John Ogborne asks:

Traction Electrics - Are they your Weakest Link?

PART 1 : "DOUBLE OR QUITS" - THE CASE FOR AND AGAINST 12 VOLT CONVERSION

INTRODUCTION

This is the first of two instalments of an article dealing with re-wiring and the 6 volt/12 volt controversy. Whilst it is aimed primarily at the French Traction, most of the content is universally applicable and I hope that it provides useful information for all owners. I am a firm believer in the principle that if you understand the way in which something works, it enables you to solve most problems that occur. The first instalment therefore deals with electrical fundamentals, with which many of you are familiar and may choose to skip. However, some may have an electrical blind spot that I hope this will help to illuminate. The second instalment will cover the practical aspects of wiring, fuses (you know, those things that André forgot about!) and general improvements to the lights whether the car is running on 6 or 12 volts.

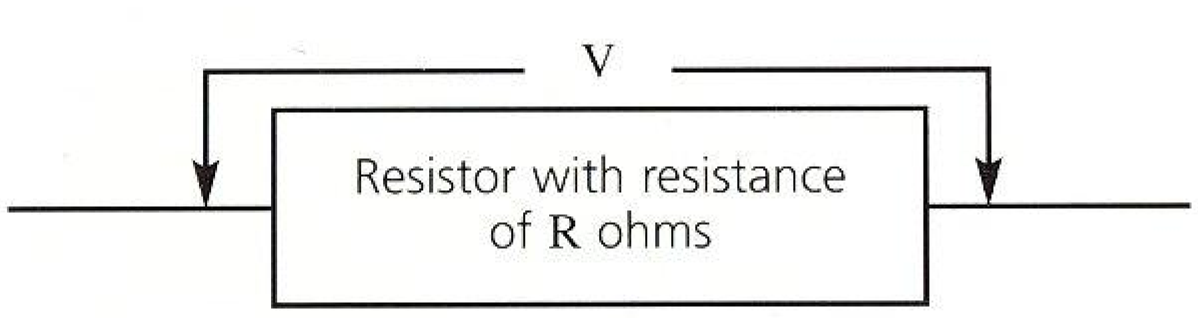
I am the first to admit that if I were designing a car today, 12 volts would be the clear choice, if only because it is standard on all common production cars and most components and accessories are designed for 12 volt operation. Nevertheless, there is nothing intrinsically wrong with 6 volt systems - watts are watts regardless of the voltage of the power source. This series of articles sets out to explain the reasons for this and how to get your 6 volt Traction electrics to perform as well as 12 volt conversions.

A LITTLE LEARNING!

(with apologies to those who know this stuff already - feel free to skip it)

Remember Ohm's Law? It states that the voltage (V) across a resistor (with resistance R ohms) is proportional to the current (I amps) flowing through it or:

$$V = I \times R$$



The resistor is absorbing power (and getting warmer as a result). Without going into the algebra, this power (W in watts) is calculated by multiplying the current (I) by the voltage (V):

$$W = V \times I$$

These two relationships ($V = I \times R$ and $W = V \times I$) are all we need to understand what is going on.

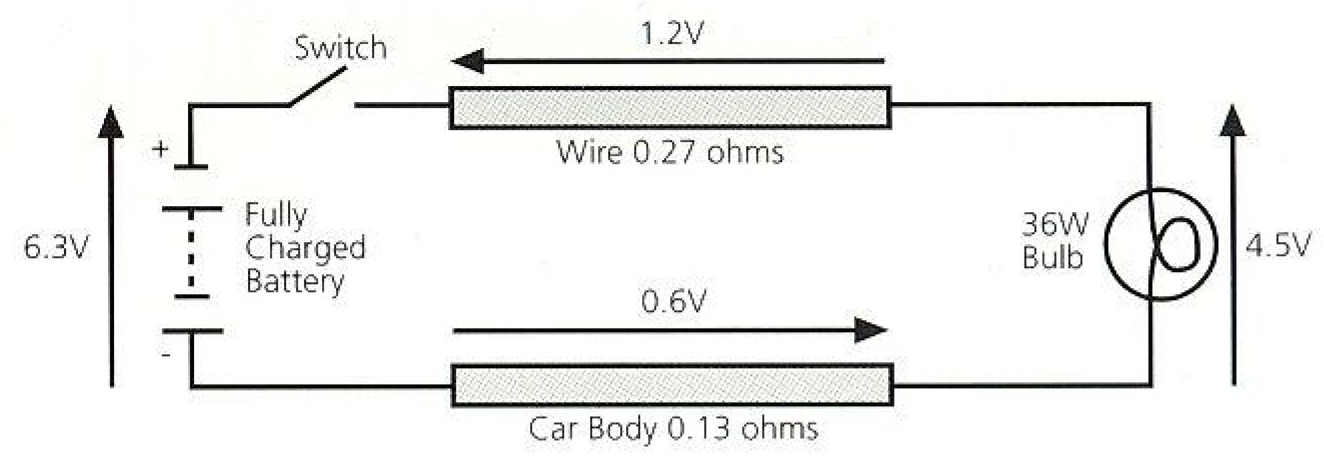
A headlight bulb is just an electrical element in a vacuum - the vacuum prevents the element from oxidising and fusing. When current is passed through the element, because it is has electrical resistance, it absorbs power, gets hot and glows thereby providing light. The amount of power it absorbs, hence the amount of light it gives off, is called the 'wattage'.

