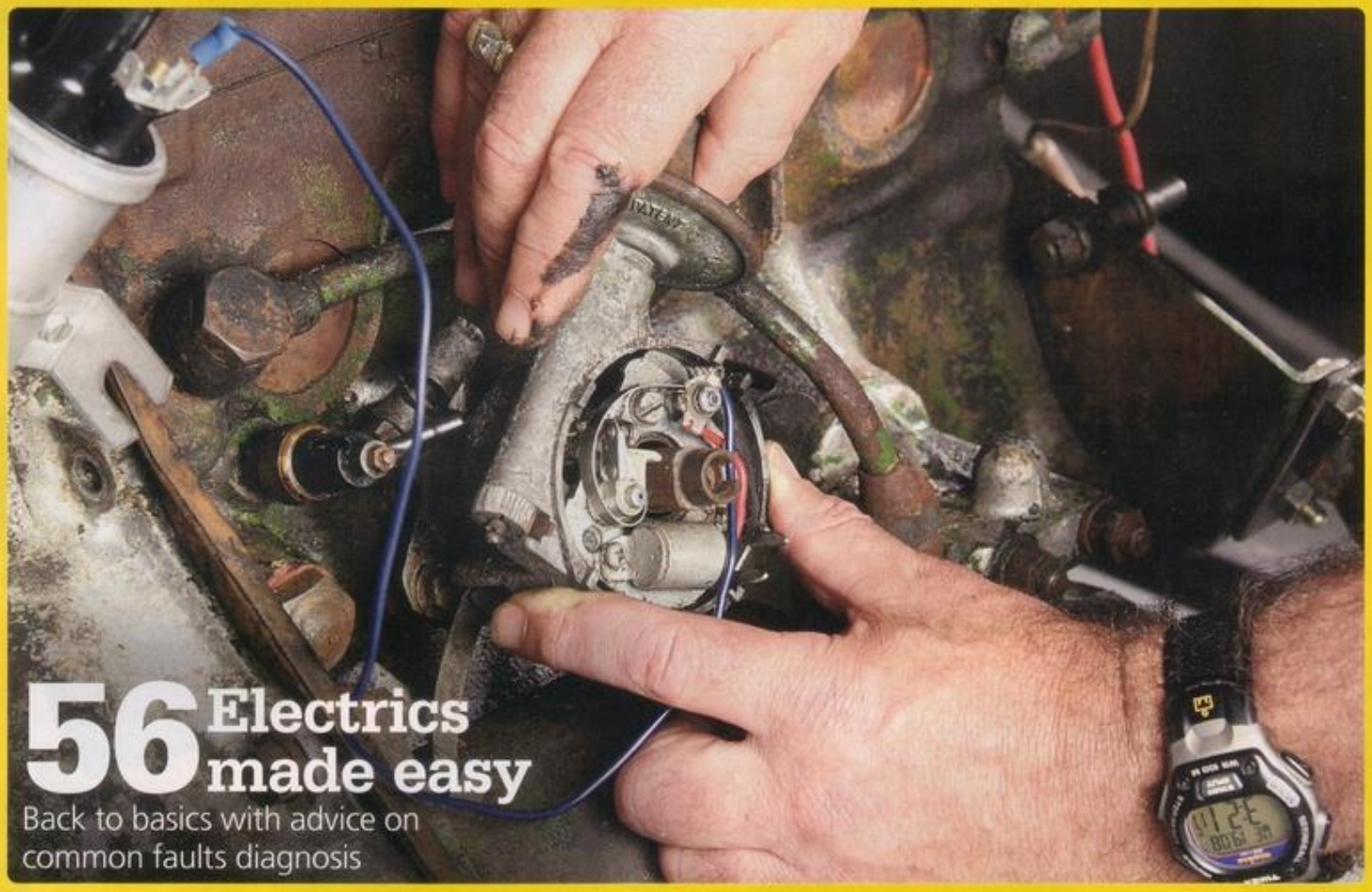
WORKSHOP

Keeping your classic on the road



56 Electrics made easy
Back to basics with advice on common faults diagnosis

64 Dynamo to Dynalite
It looks like a dynamo but works like an alternator. Get the output and the looks with our guide.

70 Lighting upgrades
How to fit LED interior lights, a door timer and warning buzzer timer. Illuminating!

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Fitting the latest bespoke kits from Revotec to keep your classic cool in summer and smoother all the time.

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The hard-wire fit that allows you to power a phone charger, sat-nav and loads of other gadgets.

82 Engine immobiliser
A simple switch could make the difference between theft and security. Here's how to fit one.

146 Quicktech How to solder
Join two wires the old-fashioned way – it works and it's easy.

Health and safety – it could save a life!

