# Keeping The “Smoke” Within Those Wires

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# Welcome

- This is a semi-technical (and hopefully entertaining) discussion about our Triumph electrical systems.
- Whether you know nothing about all of those funny wire colors, or you could present this session while you test alternator diodes…
- This session is intended to help you learn something new to maintain your Triumph electrical system.

You are welcome to ask questions as we go through the presentation.

# Humor…

## Lucas Replacement Wiring Harness Smoke Kit

**Have you inadvertently let the smoke out of the wires on your classic British car?** This, then, is the solution to your problem!

**Consider the Lucas Replacement Wiring Harness Smoke Kit, P/N 530433, along with the very rare Churchill Tool 18G548BS adapter tube and metering valve.** These kits were supplied surreptitiously to Lucas factory technicians as a trouble-shooting and repair aid for the rectification of chronic electrical problems on a plethora of British cars.

**The smoke is metered, through the fuse box, into the circuit that has released it's original smoke until the leak is located and repaired.** The affected circuit is then rectified and the replacement smoke re-introduced.

An advantage over the cheap repro smoke kits currently available from others is **the exceptionally rare Churchill metering valve and fuse box adapter. It enables the intrepid and highly skilled British Car Technician to meter the precise amount of genuine Lucas smoke required by the circuit.**

# More Humor…

- The Lucas motto: "Get home before dark.“
- Lucas – Inventor of the first intermittent windscreen wiper.
- The three position Lucas switch - Dim, Flicker, and Off.
- Alexander Graham Bell invented the Telephone.
  Thomas Edison invented the Light Bulb.
  Joseph Lucas invented the Short Circuit.
- Lucas - Inventor of the self-dimming headlamp circuit.
- The Original Anti-Theft Device - Lucas Electrics.
- Why do the English drink their beer WARM?
  Because their refrigerators are made by Lucas.

And almost 100 years ago…

"A Gentleman does not motor about after dark."

Joseph Lucas, 1923

## The Reality Is…

- Triumph electrical systems are as good (or as bad) as any other auto manufacturer of the era.
- Over time and under various operating conditions, electrical systems slowly deteriorate away from good-as-new conditions.
- Electrical systems need to be maintained like any other vehicle system.
- Electrical systems can last many years. (1969 Gt6+ has the original wiring – that is 50+ years old.)
- Pay attention to the electrical system details (like you do any other vehicle system), and avoid a catastrophic failure.

68 Plymouth Fury had an electrical issue in the alternator and would occasionally not charge, The amp meter would indicate discharge when this happened. Then the car would go over a pavement bump and the alternator would work for a "good long time" before acting up again. At 14 years of age with 175,000+ miles, I did not worry about it…

When I bought my 1969 Gt6 in 1987, the headlights worked and the engine ran. Electrically, it was a nightmare of dirty connections and previous owner indiscretions. I made a copy of the wiring diagram so I could write on it. I checked each section of each circuit and repaired the issues. For example, the brake light switch has two green wires on one side of the switch per the wiring diagram. Someone cut one of these wires that goes on to feed power to the backup light circuit – that was also missing backup light bulbs.

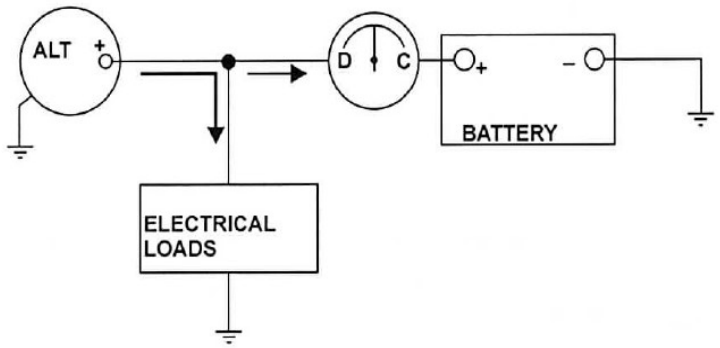
Cracked wires, broken wire strands, corroded connections, burned wire insulation, and warm switches are some of the electrical system details to address before a catastrophic failure.

## How does it work?

- Battery – stores electricity.
- Generator / Alternator – produces electricity.
- Electrical Loads – uses electricity.
- Short circuits –gives the electricity an unintended path out of the intended circuit, and hopefully blows a fuse instead of…
  - Creating HEAT and SMOKE or worse…
  - Creating a FIRE and Burning Out The Car.
- (Do you have a Halon fire extinguisher nearby?)

