11.0 Electrical

11.1. INTRODUCTION

WHAT WITH OHMS, volts, amps, relays, polarities, and a host of other electric jargon, it's not surprising that electrics baffle so many people, including, at times, those who pronounce themselves experts. There are so many factors involved when an electrical fault occurs that we should really go back to basics first of all.

About 90% of electrical problems are due to faulty connections, particularly on batteries, alternators, lights, pumps and switches. Always ensure that connections are grease free and tight fitting, especially snap connectors. The exception to this rule is the battery terminals which should be clean and smeared with light grease or vaseline to protect from corrosion.

Looms or wires passing through a bulkhead or bracket must not be allowed to chafe as this is a prime cause of dead shorts, and can lead to an electrical fire. Always use grommets, tape or even rubber tubing around the hole in question. Looms should be clipped where they hang free; the best clip to use here is an insulated 'B' type. If a standard loom is used, incorporating the standard fuse box, always use the correct amperage fuse. Do not be tempted to use an oversize fuse to overcome an overloading problem - this is defeating the object of having a fuse anyway.

Fuses should be easy to see whether they have blown, and also easy to replace. Obviously, the box should be away from sources of intense heat, ie exhaust pipes. One point, Boreham never fuse the headlights. This is not a 'must', but if headlights are fused, make sure they are NOT both on the same fuse!

When adding a loom for auxiliaries, try and obtain a different colour wire for each item. Believe me, ten red wires through a hole in the bulkhead is a real headache to trace when only one or two auxiliaries have a fault. Also, do not paint over the wires should you decide the 'banger' needs an under bonnet re spray. A neat and tidy wiring job is worth the extra bit of time it takes to prepare and looks good.

Now on to lights themselves. Headlights, spots and fogs are an individual choice, and is down to you. If in doubt, have a look at what everyone else is using.

There are legal requirements for auxiliary lighting and the fittings in the diagram should be strictly adhered to, but take in one further point. For road events run under RAC rules, you should not have more than FOUR forward pointing lights at any one time, whilst on the public highway. This is to try and cut down the annoyance of some of the solar systems charging around the lanes that we used to have. On stages though you can, of course, use all six lights.

11.2. LIGHTS

When fitting spot or fog lights, it's a good idea to make up a separate loom from the cockpit to the lamps. Have a junction in the loom about 4" from the lamp, which makes removal and changing much easier. Individual earths for each lamp are a must.

Lights should be set up to personal preference, but don't forget club rallying in this country is not on closed roads, so don't annoy other road users. Remember six lamps is the legal maximum (in practice you don't need more anyway).

To keep your lights at their best, the source of power, the alternator, and battery must be good and reliable. Remember to tightly secure the battery - something that scrutineers nearly always check. The 3" pulley on the alternator is the recommended size to use because it has the advantage of a low speed charge. The theory here is the bigger the pulley, the better as far as the battery is concerned.

With all the lamps and extras on a rally car, you need a good 'storage space' so a good battery is vital. The Ford heavy duty 57 amp/hr is adequate for most people.

To help decide which charging system would be necessary when extra lights, and all the extras are fitted on a rally car, the calculation should be as follows:

Headlights	110W
Spot Lights	110W
Side Rear No Plate	30W
Dash	4W
Brake Lights	48W
Fuel Pump	20W
Flashers	48W

The lighting total is 254 Watts. This converted into amps (that is divided by 12) gives 21 amps. Usually, the standard fittings, such as ignition, takes 3 amps, heater 4 amps and wipers 3 amps, giving a total of 33 amps, so you need at least 40 amps output.

One final point, whenever the charging system is changed, or alternator swapped, always have the control box or regulator checked and adjusted to suit power and battery. Over charging can cause just as much trouble as under charging. It will give you blown bulbs and eventually a useless battery.

11. 3. WATERPROOFING

Water on the ignition side of the electrical system is one of the best-known ways of immobilising a rally car, as anyone who has found himself stationary with his Ford stuck motionless in a ford (sorry) will know only too well.

The main cause of getting the engine drowned is via the cooling fan. This sucks water through the radiator in the same way that it sucks through air: the water hits the fan, gets itself blown about in a very fine mist and you have an instant dead engine. In other words, it's this fine mist of water, which is incredibly penetrating, that has to be kept off the ignition connections, leads and distributor cap. Boreham have tried most of the known spray-on goodies, which work very well indeed up to a point, but for deep fords you need a bit extra.

The biggest, and most important, job is the distributor. One idea is to obtain one of the waterproof covers they use for BMC Minis, which has to be used with a side-entry distributor cap. Then make sure that all the plug leads are in really good condition and check that they are secure in the distributor after you've fitted the waterproof cover. All the leads into the distributor should be sealed at their entry into the distributor cap with a waterproof sealant, such as Bostik or Salastic.

The next thing you need is a bit of motorcycle inner tube which will provide a really tight fit over the whole unit at the point where the cap joins the body. A piece about four inches long will have to be rolled onto the cap underneath the waterproof cover, which you also roll up out of the way while you're doing it. The distributor cap is then slipped onto the body, the rubber rolled back into place over both the joint and the clips. Then you pull the Mini cover down over the whole assembly and tape it into place. One thing you will have to watch is that the vents in the base of the distributor do not become obstructed, otherwise it won't breathe, it'll get dry, and it might then seize up solid.

You must use spark plug covers, preferably rubber ones, at the other end of the leads to protect the plug insulator: if they get damp you'll get arcing, misfiring and all sorts of aggravation.

The bits that supply the electric power to the distributor - the coil or transistor pack - need just the same amount of careful sealing. The high-tension or "king" lead should be covered by a rubber sleeve and then sealed as one, and so should all connections on this side of the ignition system. Then you get your little aerosol (one of the silicone mixtures that are on the market) and spray all over the leads and connectors of the entire system - and don't skimp any part that might be affected by water, however well you think it is protected.

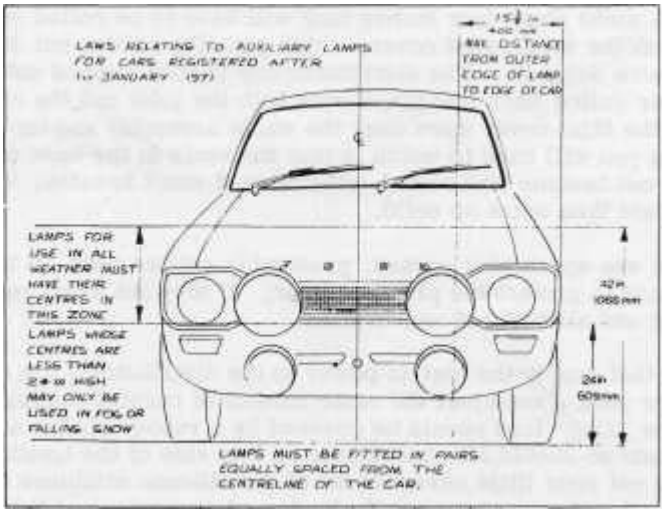
This silicone spray should also be applied to the spot and fog lamps connections exposed to the elements, and if you've got children pinch some of their plasticine, which is excellent stuff for sealing spot-lamp rims or where wiring passes through rubber grommets in body panels. A dose of plasticine can also be applied where the headlamp loom enters the body of the headlamps - in fact, you can use it on any hole that might let in water or even damp. If you haven't got kids or small brothers or sisters, you'll have to buy your own, in which case you can get it coloured to match your car. It costs no more and looks a lot smarter.