Using $W = V \times I$

- a 12 volt/36 watt headlamp bulb takes a current of 3 amps (12 x 3 = 36)
- but a 6 volt/36 watt bulb takes a current of 6 amps (6 x 6 = 36).

In other words, ***halving** the voltage* has ***doubled** the current* for the same wattage. So in a 6 volt system the wiring has to carry twice the current in order to achieve the same light output. Here lies the problem with 6 volt systems!

Unfortunately wire has resistance as well, albeit relatively small, but big enough to consume some of the power intended for the headlamp bulb or other electrical equipment. To add insult to injury, the negative connection is via the car body, which is likely to have rust sandwiched between the panels. Rust is not the best conductor of electricity! The higher the current the greater will be the loss in the wire and car body; hence a 6 volt system is much more vulnerable to these parasitic resistances. Here is a typical situation in a 6 volt Traction.



If you do the calculations, here the 36 watt bulb is actually operating as the equivalent of a 20 watt bulb - and that is without any allowance for corroded connectors and poor switches and contacts. As someone once said - "the road ahead retains an air of mystery". If we had run the same system on 12 volts (with a 12 volt/36 watt bulb), the bulb would have been operating pretty close to 36 watts. So now we can see why 6 volt systems are so vulnerable to poor quality wiring and why so many Traction owners choose to convert to 12 volts.

SO WHY STAY WITH 6 VOLTS?

Based on the purely electrical considerations above, the case for 12 volts is pretty strong. However, it is not the only solution and a well designed and maintained 6 volt system produces the same result as a 12 volt one. Wiring that has been in place for anything up to 67 years almost certainly requires attention anyway; compensating by increasing the system voltage is not necessarily a wise, or safe, solution. If the wiring can handle the current, be it from a 6 or 12 volt battery, the result will be the same. Aside from increasing reliability and safety and maintaining originality, re-wiring with 6 volts is also an opportunity to introduce other features such as fuses and accessories. Regardless of whether the system is running on 6 or 12 volts the essential requirements are to:

- use the right size and quality of wire
- ensure that the negative connection through the body is sound
- ensure that all connections, connectors and switches are making good contact
- ensure that the light fittings are making best use of the light from the bulb

The choice is yours!

WIRE SIZE AND QUALITY

I hate to take issue with André and his design team but the original wiring is not really up to scratch. I would love to know how many of the 6 volts on a brand new Traction made it to the headlamp bulbs. I would be surprised if it were much better than 5 to 5.5 volts. If you think your wiring is as good as new - or you have put in an original wiring loom recently - check the voltage across the offside headlamp bulb with the lights switched on and let me know the result.

Wire Size

Using Ohm's Law and some wire data it is pretty straightforward to calculate the optimum wire size. The resistance per unit length is proportional to the cross sectional area of the copper conductors; the bigger the conductor, the lower the resistance (good) and the longer it is, the higher is the resistance (bad). So short and thick (rather like me) is best.

There is of course a trade-off between size, cost and physical constraints. The trick is to choose the shortest practical run of the thinnest wire that delivers sufficient power for the job it has to do. There is no point in using wire the size of jump leads to supply the petrol gauge any more than trying to get away with thin wire for the headlights. For those who wish to do the calculations, I have given the wire data for the most useful sizes in the table below.

Wire Composition (no. of conductors/ conductor diameter. in mm)	**Cross-sectional Area** (mm2)	**Ohms per Kilometre**
9/0.3	0.65	29
14/0.3	1.00	19
28/0.3	2.00	9.5
44/0.3	3.00	6.3
65/0.3	4.50	4.2
84/0.3	6.00	3.2

As a rough guide, the wiring diagram given in the second instalment uses 84/0.3 for the main 'arteries', 44/0.3 for most lights and 14/0.3 for instruments and low wattage bulbs.