Show battery and charger with light bulb that highlight the following wiring diagram

## Wiring Diagram with Amp Meter




If the battery is providing the current, the amp meter will show discharge.

# 12 Volt Circuit Components

- The battery or alternator provides the electricity source.
- Wires, connectors, and fuses provide a path for the electricity.
- Switching devices control the electricity.
- Electrical loads such as lights and horns use the electricity.
- A ground path allows the electricity to return to the source.

## Wires

- Wire colors identify the circuits. For example:
  - RED is fused parking lamps .
  - PURPLE is fused battery feeds to courtesy lamps, horns, and hazard flashers.
  - GREEN is fused power to most of the loads that are switched on with the ignition key.
- Look at the wiring diagram for your vehicle to determine the circuit wire colors. For example UW is a blue wire with a white tracer and it is the high beam light circuit.
- Wire size is important – Bigger diameter wire carries more current.

The English standardized wire colors across different manufacturers. Refer to wire color code **printed reference**.

I do not have a wiring diagram for the 1973 Gt6 Mk3. This was the first year for seat belt buzzers and gearbox neutral switches. However I did have a 1973 TR6 wiring diagram that had the same color scheme so I could identify the wires and circuits.

Dan Masters explains the number of wire strands indicates the current handling ability. **SEE PRINTED INFORMATION**

## Wire Size – Count the Strands!

From Dan Masters – British wire size is determined by counting the number of .030mm copper wire used to make the wire.

Number of strands = Current rating
9 = 5.75 amps
14 = 8.00 amps
28 = 17.5 amps
44 = 25.5 amps
65 = 35 amps
84 = 42 amps
120 = 60 amps

L to R across the bottom are 14, 28, 44, 65, and 120 strand wire.

# British Wire Size

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# Connectors

As auto manufacturing evolved, so did the wiring connection methods used in our Triumphs:

- Screw Terminals
- Bullet / Sleeve Connector
- Spade and Lug Connector
- Pin Connectors

Ensure your connections are clean, tight and intact.

- Light sand paper, glass bead, and even scraping with a flat screwdriver can clean connectors.

## Connector Examples

Screw terminals are on the generator control box.

Bullet / Sleeve connectors – note the crushed single connector and the broke double connector - these bullets are the soldered type

The lug has been cleaned. The spade has corrosion. However they are still a tight fit.

Multi-pin connector has four connections in a housing that fits five. Special tool can remove these pin sockets.

## Fuses are your Friends

- Fuses protect wires from handling current beyond the fuse amp (current-handling) rating.
- Lucas fuse amp ratings are different than American fuse ratings. (A 35 amp Lucas fuse is 17 amp current rated and 35 amp blow rated.)
- A 35 amp American fuse will handle current near 35 amps indefinitely.
- American fuse recommendations:
  - 10 amp for the RED fuse,
  - 15 amp for the PURPLE fuse, and
  - 20 amp for the GREEN fuse.

Fuse blocks – early, Spit/Gt6, TR7

## Switches

- …are a means of opening and closing circuit connections.
- Usually have contact points and allow current to flow without any resistance.
- May have electrical grease inside to allow the switch to operate easily.
- Over time, the contacts can become dirty or pitted, and the optional grease can harden.
- Most switches can be opened and cleaned.

Rocker switch, gearbox switch, brake switch, column switches, ignition switch, toggle switch,

## Relays and Starter Solenoids

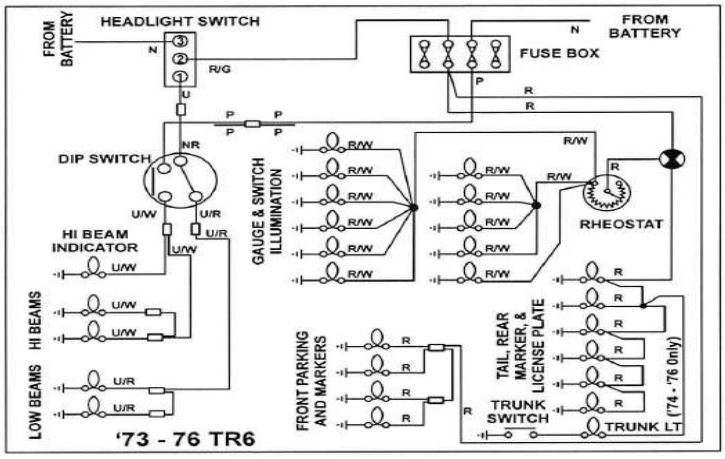
- … are electrically operated switches. A coil of wire creates an electromagnet that pulls switch contacts together or apart.
- Relay and starter solenoid switch contacts can handle greater current than the light duty switch operating the electromagnet coil.
- Relays are often used on horns and overdrives.
- Consider using a relay on high wattage loads such as 100 watt driving lights. (2 lights x 100w / 12v = 16.7 amp)

