# TRIUMPH TR250 - TR6 ELECTRICAL MAINTENANCE HANDBOOK

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*NOTE: The material in this manual is provided as an aid to Triumph owners who want to do their own electrical trouble shooting and repair. The author makes no claims for its accuracy or suitability for use, although every effort was made to make it as correct as possible. Standard-Triumph didn't always correctly document the electrical systems when the cars were built, and often made undocumented changes on the production line. Also, in the over two decades since these cars were new, it is not uncommon for them to have been modified by previous owners; Therefore, the material in this manual should be used with discretion, and is to be used at the readers risk. This information should be considered general rather than specific to any particular vehicle, and no warranties exist, either expressed or implied*

# PREFACE

## LUCAS - PRINCE OF DARKNESS?

Unfortunately, that is the typical response to the electrical systems in our Triumphs. I say “unfortunately,” because the Lucas electrical components are just as good and as reliable as any. ANY 25 year old car that has been neglected, perhaps stored in a barn or a field for 15 of its 25 years, will have problems with the electrical components. Why does Lucas have such a bad reputation? Simply because Lucas supplied components to virtually all British cars during the era we are now concerned with. You have a bad switch in your Triumph, your buddy has a failure in his MG, and yet another friend has similar problems in his Jaguar. With Lucas being the only commonality, it’s easy to assume Lucas is the problem. If you have problems with a 25 year old Chevrolet, and your buddy is experiencing the same type of problems with his old Ford, you both are much more likely to attribute the problems to age than to manufacturer, as the electrical components are not made by the same company.

With proper maintenance and care, Lucas electrical components will provide many years of reliable service; without proper care, no manufacturer’s parts will last for the quarter to half century we expect our cars to serve.

For the last few years, I have been a member of the Triumphs mailing list (Courtesy of Mark Bradakis and the Fat Chance Garage) at autox.team.net*. Problems with electrical systems seem to occupy as much or more time on the list as any other single type of problem, and I have spent a fair amount of time trying to provide list members with simple, yet complete, solutions to those problems. It seemed as if everyone, regardless of the condition of their car - show car or beater, has electrical problems from time to time. After the first year or so, I recognized the need for a ready, reliable, source of help for these electrical problems. It occurred to me that if I could put answers to all the electrical problems that might be encountered during the course of Triumph ownership into a book, and if the book were complete, thorough, and most of all, easy to understand, I would be doing a great service to my fellow Triumph enthusiasts, and perhaps save a number of the Triumphs from the scrap yard as well. This, then, is my attempt at that book.

## WHO AM I?

Many of you who buy this book know me from the Triumphs mailing list; the fact that you bought this book indicates that you have a reasonable confidence in my electrical expertise. For those who don’t know me, a little background material may be in order. My first electrical experience began with a four year tour of duty in the USAF as a radar technician. Following that, I attended the University of Tennessee, where I earned a BSEE. Starting part time while still a student, and ending with early retirement in ‘94, I spent 28 years designing instrumentation and control systems for nuclear power plants with the Tennessee Valley Authority.

None of which qualifies me as an expert in Triumph electrical maintenance. I have no formal training in automotive applications, nor am I certified as an automotive authority by any certifying agency. I bought

** If you are not already a member of the Triumphs mailing list, you really should join. It’s free (although contributions are welcomed), it’s easy, and it’s an invaluable source of information (and moral support) for Triumph owners. All models of Triumphs are represented, although the more popular TR series are discussed more often than others. To join, just send an e-mail to: majordomo@autox.team.net with NOTHING in the body of the text EXCEPT two words:* ***subscribe triumphs***

*Within a few moments, you will get a confirmation email, with directions for initiating your subscription. Return the confirmation, and within another few moments, you will begin receiving mail from some of the more than 700 members world wide.*

my first TR6 in 1990, and I have spent the years since applying my electrical background to an understanding of the principles and foibles of automotive electrical systems, particularly as they pertain to Lucas and British cars. Electrical principles are the same, regardless of the application, but the particular requirements of an automobile can create some unusual designs. At first glance, some automotive systems appear to be an exercise in stupidity, yet when studied further, turn out to be a quite clever solution to a peculiarly automotive problem.

This book, then, is not the writings of an "expert." It is, rather, a compilation of the experiences and the research of an amateur Triumph enthusiast, just like yourself. I have spent many hours in research during the preparation of this manual, and I would like to say that it is without error, but the nature of the problem prevents that. In spite of my best efforts, I am sure there will still be errors. There is no official documentation available from Triumph that can be relied upon with absolute certainty (in many cases, the official documentation is ***very*** wrong!), and the availability of truly original examples to evaluate is limited. Any errors in the book, however, should be of a minor nature, and shouldn't impact the overall usefulness of the manual. It is my intention that the supporting material - circuit descriptions, operational diagrams, theoretical explanations, etc., - that accompany each chapter of the book will provide sufficient background material that the reader will be able to work around any errors that may exist.

I hope you enjoy this book as much as I have enjoyed writing it. If it saves you any where near the time it has taken me to write it, it will be well worth your money. Hopefully, we can keep the evil electrical gremlins at bay, and keep our Triumphs on the road!

Dan Masters,
(DANMAS@aol.com)
June, 2000

NON-ELECTRICAL PROBLEMS

Electrical problems may be among the most vexing you're likely to encounter during a restoration of a Triumph, but they are not the only problems encountered. The scope of this manual is limited to electrical problems, but there is available an excellent book covering most of the remainder of the restoration activities. Written by well known British author Roger Williams and available from most book dealers, it is entitled "How To Restore Triumph TR5/250 & TR6," Published by Veloce Publishing, ISBN 1-901295-92-3.

## ACKNOWLEDGMENTS:

First of all, I would like to thank Ken Gano, Irv Korey, and Dave Massey for their kind assistance in reviewing the manuscript for accuracy and completeness. I would also like to think Frank Bandre, Dave Gauthier, Bill Kelley, Tom O'Malley, Anthony Rhodes, John Rossi, Brian Schlorff, Bob Sykes, Randall Young, and Peter Zaborski (and many others, too numerous to list) for their help in resolving many of the wiring configuration concerns. Without their help, I would not have the confidence to offer this book for fear of errors. Of course, all errors remaining are of my making alone, and I take full blame for them.

I would also like to thank the members of the autox.team.net Triumphs and Spitfire mailing lists for allowing me the opportunity to participate in the "on-line" Internet discussions of technical issues involving these cars. I have learned much more from answering electrical questions than I have taught.

Most of all, I would like to thank Christa, my lovely wife of 30 years, for her patience and understanding, most particularly, her willingness to cheerfully, and (almost) without complaint, allow the inevitable "honey-does" to stack up while I pursued the writing of this manual.

# TRIUMPH TR250 - TR6 ELECTRICAL MAINTENANCE HANDBOOK

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# 1
# INTRODUCTION

One of the most frustrating aspects of a Triumph restoration, as least for the majority of owners, is the electrical system. Folks who have no fear at all of tearing the engine completely apart and rebuilding it cringe at the thoughts of dealing with the "Lucas" demons. This is certainly understandable, given the nature of the electrical systems when compared to the mechanical systems. Take the head off of the engine, and you can see the valves opening and closing and the pistons going up and down, and you can fairly easily understand the operation of these components. Look at a bundle of wire, on the other hand, and there are no visual clues as to what's going on.

In reality, though, electrical repairs and/or maintenance are not any more difficult than any other aspect of restoration if you have a basic understanding of the principles involved. Unfortunately, just as it takes a time to become familiar with engine, transmission, or suspension principles, it also takes time to become familiar with electrical systems. Also unfortunately, most of us don't have the time to spend to delve deeply into theory, and that's where this manual comes in. If I have done my job well, electrical repairs should be well within the capability of the typical Triumph owner, using simple test equipment.

Although no theory is required, a little bit of theory will be of benefit never the less, so I have included a little bit of theory in this chapter. In keeping with the direction of this handbook, the theory is as simple as I can make it, including only what I think is required to understand electrical theory as it applies to our cars.

To start, study **figure 1** at the top of the page for a moment, and then take a little quiz. This figure is a modified version of one of the figures in the chapter on starters, but I have cut the heavy gauge cable from the battery to the starter solenoid and spliced in a small light bulb, such as the ones found inside the instruments for night time illumination. The wires to the light bulb are very small gauge. Suppose I then hit the starter switch as if to start the engine. What will happen?

A. The starter will turn as usual, and the bulb will light as an indication that the starter is working.

B. Neither the starter not the bulb will operate.

C. The bulb will be smoked!

D. The bulb will light at full brilliance, but the starter will not turn over

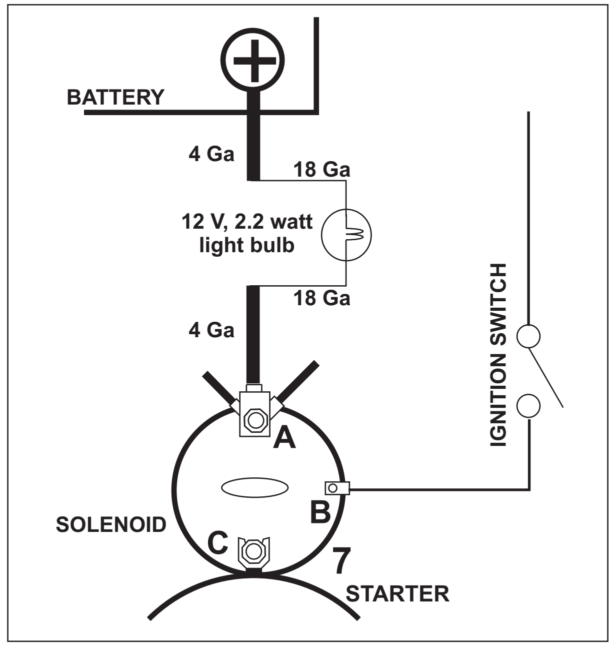



FIGURE 1

The correct answer is D. To the light bulb, the starter solenoid looks like a solid ground connection, while the resistance of the bulb will prevent the solenoid from engaging. Details on this later.

CONVENTIONS

In this handbook, I will use the following conventions:

V = Voltage,

A = Amperes (current),

Ω = Resistance (Ohms)

W = Power (Watts)

In other sources, you may see E instead of V, I instead of A, R instead of Ω, and P instead of W.

When describing the operation of various circuits in this handbook, I will use the "current flow" theory, rather than the "electron flow" theory. The current flow theory states that electricity consists of positive charges moving from the positive pole of the battery, through the circuit, and back to the negative pole of the battery. Electron flow states that electricity consists of a flow of electrons moving from the negative pole of the battery, through the circuit, and back to the positive pole.

Which one is correct? Actually, they are both correct. For more details on this topic, refer to appendix A.

Why am I using the current flow theory? Quite simply, because it is easier, both to describe and to understand circuit operation. Somehow, it just seems to make more sense to think of current flowing from the battery to the loads, and then dispersing through the loads to chassis ground on its way back to the battery. Thinking of electricity flowing through the chassis, up through the loads, and then returning to the positive post of the battery just doesn't seem right (right though it may be).

Additionally, the symbols for various electrical devices are aligned to the current flow theory. Way back when, as electricity was just beginning to be understood, and devices were being designed to use electricity, the current flow theory was the only one in use, so all the symbols for electrical devices were created with this in mind. A good example of this is the symbol for a diode (or rectifier prior to the invention of the diode). The arrow in this symbol points in the direction of current flow. If you use electron flow, you have to think of the electrons flowing against the arrow. It can be done, but it can very easily be confusing to do so, and, as the answers are the same using either theory, there is just no reason to. If you dig deep enough into electrical theory that it really makes a difference, you will by then have a deep enough understanding of the differences that you will not be confused.

FORMULAS

There are only two formulas to remember, which can be re-arranged as needed. They are:

Volts = Current X Ohms, V = A X $\Omega$

Power = Current X Volts, W = A X V

These two formulas can be rearranged as:

A = V/$\Omega$, $\Omega$ = V/A, A = W/V, and V = W/A. To make these easier to remember, use the diagrams in **figure 2**.

To use these figures, place your thumb over the parameter you're trying to find, and see the equation which gives you that parameter. For example, in **figure 2c**, with your thumb over A, the wheel shows A = V/$\Omega$. Similarly, with your thumb over V in **figure 2d**, the wheel shows V = W/A. In **figure 2e**, V = A X $\Omega$, and in **figure 2f**, A = W/V.

OK, so what is voltage, current, resistance, and power? A simple analogy to a household water system may be helpful. Voltage would correspond to the water pressure (PSI), and current would be the equivalent of flow (GPM). Resistance would have the same effect on current flow that pipe restrictions would have on the flow of water. There is no ready equivalent for power in a water system, but power is simply a measure of the work performed by the flow of current. In most cases, this work takes the form of heat and light, as in a light bulb, or in motion, as in a heater fan motor. This analogy breaks down as you delve deeper into electrical theory, but it is adequate as an aid to understanding electricity.

Battery (or alternator) voltage is the "pressure" that pushes electricity (current) through the wires (pipes) against restrictions (resistance). Power is the work done by the current as it overcomes the resistance of the circuit (typically, the resistance is in the form of lights or motors).

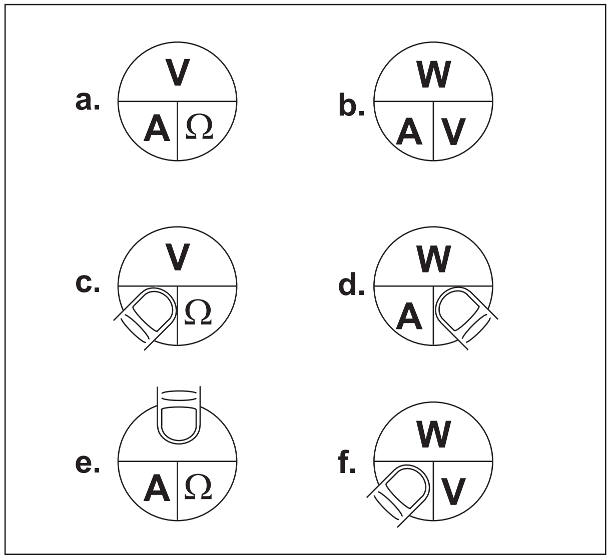



FIGURE 2

NOMINAL VALUES

When you go to the lumber company and ask for a 2 by 4, you get a board that is 3 ½ inches wide by 1 ½ inch thick. Similarly, when you buy a 12 volt battery, you get a battery that produces about 12.6 volts with a full charge. When the engine is running fast enough to spin the alternator to its full output RPM, the voltage in your car's electrical system is around 14.6 volts. Never the less, for the same reason that we call a 3 ½ by 1 ½ board a 2 by 4, we refer to our car's electrical system as a 12 volt system.

When you are using the above formulas to determine the current draw of a light bulb, for example, what value should you use? 12 volts? 12.6 volts? Or 14.6 volts? To be exact, you should use the voltage value the manufacturer used in determining the wattage of the bulb. Unfortunately, unless you have the manufacturer's data sheet handy, there is no way to tell what value he used. They use all three of the aforementioned values, plus a few others, when evaluating wattage ratings. In fact, in some dual element bulbs, they use one voltage for one element, and another for the other element. Luckily, there is no need for precision. There is enough conservatism in the various ratings for such things as wire and fuse sizes that using 12 volts for all calculations will be fully adequate.

To see how these formulas work, examine **figure 3** below. In this figure, we have a simple circuit, with one light bulb. This bulb is listed as a 21 watt bulb, typical of the bulbs used for back up lights in our Triumphs. Placing our thumb over the A symbol in wheel "b" of the diagram on the preceding page, we find that this bulb will have a current of 1.75 amps with 12 volts applied (all calculations are rounded off to 2 decimal points). Placing our thumb over the Ω symbol in wheel "a", we see that the resistance of this bulb is 6.86 ohms. You will rarely have a need to know the resistance of a device, but an understanding of resistance values will be of help when you get to the chapter on bad grounds and connections.

The diagram on the left of **figure 3** is a complete circuit diagram, showing all of the components in the circuit. In most diagrams, the circuit would be shown as on the right, the battery and the ground connection being understood. Almost always, the ground, or return connection, in an automotive circuit is either the chassis or the body sheet metal, or a combination of both.

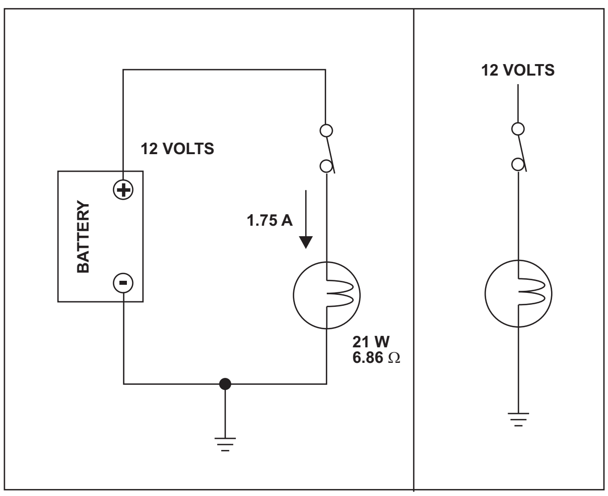



FIGURE 3

PARALLEL CIRCUITS

Most of the circuits you will find in an automobile will be of the parallel type. In this type of circuit, the high end of each device (or the plus side) will be connected to a 12 volt source, and the low, or ground side, will be connected to the chassis. **Figure 4** illustrates a parallel circuit, typical of the circuit you might find at the rear of the car, with one tail light, one marker light, and one license plate light per side.

In a parallel circuit, the voltage at each device is the same, but the current may vary, depending on the resistance of the device. The current through the main power feed is the sum of the individual currents through each of the bulbs, and the current flow through the rest of the wire is reduced as each lamp draws off its own current demand.

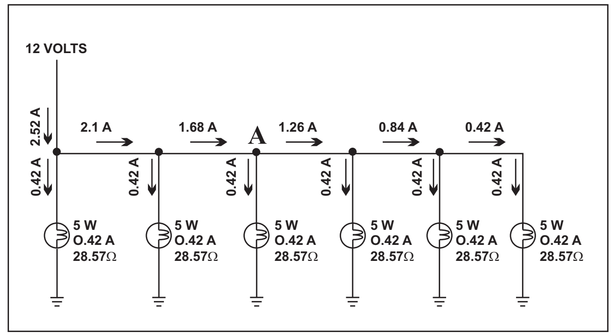



FIGURE 4

This is a fundamental law of electricity: ***the sum of all current flowing into a junction is equal to the sum of all current flowing out of the junction.*** For example, the current flowing into the junction marked "A" is 1.68 A, and the current through the lamp connected at "A" is 0.42 A (A = W/V), leaving 1.26 A to flow to the rest of the circuit.

Even though the current is different for each device in a parallel circuit, it should be noted that the voltage applied to each device is the same. All of the lamps in the above figure receive 12 volts.

Christmas tree lights that continue to work when one bulb is out is an example of a parallel circuit. Removing one lamp from the circuit above has no impact on the other lamps; the voltage to each lamp stays the same, but the total current supplied by the power lead will be reduced, as will the current in each leg of the circuit.

This diagram above is a stylized representation of the circuit, or a schematic diagram. The diagram below, **figure 5**, is the same circuit, but is laid out to more or less represent the actual wiring of the circuit. It is still a schematic, but is can also be considered a connection diagram, as it shows the actual connectors used in the car. The small rectangles shown on the wiring represent the bullet and sleeve connectors used for most connections in a Triumph.

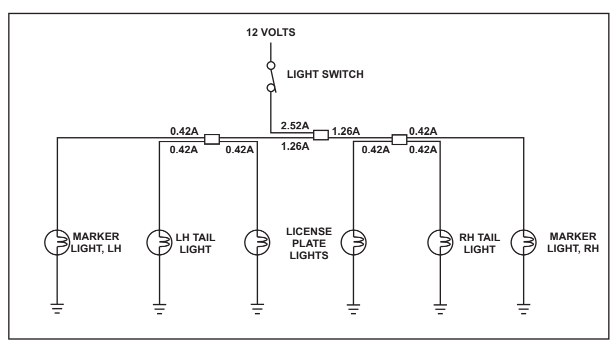



FIGURE 5

This is the type of diagram normally used in the Triumph manuals, and can be beneficial, as it helps to locate the circuit connectors, and to a lessor extent, the routing of the wires. In this diagram, the bullet connectors are the junctions, and the current flowing into each connector must be equal to the current flowing out.

Now, let's redraw the circuit shown in **figure 4** just a little bit, by drawing a box around the lamps, as shown below in **figure 6**.

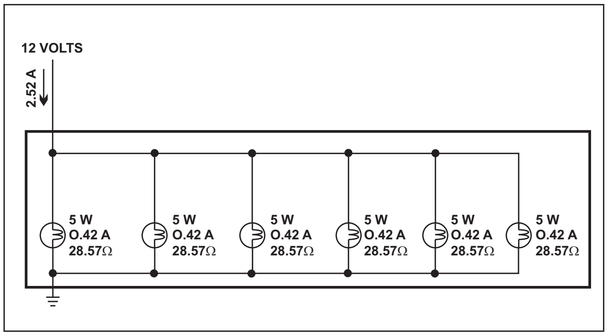



FIGURE 6

Let's go one more step in **figure 7**, and put the cover on our "black box" so we can't see what's inside.

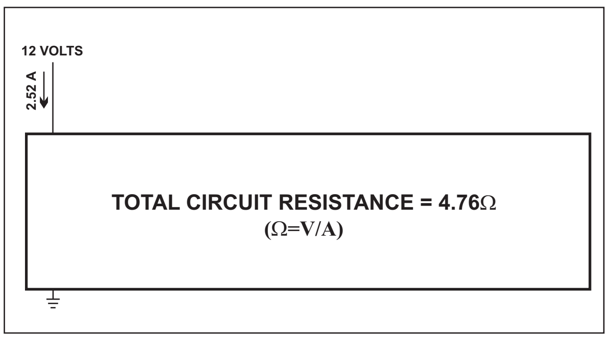



FIGURE 7

Using our formulas from the beginning of the chapter, we can see that the total resistance of the components inside the box is only 4.76Ω, much less than the 28.57Ω of each individual lamp, 1/6 as much, in fact.

This represents another fundamental law of electricity: ***The resistance of a parallel circuit is less than the resistance of the smallest resistance in the circuit.*** This is really just another way of saying the more devices you add to a parallel circuit, the more current it will draw.

SERIES CIRCUITS

Only rarely used in automobiles, series circuits are worthy of study never the less, as an understanding of them can be very helpful in understanding the trouble shooting techniques described in later chapters of this manual. The figures below show four examples of series circuits. Christmas tree lights that all go out if one bulb fails is an example of a series circuit.

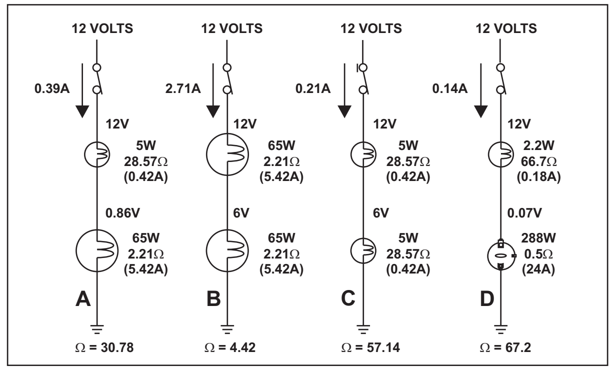



FIGURE 8

In circuit A of **figure 8**, above, I have placed a small 5W bulb, typical of the type used for the trunk lamp, in series with a 65W headlamp. Using the formulas given earlier, we find that a 5W bulb has a resistance of 28.57Ω, while a 65 W bulb has a resistance of 2.21Ω. In a series circuit, resistance adds, so the total circuit resistance is 30.78Ω. Using the formulas again, we find that a circuit resistance of 30.78Ω allows a current of 0.39A. Back in **figure 4**, we saw that a 5W bulb in a parallel circuit draws 0.42A (the current values shown in parenthesis in the above figure are the currents that would be drawn by the device if it were in a parallel circuit). With 0.39A, a 5W bulb will be drawing 93 % of its rated current, so it will be almost as bright as if it were in the circuit by itself. A 65W bulb, on the other hand, normally draws 5.42A. A current of 0.39A is only 7 % of its rated current, so it will not be drawing enough current to light it at all.

This is another fundamental law of electricity: ***The current through all devices in a series circuit is the same.*** No matter how many devices I wire in series, the current through each and every one will be the same. The amount of current will be determined by the ***total*** resistance of all devices in the circuit. This law will be invaluable later when you get into the trouble shooting sections of this manual, particularly when reading the chapter on bad grounds and connections.

It should also be noted that in a series circuit, all devices ***do not*** receive the same voltage. More on this later.

Circuits B, and C are two more examples of series circuits, which should be reviewed for understanding before proceeding. Use the formulas from the beginning of the chapter to see how the values were derived.

Circuit D is a representation of the light bulb/starter circuit shown in figure one, and discussed in the quiz. A starter solenoid has a resistance of about 0.5Ω, and a 2.2 W bulb has a resistance of about 66.7Ω. Total resistance for the circuit, then, is 67.2Ω, or almost the same as the 2.2W bulb by itself. The solenoid resistance represents less than 1 % of the bulb resistance, so current through the circuit is, for all practical purposes, determined solely by the resistance of the bulb. The 0.5Ω resistance of the solenoid looks to the bulb almost like a short circuit to ground. Thus the answer to the quiz is D. The bulb doesn't know the solenoid is there, and the solenoid doesn't know any current is flowing in the circuit.

Notice the voltages applied to the last device in each circuit. In circuit A, the voltage on the 65 watt bulb is 0.86V (0.39A X 2.21Ω), which means that the remainder of the battery voltage must be dropped across the smaller bulb (12V - 0.86V = 11.24V). Applying 0.86 V to the headlight is virtually the same as applying zero volts, while the 11.24V applied to the smaller bulb is almost full voltage. In other words, the headlight doesn't receive enough voltage to illuminate it, while the smaller bulb does. This jibes very nicely with the results obtained by comparing the current flow to the required current flow for each device.

SUMMARY

As stated earlier, it is not necessary to know all of this to fix your TR. The information presented in the remaining chapters (with the exception of chapter 3 - Bad Grounds and connections), should be sufficient to enable you to find and fix most any electrical fault you may encounter without this knowledge, but it will make your job so much easier, and more fun, if you understand the proceeding material.

The most important things to remember are:

**1. Resistance limits current. The higher the resistance, the less the current (this is true whether we are talking about the resistance of a light bulb, the resistance of a bad connection, or the resistance of switch contacts).**

**2. The higher the wattage of a device, the less resistance it has. A 65W headlight bulb has much less resistance than a 5 W marker lamp, and will draw much more current.**

**3. A high resistance device in series with a low resistance device may limit the current such that the high resistance device will work but the low resistance device won't.**

**4. Current through resistance produces wattage, usually in the form of heat.**

**5. In a series circuit, the current through each device is the same, but each device may see a different voltage.**

**6. In a parallel circuit, each device will see the same voltage, but the current through each device may have a different current through it.**

# 2
# GENERAL PROCEDURE

ELECTRICAL TROUBLE SHOOTING PRACTICE

GENERAL CONCEPTS

Every electrical circuit in your car consists of five basic parts:

1. Source of electricity: battery or alternator.

2. Path for electricity from source to consumer: These are the wires, plugs, connectors, fuses, etc.

3. Control device: switches, such as turn signals, headlight switch, oil pressure switch, etc.

4. Consumer of electricity: Lights, horn, wiper motor, etc. - the reason for the circuit in the first place.

5. Return path for electricity from consumer back to source: this is the ground connection. In some cases, the device is connected directly to ground, such as the horns, and in other case, there is a separate wire for ground, such as the headlights.

Remove or disable any one of these five, and the circuit will not function. It follows, then, that if a circuit isn't functioning, one of these five items is the source of the trouble. To determine which of the five items is the problem, a systematic trouble shooting procedure is helpful.

TOOLS REQUIRED

Almost all electrical troubleshooting can be accomplished with only a very small set of tools. In addition to the normal assortment of screwdrivers, wrenches, etc, you should have the following:

<u>A cheap test lamp.</u> These can be bought for as little as \$4.00, or for as much as \$25.00. The \$4.00 lamp is just as good as any. This lamp consists of a plastic holder for the bulb, with a sharp tip on it, and a long wire with an alligator clip on it. See **figure 2**. This is just about a mandatory tool to have, and is almost sufficient for all troubleshooting efforts

<u>Multi meter.</u> The next step up in the electrical tool department is a cheap VOM, commonly referred to as a multi meter. VOM stands for Volt Ohm Meter. Some of the better meters also have an ammeter as well. I don't recommend buying an expensive meter, as high quality isn't needed, and there is a very good chance that you will ruin it through misuse sooner or later. Ruining a cheap meter doesn't hurt as much as ruining an expensive meter.

<u>Buzzer.</u> A handy tool to have, especially if you work by yourself a lot. This you will have to make yourself, as they aren't readily available most places. It consists of nothing more than a 12-volt buzzer or chime module, with two long leads on it, both with alligator clamps. To use it, clip the negative lead to ground, for example, and the positive lead to the circuit you're trying to test. When you have power to the connection in question, the buzzer will sound, so you will know that you have succeeded in completing the circuit-much better than asking your SO to stand around and tell you if the meter is now reading 12 volts or not.

<u>Continuity tester.</u> A handy device, but very dangerous if you are not careful. Not dangerous in the sense that it will harm you or the car, but dangerous in that the indications can be very misleading. Exercise great care when interpreting continuity tester readings. More on this later. The tester itself is very simple, consisting of a plastic holder for a bulb and a battery, with a sharp tip on it and a long lead with an alligator clip. Some of these are nearly identical in appearance to the test lamp described above.

<u>Schematic.</u> Mandatory! Many electrical repair experts will tell you they don't need a schematic, but they are wrong. They may not need to have a printed schematic in front of them, but they MUST have a schematic in their head if they don't. I've worked with electrical problems on TR6s long enough that I can *almost* draw the schematic from memory, so I can do a lot of repair without a diagram in my hand. When working on my Toyota pickup, though, I must pull out the manual and review the schematic.

<u>Test leads.</u> A few short lengths of wire with alligator or crocodile clips on each end will be very helpful when trouble shooting. At least one of the leads should have an in-line fuse added.

<u>Soldering iron and solder</u>. A 100 watt or so soldering iron is best for this type of electrical work, but too big (within reason) is better than too small. If the iron is too small, it will take a long time for the wire to get hot enough to melt the solder, which will allow time for the heat to wick up the wire , and may damage the insulation. With a larger iron, you can get the wire hot enough before there is enough time for the wire to get hot beyond the area of the joint.

NEVER use acid core solder, as the acid will cause corrosion over time. Use a small diameter, low temperature solder, with a rosin core

Crimping tool. Don't skimp here. A poor quality crimping tool will make terminations that are prone to working loose with time.

Common sense and logic. It's amazing how much trouble shooting can be done without ever touching the car or a tool.

PROCEDURE

1. Source of electricity

The first thing we'll look at is item one of our list of basic circuit parts: source of electricity. The distribution of electricity in a British car can be divided up into four groups, distinguished by the main color of the wires used in each group. The four groups are:

BROWN: These wires are hot all the time, and are not fused.

WHITE: These wires are hot only when the ignition key is on, and are not fused.

PURPLE: These wires are hot all the time, and are fused.

GREEN: These wires are hot only when the ignition key is on, and are fused.

These four groups of wires and their colors need to be COMMITTED TO MEMORY. This bit of knowledge will be extremely valuable when trouble shooting electrical circuits.

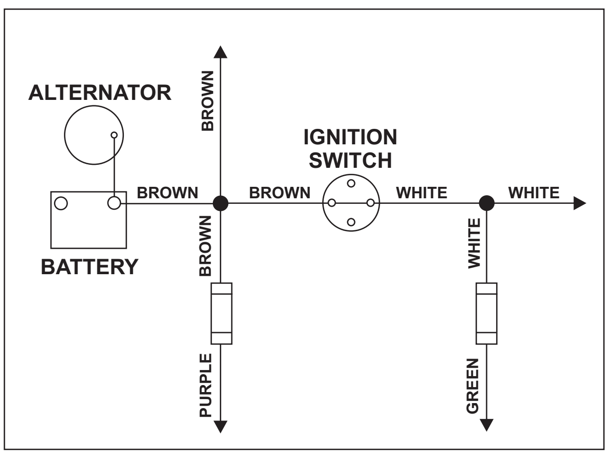



FIGURE 1

Refer to the **figure 1**, above. This is a very simplified diagram of the power feed/distribution scheme used in all TR6s, and in virtually every other British car of this era. The four groups of wires provide power to various loads as follows:

BROWN WIRES: starter, ignition switch, headlights, horns (if not fed by purple wires), and the fuse for the purple wires.

WHITE WIRES: ignition coil, electric fuel pumps, low oil pressure warning lamp, brake failure warning lamp, alternator warning light, and the fuse for the green wires.

PURPLE WIRES: horns (if not fed by brown wires), courtesy lamps, trunk lamp, glove box lamp, hazard flasher, and the high beam flasher (flash to pass).

GREEN WIRES: windshield wiper, windshield washer, brake lights, back-up lights, gauges, turn signals and the heater fan.

How's all this going to help us? Well, let's take a typical problem and see. Suppose you find that your brake lights don't work. Let's follow a logic path to a resolution. Remember, the brake lights get power from a green wire!

Does the engine turn over when you turn the key? If so, you know the battery is good, you have power on the brown wires, and you have power to the ignition switch, or else you wouldn't be able to get power to the starter.

If the engine doesn't turn over, then you know the battery is bad, or you have some bad connections somewhere in the main power circuit, so there's no need to waste time looking for the brake light problem till that problem is fixed.

Does the engine run? If so, you know you have power to the white wires, and you should have power to the fuse for the green wires.

If the engine doesn't run, you need to find out why. Maybe the white wires don't have power because the ignition switch is bad. If the white wires don't have power, it's for sure the green wires won't.

Do any of the other loads fed from the green wires work -- gauges, windshield wipers, turn signals, etc? If so, then you know you have power to the fuse, and you know that the fuse is good - otherwise, none of the other "green wire" loads would work.

If none of the other "green wire" loads work, it's a safe bet that either the fuse is blown, the fuse isn't getting power from the ignition switch, or there is a bad connection near the fuse.

By now, we've either found the source of our problem, determined that it is not a power problem, or we've narrowed the power problem down to particular area for further testing. We're left with two possibilities now - either we have power to the "green wire" or we don't

First, let's assume we don't have power to the green wire circuit, i.e., none of the green wire loads work. The first thing to check is the fuse itself. Most of the time, but not always, a blown fuse will be obvious from a visual examination. If this turns out to be the case, we are finished. If not, more work is needed.

The next step, then, is to look for power. The preferred approach to this is to start at a place where you know you have power and trace till you find a point where you don't, or, start with a place where you know you don't have power and trace till you reach a point where you do. In reality, though, it is often easier to pick a point that is easily accessible and work from there, moving in whichever direction is needed. If you find voltage at this point, move toward the load till you don't have voltage. If you don't have voltage at this point, move toward the battery till you find voltage.

In this case, the fuse is probably the easiest point to get to, so we will start there. With your test probe (or voltmeter), check for voltage on one side of the fuse or the other. Which side you start with doesn't matter. For the sake of argument, let's say you started with the white wire side of the fuse and found no voltage. As we have already established that we have voltage on the white wires (the engine runs), we can assume there is a break or bad connection in the white wire from the ignition switch to the "green" fuse, which will need to be fixed.

If we do find voltage on the white wire side of the fuse, then we know the fuse is bad, the fuse contacts are bad, or the connections/terminals for the green wires are bad.

2. Path for electricity

If we've determined that we have power (at the green wire), the next step is to verify a path for the power to get to the brake lights. How are we going to do this? Not with a continuity tester, as one might expect, but by looking for the presence or absence of voltage.

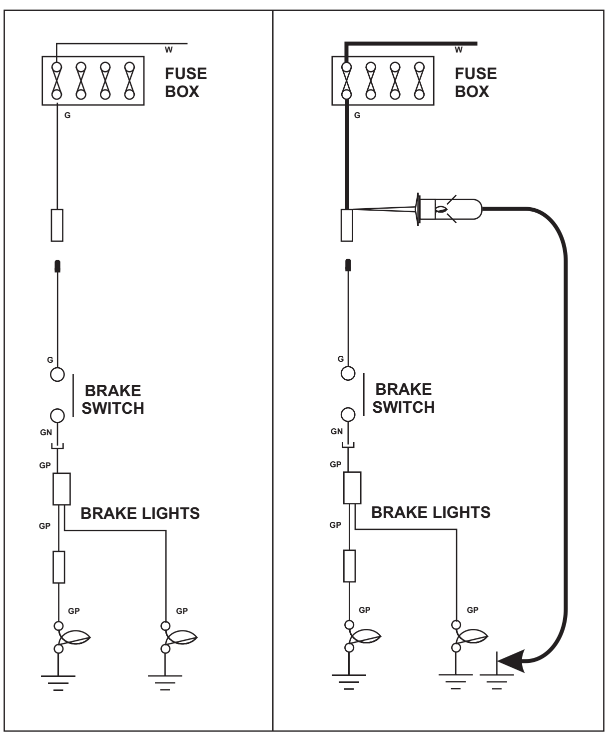



FIGURE 2

How does the presence of voltage verify continuity, when you can get a voltage reading on a battery that isn't even connected into the circuit? Refer to **figure 2**, below left.

On the left side of this figure, we see that one of the bullets has pulled loose from it's sleeve, interrupting the flow of electricity in the circuit. On the right side of the figure, we have connected our test light between the sleeve and ground. In order for the light to be lit, there must be voltage present at the bullet, and the test lamp provides the current path to ground through the light. If there isn't continuity, the test light will not illuminate. Continuity must exist from the battery, through the upper portion of the brake circuit, through the lamp, and through ground back to the battery; therefore, we have proven continuity through the brake circuit, at least up to the sleeve.

Suppose, though, that the bullet was not loose at this point, rather it was loose at the point shown on the left in **figure 3**. In this case, we would move our test lamp from the upper sleeve to the top of the brake switch. Finding voltage there, we would next move our probe to the lower side of the brake switch.

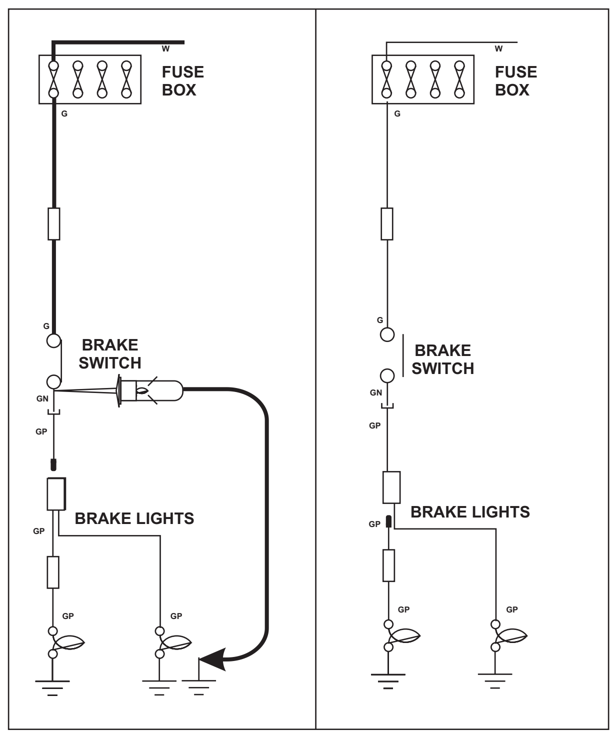



FIGURE 3

In order to check for circuit continuity here, the brake switch must be closed. If we have voltage here, we move our probe on down the circuit to the harness connector for the rear wiring harness (by the way, we have just proved our brake switch is OK, but more on that later). We continue moving our probe till we get to the top of the sleeve. At this point, we will find no voltage, so we know that the break is between the sleeve and the harness connector. A physical examination will be required to find the break. In this case, it was a loose connector, which will not be hard to find, but it might just as well been a break in the wire somewhere along the harness routing behind upholstery panels or carpet.

Suppose the break had been a loose connecter as shown on the right hand side of **figure 3**? If that were the case, we shouldn't have been going through all this testing in the first place. If the brake light on one side of the car is working, but not the other, we know the problem is somewhere in the circuit where the wiring for the two sides split. Our search would have been similar to the above, but confined to the wiring at the rear of the car, and we would not have been checking on the availability of power at all - if even one light works, we know there is power to the circuit.

That would be an example of how we can use common sense and logic to do a lot of our trouble shooting. A review of the wiring diagrams, a little process of elimination, and many problems can be solved without ever using a piece of test equipment.

3. Control device.

We've already seen, in our example above, one excellent way of testing control devices. If we have voltage on one side of a switch, but not on the other when the switch is in the on position, we know that the switch is bad. Having voltage on both sides of the switch is not, however, a guarantee that the switch is good. It is possible that there is so much internal resistance from contact corrosion that there will be an excessive voltage drop through the switch when an actual load is connected that the load won't work (refer to chapters 1 and 3 for more details on this).

The only way to be sure that the switch is good, other than actual operation in a circuit, is to use the ohms scale on a multimeter. The resistance from the input to the output of an ideal switch is zero. In practice, though, there will always be some resistance, but for a good switch, the resistance should be too low to read on any but a very precision ohmmeter. An internal resistance of just one tenth of an ohm in your headlight switch, as an example, will drop the voltage to the headlights by one volt or more - enough to cause a noticeable dimming of the headlights. An internal resistance of one ohm would drop the voltage to the headlights by 10 volts!

4. Consumer of electricity

Depending on the situation, it may be easier to check everything else first, and conclude that the device in concern is the problem, rather than just checking the device itself. In other cases, it may be easier to check the operation of the device first, before doing any other trouble shooting. An example of the former would the heater fan. This fan is ***VERY*** hard to get to for testing, so you would definitely want to try everything else first. The glove box lamp, on the other hand, is so easy to get to that it would be far easier to test it first.

In most cases, you will want to have the device you are testing out of the car, and on your work bench. To do this, you will need to have access to either a battery or a 12 volt power supply, and a set of test leads. In general, the test procedure involves connecting the device to the battery or power supply with the test leads, observing polarity if needed, and observing the operation of the device.

For the most part, polarity is not of concern, as most items on our Triumphs function perfectly well with either polarity. Off hand, I can't think of anything that came stock from the factory (alternator and radio excluded) that won't operate just as well with reverse polarity (although some of the motors will run backwards if the incorrect polarity is used). By the same token, it is just as easy to ensure correct polarity that you may as well do it and be on the safe side. Electric fuel pumps, as an example, are not in general polarity sensitive, but they may well have point protection diodes installed which will be destroyed by the application of reverse power polarity.

When testing light bulbs, a fused test lead is not really required, as light bulbs rarely, if ever, fail in the short circuit condition. For other devices, such as motors and fuel pumps, it is a good idea to use a fuse, as these can fail in a short circuit condition. If the power supply you are using isn't adequately fused, or if you are using a battery, you should use a fused test lead for motors (or any other device if you are not sure).

Most items on the car can be tested on the bench, with the exception of the ignition system. There are some tests you can make on the ignition coil and the condenser, but a thorough test will require testing in operation. Details for testing these items will be covered in chapter 20, Ignition Systems.

5. Return path (grounds)

Probably the most common, and most vexing, problems encountered with automotive electrical systems are faulty grounds. Perhaps the easiest way to locate ground problems is by the process of elimination - if everything else is OK, it must be a ground problem. There are, though, three tests you can make if you believe everything else is OK, and prefer to go directly to the ground problem:

a) Power bypass: if you know, or at least are reasonably sure, that the non-working device is good, you might try to bypass the rest of the circuit with a jumper directly from the battery. If the device is good, but still doesn't work, you can be pretty sure the ground connection is bad.

b) Ground bypass. In this test, just jumper from the ground terminal of the device directly to ground, using one of your test leads. If you have a good contact to the ground terminal of the device and to chassis ground, and the device then works, you can be sure your problem is a bad ground connection.

c) “Shotgun” approach: in this approach, just assume the ground connection is bad, and go ahead and fix it. Even if the ground connection is not bad, there is a good chance that it is going bad, and will cause problems later on anyway, so go ahead and clean all the contacts, terminals, etc, in the ground path as insurance. If this doesn’t fix the problem, you haven’t wasted your time, and you now know, at least, where the problem isn’t!

CAVEAT

In the tests above for a current path and for control devices, it was assumed that these would either be good, or they would be bad. In reality, it is not all that black and white. Most of the time, the real world condition will be somewhere in between these two extreme. You might find that one of your connectors, while still being functional and conducting current, has a very high resistance. In your testing, you might find that you do indeed have voltage throughout the circuit, and still have problems. This is covered in detail in chapter 3, Bad Grounds & Bad Connections.

SNEAK CIRCUITS

As you are doing your testing, particularly when using test leads to jumper directly from the battery to various points in the circuit, great care should be taken to avoid sneak circuits, or at least to be aware of them and know the potential problems they may cause. A “sneak” circuit is a circuit configuration that allows current to go where it isn’t wanted, usually an unexpected condition. Refer to **figure 4**, below left, for details.

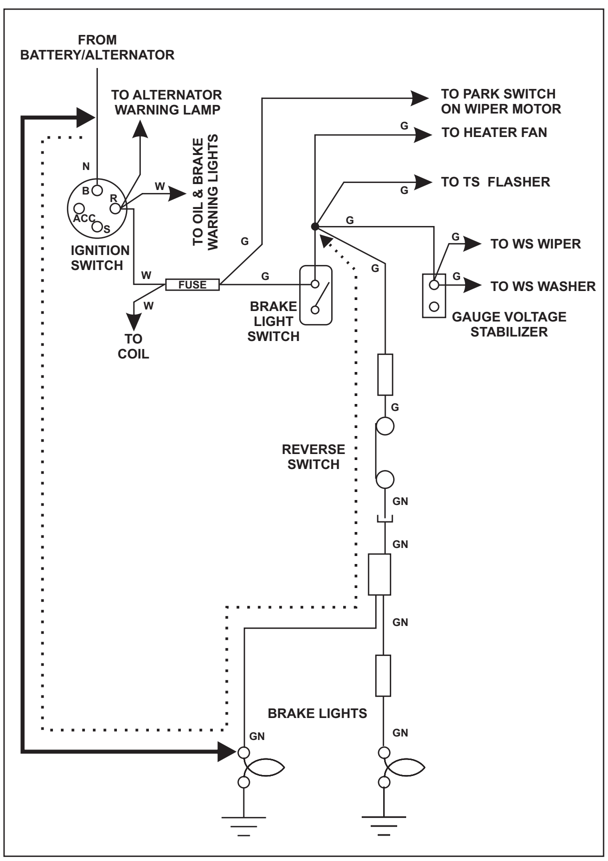



FIGURE 4

This figure shows the reverse light circuit and the power distribution portion of the “green” wire circuit in an early TR6. The heavy line to the left, with arrow heads on each end, represents a test lead used to jumper from the battery to one of the reverse lamps, as you might do for circuit testing. If the transmission should happen to be in reverse gear when you do this, you will create a potential circuit overload by the test lead. As shown by the dotted line, current will flow from the battery, through the test lead to the lamp, and from the lamp back up to the junction of the reverse lamp circuit to the rest of the green wire circuit. Any and all green wire loads that should happen to be on when you do this will now be powered through the test lead, including the ignition coil.