FUSES AND WIRING SCHEMES

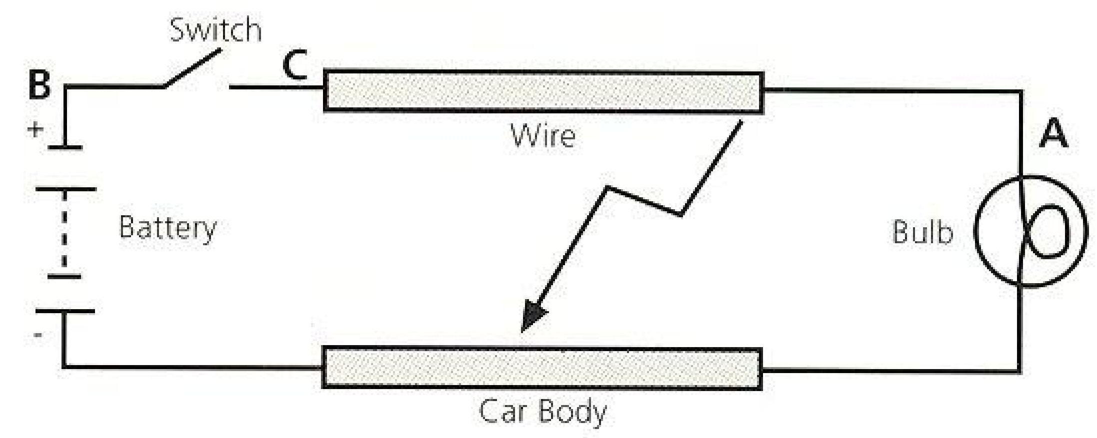
With the exception of the indicator switch there are no fuses in the French Traction. This probably explains why so many have ended their days in flames! If re-wiring is carried out it is a lost opportunity not to incorporate fuses in at least the main circuits. However, it is not always obvious where the fuses should be placed (electrically speaking) and it is worth looking at the basic principles of fusing.

How a Fuse Works

The purpose of a fuse is to protect a circuit from too high a current. It does so by providing a 'weak link' which will safely break the circuit when the current reaches a certain limit. In a car, overcurrent is typically caused by a live wire coming into contact with the bodywork due to a loose connection or damaged insulation. The wire, because of its low resistance (remember Ohm's Law), will take a very large current, consume a great deal of power and produce considerable heat. A general melt-down results. It is rather like a very high wattage bulb without the bulb!

Positioning the Fuse

So where does the fuse go? Consider the case of a bulb supplied from a battery via a switch and a length of wire.



If the fuse is inserted at 'A' it will protect against a fault at the bulb, but if a short circuit occurs anywhere between 'A' and the battery it will not blow and will have no effect at all. So, logically you might think that the fuse should be inserted at 'B'. For this simple circuit that is the best position but, in practice, the battery side of the switch probably supplies other circuits and a fault in one circuit would take the others out with it.

'C' is typically the best position - it is a compromise between getting as close as possible to the battery without affecting other circuits. Of course, the best solution of all (but usually over-the-top) is a high rated fuse at 'B' and a lower rated one at 'C'. In summary, put the fuse as close as possible to the battery but make sure that the circuits are sensibly grouped. The suggested wiring diagram and the scheme that I have adopted uses 8 fuses. It is only a recommendation as there is a virtually infinite number of variations, any one of which will be suitable provided that it follows the basic principles.

Fuse Number	**Circuits**	**Rating** (amps)
F1	Interior light and parking light	5
F2	Headlights	30
F3	Indicators	15
F4	Petrol gauge, brake lights and coil	15
F5	Wipers	10
F6	Tail lights and number plate	10
F7	Horn	10
F8	Front side lights	5

This scheme is based on the various electrical functions within the car. Others may prefer a left/right scheme whereby at least one side of the car remains live should a fuse blow for any reason - the choice is yours, there is no 'right' answer.

In the second instalment we will cover the practical aspects of re-wiring and other ways of improving the Traction lighting system. A full wiring diagram will be included.

John Ogborne

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PART 2: "THE TIME HAS COME THE WALRUS SAID TO TALK OF MANY THINGS - OF CRIMPS AND CLAMPS AND BATTERY BRAIDS, OF TERMINALS AND RINGS" - WITH APOLOGIES TO LEWIS CARROLL.

INTRODUCTION

Part One of this article dealt with the basics of vehicle wiring; this second and final part covers the practical aspects. Part 2 is more specific to the 6 volt French Traction; the diagram assumes that the car is fitted with French style flashing indicators, lights, instruments and general layout. However, whilst most of the content is equally applicable to the Slough 12 volt vehicle, perhaps there is a TOC member who would like to contribute a follow-up article in similar style for British cars.

THE WIRING DIAGRAM

1. The diagram has been split into two sheets for clarity, with connections between Diagrams A and B clearly shown. Diagram A covers interior components whilst Diagram B deals with the exterior and under-bonnet components.
2. Each wire has been assigned a number shown in a circle. The numbers have no significance other than that they are unique and show the order in which the wiring was carried out. Note that certain numbers in the sequence are missing; again this has no significance.
3. Wire sizes are indicated by a figure in mm^2 alongside each wire. Note that $3.0mm^2$ is used as it has now largely replaced the old standard of $2.5mm^2$. However, $2.5mm^2$ is entirely adequate if preferred.
4. Negative connections to the chassis (see text) are shown but have not been assigned numbers - use $3mm^2$ (or $2.5mm^2$) wire.
5. Wire sizes assume a 6 volt system. For 12 volts the sizes may be reduced, although it is only recommended to reduce the 6 mm^2 to 3 mm^2 and to keep the other sizes the same.
6. The rear terminal block shown on Diagram B is cunningly located at the level of the parcel shelf behind the back seat on the left hand side. Access can only sensibly be gained by removal of the seat.