There are one or two extra things, when talking about electrics, which, as far as competition cars are concerned, are necessary to comply with regulations or law.

Battery earth leads must be either painted yellow or covered in yellow tape. The battery master switch, identified by "flash and triangle" sticker, must be capable of cutting out not only the battery, but also the ignition: on a car equipped with an alternator, cutting out the battery won't stop the engine.

11. 4. LIGHTING REGULATIONS

The dip-switch, when operated to put the headlights onto dip, must cut out all the other main lights, leaving only the dipped beam in use. And the reverse light must be operated only be engaging reverse gear.



Broadly, there are two sets of regs, both are interlinked, just to complicate things.

On cars registered before 31 December, 1970, a pair of auxiliaries have to be no less than 13. 8 inches apart (measured to the inner lit edges). After that date, the distance of each outer lit edge to the outer extremity of the car (note that this means what it says - it could be your flared arch, or your doorhandle) must be less than 15. 8 inches.

To cap that lot, any light mounted less than 24 inches from the ground (to its centre) can only be used legally on the public roads in fog or falling snow. Above that height, the lights may be used in any weather conditions, but must be extinguishable with the standard dipswitch.

Note: that no mention is made of types of lamps - if you put a driving lamp six inches from the ground, the law thinks of it as a fog lamp. Barmy, but we have to live with it.

11. 5. SPOT LIGHT RELAYS

It's best when dealing with a complex system such as electricity to start from the first principles: Your car depends entirely on what happens in that bundle of coloured wires behind the dash, and how and where the wires go; but it all starts at the battery. Like most other things inside a car, successful performance is a result of keeping it happy. Like women, batteries need attention: in the long run, simple, cheap maintenance will be rewarded by way of lack of aggro and expense. It's not necessary for me to go into battery theory.

Suffice it is to say that the battery functions as an electrical reservoir as a result of a chemical reaction between lead plates and sulphuric acid. The best place for this acid - which is highly corrosive - is inside the battery. If it spills or seeps out it will commence its devilish work on your terminals. The posts and clamps will start to look white and fluffy - at worst they will later disintegrate, at best a layer of highly resistive deposit will form at the electrical connection. Voltage in the system will thus be low, resulting in poor starting, dim lights and perhaps misfiring. The moral is: keep your battery clean and the connections tight, and it won't let you down.

The battery is kept charged by the alternator or dynamo. These are generally trouble free if kept clean and protected from clumsy spanners. Any charging troubles can usually be traced to a 'nasty' inside the little box of tricks known as the Regulator. Unfortunately, if this goes on the blink there's very little you can do about it - replacement is the only answer. However, make sure the terminals are clean and tight. Should you have to remove it, please ensure the cables go back on the correct terminals - you can check on this with the wiring diagram in the car's handbook - otherwise you will damage it irrepairably.

The next "component" is the wiring loom. All you need do as far as the standard loom is concerned is to keep the connections clean and tight, and the looms well protected from chafing. Where they pass through a hole in the bodywork - for example the bulkhead - there should always be a rubber grommet to prevent the cables running on the sharp metal edge. Rubber does, in time, perish, so preventative maintenance is again the answer to prevent disaster. Naturally this goes for any extra wiring you carry out -for example, remounting fuses within the passenger compartment, or fitting auxiliary lights. Having mentioned D-I-Y wiring, the cable you use must be able to cope with the current it is going to be asked to carry: failure to make allowances on this score can result in voltage drop (of which more later) or the cable over-heating and perhaps burning. This can spell real disaster, for obvious reasons.

A good cable gauge to choose for most installations is 28/030 (metric) - which means that the cable has 28 strands each 0.030 mm in diameter. Beware of using this gauge as an alternator charging cable - it cannot take that sort of current.

Next, fuses: their job is protection of the circuit from a current that will damage the circuit or component. The necessary fuse value can be worked out by the simple formula:

Wattage of component Rating (continuous) = Wattage of component / 12

Note that this is a threshold value: the chosen fuse should be rated about 25% higher than this. For example, two Halogen lights at 55 watts each:

Rating = 110/12 = 9.2 amps

Choose a fuse of about 12 or 15 amps continuous rating. On a competition car it's a good idea to fuse all important circuits independently, mounting the box of tricks within the passenger compartment. The advantage of this is that they're all easily accessible for the co-driver to deal with if necessary; and make sure appropriate spares are always carried. One hang-up that all circuits suffer from, to a greater or lesser extent, is voltage drop.

Any cable has a certain resistance, and therefore the voltage available at the component will be less than 12V. It's impossible to completely avoid voltage drop, but it can be minimised. To give an example of its effect; an Oscar run at 11V instead of 12V will produce 25-30% less light. Points to watch are (again!) cable gauges and connections. Also, it is likely that switches, especially if they have been in use for some time, have slightly burnt contacts. The deposit thus formed is resistive and will cause voltage drop. So if you have a low voltage problem, investigate the switchgear - the answer might be to replace it.

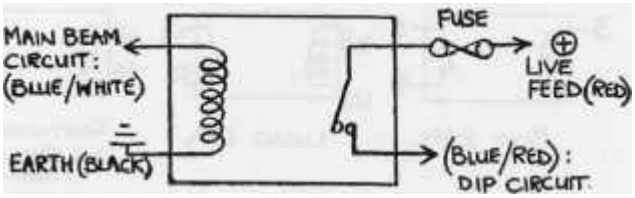
Another way of avoiding low voltage is to use relays. These are simply remotely-operated heavy duty switches, capable of handling 15-18 amps. Mount the relay so that the run of cable from the battery to the component is at the minimum,

thus lessening the resistance of the circuit. Actual switching of the relayed circuit is completely independent, whereby the relay is "fired" by providing a live feed through the relay coil, via a dashboard switch, to an earth point; this also means that each dashboard switch only requires one cable passing through the bulkhead.

Below are three commonly used relay circuits. Obviously, the method can be applied to almost any other circuit within the car, with beneficial results.

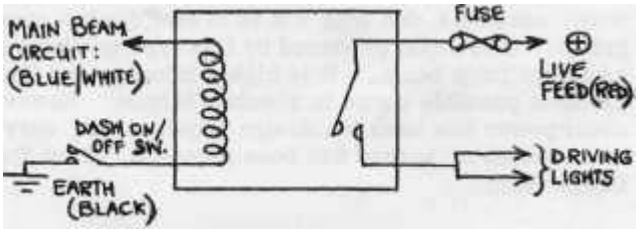
1. It is often advantageous to have both main and dip filaments alight on main beam: the dipswitch then effectively becomes an on/off switch for the main beam.