If your test lead is large enough to handle the current, there will be no problem with it, but you could get a nasty surprise if you should happen to have one of the other loads disconnected, and its power feed should be touching ground. In most cases, there will be no serious problem, but the potential exists for trouble, and it can often cause misleading results. Or, if a component should suddenly start working, you might be led to believe you have a short in the wiring somewhere. Electrical troubleshooting is confusing enough as it is, so review the schematics carefully before proceeding.

CONTINUITY TESTS

As mentioned earlier, continuity test can be very misleading. Refer to **figure 5** below for details.

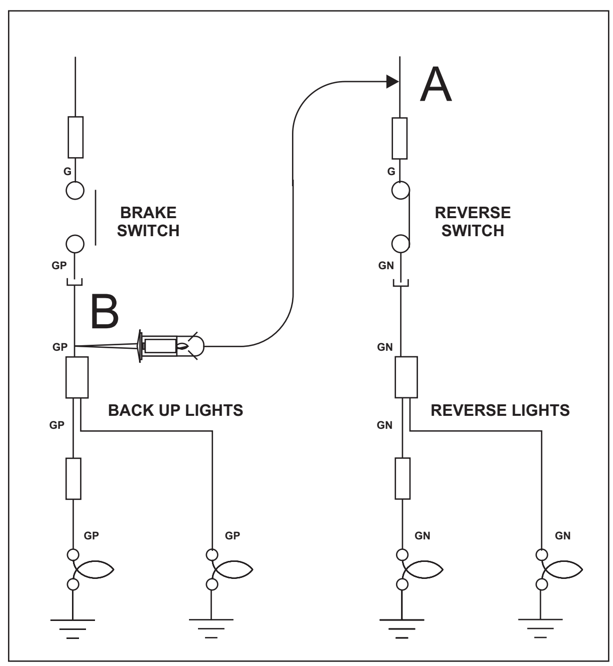



FIGURE 5

In this diagram, I have shown a battery operated continuity checker connected between points identifies as A and B. The two circuits, brake and reverse lamps, should be completely isolated from each other, and the continuity lamp should not light. However, because the lamp in the tester is a very small wattage (around ¼ W), much smaller than the other lamps (21W), there will be enough current flow in the circuit to cause the small test lamp to light, without the other bulbs being lit.

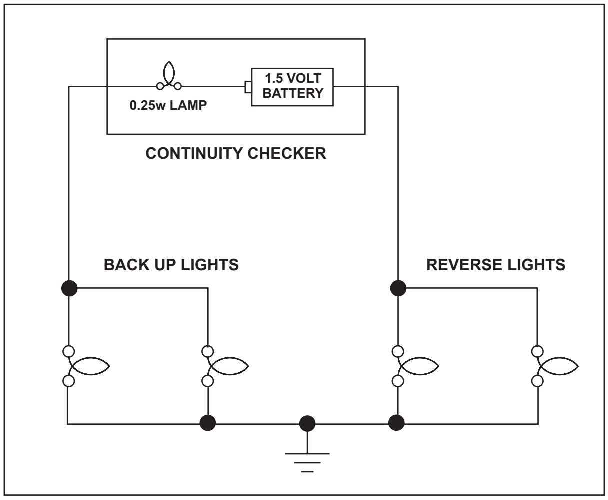



FIGURE 6

To illustrate this a little better, I have redrawn figure 5 as **figure 6**, above. If you do the numbers, using the formulas given in chapter 1, you will find that the current flow through the test lamp is about 0.10A, or about 60% of its rated current flow of 0.17A. This is enough to make the bulb glow, but not at full brilliance. Unless you are looking closely, you might not notice the difference. A current flow of 0.10A, split between the two bulbs in parallel in each circuit, 0.05A each, amounts to less than 2% of rated current for them, so they will not be lit at all.

In theory, that is. In reality, it's even worse. Using wattage and voltage to find the resistance of a bulb will give you the "hot" resistance value. When cold, a light bulb has much less resistance than when it is hot. In actuality, then, the test lamp might see as much as 80, 90 % or more of its rated current, as the brake and reverse lamps would not get hot enough to have more than a very small resistance. You would have to have pretty good eyes indeed to spot this small difference. Using the ohms scale on an in-expensive multi meter (and I recommend you use an inexpensive meter), the resistance of the lamps might not show up at all. The resistance of the bulbs might well be so small as to get lost in the inaccuracies of the meter. With many in-expensive meters, resistance values less than several ohms show up as zero, especially if the meter hasn't been re-calibrated recently for the ohms scale.

If you wish to make a continuity test, you must make sure that the circuit you are testing is ***completely*** isolated from other circuits. When done properly, these tests can be very valuable, but if improperly done, they can send you on a wild goose chase, looking for problems that don't exist. Goodness knows, there are enough real problems to attend to without any imagined problems.

GENERAL PRECAUTIONS

1. ALWAYS remove the negative lead from the battery when performing electrical work, unless the battery is needed for voltage or operational checks. Regardless of how careful you are, sooner or later you will create a short to ground, with a great potential for serious damage to the wiring. In fact, it is a good idea to remove the negative lead from the battery when doing ANY work under the hood, or any other work that might create a situation where your tools or equipment might accidently come into contact with a terminal or connector. The most common cause of fuses blowing is accidental contact with a tool, or with a part being removed or replaced.

2. When making voltage or operational tests that require the ignition key to be on for an extended length of time, it is a good idea to disconnect the white or the white/yellow wire from the ignition coil. If the points should just happen to be slightly open, there is a potential for damage from a mild arcing that can occur. Fully open or fully closed, no problem, but if just slightly open arcing can occur. In a short time, no damage will be done, but over a long time period, the points can pit. If the points are closed for a long time, the coil can overheat.

3. When making voltage checks, unless stated otherwise, there is no need to remove the wire from the terminal you are checking. When making temporary ground connections for testing, unless told otherwise, the existing ground wire can be left in place.

TROUBLESHOOTING PROCEDURES

In some of the following chapters, I have included detailed step-by-step procedures for troubleshooting various circuits, along with flow charts. Don't be dismayed if you get to the end of the procedure and the circuit still doesn't work - most likely, you had more than one problem. Just go back to step one and start over. Your procedure will follow a different path this time, but the path should lead to a satisfactory conclusion (unless of course, you had 3 problems!)

# 3
# BAD CONNECTIONS & BAD GROUNDS

Probably nothing in the electrical system causes more grief and trouble than bad grounds and/or bad connections. One of the best things you can do during the process of restoration is to thoroughly clean/repair/replace all connectors and grounds. Doing this up front, before you actually get into doing electrical restoration, can often make it unnecessary to do any further trouble shooting. Amazingly, things just might work right the first time!

BAD CONNECTIONS

In the left hand side of **figure 1**, below, I have recreated one of the series circuits from figure 8 of chapter one. In this circuit, a 5W lamp has been placed in series with a 65W headlamp bulb.

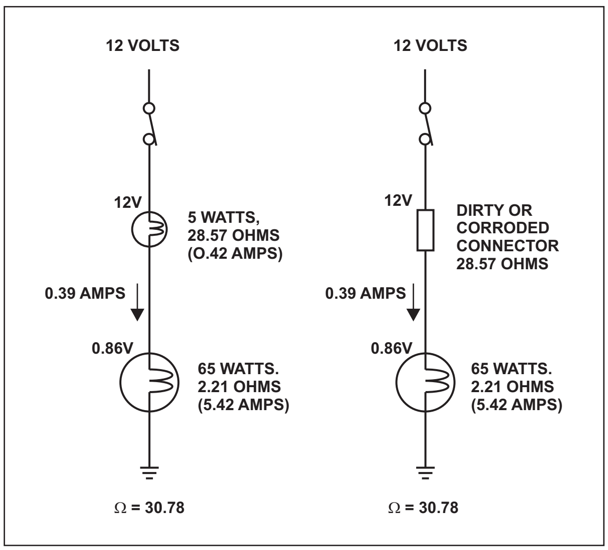



FIGURE 1

If you will recall from chapter 1, the 5W bulb limits the current in the circuit to 0.39A - enough to light the smaller bulb, but not the headlight. On the left side of **figure 1**, I have replaced the small bulb with a bad connector, which just happens to have, to make comparisons easier, exactly the same resistance as the small bulb, or 28.57Ω. The resistance of this bad connector will have exactly the same effect as the small bulb. It will limit the current in the circuit to 0.39A just as the bulb did. This current flowing through the connector will produce the same wattage in the connector, in the form of heat, as it did in the small bulb.

The connector will get quite warm to the touch, but the headlight will not be lit. Looking for a warm connection is one of the ways to find bad connections. Bad connections are one of the ways in which fires start. It can generate enough heat to melt insulation, and if it's bad enough, can actually cause the insulation and/or surrounding material to ignite.

Bad connections can throw off the results of your trouble shooting efforts as well. **Figures 2** and **3**, below, illustrates the potential problems bad connections can cause.

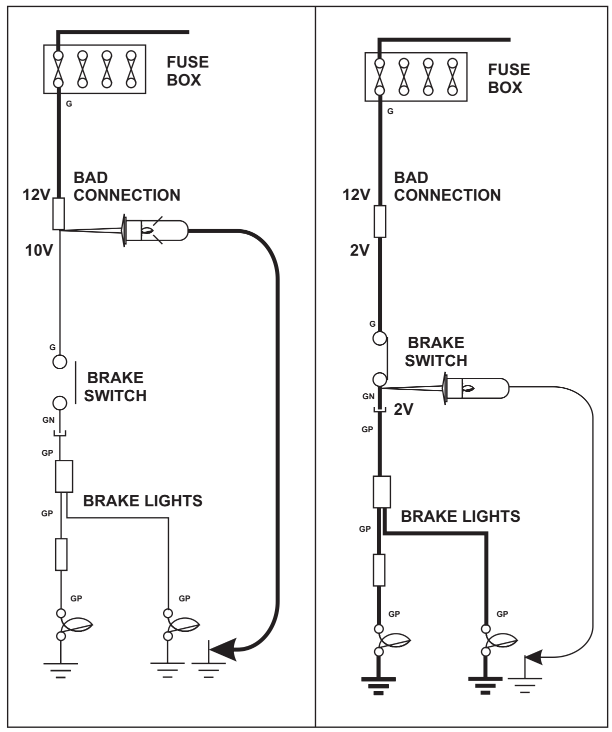



FIGURE 2

In these examples, assume the resistance of the bad connection is 5 times the resistance of the combined cold resistance of the two bulbs in parallel, and 1/5 the resistance of the test lamp - a very reasonable set of parameters.

In the circuit on the left of **figure 2**, with the brake light switch open, the test lamp forms a series circuit with the bad connector, just like the series circuit on the right of **figure 1**. With a resistance ratio of 5:1, voltage in the circuit will be divided in the same ratio - two volts will be dropped across the bad connector, and the remaining ten volts will be dropped across the test lamp. Ten volts is enough to light the test lamp to near full brilliance, at least near enough that the difference wouldn't be readily apparent to an observer.

In the circuit on the right, the brake switch has been depressed, placing the parallel combination of the two brake lights and the test light in series with the bad connector. The test lamp, having 25 times the resistance of the brake lights, changes the overall resistance of the lights by very little, so we still have an approximate 5:1 ratio of resistance between the lights and the bad connector. In this case, though, as compared to the situation on the left, the bad connection has the highest resistance, so it will drop the most voltage. This gives a 10 volt drop across the bad connector, and the remaining two volts are dropped across the lamps. Two volts are not enough to operate the test lamp, giving the impression that the brake switch is faulty, when in reality, it is perfectly good.

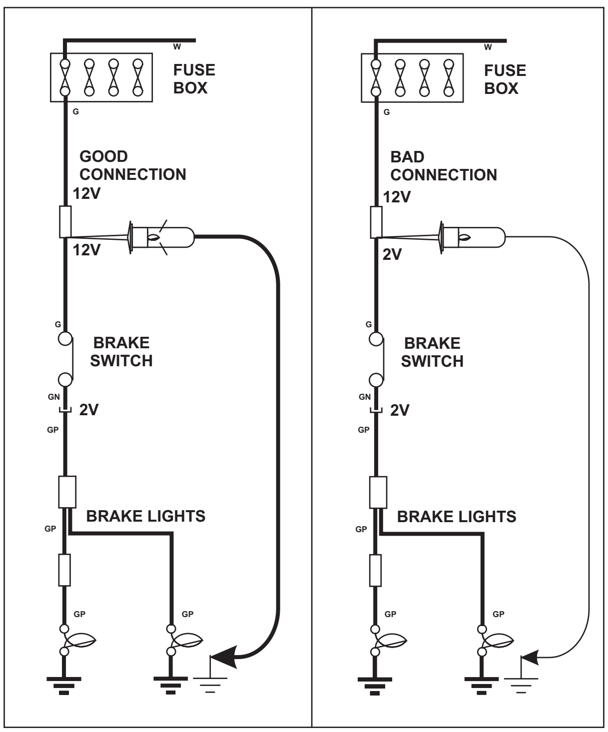



FIGURE 3

There are a couple of things you can do to help prevent obtaining misleading results:

1. Always check both sides of any connector or switch you are testing. As shown in **figure 3**, if they are good, the voltage will be the same on both sides of the item. If you have a significant noticeable difference, the connector or switch should probably be replaced or repaired. Replacement or repair is most definitely called for if the difference is near one volt or more.

2. If you can, try to have the circuit in operation, or at least as much in operation as possible, given that the circuit is probably not working or you wouldn't be testing it in the first place. Put the switch in the "ON" position at least, so the circuit will draw as much of it's normal current as it can.

BAD GROUNDS

Bad grounds can create pretty much the same type of problems as bad connections, plus they can create some pretty weird and hard to diagnose problems. For an example of a typical "bad ground" type problem, refer to **figure 4**, below. This figure is just a redraw of **figure 1**, but I have reversed the order of the components in the circuits. On the left, I have placed the smaller bulb at the bottom of the circuit, near the ground connection.

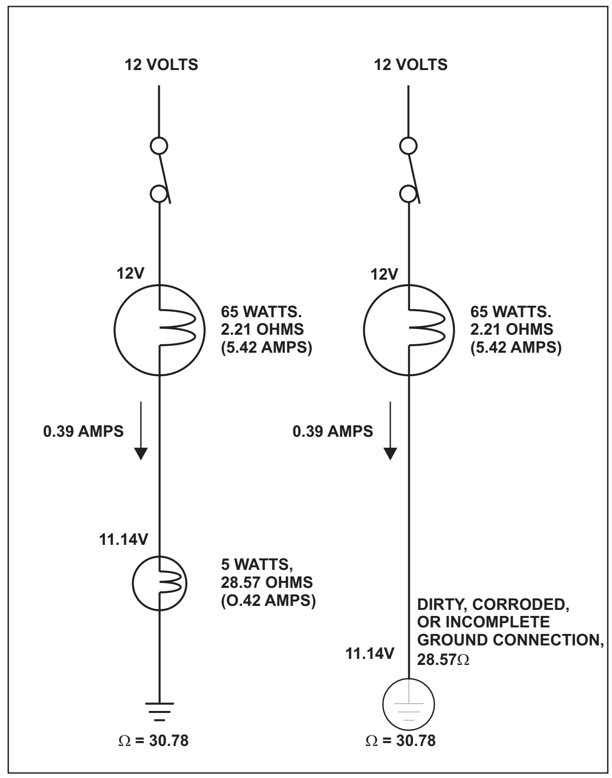



FIGURE 4

The total circuit current is the same as before, as are the voltage drops across the two bulbs. Because the bulbs are reversed, so is the relative circuit voltages. The large bulb still drops 0.86 volts as before, leaving 11.14 for the smaller bulb, just as before; however, instead of reading 0.86 volts on the wiring between the two bulbs, we now read the 11.14V of the smaller bulb (larger resistance).

On the right, I have replaced the smaller bulb with a "bad ground" of the same resistance as the original bulb. This bad ground reduces the circuit current just the same as the small bulb did, and will produce the same 5 watts of heat that the bulb did. This gives a clue as to one of the ways of finding a bad ground connection: a voltmeter placed in the circuit near the ground connection should read zero volts. If it reads more than that, the ground connection is bad. The higher the voltage reading, the worse the ground connection.

WEIRD THINGS

As stated earlier, bad grounds can cause some pretty weird problems. For an example of this, take a look at the three figures below. In **figure 5**, I have drawn a very simplified version of the combined brake and tail light circuit, leaving out some of the bulbs. The bulbs used for these functions are dual filament bulbs, each having one 5W element and one 21 watt element. The brake light uses the 21W, and the tail light uses the 5W. Both elements share the same ground connection internal to the bulb. With every thing working as it should, and the parking lights are switched on, the parking lights come on full, as shown by the heavy lines in **figure 5**.

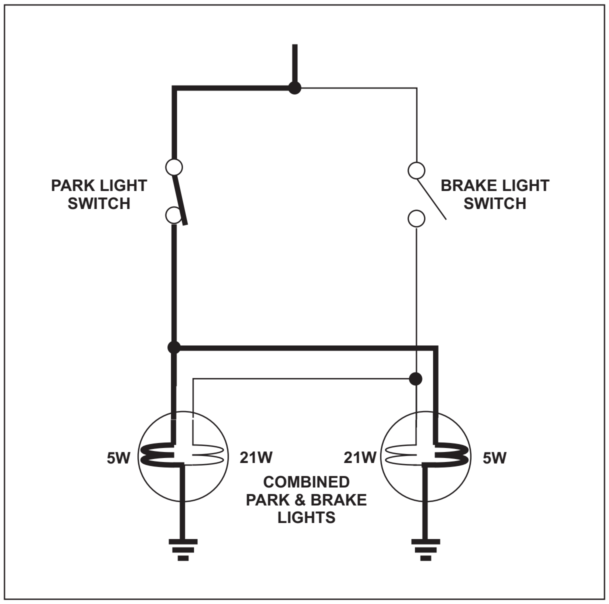



FIGURE 5

**Figure 6** shows the condition where the ground connection to the left hand bulb is missing. In this case, the right hand bulb lights as normal, but the two 21W elements (RH and LH bulbs) are now in series with the 5W element of the RH bulb. These three series connected elements are now in parallel with the 5W element of the RH bulb. With 12 volts applied to the series combination, the current is reduced through the series elements, and the voltage applied to each is split, according to the relative resistance of the bulbs. If you do the numbers (using hot resistance values), you'll find that the current through the three elements is about 70% of the rated value for the parking light element. Given that the same current is only about 16% of rated current for the 21W elements, they will not get enough current to heat up, let alone illuminate. Therefore, the 5W element will get a good bit more than 70%, probably in the neighborhood of 85 - 95%, of rated current, so it will be lit to near full intensity (the cold resistance of the 21W elements being much less than the hot resistance, more current will flow than originally calculated using hot resistance values). The end result is that the parking lights will appear to be normal, even though one ground connection is missing.

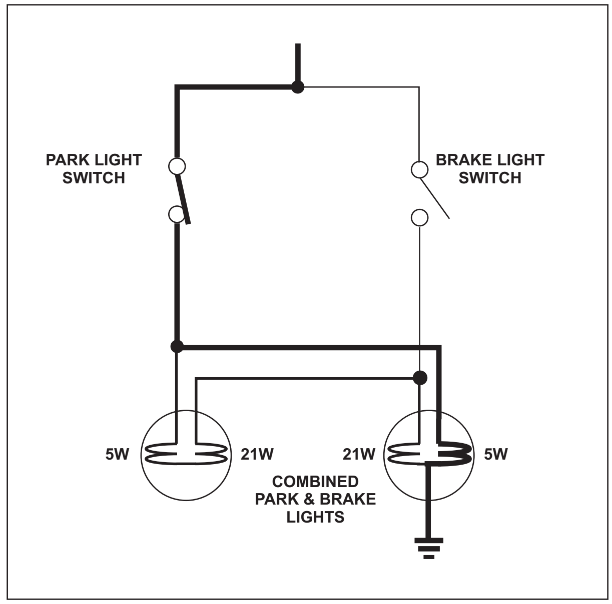



FIGURE 6

Now take a look at **figure 7**. In this figure, the brake light switch has been closed. As you can see, this places 12 volts on both sides of the LH bulb, as well as on the 21W element of the RH bulb. With 12 volts on both sides, and no ground, the LH bulb goes completely out - neither element is lit - while both elements on the right work as they should. This is certainly an oddity - turning on a switch causes a light to go ***OUT?*** Like I said, bad ground connections can cause some very funny things to happen.

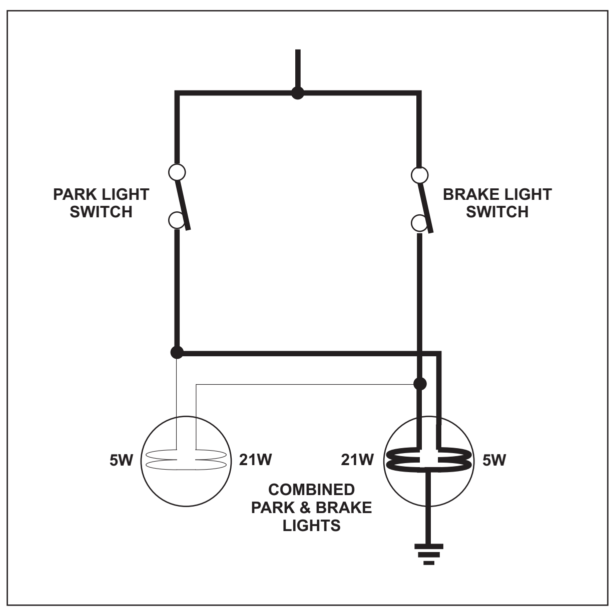



FIGURE 7

# 4
# ALTERNATOR OPERATION

ALTERNATOR WARNING LIGHT

"What does that little red light that says ALT mean when it comes on?" Very basically, it means that either the alternator output voltage is lower than the battery voltage, or the battery voltage is lower than the alternator output. If the light gets dimmer as you rev up the engine, then you most likely have a problem with the alternator. If it gets brighter, then the battery is most likely bad.

That's all well and good, but just exactly what does all that mean? To get a good idea, it is first necessary to understand how an alternator works. You don't need an engineering degree, just a basic understanding of the general principles. **Figure 1**, below, is a block diagram, or a "functional" diagram, of a “generic” alternator, and its connections to the remainder of the automobile electrical system. Following the figure is a description of the various components that make up an alternator, and a description of how each functions to keep the battery charged in your car.

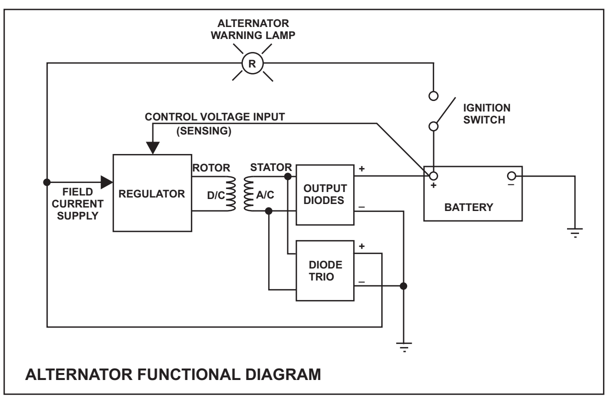



FIGURE 1

ROTOR

We'll start our tour of the alternator where it all starts in the alternator itself - at the rotor. The rotor consists of a coil of wire wrapped around an iron core. Current through the wire coil - called "field" current - produces a magnetic field around the core. The strength of the field current is controlled by the regulator, and the field current strength determines the strength of the magnetic field. The field current is D/C, or direct current. In other words, the current flows in one direction only. This field current is supplied to the wire coil by a set of brushes and slip rings. The magnetic field produced has, as any magnet, a north and a south pole. The rotor is driven by the alternator pulley, rotating as the engine runs, hence the name "rotor."

STATOR

Surrounding the rotor is another set of coils, three in number, called the stator. The stator is fixed to the shell of the alternator, and does not turn. As the rotor turns within the stator windings, the magnetic field of the rotor sweeps through the stator windings, producing an electrical current in the windings. Because of the rotation of the rotor, an alternating current is produced. As, for example, the north pole of the magnetic field approaches one of the stator windings, there is little coupling taking place, and a weak current is produced, As the rotation continues, the magnetic field moves to the center of the winding, where maximum coupling takes place, and the induced current is at its peak. As the rotation continues to the point that the magnetic field is leaving the stator winding, the induced current is small. By this time, the south pole is approaching the winding, producing a weak current in the opposite direction. As this continues, the current produced in each winding, plotted against the angle of rotation of the rotor, has the form shown in **figure 2**. The three stator windings are spaced inside the alternator 120 degrees apart, producing three separate sets, or "phases," of output voltages, spaced 120 degrees apart, as shown in **figure 3**.

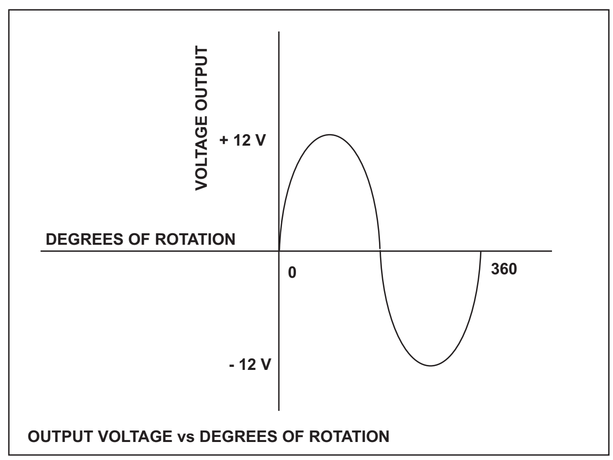



FIGURE 2

OUTPUT DIODES

A/C voltage is of little use in a D/C system, such as used in an automobile, so it has to be converted to D/C before it can be used. This conversion to D/C takes place in the "output diodes" and the "diode trio." Diodes have the property of allowing current to flow in only one direction, while blocking current flow in the other direction. The output diodes consists of six diodes, one pair for each winding. One of the pair is for the negative half cycle, and the other for the positive half cycle. As a result of this diode rectification, the output of the alternator looks as shown in **figure 4**.

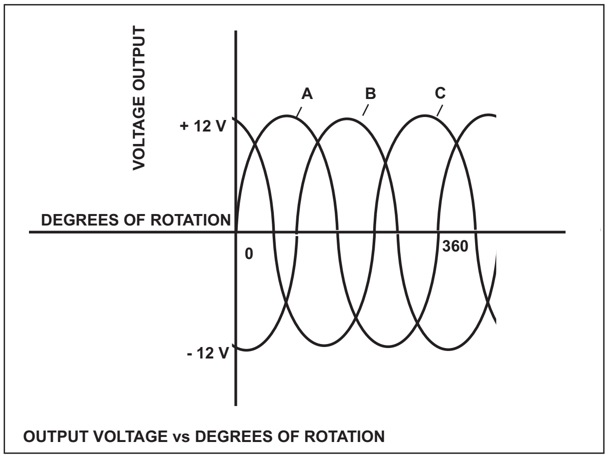



FIGURE 3

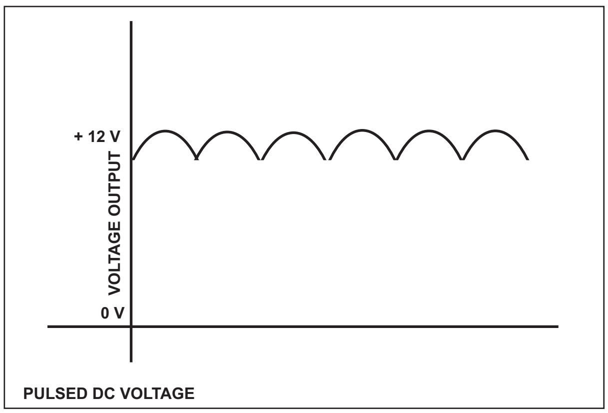



FIGURE 4

Surprisingly enough, the output of the alternator is not a pure D/C as one might expect, but a pulsating D/C. Because there are three windings, each with a positive and a negative half, by the time the voltage is passed through the diodes, there are six pulsations for each rotation of the rotor. This is close enough to D/C for most automotive components. Critical components, such as radios, have their own internal filtering circuits to further smooth out the waveform to a purer D/C.

DIODE TRIO

The diode trio consists, as the name suggests, of three diodes, one per phase, which provides field current to the alternator regulator. This output will be discussed in more detail later in the "field current" section.

REGULATOR

The regulator has two inputs and one output. The inputs are the field current supply and the control voltage input, and the output is the field current to the rotor. The regulator uses the control voltage input to control the amount of field current input that is allowed to pass through to the rotor winding. If the battery voltage drops, the regulator senses this, by means of the connection to the battery, and allows more of the field current input to reach the rotor, which increases the magnetic field strength, which ultimately increases the voltage output of the alternator. Conversely, if the battery voltage goes up, less field current goes through the rotor windings, and the output voltage is reduced.

FIELD CURRENT SUPPLY

Field current supply is provided from two different sources - from the alternator itself, via the diode trio, and from the battery, via the alternator warning lamp. When you first get in the car and turn the key on, the engine is not running and the alternator is not spinning. At this time, the voltage/current source for the field current is from the battery, through the ignition switch, and throught the warning lamp. After the engine is started, and the alternator is up to speed, the output of the diode trio is fed back to the regulator, and serves as a source of current for the field current. At this time, the alternator is self sustaining, and the battery is no longer needed to power the automobiles electrical system. !!!WARNING!!! This is theoretical only - in actual practice, the voltage surges resulting from disconnecting the battery can seriously damage the regulator circuitry. All alternator manufacturers strongly advise NOT doing this!!!

WARNING LAMP

This brings us back full circle to the starting point - the alternator warning lamp. As can be seen from **figure 5**, a simplified Lucas schematic, there is a path to ground from the field current supply input [1] to the regulator.

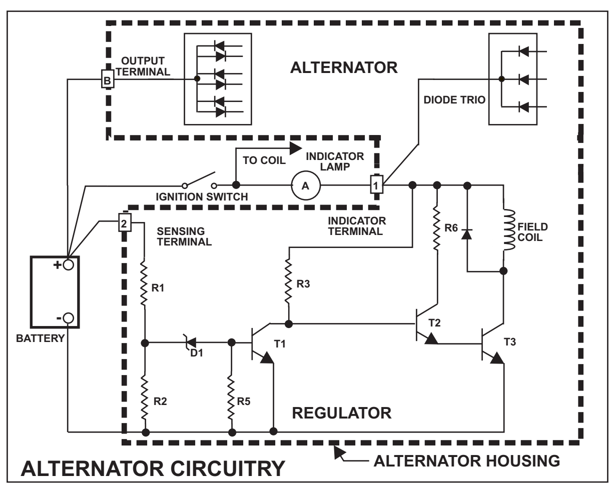



FIGURE 5

As a result, when the key is turned on, current flows through the warning lamp, through the resisters, transistors, field coil, and then to ground, causing the lamp to illuminate. Once the alternator is at full output, voltage from the diode trio, applied to [1] also, equals the battery voltage. At this time, with 12 volts on both sides, the lamp is out.

If the alternator should fail, voltage from the diode trio would drop, and once again the lamp would light from the battery voltage. If the alternator output is only a little low, the lamp will be dimly lit. If the alternator fails completely, and the output voltage goes to zero, the lamp will be lit at full brilliance. Conversely, if the battery should fail, and the battery voltage drops, with the output voltage of the alternator on one side and the low battery voltage on the other, the lamp will also light.

As stated earlier, if the light grows dimmer as the engine is rev'd up, it is because the alternator voltage is rising with the RPM, producing more voltage on the alternator side of the lamp. The closer the output voltage gets to the battery voltage, the dimmer the bulb becomes. By the same way, if the light gets brighter with increasing RPM, it is because as the alternator voltage increases, it is getting higher than the battery voltage. The higher the voltage with respect to the battery voltage, the greater the voltage difference across the lamp, and the brighter it gets.

Note that the warning light actually serves two functions: one, as a warning that something is amiss, and two, it provides the initial field current. Theoretically, not having a permanent magnet like the old generators had, an alternator cannot operate without this initial filed current, and thus cannot operate without a battery. In most cases, the theory holds true, but not always. Sometimes, the internal iron in the alternator can become magnetized enough to supply a very small magnetic field without the field current. If the magnetism is large enough, a small output current will be generated, creating a small field current, which will increase the magnetic field, producing more field current, and so on, until the alternator is fully functional.

REGULATOR CIRCUIT OPERATION

The first thing to keep in mind as you study the circuit diagram in **figure 5**, and it's not at all obvious from the circuit diagram, is that the circuit is NOT a linear analog circuit, rather it is an "on-off" circuit. When the system voltage exceeds the set point, the field current is cut off. When the voltage drops below set point, the field current is turned back on. If you look at a trace of the field current, it is a square wave, very much like the output of the old relay type regulators.

The field current is controlled by transistor pair T2 and T3. These transistors are biased by R3, R5, and R6, which sets the amount of current through the field windings. When these transistors are on, battery voltage, applied via terminal 2, determines the bias. This provides some degree of regulation, but is not the main source of regulation.

The main source of regulation are the components on the left side of the diagram, R1, R2, D1, and T1. D1 is a zener, and R1/R2 form a voltage divider network. When the voltage at the junction of D1, R1, and R2 exceeds the breakdown voltage of the zener, T1 will conduct. There is no emitter resistance, so the collector voltage on T1 goes to near ground. The collector of T1 is tied to the base of T2. With near ground on the collector of T1, T2 will be off, which puts the emitter of T2 near ground as well. The emitter of T2 is connected to the base of T3, which will now be near ground. With near ground on the base of T3, T3 is also off, so the field current is off.

When the voltage drops again, D1 will be reverse biased, and below its breakdown voltage, so T1 will be off. With T1 off, the base of T2 sees near battery voltage, dropped through R3. With near battery voltage on the base of T2 it will be on, turning T3 on as well, and the field current will also be turned back on.

This operation is continuous, at a very rapid rate, and it is the ratio of ON to OFF that regulates the charging voltage and/or current. The ON-OFF cycles are very rapid, and, given the nature of the components used in an automobile, this pulsing voltage works just as well as a steady voltage. The average, or effective, voltage is regulated to be the required 14.6 volts.

SUMMATION

In summary, then, we can say that field current through the rotor coils produces a magnetic field, which is coupled over to the stator coils, producing an AC voltage. This AC voltage is converted by the output diodes into pulsating DC voltage, which charges the battery.

The field current is supplied from either the battery, via the warning lamp, or from the diode trio. The amount of field current allowed to pass through the regulator to the rotor, or field coil, is controlled by the voltage feedback from the battery.

And there you have it - the complete operation of an alternator in a nutshell. The next time you see the little red light, you will know exactly what it is trying to tell you.

# 5
# BATTERIES AND BATTERY CHARGING

BATTERIES AND BATTERY CHARGING CONCERNS

I'm not a battery expert, but I'd like to offer a few observations concerning battery charging and chargers. These comments are based on simple observations, and I think they can be of some help in trying to deal with your battery while your car is laid up, either for restoration, service, or for the winter season.

GENERAL OBSERVATIONS

A good battery, with a full charge, produces 12.6 volts. An alternator is regulated to produce a steady 14.6 volts under all conditions, within it's capacity. If the load on the alternator increases, the internal regulator increases the field current to maintain the 14.6 volt output. With 12.6 volts from the battery and 14.6 volts from the alternator, all of the automobile's electrical loads are being supplied by the alternator. The battery cannot supply current as long as it is being fed from a higher voltage source.

On a long trip, such as the ones I take on a regular basis of 15-16 hours duration, the battery is constantly being fed the 14.6 volts from the alternator. No harm is done to the battery by this constant higher voltage. The only time the battery ever supplies current on these trips is when I start the car after refueling and eating -- about five times total. I don't believe the battery would be harmed by this if I drove the car 24 hours a day, seven days a week, for weeks at a time, without ever restarting the car. It doesn't seem to be a problem for long haul tractor/trailer rigs. As a rule, the drivers of these rigs never shut the engine off unless they are going to be parked for a long spell, often even running the engine during an overnight stay

An ideal battery has zero internal resistance. A real battery has two types of resistance -- resistance to charging current, and resistance to discharge current. On a fully charged battery, the resistance to charging current is high, and the resistance to discharge current is low. On a weak, or discharged, battery, the opposite situation exists -- the resistance to charging current is low, and the resistance to discharge current is high.

I have a heavy duty battery charger (60 amps charge, 240 amp boost). The only components in the charger are a transformer with a multi-tap primary, a rectifier, a switch, an ammeter, and a timer. The switch has three positions-- slow charge, fast charge, and boost. The only difference in the three positions is the tap on the primary of the transformer, which changes the output voltage of the secondary. There is no regulation whatever.

When I connect the charger to a very flat battery, the ammeter shows an initial charge current of up to 60 amps. As the battery charges, the charging current slowly tapers off to a minimum value, on the order of 10 amps. On the slow setting, the output voltage is 13.4 V; on the fast setting, it is 14.8 V; and on the boost setting, it is 17.6 V. These measurements were made with no load. I haven't measured the voltage when it is charging a flat battery at 60 amps, but I'm certain the voltage goes down from the heavy loading. The label on the unit states that the output voltage drops to 7 volts at the full 240 amp output.

Given the above, it appears that the battery itself provides a degree of regulation of the charging current, for a given charging voltage. A constant charging voltage, whether in storage on in operation, of 14.6 volts will maintain a full charge without any damage to the battery. I don't know if the battery needs to be used occasionally or not, but I don't think so. Not as long as it maintains a full charge. I would think that a power supply, set to deliver 13.5 V or so, would do the job of maintaining a battery for long term storage. Just for "feel good" until better information is available, you might want to rig up the charger setup with a switch so that you could shut it off, and connect the battery to a load for a short period of time. You would only need to do this on occasion, just whenever you happened to think of it. (I don't believe that is necessary, but I'm not a battery expert, so I can't be sure).

As a point of reference, at our nuclear power plants (at the Tennessee Valley Authority), we maintain the equivalent of 13.5 volts on our batteries at all times, with an equalizing voltage of 13.98 applied on a periodic basis. I say "the equivalent" because our batteries are either 125 volts or 250 volts, and consist of multiple 12 volt batteries, very similar to car batteries, arranged in series/parallel as required to produce the needed voltage and current capability. Because of the large number of cells involved, and the fact that they are arranged in parallel, it is necessary to equalize the charge on these battery setups. Because these batteries are used to perform safety functions, they are tested on a very frequent basis, so the need for discharging on occasion is never addressed -- they are automatically discharged as part of the testing.

Not directly related to charging, but of interest none the less, is the internal resistance to discharge current. A fully charged battery has a terminal voltage of 12.6 V, whereas a very flat battery has a terminal voltage of about 11.6 V. The difference of one volt is not enough to cause real problems in an automobile. The problem stems from the high internal resistance of the flat battery. When you measure the voltage, the meter has very little current draw (compared to the typical battery load, it is virtually zero), so no voltage is dropped over the internal resistance, and the terminal voltage stays high. When a heavy load is placed on the battery, the high current draw causes a large voltage drop on the internal resistance, reducing the terminal voltage to a very low value. The low voltage, combined with the high circuit resistance, is what causes the starter to groan rather than spin the engine. To get a true measure of a battery's condition using a voltmeter, it is necessary to load it heavily, heavily enough to get a voltage drop across the internal resistance.

As an aid to understanding the above, consider the batteries used in portable radios. The next time you have a 9 volt radio battery go flat, replace it with a good 6 V battery, just as an experiment. You will find that it will work just fine, although the volume won't be as high. What happens when a 9 volt battery goes flat is the same as what happens when a car battery goes flat -- the internal resistance goes up. This internal resistance causes distortion. When the radio is playing a loud passage, the high current causes a voltage drop across the internal resistance, dropping the output voltage of the battery, and, in effect, turning down the volume. Conversely, on soft passages, the voltage drop is not as pronounced, and the battery voltage goes up, cranking up the volume. Turning down the loud sounds and turning up the low ones is not the way to enjoy music! Replacing the 9 volt with a good 6 volt cures the problem, as the internal resistance is still quite low. On any radio, when the volume is turned up to the point that the battery can't keep up, you get distortion. Operating a 9 volt radio with a 6 volt battery will lower the volume at which this distortion occurs.

## BATTERY TESTING

For the most part, I don’t think it is worth the trouble to test your battery at home, as most battery dealers will test it for you at no charge. They have the necessary equipment to test it properly, and, should the battery turn out to be bad, you can have a new one installed on the spot.

If you should desire to test it yourself, there are two ways to do it. The first is with a hydrometer. The simplest hydrometer consists of a clear, hollow tube, containing a smaller cylindrically shaped glass float, . The chemical makeup of battery acid varies with its charge, and this variation in chemical makeup causes a variation in the specific gravity of the acid. The higher the battery charge, the higher the specific gravity. When the hydrometer is filled with battery acid, the float will be higher or lower in the tube depending on the acid’s specific gravity. By reading the float marking that matches the acid level, the charge condition can be determined.

A fully charged battery will give a reading of 1260, indicating a specific gravity of 1.26, while a discharged battery will give a reading of 1070, indicating a specific gravity of 1.07. Temperature also affects the specific gravity of the acid, so compensation must be made for this. Using 80°F as a reference, add four points to the reading for each 10°F above, and subtract 4 points for each 10° below.

The second method for testing at home is to measure the battery voltage. Under no load conditions, a battery with a full charge will read 12.6 volts, while a completely discharged battery will read 11.64 volts. Just as with using a hydrometer, there are other variables that will effect the voltage readings. If the battery has just been charged, the voltage will be higher; conversely, if it has just been supplying a heavy load, the voltage will be lower. The amount of the voltage differences will depend on how heavy the charge or discharge current was, so no hard and fast conversion factors can be given.

# 6
# DWELL vs POINT GAP

WHAT IS DWELL ANGLE?

The question is often asked, how does one calculate dwell angle from the manufacturers specification for point gap? Actually, it is the other way around - point gap is derived from the requirements for dwell angle. Because, in "the good old days," most mechanics didn't have dwell meters, the dwell angle was expressed in terms of point gap. Any competent mechanic had a set of feeler gauges. To understand the relationship between point gap and dwell, consider the operation of the 4-stroke internal combustion engine, using the Kittering ignition system, as used in nearly all Austin-Healeys, Triumphs, MGs, etc.

For each complete combustion cycle, i.e., two revolutions of the crank, the distributor rotor makes one revolution, or 360 degrees. During this 360 degrees of rotation, each cylinder receives one spark. For a six cylinder engine, there are 60 degrees of distributor rotation between each spark event (360/6 = 60. For a 4 cylinder engine, 90 degrees, and for an eight cylinder, 45 degrees, etc.).

During this 60 degrees of rotation, the points must: open to allow the magnetic field in the primary winding of the coil to collapse, generating a high voltage discharge from the secondary side; remain open long enough for the spark energy to do its work and for the secondary circuit to reach equilibrium; re-close; remain closed long enough to allow the magnetic field to build up in the primary side of the coil again; and then reopen. If the points don't stay closed long enough to build the magnetic field, a weak spark will result. Too long, and the discharge time is reduced, and the coil can over heat (at low RPM).

Dwell, then, is defined as the number of degrees of rotation of the distributor, during which the points remain closed. How is it set? There is only one link between the engine and the points, and that is the rotor button, or cam, on the distributor shaft - how does one set both the timing and the dwell with only one link?

ADJUSTING DWELL ANGLE BY SETTING POINT GAP

The time at which the points open is set by rotating the entire distributor body, and the time at which they close is set by adjusting the gap. The wider the gap, the more the distributor must rotate to get the points to the maximum opening, and the more it must rotate to allow them to close again. Thus, a wider gap leaves the points open for a longer time, or a larger angle of rotation, which reduces the dwell angle, and a smaller gap leaves the points open for a shorter time, which is equivalent to being closed for a longer time, which increases the dwell angle. Larger gap, shorter dwell angle, smaller gap, larger dwell angle.

MEASURING DWELL ANGLE

That's how dwell is set using a set of feeler gauges, but how is it set by using a dwell meter. What is the dwell meter actually measuring? It certainly isn't measuring the actual rotation of the distributor rotor button. Probably the best way to understand that is to make a dwell meter. It is very easy to do, and very cheap as well. **Figure 1**, below, is a simplified diagram of a dwell meter, one that can be very easily made at home. Since a set of points is nothing more than a switch, they have been replaced with a simple ON-OFF switch in the diagram below.

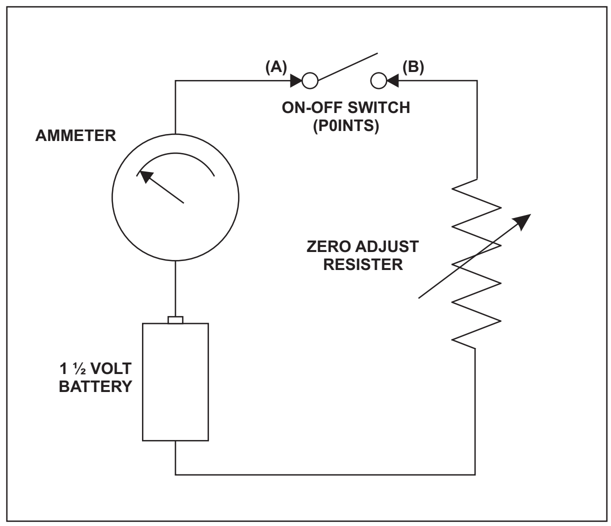



FIGURE 1

There are two extreme conditions of point operation: 1) the points never open, which would be, for a six cylinder engine, the equivalent of 60 degrees of dwell, and 2) the points stay open, which would be the equivalent of zero degrees of dwell. In the circuit above, leaving the switch closed is the same as 1), or 60 degrees, and leaving them open is the same as 2), or zero degrees. With the switch closed, the meter will read full scale (as set by the zero adjust resister), and with the switch open, the meter will read zero.

What if we continuously open and close the switch, having it open 50% of the time, and closed the other 50% of the time. The meter will swing back and forth between zero and full scale. If we open and close the switch fast enough, however, the meter needle will not have time to complete the movement from zero to full scale and back again, but will settle out at half scale. Since full scale is 60 degrees and zero scale is zero degrees, half scale will be equal to 30 degrees. If we change the ratio of closed to open, say closed two thirds of the time and open one third, that would place the needle at the two thirds mark on the scale, which is equal to 45 degrees.

Notice that nothing was said about the units on the meter dial. It doesn't matter if the meter is a 0 - 1 ma, 0 - 5 ma, 0 - 100 ma, or whatever. It is the ratio that counts. To convert the ma. units to degrees of dwell, simply divide the full scale value by the maximum number of degrees of dwell for the engine of concern. If you are using, for example, a 0 - 10 ma meter, on a six cylinder engine, 60/10 = 6. Therefore, each major unit will equal 6 degrees dwell.

