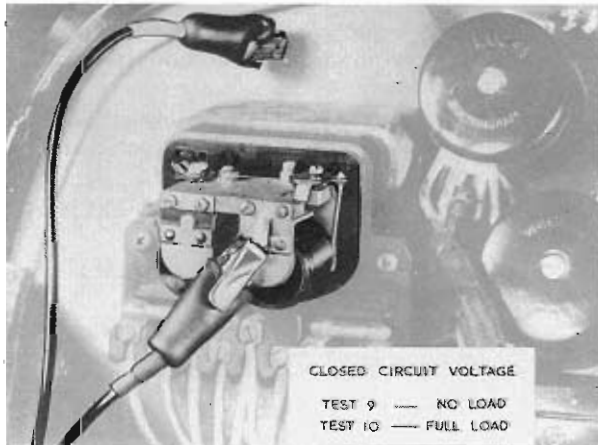
TESTS 9 AND 10

We next removed the paper from the cut out points and switched off the load. We accelerated the engine to a good charging speed and, leaving the voltmeter still where it was, read off the closed circuit voltage.

Under these no-load conditions, the reading was 14 volts.

We then switched on the same full load as before and noted the reading : 13.8 volts.

This indicated that the generator was maintaining its closed circuit voltage under load — stated more simply, the generator was able to supply sufficient output to balance all the lighting we had switched on. It would not have been able to do this for instance if the driving belt had been slipping. If such a fault does occur, the battery gradually becomes discharged. The lights when idling are less brilliant and light lift becomes noticeable when accelerating.



TESTS 11 AND 12

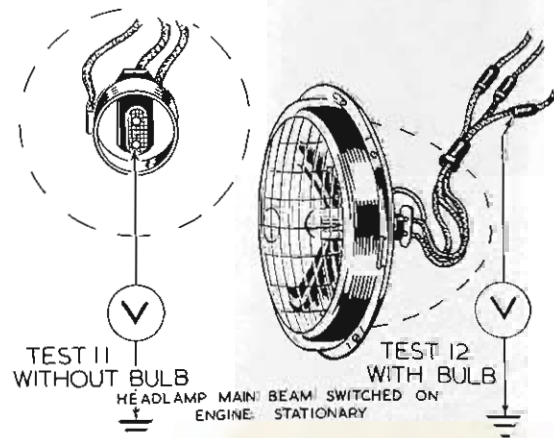
We returned then to the headlamps themselves, to make two tests at the cable ends. Both headlamp bulbs were taken out and the lighting switch moved to the "head" position (main beam). The voltage in the holder was measured with the engine stationary.

At the same time, the contacts were inspected for dirt, as this would prevent the full battery voltage from being applied to the bulbs, causing voltage drop and hence light lift.

We next inserted the bulbs and took two more voltage readings, as close as possible to the bulb contacts — in our case at the nearest snap connector.

The reading without bulbs was 12.3 volts and with the bulbs lit 11.8 volts.

This was a normal drop for the correct wattage bulbs — and this is a point we would like to stress : make sure the bulb wattage is not excessive, i.e. that specified bulbs are fitted. Bulbs with excessive wattage can easily cause light lift.



TESTS 13 AND 14. COMPLETE CIRCUIT

The final tests we made checked the wiring for voltage losses due to high resistance connections, lengths of cable of insufficient section to carry the current, bad earths, etc.

We tested the insulated line first, with a voltmeter between the generator "D" terminal and the cable ends at the headlights — with the lighting load switched on and the engine running.

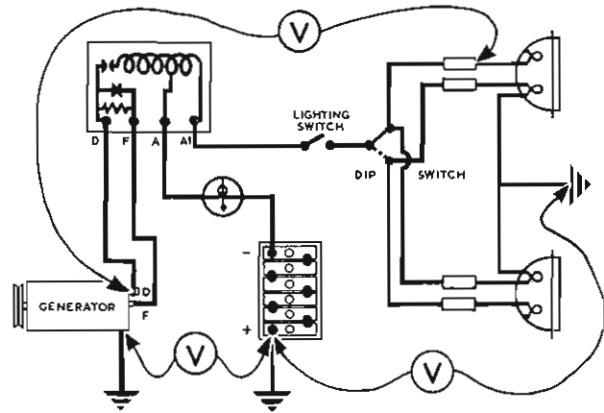
Our reading was exactly 0.5 volt, which we consider the maximum permissible voltage loss on the insulated line.