Circuit:

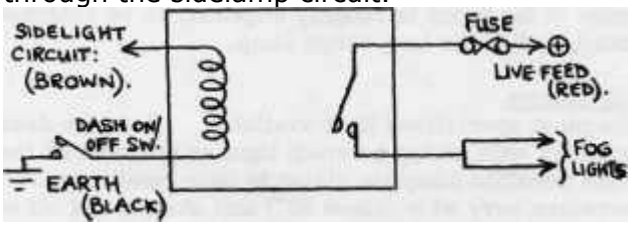


2. To operate legally, driving or spot lights must be wired to extinguish when dip beam is selected.

Circuit:

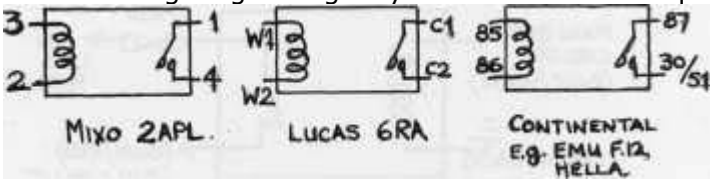


3. Fog lights should operate independently of headlights; preferably switched through the sidelamp circuit.



Any make of relay is suitable, assuming the current capacity is great enough; however, the terminals of different relays are not, surprisingly, coded differently.

The following diagrams give you some common equivalents:



One last word about relays, they are very sensitive to heat and water. They should therefore be fitted away from direct heat, and in a place where they are protected from water.

11.6. CIBIE LIGHTS

A) Long Range ("Spot") Lamps

These can be recognised by the almost completely clear lens -Note: not glass, but lens - it is in fact itself a complex form of prism. The beam produced by this type is what used to be known as a spot lamp beam. It is highly intense, and thus has the greatest possible range in absolute terms. However, because sheer power has been the design requirement, very little lateral illumination or spread has been provided, hence the term Long Range lamp.

B) Driving Lamps

A development on the above theme. Here, though, the lens is provided with a larger number of separate prisms - each individually designed - in order to give adequate lateral illumination. Whereas the long range lamp has a much greater spot intensity, the driving lamp is, in fact, much better as a road illuminator, although it has not got the range capability of a long range model. Shape of the beam is roughly elliptical, to be contrasted with the round spot of the long range lamp.

C) Fog Lamps

The most specialised light available. Here the designer has been faced not with giving as much light as possible on the road, but to make possible adequate vision in poor conditions. The beam is therefore very wide (about 80 deg) and sharply cut off at its upper limit. The reason for this is to avoid, as far as possible, the back-scatter of light - that effect which precludes the use of main beam in fog. The lensing to give this beam is distinctive, and is composed completely of vertically aligned prisms. Some small element of scatter is allowed far above the cut off so that the position of the light can be seen by other road users. The light should, of course, be mounted as low as legally allowed.

There is another type of lamp that is not supplied by Cibie as such, but is a derivative of the Fog lamp. The modification is very simple, and the lamp is then known as:

D) "The Virage"

If the fog lens of your fog light unit is dismantled (by levering the bulb holder from the reflector) you will see that the bulb is shielded by a black metal pressing, which is attached to the holder by three rivets. Drill these out, throw the black thing away, reassemble, and you are the proud owner of a Virage. You may now ask what good is all that? The answer is that it improves intensity of the wide beam, at the expense of the sharpness of the cut-off.

So, what is the best to use? For the first pair we would recommend a pair of driving lights without hesitation, as the best all-round performers. For sheer power go to the Super Oscar. Better 'cos it's bigger'. The other pair (you aren't really allowed more than two pairs by the Road Traffic Act or RAC regs) is up to you to choose, but make sure they are suitable for the type of event you are going to do. If the event is in the forests, have a pair of Fog or Virage - beam width is very useful for corners. If you are doing a very fast, mostly straight event, try a pair of long range lamps. The range is the important thing, and if they are supplemented by driving lights as suggested, you should have enough lateral illumination.

You'll probably see some cars with the lower pair of lights aimed so that they diverge or even cross. Some folk like one pointing up, the other down. This is again to your own preference: up/down divergence is useful for yumpy stages, where you need to see over a brow or up a hill, before you get to it. Lateral divergence helps vision around corners -but only very slightly.

E) Reversing Lights

Most of the time, you will be driving forwards. However, even the best can wrong-slot, and you have to use that other position on your box and go into reverse. Again, it's nice to see where you're going, so what about reversing lights. The law limits these to 21 watts each, but we would recommend a Halogen Foglight for off-road use. The Cibie type 40 is ideal. Wire them into the existing circuit, using a gearbox-switched system if possible. We must stress that the use of Halogen 55W lamps, in this case, is technically illegal - but that's your decision.

F) Headlights

Lastly, headlamps: The make is a matter of personal preference, but one thing you can do, assuming you are using quartz halogen units, is to wire up both filaments on the double filament bulbs. This will shorten the bulb life very little, but gives you a good spread of light without much effort. In other words, the dip beam remains on all the time once the headlamps are on, and is supplemented by the main beam. This will give you the advantage of the Cibie Biode system, but without the slight problem of that particular light in adjusting the main beam relative to the dip beam.

11.7. WIRING UP HEADLIGHTS

To make sure that the dip switch does not become overloaded, the headlight system, using double filament bulbs, as well as the auxiliary lighting, is run through relays. We use the Bosch 30 amp relay.

The best way to attack this problem of wiring is to mount the fuse box and all lighting relays (and there are four of them) on one panel. This panel is made up from sheet ally, and is located above the parcel tray on the inside of the quarter panel by three Dzus fasteners. The panel mounts, in which the fasteners seat, are raised from the car structure so that the mounts for the relays and fuse box do not rub against the vehicle bodywork. There are multi connectors for all wiring leading to and from the panel for ease of removal. The main reason for putting all these items on one panel is to facilitate removal, and also to do a neat job.....if you think about it, it's almost impossible to attach four relays and a fuse box direct to the car under the dash and make a good job of it; one relay is bad enough!

Without going into the wiring of the fuse box now (because it needs a complete article in itself) let us simply say that it is a standard Ford fuse panel cut short. The incoming power is direct from the shunt, and in the case of the headlights, power is taken on the incoming, ie non-fused side of the box, to the relevant relays, one for dip and one for main beam. Stopping here for one moment, you'll note that the headlight system is not fused at all. This is really driver preference, no more, because there are two schools of thought on this one. The main point against having headlights fused is that if both fuses go (which is not very likely) you can be plunged into instant darkness. On the other hand, you should consider the more likely case of a possible electric fire being caused by the obliteration of one headlight in a minor incident, with a tree for example, that can be caused by non fusing headlights. Anyway, it's the driver's choice, and Boreham doesn't fuse

the headlight system.

On the Bosch relay, the power is taken to the terminal marked 30/51. The offtake to the lights is from the terminal marked 87. You will note that this terminal is divided, and the power to each light is taken separately to each headlight, (and indeed spotlight) by its own wire. Terminal 86 goes to earth, and the remaining 85 to the dash dip and light on/off switch.

11.8. QUARTZ BULBS

To finish, some information about the Halogen bulb. This has been known by many names, ie Iodine , Iodine Vapour, IVB, Quartz, Quartz Iodine , Quartz Halogen, etc, etc. They all mean the same thing: that is, the "glass" is quartz, and the gas inside is a Halogen vapour. You'll notice one main difference between this and the conventional Tungsten bulb (by the way, QI bulbs also have a tungsten filament), and that is that they are smaller. The reason for this is to promote a higher operating temperature of about 2000 C. This is the reason for the considerable gain of brightness. It is the Halogen gas inside that stops the filament deteriorating rapidly as it would do under such extreme heat, and gives it a longer life.

11.9. AMMETER & HUNT

Let's have a bit of background first, with the Gp 4 cars, for which we make up our own looms, and later go on to Gp I adaptations and the Escort II.