TO CRIMP OR NOT TO CRIMP? - THAT IS THE QUESTION

Hamlet may have had bigger things on his mind, but discussions about crimping often produce a significant rise in blood pressure. In the March/April 2001 issue, Alec Bilney wrote an excellent article on the question of 6volt to 12volt conversion and of the importance of good, clean, solid connections. Hear hear! However, on the subject of crimping I find myself more in agreement with Chris Bailey of California whose letter was published in the August/September 2001 issue. Soldering gives an excellent result in the short term but is not the solution for long term reliability.

The problem with soldering stranded wire is that solder 'wicks' up the strands and produces a stiff section which usually extends well beyond the point where the wire is supported by its terminal. Under vibration (and who can deny that there is vibration under the bonnet of a Traction!) the wire flexes at the point where the solder 'wicking' stops and very soon fractures. Unfortunately the fracture, supported by the insulation, often continues to make intermittent contact rather than failing completely thereby producing the most elusive of faults. Soldering is an excellent technique where the wire is supported beyond the point that the solder has 'wicked' or in situations with little or no vibration but, generally, crimping is best. For example, you will not find soldered joints in the wiring looms of aircraft where reliability is a safety critical feature.

So the answer is to crimp - but to crimp properly. This means using the right size crimp terminal for the wire, a good quality crimping/stripping tool and a little practice. Standard pre-insulated crimp terminals come in three colour-coded sizes; red (0.65 to 1.5 mm^2), blue (1.5 to $2.5mm^2$) and yellow (3.0 to $6.0mm^2$). There are rings, forks, blades (male and female), bullets (m&f) and pins, but for the French Traction plus a fuse box you will only need rings and blades. A better, if more expensive, 'heatseal' crimp terminal is also available that gives excellent support to the wire and produces a really professional job.

Crimp tools vary in price from a few pounds up to several hundred pounds for one that is up to aircraft industry standards. The basic ones are perfectly adequate provided that care is taken to prepare the wire properly and to apply sufficient pressure to close the crimp to its correct deformation. Many tools incorporate a wire stripper but it may be necessary to use a separate one. Again, wire strippers vary from the cheap and simple to the sophisticated and expensive but, with care, the cheap ones yield perfectly acceptable results.

A typical crimp terminal looks like this with the pre-insulation removed.

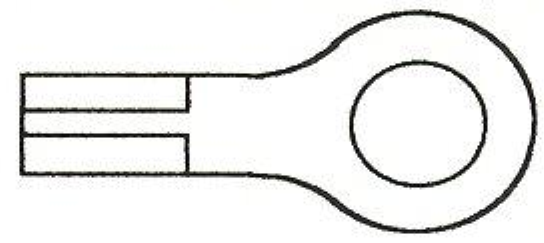


figure 1

Strip the wire such that there are just sufficient bare strands to fill the barrel section of the crimp. Twist the strands, slip on the wire identification sleeves and insert the wire into the crimp, ensuring that the insulation butts up tightly to the barrel; the strands should be visible as they emerge at the ring end. The diagram shows this with the pre-insulation removed for clarity.

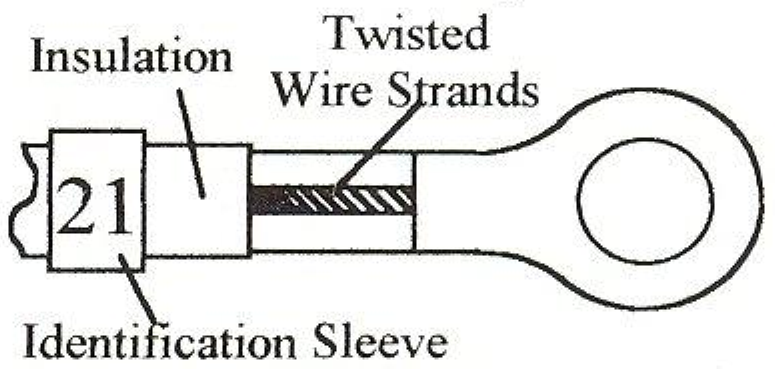


figure 2

Finally apply two crimps - one to crimp the conductors and one to support the insulation. Apply the crimp tool half way along the conductor barrel and half way along the insulation support section. The crimp tool must close fully in each case to ensure the correct closure of the crimp. Finally give the wire a tug to ensure that it has been properly secured.