Protect yourself as much as possible when working on a car. Always wear gloves to protect your skin from dirt, rust and oil, use steel toe-cap footwear and eye protection. Disconnect the car's battery before you begin.

Never get under a vehicle without ensuring it's correctly supported. Refer to workshop manuals for the correct procedures before starting the job, always use the correct tools and ensure you know how to use them. Cheap low-quality tools can break suddenly. Be aware of fumes and vapour – especially those from flammable fuels. Familiarise yourself with the location of fire extinguishers and emergency exits. Always clear up spills and rubbish immediately.

Electrics are a black art to many of us. Faults seem impossible to diagnose and cure, and wiring diagrams look like a bunch of random hieroglyphics. At some point, though, a classic is bound to suffer from electrical maladies, and gaining a greater understanding of the systems involved will give you the confidence to tackle them.

Anyone can gain a basic knowledge of electrics, as we proved by heading to S&B Automotive Academy. Harry Friedlander is the specialist who'll be leading us through an explanation of the systems used on classics, with particular emphasis on those relating to ignition, starting and charging.

Taking a few minutes to look at electrical systems as part of your regular maintenance schedule could make your car run smoother than ever. So, rather than avoiding anything to do with them, take the time to learn about your classic's electrics. It could save you a world of trouble.

The Specialists

S&B Automotive Academy

S&B specialise in training courses for the industry. Their trainees carry out courses in truck, van and car maintenance, auto electrics, and more.

Princess Street
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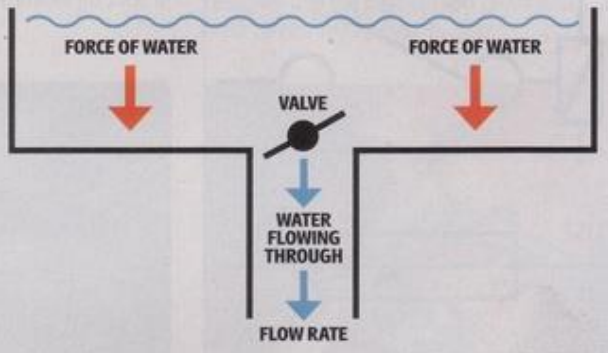
Electrical Terminology



- Imagine a tank full of water. At the bottom of the tank is a narrow pipe through which the water can flow.
- In electrical terms, the pressure acting on the water is the **voltage**.
- The water flowing through is the **current**.
- The rate at which it's flowing through would be measured in **amps**.
- Anything placed between the tank and the pipe (such as the valve shown above) forms resistance. In electricity, that's measured in **ohms**.

Jargon Buster

Earth
Return circuit to the battery.

Low-tension system (LT)
Low-voltage circuit running through battery, coil, distributor and back to earth.

High-tension system (HT)
High-voltage circuit sending spark to plugs; formed when LT circuit is broken via the points.

Coil
A step-up transformer that converts the low voltage in the LT system into the high voltage needed for the HT system.

Distributor
Contains points and condensor for LT circuit in main housing. Cap sends high voltage in HT system to each spark plug.

Points
Two flat metal surfaces that form the LT circuit when closed.