Our own loom for Roger Clark's car made up especially?

That's right. As the Gp 4 cars developed and became more sophisticated, various items were moved around and we started to land up with a right hotch-potch of wires that were lengthened and thickened chasing the components around the car. The real crisis came when the fuse box was moved (more of that later), and from then complete looms for each shell were made as it arrived at Boreham. Later on, when this became a standard job and all the wire lengths etc were known, we got the looms made up outside.

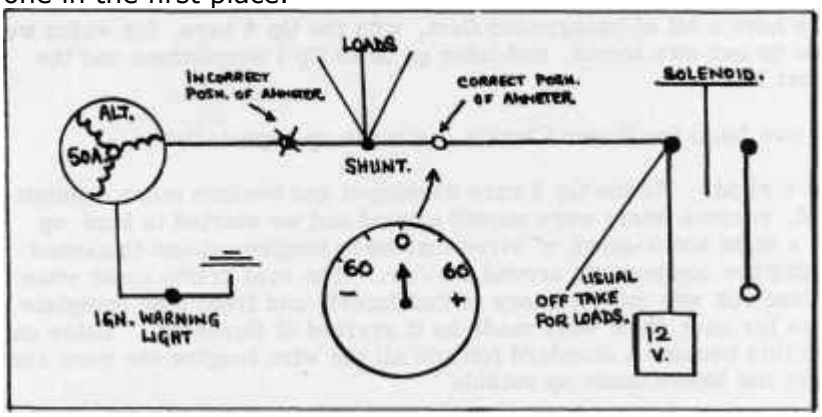
A typical example of one problem we faced was the use of a larger alternator to keep up with output demands. This meant the wire cable size going up, from the alternator output cable to the shunt, to 97/012, added to which the cable in the headlight circuits, ignition and fuel pump circuits was increased from 14 to 28/012 (012 is standard thickness of one strand of wire at .012").

One of the first things to realize when talking car electrics is that the generator, be it dynamo or alternator, must be able to take all the loads put on it without having to lean' on the battery reserve. To be able to check this accurately then, the first thing you must do on any serious rally car is fit an ammeter, and an accurate one at that. You'll find that the standard gauge fitted, for example to the 1300GT, 1300E, Mexico, RS 1600, RS2000, etc is described as a voltage charge indicator, which is not the same thing as an ammeter. The voltage gauge tells you approx-imately the state of battery reserve, but not the state of balance in the eletrical system.

If an ammeter is not fitted, you are dependant upon the ignition warning light to tell you when anything is wrong. This might be fine for a shopping car, but by the time this light appears on a rally, it's usually too late to do much about it. An example - if one of the three phases in our rally alternator burns out, the ignition light won't come on, but eventually the whole system will drain the battery, and

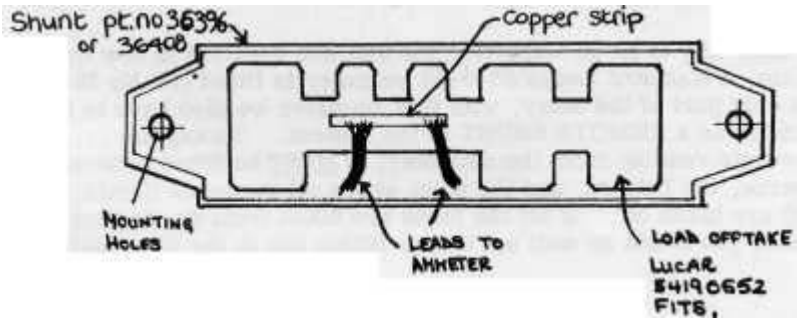
the middle of Kielder is not the most convenient place to come to a halt.

Now you know why to fit an ammeter, the $60,000 question is how to fit it. At Boreham, a standard Lucas 60-0-60 ammeter is fitted (Pt No 36408), but that's only part of the story, with this ammeter we also have to fit what is known as a REMOTE SHUNT in the system. To explain___.. to get an accurate reading from the ammeter, it MUST be fitted between the power source, the battery, and the point where all the loads (lights, wipers, horn, etc) are taken off. If all the loads are taken from the system after the ammeter you might as well not bother fitting one in the first place.



From the drawing, you can see that normally these loads are taken direct from the battery side of starter solenoid, which of course links straight to the battery. The answer is then to move the offtake for the loads. Now this can be done on certain ammeters by having a vast bunch of wires going to the fusebox linked directly to the gauge. In practice though, with any dashboard mounting this is very difficult and untidy, so the remote shunt is put in the system and all the wires linked to that; in other words, it is also a remote junction box.

The shunt has a calibrated strip of copper which records the millivolts drop between either end, and this is recorded on the ammeter. There are two types of shunt box made by Lucas, both look just the same, but one has longer leads with the spade connectors to run to the ammeter than the other. The length of these leads is related to the calibrated strip, so they MUST NOT be cut or lengthened.



Having told you how to fit your ammeter in the system, it's up to you where you put the gauge. In an ideal situation, the gauge needle should be nicely balanced on 0-this means everything is working normally, other than when starting. Here, with a fully charged battery, which, incidentally, is around 14. 2 volts (although described as a 12v unit - it's 2. 35v per cell) from the voltage regulator incorporated in the back of a standard alternator, but separate on our rally alternator (which we'll talk about at a later date), you should get a + reading on the gauge for a few miles only. After this the needle should swing back to 0 pretty quickly. A plus reading is therefore indicative of a charge being restored to

the battery from the alternator. A negative reading is power being drained by the system from the battery.

Works Mkll Escort dashboard. Note centrally positioned ammeter as only extra gauge.

11.10. ALTERNATOR

Firstly then, the following simple formula will help you decide the output needed from the alternator:

Total Watts / 12 = Amps

Therefore, add up the total wattage of your lights, flashers, heater, wiper motor, etc, divide by 12 and that will give you the minimum size of alternator needed. In the majority of cases, this is going to mean using a higher output alternator, since the standard 17 ACR Lucas unit (or equivalent) produces a maximum 35 amps under ideal conditions. Staying on the Lucas range for a moment, within the same casing as the 17 ACR unit is the 45 amp output 18 ACR, and there is a possibility of Lucas manufacturing a 55 amp output 20 ACR type. As said, all these are in the same machine casing (? Gp I adaptations). Two bodily larger

alternators are the 23 ACR, giving 55 amps, and the 25 ACR, giving 70 amps output. The suffix 'R' here means that the regulator is incorporated in the alternator.

11. 11. REMOTE REGULATORS

Now, many of you will have heard about remote regulators being needed on rally cars, and to fit a sound reliable system, this is indeed necessary. An advantage of the Bosch alternator here has always been that it is supplied with a remote regulator unit. The reason for the separation of alternator and regulator is principally engine vibration, and thumping that rally cars take adds even more strain. For instance, Boreham fit a nylon top support arm to the alternator and a couple of metalastic bushes on each base bolt, to further stop vibration, plus, of course, remotely mounting the voltage regulator and rectifier, which I'll talk about in more detail shortly.

