

LUCAS: PRINCE OF DARKNESS?

MG WIRING CLINIC



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BASICS

- ▶ Electricity 101 - How electrons flow
- ▶ How to Test Circuits
 - ▶ Multimeters
 - ▶ Test Light
 - ▶ Clip lead
- ▶ What it takes for things to work in a car
- ▶ Why does it STOP working

BASIC PRINCIPLES

When it comes to automotive troubleshooting, there are several basic principles of electronics that apply. Here are a few important ones:

- ▶ **Diagnostics Tools:** Utilizing specialized diagnostic tools, such as a multimeter, a test light, or even a simply jumper wire can aid in diagnosing problems in MG electrical systems. Remember that automotive electronics troubleshooting can be complex, and it's often best to consult a trained professional or refer to vehicle-specific repair manuals for more detailed guidance.
- ▶ **Power and Ground:** A reliable power supply and proper ground are essential for electronic parts. Checking and ensuring that connections are tight, clean and **free from corrosion** is crucial. 99.9% of all problems are these.
- ▶ **Voltage and Current:** Understanding voltage and current relationships is important for diagnosing electrical issues. Using a multimeter to measure voltage levels and current flow can help identify problems such as open circuits, short circuits, or excessive resistance.
- ▶ **Wiring Diagrams:** Familiarity with wiring diagrams is vital for troubleshooting electrical problems in your car. These diagrams illustrate the connections and components in the electrical system, where the wires come and go, and will help to locate faulty components.
- ▶ **Circuit Analysis:** Simple circuit analysis techniques can help in diagnosing electrical faults. By analyzing voltage drops, resistance values, and current paths, you can pinpoint the source of an issue within a nearly any circuit.

VOLTAGE & CURRENT

- ▶ A typical car battery voltage is around 12.6 to 12.8 volts when the vehicle is not running and there is no load applied. This voltage represents a fully charged battery at rest. However, when the engine is running, the alternator/generator recharges the battery, and the voltage should increase to around 13.5 to 14.8 volts, depending on the charging system's design, health, and the car's other electrical demands. It's important to note that these voltage ranges can vary depending on temperature, battery and charging system condition, and the specific MG model.
- ▶ In the context of a typical MG car circuit, such as say headlights, current refers to the flow of electricity through the lights. When you turn them on, current flows from the battery through the wiring and reaches the bulbs. "Resistance" is a term we use to describe how hard it is to push the electricity through the circuit. The amount of current flowing through the circuit depends on the voltage provided by the car's battery and the resistance of the circuit itself. The voltage typically remains constant, but the resistance can vary based on factors like the type of bulb, switch and wiring condition, and connections along the way. You can think of current as being similar to water pressure in a hose, where current is essentially how hard it is to push electrons through the hose-like wiring. If any of the connections are dirty or corroded, it's harder for the electricity to move, and some of the electricity will be converted to heat, leaving less power to light the bulb, hence dim or yellowed headlights, poor brake lights, reverse lights, etc.

POWER & GROUND

- ▶ Virtually every electronic device on the car simply needs good power and a good ground to operate. Some exceptions include:
 - ▶ Alternator
 - ▶ Analog signals like temperature, oil pressure, tachometer, dimmed gauge lights
- ▶ Remember that ever thing that comes on and off is simply having it's flow of power removed by it's switch. Bypass the switch, and it should operate.
- ▶ Nearly everything has a simple pattern: Power from the battery, through a fuse, through a switch, through the part, then to ground. In between are wires. In an MG, the wires are often made up of short sections of wire joined by connectors.
- ▶ The connectors used in MGs are notoriously bad at carrying power and ground all the way from their source to the destination without issues. **This is usually the puzzle. Where did the power or ground disappear along the way?**

DIAGNOSTIC TOOLS

▶ Multimeter:

- ▶ A Multimeter is a great investment. They can be found for under \$15 on Amazon or at Harbor Freight. The cheapest ones are adequate for basic troubleshooting and diagnosing of most problems.
- ▶ What they're good for:
 - ▶ Testing to see if Voltage is reaching the thing that your troubleshooting
 - ▶ To see if Grounds are good at the problem site
 - ▶ Checking to see if the battery is good, and is it charging while the car is running, and is there a load on it when the car is off...
 - ▶ Is power or ground flakey? (easier with a meter that has a needle...)