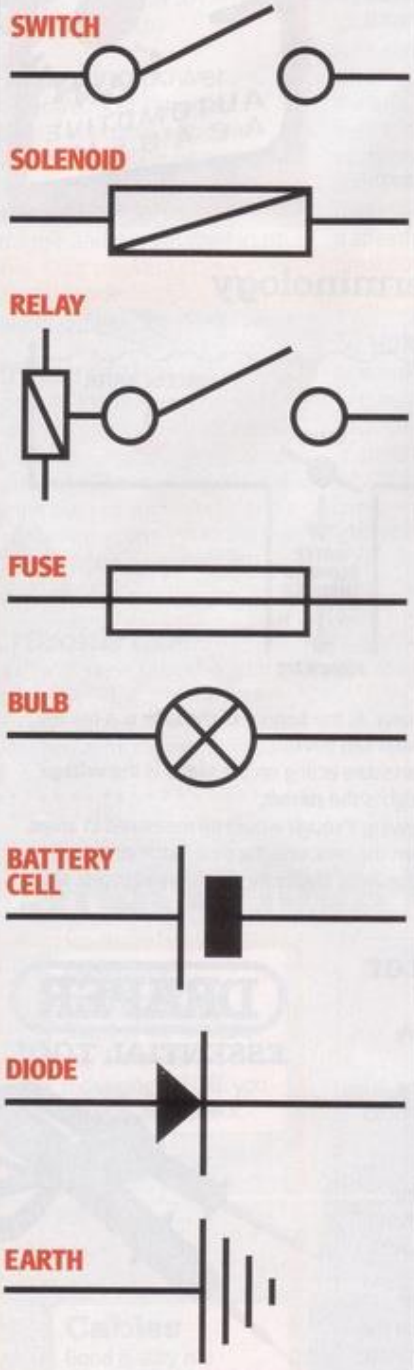
DRAPER
ESSENTIAL TOOL

Voltage tester

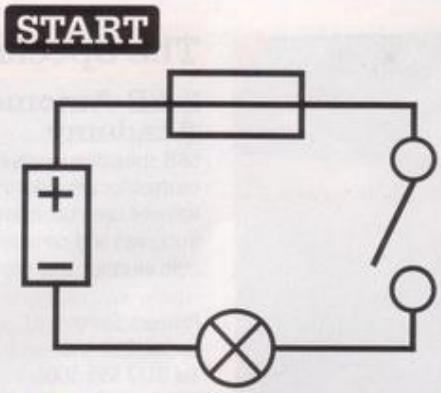
Uses LEDs to indicate voltage, 1.2m lead, range of 4.5-400v DC, 120-400v AC.
Item number 37873
Price £13.43
Tel 02380 494333
Web www.draper.co.uk

Wiring Diagrams

Specific keys for wiring diagrams can vary, so check your workshop manual when working with one to make sure you're familiar with the diagram for your car. These are some of the most common things you'll find…



Don't be intimidated by the apparent complexity of a wiring diagram. Rather than trying to take in the entire thing, remember that you'll generally only need to be tracing one circuit or working with one part of it in order to either rewire it or trace a fault. To make life easier, the colour of the individual wires will also be given in the diagram.



1 Basic systems

In its most basic form, an electrical circuit on a car needs four things: a power source (the battery), circuit protection (a fuse), a controller (the switch) and a consumer (a bulb, for example).

2 Circuit conditions

This circuit can exist in four conditions: closed (complete – the consumer's working); open (incomplete – switch is off or fuse has blown); short low (short circuit on the earth side of the consumer); and short high (short on the positive side).

3 Short circuits

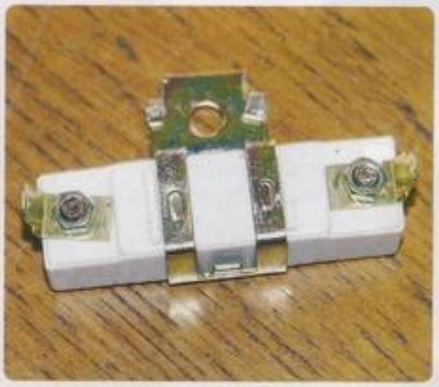
The circuit needs to be closed for everything to work, but electricity will always find the shortest route back to earth. In cars, the metal of the chassis is used as the earth – the return circuit. Lighting problems can often be traced to a rusty earth connection.

4 Starting systems

The biggest current draw on a car is the starter motor, which needs about 180 amps just to get the engine cranking. Shown here is a Bendix-style motor, on which the pinion starts spinning before engaging with the flywheel.

5 Pre-engaged starter

On a pre-engaged starter motor, a solenoid triggers a pinion, which goes out and meshes with the flywheel. A second set of contacts are then struck, which starts the motor spinning.



6 Ballast resistor

Later classics can be fitted with a six-volt coil. In normal running, a ballast resistor is used to halve the 12-volt current from the battery. These can be mounted on the coil or hidden away in the loom.

7 Bypass wire

When the engine's cranking, the ballast resistor is bypassed. The coil gets the full 12 volts from the battery, leading to a strong spark and better cold starting. When the engine fires, the bypass is switched off and the current goes through the ballast resistor.

8 Ignition system

The ignition system uses two circuits. The low-tension (LT) one goes from the battery to the ignition switch, through the coil, into the distributor, through the points and condensor, then back to earth.

9 Storing energy

While the LT system (blue wire) is in operation, the coil builds up a magnetic field. When the points open, that LT circuit is broken, the magnetic field in the coil collapses and the high-tension circuit (black lead) comes into operation.

10 Creating a spark

You can still get a spark at the points, though, meaning the LT circuit doesn't collapse. It can then overheat and damage the points. A condensor (or capacitor) absorbs the spark to ensure the LT circuit is broken.

11 High-tension system

The coil is basically a step-up transformer – it converts the battery's 12 volts to the thousands needed for the spark plugs. On classics, the coil is cooled by oil, which is why it's cylindrical.