What can happen is that the main output lucar connector on the back of the alternator can loosen under vibration, resulting in overheating and eventually an open circuit. When this happens, the battery sensing lead (B+) can no longer sense the voltage, and the alternator becomes free to generate its full open circuit voltage of over 150 volts. For this reason then, Boreham use the Lucas AC11 alternator, with remote regulator and rectifier. This unit is available in two types, a 50 amp output (Lucas Pt No 54021271) and a 60 amp output (Lucas Pt No 54021243). Because of its greater output Boreham use the 60 amp one on the works cars. As a point of interest, if you do overload an alternator, you will just end up flattening the battery until you stop and try to restart the engine, when there will be that familiar click of a dead battery when the key is turned. A dynamo, however, will eventually overheat and melt the solder on the end of the commutator bars if it is overloaded, and the vehicle will eventually grind to a halt.

Having decided on the big alternator with remote regulator, let me just advise you that you'll really have to fit the works type 'Polly Vee' drive belt arrangement for reliability. This is a broad drive belt for which you will have to fit special pulleys on both crankshaft and alternator. The works found that with the estimated 6/7 bhp absorbed in driving the higher output alternators, the standard design belt could not take the strain.

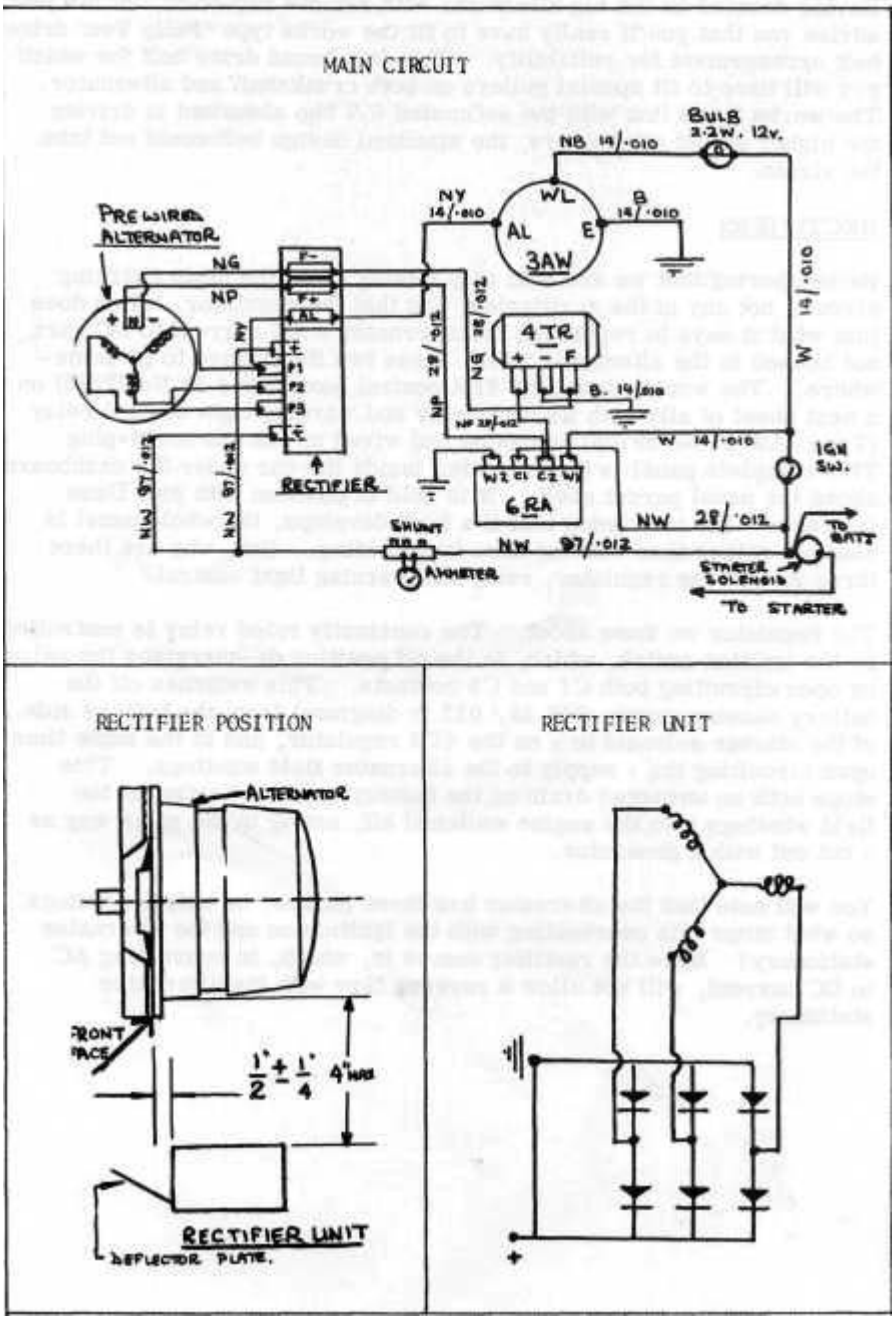
11. 12. RECTIFIERS

Remembering that we are still only talking about the main charging circuit, not any of the auxiliaries, and that the regulator, which does just what it says in regulating the alternator's AC current to DC, are not housed in the alternator itself, these two items have to go somewhere. The works mount the 4TR control box (Lucas Pt No 37585) on a neat sheet of ally with its 6RA relay and warning light control relay (Type 3AW Pt No 38706) alongside and wired up via one multi-plug. This complete panel is then mounted inside the car under the dashboard above the usual parcel shelf. It is held in position with four Dzus fasteners - the idea being that if a fault develops, the whole panel is changed rather than wasting time fault finding. But, why are there three items, the regulator, relay and warning light control?

The regulator we know about. The constantly rated relay is controlled by the ignition switch, which, in the off position de-energises the relay . by open circuiting both Cl and C2 contacts. This switches off the battery sensing supply (NW 28/. 012 in diagram) from the battery side of the starter solenoid to + on the 4TR regulator, and at the same time open circuiting the + supply to the alternator field windings. This stops both an unwanted drain on the battery and

overheating of the field windings with the engine switched off, acting in the same way as a cut out with a generator.

You will note that the alternator has three phases, or output windings, so what stops this overheating with the ignition on and the alternator stationary? Here the rectifier comes in, which, in converting AC to DC current, will not allow a reverse flow with the alternator stationary.



The warning light control, which picks up from the P1 terminal on the rectifier unit, merely reverses the warning light current so that the ignition light does the normal thing of remaining off when running, and coming on when the engine is not turning over.

Lastly, onto the rectifier unit (Pucas Pt No 47220A). This piece of equipment converts the alternator's AC current to a useful DC supply. Now, although its strong metal case looks pretty robust, the actual unit is very fragile and doesn't

like heat at all. Being mounted in the engine bay is therefore perhaps not the best place, except that it has to be directly linked to the alternator, with as short wires as possible. Because of the heat problem, we in fact link two rectifiers in parallel in the same box, which means each does half as much work and is less likely to overheat. The two rectifier offtakes are then wired together to give one feed to the loads supply via the shunt and then battery. Continuing on the heat problem, the rectifier, usually cooled by the alternator's own fan, must still receive a good draught of cool air. Ram effect is no good when the car is still and ticking over, so we mount it on the inner wing next to the alternator complying with the following:

1. The distance between the edge of the rectifier case to the front face of the alternator must be ½", plus or minus ¼".
2. With the belt in position, the rectifier unit must be no more than 4" from the body of the alternator and preferably with the air deflector plate next to the alternator fan blades.
3. The rectifier to be fitted away from any area subjected to direct water splash.
4. A good earth contact must be made between the body of the car and the rectifier.
5. Cooling air passage through the rectifier must remain unobstructed.
6. Leads from the alternator to rectifier must be secured to the car body.