Since most meters scales are subdivided, you can divide the total number of marks by the maximum dwell to get the number of degrees dwell per mark. Again, using a six cylinder engine and a 0 - 10 ma meter, with each ma marking further subdivided into four sub-marks, we get 60/(4x10) = 1.5 degrees per mark. By reading between the marks, the meter can be read to less than one degree.

## CONNECTING DWELL METER TO THE POINTS

Now that we have a good understanding of just how a dwell meter works, how is it connected to the ignition system? As usual, the instructions that came with the dwell meter, if you are using a commercial unit, should be followed, but if you are using a home made meter, as shown above, some precautions are in order. Before connecting the dwell meter to the ignition system, the ignition coil should be disconnected from the distributor by removing the wire from the coil minus terminal to the distributor. The lead marked (A) should then be connected to the wire you just removed from the coil minus terminal, and lead (B) should be connected to ground. Actually, you can reverse the connections as well, with no problem, as the ignition points are isolated from the rest of the car by disconnecting the coil lead. Polarity across the points, since they are nothing more than a switch, is immaterial.

## OBTAINING DWELL ANGLE FROM GAP SPECIFICATION

Which brings us back to the original question, how do you determine the dwell angle from the gap specification? Unfortunately, you can't; there are too many variables. The best thing to do is to set the gap one time using a feeler gauge, and then measuring the dwell and recording it. Then, in the future, you can use that number. In general, though, the points are closed for about two thirds of the total angle available, and open the other one third. For a four cylinder engine, this would be a dwell angle of 60 degrees, and 40 degrees for a six cylinder engine. This rule of thumb is akin to the old timer's trick of using a match book cover to set the gap in an emergency, when feeler gauges are not available.

# 7
# FUSES

FUSE EQUIVALENTS

According to the owner's manual, and stamped on a slip of paper inside the fuse itself, the correct fuse rating for a Triumph TR6 is 35 amps. This means if a fuse blows, and I don't have a spare, I can just go to the local auto parts store and pick up a 35 amp fuse from the rack and pop it in the holder, right? WRONG! Never, ever, replace a Lucas 35 amp fuse with a 35-amp fuse of American origin.

Why not? Although there is really not that much difference between the structure of a Lucas and an American fuse, there is a big difference in the way they are rated. Every fuse has a time/current characteristic curve, depending on the type of fuse. Below a certain current, the typical fuse will last indefinitely without blowing. Above a little higher current, the fuse will blow in a few minutes. As the current increases, the time required before the fuse blows is decreased. Above a maximum current for a particular fuse, the time to blow is reduced to near instantaneous. There are other types of fuses, some (fast-blow) designed to blow very quickly if the current exceeds the rating by only a bit, and others (slow-blow) designed to blow over a longer time, even if the current is higher than rated. For an American fuse, a 20 amp fast blow will blow fairly quickly above 20 amps, while a 20 amp slow-blow will take a while at higher amps (not a great while - just long enough to ignore short current spikes). Normally, though, these other types of fuses are available only on special order from electronic supply houses, and not from the local auto parts store.

This gets us then to the rating of the Lucas fuses. According to the Haynes manual for the MGB, the 35 amp Lucas "...fuses are 17 amp current rated, 35 amp blow rated." What does that mean? Well, not being a fuse expert, and not having precise data, I'm going to have to take a guess, but I assume that over a long time period, current "around" 17 amps will blow the fuse, and 35 amps will blow it instantaneously. By comparison, a 35 amp American fuse will handle current very near 35 amps indefinitely. I don't know how much it would take to blow it instantly, but it would be a lot more than 35 amps, and certainly a lot more than the wiring in a Triumph is rated for.

PURPOSE OF FUSES

This would be a good place to explain the purpose of fuses in an automobile. There is a lot of misunderstanding about this. The purpose of fuses is to protect the WIRING, and ONLY to protect the wiring. A fuse is NOT meant to protect a radio, heater motor, lights, etc. It is not meant for that purpose because it can't perform that function. It is entirely possible for a radio, for example, to be damaged due to the heat of an internal short while it is pulling less current than the fuse rating, and even while pulling less current than it uses when played at high volume. A fuse can't protect a lamp, because the only way to get more current through a lamp is for it to have failed already. A fuse serves its purpose by offering itself up as a sacrifice when a short occurs to save the wire from burning. It is much better to replace a fuse than to replace burnt wiring, or, even worse, a burnt car! (As an interesting aside, the National Electric Code, which governs most electrical installations in this country, is published by the National Fire Protection Association, rather than by an electrical engineering organization as one might think).

DETERMINING FUSE RATINGS

Lacking a conversion table, how then should you determine the correct size American fuse to replace the original Lucas fuses? Ideally, fuses should be sized according to the current carrying capacity of the wires they are feeding, without regard for the size of the original Lucas fuse (and the wire, in turn, should be sized for the load it will carry). If the wire is rated for 30 amps, then it is safe to use a thirty-amp fuse as a MAXIMUM! A 15-amp fuse should be used for a wire that is rated at 15 amp. Of course, a wire that is rated at 15 amp will not burst into flames if 15.5 amps are ran through it. Running 30 amps through it, though, for a long period of time will probably heat it up enough to melt the insulation, and maybe even catch it on fire. For a very short period of time, you might even be able to shoot 50 or more amps through it without any problem, depending on how the wire is routed. If it is in open air in a cool atmosphere, it will handle it better than it would if it were in a wiring harness running close to the exhaust manifold. I can state from experience that a 16 gauge wire, rated at about 10 amps, will carry the total load of a TR6 (including headlights), without burning, if you route the wire through the cockpit, away from the engine. In an emergency once, I ran my car that way for about an hour. I held the wire in my hand just to monitor the temperature, and it got quite warm. In a wiring harness, it probably would have burned (the insulating effect of the other wires and the harness wrapping would have held the heat in).

Most wires in a Triumph, with the exception of the battery and main alternator cables, are rated at 8 amp continuous, with a few rated at 5.75, and a very few rated at 17.5. When you are choosing the fuse based on the wire size, you have to keep in mind that a 17.5 amp wire may feed into an 8-amp wire, which in turn may feed a 5.75 amp wire. The fuse should be sized for the 5.75 amp wire, and not the 17.5 amp. This means that the fuses in a TR6 (or any Triumph, for that matter) probably should be all sized at 6 amps or less, unless you have traced the wires and know for sure the sizes involved. If you do this, however, I doubt that you could use the car for blowing fuses. Fortunately, there is a lot of conservatism built into the wire ratings.

FUSE SIZE RECOMMENDATIONS

For practicality sake, I would size the fuses to be just over the maximum current draw for all loads fed by a given fuse. For a stock TR6, and typical for other Triumphs, this would be:

"RED" fuse - This fuse feeds red wires and supplies all the tail, parking, marker, and dash lights, and pulls less than 6 amps.

"PURPLE" fuse. - This fuse feeds purple wires and supplies the glove box lamp, courtesy lamps, trunk light, the horns, the hi-beam flasher, and the hazard flasher circuit. With the exception of the horns and the hi-beam flasher, the maximum expected load is less than 8 amps on this fuse. For a stock headlight, flashing the hi-beams pulls about 9 amps, and the horns draw around 5 amps. If you have high powered lights, the current will be more, but you probably should have them on a separate, un-fused, power source anyway, if they are very high powered (yes, I said "un-fused" - that is not a typo!), and they should be relay operated. It is very unlikely that you will have the hazard flasher going, the doors, trunk, and the glove box open while blowing the horn and flashing the lights. Even if you should do this and blow the fuse, the headlights, both hi and low beams, will still work, as they are fed from another circuit. The hi-beam flasher merely bypasses the headlight switch. None of the PURPLE loads are what might be considered mandatary loads anyway, so even this very unlikely scenario is not a problem.

"GREEN" fuse - This fuse feeds the green wires, supplying power to almost all of the loads that are switched on with the key, the most notable exception being the ignition circuit, which is fed directly from the ignition switch with no fuse. The load on this one is a little harder to determine, as you will seldom have all loads on at the same time, but the maximum load, with everything on, is less than 20 amps.

My recommendation? For a TR250/TR6, I recommend 10 amp for the RED fuse, 15 for the PURPLE, and 20 for the GREEN (all values are stated in American fuse ratings). I'm using a 15 amp for the GREEN circuit, and I've had no problems with it blowing. It should go without saying that you should always carry spares. To simplify spares, as the fuse box only has room for two, you can use a 15 amp fuse as a spare for both the RED circuit and the PURPLE circuit as well. See the tables below for clarification.

TABLE ONE

The following table lists EVERY electrical load in an early model TR6. It would be extremely rare for you to have ALL loads listed on at one time, so a fuse rated for the maximum current draw would not be needed. Loads for a TR250 or a later model TR6 would be similar, so the table will be usable for them as well. If you want the precise values for the other models, use the table below as a guide.

“RED" fuse:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Parking Lamps | 2 | X | 5 watts | = | 10 watts | = | 0.8 amps |
| Marker Lamps | 4 | X | 4 watts | = | 10 watts | = | 1.3 amps |
| License Plate Lamps | 2 | X | 6 watts | = | 12 watts | = | 1.0 amps |
| Tail Lamps | 2 | X | 5 watts | = | 10 watts | = | 0.8 amps |
| Instrument Lamps | 8 | X | 2.2 watts | = | 18 watts | = | 1.5 amps |
| Total | | | | | | | 5.4 amps |

"GREEN" fuse.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| WS Wipers | 1 | X | 14 watts | = | 14 watts | = | 1.2 amps |
| WS Washer | 1 | X | 7 watts | = | 7 watts | = | 0.6 amps |
| Brake Lights | 2 | X | 21 watts | = | 42 watts | = | 3.5 amps |
| Back-up Lights | 2 | X | 21 watts | = | 42 watts | = | 3.5 amps |
| Fuel Gauge | 1 | X | 2.4 watts | = | 2.4 watts | = | 0.2 amps |
| Temperature Gauge | 1 | X | 2.4 watts | = | 2.4 watts | = | 0.2 amps |
| Heater Fan | 1 | X | 48 watts | = | 48 watts | = | 4.0 amps |
| Turn Signals | 2 | X | 21 watts | = | 42 watts | = | 3.5 amps |
| Total | | | | | | | 16.7amps |

"PURPLE" fuse:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Horns | 2 | X | 30 watts | = | 60 watts | = | 5.0 amps |
| Hi-Beam Flasher | 2 | X | 50 watts | = | 100watts | = | 8.3 amps |
| Hi-Beam Indicator | 1 | X | 2.2 watts | = | 2.2 watts | = | 0.2 amps |
| Hazard Flasher | 4 | X | 21 watts | = | 84 watts | = | 7.0 amps |
| Glove Box Lamp | 1 | X | 2.2 watts | = | 2.2 watts | = | 0.2 amps |
| Trunk Lamp | 1 | X | 3 watts | = | 3 watts | = | 0.3 amps |
| Key Lamp | 1 | X | 2.2 watts | = | 2.2 watts | = | 0.2 amps |
| Courtesy Lamp | 1 | X | 3 watts | = | 3 watts | = | 0.3 amps |
| Total | | | | | | | 21.6amps |

TABLE TWO

The table below lists all of the loads that would normally be on at any one time during any normal driving condition. The back-up lights, for example, are never on while driving. These values indicate the absolute minimum fuse ratings required for each circuit. Other loads will have to be added to this to get the correct size fuse. For example, even though the back-up lights won't be used while driving, there will be times when you have to back up, and you don't want to have to turn off the heater to keep from blowing a fuse. Normally, there are no loads at all on the purple fuse, but if you are stuck alongside the road, the loads listed in the table would be the normal loads for this condition.

"RED" fuse

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parking Lamps | 2 | X | 5 watts | = | 10 watts | = | 0.8 | amps |
| Marker Lamps | 4 | X | 4 watts | = | 16 watts | = | 1.3 | amps |
| License Plate Lamps | 2 | X | 6 watts | = | 12 watts | = | 1.0 | amps |
| Tail Lamps | 2 | X | 5 watts | = | 10 watts | = | 0.8 | amps |
| Instrument Lamps | 8 | X | 2.2 watts | = | 18 watts | = | 1.5 | amps |
| Total | | | | | | | 5.4 | amps |

"GREEN" fuse

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| WS Wipers | 1 | X | 14 watts | = | 14 watts | = | 1.2 | amps |
| Fuel Gauge | 1 | X | 2.4 watts | = | 2.4 watts | = | 0.2 | amps |
| Temperature Gauge | 1 | X | 2.4 watts | = | 2.4 watts | = | 0.2 | amps |
| Heater Fan | 1 | X | 48 watts | = | 48 watts | = | 4.0 | amps |
| Total | | | | | | | 5.6 | amps |

"PURPLE" fuse

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hazard Flasher | 4 | X | 21 watts | = | 84 watts | = | 7.0 | amps |
| Glove Box Lamp | 1 | X | 2.2 watts | = | 2.2 watts | = | 0.2 | amps |
| Trunk Lamp | 1 | X | 3 watts | = | 3 watts | = | 0.3 | amps |
| Key Lamp | 1 | X | 2.2 watts | = | 2.2 watts | = | 0.2 | amps |
| Courtesy Lamp | 1 | X | 3 watts | = | 3 watts | = | 0.3 | amps |
| Total | | | | | | | 8.0 | amps |

HEADLIGHTS AND FUSES

I said above that headlight circuits should not be fused. At first glance, that sounds like heresy, but there is a good reason for that. A fuse is an instantaneous, non-resettable device. A momentary short will blow a fuse, and once it is blown, that circuit is out of service until the fuse is replaced. Suppose you are driving along your favorite winding country road, on a moonless, cloudy night, in a very "spirited" manner. You hit a pothole, causing one of the leads to your headlights to bounce against the body of the car. If the wire is frayed, or the connectors are not firmly in place, a momentary short can occur, instantly blowing the fuse, leaving you without any lights at all. Navigating in the dark through a cornfield can be difficult at best; failing to see the large oak tree dead ahead at 55 mph can be fatal.

If you must have fuses in the headlight circuit, use four fuses, one each for the RH and LH low and high beams, and RELIGIOUSLY check your headlights to ensure they are working. Having redundant fuses won't do you any good if one of the bulbs is out. You could just switch beams in that case, but you may very well not have time to do it before you are in deep trouble.

A better option is to use fusible links. These have the property of taking time to blow, so that a momentary short will not do it. On the other hand, a sustained short will blow the link before any damage is done, protecting the wiring. A fusible link is nothing more than a very short (2 inches or so) piece of wire with a special insulation. The insulation is of a nature that it will burn without coming off of the wire, thus still providing short circuit protection after the link has “blown.”

The wire size is selected to be 2 gauges (four numbers) smaller than the wire it is protecting, e.g., To protect a 12 gauge wire, use a 16 gauge fusible link. Because it is smaller, the wire in the fusible link will burn up before the main wire can be damaged.

Circuit breakers are another option, but less desirable in my opinion. Circuit breakers can withstand very brief overloads without tripping, but may trip if the shorted condition exists for a longer period of time. Under some conditions, a momentary short, such as described above, may last long enough to trip the breaker. If you are using the automatic reset type, the breaker will re-close and not trip again if the shorted condition is gone, but a lot of distance can be traveled during the tripped interval.

No matter what type of set-up you use, there can be conditions that will permanently disable your lights, and there is nothing you can do to prevent it, other than making sure your wiring is in tip-top condition. For example, a really deep pothole may jar a wire loose from the light switch. Whether you use fuses, breakers, fusible links, or straight wiring, if that happens, -- not a pretty sight!

# 8
# IGNITION THEORY

INTRODUCTION

If you hold a ball in front of you, and drop it, it will fall to the floor. Every time. Although you can calculate the speed at which it will fall, and the force with which it will hit the floor, and you know that it falls because of gravity, no one really knows why. Gravity is one of the fundamental forces of nature. We know it's there, we can calculates its effects on objects, so we just accept it

If you hold a magnet in one hand and a coil of wire in the other, and wave the magnet close to the wire, electrical current will flow through the wire. If you hold the magnet still, and don't move it with respect to the wire, no current flow will be induced. No one knows why. This is another of the fundamental properties of nature.

If you run a current through a coil of wire, it will create a magnetic field around the wire. No one knows why, it just does. If you increase the current, the magnetic field will increase. If you decrease the current, the magnetic field will decrease. If you alternately increase and decrease the current, the magnetic field will also alternately increase and decrease.

A magnetic field that alternately increases and decreases looks pretty much like the magnetic field surrounding a permanent magnet that is moving back and forth. If you place a second coil of wire (secondary) near the coil of wire with the fluctuating magnetic field (primary), the second coil of wire sees the fluctuating magnetic field as if it were seeing a moving magnet, and current will be induced into it.

This, then, in a nutshell, is how a transformer works. In **figure 1** below, I show a simple transformer circuit. By applying a varying current to the primary winding, a varying magnetic field is produced, which is coupled over to the secondary windings. This in turn produces a varying current in the secondary, which will be fed to the load.

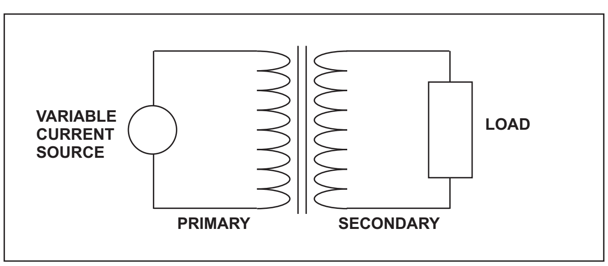



FIGURE 1

A variable current source is of interest, for the most part, only to laboratory technicians. For the rest of us, we are used to thinking in terms of a voltage source - 120 VAC from the wall mains, or 12 volts DC from a battery. So, instead of a varying current source, lets redraw **figure 1** as shown below in **figure 2**.

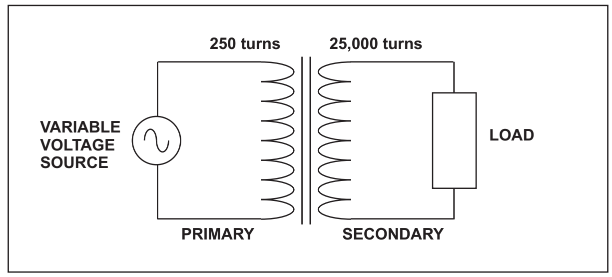



FIGURE 2

Notice that I have added the number of turns of wire in each of the transformer windings. 250 turns in the primary, and 25,000 turns in the secondary, i.e., the transformer has a turns ratio of 100:1. This illustrates another property of transformers, in that the voltage out of the secondary will be a multiple of the voltage applied to the primary, in this case, 100 times as much. In **figure 2**, if we apply 12 volts to the primary, we will get 1200 volts out of the secondary. Of course, as with anything else in life, you don't get something for nothing. You do multiply the voltage, but the current is divided by the same ratio. 12 volts @ 5 amps on the primary will give 1200 volts @ 0.005 amps from the secondary.

Suppose, though, that instead of using a varying voltage source, I connected the primary to a steady voltage source, such as an automobile battery? In this instance, no current would be delivered to the secondary, as a moving magnetic field is required, and a constant current does not provide a moving magnetic field. With that in mind, it may be surprising to learn that the ignition coil in your car is nothing more than a simple transformer. How can that be, if we just said that a transformer won't work with a steady current source, and the battery in a car is a steady current source? To answer that, look at **figure 3** below.

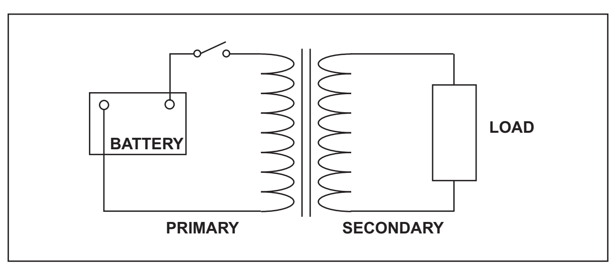



FIGURE 3

In this figure, the varying current source has been replaced with a battery and a switch. With the switch open, there is no current flowing in the primary. When the switch is first closed, primary current goes from zero to a maximum value very rapidly, (rapid, but not instantaneous), producing a very rapidly rising magnetic field. This “spike” of current in the primary produces a corresponding spike of current in the secondary. Likewise, when the switch is opened again, the maximum current primary current flow once again returns to zero, in a rapidly changing manner, and a corresponding current change takes place in the secondary.

With the exception of the condenser, **figure 3** is the diagram of the ignition system in a car, the switch being the points, and the transformer being the coil. The turns ratio of 100:1 is also typical of an automotive ignition coil, which means that the most voltage available from the secondary would be 1200 volts, not nearly enough to produce a spark at the plugs, and certainly less than the 20,000 - 30,000 volts we expect. So, where does the extra voltage come from? To understand that, we have to dig a little deeper into theory, and examine inductors.

INDUCTORS

What is an inductor? An inductor is nothing more than a coil of wire. The wire may be wrapped around an iron core, wrapped around an air core, or wrapped around another coil of wire. In our ignition coils, it is the latter. The primary coil is wrapped around the secondary coil (the primary coil, carrying the most current, gets the hottest, so by placing it on the outside of the secondary, near the surface of the case, heat dissipation is maximized for the primary).

An inductor has an interesting property, in that it tends to resist a change in current. If you apply voltage to an inductor that has no current flowing - by closing a switch, for example - the inductor presents a very high impedance to the current flow (impedance is just a fancy word for resistance, and is used mostly when talking about inductive or condenser circuits). After a period of time, the inductor presents no more impedance to current flow than the resistance of the wire in the coil. Coincident with the buildup of current in the coil, there is also a build up of a magnetic field around the coil.

What happens now if the switch is opened? As stated above, an inductor tends to resist a change in current, so it will try to maintain the same current as it had before the switch was opened. It does this by means of the magnetic field collapsing. As the field collapses, it cuts through winding of the inductor, and creates its own current flow. Initially, the current flow is just the same as before the switch was opened, decreasing to zero as the field decays.

**Figure 4**, top right, shows the current in the inductor when the switch is closed and when it is opened. You can see the rise and fall of the current is not instantaneous.

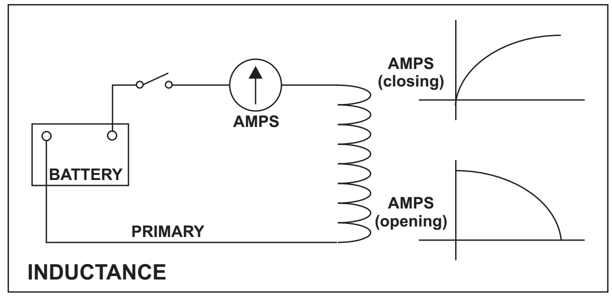


FIGURE 4

This, though, raises an interesting question: where does the current go if the switch is open? Answer: the current will arc across the switch contacts. Which brings another question: how does the arc form, if there is only 12 volts on the coil terminals? Answer: if there is no good path for the current, the voltage on the coil will rise to a quite high value, as it attempts to maintain the current flow. On an automobile coil, the voltage on the coil primary will reach 250 volts or more as it tries to establish an arc. This is not good for the points, but this phenomenon is quite good on the secondary side.

I stated earlier that an inductor resisted a change in current. That is true only if the current change is imposed by a current source (or voltage source). If the coil is exposed to an external magnetic field, the current change is instantaneous. When the field in the primary of the ignition coil collapses because the switch (points) has been opened, there is an instant increase in current in the secondary. Or there would be if the current had anyplace to go. Until an arc is established across the spark plug, no current flow can take place. Just like the primary, however, the output voltage of the secondary will rise to a quite high value as it tries to establish current flow. As much as 20,000 - 30,000 volts - just the right amount to fire the plugs!

The secondary won’t produce that much voltage though, unless the decay of the primary field is very rapid. A slow decay will not produce a high voltage. To ensure a rapid decay, a condenser is used. The condenser also has another valuable purpose, in that it also protects the points from burning as a result of the primary arcing. The condenser basically prevents an arc from forming. So, what is a condenser?

CONDENSERS

A condenser (often called a capacitor, and almost always called a capacitor in any application other than the ignition circuit in an automobile) is nothing more than two conductive plates separated from each other by an insulating material. Usually, the two plate are long, thin, strips of foil, separated by long, thin strips of a paper-like insulating material, and all three strips are then rolled up like a roll of toilet paper, and packaged in some sort of protective material. See **photo 1** for a view of a disassembled ignition condenser.

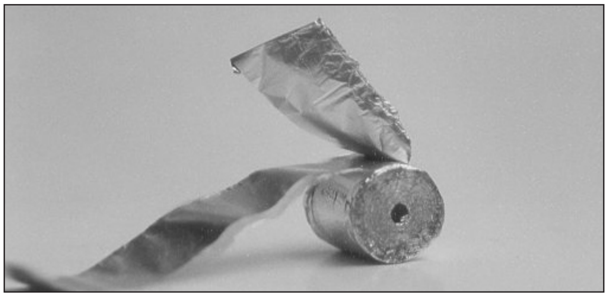


PHOTO 1

In operation, a condenser operates much like a battery. If you apply a voltage to it, it will charge up to the applied voltage, and hold that charge after the voltage is removed. The charge will remain on the condenser until a discharge current path is provided, either by placing a load on the condenser, or by leakage current through the atmosphere.

Whereas an inductor tends to resist a change in current, a capacitor tends to resist a change in voltage. If a voltage is applied to a discharged condenser, the condenser will initially look like a short circuit to the voltage source. The voltage across the condenser terminals prior to placement of the voltage source was zero; the condenser will try to maintain the zero voltage by absorbing as much of the current as it can. In time, the voltage across the terminals will equalize to the applied voltage, the condenser will be fully charged, and no more current will flow.

If a load is applied to a fully charged condenser, the full voltage of the condenser charge will be applied to the load, and the maximum current will flow through the load as the condenser tries to maintain its charged voltage. In time, the charge will be dissipated, and the voltage will drop to zero

The operation of a condenser circuit is shown in **figure 5** below. When the switch is placed in position A, voltage is applied to the condenser, electrons pile up on the negative side of the condenser, positive charges (holes) pile up on the positive side, and the voltage rises on the condenser terminals as shown in the top right of **figure 5**. If the switch is then placed in position B, the condenser will discharge, the electrons and holes will equalize on both sides of the condenser, and the voltage curve shown in the bottom right of **figure 5** is produced. Flip the switch back to "A" and the process stars all over again.

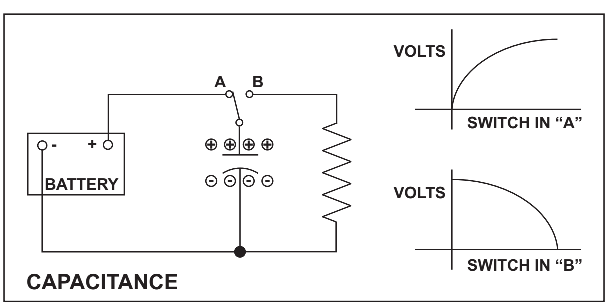



FIGURE 5

Now, it's time to put these components together into an ignition circuit, and see it works. **Figure 6** below illustrates a typical ignition set up.

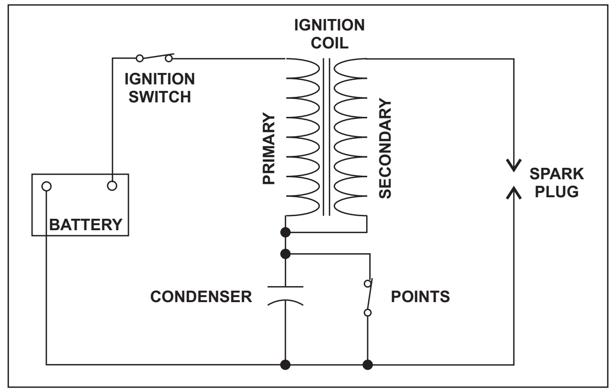



FIGURE 6

To start our analysis, assume the ignition key is on, and the points are closed. Current will flow through the inductor (the coil primary), rising slowly as shown previously. As the current builds up, so does the magnetic field surrounding the primary. As the engine rotates, the points will open, interrupting the current path through the primary. The primary, being an inductor, will try to maintain the current flow as the magnetic field collapses.

Without the condenser, the only path for the current is through the points, by means of an arc. This path is not a very good path, though, and the decay of the inductor current will be rather slow. Enter the condenser. While the points were closed, the condenser was shorted out, and had zero volts across its terminals. Being a condenser, it will try to maintain zero volts across its terminals after the points are open. It does this by acting as a short circuit to the current from the primary. If the coil primary and the condenser are sized properly, the primary current, and the associated magnetic field, will collapse much, much quicker than they would if they had only the arc through the points as a discharge path. The current through the primary will look pretty much like that shown in **figure 7** below.

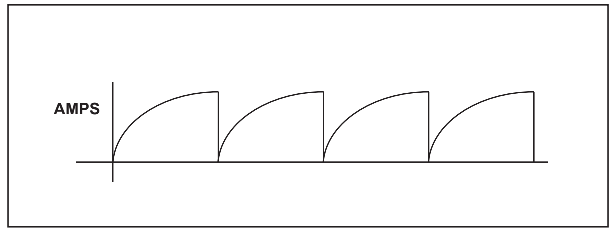



FIGURE 7

It was stated earlier, and illustrated in **figure 4**, that the current rise and fall in an inductor occurs over a period of time, yet the current *fall* in **figure 7** appears to be instantaneous. Actually, it's not. If the horizontal scale were stretched, the fall time would look a lot like the inverse of the rise time. With the condenser out of the circuit, the fall time would be about the same as the rise time. The condenser dramatically shortens the current and - most importantly - the magnetic field decay time.

There are a couple of interesting items of note in **figure 7**. First of all, as stated above, is the rapid current decay when the points open. Only a rapid current decay in the primary will produce a sufficiently rapid field decay to produce the required output voltage from the secondary. Secondly, with a rather slowly rising current when the points close, the rise time of the current, and the magnetic field, is not quick enough to generate a spark from the secondary.

I must admit, now, that I have taken a lot of liberties with all of the above, and I have simplified the theory a great deal. An electrical engineer reading this will probably cringe, but then an electrical engineer already knows all of this, and has no reason to read it. I have tried to take a very complicated subject and simplify it enough that some one who is not well versed in electrical theory can have a fair understanding of what is involve in generating a spark.

# 9

# SWITCHES, RELAYS, AND SOLENOIDS

SWITCH FUNCTIONS

Switches are to electricity what faucets are to water. Just as a faucet controls the flow of water, switches control the flow of electricity. There are, however, some significant differences in the functions of the two items.

1. We open a faucet to allow water to flow, and close it to stop the flow of water. Electrical switches operate just the opposite: we close a switch to allow electricity to flow, and open it to stop the flow.

2. Faucets can be adjusted to regulate the water flow, from a mere trickle to full flow. Switches, in general, are all or nothing; closed, they allow full flow, and open, there is no flow at all

3). The typical faucets we are accustomed to in our homes are simple on-off devices, controlling the flow of water from one source to one outlet. Electrical switches can be used in the same manner, but they can also perform more complicated switching functions. For example, the hazard switch in a later model TR6 disconnects the turn signal flasher, bypasses the turn signal indicator lamp, turns on the hazard flasher and the hazard flasher indicating lamp, and connects together the turn signal lamps on both sides of the car. Quite a bit for one simple switch, and all without the use of a relay.

SWITCH TYPES

The most basic type of switch found in a Triumph is a simple on-off switch, such as the switch that operates the brake lights. This type of switch is illustrated in the upper left of **figure 1A**, below.

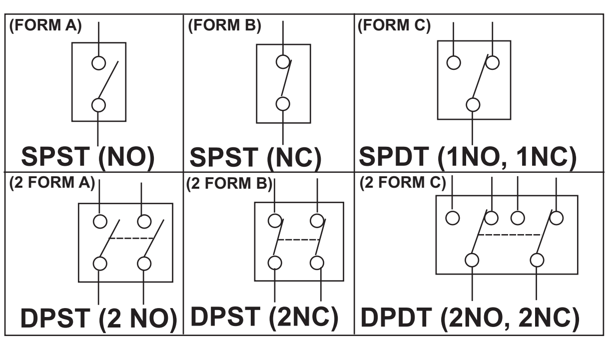



FIGURE 1A

This switch is commonly referred to as a "normally open, single pole, single throw" switch. The phrase "single pole, single throw" is usually abbreviated SPST, and "normally open" is abbreviated NO.

The switches shown in **figure 1A** can be either "maintained" or "momentary" switches. A maintained switch stays in the last position it was placed in, whereas a momentary switch will return to its "shelf" position as soon as the operator releases it. Generally, maintained switches are depicted as shown in **figure 1A**, while momentary switches are usually depicted as shown in **figure 1B** below. Note that the symbols for the SPDT and the DPDT switches are the same for either maintained or momentary types. For these switches, you will have to read the description to determine the operation for a given switch.

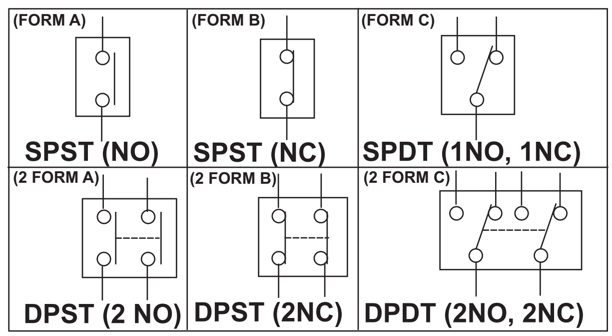



FIGURE 1B

When describing a manual, maintained position, switch, the term "SPST" is generally adequate, without the use of a "normally open" or "normally closed (NC)" modifier, as there is usually no "normal" position. When describing the operation of a momentary switch, such as the brake light switch, though, this modifier is very important. In fact, the brake light switch is a SPST, normally CLOSED, momentary switch. That is, when the switch is laying on the bench, the contacts are closed. In operation, when the brake pedal is released, the switch is operated, and the contacts are then OPEN (this peculiar method of operation is explained in chapter 11, Brake and Back Up Lights).

A SPST, normally closed switch is depicted in the upper middle of **figures 1A** and **1B**. In most engineering departments, these switches are not usually referred to as SPST; rather they are described as "form a" or form b," as shown. The term "form a" simply means a SPST, (NO) switch, and "form b" means a SPST (NC) switch. This terminology is much more concise and definitive than the SPST designations, but, unfortunately, will not be understood by most folks outside of electrical engineering, so you will need to use the SPST terms for the most part.

In the upper right of **figures 1A** and **1B** is a SPDT (single pole, double throw) switch, with one NC and one NO contact, also referred to as a "form c" switch. This type of switch is typically used as a "selector" switch - operating, for example, the high beams in one position, and the low beams in the other. Just to confuse matters even further, this switch is available in two configurations. In one configuration, the switch has three positions, with the center position being off, and in the other configuration, the switch has only two positions. Two types of "center-off" switches are depicted in **figure 2**, below, and are shown in the "off" position.

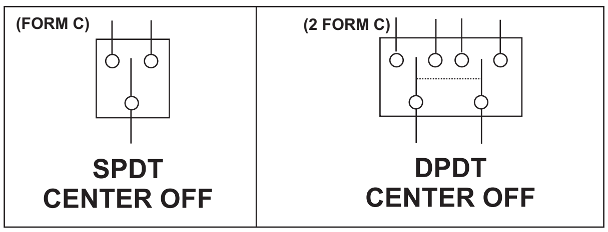



FIGURE 2

At the bottom of **figures 1A** and **1B** are three other examples of switches, and the diagrams should be self explanatory. The dashed line indicates that the two poles of each switch are operated simultaneously, with only one handle or knob.

The switches shown in the above figures cover most of the types you will normally encounter when working on a Triumph, and about the only types readily available in the typical auto parts stores. Other types of switches used will be described as they are encountered in the various chapters of this book.

RELAYS

Relays are nothing more than electro-mechanical switches, replacing the manual operation with electrical operation. The components that make up a relay are:

1. A coil of wire wrapped around an iron core,
2. A metal armature with one or more electrical contacts attached,
3. A spring to return the armature to its rest position when the relay is de-energized,
4. One or more fixed brackets with contacts attached,
5. Terminals for attaching wires for connecting external wires to the internal components described above, and
6. A protective housing, with mounting fixtures.

A typical relay is shown in **photo 1**, top right.

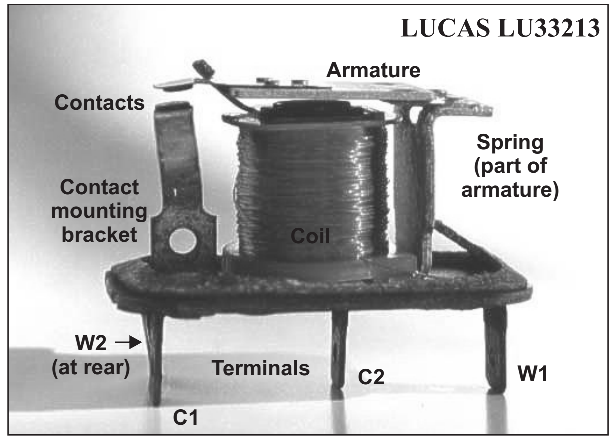



PHOTO 1

In operation, current through the coil of wire (1) creates a magnetic field, which magnetizes the iron core. The magnetized core than attracts the armature (2), pulling it toward the core, causing the contact on the armature to make contact with the contact on the fixed bracket (3), allowing current to flow through the contacts

When current flow through the coil of wire is interrupted, the iron core is no longer magnetized, and the spring (3) pulls the armature away from the core, and the contacts are separated, interrupting the flow of current.

The left hand side of **figure 3**, below, shows the physical details of the external connections and the schematic diagram for this relay. On the right are representations of a DPST relay, which is also shown in **photo 2**, next page.

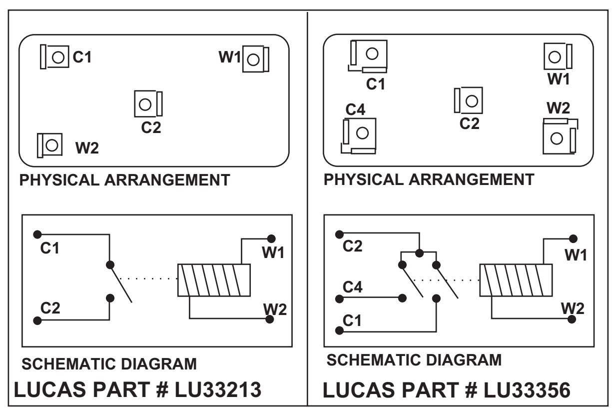



FIGURE 3

There are a couple of items worth noting with this particular DPST relay. First of all, notice that, unlike the DPST switch shown in **figures 1A** and **1B**, the two poles are not isolated from one another. One side of each pole is connected to the other pole, making this switch a three terminal device. In other words, this relay has one input and two outputs. When the relay is operated, power from the input terminal is fed to both output terminals. Secondly, notice the absence of a contact pad on the C1 bracket! This relay, removed from a '75 TR6, is very definitely bad.

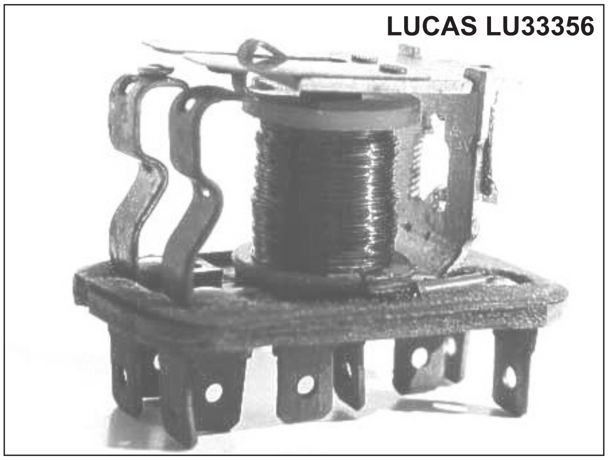



PHOTO 2

WHY USE RELAYS

If a relay is nothing more than an electrically operated switch, why bother using one. Why not just use a switch and be done with it - using a relay in addition to a switch has to cost more. There are a few good reasons:

1. CURRENT CAPACITY: often, for esthetics or space concerns, it is desirable to use small switches to operate high current loads. When these small switches lack the capacity for switching heavy loads without damage, a relay can be used as a go-between, allowing a small current through the switch to operate a relay coil, and using the relay contacts to operate the heavy load. In this situation, a relay is often referred to as an “interposing” relay, i.e., it is interposed between the load and the switch.

2. EASE OF REPLACEMENT: It can be quite difficult sometimes to get to a dash mounted switch to replace it, and it can be extremely difficult to get to some of the mechanically operated switches, such as the reverse switch in the transmission, for replacement. Relays, on the other hand, can be conveniently mounted so as to make replacement easy. In a TR250 or a TR6, in fact, they are mounted on a small bracket under the hood, where they can be removed and replaced with very little difficulty. Even if the primary switch can handle the load, they still fail after time, and so will a relay, so ease of replacement is a very important consideration.

3. CONTACT MULTIPLICATION: not as often a factor in automotive usage as in industrial applications, using a multiple pole relay can allow a simple on-off switch to operate several devices at once. In my workshop, for example, I have a 12 pole, double throw relay, left over from some long forgotten project. Using this relay and a SPST switch, I could operate up to 24 independent devices at once - turning 12 off, while turning another 12 on.

More appropriate to automotive usage would be the use of one switch to control two relays, one for each of a pair of high powered driving lights. One set of contacts in the switch controls two relay contacts. Of course, you could always buy a switch with ample capacity to operate both lamps, or a double pole switch, but it may be that the switch you prefer for esthetic reason has only one set of low current contacts.

4. COMPLEX FUNCTIONS: prior to about 1972, Triumph used a simple DPDT (one NO and one NC contact) switch, operating a relay, to control the hazard flasher. In ‘72, the relay was eliminated, resulting in the need for a more complex switch. The pre ‘72 switch can be replaced with an off the shelf switch, but not the later models.

You may also want to “interlock”certain functions, such as allowing your driving lights to be on if and only if you have both the driving light switch on and the headlights on high, or allowing the starter to operate only if the transmission is in neutral. Again, it may be possible to do all of this with only switches, but the use of relays often greatly simplifies things.

RELAY SUBSTITUTES

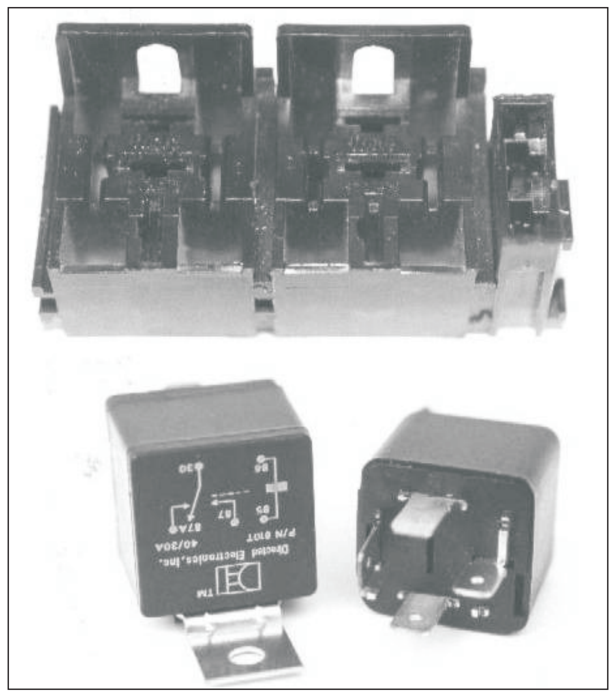


PHOTO 3

As this book is written, genuine Lucas relays are still readily available for the TR250/TR6, although they are a bit pricey. Luckily, aftermarket relay are available to substitute for all applications, and are quite a bit cheaper. Prices range from around $5 for a simple SPST relay, with a 30 amp rating, to around $12 for a SPDT, 30 amp relay. Too make life a bit simpler, relay sockets are also available at a very reasonable price. **Photo 3** above shows typical aftermarket relays, along with the matching interlocking sockets and a fuse holder that also interlocks with the sockets. You'll notice that one of the relays has a mounting tab on it, which may eliminate the need for sockets.

**Figure 4**, below shows two types of replacement SPST relays that are available in most auto parts stores. In this figure, I have labeled the terminal with both the industry standard for automotive relays, and, in parentheses, the equivalent Lucas identifiers.

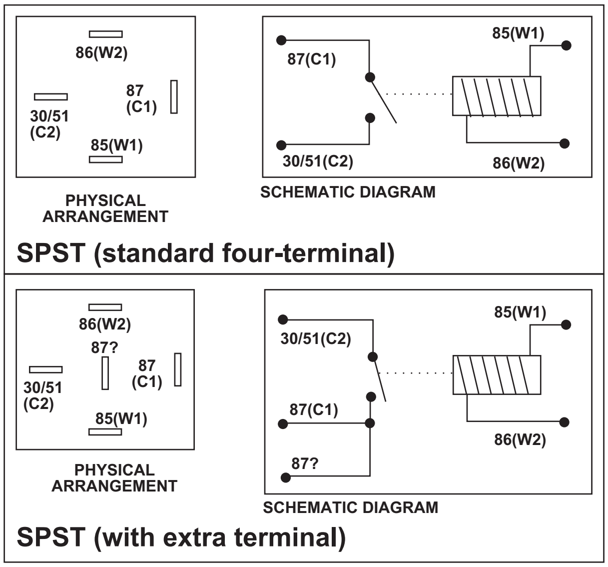



FIGURE 4

If you want to operate two loads from the same relay, such as a pair of driving lights, using the five terminal relay may simplify things, as you can connect each of the lamps to a separate terminal, eliminating the need to terminate two wires into one terminal. On the other hand, if all you have is the standard four terminal relay, there is nothing wrong with connecting two or more wires to the same terminal- automakers do it often.

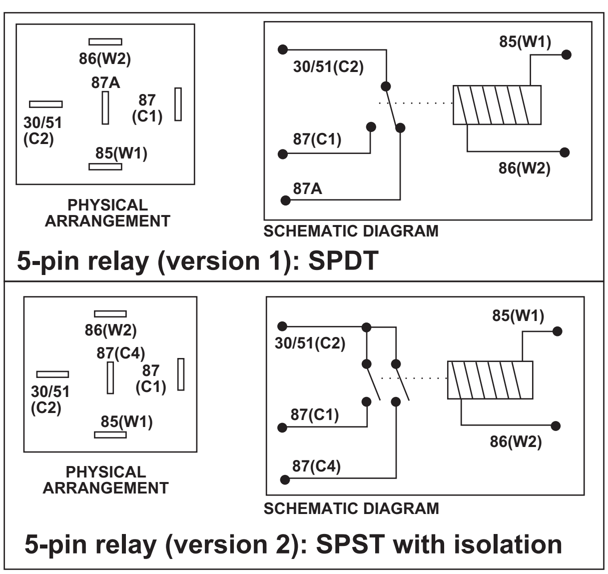



FIGURE 5

In **figure 5**, below left, are two other versions of a 5-pin relay. Externally, they are similar, but their operation is quite different. Version 1 is a "selector" type - i.e., ***either*** 87 ***or*** 87a will have power, but not both. With the relay energized, power is applied to terminal 87. With the relay de-energized, power is applied to terminal 87a.