If the reading had been higher we should have had to test with the voltmeter across every connection in the line to locate the loss.

Two tests were necessary on the earth side, the first between the generator earth, that is, the body of the machine, and the battery earth post. Then from battery earth to the headlamp earth — the lights were still on in each case.

No voltage drop was recorded on our meter, proving that the earth connections were sound.

Again 0.5 volt loss is the maximum allowed.



VOLTAGE DROP TESTS WITH ENGINE RUNNING & LIGHTING LOAD ON.

TEST 13 INSULATED LINE.
TEST 14 EARTH LINE



OPEN-CIRCUIT SETTING ADJUSTMENT

Having checked the complete circuit, we corrected the faults we had found.

The regulator open-circuit setting was dropped to a mean figure of 16.0 volts and the light lift again measured as at the beginning of the procedure.

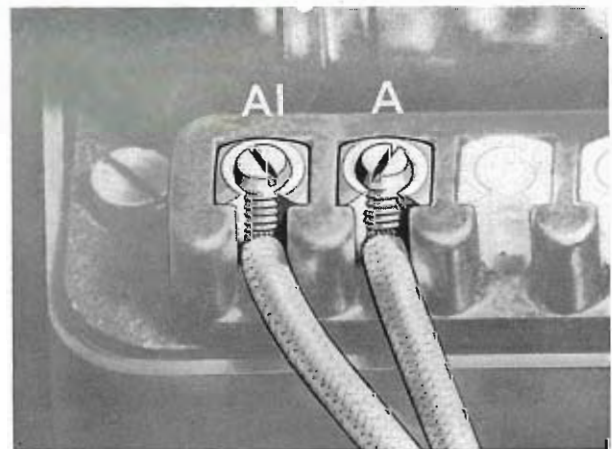
The readings were 11.75 volts with the engine stationary; and 12.5 volts with the engine running. This worked out at 0.75 volt difference, which meant that we had slightly reduced the voltage rise causing the light lift.

RE-CONNECTING THE A AND A1 LEADS

We then changed over the A and A1 leads, connecting them correctly at the control box.

This had an appreciable effect. The difference in voltmeter readings was now only 0.25 volts, with the engine idling in the one case and revving hard in the other.

In a darkened room, the difference in the light intensity was hardly noticeable, quite within normal limits.



TEST PROCEDURE ————— LIGHT LIFT

SUMMARY OF TESTS

This summary will give you an overall picture of the test procedure. It can be shortened with experience—for instance if a fault is found early on, rectify it and check the result.

But carrying out the whole procedure in this logical order will test the vehicle completely, ensuring that no fault is overlooked.

- 1 VOLTAGE AT CABLE ENDS, WITH BULBS:
 - ENGINE STATIONARY
- 2 ENGINE RUNNING
- 3 TEST BATTERY—S.G. & H.R.D. TESTS.
- BATTERY TERMINAL VOLTAGE:
 - 4 ENGINE STATIONARY —
 - 5 ENGINE RUNNING —
 - 6 ENGINE RUNNING + FULL LOAD
- REGULATOR O/C VOLTAGE:
 - 7 NO LOAD —
 - 8 FULL LOAD —
- CLOSED CIRCUIT VOLTAGE:
 - 9 NO LOAD —
 - 10 FULL LOAD —
- VOLTAGE AT CABLE ENDS, ENGINE STATIONARY:
 - 11 WITHOUT BULBS —
 - 12 WITH BULBS —
- VOLTAGE DROP TESTS, ENGINE RUNNING:
 - 13 INSULATED LINE —
 - 14 EARTH LINE —

TESTS 1 & 2 SHOULD BE REPEATED AFTER EACH FAULT CORRECTION.