▶ Test Light:

- ▶ Clip one end to ground, and touch the other end to where power should be - if it lights, you have power!
- ▶ Clip one end to power, and touch the other end to where a ground should be - if it lights you have a ground!
- ▶ Wiggle wires near where it's connected, and if it flickers, you have a bad connection!

▶ Test Wire:

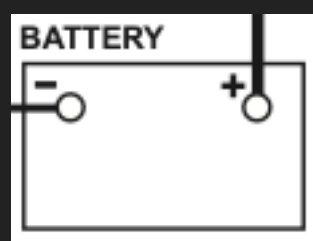
- ▶ Clip one end to power, and the other to where power should be, and if the thing works, you have a power problem
- ▶ Clip one end to ground, and the to where the problem part is grounded, and if the thing works, you have a ground problem
- ▶ Power to Power, or Ground to Ground should NOT do anything, but if it does, you're homing in on the issue. **Power to Ground, and you will fry the wire, blow the fuse, or worse.**

- ▶ A Push Pin: In a pinch, you can poke a pin into a wire to connect a test tool to it for testing without unplugging it. The teeny hole should self close, but put a drop of nail polish on it when you're done if you can just to be safe.

WIRING DIAGRAMS

► Important Symbols to memorize:

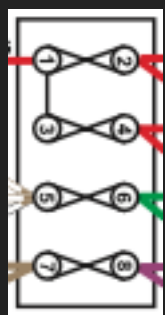
► Battery



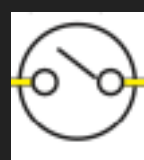
► Ground



► Fuse