Show Relays, Starter Solenoid, and “cousins” such as turn signal flasher, hazard flasher and gauge voltage stabilizer

A and D type overdrives use relays due to 20 amp engagement in coil . J type overdrives only have a 2 amp holding so not relay is used.

TR3, 4, and maybe 250 do not use horn relays. Check the wiring diagram and physical location for a horn relay.

# Lighting Circuit Example




Highlight electricity flow through the components. Point out bullet/sleeve connectors, ground symbols, fuse symbols, switches.

## 12 Volt Test Light

- … is a light bulb wired between a pointed test probe, and a wire lead with an alligator clip.
- The wire alligator clip is connected to a good ground so the test probe can check for 12 volts and light the test light.
- Test the battery to see how bright the test light is.
- A dimmer test light on the circuit being tested indicates a voltage drop and a poor electrical connection.

Show test light and connect to battery. Turn on power supply to make light slightly brighter.

I found my recent Gt6 poor fuse connection with a test light. The fuse was good however the clip holding the fuse had resistance causing the test light to be dim. The voltage was 9.5 volts without a load. The brake lights and turn signals added a load when being used and caused the voltage to drop further so they would not work.

## Voltage Testing

- Get a Volt Ohm Meter (cheap Harbor Freight VOM models generally work fine).
- Test Battery Voltage at rest - **12.6 volts** is considered a full charge. My parked-for-the-past-two-weeks Triumphs are 12.14 and 12.46 volts. One source considers 11.6 volts a discharged battery.
- Test Battery Voltage with engine running - Anything above **13.2 volts** indicates the charging system is charging. **14.6 volts is a good alternator charge output.** My Triumph running battery voltages are 14.25 for the Lucas alternator, and 14.43 volts for the GM alternator.
- Use the VOM Volt setting for testing **voltage drops** across connections and switches.

Show VOM, connect to battery, and read voltage. Turn on power supply to simulate an alternator/generator and read new voltage.

# Voltage Drop Testing Example

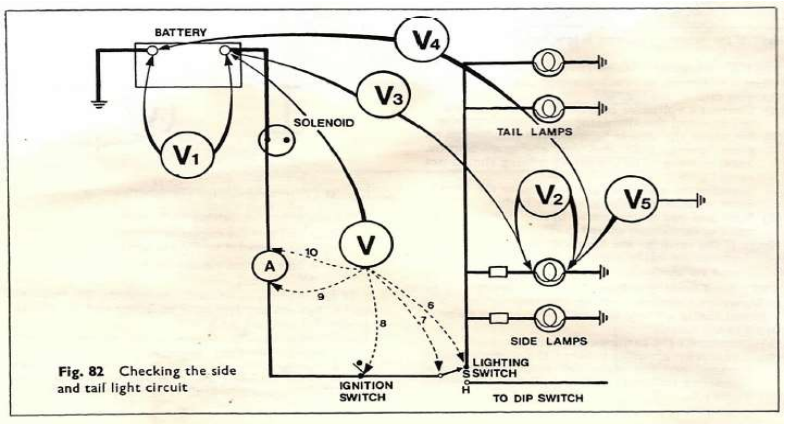
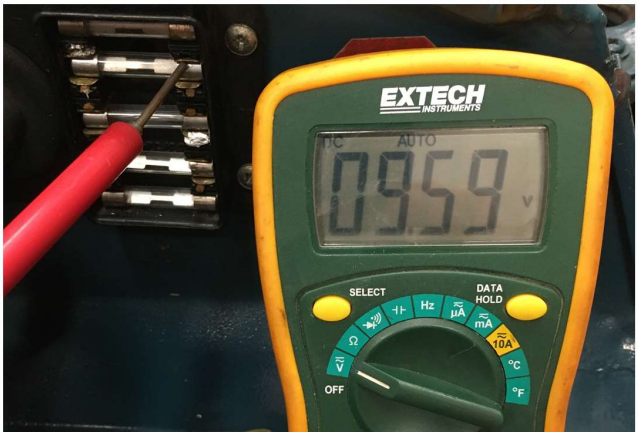



Fig. 82 Checking the side and tail light circuit

Point out test points.