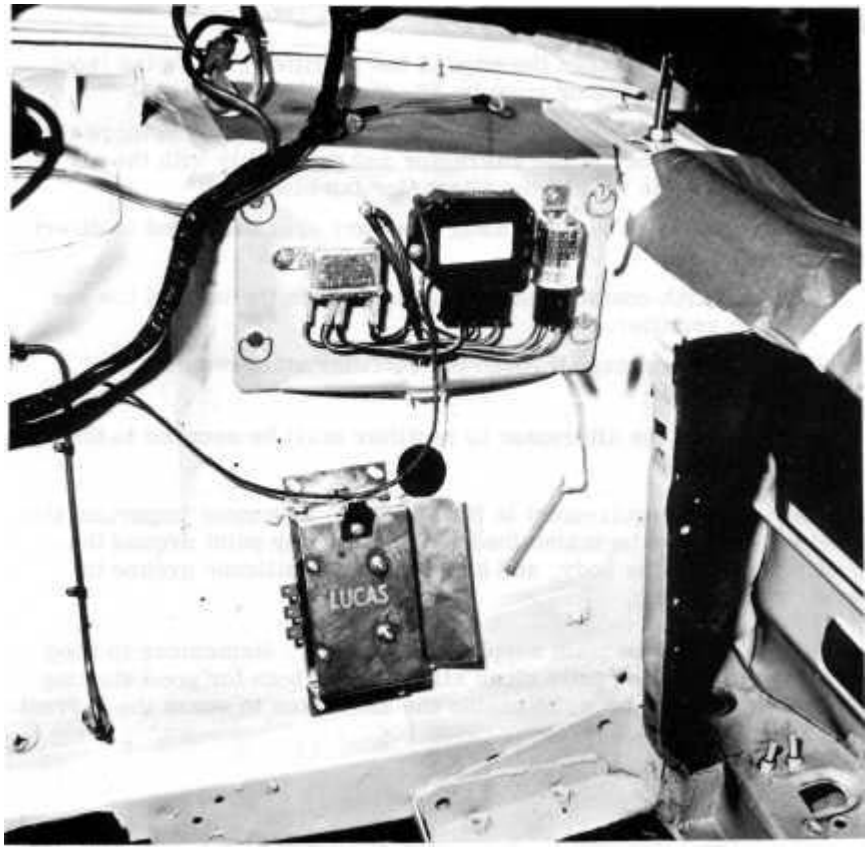
We underline the requirement in No 4 because it is most important that a good earth always be maintained. Clean off any paint around the mounting holes on the body, and add a smear of silicone grease to prevent rust forming.

That's it on the works main supply system then. Remember to keep the battery terminals really clean all the time, both for good starting and, on the subject above, to enable the alternator to sense the correct voltage all the time.

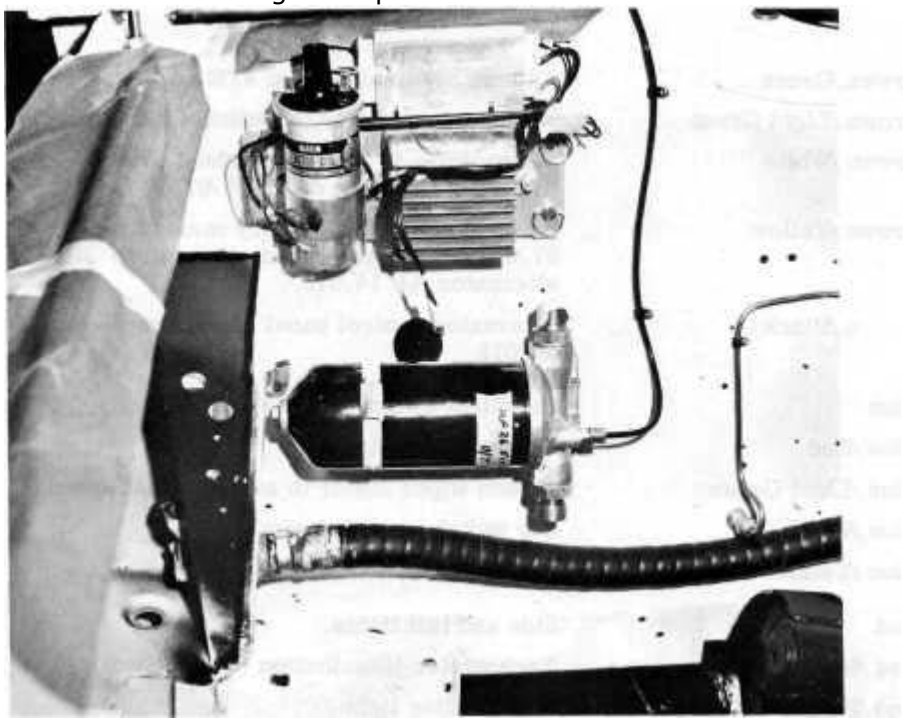
11.13. RS ELECTRICAL PARTS

RS Parts Dept have now made available the following Boreham spec eletrical components. Poly V alternator /waterpump drive:

Kit	- Poly V	9054022
Pulley	- Crankshaft	9054019
	-Waterpump	9054018
	-Alternator	9054017
Bracket	- alternator mounting	9054020
Belt	- drive	9054021
Strap	- alternator adjust	9054082



Rectifier unit and regulator panel


Transistorised ignition and coil pack.

11.14. WIRING LOOM - ESCORT I

When wiring anything, be it a flexilight, spotlight or whatever, I cannot overstress the need to stick to some form of colour code. On a competition vehicle this is doubly important - tracing ever-changing wire colours in the middle of the night

can make the difference between finishing and not finishing an event. Boreham base their loom on the old Lucas system, although there are added problems now for the later Escort I's and Escort II conform to the standard European code which is very different. Although there are mixed feelings on this new code, at least one good thing has come out of it - all live wires are red.

Anyway, here is the code used on Mk I cars, and if you're building it from scratch or just adding the bear necessary extras, say wires to sportlights via a relay, I suggest you use this as your reference:

Brown	All live supply feeds from alternator side of shunt.
Brown/Blue	Live feed to spot light switch
Brown/Purple	Alternator Field to + on 4TR regulator via 6RA relay.
Brown/Green	Alternator Field to F on 4TR regulator.
Brown/Light Green	Screen wiper motor to switch - slow speed.
Brown/White	Alternator + to ampmeter shunt 97/012. Alternator sensing cable 28/012.
Brown/Yellow	Ampmeter shunt to battery master switch 97/012. Alternator control panel to alternator AL 14/012.
Brown/Black	Alternator control panel to warning light 14/012.
Blue	Headlight switch to dip switch.
Blue/Red	Dip switch to dip beam.
Blue/Light Green	Screen wiper motor to switch - fast speed.
Blue/White	Dip switch to main beam.
Blue/Yellow	Spot lights.
Red	Side and tail lights.
Red/Brown	Tachometer illumination (unswitched).
Red/Purple	Map reading light.
Red/White	Panel light switch to panel lights (instruments).
Red/Yellow	Fog lights.
White	Ignition switch controlled circuits.
White/Brown	Oil warning.
White/Red	Starter solenoid from ignition switch.
White/Purple	Feed to fuel pumps.
White/Green	Link to second fuel pump.
White/Light Green	Feed to heater motor (fused).
White/Black	Coil Neg to distributor LT.
White/Pink	Cigar lighter and radiator fan warning light from Aux Post, on ignition switch.
White/Orange	Feed to wiper motor (fused).
Black	All earth connections.
Black/Yellow	Override manual switch to radiator fan relay.
Black/Green	Thermal switch to radiator fan relay.
Purple	Clock and Halda lights.
Purple/Brown	Horn supply.
Purple /Black	Horn buttons to relay.
Purple /Red	Boot and bonnet lights.