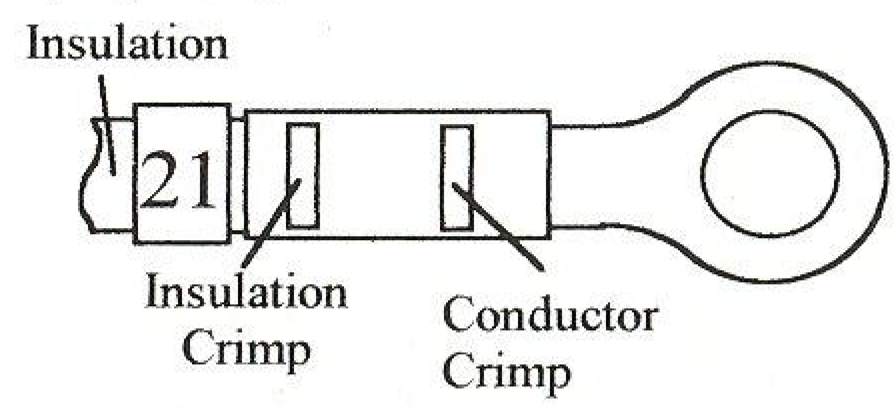


figure 3

NEGATIVE CONNECTION POINTS

Standard Traction wiring in common with all cars relies on the metal of the bodywork to provide the negative return connection to the battery. Unfortunately the ravages of time, and rust in particular, cause a less than perfect connection and a subsequent power loss. Consequently it is best to provide a solid negative connection in the form of a wire. However, the main body of the car and anything welded to it can still be relied upon to provide a low resistance path and so it is only necessary to establish a number of 'local' negative connection points referred to as 'chassis terminal' on the diagram.

A suitable position at the front of the car is adjacent to the offside and nearside terminal blocks under the bonnet on the 'jamboneaux'. It is less convenient at the rear but a reasonable position is at the top of the side panels inside the boot - one each side. Drill a 6mm hole and clean the surface down to the bare metal around the hole. Fit an M6x25 nut and bolt plus washers and tighten fully. There should be sufficient thread left for a number of 6 mm ring terminals to be secured between washers by a nut and lock-nut. Touch up any visible bare metal around the area to prevent rust. For the front terminals it is necessary to remove the access panels in the 'jamboneaux' to allow the bolt to be fitted and to clear out drill swarf.

An additional negative terminal is required for the main battery connection. Battery braid cables are available ready made in various lengths and come complete with 8 mm ring terminals on both ends or with a ring on one end and a battery connector on the other. One of each type is required. The most convenient place for the chassis terminal is about 150mm below the brake cylinder and just above the access panel. Use an 8mm bolt, nuts and washers.

The ring-to-ring braid connects between the new terminal and one of the bolts securing the timing chain cover at the back of the engine - awkward but possible with patience. The other braid runs from the timing chain cover bolt to the battery. Ensure that the braids are long enough to allow for movement of the engine on its mountings.

FUSE BOX

Fuse boxes come in various shapes and sizes but a straightforward 8 way surface mounting box designed to take blade fuses and fitted with 6.3mm spade connectors is suitable. The most convenient position, bearing in mind its electrical position within the circuit, is under the dashboard immediately behind the steering wheel. There is vacant space on the bulkhead and it is simple to drill the fixing holes and secure the box with a couple of screws and nuts.

WIRING SEQUENCE

One of the advantages of the French Traction is that it is possible to re-wire the car in stages. For example:

- *Charging, regulating and battery circuits*
- *From each of the under-bonnet terminal blocks to the front lights and horns*
- *From the rear terminal block to the rear lights*
- *From the under-dashboard terminal block to the interior and parking lights*
- *Everything else*

The ideal solution of course is to take the car off the road, strip out the old wiring and start from scratch.

Number each wire at both ends as you make the connection - remember to put the identification sleeves on the wire before the crimp! - and mark up the diagram with the numbers as you go. Run the wires in bundles and when a group is complete bind them with non-adhesive plastic tape to create a cableform. Secure the ends with adhesive tape. Self-amalgamating tape can be used but it is very difficult to remove should modifications be necessary. Always leave some slack in the wire at the point of connection; this allows for a small amount of movement for strain relief and for the connection to be remade if necessary in the future.

One of the more difficult tasks involves running wires from under the dashboard to the rear of the car and to the interior light. The simplest way is to detach the roof lining along the driver's side. The lining is secured by a row of teeth fixed to the bodywork and it is a fairly simple matter to release it by inserting a small screwdriver or similar tool between the beading and the lining. By catching the lining fabric and pushing upwards it is possible to release it with the minimum of damage, although great care will be necessary if the lining is very old. The existing wiring is then revealed running along above the doors and replacement is straightforward. With a little patience it is possible to feed the wires up behind the metal trim at the left hand side of the windscreen, although removal of the trim makes it much simpler. Replacement of the roof lining is the reverse of removal but with care taken to ensure that it is correctly and evenly tensioned.

MATERIALS AND COMPONENTS

A tedious but essential part of the process is estimating quantities of materials and components. As cars vary from one to another it is difficult to give a definitive parts list, particularly with respect to connector thread sizes, so the only solution is to measure them all. However, for guidance, the following list may be useful.