This diagram is from the Lucas Fault Diagnosis Service Manual and it is a raffle item!

# Voltage Drop Example




This is my recent Gt6 poor fuse connection. The fuse was good however the clip holding the fuse had resistance causing the voltage drop. The voltage was 9.59 volts without a load. The brake lights and turn signals added a load when being used and caused the voltage to drop further so the lights would not work.

Note the addition of tin foil and toothpicks to “tighten up” the fuse connections.

# Resistance Testing

(aka – Do I have good connections?)

- Use the Volt Ohm Meter Ohm function (Greek letter Omega).
- A direct connection has no resistance and reads as Zero Ohms on the VOM scale.
- No connection has infinite resistance. Depending upon the VOM meter, it may indicate “OL” for open line.
- Uses…
  - Is there a good ground connection to this light socket?
  - Is there a poor connection along this wire?
  - Does this switch have resistance across the (dirty, pitted) electrical contacts?

Gearbox switch with 68,000 Ohms

## Corrosion is Always a Problem

- Corrosion introduces resistance and voltage drops.
- Start at the battery and test voltage throughout the circuit.
- Fuses, switches, lights, motors, and grounds have connections to test.
- Connections that are clean and tight do not create heat, or have voltage drops.
- The contacts in plastic main light switches melt the plastic housing and become recessed instead of connecting when they get too hot.

Worked on a TR6 wiper motor circuit. Found voltage drops due to corrosion and dirty connections on the ignition switch, wiper motor switch, wiper motor and ground. All of the voltage drops across these components added together would not drive the wiper motor.

More importantly, the resistance creates heat and the potential of a fire if it gets too hot.

Light sockets, fuse blocks, switches, …

## Corrosion Example

Fuse block on the right probably has 55+ years of corrosion.

Fuse block on the left is just as old however the connections were glass bead blasted to clean them to like-new condition

Show wire with internal corrosion that looks black instead of like shiny copper.

## Bad Grounds

Cause strange things to happen such as:

- Parking lights work until the brake lights are powered – then one brake light works while the parking lights go out.
- One headlamp is bright while the other is dim.
- Only some of the dash lights work.
- The horn switch will not operate the horn relay.
- Inoperative overdrive could be a bad ground issue.

Going through every circuit includes cleaning every ground.

Check resistance (ohms) to ensure the ground is good. All the way back to the negative battery terminal.

Horn switch relies on ground wires in flexible rubber joint between steering shafts, and the rack and pinion housing ground.

## Scorched Wires or Blown Fuses

- It is never a good day when a powered wire short circuits to ground. May it only blow a fuse.
- What happened to your fuse friends?
- What if the wire was not fused?
- So where did the 12 volt power go to ground?
- Look for a wire harness with a melted line running inside the harness.
- Look for broken insulation, connections touching ground sources, and arced clues to find the problem.

A smaller wire will get hotter than a larger wire carrying the same current. Any wire carrying more current than intended will get very hot and burn the insulation.

Show bad wires.

The correct size fuse should blow before the protected wires burn up. A high amperage fuse used in place of the correct smaller fuse could handle more amperage than the wire it is intended to protect.

Unfused power wires that short to ground burn up until the short circuit is interrupted.

You can trace the circuit with a VOM on the Ohm setting. Test sections of the circuit to isolate the problem.

Fusible links are short wires intended to burn up and protect bigger wires. My 105 amp alternator has six gauge wire with an eight gauge fusible link going to the battery. The 8 gauge wire handles 80 amps. If a short circuit happens, the 8 gauge wire will burn up before the larger 6 gauge wire does.