With version 2, power is applied to both output terminals, both labeled 87, when the relay is energized. This configuration allows the loads to be isolated from each other when the relay is de-energized. The starter relay used on the later models is an example of an application of this type relay. In this application, it is important that the ballast resistor bypass ***not*** be connected to the starter solenoid when the relay is off, yet they both must be connected to power when the relay is on.

POLARITY

The coils and contacts in all of these relays are non-polarity sensitive, meaning is doesn't matter which way you wire them. You can make the W1(85) terminal negative, and the W2(86) positive, for example, or the other way around, and the relay will work just fine. The same is true of the C Terminals. On the DPST relays, the C1(87), the C2(30/51), and the C4(87A) terminals are all isolated from one another when the relay is de-energized, and they are all three connected together when the relay is energized. Therefore, as long as you don't mix up the wire connections ***AT*** the terminal, it doesn't matter ***WHICH*** terminal you use.

To clarify that a little bit: if you now have one black wire on terminal W1, and two purple wires on terminal W2, you can place the black wire on terminal W2, and BOTH purple wires on terminal W1. It is NOT OK to move just one of the purple wires to terminal W1.

CAVEAT!

When you receive your relays, but before you use them, check the diagram printed or stamped on the side of the case. These relays all look alike, and it is not at all uncommon for them to get mixed up in the bins at the warehouse. When the stock picker reaches into a bin for a relay, he or she usually assumes the relays are as marked on the bin, and doesn't check them to be sure. It is very rare when I order several relays at a time that they are all what I asked for.

SOLENOIDS

A solenoid consists of the following components

1. A coil of wire wrapped around a hollow core,
2. A movable iron rod inside the wire coil,
3. A spring to return the iron rod to its rest position when the solenoid is de-energized,
5. Terminals for connecting external wires to the solenoid

coil, and
6. A protective housing, with mounting fixtures.

When a current is passed through the wire coil, the movable iron rod moves, either into or out of the hollow core, depending on which end of the rod you are referring to.

And that's all there is to a solenoid! And this simple operation is what makes solenoids so versatile. Through mechanical coupling, the movement of the rod can be made to do many things. By coupling it to a diaphragm, as an example, it can be used as a horn; couple it through a lever to the drive gear, and it becomes a starter solenoid; attach a set of electrical contacts to it, and it serves as a relay, usually, a high power relay, capable of switching many amps.

**Photo 4**, below, shows the internals (well worn) of a starter solenoid from a TR3 (and typical of those used in a TR250). Notice the size of the electrical contact area as compared to the relay shown in **photos 1** and **2**.

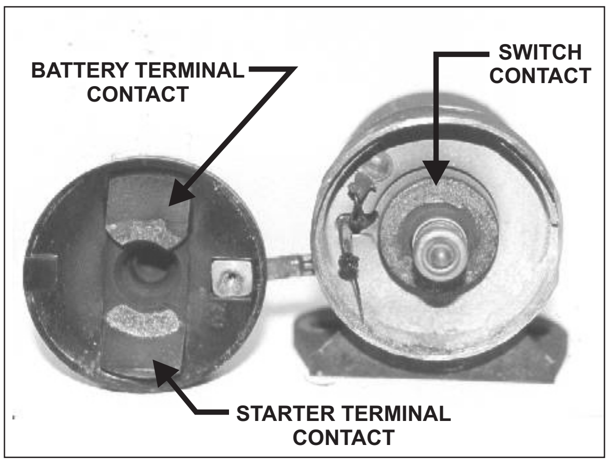



PHOTO 4

Theoretically, there is no reason a relay can't be made big enough to handle high current, but in practice, solenoids are made much more powerful than relays. Being more powerful, they also draw a lot more current than a relay, and they close the electrical contacts with much more force, making a much better contact. Because of the high power aspects of a solenoid, they can operate much larger contacts than a relay, which aids greatly in producing the higher current handling capacity.

The only solenoids used in a TR250 or a TR6 are those used in the horns, and the starter solenoids. The horn solenoids are described in the chapter 18, Horns, while the starter solenoids are described in chapter 25, Starters. Suffice it to say at this point that the starter solenoid schematics are identical to the schematics for the relays previously described. The solenoids used in the TR250 and early TR6 models are the equivalent to a SPST relay, while the later TR6 models, with a ballast resister bypass connection, are equivalent to a DPST relay.

SWITCH REPAIR

Even though new switches are readily available for most applications, sometimes it is more desirable to repair the one you have. To repair a rocker type switch, it will have to be taken apart and cleaned. Disassembly is quite easy, and how to do it is clear from an examination of the switch, as shown in **photos 5** and **6**, below.

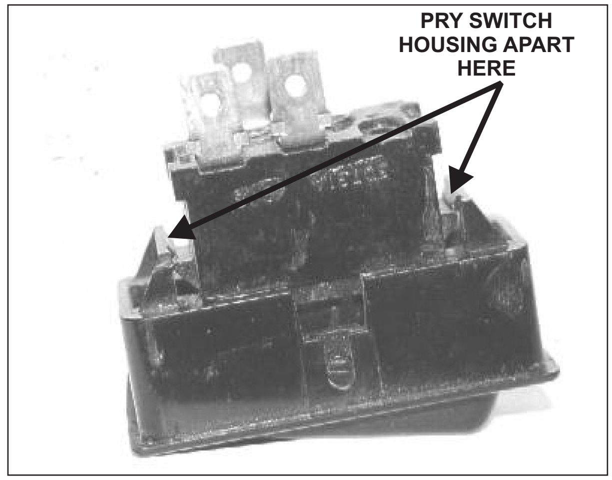



PHOTO 5

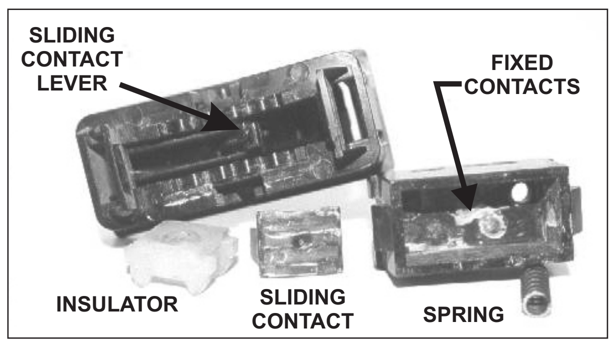



PHOTO 6

Basically, it involves slightly spreading tabs on the switch housing and removing the internals. Once you have the switch apart (watch for the spring so that it doesn't jump out and roll under the workbench where you can't get to it), clean the old grease out, and with a pencil eraser, or similar abrasive, lightly wipe the contacts until they are shiny. If you can locate it, replace the grease with a suitable grease for electrical contacts, available from Radio Shack or other electrical supply house, and reassemble. As they say, reassembly is the reverse of disassembly. If you can't find the proper grease, go ahead and reassemble dry, and you shouldn't have any problems.

There are two types of momentary door switches used, as shown in **photos 7** and **8** below. The first type, **photo 7**, has open contacts. To repair these type switches, all that is necessary is to carefully clean the contact with a mild abrasive, such as a fine grit sandpaper.

The other type, shown in **photo 8**, has the contacts enclosed in the plastic housing. To repair this type, use a fine toothed hobby saw to saw the plastic housing in two, being very careful not to cut into the internal mechanism. Use a mild abrasive, such as a pencil eraser or fine grit sandpaper, to clean the contacts, and use super glue to glue the two halves back together. I have two switches on one my cars that were repaired this way ten years ago, and they are both still working just fine. Economically, it's not really worth the trouble, but if you have the time, it can be a satisfying thing to do - restoration vs replacement!

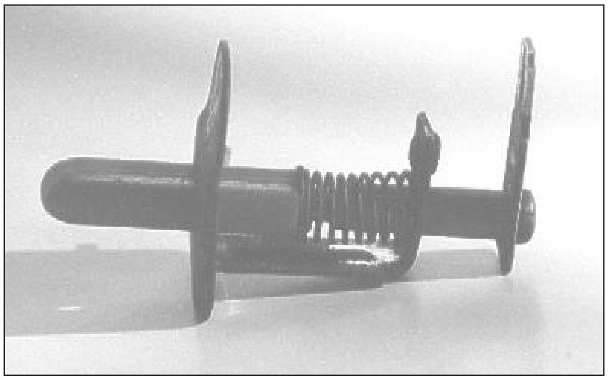


PHOTO 7

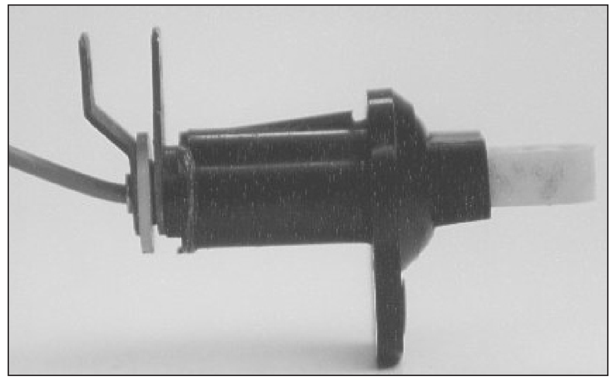


PHOTO 8

# 10
# WIRING TECHNIQUES FOR MAKING OR REPAIRING A WIRING HARNESS

MAKING OR REPAIRING A WIRING HARNESS

Whether it is advisable to make your own harness, as opposed to repairing the existing harness, depends on a number of factors. If you have no harness at all, it would be much easier, and cheaper, to buy a ready made harness. Building a harness from scratch, without a pattern to go by, is extremely tedious, to say the least. If, on the other hand, you have a fairly good harness, with only a few wires damaged, then it would be cheaper, and almost as easy, to do a repair. These two extremes make the choice fairly easy; it's when your situation is somewhere in between that the decision is difficult.

A common situation is to have one or more harnesses that have been salvaged from the junkyard. In this case, it may be desirable to save as much of the harnesses as you can, re-using the connectors and wire to make a new one, or to repair the better of the harnesses to make one good one out of those that you have.

As for re-using the connectors, I would advise caution. Of all the pieces of the harness that give problems, the most likely is the connectors. If you do re-use them, make sure they are clean and corrosion free. The bullet connector sleeves, the black pieces that are used to connect two pieces of wire, are particularly trouble prone. Often, the metal sleeve inside will crumble with age, and will no longer have sufficient tension to make a good connection (not being a metallurgist, I can't explain this, but when I removed about six sleeves on my '71, pieces of the metal sleeve fell out on the ground).

Salvaging the wire is not a problem, as long as the wire has not been damaged. If you can, i.e. the wire is long enough, I recommend cutting the wire an inch or two from any connector. Often, moisture will wick up the strands and corrode the wire, making it difficult to get a good connection. You should cut back to where the wire is clean and shiny.

The easiest way to repair a harness is to clear out a large space on the garage floor, and lay the harness down, stretched out, with each "leg" of the harness laid out by itself. Strip back the tape surrounding the damaged area, being carefully not to displace the wires from their original position. Lay the new wires down, one at a time, alongside the original wires, to make sure they are the same length (allowing 3/4 " overlap for the splice). Strip off 3/4" of the insulation from both the old, and the new, and slip a piece of heat shrink tubing over one of the wires. Twist the wires together, and solder. After the joint has cooled, slip the heat shrink tubing over the joint, and apply heat to shrink. Attach whatever connector is appropriate to the free end of the wire. Continue with each wire, till that section is done, and then go on to the next section. Use plenty of cable ties to hold the wiring in place as you work, prior to re-wrapping. As you come to each cable tie, during the re-wrapping process, cut it off and discard it. Be prepared to use ***plenty*** of cable ties.

Don't make all the splices in exactly the same place. If you do, the wire bundle will be very thick at this point, and all the stress will be concentrated in this area. Space the splices out over the length of the harness, at least six inches between each splice, if you can. Don't worry about making splices, all automakers do it.

When you do the re-wrapping, begin with the terminal, or connector end, and work back towards the main harness. That way, you have fewer loose ends of the wrapping tape to worry about, as the wrapping for each leg gets wrapped again by the main wrap. Start by running a short piece of the harness tape parallel to the wires, heading away from the connector end, and start wrapping back over this piece, towards the main harness. This way, the wrapping secures that end of the tape. Use the special harness tape supplied by British Wiring, which has no adhesive, but adheres to itself. When you get to the last piece, use electrical tape to secure the last wrapping.

Be careful to note any pre-formed bends in the harness, and reproduce them when you do the repairs. If you bend the wires and tie them tightly with the wrap, the harness will hold its shape surprisingly well.

Making a new harness will be exactly the same as above, except you will run the wires from one end to the other, using the existing harness as a guide. Even if you are making a new harness, there will be places where you will have to splice, just as the factory did. Just make your splices in the same place and manner as original.

If you don't have a harness to use as a pattern, you can still make your own, but the degree of difficulty goes up significantly. In this case, you will need to route each wire individually, in place, in the car, connecting each end as you go. If you can, It's a good idea to look at a completed car to see how the harness was ran by the factory. The factory provided sufficient supports, and these should be used for the new harness. The location of the supports provides a good indication of the correct harness routing. Connect one end, then route the wire to the other end, and make that connection. As you lay the wires down, pay particular attention to the need to remove and replace both the harness and the electrical components. There must be sufficient slack in the wire to allow for this. Also, great care must be given to the routing of the wire to avoid any possibility of damage from rubbing against sharp edges of the body, and to making sure that the wire is properly supported to eliminate strain on the connectors. As you run the wires, use plenty of cable ties to hold everything in place. When you have completed and tested the wiring, very carefully remove the harness from the car and wrap as described above.

Whichever route you take, you will need to obtain the required supplies. There are five different sizes of wire used in a Triumph (or most British cars for that matter), and over 50 different color codes on the later models (out of a possible 144, 106 of which are available), the exact number depending on the model year. British wire, as used in Triumphs, MGs, etc., is not sized by gauge as is American wire. The size of British wire is stated as the number of individual strands of 0.30 mm copper used to make the wire. The sizes available are listed below, along with the maximum current rating of each size:

| Number Of Strands | Current Rating |
|---|---|
| 9 strands | 5.75 amps |
| 14 strands | 8.00 amps |
| 28 strands | 17.50 amps |
| 44 strands | 25.50 amps |
| 65 strands | 35.00 amps |
| 84 strands | 42.00 amps |
| 120 strands | 60.00 amps |

A typical TR6, for example, will use the first 4 sizes, and either the 65 or the 84 strand wire, depending on the alternator rating ( I think the later models with the larger alternators use the 84 strand - I haven't confirmed this. I know the earlier models use 65 strand.) For any given wire in your existing harness, just strip a short length and count the strands. This will tell you what size to buy for replacement. (you may find some oddballs - somewhere in my collection of British wire, I ran across a piece of 21 strand wire! I have no idea where it came from). It is very unlikely that you will encounter the 120 strand wire, but if you should ever upgrade your alternator to a more powerful unit, this is the size wire you should be using. The correct color and size wire is available from:

British Wiring
20449 Ithaca
Olympia Fields, Ill 60461
708-481-9050

Call them and ask for a catalog. They also supply all the associated wiring supplies, such as connectors, bullet terminals, etc., as well as complete harnesses. By the way, even if you plan to solder all of the British type bullet connectors, buy the bullets that are suitable for soldering OR crimping, and not the type intended ONLY for soldering. Why? They just work better for soldering. They fit onto the wire a little bit snugger so they don't have as much tendency to fall off while you are trying to solder them, and the finished connection is just a little bit better. The dual purpose type are just so much easier to use when soldering than the solder type.

At the end of this chapter is a table listing all of the colors used in a TR6, with a description of the usage for each color.

If you prefer, you can use American gauge wire, but you may not get a color match. Most wire that is readily available at auto parts stores is all of one color, without any stripes at all, and the color choices are limited (a late TR6 uses 54 different color codes). I'm sure there must be places that will sell American gauge color coded wire in a wide variety of colors, but I don't know of any at this time.

There isn't a one-to-one correlation between American gauge and British wire sizing, so you will have to base your size choice on the current load of the circuits, rather than what was there before. Use the table below to determine your wire size (for automotive use only).

| AWG: | Current rating: |
|---|---|
| 18 Gauge | 5 amps |
| 16 Gauge | 10 amps |
| 14 Gauge | 15 amps |
| 12 Gauge | 25 amps |
| 10 Gauge | 50 amps |
| 8 Gauge | 80 amps |

## TERMINATION TECHNIQUES

### SOLDERED VERSUS CRIMPED CONNECTIONS

There is a lot of contention among the experts over this subject. Some people swear by soldered joints, and others won't use them at all. My opinion is that EITHER soldered or crimped joints are perfectly OK, provided they are made correctly and the rest of the wiring installation is correct. Vibration is a problem only if there is a sufficient length of unsupported wire which is allowed to move with respect to the connection. In other words, it is the flexing of the wire that causes the wire to work harden and break.

Proponents of crimping say that solder wicks up the wire for a short length, causing it to be stiff. This is true, and the problem area is the point where the stiff portion of the wire meets the portion that is still flexible. This is also a problem with crimped joints. The joint itself is very stiff, exactly like the soldered joint. If the wire is allowed to flex, it will break just the same as it would for a soldered joint. The one real disadvantage of the solder joint is that the extra length of stiffening makes it a bit harder to route the wire, as the bend radius is a bit larger than for a crimped connection.

## SIMPLE RULES FOR MAKING GOOD TERMINATIONS

RULE # 1:

Never allow the connector to be the only support for any appreciable length of wire. The wire must be supported so there is no movement relative to the connection. This is true even if you are wiring between two components that must move with respect to each other. The wire must be supported so there is no movement AT THE TERMINAL!

RULE # 2:

A ***GOOD*** type X connection is better than a ***POOR*** type Y connection. Insert your choice for X and Y. If I could get a good crimping tool, and good crimping terminals, I would never make another soldered connection. The joints made by the factory, using automated crimping tools, are unbeatable. The tools that are available for the average person are only OK at best, and terrible if not used properly. If you notice, the jaws on most crimping tools do not close completely. If you use the correct size terminal, the correct size wire, and the correct crimping tool opening, and squeeze till the tool stops, you will produce a good crimp. Otherwise, it is possible to crimp too hard, and weaken the wire, or not hard enough, and get a weak connection. The thing that bothers me the most about standard crimping tools is that they crimp "across" the wire. This places a great deal of stress over a very small area, making it very susceptible to breaking due to flex stressing. A "good" crimping tool will make the crimp along the length of the wire, distributing the stress over a larger area.

RULE # 3:

The ***material*** you are soldering must be hot enough to melt the solder. It isn't good enough that the ***soldering iron*** melts the solder. If you touch the solder to the iron till it melts, and let it flow around the wire, it will produce a glob, and the solder will not stick to the wire. It may look like it did, but it didn't. Unless the solder flows when touched to the wire, but not touching the iron, the wire isn't hot enough. Unfortunately, if you hold the solder to the wire, and wait til it is hot enough, the length of time that it takes may melt the insulation. A good technique to use is to melt a glob of solder on the iron, where it touches the connection, and let it flow around the connector. When the connector and the wire are hot enough to melt the solder, you will see the blob of solder flow and smooth out. At this time, the joint is hot enough to complete the soldering by adding more solder to the joint. The glob of molten solder acts as a heat sink, transferring the heat to the joint better than just the contact of the tip of the iron. When a solder connection is made well, the solder flows smoothly, and basically becomes one with the joint. If there is any abruptness in the solder flow, it is probably a cold joint. In other words, if it looks like the solder is just sticking on, it probably is just sticking on. A little practice with some scrap wire and connectors will make this all clear.

RULE # 4:

Use the right heat range soldering iron/gun. Too big is better than too small for our usage. A hot iron will get the joint to the proper temperature quickly, so you can make the connection and get away before the heat has had time to flow to adjacent areas, or up the wire. An iron that is too small will take so long to get the joint hot enough that the wire will be hot for an appreciable length, and might even damage the insulation before you can finish. It is also helpful to use low temperature solder. Radio Shack sells a roll of low temp solder that is just right for this purpose. In addition to being low temp, it also has a small diameter, making it perfect for wiring use. ***Whatever you do, don't use acid core solder, as it will cause severe corrosion later.***

## TECHNIQUES FOR SOLDERING BULLET CONNECTORS

Soldering bullet connectors is actually pretty easy, once you get the hang of it. The first thing to do is to make sure you have the right size for the wire you are using. The bare wire should slip into the bullet easily, but with as little excess room as possible. Strip the wire just long enough so the wire end reaches the end of the hole in the bullet, and the insulation *just* slips into the end of the bullet. With the bullet on the wire, hold the iron to the bullet until it is hot enough to melt the solder by itself. Place the solder to the hole in the end of the bullet, and allow the solder to wick up into the bullet, until it has absorbed enough solder to completely fill the void in and around the wire. This guarantees a good joint, as the solder will not flow till the wire and the bullet are both hot enough. You can't get a cold solder joint this way.

If you are making connections on your workbench, rather than in some contorted position under the dash, you can simplify your process by clamping the iron in a vice, thereby freeing both hands. Use one hand to hold the wire and bullet against the iron, and the other hand to feed the solder. Working this way, you can make a lot of GOOD joints in a hurry.

If you are working upside down under the dash, these connectors can be a real pain, as they want to slip off the wire and hide in a crevice where they can't be found. To reduce this problem, try to bend the wire so the wire end is pointing upwards. It will help a lot if the wire is a snug fit in the bullet.

# TR250/TR6 WIRE COLOR CODES

| Body | Tracer | Code | Usage |
|---|---|---|---|
| Black | None | B | Ground connections |
| | Blue | B/U | Grounding lead from LH seat sensor to seat belt interlock module (later models only) |
| | Brown | B/N | Grounding lead from LH seat belt switch to seat belt interlock module (later models only) |
| | Green | B/G | Connection between ignition key contact and ignition alarm switch (later models only) |
| | Orange | B/O | Grounding lead from ignition key alarm switch to seat belt interlock module (later models only) |
| | Purple | B/P | Grounding lead from the PDWA to warning lights (later models only) |
| | Red | B/R | Grounding lead from RH seat belt switch to seat belt interlock (later models only) |
| | Slate | B/S | Grounding lead from RH seat sensor to seat belt interlock (later models only) |
| Blue | None | U | Power from the headlight switch to the dimmer switch |
| | Lt Green | U/LG | High speed power feed from WSW switch to wiper motor |
| | Red | U/R | Low beam power from dimmer switch to headlights |
| | White | U/W | High beam power from dimmer switch to headlights |
| Brown | None | N | Primary power feed, connected directly to the battery. These wires are NOT fused |
| | Lt Green | N/LG | Power return from WSW parking switch to wiper switch. This wire IS fused |
| | Red | N/R | (1) Feed from main power junction box to the alternator sensing input ('69 - '72 models only). This wire is NOT fused<br>(2) Power feed from ignition switch to gulp or anti run-on valve (Later models only).<br>(3) Hot when ignition key is off. This wire is NOT fused |
| | White | N/W | Primary power feed, connected to the ammeter on earlier models. These wires are NOT fused |
| | Yellow | N/Y | Alternator failure warning lamp connection to the alternator. This wire is NOT fused |
| Green | Black | G/B | Fuel gauge to sending unit |
| | Blue | G/U | Temperature gauge to sending unit |
| | Brown | G/N | Power from back-up light switch to back-up lights; high speed lead from switch to heater fan |
| | None | G | Main power feed to loads that are operable only when the ignition key is on. These wires ARE fused |
| | Lt Green | G/LG | Power feed from transmission neutral safety switch to seat belt interlock module (Circa '74, '75 models only) |
| | Purple | G/P | Power feed from brake light switch to brake lights |
| | Red | G/R | LH turn signal leads from TS flasher |
| | White | G/W | RH turn signal leads from TS flasher |
| | Yellow | G/Y | Oil pressure gauge to sender; Low speed lead from switch to heater fan |

# TR250/TR6 WIRE COLOR CODES

| Body | Tracer | Code | Usage |
|---|---|---|---|
| Lt Green | Black | LG/B | Power feed from switch to WS washer |
| | Brown | LG/N | Output of turn signal flasher to turn signal switch |
| | Green | LG/G | Output of hazard flasher from hazard flasher switch (later models only) |
| | Orange | LG/O | Grounding lead from seat belt interlock module to seat belt warning light (later models only) |
| | Pink | LG/K | Output from hazard flasher to hazard flasher switch (later models only) |
| | Purple | LG/P | Power feed from hazard flasher to hazard flasher warning light (early models only) |
| | Slate | LG/S | Power feed from hazard switch to turn signal flasher (later models only) |
| | White | LG/W | Bulb test relay to EGR switch and warning lamp ('76 model only) |
| Pink | White | K/W | Ballast resister wire |
| Purple | Black | P/B | Grounding lead from horn push button to horns or horn relay |
| | None | P | Power feed to loads that are hot all the time, key on or off. These wires are fused |
| | Red | P/R | Power feed from hazard flasher switch to hazard flasher/relay (early models only) |
| | Slate | P/S | Bulb test relay to oil and brake warning lamps ('76 model only) |
| | White | P/W | Grounding leads from door, trunk, and glove box switches |
| | Yellow | P/Y | Power feed from horn relay to horns |
| Red | Green | R/G | Power feed from headlight switch to fuse for parking, marker, tail, license plate, and gauge lamps |
| | None | R | Power to parking, marker, tail, license plate lamps, & dash light dimmer from fuse |
| | White | R/W | Power to gauge illumination lamps from dimmer rheostat |
| White | Black | W/B | Grounding lead from the PDWA to warning light (early models only) |
| | Brown | W/N | Grounding lead from oil pressure switch to warning light |
| | Orange | W/O | Start signal return from seatbelt interlock to starter relay ('74 only)<br>Start signal return “hardwired” from seatbelt interlock to starter relay ('75 only)<br>Signal from starter to “bulb test relay” and to seat belt module (’76 only) |
| | Purple | W/P | Grounding lead from oil pressure switch to gulp or anti run-0n valve (later models only) |
| | Red | W/R | Power feed from ignition switch to/from starter relay or solenoid (to seat belt interlock for circa '74 models) |
| | None | W | Power feed from ignition switch. Hot only when key is in run or start position These wires are NOT fused |
| | Yellow | W/Y | Ballast resister bypass lead from starter relay or solenoid to ignition coil (later models only) |
| Yellow | Green | Y/G | OD relay switching lead to OD switch (early models).Solenoid Power feed to OD &transmission permissive switches (later models) |
| | Purple | Y/P | Power feed from OD relay (early models) or OD switch (later models) to OD solenoid |
| | None | Y | OD relay switching lead from transmission permissive switches to OD switch (early models only) |

# 11
# ANTI RUN-ON VALVES

CIRCUIT DESCRIPTION

Around 1973, Triumph begin adding on various emissions control and safety equipment to meet increasingly stringent federal standards. Items added by Triumph included anti run-on valves. The purpose and mechanical operation of these valves is beyond the scope of this manual, but the electrical circuitry and operation will be covered.

**Figure 1** below shows the schematic diagram for an anti run-on valve. In this figure, the ignition key is on, but the engine isn't running, or, if it is running, there is no oil pressure. The valve has neither a source of power nor a ground, so it will be de-energized.

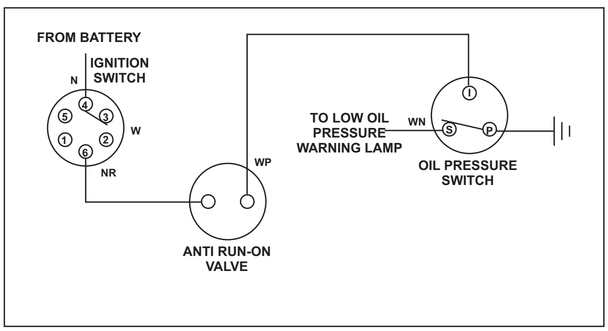



FIGURE 1

**Figure 2** below shows the situation after the engine is up to speed, and has sufficient oil pressure. In this case, the valve has a ground, but it still doesn't have a source of power, so  the valve is still de-energized.

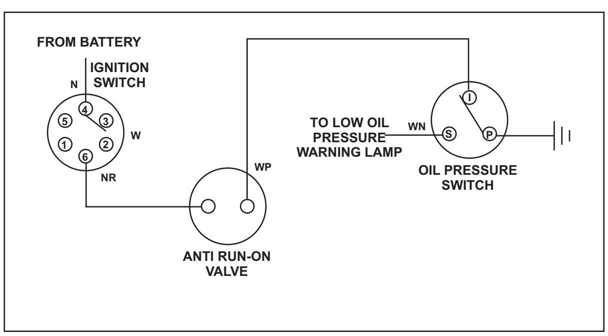



FIGURE 2

In **figure 3** above right, the ignition key has been turned off, but the engine is still running enough to maintain oil pressure. The valve now has both a source of power and a ground, and it is now energized. The current path is shown by the heavy lines.

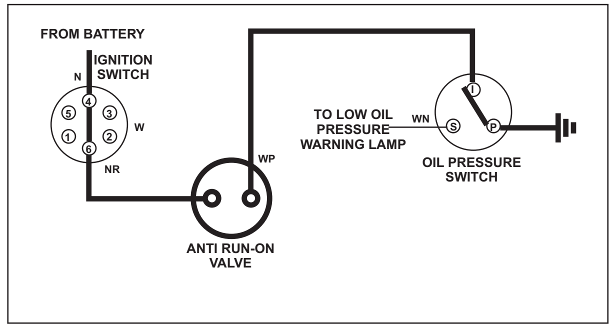



FIGURE 3

**Figure 4** below shows the condition after the engine has had time to coast down, and the oil pressure has dropped. The valve is once again de-energized.

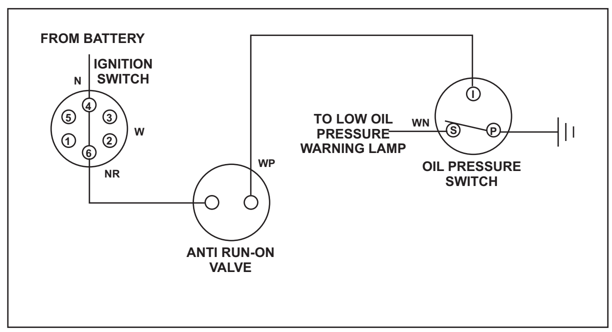



FIGURE 4

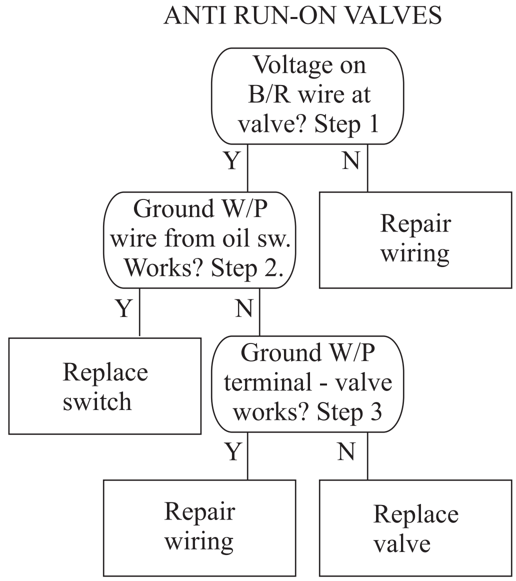
TROUBLESHOOTING

Step 1). With the ignition key in the off position, check for voltage on the brown/red wire at the valve. If you don't have voltage here, your ignition switch is bad, or there is a break in the N/R wire from the switch to the valve. If you do have voltage, go to step 2.

Step) 2. With the key still in the off position, remove the white/purple wire from the oil pressure switch and touch it to ground. If the valve works, your oil pressure switch is bad. If not, go to step 3.

Step 3). With the key still off, use a short piece of wire to short the valve terminal with the W/P wire to ground. If the valve works, you have a break in the W/P wire to the oil pressure switch. If not, the valve is bad.

# TROUBLESHOOTING FLOW DIAGRAM



# 12
# BRAKE AND BACK-UP LIGHTS

CIRCUIT DESCRIPTIONS

The brake and back up light circuits are virtually identical for all models, from the TR 250 to the '76 TR6. The only changes are in the physical routing of the wiring. I have included the diagrams for all models, showing these minor changes, but I'll only describe the circuit and trouble shooting procedures for the TR250, as they are the same for the other models as well.

These circuits are about as simple as you can get, consisting of nothing more than a simple SPST switch and two light bulbs each. See **figure 1**, below, for the details of the circuits for a TR250.

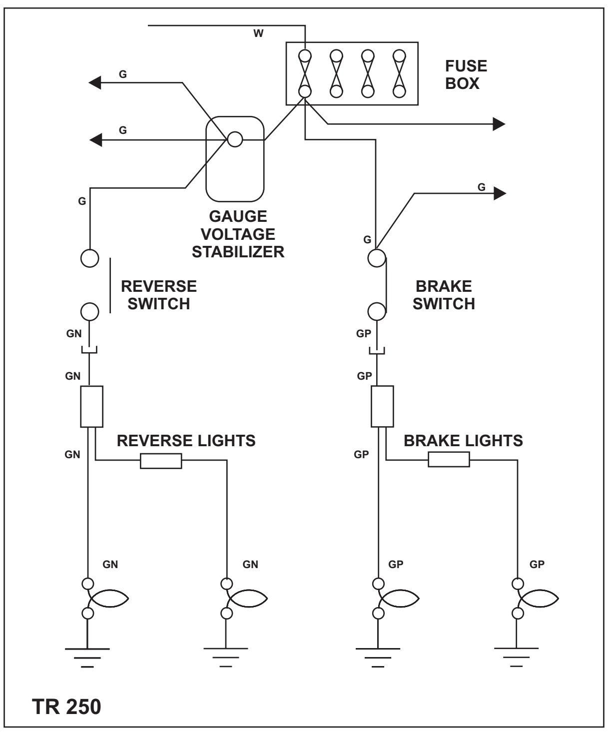



FIGURE 1

The reverse switch is located on the side of the transmission, with the wires coming through a hole in the transmission tunnel. When the transmission is in reverse, one of the shift levers inside the transmission presses on the reverse light switch, causing it to close. With the switch closed, and the ignition key in the on position, current flows from the "green" fuse, through the switch, and then to the backup lamps at the rear of the car.

The brake light circuit in a very similar manner, except the brake switch is mounted on the clutch and brake pedal support assembly, under the dash. There is a peculiarity, though, with the brake switch that might be a little puzzling at first.

The brake switch is a SPST, ***NC*** switch, meaning that the switch is closed when it is out of the car and on the workbench. In operation, when you remove your foot from the brake pedal and the pedal returns to its rest position, it presses against the brake switch and opens it. When you press on the pedal, even lightly, the pedal moves away from the switch and the switch closes. In other words, when you operate the brake, you "un-operate" the switch, causing it to operate the brake lights. Kinda confusing, huh?

Actually, though, there is a good reason for this. You want the brake lights to come on whenever you use your brakes, whether it be lightly, as when slowing down for a turn, or hard, as in a panic stop. If you had the brake pedal operating the switch when it was depressed, it would only operate at the end of its travel, which means it would only operate during a full panic stop. Without a lot of awfully complicated linkages, the switch would not be operated for a gentle stop. If you adjusted the switch to operate at the beginning of travel, the switch would prevent the pedal from traveling further.

TROUBLESHOOTING

As both the brake and the backup lights receive power from the "green" fuse, the first step is to determine if there is power at this fuse. The windshield wipers, windshield washer, turn signals, gauges, and heater fan all receive power from this fuse, so if ***ANY*** of these items work, then you have power at the fuse. If ***NONE*** of these items work, then you need to go to the power distribution chapter and resolve the power issue before proceeding. If you have power, then you can proceed with the troubleshooting steps.

BRAKE LIGHTS

A. Neither of the brake lights work.

Step 1). With a voltmeter or a test lamp, and with the ignition key on, check for voltage on the green wire (or wires) at the brake switch. If you have voltage here, go to step 2. If not, there is a break in the wiring somewhere between the switch and the fuse. There are no connectors between the brake light switch and the fuse, but there are one or two multi-conductor splices in the green wires on the ‘74 through ‘76 TR6 models, as shown in **figures 2** through **5** below.

Step 2). Depress the brake pedal and check for voltage again on the green wire You should have the same voltage as you had in step 1 if you are using a voltmeter, or the test lamp should be equally as bright as in step 1 if you are using a test lamp. If the results of this test are satisfactory, proceed to step 3. If not, you have a break in the wire or a bad connection somewhere between here and the fuse, causing the voltage drop which will have to be corrected.

Step 3). With the pedal still depressed, check for voltage on the green/purple wire at the brake switch. If the voltage or the test lamp illumination is the same as in test 1, proceed to test 4. If not, the, switch is bad and needs to be repaired or replaced.

Step 4). Locate the multiple pin connector which connects the wiring in the rear of the car with the under dash wiring. It is found on the side wall next to the clutch pedal. You may have to use a fine needle to pierce the insulation for this test. With the pedal depressed, check for voltage on the green/purple wire on the side of the connector nearest the rear of the car. The voltage, or lamp brightness, should be the same as for test 1. If so, proceed to step 5. If not, there is a break in the green/purple wire from the switch, or the connector is bad, and repairs will be needed.

Step 5). Proceed to the trunk and, for the TR6 only, remove the plastic panel at the left rear of the trunk. Check for voltage at the green/purple wire at the brake light, again with the pedal depressed. If you have no or low voltage here, there is a break in the wiring between the multi pin connector and this point. Except for the TR250, there are no connectors between these two points, so the only thing to go bad is the wire itself. For the TR250, there is one double bullet connector, located near the lamp assembly, where the wires split for the two sides of the car. This connector will have to be checked as well as the wire for this model. If you have full voltage here, your problem is either in the ground connection or in the light sockets. Repair or replace as needed.

Move over to the right side of the trunk and repeat the test there. For the TR250 only, there is another connector between the two sides which will need to be checked.

B. Only one of the lights work.

If one light works, you know you have power to the left hand light assembly (or connector for the TR250), so there is no need to run tests all the way from the front of the car. The first thing to check is the bulb on the bad side. If the bulb is good, then proceed with step 5 above to resolve this situation.

C. Lights work but are dim.

This is just a lessor case of A, so the same procedure could be followed. However, it might be easier to just trace the wires by hand, looking for bad connections or breaks. If you don’t find any by visual examination, then you will have to follow the above procedure.

BACKUP LIGHTS

With only minor differences, the procedure for troubleshooting the back up lights is the same as for the brake lights. To eliminate as much confusion as I can, however, I will repeat them here changing them as needed to reflect the minor differences.

A. Neither of the backup lights work.

Step 1). Locate the green and the green/brown wire where they pass through the transmission tunnel to the backup light switch on the transmission. With a voltmeter or a test lamp, and with the ignition key on, check for voltage on the green wire (or wires) at the connector just before the wires enter the tunnel. If you have voltage here, go to step 2. If not, there is a break in the wiring somewhere between the connector and the fuse, or there is one or more bad connections. The wiring for the backup lights follows a slightly more complicated path than the wiring for the brake lights. Refer to the appropriate diagram below for details. If the brake lights work, you know you have power to the brake light switch, or if the gauges work, you know you have power to the gauge voltage stabilizer, so this will limit you search, as the backup lights get their power from a common terminal on one or the other of these items, depending on the model.

Step 2). Place the transmission in reverse and check for voltage again on the green wire You should have the same voltage as you had in step 1 if you are using a voltmeter, or the test lamp should be equally as bright as in step 1 if you are using a test lamp. If the results of this test are satisfactory, proceed to step 3. If not, you have a bad connection somewhere between here and the fuse, causing the voltage drop which will have to be corrected.

Step 3). With the transmission still in reverse, check for voltage on the green/brown wire at the tunnel connector. If the voltage or the test lamp illumination is the same as in test 1, proceed to test 4. If not, the backup switch is bad or there is a break in the wiring between the tunnel connector and the switch. In this case, you are now going to have to get dirty by crawling under the car and repeating steps 2 and 3, only this time you will be checking at the switch itself, on the side of the transmission top cover.

Step 4). Locate the multiple pin connector which connects the wiring in the rear of the car with the under dash wiring. It is found on the side wall next to the clutch pedal. You may have to use a fine needle to pierce the insulation for this test. With the transmission in reverse, check for voltage on the green/purple wire on the side of the connector nearest the rear of the car. The voltage, or lamp brightness, should be the same as for test 1. If so, proceed to step 5. If not, there is a break in the green/brown wire from the switch, or the connector is bad, and repairs will be needed.

Step 5). Proceed to the trunk and, for the TR6 only, remove the plastic panel at the left rear of the trunk. Check for voltage at the green/brown wire at the backup light, with the transmission still in reverse. If you have no or low voltage here, there is a break in the wiring between the multi pin connector and this point. Except for the TR250, there are no connectors between these two points, so the only thing to go bad is the wire itself. For the TR250, there is one double bullet connector, located near the lamp assembly, where the wires split for the two sides of the car. This connector will have to be checked as well as the wire for this model. If you have full voltage here, your problem is either in the ground connection or in the light sockets. Repair or replace as needed.

Move over to the right side of the trunk and repeat the test there. For the TR250 only, there is another connector between the two sides which will need to be checked.

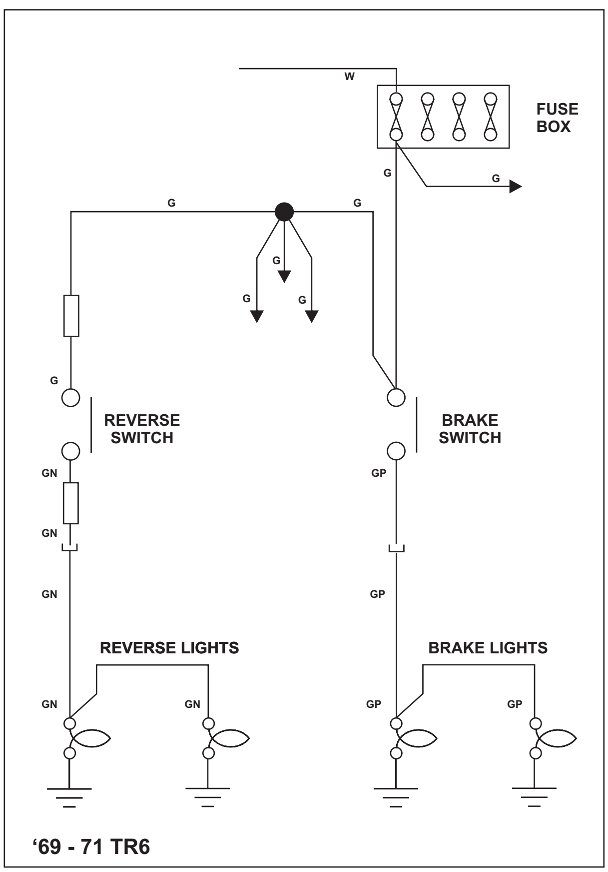



FIGURE 2

B. Only one of the lights work.

If one light works, you know you have power to the left hand light assembly (or connector for the TR250), so there is no need to run tests all the way from the front of the car. The first thing to check is the bulb on the bad side. If the bulb is good, then proceed with step 5 above to resolve this situation.

C. Lights work but are dim.

This is just a lessor case of A, so the same procedure could be followed. However, it might be easier to just trace the wires by hand, looking for bad connections or breaks. If you don't find any by visual examination, then you will have to follow the above procedure.