4mm rings	**50 off (20 red, 20 blue, 10 yellow)**
5mm rings	**100 off (30 red, 50 blue, 20 yellow)**
6mm rings	**10 off yellow**
8mm rings	**10 off yellow**
6mm spades	**40 off (10 red, 20 blue, 10 yellow)**
6mm 'stationary' spades	**3 off (2 off '2 into 1', 1 off '3 into 1')**
(for connecting several wires to one fuse box blade)	
40 mm^2 Battery clamp	**1 off**
8 mm/40 mm2 ring for starter	**1 off**
1.00 mm^2 cable (black)	**50m**
3.00 mm^2 cable (black)	**50m**
6.00 mm^2 cable (black)	**15m**
40 mm^2 starter cable	**1m**
Ring to ring braid	**300mm**
Ring to battery clamp braid	**300mm**
8 way fuse box	**1 off**
Cable markers	**As required**
Cableform tape	**2 reels**
Fuses	**See diagram**

Note that fuse values given in the diagram are for a 6 volt system. The table shows equivalent values for a 12 volt system.

6 Volts	12 Volts
5 amps	5 amps
10 amps	5 amps
15 amps	10 amps
30 amps	15 amps

It is also advisable to fit an isolation switch on the battery connection. Depending on the type chosen this may affect the type of termination required on the battery cables.

THE LIGHT FITTINGS

Monsieur Citroën's light fitting designers do not strike me as being up to the same standard as those who designed the rest of the car - bizarre seems to be the best word to describe some of them. The indicators and rear lights are particularly idiosyncratic and prone to poor connections. However, a few simple modifications can be made that result in a significant improvement.

INDICATORS

As clear indicators are a necessity in modern traffic it is vital that the connections are solid and reliable. The original design is mostly of steel with a rather flimsy brass pin and spring assembly for the centre contact; the connection relies on contact between the brass pin and the steel frame. This seem to be the one occasion where soldering is unavoidable!

Begin by removing the fitting from the vehicle. For the negative connection solder a flying lead of 3mm^2 wire about 150mm long directly to the steel frame just below the bulb barrel holder. For the positive connection solder a short piece of wire between the back end of the brass pin and the frame into which the pin fits; this bypasses the intermittent contact between the pin and the frame. A second similar flying lead forms the positive connection and is soldered to the back frame at the same point as the short wire. Feed the leads through the hole in the base of the fitting and use bullet connectors to connect the flying leads to the wiring system.

To minimise the effects of solder embrittlement, leave some slack in the wires within the light fitting and ensure that they are not under any stress. Soldering to steel can be problematic but careful cleaning to expose bare metal and the use of a little extra flux normally produces good results. The brass should present no problems. Clean the steel frame where it makes contact with the barrel of the bulb and the end of the brass centre contact. Make sure that the insulation between the positive and negative parts of the fitting is intact.

The design of the fitting is such that much of the light is lost within the murky depths of the fitting itself. A simple reflector makes a huge difference to the efficiency of the light. Using tin snips, cut out the shape shown below from a piece of tin plate - biscuit tin lid is quite good. Fit the reflector onto the barrel of the bulb before inserting it. Even better results will be obtained by covering it in crinkled-up tin foil. *See figure 4 below*

Whilst not maintaining originality, the fitting of orange lenses all round provides a solution that is consistent with current standards for indicators. Other drivers do not expect to see red indicators to the rear or white ones to the front and can easily misinterpret signals as brake lights or side lights. Orange lenses are available from club spares.

REAR LIGHTS

The festoon bulb arrangement found here is best abandoned altogether and a conventional double filament stop/tail bulb fitted. The main problem is obtaining a suitable bulb holder, but a visit to a scrap-yard and the location of an early Rover 400 solves the problem. There may well be other similar holders available but the Rover one is an almost perfect fit. Strip down the Rover holder so that it comprises the holder itself, two flying leads and a pair of lugs. Make up two small angle brackets to enable the holder to fit into the lower of the two festoon connections using self-tapping screws. The diagram *(Figure 5)* shows a top view of the arrangement

Make the negative connection by means of a ring terminal under one of the self-tapping screw heads and use bullet connectors for the two positive connections to the bulb holder. Finally, using the same techniques as for the indicators, make a simple rectangular reflector to fit behind the bulb and holder.

IN CONCLUSION

Given the right wire size, good connections, a few simple modifications and a not insignificant amount of patience, it is possible to make the Traction 6 volt system as good as a 12 volt one. The only remaining reservations are that the starter motor remains sluggish and that 6 volt accessories are hard to come by. On the plus side, whilst certain compromises have to be accepted, authenticity is more or less maintained. Whichever route you decide to take, I hope that this article has provided at least a few pointers that will help you in any re-wiring tasks and render the road ahead not quite so much of a mystery.