Purple/White	Interior light switches.
Purple/Yellow	Horn to horn relay.
Green /Brown	Reverse light.
Green/Blue	Water temperature.
Green/Red	Left hand flashers.
Green/Purple	Stoplights.
Green/White	Right hand flashers.
Green/Yellow	Slow speed heater motor.
Green/Black	Fuel gauge.
Green/Slate	Fast speed on heater motor.
Light Green	Instrument voltage stabiliser to instrument
Light Green/Brown	Flasher switch to flasher unit.
Light Green /Black	Screen washer.

11.15. WIRING LOOM - ESCORT II (EUROPEAN STANDARDISED)

Brown	Earth (negative).
Black	Coil in line resistance to give 6 volts. (Ballast resist for starting) Fuse 6 & 7 - see below - to: 1) Backup lights 2) Heated rear window (control of relay) 3) Brake lights.
Blue	Ignition switch from alternator.
Black/Yellow	Ignition controlled feeds.
Black/Red	1) Ignition switch to starter solenoid 2) Brake light switch.
Black/Blue	Windscreen washer motor.
Black/White	Left hand indicators.
Black/Green	Right hand indicators.
Blue/Black	Fuel gauge.
Blue/Light Green	Oil warning light.
Blue/White	Main beam warning light.
Black/White/Green	Flasher relay.
Black/Purple	Ignition controlled supply to wiper.
Black/Red/Yellow	Ignition controlled supply to heater blower.
Black/White	Supply from No 4 fuse to r. h. headlamp main beam.
White	1) Loop from r.h. to l.h. headlamp main beam 2) Main beam feed to No 4 fuse from column lighting switch.
Yellow	1) Dip beam feed to No 4 fuse from column lighting switch. 2) Loop from r.h. to l.h. headlamp dip beam.
Yellow/White	Supply from No 5 fuse to r.h. headlamp dip beam.
Grey/Black	Left hand front side and tail light.
Grey/Red	Right hand front side and tail light.
Grey/Yellow	Instrument panel illumination.
Red	1) Interior light 2) Ignition switch feed 3) Heated rear window

	4) Alternator output 5) Feed from battery. (Most reds should be common (unswitched and unfused) live supplies through soldered connections)
Purple	Brake fluid warning light level switch - to 2 pin plug, then to brown and brown/fellow.

11.16. FUSE BOXES

Using the Escort II wiring as above, the fuse box, mounted on the dash panel top in the engine bay, can be wired in as follows:

No 1 fuse 8A To:	Interior lamp	red
	Cigar lighter	red
	Emergency flasher	red
Supply:	Red/Blue 28/012 Soldering connection to alternator and battery (red) in engine compartment.	

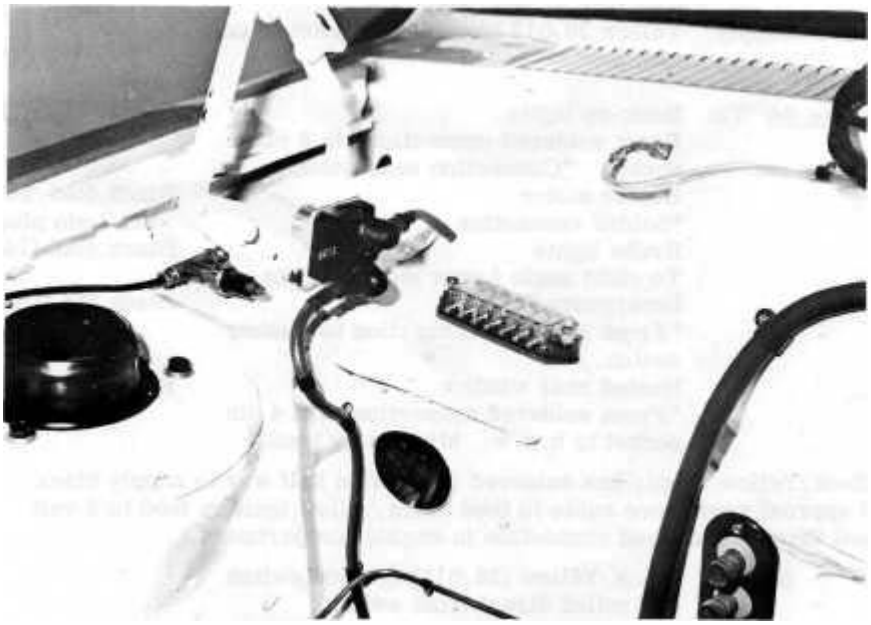
No 2 fuse 8A To:	Side light l.h.	grey/black
	Tail light l.h.	grey /black
	Number plate light	
Supply:	Grey 14/012	
	To fuse from 9 pin socket into column switch. Common supply (link) No 3 fuse.	

No 3 fuse 8 A To:	Side light r.h.	grey/red
	Tail light r.h	grey/red (via 8 pin rear plug)
	Instrument panel illumination	grey/Yellow (looped from 8 pin rear
Supply:	Common Grey 14/012 with No 2 fuse.	
NB: Also looped from above	via soldered connection is:	
	1) Grey cigar lighter illumination	
	2) Grey/yellow heater control panel illumination.	

<u>No 4 fuse 8A To:</u>	R.h. headlamp (main)	Black/white (36/012)
	White 14/012 loop from r.h. headlamp plug to l.h. headlamp plug.	
Supply:	White 36/012 from 4 pin socket in column switch.	
NB: Blue/White 14/012 loops	from this white in 4 pin plug to Main Beam warning light on instrument	panel.
<u>No 5 fuse 8A To:</u>	R.h. headlamp (dip)	Yellow/White (36/012)
	Yellow 14/012 loop from r.h. headlamp plug to l.h. headlamp plug.	
Supply:	Yellow 36/012 from 4 pin socket in column switch.	
<u>No 6 fuse 8A To:</u>	Back-up lights	Black (28/012)
	From soldered connection via 8 pin socket. * Connection near column.	
	Heater motor	Black/Red/Yellow
	*Solder connection	via 2 pin plug
	Brake lights	Black/Red (14/012)
	To right angle Lucar on foot brake pedal.	
	Emergency flasher	Black (14/012)
	*From soldered connection to flasher switch.	
	Heated rear window	Black/Red (14/012)
	*From soldered connection, via 4 pin socket to h. r. w. Mixo relay (coil)	
	*= Black/Yellow supply has soldered connection half way to supply black (2 approx) resistance cable to feed black /fellow ignition feed to 6 volt coil through soldered connection in engine compartment.	
Supply:	Black/Yellow (28/012) ignition switch	
	controlled direct from switch.	
	ALSO FEEDS No 7 FUSE BY DIRECT LINK.	