## Steps to find a problem…

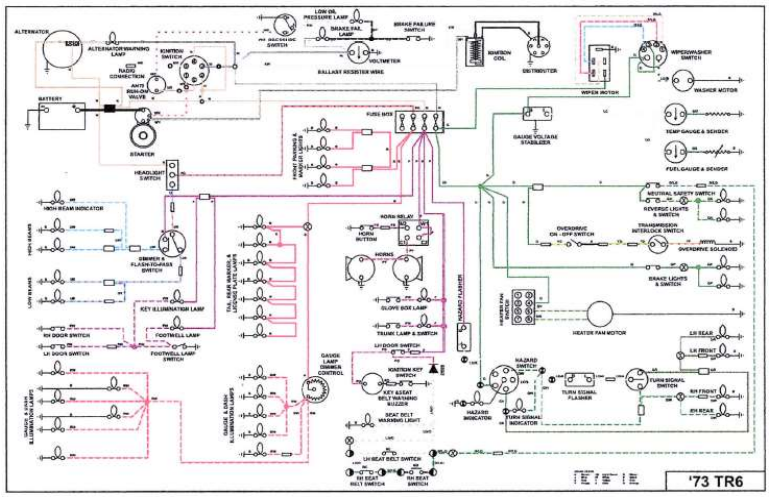
- Review the wiring diagram first.
- Begin testing at the battery.
- Test the circuit step by step from the battery.
- Test wires, connections, fuses, and switches for continuity, resistance, and voltage drops.
- Test the electrical load by powering it directly from the battery – **USE CAUTION** in case of a short to ground.
- Test the load ground path for continuity and resistance.

# Wiring Diagram Review

Refer to the following 1973 TR6 wiring diagram color copy.

- Note the lighting wiring circuit shown earlier in the presentation.
- Review some of the other circuits.
- Apply the previous steps to find a problem.

# ‘73 TR6 Wiring Diagram




This is from the Dan Masters information.

## Improvements and Upgrades

Add fuses and relays first!

Use the right size wire for the electrical load!

Common upgrades:

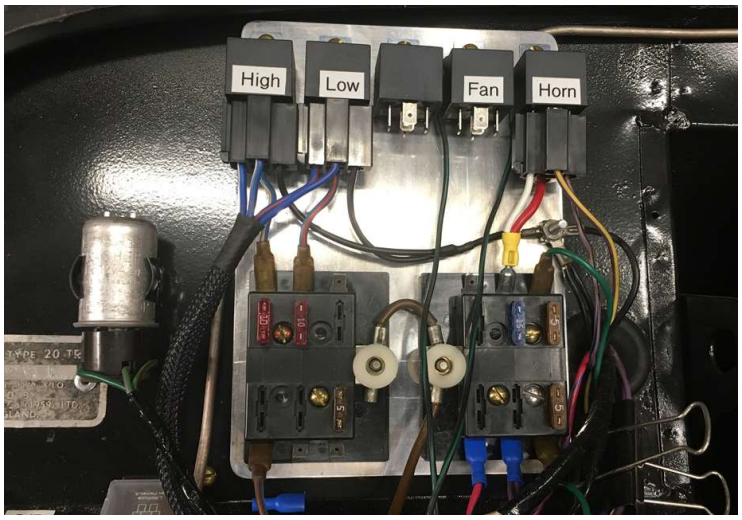
- USB and Power Outlets
- Driving Lights
- Electric Fan
- Electric Fuel Pump
- Alternator Upgrade

Power outlets – live fused to the battery – add a relay if switched from ignition switch.

Lights – higher wattage = higher amperage = bigger wires and fuses + a relay if you do not want a big switch.

Electric fan is usually relay driven by a temperature sensor in the radiator when the ignition is switched on.

# Fuses and Relays




Main fuse and relay panel in my TR3 and located where the generator regulator once was.

Note the paper binder clip to hold wires in place as I build the wire harness in the car.

A smaller fuse and relay panel will be inside for the ignition switch switched loads.

# Questions?

- What else should we discuss?
- Who has other electrical pointers to add?
- Any good “electrical gremlin” stories?

- Credits and Resources is the last slide - then…

- Door prize drawing time!!!

# Credits and Resources

- Thanks to **Jim Bauder** for giving me his eleven volume reference materials that he assembled while totally rebuilding his TR250. (The electrical information alone is 4.5 inches thick!)
- The **Robert Bentley Factory Service Manual** reprints **(**also **Brooklands Technical Books)** contain the same repair information used by the Triumph Dealer service technicians. (The wiring diagrams can help you determine the road the electrons should be traveling!)
- **Dan Masters** wrote an **Electrical Maintenance Handbook** for the Triumph TR250 – TR6. This is a detailed reference to help you REALLY understand and troubleshoot Triumph electrical systems.
- **Lucas Fault Diagnosis Service Manual** – A raffle item!