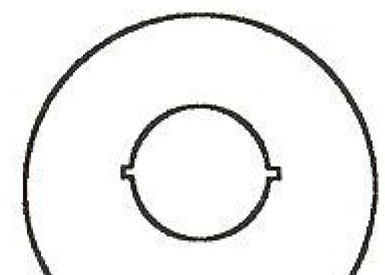


figure 4

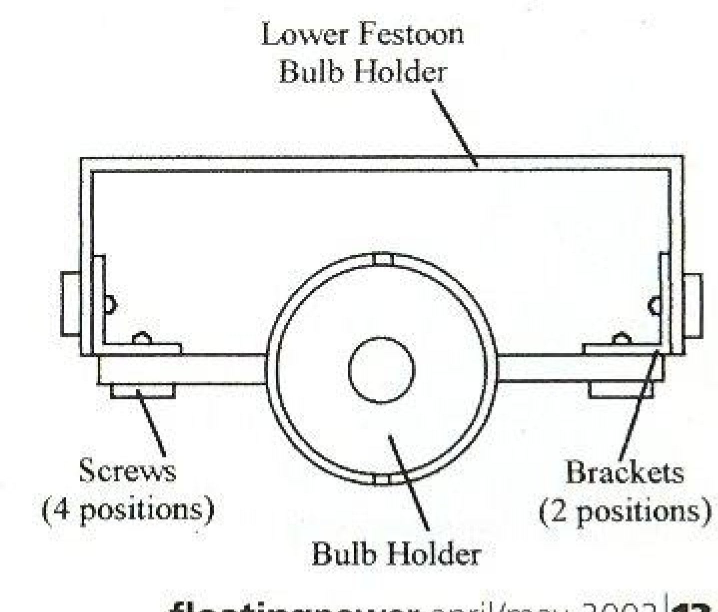
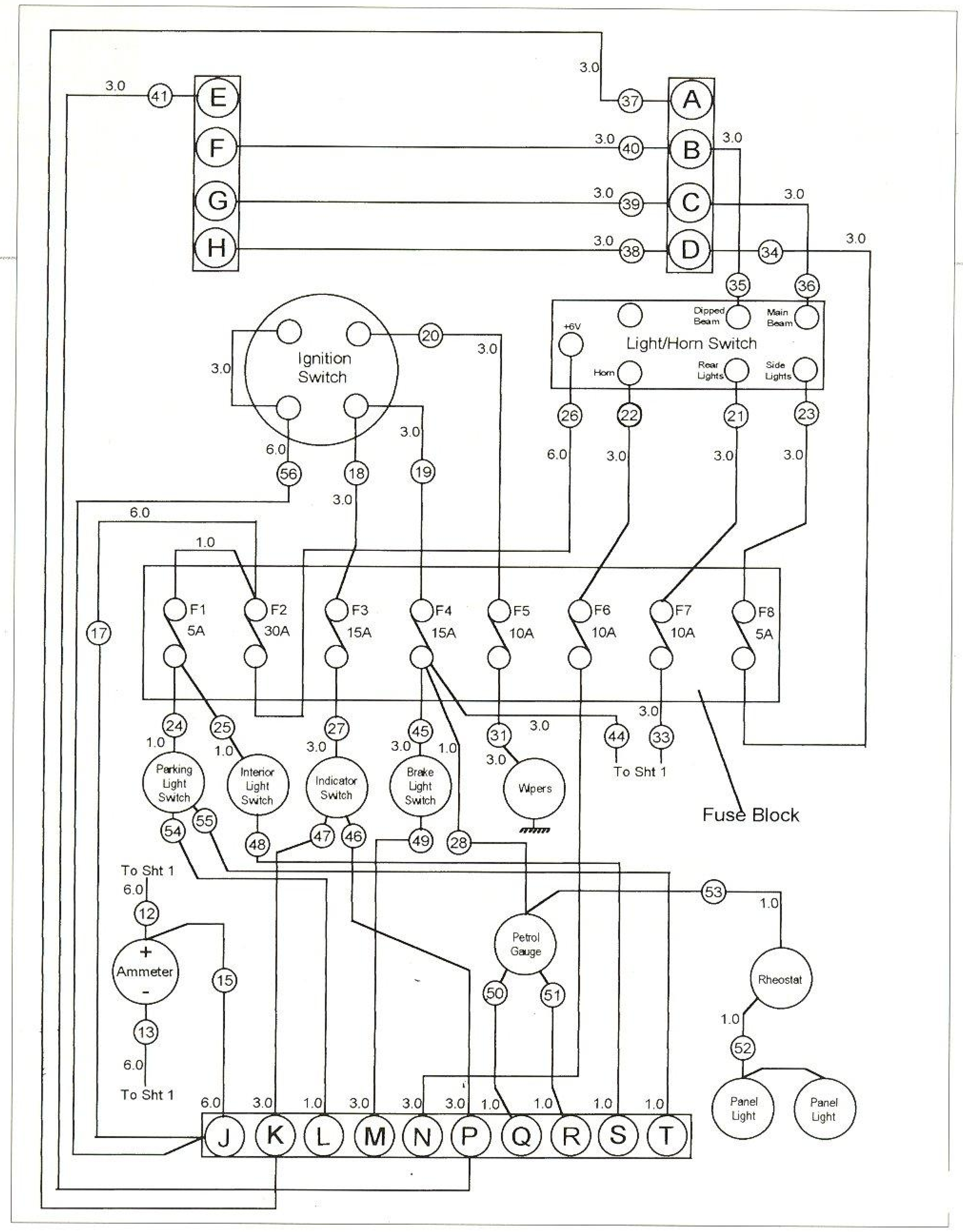