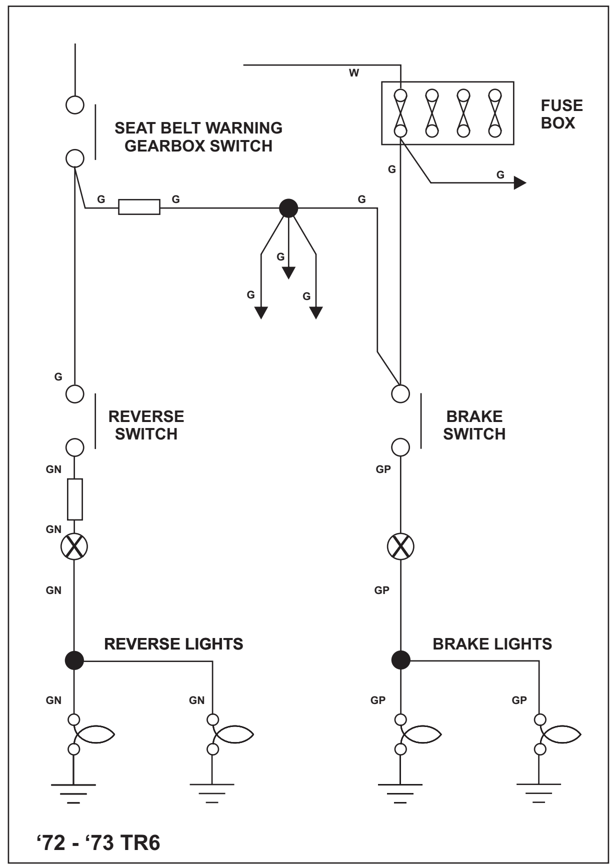



FIGURE 3

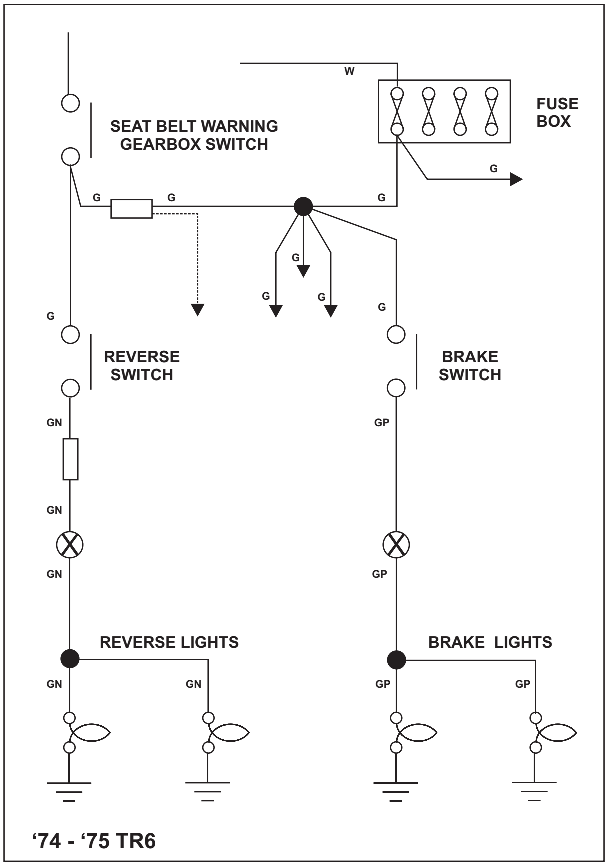



FIGURE 4

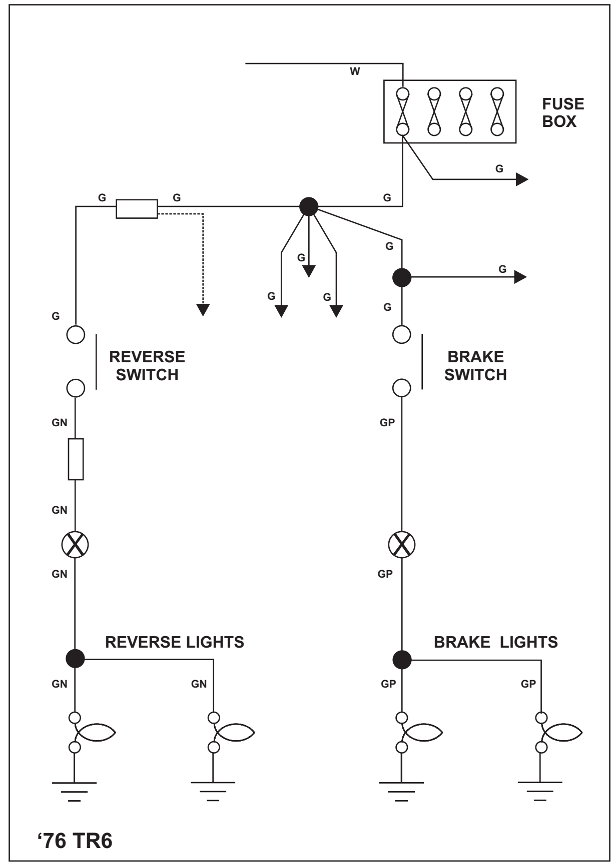
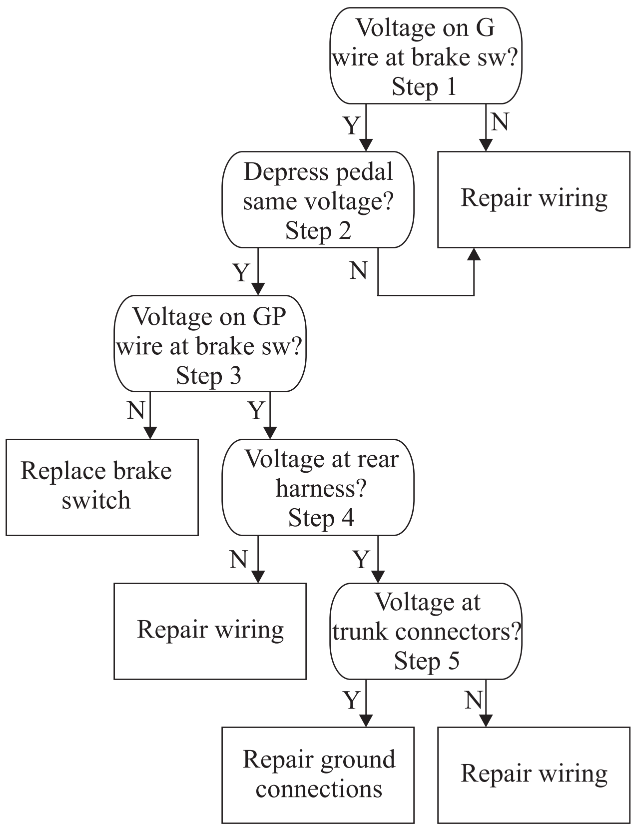


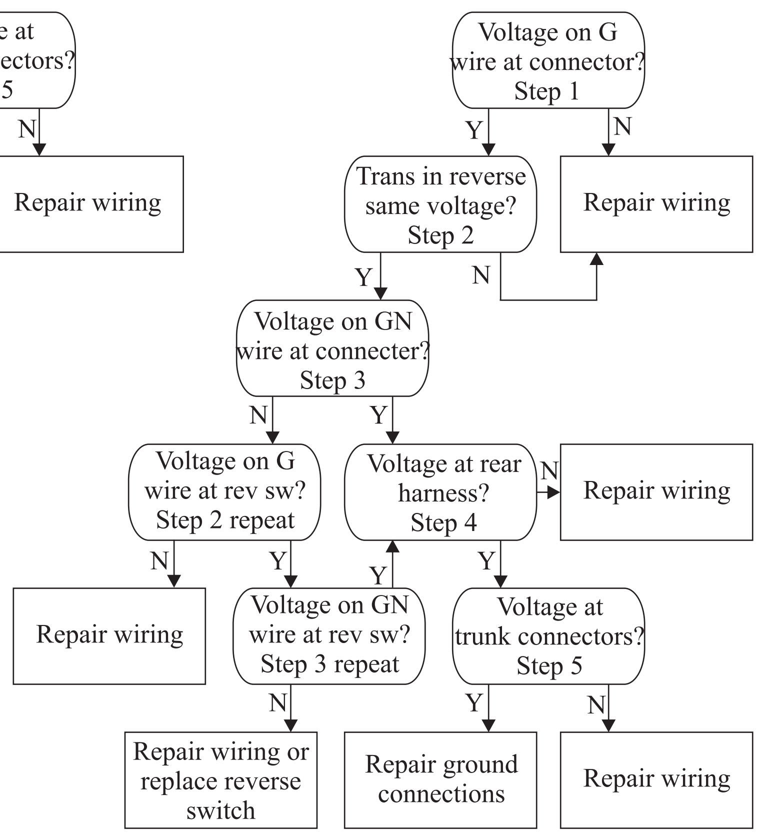

FIGURE 5

# TROUBLESHOOTING FLOW DIAGRAMS

## BRAKE LIGHTS




## REVERSE LIGHTS



# 13
# CHARGING CIRCUIT

GENERAL DESCRIPTION

Under normal operating conditions, all of the current used by your car is supplied solely by the alternator. Once the car is started and the alternator is up to speed, the battery isn't really needed. In fact, with the older model Triumphs with generators and a crank handle, you could do away with the battery all together. The generators had permanent magnets to provide the initial magnetic field, so the battery wasn't needed. In addition to the current required to operate your car and any electrical accessories you may have, the alternator also supplies the current needed to replenish the battery charge that was depleted by the starter when the engine was cranked. For more information on alternators and generators, refer to chapter 4, Alternator Operation.

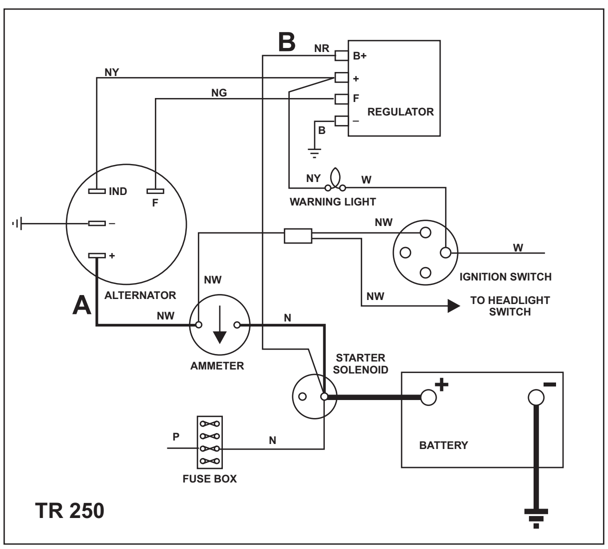



FIGURE 1

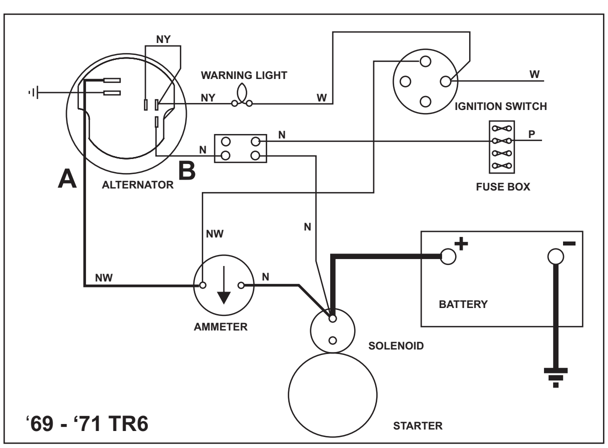



FIGURE 2

For the TR250 and the TR6 series, Triumph used three basic charging circuit configurations:

1) An externally regulated alternator with an ammeter was used on the TR250 only.
2) an internally regulated alternator with an ammeter was used on the '69 - '72 TR6 models.
3) An internally regulated alternator with a voltmeter was used for the '73 - '76 TR6 model.

Circuit diagrams for these three configurations are depicted in **figures 1, 2, 3,** and **4**, below. These diagrams do not depict all of the connections used by Triumph - only those for which documentation has been provided by official Triumph or Triumph approved publications, or for which I am personally acquainted. These cars have also appeared with other configurations at various times. I did not attempt to include every configuration, because of the uncertainty involved. I have no way of knowing if the different wiring schemes are original factory installations

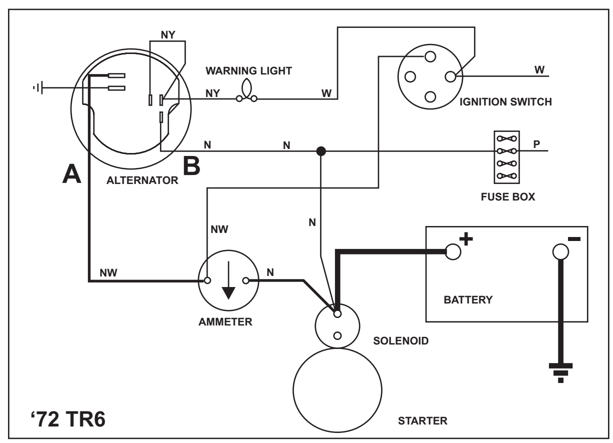



FIGURE 3

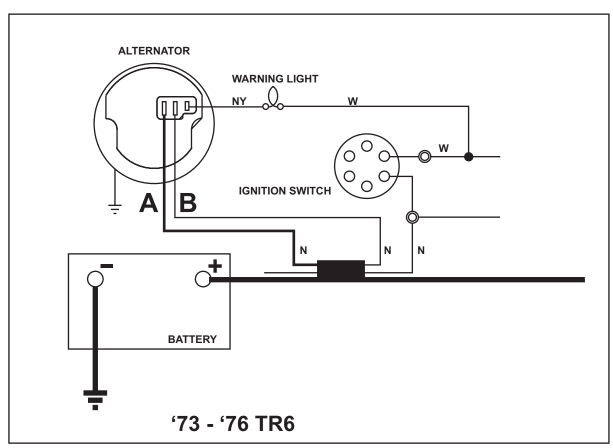



FIGURE 4

or modifications made by previous owners, and, in many cases, it is not possible to determine the exact wiring scheme without tearing up the wiring harness. As you can imagine, not many owners are willing to let me do that! In most cases, if not all, the differences between what is shown here and what may actually be installed are minor, and the following material is applicable to them as well.

TROUBLE SHOOTING

As a general rule, I recommend that you take your car to a battery or alternator dealer for testing, as they have the requisite equipment to do a proper and thorough test. There are, however, simple tests you can perform yourself, which may be sufficient to determine the fault.

The first test you can perform is one you should be performing on a regular basis anyway, every time you start your car: does the alternator warning lamp come on when you turn the key to the on position? If not, it is almost certain that your alternator won't work (in theory, it won't, but in practice it might - see chapter 4, Alternator Operation, for details). In this case, either the battery is dead, the warning lamp is bad, or the alternator is bad. If the battery will turn the engine over, then it is ok, so that only leaves the other two options.

TESTING PROCEDURES

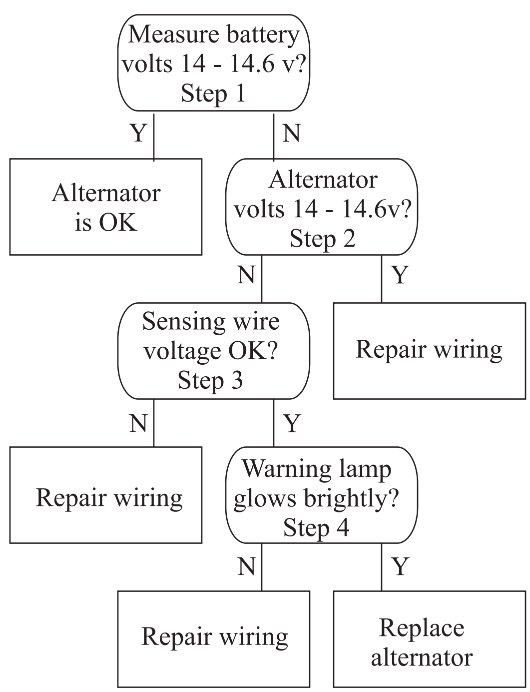
Step 1). With the engine running at a high idle - 1500 rpm or more, and a moderate load (headlights, for example) on the electrical system, measure the voltage at the battery positive terminal. It should be around 14 - 14.6 volts. Increase the electrical load to the maximum by turning on all electrical items, and re-measure the voltage. Voltage should not drop by more than one volt. If the voltage measurements are satisfactory, your alternator is OK; if not, proceed to step 2.

Step 2). Measure the voltage on the brown, or the brown/white wire, identified as "A" in the diagrams in **figures 1, 2, 3,** and **4**, at the alternator. The voltage here should be 14 - 14.6 volts for a moderate load, and 13 - 13.6 volts for a full load. If you have the correct voltage here, but not at the battery terminals, you have a high resistance in the wiring/connectors leading from the alternator to the battery, which will have to be fixed. If you don't have the correct voltage, proceed to step 3.

Step 3.) With the engine off, measure the voltage at the battery, and then measure the voltage at the small brown wire where it enters the alternator (TR6), or at the brown/red wire where it connects to the regulator (TR250). These wires are the voltage sensing lines, and are identified as "B" in the diagrams. The two voltage readings should differ by no more than 0.2 volts. If you find a voltage difference of more than that, you have a high resistance in the wiring/connections which will need to be repaired. If you have the same voltage, go to step 4.

Step 4). with the engine off and the key in the "RUN" position, remove the wiring plug from the alternator and short the brown/yellow wire to ground (if you have a five wire connector, either of the N/Y wires will do). The alternator warning lamp should glow brightly. If not, either the bulb is bad or there is a high resistance in the circuit. Repair or replace as required. If the bulb does light up properly, your alternator is defective.

TROUBLESHOOTING
FLOW DIAGRAM



# 14
# COURTESY LIGHTS

COURTESY LIGHT CONFIGURATIONS

Starting with the TR6, Triumph TRs begin to appear with what are known as "courtesy" lights. For the '69 model, these lights consisted of a trunk light, a glove box light, and a transmission tunnel mounted interior light, as shown in **figure 1**, top right.

For the '70- '71 models, a light was added to the ignition switch, to help you find the keyhole in the dark, along with a buzzer to remind you to take your key with you when you leave the car. See **figure 2**, bottom right, for details.

For the '72 model, a seat belt warning system was installed, which included a dash mounted warning light. Through the use of a diode, the ignition key warning buzzer also served as an audible warning that the belts weren't properly fastened This function is discussed in chapter 24, Seat Belt Interlocks. Otherwise, the courtesy lights for this year is identical to the previous years, as shown in **figure 2**, bottom right.

For the '73 model, the tunnel light was replaced with a footwell mounted light, attached to the underside of the dash where it would shine into the passenger footwell. The remainder of the circuit, including the seat belt portion, remained much the same as for the '72 model. See **figure 3**, next page, for details.

The '74 - '76 courtesy lights remained the same as the '73, except for the ignition warning buzzer. The seat belt circuit was extensively revised, and the seat belt buzzer served double duty as the ignition key warning buzzer. See **figure 4** for details of the courtesy lights, and chapter 24 for the seat belt circuit.

SWITCHES

With the exception of the ignition key lamp (and the buzzer) on the '70 - '72 models, all of the courtesy lights are ground switched, that is, power is applied at all times, but the connection to ground is turned on and off to operate the lights. With the exception of the manual switches for the transmission tunnel or the footwell lights, all of the switches are of the momentary type. The tunnel or footwell light switches are SPST, maintained switches. The driver's door switch on the '70 - '76 models is a DPST switch, with two normally closed contact sets (one for the courtesy lights and one for the seat belt system), while the ignition key switch is a normally open type. The remainder of the switches are SPST, normally closed. See chapter 9, Switches, Relays, and Solenoids for more information about these switch types.

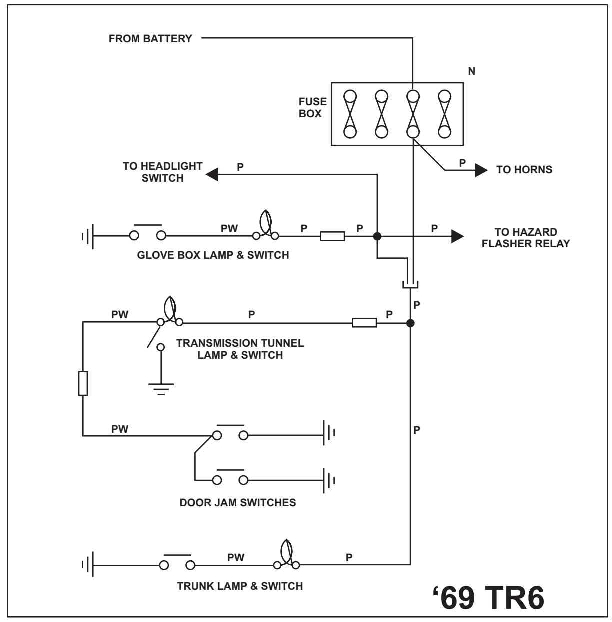



FIGURE 1

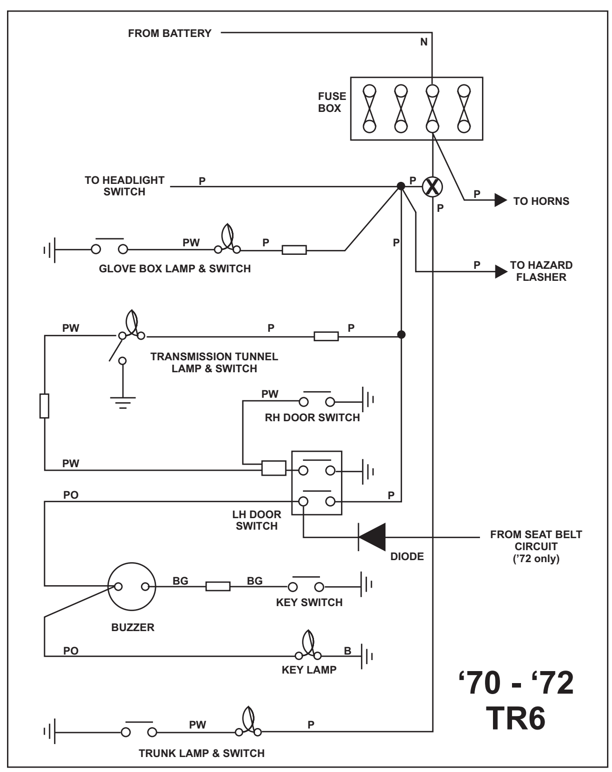



FIGURE 2

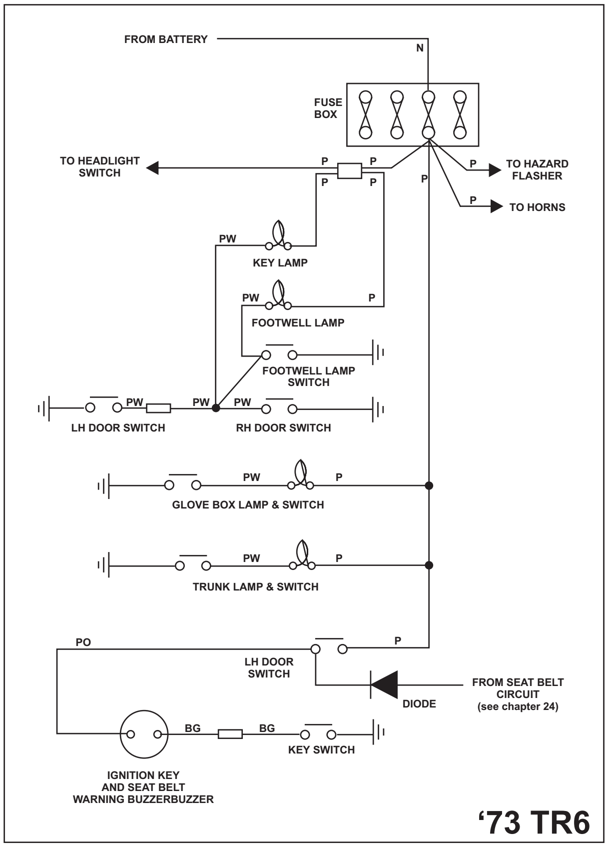



FIGURE 3

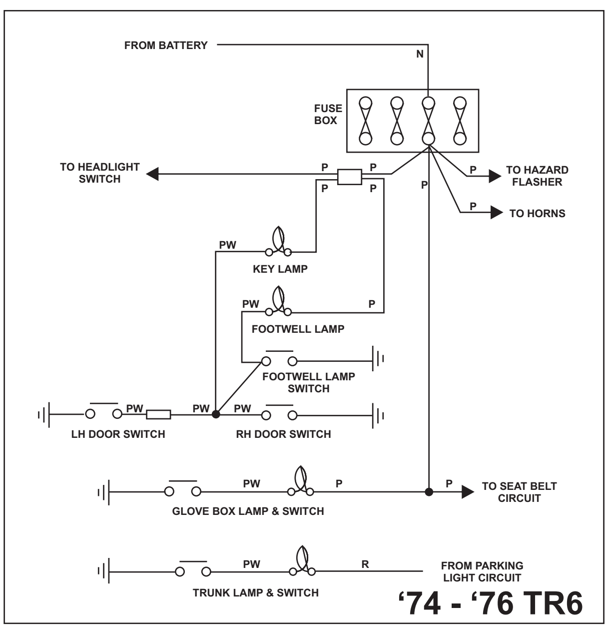



FIGURE 4

CIRCUIT OPERATION

'69 TR6: As might be expected, this earliest TR6 is the simplest. All of the lamps receive power from the "purple" fuse, which is hot all the time. When either door is opened, the spring loaded momentary switch mounted in the door jam closes, grounding the tunnel light, which is then illuminated. A similar arrangement exists for the glove box door and the trunk lid. The glove box switch is mounted in the upper right hand side of the box, and the switch for the trunk light is mounted on the support bracket for the gas tank, operated by the RH trunk lid hinge. The trunk switch can be seen by looking into the hinge slot cut out of the fiber board at the back of the trunk. The transmission tunnel light also has a slide switch to allow manual operation of the light with the doors closed.

'70 -'71: For these model years Triumph added an ignition switch light, ignition key warning buzzer, and a key operated switch, as shown in **figure 2**, previous page. When the key is inserted into the ignition lock, one side of the buzzer is grounded. Unlike all the other courtesy lights, the ignition lock illumination light is always grounded. Neither the ignition light nor the buzzer receive power until the driver's door is opened. When the driver's door is opened, the DPST switch contacts close. One side of the switch operates the transmission tunnel lamp just as in the '69 model, while the other side switches power from the "purple" fuse to the buzzer and the ignition light. The key light, being grounded, will now light. The buzzer will also sound if the ignition key is inserted into the ignition lock.

The ignition light/buzzer circuit is a nifty little design. As long as you hold the driver's door open, the ignition lock will be lighted to help you find the keyhole, and if you open the driver's door with the key still in the lock, the buzzer will sound to remind you to remove it.

'72: The courtesy light setup remained the same for '70 - '71, but a seat belt warning system was added, which utilized the same ignition key buzzer (and key light) for the seat belt warning. If the seat belt interlock system is not satisfied, power is fed from that system to one side of the driver's door switch, powering the buzzer and the key light just the same as if the door were open. However, as only one side of the door switch is used to switch power, the other side being a ground side switch, only the buzzer and the key light operate. The transmission tunnel light will not be operated by the seat belt interlock system. For more details on the seat belt interlock system, refer to chapter 24.

'73: this model year retained the seat belt interface of the previous years, but the courtesy light circuit was changed to be the almost same as the '74 - '76 models (the trunk light circuit remained the same as before). Refer to the sections above for the seat belt interface, and the section below for the remainder of the courtesy light operation.

'74 - '76: interestingly, with two minor exceptions and the replacement of the transmission tunnel light and switch with the a footwell light and dash support mounted switch, the courtesy light circuits for these years revert back to the same operation as the '69 - '71 models. One of the exceptions is the trunk light. The operation and switch location is the same, but the power source is now from the parking light circuit, fed from the "red" fuse. The trunk light will now only operate if you have the headlight switch on, either in the park position or the full headlights-on position. The other exception is the operation of the ignition key light. Unlike the previous models, the key light now comes on any time the footwell light is on. Both lights are on if either door is open or the switch is operated. This manual switch is a pull on - push off, maintained switch, and is mounted on the center dash support.

TROUBLESHOOTING

A) All except key light and buzzer,

With the exception of the trunk light on the '74 - '76 models, the courtesy lights get their power from the "purple" fuse, which also supplies power to the headlight "flash to pass" switch, the hazard flasher, and the horns. If ***ANY*** of these other items work, you have power to the "purple" fuse. If ***NONE*** of these items work, then you need to refer to the chapter 23, Power Distribution, and resolve the power issue before proceeding. If you have power, then you can proceed with the troubleshooting steps. Likewise, the trunk light ('74 - '76) gets its power from the "red" fuse, which also feeds the parking lights, marker lights, license plate lights, and the gauge illumination lamps. If **NONE** of these items work, refer to chapter 16, Headlights, before proceeding.

Step 1). The most common problem by far with these lights are the momentary switches (see typical example in **photos 1** and **2**, right). These switches do not have the wiping action of most other switches, so the contacts are not self cleaning, and can develop a thin film of corrosion over time. Therefore, it follows that this should be the first place to look for problems. With the exception of the key light and buzzer in the '70 - '73 models, all lights are grounded to operate, and the grounding wires are all purple/white. Using a short test lead with an alligator clip on one end, fasten the alligator clip to a good ground and touch the other end of the test lead to the purple/white wire at the switch. If the light works when you do this, the switch is either bad or not making a good ground connection to the body. I don't recommend removing the purple/white wires from the switch for testing, as they may be damaged in the process. Over time, with corrosion buildup, the bullet connectors on these wires have become one with the switch sockets, and can be quite difficult to remove. Only after you've determined that the switch is bad should you remove the wires, and you may have to replace the bullet connectors after you do.

Step 2). If grounding the purple/white wires doesn't cause the light to operate, then you will need to test for voltage on the purple (or red) wire feeding the light, measured with a voltmeter or test lamp at the light socket connection. If you have 12 volts here, the bulb or the bulb socket is bad. Proceed to step 3. If you don't have voltage here, there is a break or a bad connection in the purple (or red) wires somewhere, and will need to be fixed. Using your test lamp, follow the purple (red) wire from the bulb socket back to the fuse, until you reach the point where you do have voltage. Use the diagrams on the previous page as a guide for your voltage tests. When you reach the point where you have voltage at one place, but not the next, you know your break is at that point. Refer to chapter 3, Bad Grounds and Connections, for more information on tracing wiring.

Step 3). Remove the bulb and test it, using your test leads. If the bulb is OK, then you need to repair the socket. Often, there is a lot of corrosion, usually on the contact pad in the bottom of the socket connected to the purple wire, which will need to be cleaned. A pencil eraser works well for the contact pad, while steel wool is a good choice if there is corrosion on the sides of the socket.

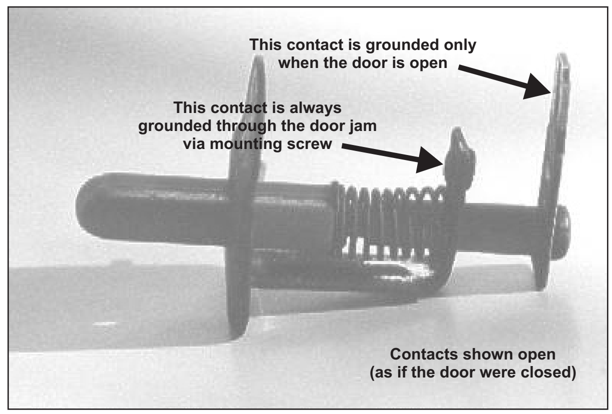



PHOTO 1

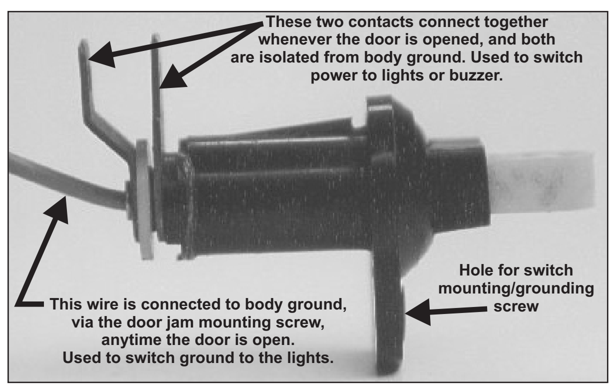



PHOTO 2

B) Key light and buzzer.

Unlike the other courtesy lights, the key light has its power switched, rather than ground. The warning buzzer is even odder yet, in that it has both the power and ground switched. These differences call for a slightly different approach to trouble shooting.

Step 1). What are the symptoms (with the driver's door open, of course)?

i) The key light works, but not the buzzer? Go to step 2.

ii) The buzzer works but not the light? Go to step 3.

iii) Neither one works? Go to step 4

Step 2). If the key light works, then you know you have power through the door switch to the buzzer and the light, so there is no need to check for that. Find the black/green wire from the ignition key wiring, and locate the bullet connector in this wire. Using your test lead with the alligator clip, connect the alligator clip to a good ground and touch the other end to the black/green wire at the connector. If the buzzer now works, you have a bad switch or ground connection in the switch, or the black/green wire connection to the switch is bad. If not, the buzzer is probably bad. Remove the buzzer from the car, and, using test leads, connect the buzzer directly to the battery or a power supply/battery charger. If the buzzer still doesn't buzz, it is defective and should be replaced.

Step 3). As before, if the buzzer works, you know you have power to the buzzer, and should also have power to the light. Using your voltmeter or test lamp, check for power on the purple/orange wire at the key light. If you have power here, go to step 6. If not, there is a break in the P/O wire from the buzzer, or the P/O wire to the light is not making a good connection to the terminal on the buzzer. Replace or repair as needed.

Step 4). If neither item works, the most likely problem is a bad door switch. Using your voltmeter or test lamp, check for power on both the purple and the purple/orange wire at the door switch.

If you don't have power on the purple wire, there is a break or bad connection in the purple wire from the fuse. Repair or replace as needed.

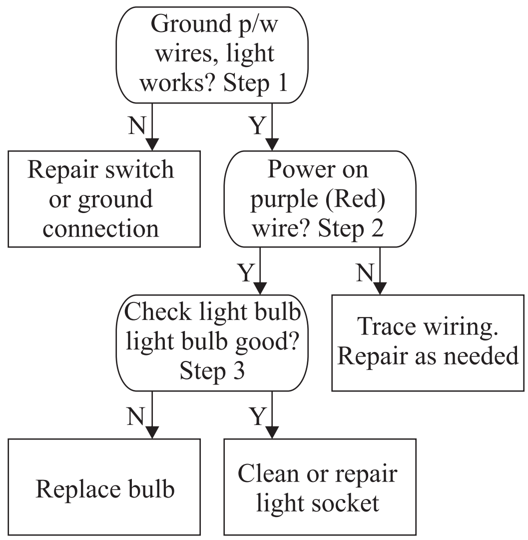
If you have power on the purple wire, but not on the P/O, the switch is bad and needed to be replaced or repaired.

If you have power on both wires, the purple and the P/O, move your meter or test lead to the buzzer terminal with the P/O wires on it and check for voltage there. If there is no voltage, repair or replace the P/O wiring. If you do have voltage, then you really had two problems to begin with, problems 1 and 2 above. Follow the procedures for both of these problems.

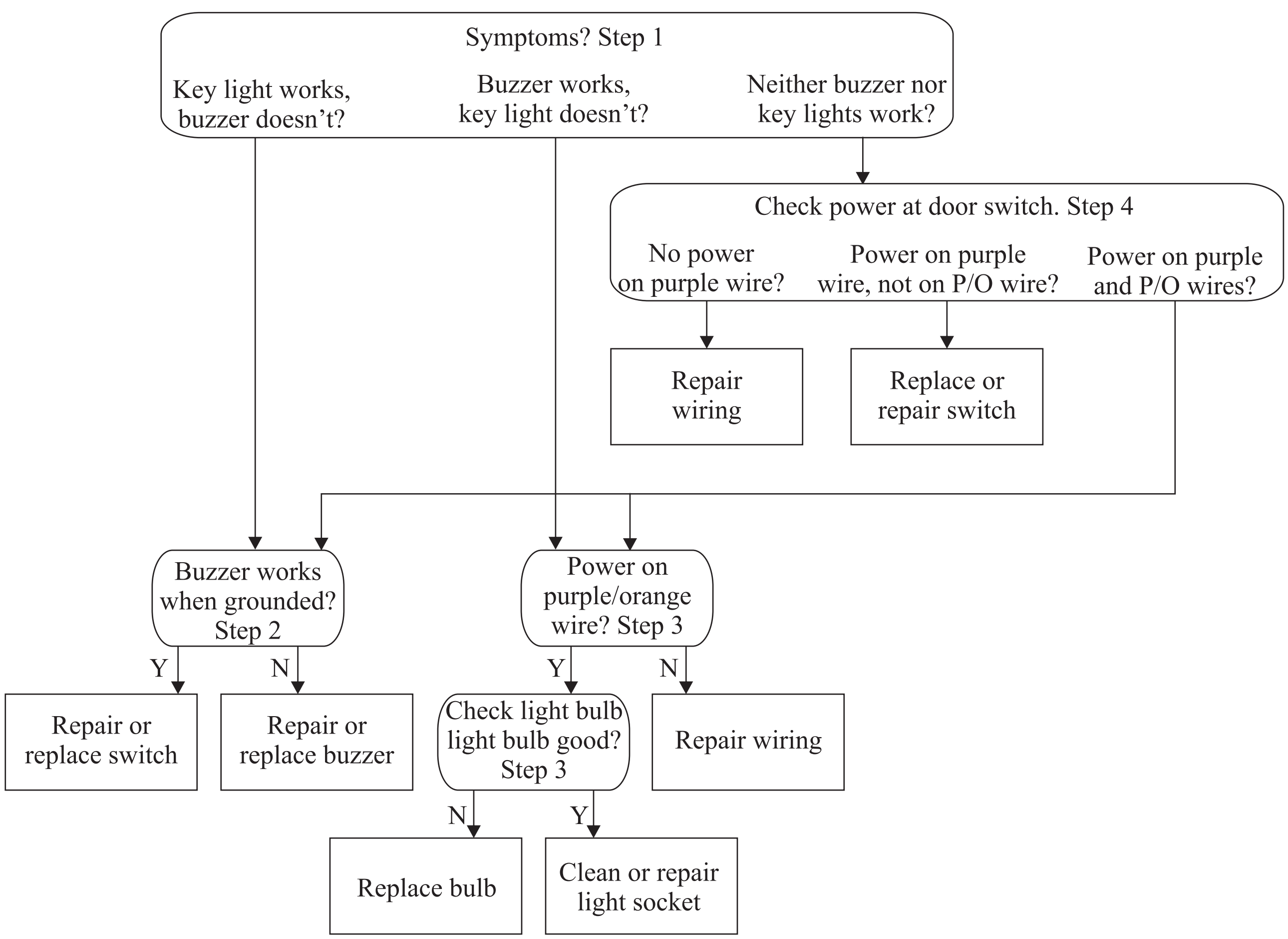
Step 6). Remove the bulb and test it, using your test leads. If the bulb is OK, then you need to repair the socket. Often, there is a lot of corrosion, usually on the contact pad in the bottom of the socket connected to the purple wire, which will need to be cleaned. A pencil eraser works well for the contact pad, while steel wool is a good choice if there is corrosion on the sides of the socket.

# TROUBLESHOOTING FLOW DIAGRAMS

## ALL, EXCEPT KEY LIGHT AND BUZZER




## KEY LIGHT AND BUZZER



# 15
# GAUGES

GAUGE OPERATION

Of the six gauges found in a TR250 or a TR6, three are electrically operated (water temperature, fuel level, and ammeter or voltmeter) while the remaining three (speedometer, tachometer, and oil pressure) are mechanically operated. This being an electrical repair manual, the mechanical gauges will not be addressed. The TR250 through the '72 TR6 models had an ammeter, while the '73 through '76 TR6 models came equipped with a voltmeter. All models covered had electrical fuel level and water temperature gauges.

Unlike the gauges used in earlier Triumphs, the voltmeter, fuel, and water gauges are of the bimetal, or thermal, type. **Photo 1**, below, shows the internals of a thermal meter. The ammeter is of an entirely different type, and will be discussed later. Within the body of a thermal meter is a bimetal strip, a pair of dissimilar metal strips bonded tightly togther. Surrounding these strips is a coil of resistance, or heater, wire. As electrical current flows through the coil, it heats up, just as the coils in a space heater do (although obviously not as hot). Because the two strips are of dissimilar material, they expand at a different rate in response to temperature changes. As one piece gets longer than the other, they must bend to compensate, the piece on the outside of the curve being longer than the piece on the inside.

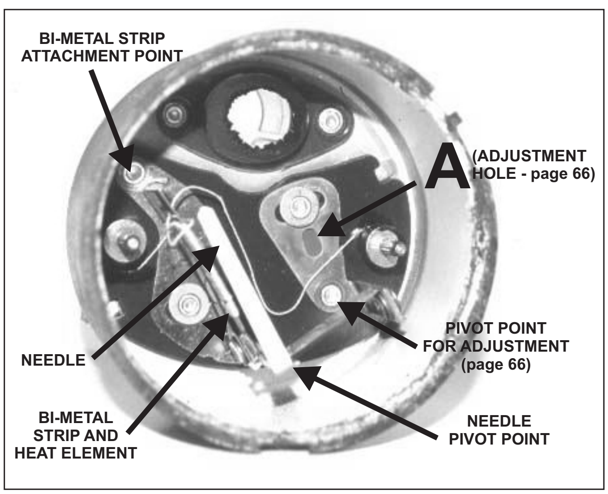



PHOTO 1

One end of the bimetal strip is permanently attached to the meter housing, while the other end is free to move. The meter needle is mechanically connected, through a series of levers and pivots, to the free end of the strip in such an arrangement that the motion of the needle indicates the amount of movement. As the amount of movement is dependent upon the temperature of the wire coil, and the temperature of the wire coil is dependent upon the current flow, the needle, in effect, is reading the amount of current flowing through the meter.

If a way can be found to relate the current flow to a physical parameter, such as water temperature, the needle movement will then correspond to the value of the parameter. And, of course, there is a way, as illustrated in **figure 1**, below. The resistance of the fuel sender varies as the fuel level varies, and the resistance of the temperature sender also varies as the water temperature varies. As current is equal to voltage divided by resistance, if we can keep the voltage constant, and let the resistance in the circuit vary according to temperature or fuel level, the current will then be a function of temperature or fuel level.

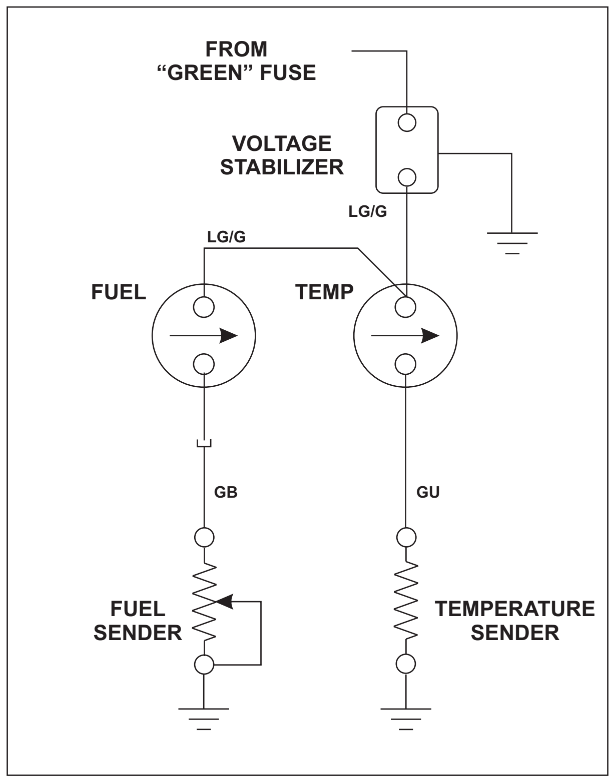



FIGURE 1

If the voltage isn't kept constant, the gauge readings will also vary with voltage, depending on the engine rpm, battery condition, electrical loads, etc. To ensure a constant voltage, a voltage stabilizer is used. Similar to the gauges, the voltage stabilizer also has a bimetal strip, but this strip is connected to one of a pair of electrical contacts, the other contact being fixed. When the strip is cold, it is straight, and the two contacts touch, creating a path for current flow. As the strip is heated by the flow of current, it bends, separating the contacts and cutting off the current flow. The contacts stay apart until the strip cools, at which time it straightens out, and the contacts touch again, starting the cycle all over. **Photo 2** below shows the internals of a voltage stabilizer, and **figure 2** below shows a schematic diagram for it.

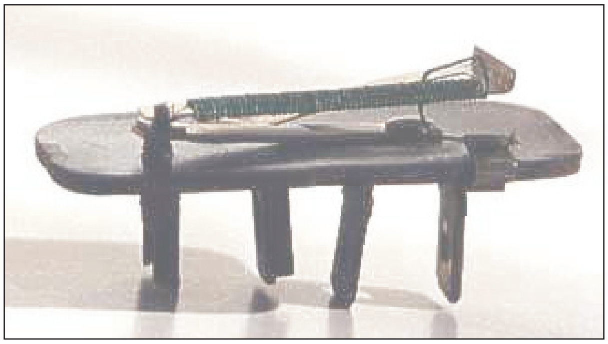


PHOTO 2

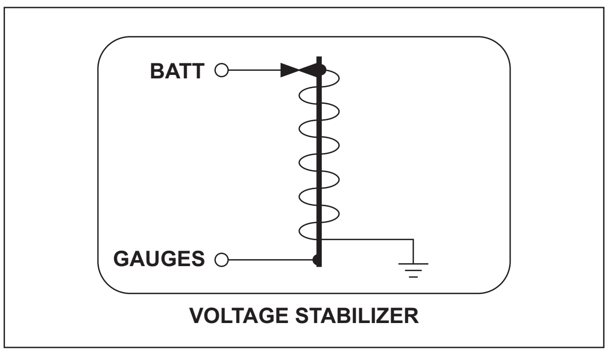



FIGURE 2

Notice in **figure 2** that the coil is connected between ground and the battery when the contacts are closed, but the gauges are connected directly to the battery terminal. With the arrangement, the gauges receive full battery voltage with the contacts closed, and zero voltage when the contacts are open. The voltage seen by the gauges, then, consists of a series of ON-OFF operations, swinging from 12 volts to zero volts and back again, as shown in **figure 3**, above right. The average voltage seen by the gauges depends on the relative amount of time the contacts are closed as compared to the time they are open. If the two times are equal, the average voltage seen by the gauges is 50 % of battery voltage. If the contacts are open one half as long as they are closed, the average voltage will be 66.7%, and so on. With a battery voltage of 14.6 volts, and a 68.5% on-off ratio, the average voltage seen by the gauges will be about 10 volts, which is the correct value for a TR250 or a TR6.

But what if the battery voltage isn't 14.6, but a lower value, such as 12.6? In this case, the current through the heat element will be less, and it will take the element longer to heat the bi-metal strip to its opening temperature. As the bi-metal strip opens at the same temperature, regardless of current, it will still take the same amount of time to cool off enough to re-close the contacts. Thus, the on time will increase compared to the off time, so the gauges will see a higher percentage of the battery voltage - ideally, the same 10 volts as before, or 79.4% of battery voltage. In the same manner, if the battery voltage increases, the strip will heat up faster, reducing the on to off ratio.

The ON-OFF ratio is, however, not adjustable, so if it is off, the stabilizer will have to be replaced. Unfortunately, unless you have some specialized equipment, or know how to rig up a special test set-up, you can't measure the average voltage - your meter needle will just swing from one extreme to the other. The only way to know that the stabilizer voltage is off is if both the fuel meter and the temperature meter are showing the same error, high or low.

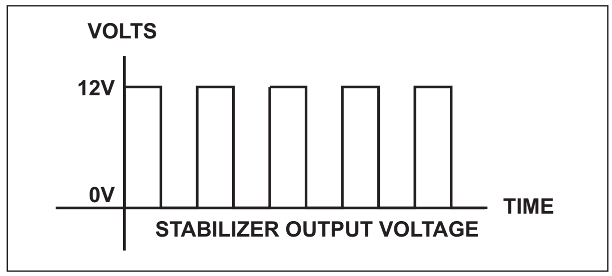



FIGURE 3

In **photo 3** below, I have shown the interior of a fuel sender. As the fuel level rises and falls, the lever attached to the float rotates around the pivot point, moving a wiper across the resistance wire. When the fuel tank is near empty, the float is near the bottom, and the wiper is near the end of the resistance wire. The entire length of the wire is now in the circuit, and the sender resistance is maximum. As the fuel level rises, the float also rise, moving the wiper to the beginning of the wire, offering the minimum resistance to the circuit.

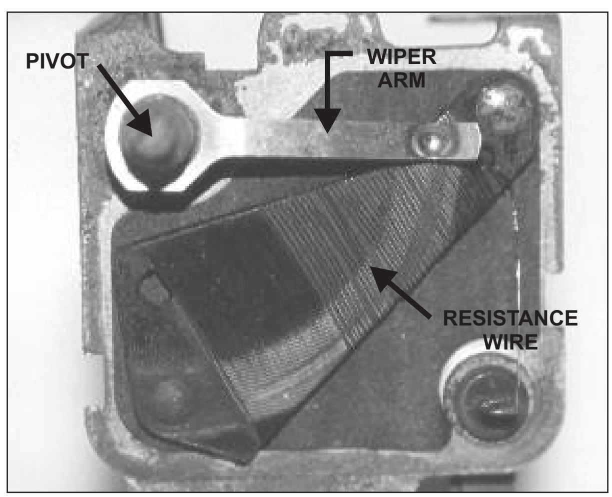



PHOTO 3

Internally, a voltmeter is constructed the same as the fuel level and water temperature gauges (isn't it interesting that we call those indicators "gauges," but we call a voltage indicator a "meter!"), but it has a higher resistance heater coil, and is designed to connect directly between a full 12 volt source and ground. Obviously, the voltmeter isn't connected to the voltage stabilizer, for the exact opposite reason we connect the other meters to it. We don't want voltage variations to alter the fuel level reading, for example, but voltage variations are exactly what we want to see on the voltmeter. Figure 4 below illustrates the voltmeter connections as used in the '73 - '76 model TR6. Also illustrated in **figure 4** is an ammeter

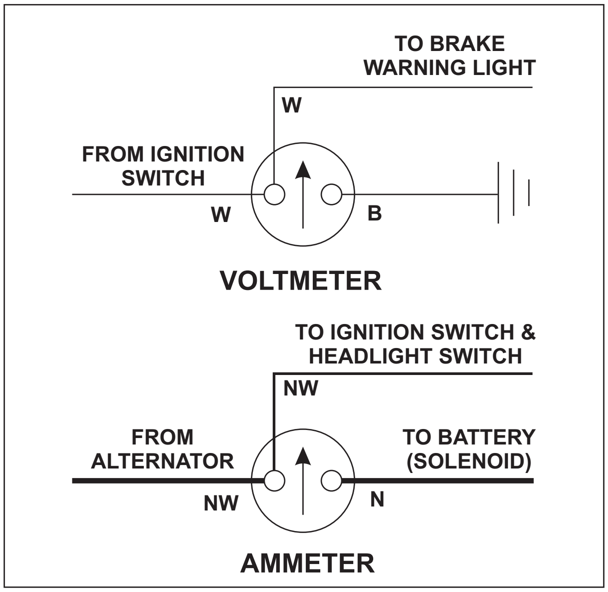



FIGURE 4

circuit. An ammeter operates on a different principle than the other meters discussed above. As shown in **photo 4** below, current is passed through a loop of wire, (**A**), inside the meter. Current flow through a loop of wire creates a magnetic field around the wire. This magnetic field interacts with an iron pole piece, (**B**), which is coupled to the needle. The iron pole piece rotates in response to the magnetic field. The direction of rotation is determined by the direction of the current, and the amount of rotation is determined by the strength of the current.