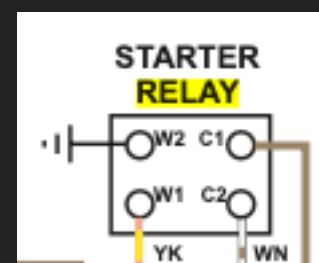
► Switch



► Light Bulb



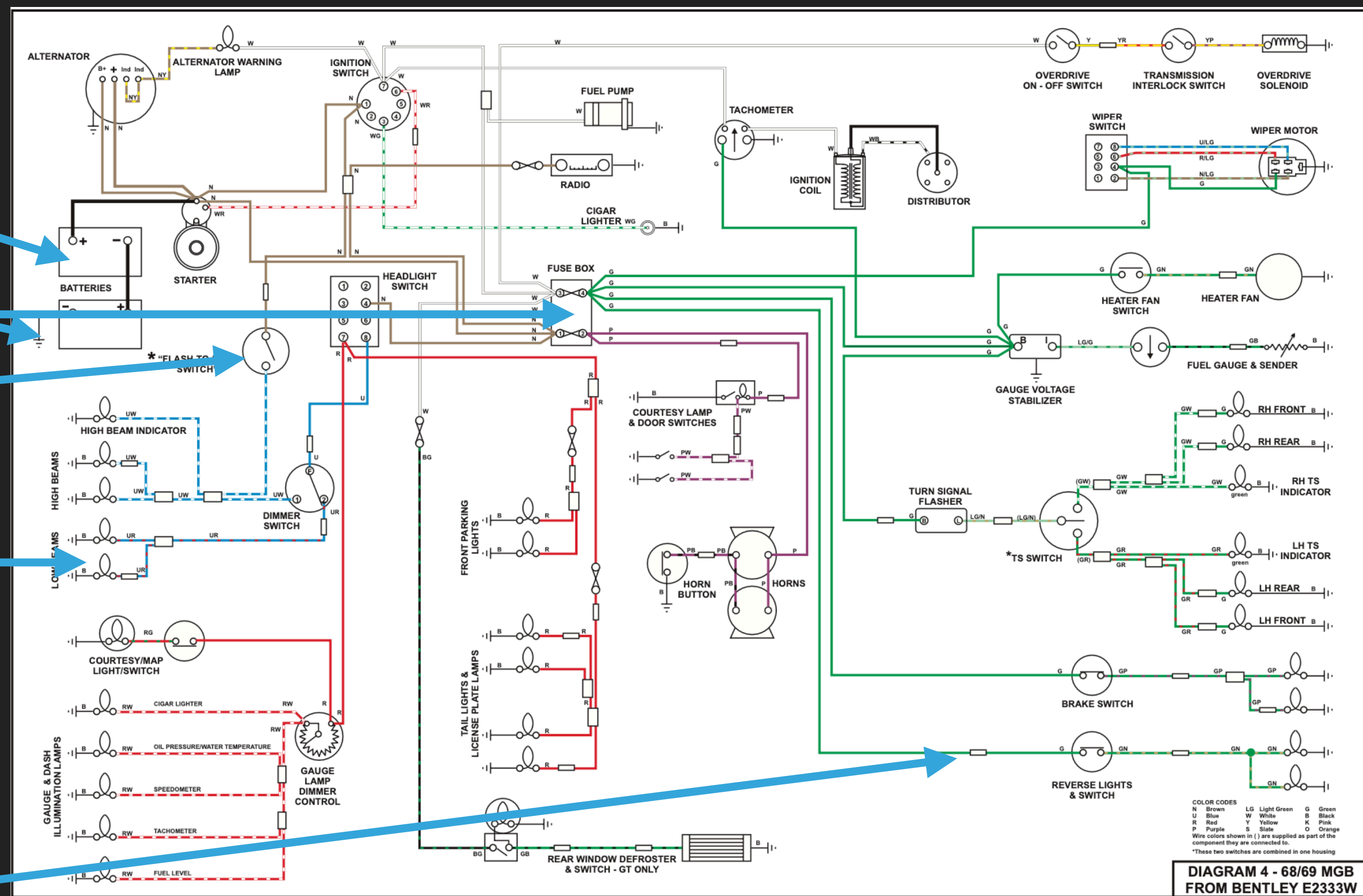
► Relay



► Diode



► Connector



CIRCUIT ANALYSIS

Standard British Wire Color Codes

- ▶ **Brown:** Used for power supply from the battery (often referred to as the live or positive wire).
- ▶ **Blue:** Typically used for auxiliary power, such as the ignition switch or accessories that are activated when the ignition is on.
- ▶ **Green:** Used for connections related to the vehicle's lighting circuits, such as the parking lights, side markers, and dashboard illumination. Often there is a secondary color stripe which indicates what KIND of light, or which side of the car.
- ▶ **Yellow:** Typically used for connections related to the vehicle's ignition system, including the starter circuit and coil.
- ▶ **Red:** Often used for connections to the vehicle's brake lights, stop lights, or other safety-related lighting circuits.
- ▶ **White:** Used for connections to the vehicle's ground or earth points.
- ▶ **Black:** Commonly used for connections to the vehicle's chassis or negative ground.
- ▶ **Purple:** Sometimes used for connections to the vehicle's fuel gauge or fuel-related circuits.