12 Looking for earth

As the current goes to the distributor cap, the rotor arm sends it down the HT leads via contacts in the cap. It then arcs on the spark plug, igniting the fuel/air mixture.

13 Charging system

A car's battery uses a chemical reaction to make electricity. If nothing was done to keep it recharged, it'd go flat. The dynamo or alternator take care of recharging.

TECH TIP

If a fuse keeps blowing, don't just put a higher-rated one in. The circuit will become seriously overloaded.

14 Alternator vs dynamo

To make electricity, all you need is a conductor (wire), a magnetic field, and relative movement between the two. In a dynamo, the wires move around the magnet; in an alternator, it's the other way around.

15 Fault diagnosis

If you've got an engine that doesn't run, has it got compression, has it got fuel, has it got spark, and is that spark coming at the right time? Those last two are what you're looking for in electrical diagnosis.

Quick Checks

Working in order through the components in an electrical circuit will stop you getting frustrated.

FAULT: Engine wants to fire but dies when I let go of the ignition key.
CHECK: Ballast resistor.

FAULT: Engine runs but has a misfire.
CHECK: Plugs and HT leads.

FAULT: Engine won't crank – the only noise is a 'click'.
CHECK: Starter motor solenoid.

FAULT: Engine won't crank – only noise is a high-pitched 'whirring'.
CHECK: Starter motor pinion.

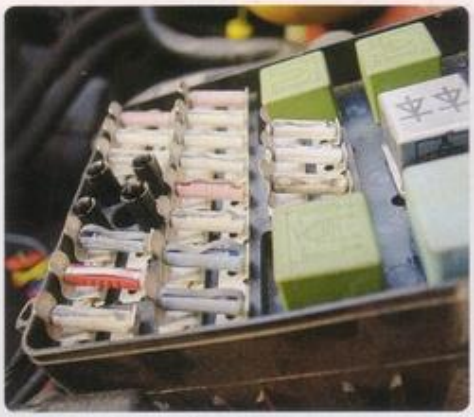
FAULT: Engine turns over lazily and won't fire.
CHECK: Battery.

FAULT: Engine fires up but all systems fail after a period of driving.
CHECK: Alternator / dynamo.

FAULT: Lights don't operate as intended (flashing, staying on, etc).
CHECK: Earth connections.

Listen carefully to what the engine's doing in order to diagnose which components are likely to be at fault.

Never overlook the basics, such as establishing the level of charge in the battery.



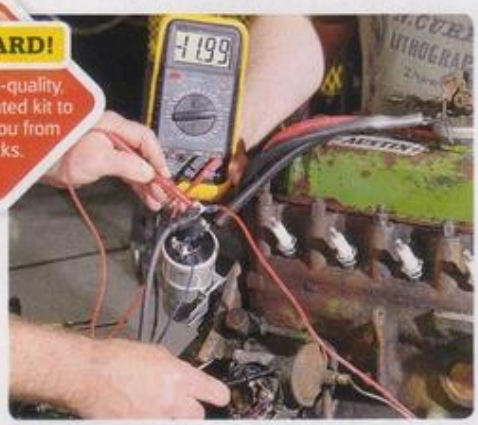
16 Check the basics

Before you start checking any circuit, look at the basics. Check the fuse, the connections, and the battery.

17 Logical diagnosis

Work systematically with a test bulb or voltage tester, following the path that the electricity will take. With any electrical system, go first to the switch operating that circuit. In the case of engine electrics, this is the ignition switch.

HAZARD!
Use good-quality, well-insulated kit to protect you from shocks.



18 Pinpointing trouble

If you can't get a test bulb to light at the switch controlling the circuit, the fault lies between there and the battery. If the switch is okay, move to the next link in the circuit. This is the key to diagnosis – move along the circuit, ticking off the results as you go.

19 Power at the coil

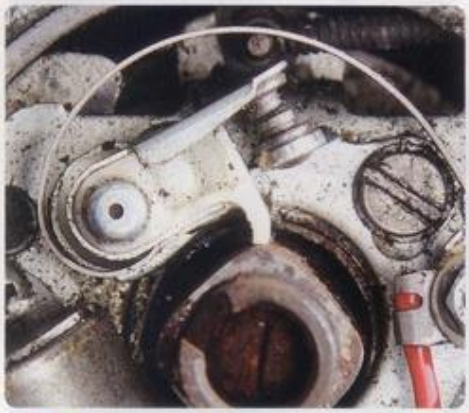
Applying that logic to engine electrics, if you've established the ignition switch is operational, check you're getting current from the battery at the coil by attaching a voltmeter to the coil's terminals.

20 Coil to distributor

From the coil, the current in the LT system runs to the points in the distributor. Manually opening the points with a screwdriver breaks the circuit and should produce a spark. This proves that the current is getting as far as the points.