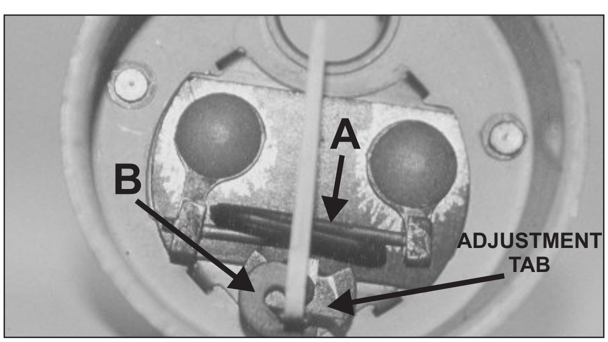



PHOTO 4

The response time for the ammeter to react to a change in current is virtually instantaneous, while the thermal type gauges are quite sluggish in their response to a change in resistance. There is no particular advantage to a quick response time for any of the gauges, but a slow response time is an advantage for the fuel gauge. Under no reasonable condition will the engine coolant temperature change rapidly, and sudden changes in charge/discharge current, such as when turning on or off electrical loads, are little concern as compared to long term discharge indications. A rapidly responding fuel gauge would be a real nuisance, in any car, but especially so in a sports car. Fuel sloshing around in the tank when the car is cornering or bouncing over bumps would cause the needle in the fuel gauge to bounce all over the dial, making it difficult, if not impossible, to get a good indication of the actual fuel level.

AMMETER OPERATION

The operation of the gauges described above, voltmeter, fuel gauge, and water temperature gauge, is pretty straight forward and simple. At first glance, the ammeter operation appears to be just a simple and straight forward, but it is just a bit more complicated than it seems. **figure 5** below depicts the operation of the ammeter under normal operating conditions, with the battery fully charged, the alternator working as it should, and the electrical load within the capacity of the alternator. ***ALL*** of the electrical load is being supplied by the alternator, and it is also supplying a small charge current to the battery to maintain its charge. The battery is not supplying any current at all.

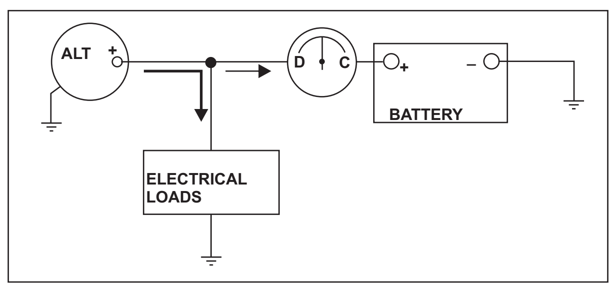



FIGURE 5

**Figure 6** shows the same conditions, except the battery has been discharged quite a bit by starting the car, and the alternator is now having to supply the full electrical load ***and*** provide a fairly large current to recharge the battery.

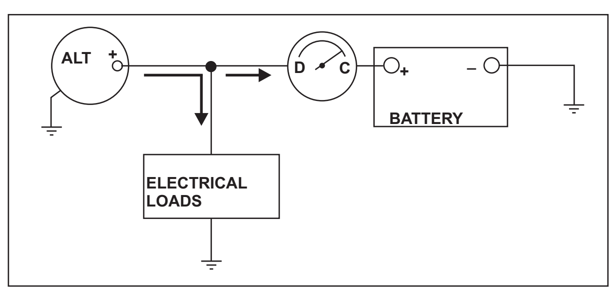



FIGURE 6

In this situation, the capacity of the alternator must be equal to the electrical load AND the recharging current. If not, you will see a noticeable dimming of your lights. In this case, the ammeter will show a fairly large charge current.

In **figure 7**, the electrical load exceeds the capacity of the alternator, and the battery is making up the difference. The ammeter will show a discharge. Typically, this is a small discharge, but if the electrical load is very excessive, the discharge current can be quite large.

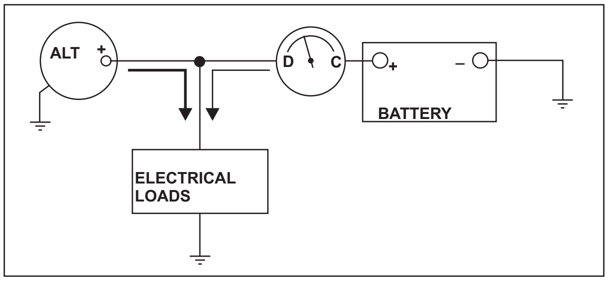



FIGURE 7

In **figure 8**, the alternator has completely failed (or the engine is not running). The total electrical load is now supplied by the battery, and the ammeter reads a heavy discharge current.

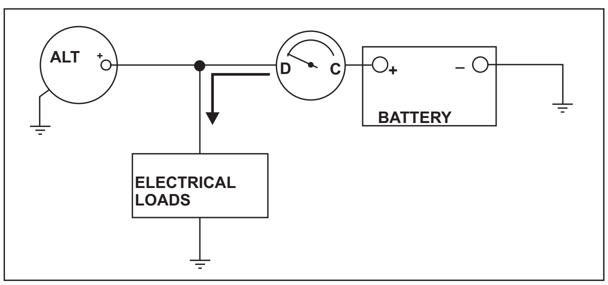



FIGURE 8

**Figure 9** represents a more realistic configuration, and one that is seen in the TR250 and the ‘69 - ‘73 TR6 range. Some of the electrical loads have been connected on the battery side of the ammeter, rather than on the alternator side. These loads are non-metered, and will not show on the ammeter. If everything is working as it should, and the

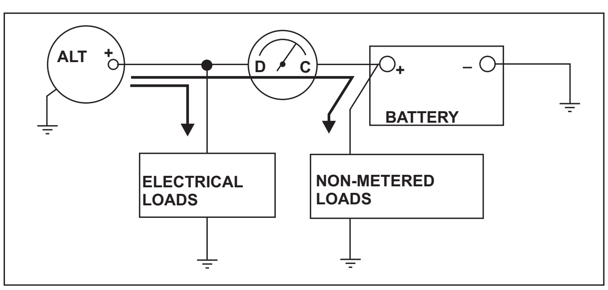



FIGURE 9

alternator is supplying the full metered load, operating any of the non-metered loads will cause the ammeter to show a *charge* current. In the TR250/TR6, the horns and the high beam “flash to pass” function are non-metered. If you blow the horn or flash your headlights, the ammeter will show a charge reading.

**Figure 10** illustrates what happens if you should upgrade your alternator with a more powerful unit, one whose output can exceed the range of the ammeter, and the ammeter has been bypassed with a larger wire directly to the battery. As you can see, every metered load in the car will show as a discharge current, and you will have no indication at all as to any charging current that may be going into the battery.

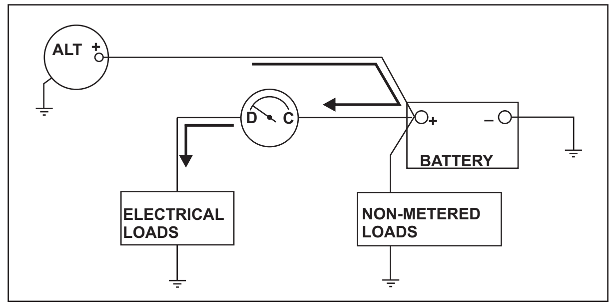



FIGURE 10

TROUBLESHOOTING

Fuel level and water temperature gauges

As both gauges receive power from the stabilizer, and the stabilizer receives power from the “green” fuse, the first step is to determine if there is power at this fuse. The windshield wipers, windshield washer, turn signals, brake and backup lights, and heater fan all receive power from this fuse, so if ***ANY*** of these items work, then you have power at the fuse. If ***NONE*** of these items work, then you need to go to chapter 23, Power Distribution, and resolve the power issue before proceeding. If you have power, then you can proceed with the troubleshooting steps.

Step 1. What are the symptoms?

a) Both gauges are operable, but read incorrectly by about the same amount? The only commonality the two gauges have that would produce this symptom is the voltage stabilizer, which will need to be replaced.

b) Both gauges read zero - no movement at all from the rest position? Go to step 2.

c) Each gauge has a different symptom?

i) gauge reads zero? Go to step 5.

ii) gauge reading is erroneous? Go to step 5.

iii) gauge is pegged at high end? Go to step 7

Step 2). With a voltmeter or a test lamp, check for voltage at the light green/green wire on the stabilizer terminal marked "I." You should see an ON- OFF indication here if the stabilizer is working properly. The lamp should flash roughly once per second, more or less, or the meter needle should swing from zero to 12 volts at the same rate. If not, go to step 3. If so, go to step 4.

Step 3). Check for voltage on the green wire on terminal "B" of the stabilizer. If you have voltage here, the stabilizer is bad and must be replaced. If you don't have voltage, there is a break or a bad connection in the green wire from the fuse, which will need to be fixed.

Step 4). Check for the presence of the pulsating voltage at the gauges, on the light green/green wires. You should see the voltage swinging from zero to 12 volts, at the rate of one cycle per second. If you don't have the pulsating voltage here, there is a break in the LG/G wires between the stabilizer and the gauges, which must be repaired. If you do have the voltage, go to step 5.

Step 5). Go to your local Radio Shack, or equivalent, and purchase two 100 ohm resisters. I recommend buying ½ watt resisters, but you can get by with ¼ watt if you wish, but they will get quite hot if you leave the circuit connected for an appreciable length of time. Lift the lead from the meter to the sender, at the sender, and connect one of the 100 ohm resisters between this lead and ground. Turn the key on and watch the meter, which should go to ***approximatel*y** mid scale. If you previously had no reading at all, and you now have a reading, your sender is bad, and must be repaired or replaced. If you still have no reading, go to step 6.

If you previously had an erroneous reading, repeat the above test, using two 100 ohm resisters in series. You should now see a reading of ***approximately*** ¼ scale. Repeat the test again, using the two resisters in parallel. You should see a reading of ***approximately*** full scale. If you get readings close to the above values, your sending unit is the problem. If not, your meter is out of whack, and should be replaced, repaired, or adjusted. See the adjustment section later in this chapter.

Step 6). If you did not get a response with the resisters at the sender end of the meter lead, lift the lead from the meter and try again, connecting the meter terminal to ground through the resister. If your meter now reads properly, there is a break in the lead from the meter to the sender which will need to be repaired. If you don't get a reading, the meter is bad and will need to be repaired, or replaced.

Step 7). If your meter is pegged on the high end of the scale all the time, key on or off, your meter is defective. If it is pegged on high only when the key on, you have a short to ground somewhere. Go to the appropriate sender and remove the lead to the meter. If the meter now reads zero, the sender is faulty, and must be repaired or replaced. If not, proceed to step 8.

Step 8). Replace the lead to the sender and move to the meter itself. At the meter, lift the sender lead and watch the gauge. If it returns to normal, there is a short in the lead to the sender which must be fixed. If not, the short is in the meter itself, and the meter must be repaired or replaced.

VOLTMETER

Troubleshooting the voltmeter is a much simpler process than the previous meters, as there is no sending unit or voltage stabilizer involved. If you are getting erroneous readings, the only thing that can be wrong is the meter, which will have to be repaired, replaced, or adjusted.

If it doesn't read at all, there are a couple of tests to make.

Step 1). Is the meter getting voltage? The voltmeter receives power from the white wire coming from the ignition switch, the same wire that feeds the ignition system and the "green" fuse. If you are getting power to the loads fed from either of these, you should be getting power to the voltmeter. Using your voltmeter or test lamp, look for voltage on the meter terminal with the white wire. If you don't have power here, there is a break or a bad connection in the white wire circuit. If you do have voltage, go to step 2.

Step 2). With a short piece of wire, momentarily short the ground lead of the voltmeter to a known good ground point. If the meter now works, you have a bad ground connection. If not, the meter is bad, and will need to be repaired or replaced.

AMMETER

As can be seen in **photo 4**, the ammeter is a very simple device - for all practical purposes, nothing more than a piece of wire. As long as the wire inside the meter is intact, the meter will conduct current, whether it gives an indication or not. If the wire breaks, you will not have to look too hard for an indication, as nothing in the car will work if the engine isn't running, except the "always powered" loads fed from the "purple" fuse (horns, the headlight flash-to-pass feature, courtesy lights, and the hazard flasher), and, if the ammeter is an open circuit, you can't operate the starter to get the engine to run. Refer to **figures 10, 11,** and **12**, next page, for details. These figures depict the circuits as if the ammeter were an open circuit. An open circuit in the ammeter is the same as if the ammeter were simply removed from the circuit.

If the ammeter is still functional as far as passing current, but just isn't working, there isn't much you can do except repair or replace it. There is no adjustment for accuracy in the ammeter, but there is an adjustment you can make to center the needle if it is off center with zero current. You can see the adjustment tab in **photo 4**, or if this tab is frozen or too tight to allow adjustment without fear of damage to the meter, you can just bend the needle very carefully. Confine the bending to the horizontal portion of the needle, at the back of the case, and your adjustments won't be seen from the front of the meter.

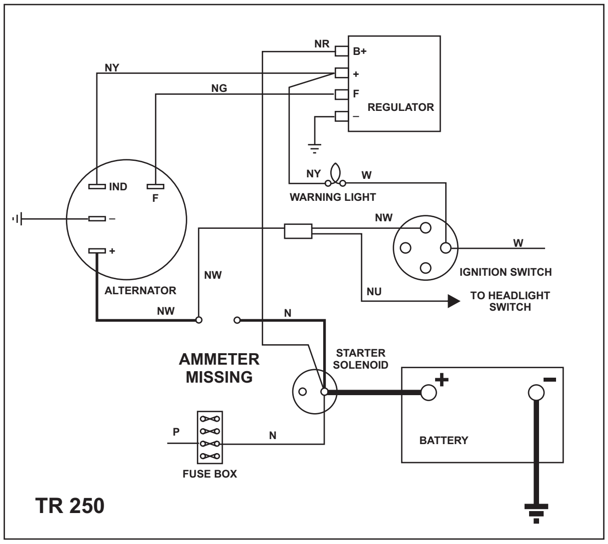



FIGURE 10

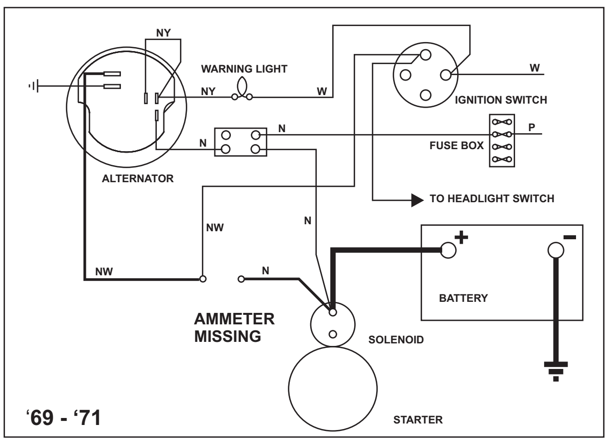



FIGURE 11

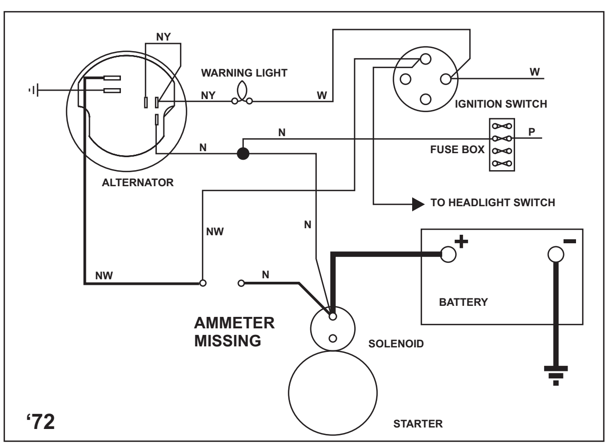



FIGURE 12

POLARITY CONCERNS

Being thermal devices, neither the voltmeter, fuel level gauge, nor the water temperature gauges are polarity sensitive. That is, you can connect them up either way and they will still work just fine. The heat elements get just as warm with current flow in either direction. However, it may be helpful to wire them in a certain way to ease the routing of the existing wiring harness, as one of the wires to the meter may be a bit longer than the other, or otherwise be routed such that it will only reach one terminal but not the other.

The ammeter, of course, ***is*** polarity sensitive. Its purpose is to tell you how much current is flowing, ***and*** which way it is flowing. For some strange reason, though, the gauge maker did not see fit to mark the terminals, so I have included the "original" connections in **figure 13** below.

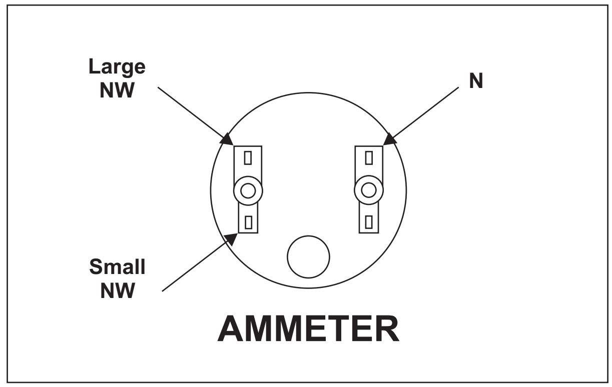



FIGURE 13

ADJUSTMENTS

If your gauges are reading inaccurately, it may be possible to adjust them for improved accuracy. In Photo 5 below, you can see two small holes in the back of the meter case. In the holes, you can see small slots in pieces of metal inside the case. One of the slots has been labeled "**A**", and this slot corresponds to the slot marked "**A**" in photo 1, page 61. As you can see, this slot is in a small, triangular shaped piece. The small end of this piece of metal is pinned to the case, and has a bracket to hold part of the meter mechanism. The large end is also pinned to the case, but there is a slot to allow this end of the piece to pivot. The remainder of the meter mechanism is also mounted to a piece of metal, which is also pinned at both ends, and has a slot on one end for adjustment. If the meter isn't too badly corroded, you can use a small screwdriver or other tool, inserted into the slots from the rear, to move the metal pieces. By adjusting these two pieces, interactively, you can re-calibrate the gauge.

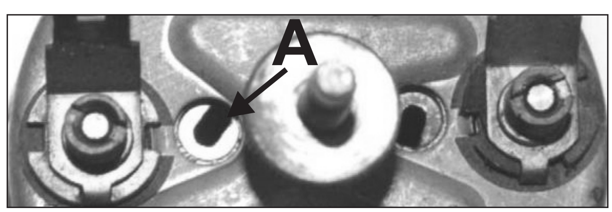



PHOTO 5

AMMETERS VERSUS VOLTMETERS

Which one is best? Which one gives the most accurate picture of your car's charging system? The ***ammeter***, without a doubt. If it's wired properly, an ammeter will tell you exactly how much current is going into your battery if it's being charged, or how much is going out if it's being discharged. A voltmeter, on the other hand, only tells you that the ***capability*** to charge your battery is available. Compare **figures 14** and **15**, right, to figure 5, page 63.

**Figure 14** shows the proper connections for a voltmeter, and **figure 15** show a not uncommon condition in an old MGB with the batteries mounted in cages under the floor board. These cages can rust out with time, and the batteries can fall out and bury themselves in the side of the road. A voltmeter would still say everything is OK! Under these conditions, an ammeter would show a zero reading, which is correct.

A ludicrous comparison, to be sure, but very illustrative of the differences nevertheless. The bottom line is, either one will work quite well, provided you know and understand what each is telling you. The following sections provide guidance on what to look for when reading the two different meter types.

AMMETER:

When you first turn on the ignition, the ammeter should show a discharge, as the battery is supplying ***all*** of the current to the car. How much discharge will depend on how many items you have on. On an ammeter equipped TR, none of the "purple" loads are run through the ammeter, so they won't show up as a discharge, and you will normally not have any of the "green" loads on when you are trying to start the car, so the discharge reading should be rather small. Whatever the reading, it should be compared to an expected reading for the loads you do have on. If the reading doesn't correspond to what is expected, something is amiss, and bears investigating.

As you crank the engine, the battery will experience a discharge, which can be quite substantial if the car takes a lot of cranking to start. After the engine is running and the alternator takes over the chore of supplying power to the car, the ammeter should show a slight to moderate charge current as the battery is being recharged to replace the energy used for cranking. The ammeter should gradually return to a near zero reading as the battery reaches full charge. The more cranking that was required, the more charge current required, and the longer it takes to replenish the battery. If the ammeter doesn't return to near zero in a reasonable amount of driving, something is amiss. You should be observing your ammeter on a regular basis so you will be aware of what is normal and what is an indication of a problem.

After the battery is fully charged, the ammeter should

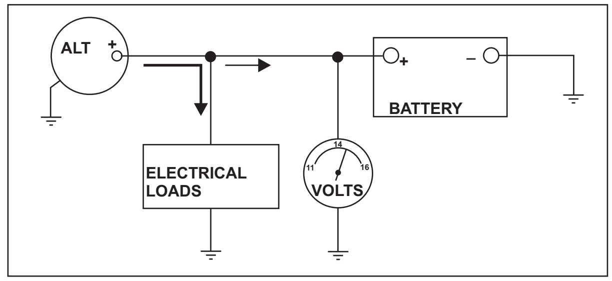



FIGURE 14

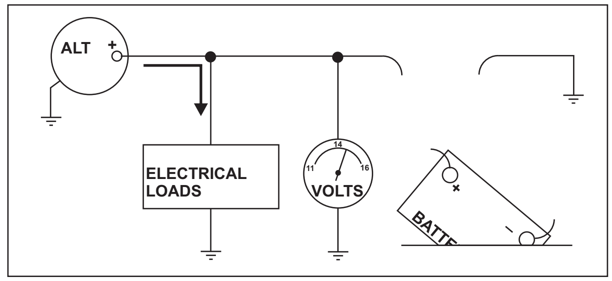


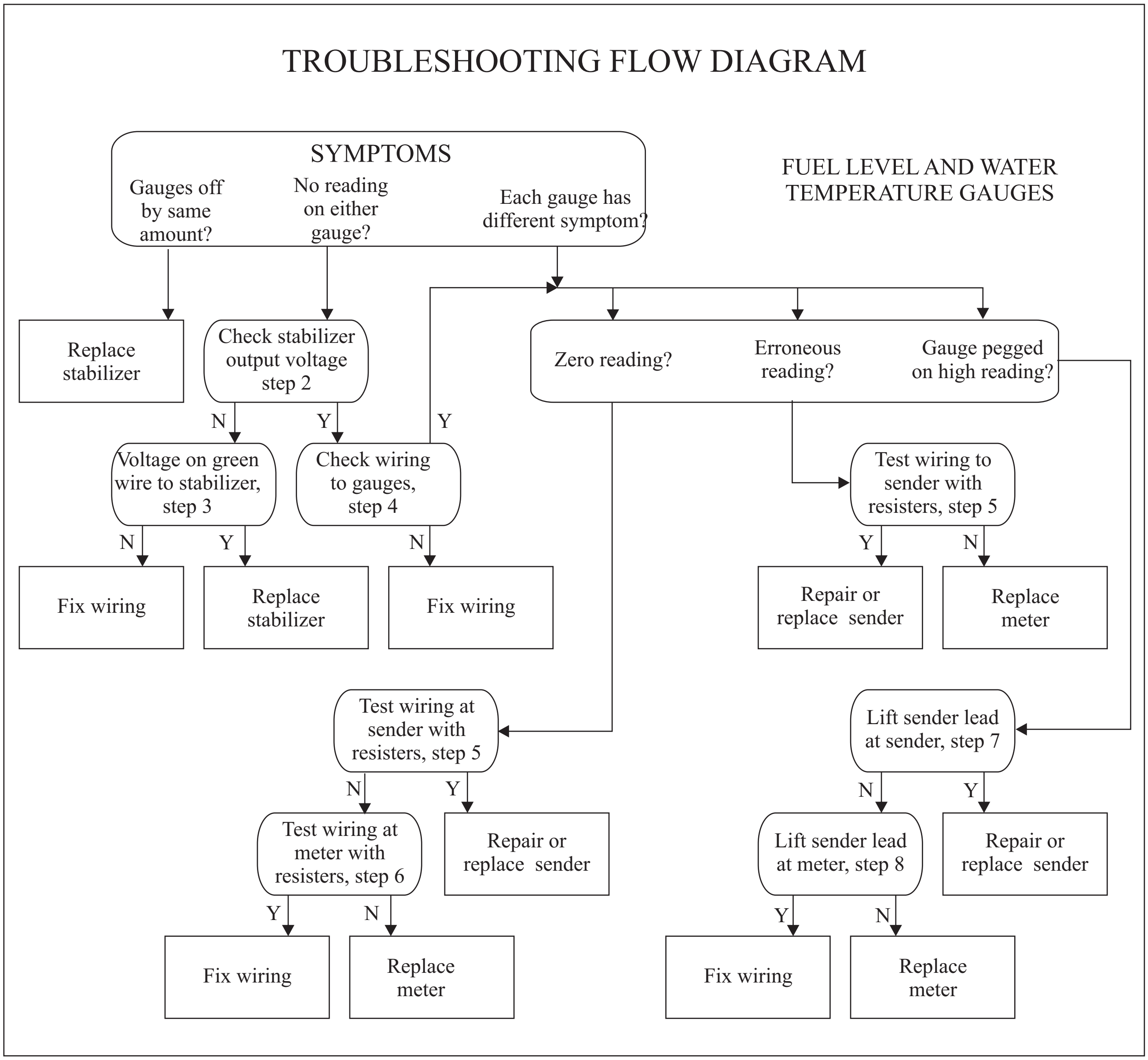

FIGURE 15

show only a very small charge current, quite often so small that it is not noticeable on the meter. If you continue to get a discharge reading, the alternator is not doing its job. If you get a high charge reading, either the alternator regulator is faulty, causing the alternator to produce an over voltage, or the battery is not accepting a charge. If it's the former, action should be taken fairly quickly, as damage to your battery could result, perhaps even causing it to boil over and severely damaging your under hood paint. If its the latter, be aware that you may not have enough battery left to re-start your car should you need to stop the engine.

VOLTMETER:

When you start your car, if you're like most of us, you turn the key past the run position immediately to the start position. The voltmeter, being a thermal device, will not have time to give an accurate reading of the battery condition if you do this. You really should get in the habit of delaying the start just long enough to monitor your battery. A good battery, in a full state of charge, should read 12.6 volts, but you should check your meter when you know the battery is good, so you can compensate for meter inaccuracies. A completely flat battery will only produce 11.64 volts. Naturally, if your battery is dead, you will know it soon enough as you try to start the engine, but if the reading is lower than it should be, yet the battery is strong enough to start the car, you will know that trouble is brewing. You can then take corrective action at your convenience, rather than while you are away from home n a vacation.

After the engine is running, the alternator should raise the system voltage to 14.6 volts. If it doesn't, the alternator is bad, and should be fixed soon, before you have a chance to be stranded with a dead battery.


TROUBLESHOOTING FLOW DIAGRAM
SYMPTOMS
Gauges off by same amount?
No reading on either gauge?
Each gauge has different symptom?
FUEL LEVEL AND WATER TEMPERATURE GAUGES
Replace stabilizer
Check stabilizer output voltage step 2
Zero reading?
Erroneous reading?
Gauge pegged on high reading?
N
Y
Y
Voltage on green wire to stabilizer, step 3
Check wiring to gauges, step 4
Test wiring to sender with resisters, step 5
N
Y
N
Y
N
Fix wiring
Replace stabilizer
Fix wiring
Repair or replace sender
Replace meter
Test wiring at sender with resisters, step 5
Lift sender lead at sender, step 7
N
Y
N
Y
Test wiring at meter with resisters, step 6
Repair or replace sender
Lift sender lead at meter, step 8
Repair or replace sender
Y
N
Y
N
Fix wiring
Replace meter
Fix wiring
Replace meter

# 16
# HEADLIGHTS, PARKING LIGHTS & GAUGE LIGHTS

GENERAL DESCRIPTION

From the TR250 through the ‘72 TR6, Triumph used a steering column mounted headlight switch, incorporating a “flash to pass” feature, and the high/low selector switch was mounted on the floor. For ‘73 -’76, the headlight switch was changed to a rocker switch on the dashboard, and the steering column switch was changed to include the high-beam/low-beam selector switch and the “flash to pass” feature. Disregarding these differences, the circuits for all model years are pretty much the same, only the details of the wiring changing from one year to the next. The schematics are depicted in **Figures 1, 2,** and **3** below.

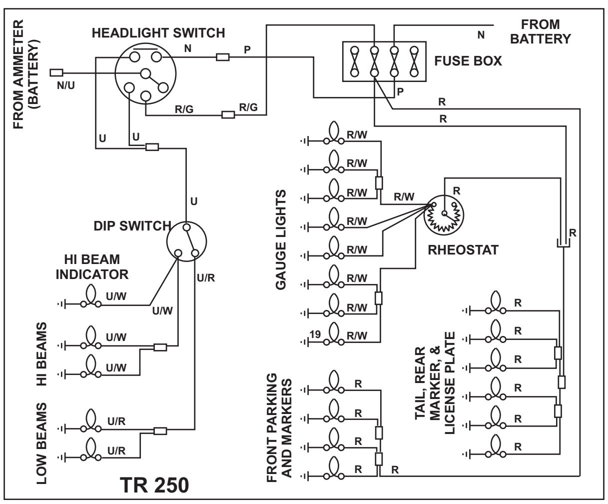



FIGURE 1

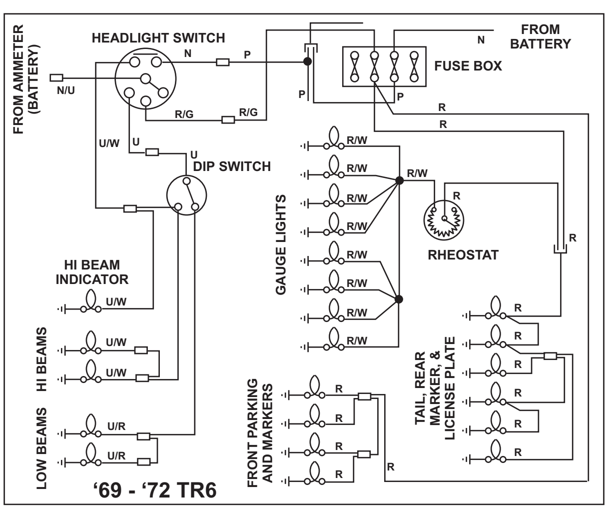



FIGURE 2

There are a couple of points worth noting about these circuits. First of all, notice that the high beams get power from the purple fuse when the “flash-to-pass” feature is used, but receive power directly from the battery or the alternator when they are operated from the main headlight switch. Secondly, notice that the wiring supplying power to the headlights when operated from the main headlight switch is ***NOT*** fused! For an explanation of this, refer to chapter 7, Fuses. As strange as this may seem, not having a fuse in the headlight circuit is really a safety feature.

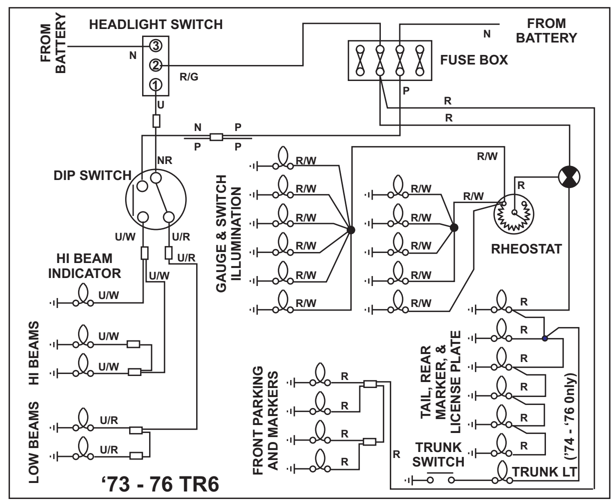



FIGURE 3

CIRCUIT OPERATION:

**Figures 4** and **5,** next page, depict the basic operation of the headlight circuits in the TR6 models. **Figure 4** is for the earlier models, while **figure 5** is for later models. The TR250, although very similar, differs in the operation of the “flash-to-pass” feature. This difference will be discussed later, after the TR6 operation has been covered.

**Diagram A** of each figure shows the power flow when the parking lights are on, but the headlights are off. In this configuration, power flow, shown by the heavy lines, is from the battery to the headlight switch, through the switch to the fuse box, and then to the parking lights, marker lights, and to the dimmer control for the gauge illumination lamps.

**Diagram B** of each figure shows the power flow when the headlight switch is in the headlight position. In this configuration, power flows to the parking, marker, and gauge lamps just as before, but power from the battery also flows through the switch to the high-low beam selector switch. Power flows through the high-low beam selector switch (dimmer, or “dip” switch) to the appropriate headlamp filament, depending on the position of the selector switch. As stated before, power to the headlights is not fused.

**Diagram C** of each figure shows the power flow when the flash-to-pass feature is actuated. In this case, power flow is from the battery to the “purple” fuse, and then directly to the headlight high beam filaments. In this instance, the headlights are fused, as you can well do without the flash-to-pass feature should you blow a fuse.

When the flash-to-pass feature is in operation, it doesn’t matter what position the headlight switch is in, but it does matter what position the dimmer switch is in. This feature bypasses the main headlight switch and the dimmer switch, and applies power directly to the high beams. If the headlights are on or off and the dimmer switch is in the low beam setting, the high beams will flash. If the headlights are on and the dimmer switch is in the high beam setting, nothing will happen, as they are already on high. If you are following someone closely enough to pass, you shouldn’t be having the high beams on anyway, so this feature isn’t needed when the high beams are on.

**TR250**: for some strange reason, the flash-to-pass feature doesn’t work on the TR250 when it is needed the most - at night with the headlights on! Usually, one blows the horn to pass in the daytime, and flashes the lights for night time passing, but with the TR250, you will have to use the horn at night as well. As can be seen in **figure 6** below, power from the flash-to-pass switch is applied to the blue wire into the dimmer switch, exactly the same as power from the main headlight switch. Flipping the headlight switch to the flash-to-pass position has no effect if the headlight switch has already applied power to this blue wire. If you wish to modify the wiring so that this feature works the same as the later models, just disconnect the blue wire from the headlight switch to the blue wire on the dimmer switch, and reconnect it to the blue/white wire at the dimmer switch.

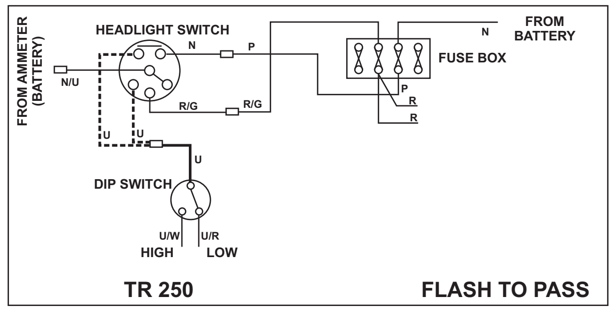



FIGURE 6

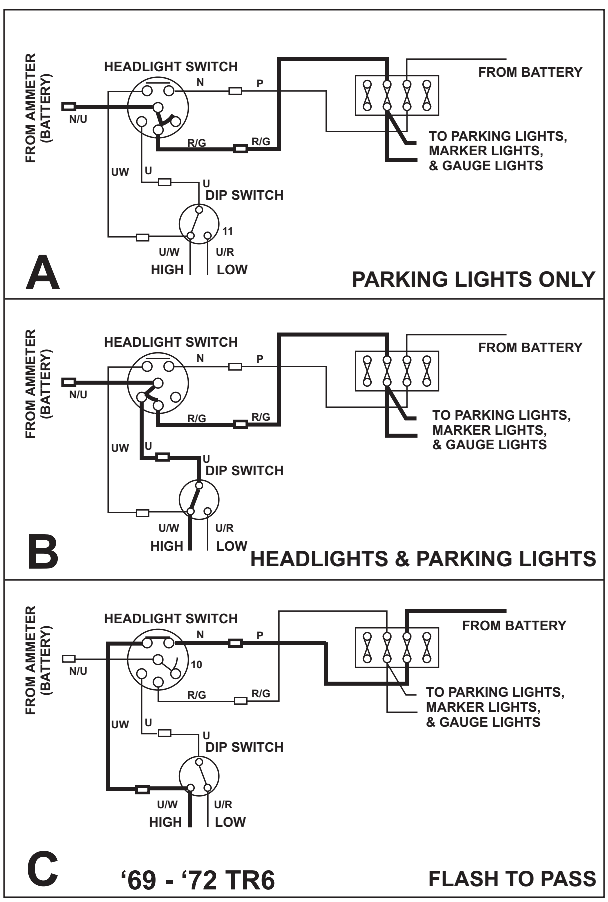



FIGURE 4

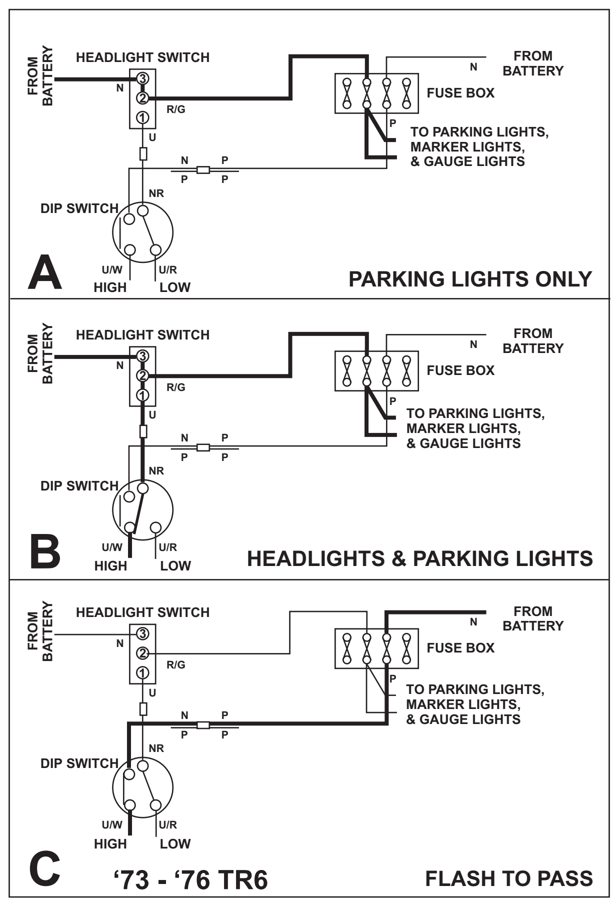



FIGURE 5

TROUBLESHOOTING:

HEADLIGHTS:

Step 1). Do the parking lights, marker lights, or gauge illumination lights work? If any of these circuits work, you know there is power to the headlight switch, so you can proceed to step 2. If not, proceed to step 6.

Step 2). Do either the high beams or the low beams work? If so, you know power is getting through the headlight switch to the dimmer switch, and you can proceed to step 3. If neither the high nor the low beams work, proceed to step 4.

Step 3). Using your voltmeter or test lamp, and with the headlight switch on, check for voltage on the either blue/white wire or the blue/red wire, depending on which beam is working, at the dimmer switch. The U/W wire is for the high beam, and the U/R is for the low. (If you are checking the high beam circuit, look to see if the high beam indicator is working. If it is, then you know power is getting through the dimmer switch, so you won't need to use your meter or test lamp. If the high beam indicator isn't working either, you will need to go ahead and check for voltage at the dimmer switch).

For the TR250 - '72 TR6, the dimmer switch is located on the floor. For the '73 - '76, you will need to locate the U/W and U/R wires as they leave the steering column under the dash. The wires from the column mounted dimmer switch connect to the remaining headlight wiring via bullet/sleeve connectors. For your convenience, I have redrawn the previous figures below as **figures 7, 8,** and **9**, showing just the headlight portion of the wiring.

If you have voltage on these wires, there is a break or bad connection in the wiring to the headlights, which must be repaired. If not, the dimmer switch is bad, and must be repaired or replaced. If the dimmer switch is bad, and it is the column mounted switch from a '73 - '76 model, it may be repairable. See the switch repair section at the end of this chapter for details. If it is the floor mounted switch from the earlier models, you can buy a replacement switch from your local auto supply house. You may have to modify either the switch or the switch housing a bit to get it to physically fit, but it shouldn't require a great deal of modification.

Step 4). Using your voltmeter or test lamp, check for the presence of voltage on the blue wire at the dimmer switch. If you have voltage here, the dimmer switch is bad, and will need to be repaired or replaced. Refer to step 3 above for more info on switch repair. If you don't have voltage on the blue wire, go to step 5.

Step 5). Check for the presence of voltage on the blue wire as it leaves the headlight switch. On the TR250 - '72 TR6, the blue wires from the switch exits the steering column just under the dash, and connects to the rest of the wiring via bullet/sleeve connectors. On the later models, you will have to reach up under the dash to reach the back of the switch to access the blue wire.

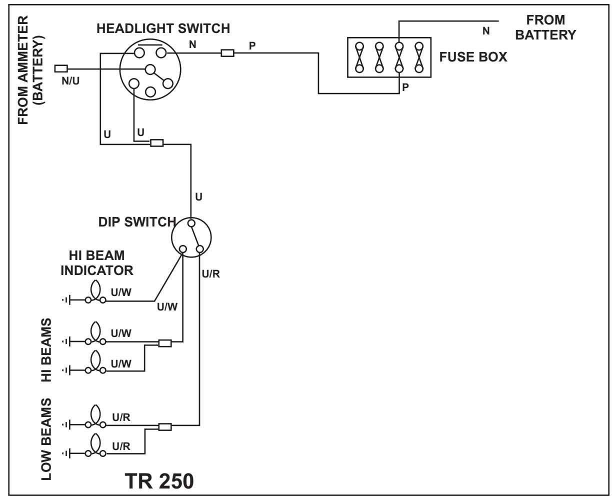



FIGURE 7

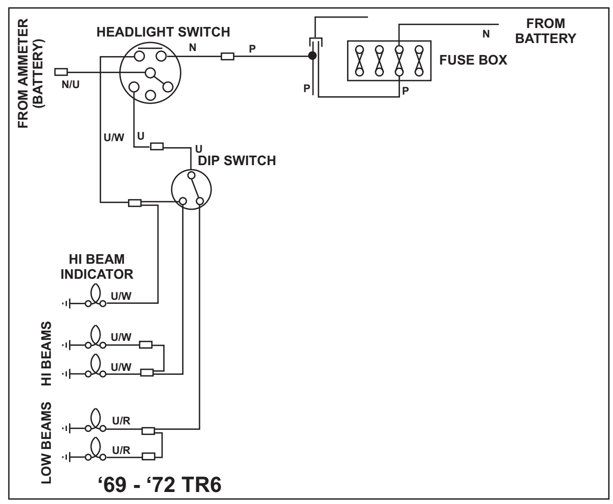



FIGURE 8

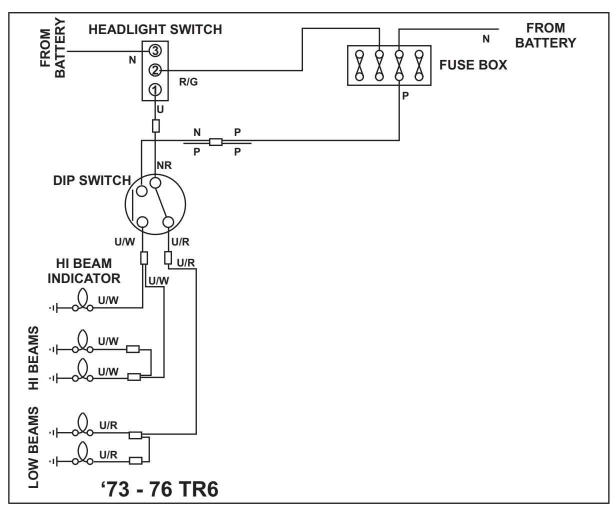



FIGURE 9

If you have voltage here, there is a break or bad connection in the wiring to the dimmer switch that will need repair. If not, the headlight switch will need to be replaced or repaired. Refer to chapter 9, Switches, Relays, and Solenoids, for details on repairing the rocker type switches as used on the later models. For the earlier column mounted switches, see the repair section at the end of this chapter.

Step 6). Do you have power on the brown/blue (TR250 through the '72 TR6),or the brown ('73 through 76 TR6) wire at the headlight switch? If not, there is a break or a bad connection in the wiring from the ammeter or the battery to the switch, which will need to be repaired. If you do have power, the headlight switch is bad. Refer to chapter 9, Switches, Relays, and Solenoids, for details on repairing the rocker type switches as used on the later models. For the earlier column mounted switches, see the repair section at the end of this chapter.

FLASH-TO-PASS:

Step 1). Do the high beams work? If the high beams don't work, you need to go to the headlight troubleshooting section, step 3, and repair this portion of the headlight circuit before proceeding with this section. The flash-to-pass circuit applies power to the high beams at the dimmer switch, so if the high beams don't work, and the flash -to-pass feature doesn't work, the odds are there is a problem in the wiring from the dimmer switch to the high beams. If the high beams do work, go to step 2.

Step 2). Do you have power on the "purple" fuse? This fuse also feeds the horns and the courtesy lights, so if ***ANY*** of these other items work, there is power to the fuse. If ***NONE*** of the other items work, the fuse is probably bad, but you will need to check to be sure. If you have power on the side of the fuse with the purple wire, proceed to step 3. If not, replace the fuse, repair the wiring to the fuse, or repair/clean the fuse holder and contacts.

Step 3). Using your voltmeter or test lamp, check to see if you have power on the purple wire at the headlight switch. On the TR250 - '72 TR6, this purple wire connects to the brown wire from the headlight switch via a bullet/sleeve connector. The brown wire from the headlight switch exits the steering column under the dash, where it connects to the purple wire. The same arrangement is used on the '73 - '76 models, except the brown wire is from the column mounted dimmer switch.