BLACK (B) Always EARTH (ground), unfused		Green/orange (GO): Brake pressure switch, handbrake switch, brake warning diode, brake warning light	
Black (B):	Various locations	Green/pink (GK):	Service interval counter (EGR light)
Black/green (BG):	URP switch to cooling fans	Green/purple (GP):	Brake light switch to brake lights
Black /white (BW):	Brake warning light	Green/red (GR):	Left turn signals to switch
BROWN (N) Always HOT, unfused		Green/white (GW)	Right turn signals to switch
Brown (N):	Various locations	Green/yellow (GY):	Heater to fan switch
Brown/light green (NLG)	Windscreen motor to switch	RED (R) Parking lights, fused or unfused	
Brown, yellow (NY)	Indicator light to alternator	Red (R):	Fusebox to sidemarkers, parking lights
Brown/purple (NP)	Unused	Red/green (RG):	Switch to lights (1963-'69)
WHITE (W) HOT with ignition ON, unfused		Red/light green (RLG):	Light switch to fusebox, panel rheostat
White (W):	Key to ignition relay, cut-off switch, fuel pump, ignition ballast resistor, fusebox, various locations	Red/white (RW):	Wiper motor to switch
White/black (WB):	Distributor to coil, coil to tachometer	BLUE (U) Headlamps, unfused	
White/blue (WU):	Stepped down voltage for distributor amplifier	Blue (U):	Panel rheostat panel lights
White/brown (WN):	Ignition switch relay to fusebox, starter solenoid to starter relay, oil pressure sending unit to gauge (1968-'69 only)	Blue/light green (ULG):	Light switch to dimmer switch
White/green (WG):	Keyswitch to radio, HOT unfused at first key position; wipers and heater (earlier)	Blue/red (UR):	Wiper motor to switch
White/light green (WLG):	Solenoid to coil, ignition ballast resistor to coil	Blue/white (UW):	Dimmer switch to low beam
White/red (WR):	Keyswitch to starter relay, starter relay to brake warning diode.	LIGHT GREEN (LG) Various applications	
PURPLE (P) Always HOT, fused		Light Green/black (LGB):	Dimmer switch to high beam, high beam indicator
Purple (P):	Fusebox to horn, various locations	Light Green/brown (LGN):	Washer pump to switch
Purple/black (PB):	Horn to horn switch	Light Green/green (LGG):	Flasher to turn signal switch, flasher to hazard switch
Purple/green (PG):	Key buzzer to time delay buzzer	Light Green/purple (LGP):	Voltage stabilizer to fuel/temp. gauges
Purple/pink (PK):	Key switch to key buzzer	SLATE (S) HOT with ignition OFF, fused and unfused	
Purple/white (PW):	Courtesy lamp/boot lamp to earthing switches	Slate (S):	Anti-run on valve to oil pressure switch
GREEN (G) HOT with ignition ON, fused		Slate/purple (SP):	Key to in-line fuse
Green (G):	From fusebox to various locations	Slate/yellow (SY):	Fuse to anti-run on valve
Green/black (GB):	Fuel tank unit to gauge	YELLOW (Y) HOT in 3rd/4th, ignition ON, unfused	
Green/blue (GU):	Temp. sending unit to gauge	Yellow (Y):	Overdrive switch to relay (1963-'67)
Green/brown (GN):	Reverse lamp switch to reverse lights; heater fan to switch	Yellow/brown (YB):	overdrive switch to 3/4 switch (1968-'76)
		Yellow/purple (YP):	Driver's seat belt to time delay buzzer
		YELLOW (Y) HOT in 3rd/4th, ignition ON, unfused	
		Yellow (Y):	
		Yellow/brown (YB):	
		Yellow/purple (YP):	
		Yellow/red (YR):	

Once you’ve learned to read the colors, you’re likely to start recognizing them when you see them in a bunch, and understand what they are for. There are several bundles of colored wire, especially under the dash, but with the help of a wiring diagram, you’ll be able to know what each wire is for. It’s actually quite intuitive once you get the hang of it.

FIXING COMMON ISSUES AND DO'S AND DON'TS

▶ Electrical things go bad for a number of reasons:

- ▶ **Water** got in, leading to corrosion, and oxidation. All the wires are copper, with a rubber insulating sleeve. If they stay wet due to a leak or a break in the rubber, moist climate etc., they will quickly turn green or black with oxidation. *You can't make a usable connection to anything that has turned green or isn't shiny copper colored. You may have to cut several inches or even feet off a bad wire to get to some good parts. Usually that means you should run a new wire :).*
- ▶ **Damage** from excessive vibration, abrasion, flexing, pinching, etc. The copper strands are tiny and weak, and they aren't supposed to move. They may look fine on the outside, and yet be completely broken on the inside.
- ▶ **Bad Connector:** MG wires are interconnected with a "bullet and sleeve" style tin-plated connector inside a short black rubber tube. When they were new, the black rubber was good at keeping water and moist air off the connector. Over time, the rubber gets hard, and doesn't grip or seal. The tin sleeve weakens its grip, and can allow air and moisture in between the bullet and sleeve. Tin is not a great electrical conductor, and corroded tin is quite terrible as a conductor. These connectors also lose grip after just a few cycles of connecting and disconnecting, so it's good to avoid disturbing them if possible. Also note that replacement of these really **MUST** be soldered on, as crimping these on requires expensive tools and may not be as good as they were originally. There are **BRASS** replacements for the tin parts that seem better suited than the originals.
- ▶ **Bad Switch:** When switches were new, they could handle a big surge of power through them as they turned something on. Over time, the metal parts inside the switch rub together, and file bits of metal off, until they get too weak to carry the load. This can also lead to heat inside the switch, add water or moist air, and other corrosion can further weaken the contacts. If a switch feels **HOT**, it's probably going bad, or at least needs to be taken apart, cleaned and refurbished if possible.
- ▶ **Bad Splices:** In the course of troubleshooting or repairs over the years, repairs are often done to wires with little crimped-on connectors. In reality, these usually only work for a short time, and can usually be pulled right off with a tug. Experience technicians will usually gravitate to these as the first place to look when there's a problem, especially if this circuit has had issues in the past. (Ever feel like you've fixed the problem over and over every few years?) Ideally, crimp on connectors **NEED A GOOD QUALITY** tool, and proper technique or they will fail soon. A better repair is to solder on a new connector. Twisting wires together, and wrapping with electrical tape is a no-no.