21 Set the points

The points gap needs to be correct to ensure a good spark at the plug. Look up the points gap in your car's workshop manual, and use a suitable (and clean) feeler gauge to set it correctly.



22 Fully open

Set the points gap when they're fully open (at the highest point on the distributor lobe). Turn the engine by hand to get it to this point. On Lucas distributors, the points gap will generally be 15 thou.

23 Check the leads

In the distributor cap, the HT system sends the current down the plug leads to the plugs. Measure the resistance in the leads by placing a multimeter at the contact in the cap and the end of the lead.

24 Newer is better

Older HT lead versions use basic wire, relying on the plug caps for the resistance necessary to generate a strong spark.

TECH TIP

A lot of electric problems in the ignition system will be centred around the points.

25 Check resistance

Modern HT leads feature wiring with a much higher resistance throughout. This means the current has to work harder to earth via the spark plug, giving a stronger spark. The resistance shouldn't exceed 15,000 ohms – if it does, the leads are worn.

26 Ignition timing

The final electrical link in the chain is making sure that the spark is delivered at the correct moment. 'Static timing' will ensure you have a baseline to work from. With the engine off, align the timing marks on the front of the engine, usually at the crank.

27 Set the spark

Now loosen its retaining screw and rotate the distributor housing (if necessary, crank the engine over to establish the correct direction of rotation) until you see and hear the spark formed when the points open. Tighten the screw again.

FINISH

28 Remember the basics

Electricity will always look for the path of least resistance – short circuits provide that. Poor earth connections will prevent the circuit becoming complete. Circuits are made up of small steps between components – work logically along the chain, testing each of them.

CM SAYS...

Diagnosing electrical faults just needs a methodical approach and patience. Have a system for working through your car's electrics, and look at the basics first: battery, connections, earthing points. That's why fibreglass cars are prone to electrical troubles – they suffer from a lack of suitable metal earthing points.

If those initial investigations show everything to be okay, systematically work along the circuit in the direction the current will flow – from the battery onwards. Equip yourself with some decent diagnostic equipment, such as a multimeter. Even understanding just the basics about how circuits are formed and the components involved will give you a huge headstart. CM

EARTHING FIXES AND TRICKS

When tracing electrical faults, earthing points should be one of your main priorities.

The problem

Poor earthing is the most common reason for electrical components not functioning correctly. The earth circuit acts like a return route for the electrical current to travel from the battery, dynamo (or alternator) and component and back again to the battery.

The main culprit for poor earthing is a corroded, frayed or missing earth connection. This might be in the wiring or in the casing of a component.

Tell-tale signs

Check for corroded sockets.

■ Earth terminals can go for years without being disturbed. In that time, their ability to pass current diminishes as connectors, washers, nuts and bolts slowly corrode. Dim headlamps, slow wipers, heaters and suchlike are the clues to look for.

■ A blown light bulb with grey/black glass is indicative of poor earthing, so check fittings for corroded bulb sockets that carry earth from the bulb's metal outer.

Polarity explained

Negative earth has become the norm.

Negative earth

The negative side of the battery terminal is connected to the car body and chassis. The positive connects to electrical equipment via individual wires. Therefore the body and/or chassis is the return circuit for the electrical charge to the battery

Positive earth

In short, the opposite of negative earth. Positive earth was phased out in favour of negative earth once it was realised electrodes corrode much faster when positive. Imagine a positive-earth-bodied car as a big electrode – it'll rust faster, and electrical components fail faster still.

Double check

Don't trust what's stamped on the battery connectors. Someone may have simply used one with an 'N' on it for the positive connector – as in the main image.

Wiring

■ The larger the load placed on a component such as a starter motor, the more capable its earth return must be. Additional cabling from an engine block to the bodyshell or chassis helps overcome this. A large braided earth cable is the most common type fitted for this reason – it's both flexible and strong.

■ Long earth cables, as found on classics with batteries at the opposite end of the car to the starter motor and charging system, are best avoided if you can. Unfortunately, this isn't always possible so care must be taken when routing such cables to avoid the chance of them shorting out against bodywork.

■ Oxidisation of connectors will cause resistance. Eventually, this will effectively separate the connection, even though it might look physically joined. This is why disconnecting and reconnecting is sometimes enough to re-establish a connection, and always worth doing first when an earthing fault is suspected.

Maintain, don't repair

Checking your classic's earthing system annually is the best way to maintain it. Use electrical terminal grease to prevent oxidisation and corrosion of main earthing points and battery terminals.


Products such as Corrosion Block grease offer long-term protection.