If you have power on this wire, the headlight switch (early model) or the dimmer switch (later models) is bad, and must be repaired or replaced. See the switch repair section at the end of this chapter for repair instruction.

PARKING, MARKER, AND GAUGE LAMPS:

For your convenience, I have redrawn **figures 1 through 4** as **figures 10 through 12**, below, showing only the wiring associated with these light circuits.

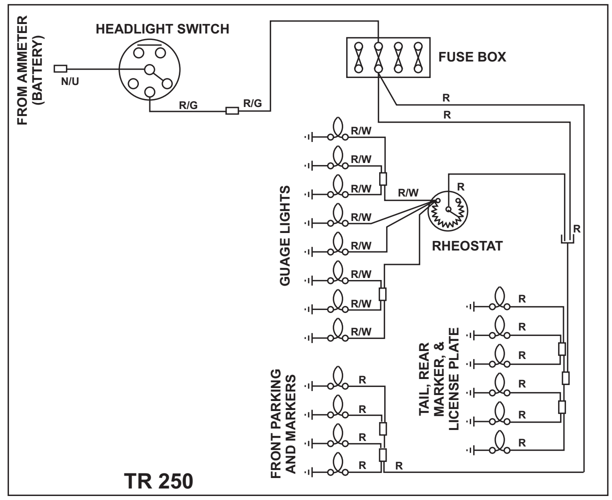



FIGURE 10

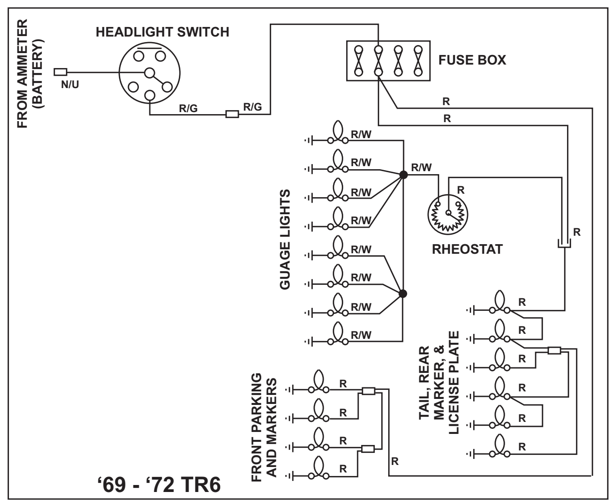



FIGURE 11

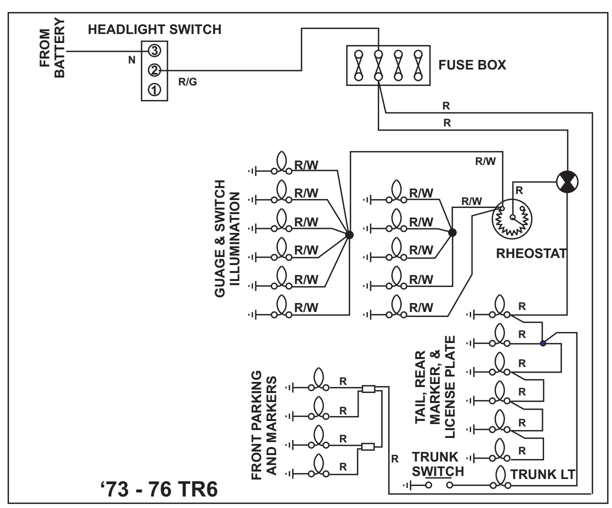



FIGURE 12

Step 1). Do the headlights work? If not, then the problem is most likely in the headlight switch or associated wiring, and this problem should be fixed before proceeding with the parking/marker/gauge light problem. If the headlights do work, proceed to step 2.

Step 2). Do you have power on the "red" fuse? If you don't have power on the red wires at this fuse, check for power on the red/green wires. If you have power on the R/G wires, the fuse or the fuse holder is bad. If you don't have power on the R/G wires, go to step 3. If you have power on the "red" fuse, it's unlikely that all of the lights will be in-operable. If they are, however, follow all of the steps listed below.

a) If the front parking and marker lights are inoperable, go to step 4.

b) If the rear parking and marker lights are inoperable, but the gauge lights work, go to step 5.

c). If the gauge lights are inoperable, but the rear parking and marker lights work, go to step 6.

d). If neither the rear lights nor the gauge lights work, go to both steps 5 and 6.

Step 3). Locate the red/green wire from the headlight switch. On the TR250 - '72 TR6, this wire will exit the steering column just under the dash, and connects with the R/G wire to the fuse box via a bullet sleeve connector. On the '73 - '76 TR6, this wire is routed directly from the back of the dash switch to the fuse box. Using your voltmeter or test lamp, check for voltage on this wire. On the earlier models, check both sides of the connector. If you have power here, there is a break or a bad connection in the wiring to the fuse. If you don't have voltage here, the headlight switch is bad, and must be repaired or replaced. For instructions on repairing the early model column mounted switch, see the repair section at the end of this chapter. For the later models, refer to chapter 9, Switches, Relays, and Solenoids.

Step 4). Power from the "red" fuse goes directly to the front lamp assemblies, with no intervening connectors. The red wire goes first to a double bullet/sleeve connectors on the left side of the car, and then to the right side, and another double connector (refer to **figures 10, 11,** and **12**, previous page, for details). If none of the front lights work, the most likely problem is the first connection, which will probably be bad. Check for voltage on the red wire from the fuse at this point. If you have power, continue testing on out to each individual lamp connection till you find the problem. If you don't have power on this wire, there is a break in the wire somewhere between here and the fuse.

If you have power on all the red wires, look for ground problems. It's a bit unusual to have bad grounds on ***ALL*** of the lights, but it is possible.

Step 5). Power from the fuse goes to the multi-pin connector for the rear wiring harness. One red wire from here goes to the gauge light dimmer control and another goes to the rear parking/marker lights. If the gauge lights don't work, power is not getting to this connection, so there is a break in the wiring from the fuse to this connector. If the gauge lights work, power is getting to this connection, so there must be a break or bad connection in the wire from this connection to the rear lights.

The red wire from the multi-pin connector goes to either a double bullet/sleeve connector or a splice, depending on the year, on the left side of the car, and then more red wires fan out from here to the lights (refer to **figures 11, 12, 13,** and **14**, opposite, for details). If none of the rear lights work, the most likely problem is the first connection, which will likely be bad. Check for voltage on the red wire from the multi-pin connector at this point. If you have power, continue testing on out to each individual lamp connection till you find the problem. If you don't have power on this wire, there is a break in the wire somewhere between here and the fuse.

If you have power on all the red wires, look for ground problems.

Step 6). As stated above in step 5, power from the fuse goes to the multi-pin connector for the rear wiring harness. One red wire from here goes to the gauge light dimmer control and another goes to the rear parking/marker lights. If the rear lights don't work, power is not getting to this connection, so there is a break in the wiring from the fuse to this connector. If the rear lights work, power is getting to this connection, so there must be a break or bad connection in the wire from this connection to the gauge light lights.

The red wire from the multi-pin connector goes to dimmer control for the gauge lights (refer to **figures 10, 11**, and **12**, previous page, for details). Check for voltage on the red wire at the dimmer control. If you don't have voltage on this wire, there is a break in the wire somewhere between here and the multi-pin connector.

If you do have voltage here, make a short test lead with ¼" male spade terminals on each end, pull the red and the red/white wires from the dimmer, and jumper them together. Do the lights work? If so, the dimmer is bad, and must be cleaned, repaired, or replaced. Repair/cleaning instructions for this are given below. If not, there is a break or bad connections in the R/W wires from the dimmer to the individual lamps, or a ground problem. You will need to move from point to point with your voltmeter or test lamp to find the problem.

HEADLIGHT SWITCH REPAIR:

It may be possible to repair the column mounted headlight or dimmer switch, depending on just how bad it is.

**Photos 1** and **2** below show a dimmer switch from a later model TR6. **Photo 1** shows the configuration of the switch contacts (in this case, very corroded contacts). As corroded as they are, though, I believe this switch is repairable.

**Photo 2** shows the roll pin holding the halves of the switch together, which must be driven out. Once the halves have been separated, cleaning of the contacts is straight forward, using a pencil eraser or similar abrasive tool. If you can find it, a good electrical grease should be applied, but if you can't, just reassemble the switch dry.

On this particular switch there is a spring missing, which is used to return the switch to its normal position after the flash-to-pass feature is actuated. If this spring is missing from your switch, any small spring will do, and can be bought at most good fastener specialty shops or hardware stores.

DIMMER CONTROL REPAIR:

**Photo 3** below shows the back of an early ('71, on the right) and a late ('75, on the left) dimmer control. As you can see, the early model is fairly easy to disassemble and reassemble. Just bend back the tabs holding the two halve together and separate. The later model will require a bit of ingenuity to disassemble. The rivets do not go through the front of the case, so you may have to tap the holes left after the rivets are removed and use screws to fasten the halves back together.

**Photo 4** shows the resistance wire inside the units. If this is broken, it will be hard to replace (but not impossible), and you will probably just want to get a replacement. If it is just corroded, a good cleaning, using a pencil eraser, may be sufficient. A chemical cleaner may also be required, and can be purchased from an electronic supply house. Don't forget to clean the external terminals as well, while you're at it.

If the dimmer is beyond repair, the best thing to do is put it back for appearance sake, and just bypass it electrically. Just connect the R/W and the R wires together with a good butt connector, and insulate well. Alternately, you can just connect all of the wires to the same terminal of the dimmer control. Either terminal will do.

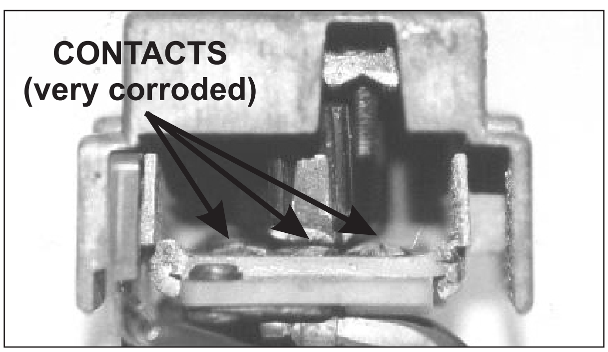



PHOTO 1

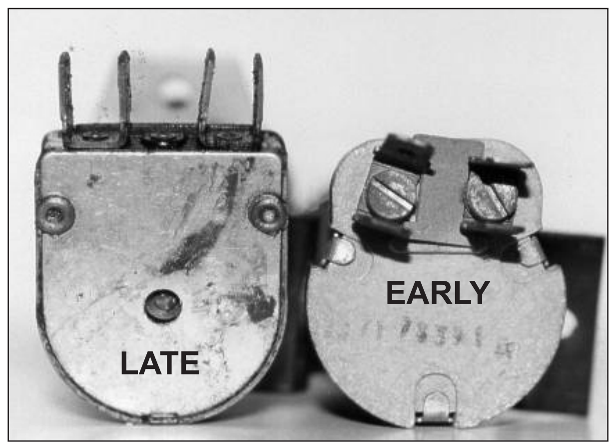



PHOTO 3

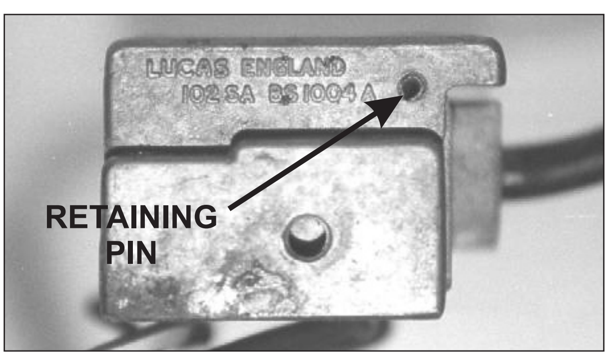



PHOTO 2

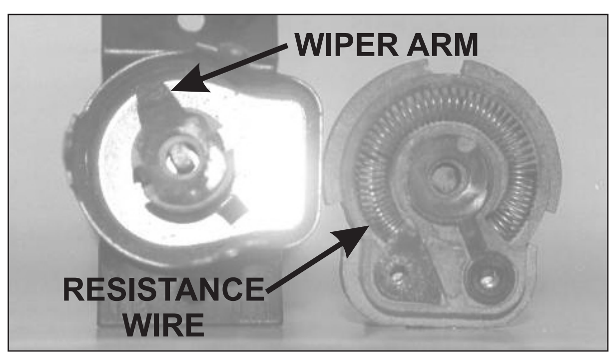
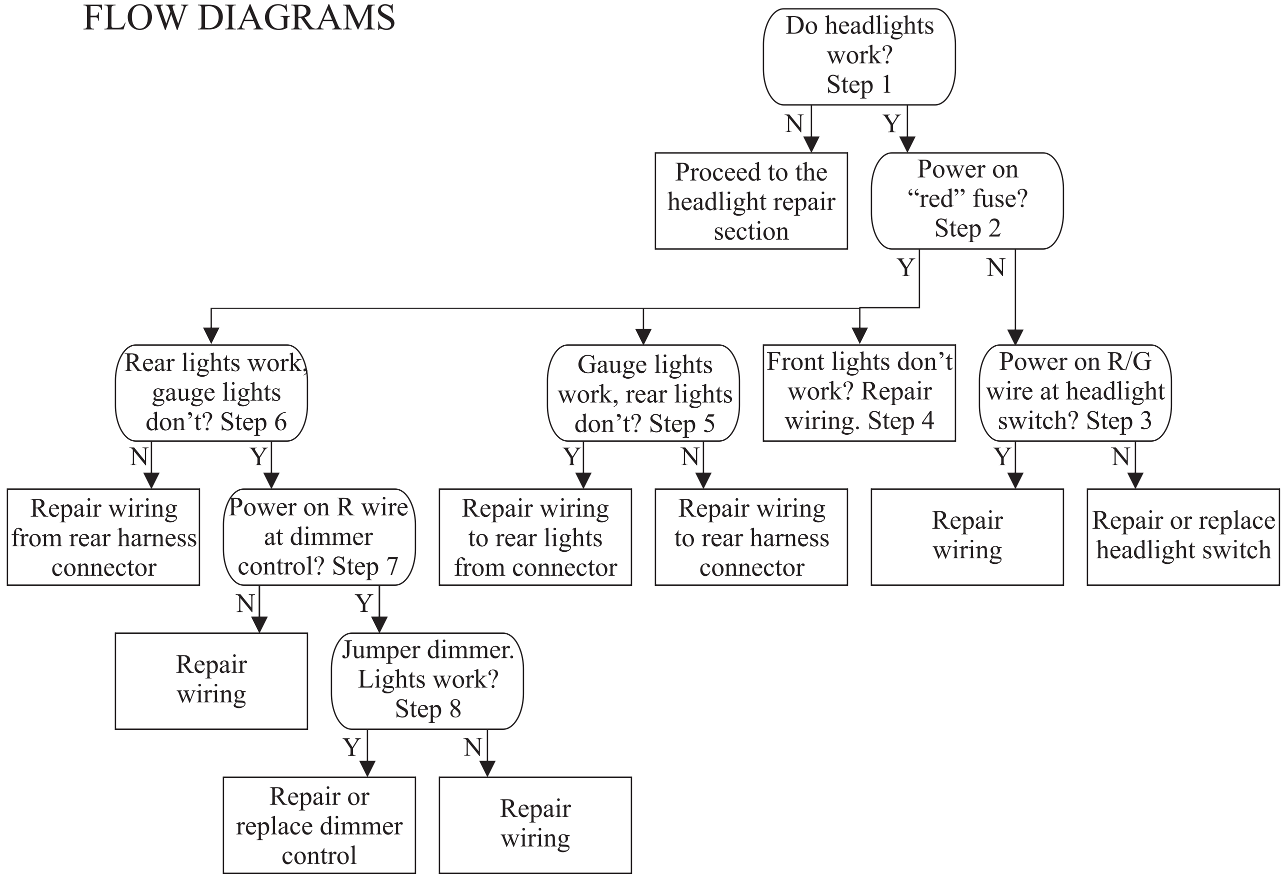


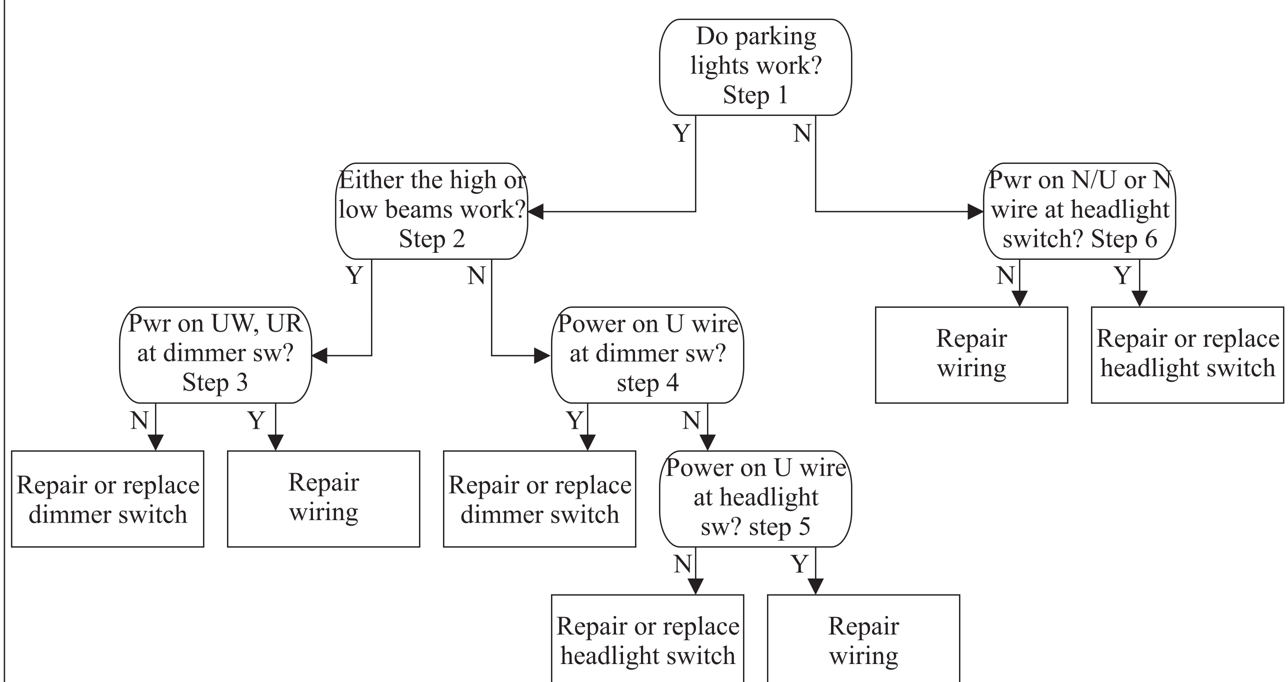

PHOTO 4

# TROUBLESHOOTING FLOW DIAGRAMS

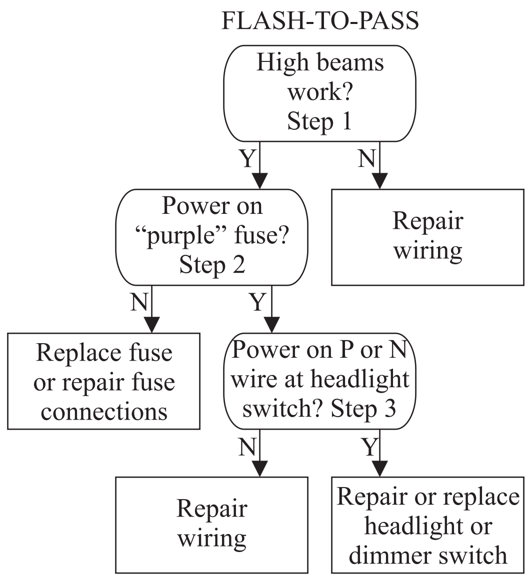
PARKING, MARKER, & GAUGE LIGHTS




HEADLIGHTS



# TROUBLESHOOTING FLOW DIAGRAMS



# 17
# HEATER FAN MOTOR

CIRCUIT DESCRIPTION

The heater fan circuit consists of a variable speed, reversible, DC motor, a three position switch, and a voltage dropping resistor. The speed of the motor is controlled by the voltage applied, and the direction of rotation is controlled by the polarity of the applied voltage.

In the low speed position, the output voltage of the fan switch is applied to a voltage dropping resistor inside the fan housing. In the high speed position, the output voltage of the fan switch bypasses the dropping resistor and is applied directly to the fan motor. The three speeds - off-low-high - are depicted in **figure 1**, right. The heavy lines depict the flow of current for the high two operating Speeds.

TROUBLESHOOTING

***NOTE:*** If you have a TR250 or a ‘69 - ‘72 TR6, make sure your cowl vent is open before assuming the fan motor circuit is bad. The only source of air for the fan is through this vent. No matter how well the fan works, if the vent is closed, precious little air will flow, only that which leaks around the vent seal. On the later models, the cowl vent is covered by plastic louvers and can’t be closed.

Trouble shooting is very straight forward for this simple circuit. The fan receives power from the “green” fuse, so is ***ANY*** if the other loads fed from this fuse (gauges, WS wipers, back up lights, etc) are working, then you know you have power to the circuit. If not, refer to chapter 22, Power Distribution, to resolve the power issue. If so, follow the procedures below, specific to the heater fan.

A) Fan doesn’t work at all:

Step 1) With the ignition key on and the fan switch in the high speed position, check for power at the green and at the green/yellow wire on the back of the switch. If you are using a voltmeter, you should read very near full battery voltage on both leads, or, if you are using a test lamp, you should see equal and full brilliance on both leads. Place the switch in the low speed position and repeat the tests, checking for power on the green/brown wire.

You don’t have power:

If you have no power on the green lead, then there is a break in the green wire to the switch, or you have a bad connection at the switch.

If you have power at the green wire, but not at either the green/ brown or the green/yellow, your switch is bad or there is a bad connection at the green/brown or the green/yellow wire.

You do have power:

If you have power on the green/brown and the green/yellow wires, but the fan still doesn’t work, examine the heater housing to see if the ground wire exits the housing. Usually, it doesn’t, which means the heater housing must be removed for further testing. If your particular unit has the ground wire available, try connecting it to a good ground (or ensure that the existing ground connection is a good one.

If you can’t get to the ground lead, or the ground lead isn’t the problem, the entire heater assembly will need to be removed for bench testing.

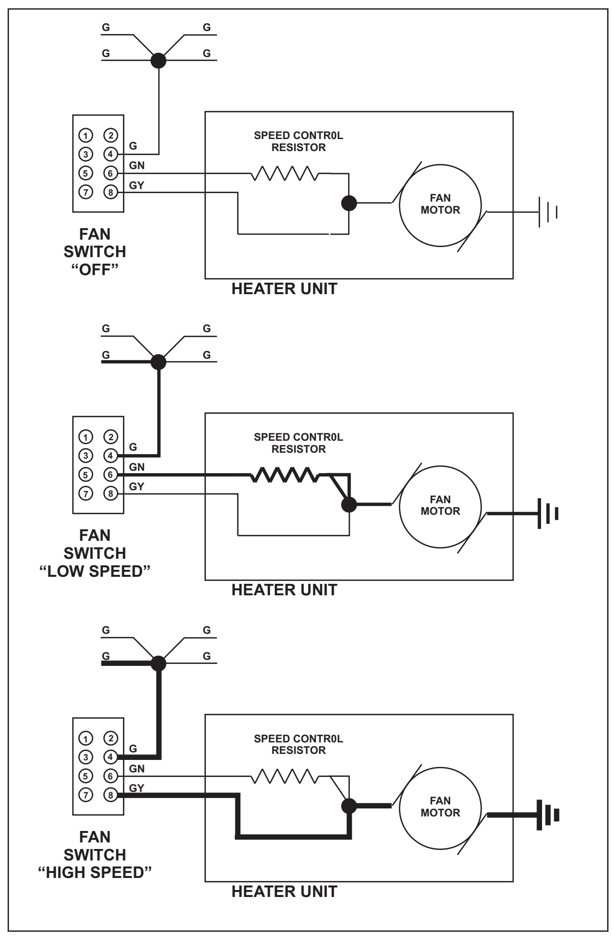



FIGURE 1

B) Fan works on one speed only:

If the fan works in only one speed, reverse the leads to the switch (swap the green/brown lead with the green/yellow lead), and try the fan again. If the fan still works in only the same switch position as before (at a different speed), then the switch is bad. If the fan works at the same speed, but only when the switch is in a different position than before, the problem is in the wiring inside the housing, and the unit will have to be removed for bench testing.

BENCH TESTING

With the motor and wiring laying on the bench, connect one end of a fused test lead to the positive post of the power supply or battery, and connect the other end to the junction of the motor wire, the green/yellow wire, and the resister. Connect the minus post to the ground wire from the motor. If the motor is good, it will operate at full speed when connected this way. If the motor doesn't operate, it will need to be replaced.

If the motor proves to be operable, remove the test lead from the junction described above and connect it directly to first the green/yellow wire, and then to the green/brown wire. If the motor operates under these conditions, then you original problem was a bad ground connection. if it doesn't, there is a problem with the wiring or the resister, depending on which speed it operated at, if any.

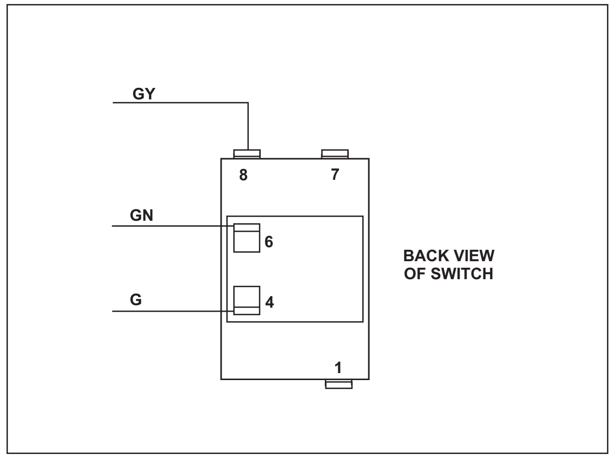



FIGURE 2

Figure 2, above, is a diagram of the rear view of the switch, and the associated wiring.

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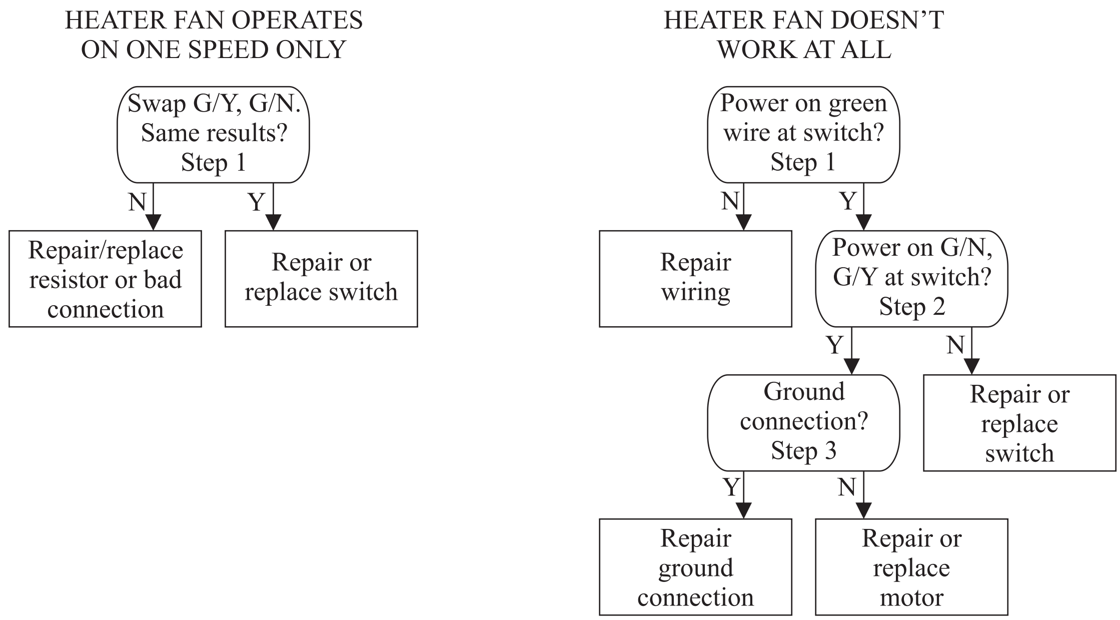
## TROUBLESHOOTING FLOW DIAGRAMS



# 18
# HORN CIRCUIT

CIRCUIT CONFIGURATIONS

Two different horn wiring configurations were used on the various TR250/TR6 models, one with a relay, and the other without. Although I can't be certain, it seems that the decision to use a relay for the horns depended upon whether or not the car was equipped with an early type "A" overdrive, as the cars only had provisions for two relays. The earlier models used a relay for the hazard circuit, so that left only one space for a relay. If the space was needed for the OD unit, there was no place for a relay for the horns. If no OD was installed, it appears the OD relay was given over to the horn circuit. You will have to look at your particular car to determine which of the two horn arrangement you have. The two configurations are shown below in **figure 1**.

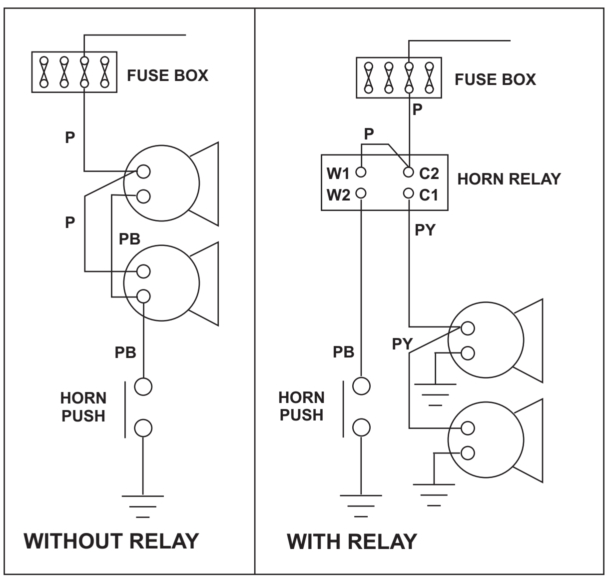



FIGURE 1

In cars without the relay, one side of each horn receives a constant 12 volts directly from the "purple" fuse. Power is present on the horns at all times, key on or not. To operate the horns, the push button in the center of the steering wheel grounds the other side of the horns when pushed. In cars with a horn relay, one side of each horn is permanently grounded, while one side of the coil winding in the horn relay receives a constant 12 volt supply. To operate the horns, the other side of the horn relay coil winding is grounded when the horn button is pushed. The relay is then energized, connecting the power from the "purple" fuse to the other side of the horns.

With either system, the horns are operable at all times, regardless of the position of the ignition key. This is a safety feature, primarily for protection of your car, rather than personal safety, although it could prevent serious personal injury as well. You might be sitting in your car in a parking lot, waiting for someone to return to the car, when an idiot in one of the humongous land yachts decides to back up, and doesn't see your car. You don't want to have to get the key out of your pocket and turn the ignition on to warn the driver to stop! Or, you might be putting packages in your car when you notice the car moving in on you. Blowing your horn quickly could save serious injury.

TROUBLESHOOTING

By far, the two most common problems with the horn circuit are bad or missing grounds, or just plain bad horns. The horns can often be repaired, and this procedure is covered in chapter 19, Horn Repair. Ground problems can always be fixed, and will be covered here. In **figure 1**, left, the ground connection to the horn button looks pretty straight forward and simple; in reality, it's anything but!

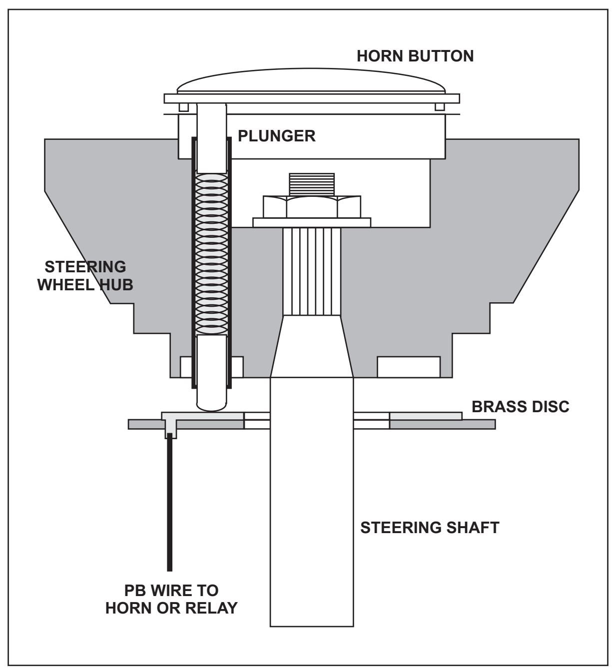



FIGURE 2

Looking at **figure 2** above, you can see that the ground path is quite torturous. Inside the steering column is a flat brass ring, isolated from ground, with a purple/black wire attached which connects to either the horns or the horn relay. Inserted into a hole in the steering wheel hub is a plastic sleeve with two brass plungers inside, separated from each other by a spring. One of the plungers maintains constant contact with the brass ring, and the other maintains constant contact with the horn button.

When the horn button is pressed, part of it makes contact with the steering wheel hub, which is grounded. The resulting ground connection is then transferred to one of the plungers, through the spring to the other plunger, to the brass ring, and then to the horns or horn relay, causing the horns to operate. If the steering wheel hub is grounded properly, that is.

The steering wheel hub is grounded to the upper steering shaft, which rides in a pair of nylon bushings, isolating it from ground. At the end of this shaft is a flexible rubber joint connecting the upper shaft to the lower shaft. This joint, being made of rubber, is an insulator The lower shaft is connected to the steering rack, which is isolated from the chassis by rubber shock absorbing mounts. So, with all the insulators, how does the horn circuit get grounded?

**Photos 1** and **2** below show the required ground connections. **Photo 1** shows the flexible braided wire connecting the upper column to the lower column. One end of the wire is terminated under one of the mounting bolts, and the wire is then routed through the flexible coupling to the lower shaft, where it is terminated under one of the lower shaft mounting bolts. **Photo 2** shows the ground connection at the steering rack. This wire is routed directly to the car's chassis. These two items probably account for more horn problems than anything else, other than actual horn failures. If your horns don't work, this is the first place to look. No tools or test equipment is required, just a quick visual examination is all that's needed. If both of these ground connections are in place, then it's time to begin the troubleshooting procedure.


PHOTO 1

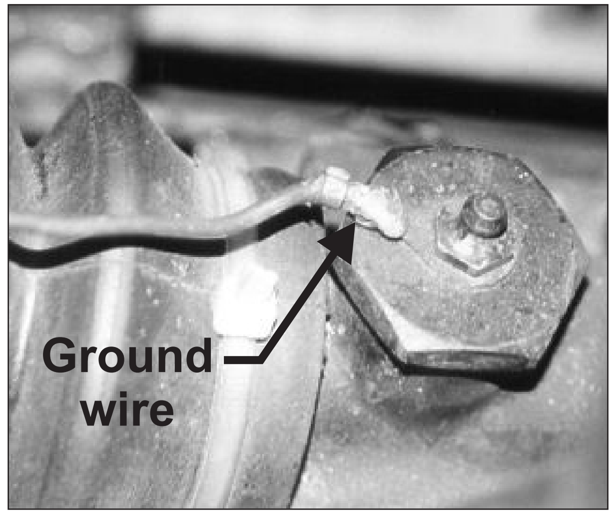



PHOTO 2

The horns receive power from the "purple" fuse, along with the courtesy lamps, high beam flash-to-pass, and the hazard flasher. If ***NONE*** of these items work, check for power from the fuse, and resolve this issue before proceeding. If ***ANY*** of these devices work, there is power at the fuse, so you can proceed with the troubleshooting steps outlined below.

A. If your car does ***not*** have a horn relay:

A1. Neither horn works

Step 1). The purple/black wire from the brass ring in the steering column, described previously, exits from the steering column just under the dash, where it connects to the remaining portion of the P/B wire with a bullet/sleeve termination. Locate this connection, and, with a short piece of wire, short this connection to ground. Short each side of the connection, in turn, with the original wires still connected, to ground, to ensure that the connection is not the problem. If the horns blow when you short one side of the connection to ground, but not the other side, the connection is bad, and will need to be cleaned and repaired. If the horns blow when either side is grounded, the ground connections in the steering column will need to be repaired, as describe previously. If the horns don't blow, proceed to step 2.

Step 2). Using a voltmeter or a test lamp, check for the presence of power on the purple wires at the horns. If you have power, proceed to step 3. If not, there is a break or bad connection in the purple wiring from the fuse box to the horns, which will need to be repaired. Check each horn in turn, as it's possible that you may have more than one problem. You might have, for example, a bad power connection to one horn, and a bad ground connection to the other.

Step3). Using a short piece of wire, ground the horn terminals with the purple/black wires. If the horns blow, there is a break in the P/B wire somewhere between the brass ring in the steering column and the horns, which will need to be repaired. Test each horn in turn.

A2. One horn works, one doesn't.

Step 1).Using a voltmeter or a test lamp, check for voltage on the purple wire at the non working horn. If you have power here, go to step 2. If not, there is a break or bad connection in the purple wire from the fuse, which will need repair.

Step2). Using a short piece of wire, ground the horn terminal with the purple/black wire. If the horn now blows, there is a break in the purple/yellow wire, or a bad connection. If not, the horn is bad.

B. If your car ***has*** a horn relay.

B1. Neither horn works.

Step 1). With your hand on the horn relay, press the horn button in the steering wheel. If you can feel the relay click, go to Step 5. If not, go to step 2.

Step 2). Find the terminal on the horn relay with the purple/yellow wire attached (should be the W2 terminal, but could be the W1). With a short piece of wire, ground this terminal to a good ground point. If the relay clicks, go to Step 3. If not, go to Step 4.

Step 3). The purple/black wire from the brass ring in the steering column, described previously, exits from the steering column just under the dash, where it connects to the remaining portion of the P/B wire with a bullet/sleeve termination. Locate this connection, and, with a short piece of wire, short this connection to ground. Short each side of the connection, in turn, with the original wires still connected, to ground, to ensure that the connection is not the problem. If the relay clicks (or the horns blow) when you short one side of the connection to ground, but not the other side, the connection is bad, and will need to be cleaned and repaired. If the relay clicks or the horns blow when ***either*** side is grounded, the ground connections in the steering column will need to be repaired, as described previously. If the relay doesn't click or the horns don't blow, there is a break in the wiring between this point and the relay, which will need to be repaired.

Step 4). With a voltmeter or a test lamp, check for voltage on the relay terminals with the purple wire (should be C2 and W1, but could be C2 and W2, or C1 and W1, or C1 and W2). If you have voltage here, the relay is bad and will need to be replaced. If you don't have voltage here, there is a break or a bad connection in the wiring from the purple fuse to the relay, which will need to be repaired.

If, after completing Steps 1 through 4, the horns still don't work, proceed to step 5.

Step 5). With a voltmeter or a test lamp, check for the presence of voltage on the relay terminal with the purple/yellow wire (should be W2, but could be W1) while pressing the horn button in the steering wheel. If you have voltage, proceed to step 6. If not, the relay is bad, and will need to be replaced, or, the connection of the purple wire to the C2 terminal is bad.

Step 6). Connect your voltmeter or test lamp to the terminal on the LH horn with the purple/yellow wire. Press the horn button and monitor for the presence of power at this terminal as the button is depressed. If you have voltage, proceed to Step 7. If not, there is a break or a bad connection in the purple/yellow wire between the relay and the horn, which will need to be repaired.

Step 7). Using a short test lead with alligator clips on each end, connect the ground terminal of the LH horn to a good ground point, and press the horn button. If the horns blow, the ground connections are bad, and need repair. If not, the LH horn is bad. Repeat Steps 6 and 7 on the RH horn.

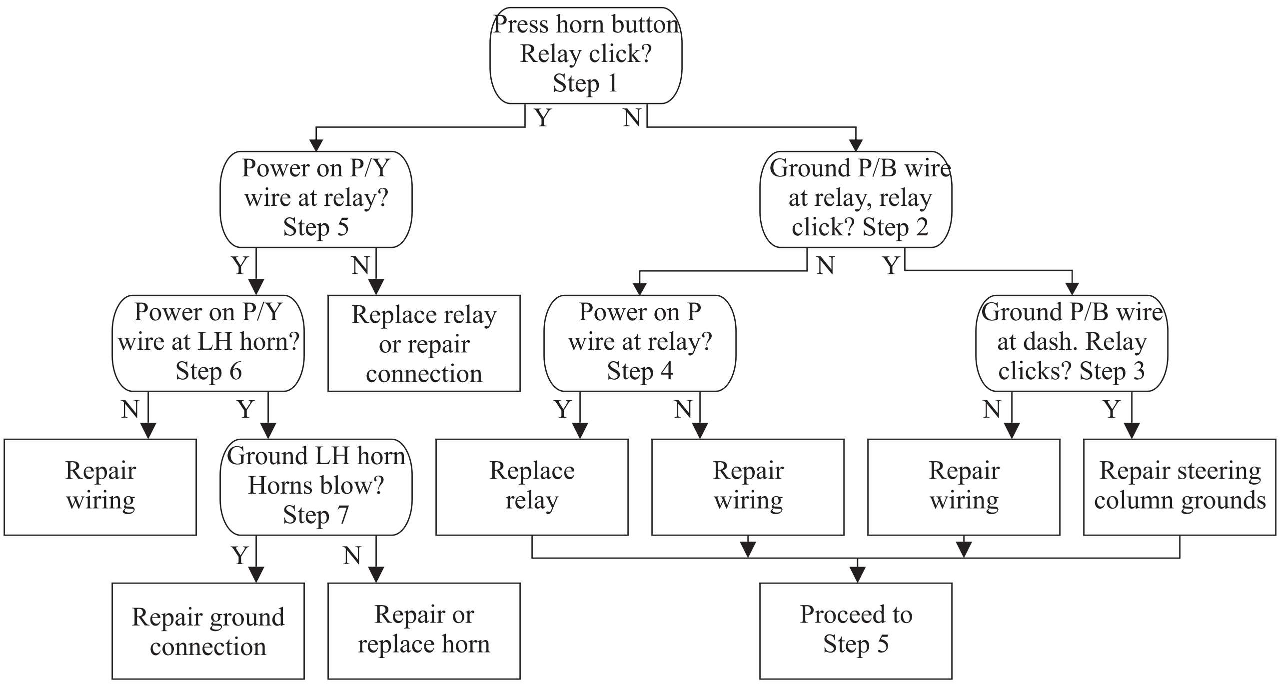
B2. One horn works, one doesn't

Step 1). Using a voltmeter or a test lamp, check for voltage on the purple/yellow wire at the non working horn, while pressing the horn button. If you have power here, go to step 2. If not, there is a break or bad connection in the P/Y wire from the horn relay, which will need repair.

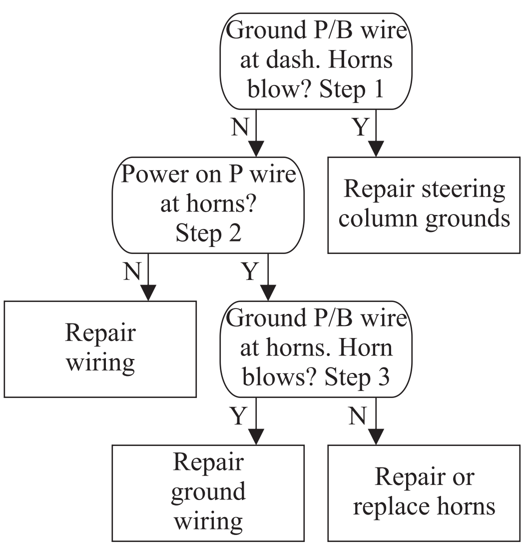
Step2). Using a short piece of wire, ground the horn terminal with the black wire while pressing the horn button. If the horn now blows, there is a break in the black wire, or a bad connection. If not, the horn is bad.

# TROUBLESHOOTING FLOW DIAGRAMS

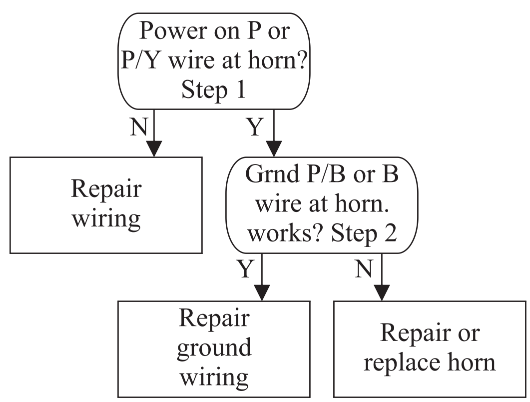
WITH HORN RELAY




WITHOUT HORN RELAY




ONE WORKS, ONE DOESN’T



# 19
# HORN REBUILDING AND/OR REPAIRING

THEORY OF OPERATION

Horns are nothing more than a buzzer with a diaphragm. If you are not familiar with how a buzzer works, an explanation is in order. A buzzer consists of a magnetically operated, normally closed, switch and an electromagnet - basically, a relay! The switch is wired in series with the electromagnet coil. Current flows through the switch into the coil, creating a magnetic field which opens the switch. This causes the field to collapse, closing the switch, at which time the field is again built up, opening the switch, which collapses the field, closing the switch, etc, etc, etc. This happens very rapidly, producing a buzzing sound. By placing a diaphragm on the switch, the sound is magnified and the tone improved. **Figure 1** below shows a relay used as a buzzer. The **A** side shows the relay with the NC contact closed and the **B** side shows the NC contact opened by the relay coil. As long as the on-off switch is closed, the relay will open and close repeatedly, as described above. In a pinch, a relay makes a quite acceptable buzzer.

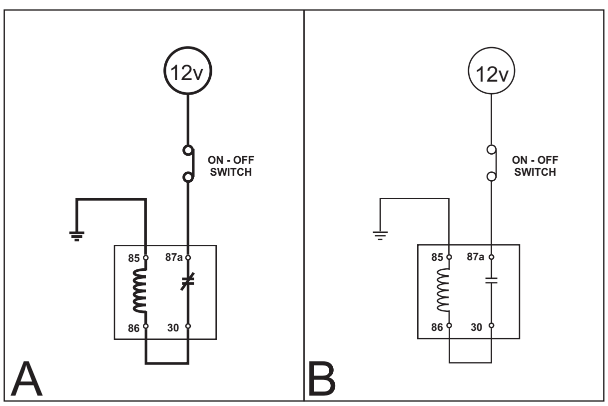



FIGURE 1

Internally, a horn has three primary components - a solenoid, a diaphragm, and a switch. **Figure 2**, opposite, is a simple diagram of the internals of a horn. The switch is wired in series with the solenoid, and the diaphragm is fastened to the solenoid plunger. When the solenoid is energized, the plunger is pulled into the solenoid, and the diaphragm moves downward. Attached to the plunger is an actuator that mechanically operates the switch. When the plunger reaches the end of its travel, the actuator opens the switch and current to the solenoid is interrupted. The plunger/diaphragm then retracts, the switch re-closes, and the cycle starts over again. The design of the assembly is such that the in/out movement is rapid enough to create the high pitched sound we hear.