No 7 fuse 8A To:	Windscreen washer motor	Black/Purple
	4 pin column switch	Black/Purple (28/012)
	(via soldered connection and then 14/012 switch)	
	Windscreen wiper motor	Black/Purple
	From soldered connection to 3 pin socket in wiper motor.	
	Tacho	Black/Yellow (14/012)
	From Black/Purple soldered connection on Fuse 7	
	10 pin column socket	Black/Yellow (14/012)
	From Black/Purple soldered connection Instrument Panel	Black/Yellow (14/312)
	From Black/Purple soldered connection to black socket in instrument panel.	

Fuse No 8	NOT CONNECTED INTO LOOM - SPARE



Fuse box and starter solenoid location.

11. 17. PETROL PUMPS

It is essential, when building a Group 4 car to use twin electric fuel pumps in conjunction with either a bag tank or an alloy fuel tank, preferably incorporating a reserve tank.

The best pumps to use are undoubtedly Bendix pumps. As all Escorts are wired to a negative earth system, make sure though, that you purchase a negative earth pump.

Bendix have three pumps available:
- Silver top (25 gallons /hour)
- Blue " (35 " ")
- Red " (45 " ")

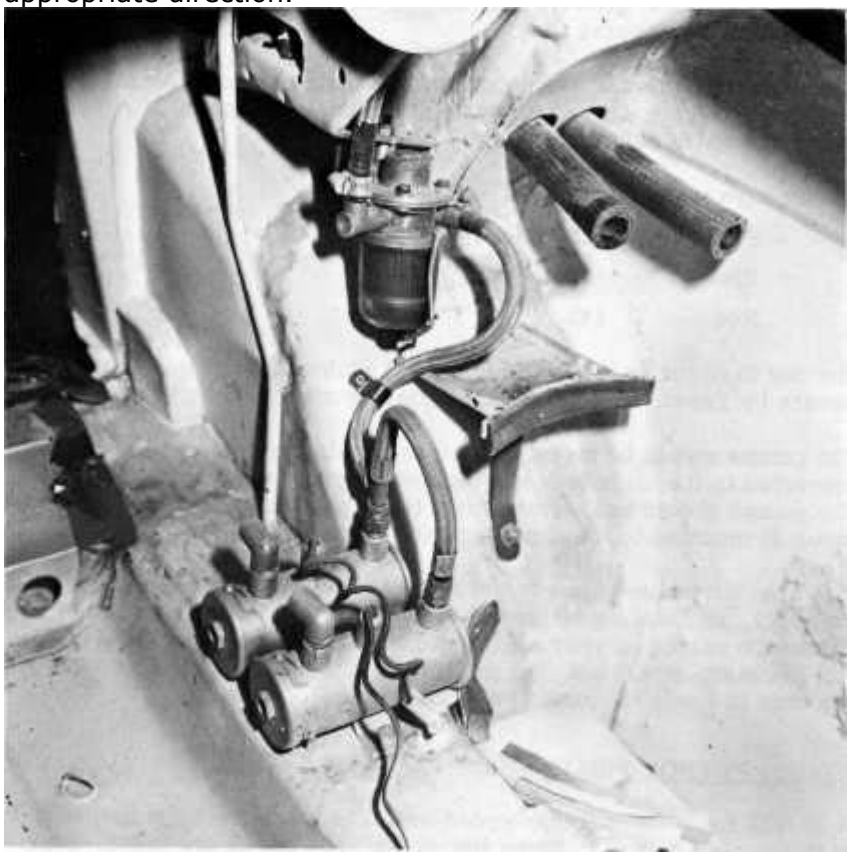
The one to go for is the Blue top, which incidentally is now made under licence by Facet, so don't let the different make bother you.

The pumps should be mounted horizontally in the boot, with one pump connected to the main tank and the second pump to the reserve tank. The pumps should be activated by a three position switch (Off, Pump 1, Pump 2) mounted to the dashboard and connected to the ignition.

It is also advisable to use a fuel filter (Filter King etc) to reduce the fuel pressure, as Bendix pumps deliver at about 7 psi, which is liable to blow the needle valves on your carburettors. Weber recommend a maximum fuel pressure of 4. 5 psi, but in practice about 4. 5 to 5 psi is needed as any less is likely to cause fuel starvation.

11.18. WIRING PETROL PUMPS

A 28/012 cable (in our case coded white) is taken from the fuel box, to a dash mounted switch. From the switch, two wires are taken, again both 28/012, one white/green, the other white/purple, and each running via a cartridge fuse each to their own fuel pumps in the boot. Number 1 pump has its offtake in the tank some three inches higher than Number 2. This means that, in the event of pump failure, the driver can simply switch over to the Number 2 pump before the car comes to a halt. It also acts as a reserve, having a lower offtake than the Number 1 pump. So, whatever the fuel problem, the driver just flicks the switch in the appropriate direction.



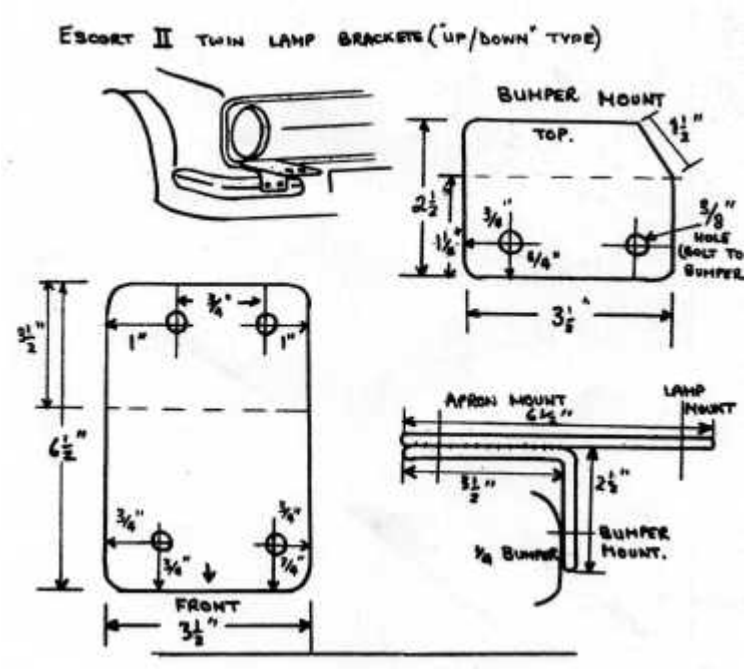
Location of two petrol pumps in boot, next to oil tank, with connecting filter.

11.19 LAMP BRACKETS

On the Mk II Escorts, as on the Mk I's, the works make their own auxiliary mounting brackets that are light, strong and most important, do not vibrate at all. On Escort II, the front bumpers are used as mounting points, whereas on the older car, although the principle and design was similar, the 1 up /I down light system brackets were direct body mounted.

For those of you building up Escort II's, here are the dimensions:

The bracket itself is made in two parts, an L bracket and flat top. The material is 3/8" dural for strength and lightness, with the L bracket 3/16" thickness. For the Mk I, the rearward projection is cut by 2". This is because the whole bracket mounts to the front apron, not the bumper.



Don't forget that this article was first written in the 1970s. Please check the latest Blue Book for the latest regulations.