DESIGN PROBLEMS

Relays:

Several MG circuits use large amounts of current and push the limits of what the original wire and switches can handle. Many of these systems benefit from simple modification to restore or improve their performance to “better than new” condition. In addition, the addition of relays to key circuits can improve the longevity of components like switches, and also add better operation. MG systems that benefit include:

- ▶ Horn
- ▶ Headlights
- ▶ Reverse Lights
- ▶ Blower Fan
- ▶ Brake Lights
- ▶ Electric Radiator Fan

Fuses:

Another significant weakness of the classic MG design is the relatively small number of fuses. Because of this, even a relatively minor problem with a light circuit can leave you stuck on the side of the road. Specifically the fuse for the fuel pump is shared across many unrelated systems, depending on the year, including wipers, brake lights, overdrive, etc. So a minor short somewhere is much more likely to leave you stuck. In addition, with so much going through ONE fuse, it can be very tricky to identify the ONE thing that is the real problem. A modern upgrade would separate each system to have it's own fuse.

BETTER THAN NEW?

- ▶ If you're trying to keep your MG as original as possible, modifications for almost any reason are unacceptable. However, if you're willing to make small changes, a handful of reasonable improvements can lead to real gains in the drivability and practicality of the car. Some of the common areas worth exploring:
 - ▶ **LED lights** - generally brighter, cheaper, and likely to outlast the car. These use dramatically less power, and will extend the life of switches across the car. These also tend to be much more tolerant of corroded bulb sockets, worn wiring, and worn out switches.
 - ▶ **Electric Radiator Fan** - The fan-belt driven fans on older cars, as well as the twin electric fans don't do a great job of cooling the car, especially at slow speeds. The belt driven fan can actually cost some measurable amount of horse power, and wear on the water pump. The electric fans are mounted so far from the radiator that much of the wind escapes without improving cooling. Electric fans, controlled by a thermostat and relay, do an optimal job of cooling when necessary, and improve engine life by lowering operating temperatures, and speeding up cooling once parked.
 - ▶ **Modern Flasher** - These are usually solid state, and more reliable, and will also not change speed when bulbs burn out. They are required for LED bulbs, but also will potentially make things brighter.
 - ▶ **Relays** - As mentioned elsewhere, adding relays to key areas is a big win for a small effort. Louder horn, brighter lights, faster fans, and other real advantages, as well as longer life for expensive components light the turn signal or headlight switches.
 - ▶ **Fuse Block** - Modern Fuse block, plus a little rewiring, and you can isolate key circuits to their own fuse, making the car more reliable, and harder to get stuck on the side of the road. No performance benefit, but big wins for troubleshooting and reliability
 - ▶ **Wiring Harness** - In some cases, old harnesses have seen a of wear and tear, and just aren't practical to repair. Once the rubber insulation gets hard, it WILL crack, let in moisture, and the copper strands will just evaporate. Replacing isn't hard, but it is tedious, and time consuming to get it right - but so worth it in the end, especially if combined with some of the other items listed.

LUCAS ACRONYMS

- ▶ Lucas Electrical, the British company known for manufacturing automotive electrical components, has gained a reputation for reliability issues in the past. It is often referred to as the “Prince of Darkness” or “Prince of Wires” because of their long history of leaving drivers with no operable lighting on a dark and stormy night. Some say LUCAS is an abbreviation. Here are some funny ones I’ve found:
 - ▶ Let Us Correct All the Shorts
 - ▶ Lousy Unreliable Car Always Stalling
 - ▶ Loose Unsoldered Connections and Splices
 - ▶ Looks Unusual, Crappy and Shoddy
 - ▶ Leaves Users Completely Annoyed and Stranded
 - ▶ Lights Undermining Cars' Authentic Spark

Q & A