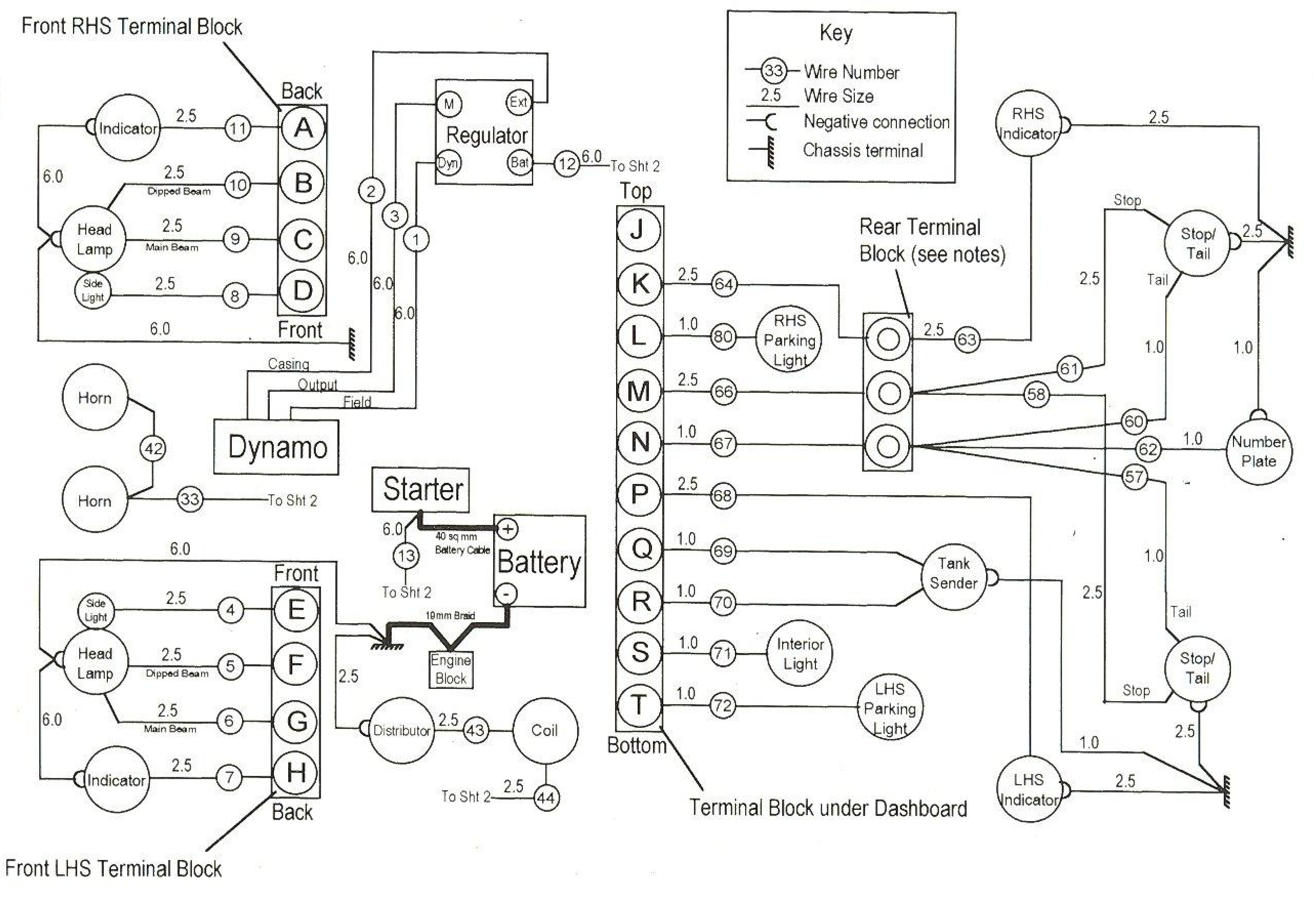
figure 5

A



Ignition Switch
Light/Horn Switch
+6V
Dipped Beam
Main Beam
Horn
Rear Lights
Side Lights
F1 5A
F2 30A
F3 15A
F4 15A
F5 10A
F6 10A
F7 10A
F8 5A
Fuse Block
To Sht 1
Parking Light Switch
Interior Light Switch
Indicator Switch
Brake Light Switch
Wipers
Petrol Gauge
Rheostat
Panel Light
Panel Light
Ammeter
To Sht 1
To Sht 1

B



Front RHS Terminal Block
Back
Front
Indicator
Head Lamp
Dipped Beam
Main Beam
Side Light
Regulator
To Sht 2
Casing
Output
Field
Dynamo
Horn
Horn
To Sht 2
Starter
40 sq mm Battery Cable
Battery
To Sht 2
10mm Braid
Engine Block
Distributor
Coil
To Sht 2
Front LHS Terminal Block
Top
Bottom
Terminal Block under Dashboard
RHS Parking Light
Interior Light
LHS Parking Light
Tank Sender
Rear Terminal Block (see notes)
RHS Indicator
Stop/ Tail
Stop
Tail
Number Plate
LHS Indicator
Key
Wire Number
Wire Size
Negative connection
Chassis terminal