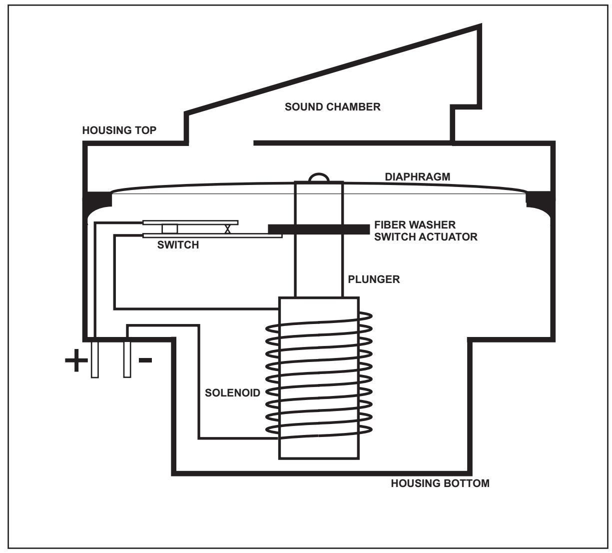



FIGURE 2

ADJUSTMENT PROCEDURE

The function of the adjustment screw (the large one with the lock washer) is to limit the forward movement of the plunger. If the movement is too limited, the plunger will not move far enough to open the switch. If it is allowed to move too far, the frequency of the sound will be too low, and the volume too soft. Physically, the adjustment screw goes into the core of the solenoid from the opposite end from the plunger.

The smaller screw is a left handed thread, and physically bends the fixed arm of the switch, increasing the rearward travel of the plunger before the switch re-opens.

CURRENT DRAW

Since the switch operates in an ON-OFF cycle, the average current is less than the maximum current, in the ratio of the ON time to the OFF time. The ON-OFF ratio will depend on the adjustment setting, and the tone of the horn, but assuming 50-50, the average current will be ½ of the max. For this reason, a horn that is misadjusted such that the switch doesn't open, or if the switch sticks closed, may appear to be shorted, based on the apparent excessive current draw. At a 50 - 50 ratio, a 2 amp horn would draw 4 amps. If the ratio were to be 20-80, a horn that would draw

2 amps when working would draw 10 amps if the switch remains closed.

REPAIR PROCEDURE:

There are three types of failures with horns:

1. The contacts corrode together, preventing the switch from opening

2. Corrosion builds up on the contacts, preventing current flow through the coil

3. The coil wire or connections break.

By drilling out the rivets, shown in **photo 1**, below, you can get to the contacts to clean them. It will be self evident what needs to be done. The success rate for this repair is fairly good. If the coil wire is broken, it can be fixed, but finding someone who knows how to do it is very unlikely, and probably very expensive.

You can, however, with a little care and patience, repair the coil yourself. If the wire is broken where it is visible, a bit of solder will usually do the trick, provided the insulation (a lacquer or enamel coating) is removed from the wire first. If the break is inside the coil, you will have to unwind the coil, and rewind it with the correct type and size of wire. As you unwind the wire, make careful note of the number of turns used, and the general arrangement of the wire.

Take a piece of the wire to an electric motor repair shop, and ask them for enough wire of the same size to rewind your coil. Most shops will be happy to sell you the small amount of wire needed, but some will insist on selling you an entire spool - enough to wire every TR250/TR6 horn in existence. Even so, the cost is not high, but probably more than it would be worth, considering you can buy after market horns, with a louder sound, for under $25 per pair. In as much as the horns are not seen, repair versus replace is mostly a matter of esthetics. Some folks prefer to remain original if at all possible, regardless of the cost or effort.

I've attached a few photos of Triumph horns, both assembled and disassembled, to help you visualize the process of repair.

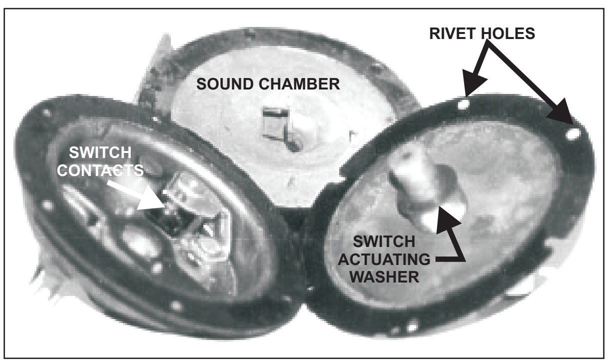



PHOTO 1

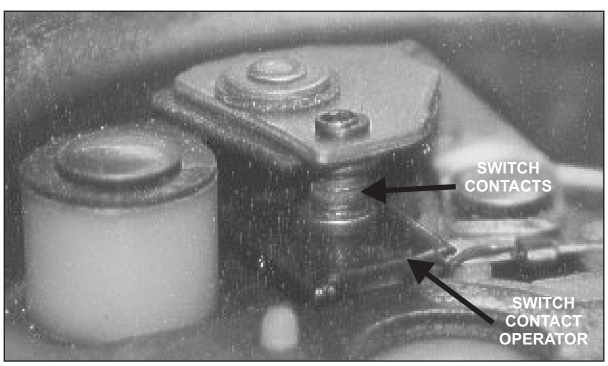



PHOTO 2

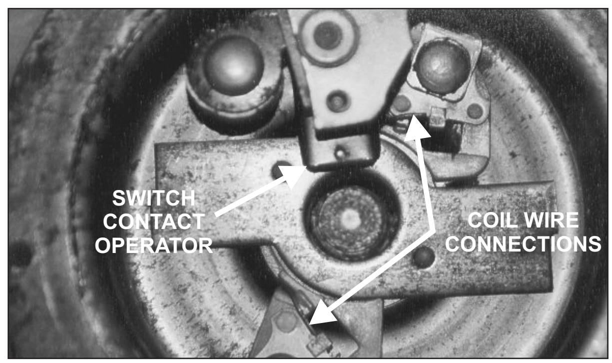



PHOTO 3

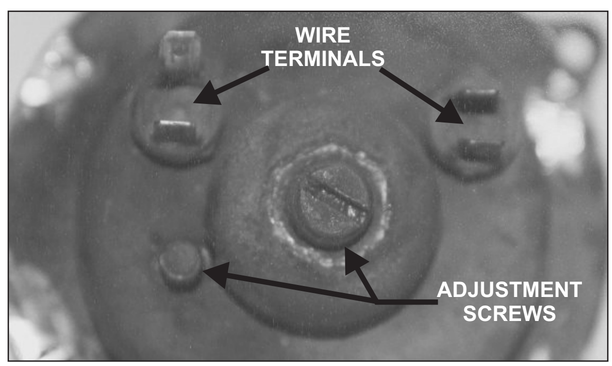



PHOTO 4

# 20
# IGNITION SYSTEM

CIRCUIT DESCRIPTION

Two different types of ignition circuits were used in the TR250/TR6 range. From the '68 TR250 until sometime around the introduction of the '73 TR6, the ignition circuit utilized a non-ballasted type coil, operating with the full 12 volts applied to the coil whenever the ignition key was on. Beginning with the '73 model, a ballast resister was added, allowing the full 12 volts to be applied to the coil only while the starter was spinning the engine. After the engine started, and the starter was no longer engaged, the ballast resister was switched into the circuit, and the coil received a lower voltage, approximately 6 volts.

The addition of the ballast resister was, I believe, necessitated by the additional environmental controls being added at this time, making the engines harder and harder to start. When the starter is operating, it draws a LOT of current, so much so, in fact, that it can drag the battery voltage down considerably, reducing the voltage available to the ignition coil (see chapter 5, Batteries and Battery Charging, for more info on this). Reducing the coil voltage on an already hard to start engine is not a good thing to do.

So, what is the difference between the two types? Basically, a non-ballast coil is designed to produce full spark output with 12 volts on the input (+ terminal). A ballast coil is designed to produce the same spark output, but with only 6 volts or so on the input.

With a non-ballast coil, the input to the coil is the full battery voltage, whether the engine is running or being cranked by the starter motor. With a ballast coil, the ballast resister is by-passed when the starter motor is spinning the engine, and the full battery voltage is applied to the coil. Since the coil is designed to provide full spark with reduced voltage, the application of the full battery voltage, even if it is reduced by the starter current, produces a much hotter spark, which is an aid in starting. After the engine starts, and the starter motor is off, the coil voltage is dropped to the lower voltage, and the coil output is the same as for a non-ballast coil.

The first thought that comes to mind, is: "why not run the ballast resister coil with full battery voltage at all times? A hotter spark sure wouldn't hurt things." The reason the ballast type coil is not run at the full 12 volts all the time for a hotter spark is to prevent damage to both the coil and the points. At full voltage, the coil would seriously overheat, and the excessive coil current would destroy the points in a short time.

With a non-ballast coil, power is applied to the coil directly from the ignition switch, via a white wire. Power to the ballast coil comes from the ignition switch to the ballast resister, and then to the coil. When the starter is operating, power from the battery is routed directly to the coil through the contacts of the starter relay ('74 - '75 models) or through an extra contact on the starter solenoid ('73 and '76 models), as shown in **figures 1 through 6** below. This shorts out the resistor wire by placing 12 volts on both ends of the wire. With the same voltage on both ends, no current flows, so no heat is generated. The current flow is shunted around the resistor wire. This bypassing of the resistor wire places the full 12 volts on the coil.

DIAGRAMS

**Figures 1** below illustrates the circuit configuration for '74 - '75 models

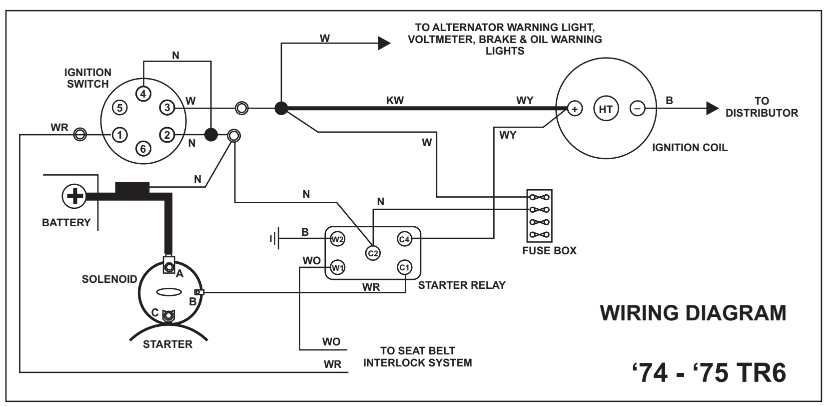



FIGURE 1

In **figure 2**, next page, we see the circuit in normal operation. The heavy lines represent normal current flow, while the dashed line for the ballast resister represents the lower current flow due to the ballast resistance. This current flow through the resister drops the coil voltage to around 6 volts.

**Figure 3** is a depiction of the circuit while starting. The starter relay is energized and power is applied directly to the coil through contact C4 of the relay. The coil now receives full voltage, and a draws a higher current than it draws during normal operation.

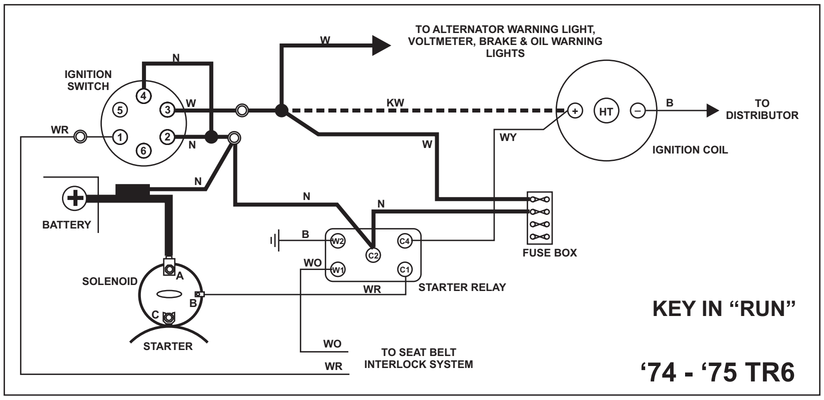



FIGURE 2

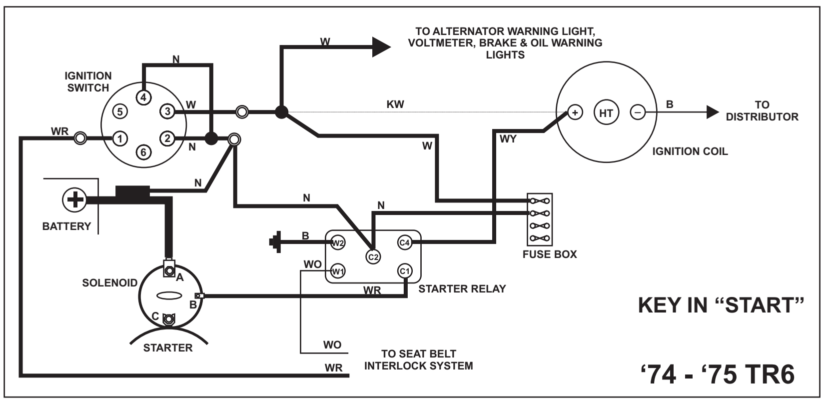



FIGURE 3

**Figures 4, 5,** and **6**, below and on the next page, depict the same as the previous figures, but for the '73 and the '76 models.

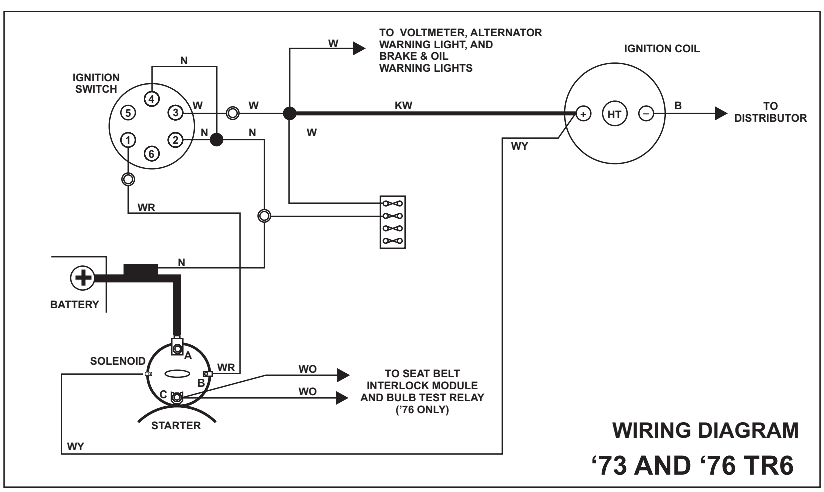



FIGURE 4

TROUBLESHOOTING

As much as I'm opposed to the "replace it and try" method of troubleshooting, that's just about all you can do with the ignition system. There are, however, a few tests you can make before you begin replacing components. You can, for example, make sure that your wiring is correct, and the coil is getting the correct voltage, and check to see that the ballast resister, if you have one, is being properly bypassed during starting.

IGNITION COMPONENTS

Step 1). Turn the ignition key to the run position, and, using your voltmeter or test lamp, check for the presence of voltage at the positive terminal of the coil. If your car doesn't have a ballast resister, the voltage check is straight forward - you have the full battery voltage or you don't. With a ballast resister, though, it's just a bit more complicated. If the ignition points are closed, you should read 6 volts (or the test lamp should glow at a lower brilliance than normal). If, on the other hand, your points are open, you will read full battery voltage even if the ballast resister is in good working order. Without the current through the coil, no voltage will be dropped across the resister, as neither the voltmeter, nor the test lamp draw enough current. To be sure, temporarily short the negative terminal of the coil to ground before measuring coil voltage.

If your car has a ballast resister, measure the voltage on the coil with the starter spinning. You should measure full battery voltage.

If you have the correct voltage on the coil during the proceeding tests, proceed to step 2. If not, there is a break or a bad connection in the white wire circuit from the ignition switch, the ballast bypass circuit is faulty, or the ignition switch is bad or not getting power from the battery. Go to the voltage testing section below.

Step 2). Locate the lead from the negative terminal of the ignition coil to the distributor, and disconnect it from the coil. If you are using a VOM, set it to the ohms scale. Connect one of the VOM leads to the engine block, and the other lead to the distributor/coil lead you just disconnected. If you are using a test lamp, connect the alligator clip to the positive post of the battery, and touch the tip of the test lamp to the wire you just removed. Have someone spin the engine, and watch the VOM or the test lamp. The VOM should alternate between zero ohms and infinity as the engine rotates, or the test lamp should flash on and off. If you get any result other than the above, go to step

3. Otherwise, go to step 4

Step 3). Remove the distributor cap and examine the points while spinning the engine. If the points are staying open or staying closed, you have a mechanical problem with the distributor, or the points are simply out of adjustment. Repair or adjust as needed. If the points seem to be opening and closing properly, but the test you just performed indicates that they are staying closed (lamp stays lit or the VOM gives a constant zero ohms reading), the most likely problem is with the plastic insulator that isolates the points from ground when they are open. See **photo 1** below for details. Often, this plastic piece gets distorted or damaged, and it is awfully hard to see the problem without taking the points out. If the previous tests indicated that the points were not closing, examine the points for pitting. Often, the pitting will prevent the points from making a good electrical contact. If in doubt, replace the points, although you might be able to file them smooth as a temporary repair.

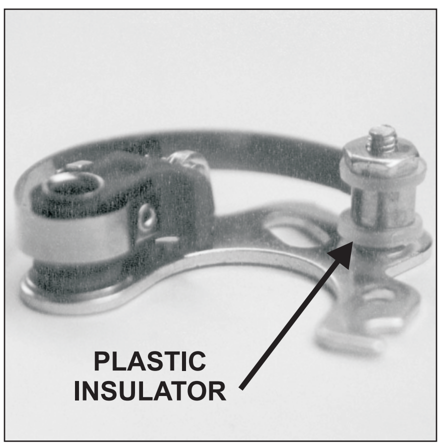



PHOTO 1

Step 4). Replace the lead from the distributor to the ignition coil. Pull the high tension lead from the center post of the coil, and insert a known good plug wire into the center post of the coil (this procedure removes the distributor cap and the rotor from the circuit, so you will be testing only the coil and condenser). Connect the other end of the spark plug lead to a known good spark plug. Hold the threaded portion of the spark plug tightly against the engine block (wearing gloves to prevent shock), and have someone spin the engine. You should see a strong spark from the plug. It's difficult to describe what a "strong" spark looks like, so you might want to perform this test on a running car first to get an idea. If you don't get a good spark, or you get no spark at all, either the coil or the condenser is bad. If you get no spark at all, it's "probably" the coil, but if you get a weak spark, it's "probably" the condenser, although there is no guarantee of this. Replace the coil or condenser. If you get a good spark, then your distributor cap or rotor is bad, or you have bad spark plug leads. Go to step 5.

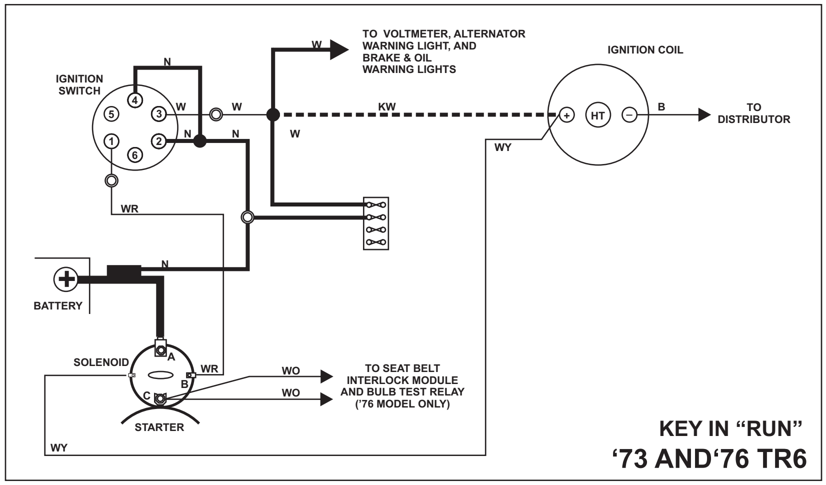



FIGURE 5

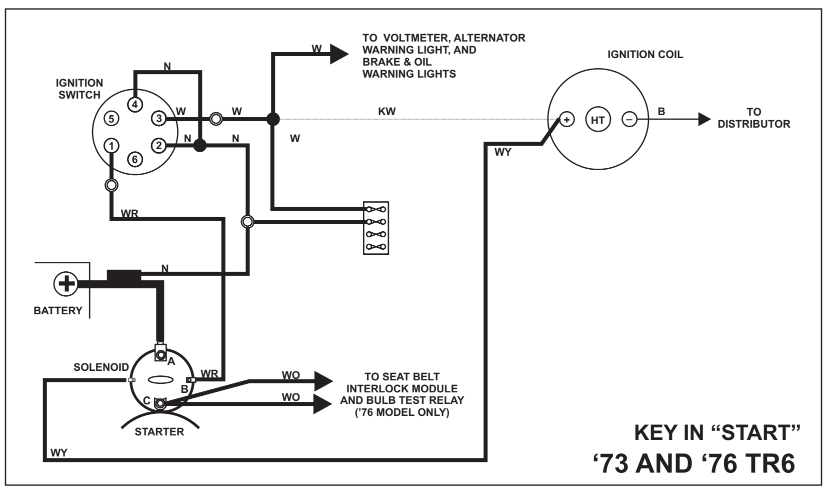



FIGURE 6

Step 5). Replace the rotor and distributor cap and reconnect the lead from the coil to the distributor, and start the engine. If it runs OK, your problems are solved. If not, remove one of the plugs, place the threaded portion of the plug tightly against the block wearing gloves to prevent a shock) and spin the engine and check for a good spark. If you don't get a good spark, your plug wires or the plugs themselves are bad. If you get a good spark, your problem is mechanical (fuel delivery, ignition timing, etc).

VOLTAGE TESTS

TR250 - '72 TR6: Voltage supply to the ignition system on these early models is very straight forward and simple, as shown in **figure 7**, next page. Voltage comes from the ignition switch to the fuse box, and then to the ignition coil, via white wires. The “green” fuse is fed from the white wire, so if you have power on ***ANY*** of the green fuse loads, then power is getting to the green fuse. If you have power on the green fuse, but not on the ignition coil, there is a break in the wiring from the fuse box to the coil. If you don’t have power on the green fuse, there is a break in the wiring from the ignition switch to the fuse box, a break in the brown wire from the battery to the ignition switch, or the switch itself is bad. Follow the procedures outlined in chapter 2, General Procedure, to resolve the voltage concern.

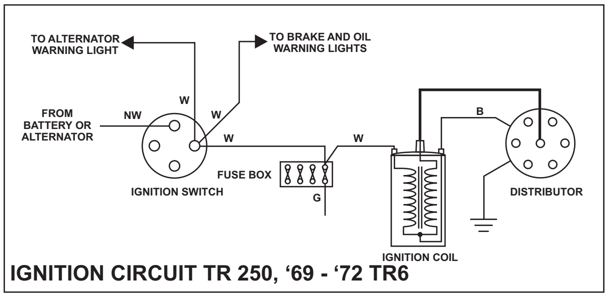



FIGURE 7

‘74 - ‘75 TR6: The addition of a ballast resistor and ballast bypass relay complicates the voltage test for these years just a bit, but the testing is still reasonably simple.

Step 1). What were your symptoms when you performed step 1 of the ignition component testing above?

a). You had no voltage on the coil when the key was on, but had 12 volts when the starter was operating? Go to step 2.

b). You had 6 volts on the coil when the key was on, but didn’t have 12 volts when the starter was operating? Go to step 3.

c). You had no voltage when the key was on, and had no voltage when the starter was operating? Go to steps 2 and 3.

Step 2) power to the ignition coil (via the ballast resistor) comes from the ignition switch on a white wire. See **figure 1**, page 85, and **figure 4**, page 84, for details. The white wire from the ignition switch also feeds the voltmeter, the alternator, brake and oil warning lights, and the “green” fuse. The green fuse feeds the WS wipers, WS washer, turn signals, heater fan, brake and back-up lights, and the gauges. If ANY of these items work, there is power on the white wire from the ignition switch- go to step 2. If NONE of these items work, the ignition switch is faulty, there is a break in the white wire from the switch, or there is a break in the brown wire to the switch. Refer to chapter 23, Power Distribution, and repair as needed.

Step 3). Locate the junction of the ballast wire (the pink/white wire, looking like a “shoelace”) and the white wire, under the dash near the ignition switch (you may need to open up the wiring harness to get to this junction), and check for the presence of voltage at this junction, with the key in the run position. If you have 12 volts, the ballast resistor is bad, and will have to be replaced as outlined below in the ballast replacement section. If you don’t have voltage here, there is a break or bad connection in the white wire from the ignition switch to the ballast wire (the other white wires should be OK).

Step 4).

‘74 - ‘75: the same relay that is used to operate the starter also operates the ballast resistor bypass, so if the starter works, you know the relay works. Using your voltmeter or test lamp, check for the presence of voltage on the relay terminal with the white/yellow wire (should be C4, but could be C2 or C1), with the key in the start position. If you have voltage here, there is a break or a bad connection in the W/Y wire to the coil, which will need to be repaired. If you don’t have 12 volts here, the relay is defective (even though it works for the starter circuit, the internal contacts for the W/Y wire are not making up properly). Repair or replace the relay.

‘73 and ‘76: using your voltmeter or test lamp, check for the presence of voltage on the starter solenoid terminal with the W/Y wire. With the key in the start position, and while the starter is operating, there should be 12 volts on this terminal. If you have 12 volts, there is a break or bad connection in the W/Y wire to the coil. If not, the internal contacts in the solenoid are faulty, and the solenoid must be repaired or replaced.

BALLAST RESISTOR REPLACEMENT

If your ballast resistor is bad, rather than tearing open the wiring harness to replace it (if you can find a replacement), you might want to use a replacement unit from your local auto parts store. If so, just ask the counter man for a 1.5 - 1.6 ohm resistor, mount it in a location away from other components (it does get hot!), And wire it as shown in **figure 8** below. Cut the ballast wire near the coil, insulate it well, and tie it back away from any possible ground. Connect the new ballast resistor between the white wire at the fuse box and the positive post of the coil, using at least 14 gauge wire.

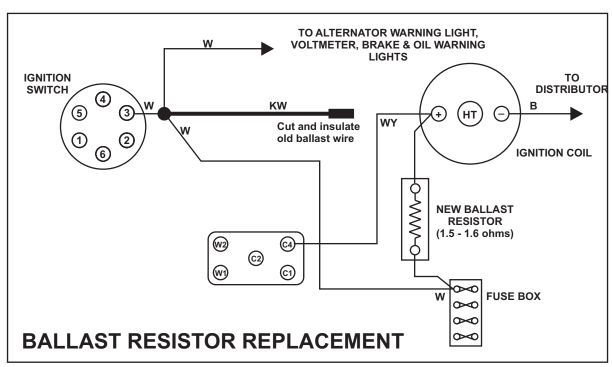
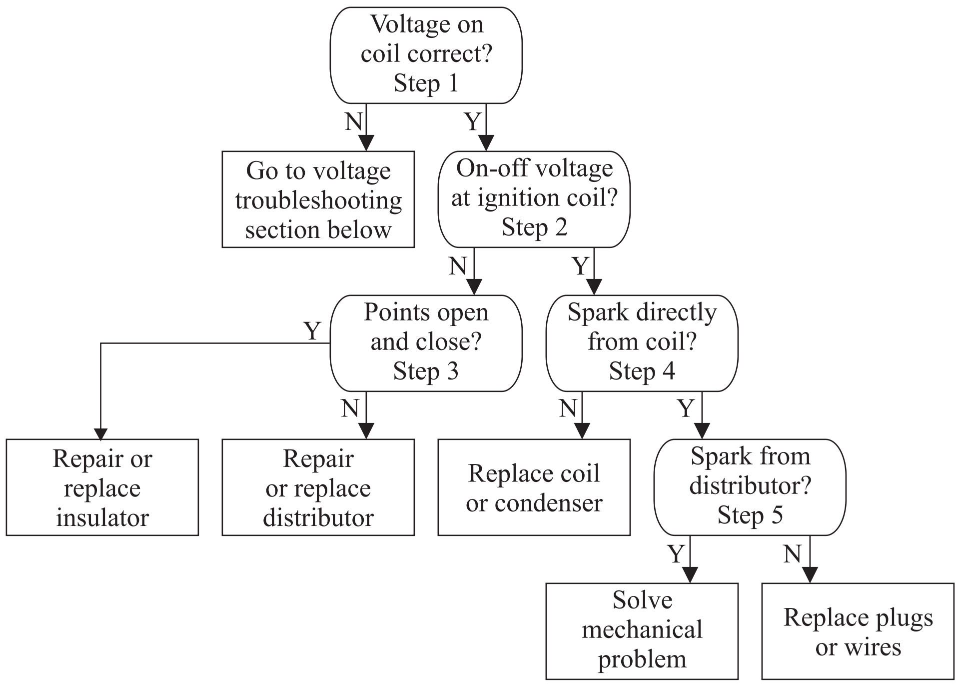


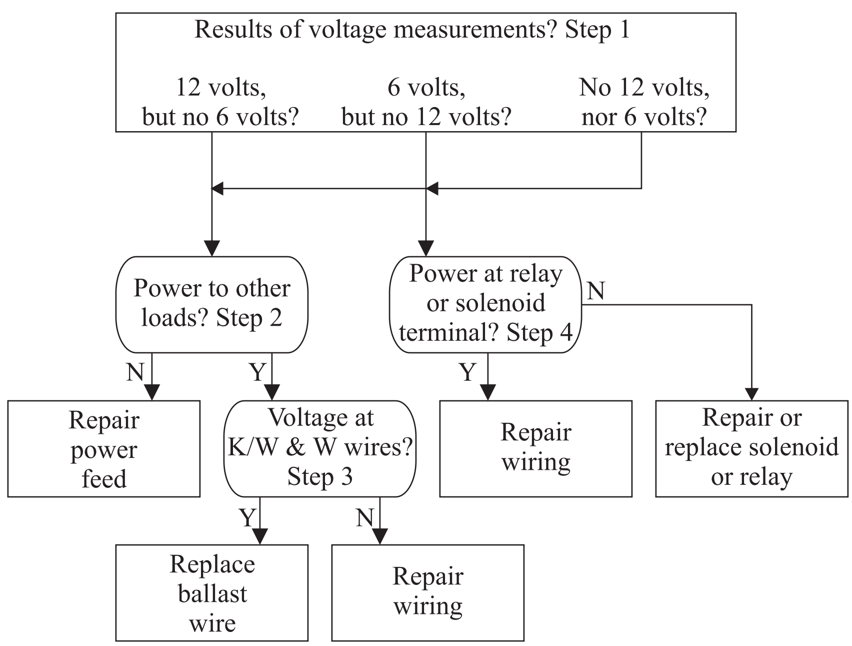

FIGURE 8

# TROUBLESHOOTING FLOW DIAGRAMS

## IGNITION COMPONENTS




## VOLTAGE TESTS



# 21

# OIL, BRAKE & EGR WARNING LAMP CIRCUITS

The TR 250 had a total of 6 “warning” lights - Alternator, brake failure, low oil pressure, turn signals, hazard flasher, and high beams. The later TR6 models had two additional warning lights, - fasten seat belts and EGR. This chapter will cover the low oil pressure, brake failure, and EGR lamps, while the remaining lamps will be covered in other chapters.

OIL AND BRAKE WARNING LAMPS

**Figures 1** and **2**, below, depict the wiring scheme for the low oil and brake warning lamps for the TR 250 and the ‘69 - ‘72 TR6. Electrically, they are identical, the only difference being the use of a splice in the TR6 models in place of the bullet/sleeve connection used in the TR250.

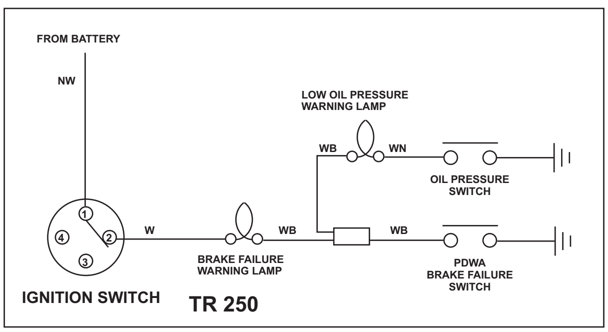



FIGURE 1

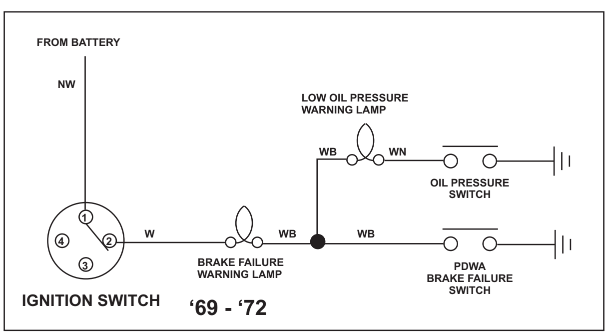



FIGURE 2

These are somewhat peculiar circuits, in that the oil pressure switch operates both lights dimly, while the brake failure switch operates only the brake failure light, and at full brilliance. As peculiar as it seems, there is a good reason for this. When you first turn the key on to start your car, the engine oil pressure is low, so the oil pressure switch is closed. The oil warning light will be on as a means of verifying that the bulb is good. When you start your car, you should be in the habit of checking the bulb to be sure that it does work. The brake failure switch, on the other hand, will never be closed unless there has been a brake failure, so there is no way to arrange for the brake failure light to come on when you turn the key on if the light were to be wired only to the brake failure switch. By wiring the lights as shown, both bulbs can be tested at startup. Brake failure being considered the most severe event, the designers chose this bulb to be the one that is at full brilliance when lit. **Figure 3** below illustrates what happens when the key is initially turned on.

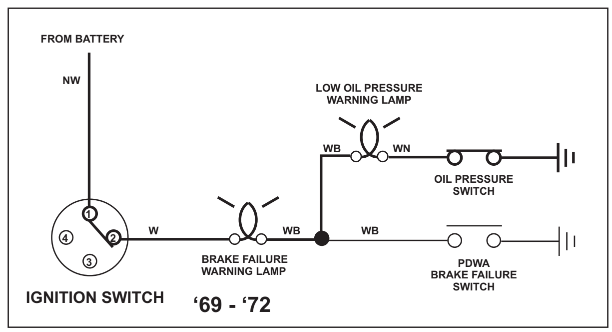



FIGURE 3

With the key on and the oil pressure not yet up to normal, current flows from the battery, through the ignition key, through the two bulbs in series, through the oil pressure switch, and then to ground. The two bulbs will each receive 6 volts, one half of their rated 12 volts, and will be lit rather dimly. This is also the same situation that will occur should the oil pressure drop after the engine has been running. Rather then seeing just the brightly lit oil pressure lamp, you will see both lamps lit. This could be confusing, but shouldn’t be, as you have the oil pressure gauge to monitor. In fact, barring a catastrophic oil pump failure, you shouldn’t be surprised to see the lamps come on, as you should have been watching the gauge to begin with.

**Figures 4** and **5**, next page, illustrate what happens when the brake failure switch is actuated. As you can see, it doesn’t matter then what position the oil pressure switch is in. With the brake failure switch closed, ground is applied to the high side of the oil lamp, so having a ground on the low side or not makes no difference.

The oil pressure switch, by the way, is a SPST, momentary, normally closed switch. Which means the switch is closed when it is out of the car and on the bench, and it is only open as long as oil pressure is applied. The contacts do not retain their position in the absence of oil pressure as would a maintained switch.

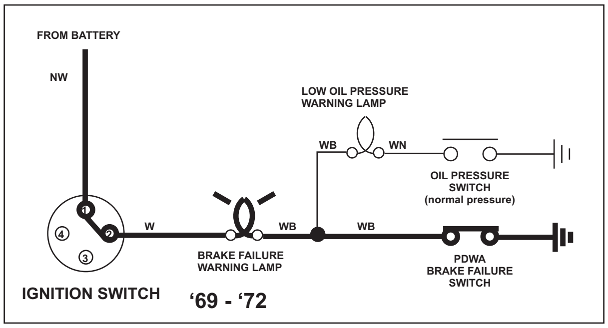



FIGURE 4

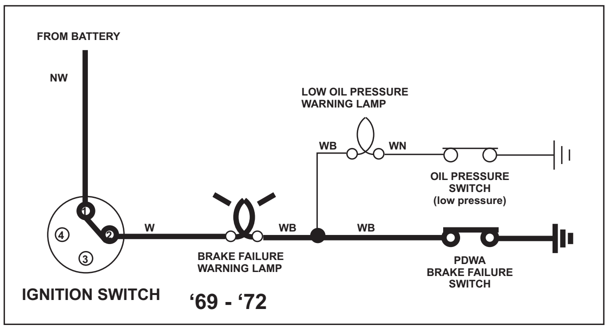



FIGURE 5

**Figure 6** below show the same circuit for the '73 - '75 TR6. The circuit is identical to the circuits above, except for the oil pressure switch configuration. In this circuit, the oil switch is a SPDT momentary switch, with one normally open and one normally closed contact. In engineering terms, this is a momentary form C switch.

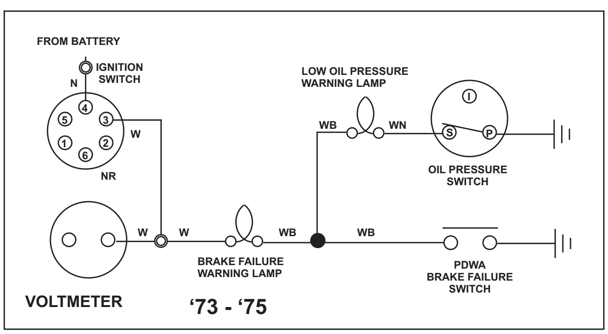



FIGURE 6

**Figures 7** and **8**, right, depicts the wiring arrangement for the '76 TR6. At least I think it does! To the best of my knowledge, there is no published schematic anywhere that correctly depicts this aspect of the '76 TR6 wiring. ***Every*** schematic I've seen has had a glaring error/ommision in this area of the wiring. The information I've shown here comes from talking with '76 TR6 owners via the Internet, and piecing together the information received. One owner confirmed part of the wiring, while another confirmed a different part, and another confirming yet another part. This circuit differs from the previous circuits in two ways: a different approach to testing the bulbs, and the addition of a switch to warn if the handbrake is on.

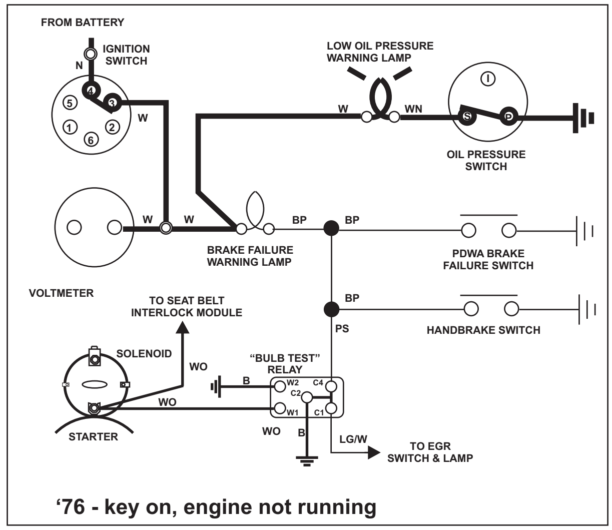



FIGURE 7

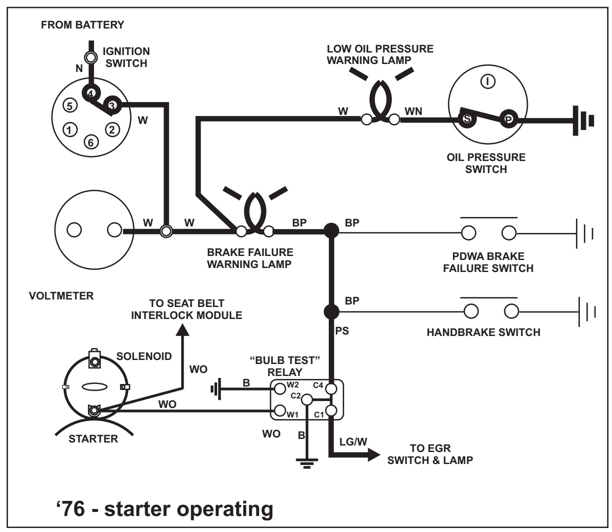



FIGURE 8

To implement the new testing scheme, power to the low oil pressure lamp was moved to the white wire from the ignition switch. Now, when the ignition key is turned on, but the oil pressure is not yet up to normal, the low oil pressure light will be on at full brilliance, as power is no longer routed through the brake failure lamp. Thus, if the low oil pressure lamp doesn't come on, you know there is a problem in the circuit, most likely a bad bulb - just as before, but the indication is a bit brighter than before, and is independent of the brake failure warning lamp.

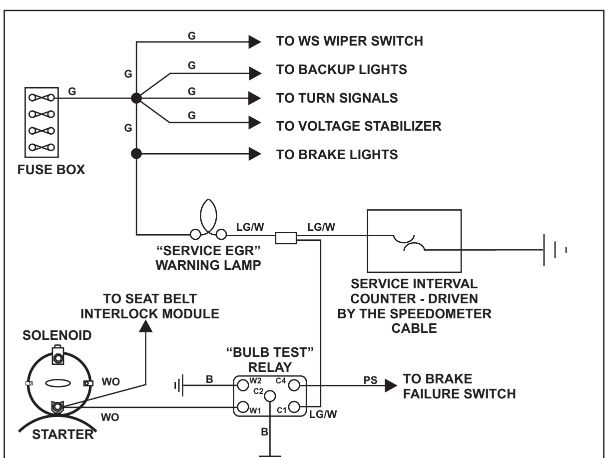
The new hand brake warning switch operates exactly the same as the brake failure switch. If the brake lamp is on after the engine has started, you either have the hand brake on or a failure in the brake system.

The brake warning lamp is tested by either the fact that the handbrake is on, or by the operation of the bulb test relay. This relay (which I have labeled "bulb test relay" because it serves no other function in a '76 model) is operated by a direct connection to the starter motor, so that the relay is energized any time the starter motor is operating. When the relay is energized, contacts C1, C2, and C4 are shorted together inside the relay. Contact C2 is connected externally to ground, which then connects the wires to relay terminals C1 and C4 to ground also. When this happens, the effect is the same as if either the hand brake or the brake failure switch has operated, and the brake failure lamp is lit at full brilliance.

## EGR SERVICE INTERVAL WARNING LAMP

The '76 TR6 added an EGR service warning light to remind the driver when it is time for the EGR system to be serviced. The circuit diagram for this is shown in **figure 8** below. To implement the warning light circuit for the '76 model year, the speedometer cable was split into two pieces; a longer piece from the transmission to a small service interval counter mounted under the hood, atop the driver's side (LH) footwell and next to the windshield wiper motor, and a smaller piece from the service interval counter to the speedometer. Inside the counter, the speedometer cable operates a cam through a set of gears. After 25,000 miles have been driven, the cam actuates a switch, closing it to provide a ground to the "service EGR" warning lamp. The contacts stay closed until manually reset by a service technician with a special key. If you don't have the special reset key, it's not real difficult to "jury rig" one.

As a side note, if you should want to remove the counter, the one-piece speedometer cable from the earlier models will fit perfectly.

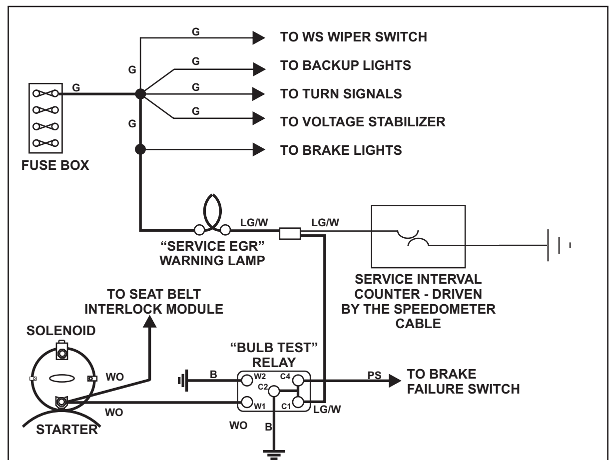



'76 EGR WARNING LAMP

FIGURE 8

The same bulb test relay used in the oil and brake warning circuit is also used to test the EGR warning lamp, as described previously. **Figure 9** above right, shows the operation of the circuit when the bulb test relay is operated.

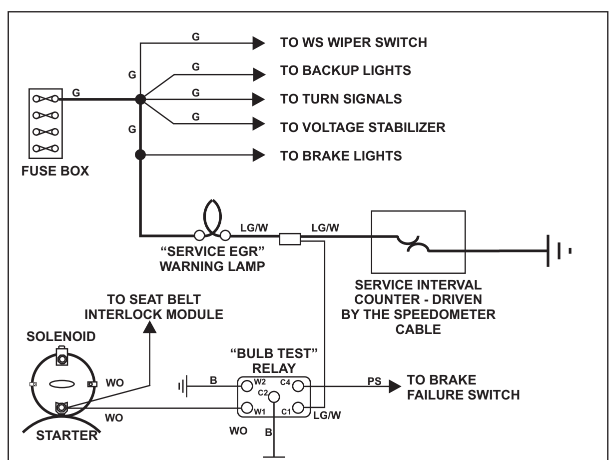
With the relay energized, the light green/white wire from the EGR bulb is grounded through the C1, C2, and C4 contacts of the relay, and the bulb is lit. Every time you start the car, the bulb is illuminated as a means of checking that the bulb is operable. Much ado over nothing actually, as the bulb only informs you that you have driven over 25,000 miles since the last time it came on and you had the counter reset, nothing that your odometer won't tell you. It's actually quite effective, though, as most folks, particularly those that aren't mechanically inclined, will be quite bothered by a warning light shining, and will more than likely take the car to a shop to find out what the trouble is.




'76 EGR WARNING LAMP - starter operating

FIGURE 9

**Figure 10** below illustrates the operation of the circuit when the counter has reached the magic number. At that time, the contacts inside the counter will close, illuminating the bulb.




'76 EGR WARNING LAMP - counter contacts closed

FIGURE 10

In this case, current flows from the "green" fuse, through the bulb, and then to ground through the counter contacts.

TROUBLESHOOTING

OIL AND BRAKE WARNING LAMPS

These lamps receive power from the ignition switch via a white wire. The ignition switch also feeds the ignition coil, alternator warning lamp, and the "green" fuse. It is assumed that you have power to these other devices, so no need to check for power at the ignition switch (if you didn't have power to the white wires, I'm assuming that you would be fixing that problem rather than this one)

TR 250 and pre 1976 TR6:

Step 1). The most obvious starting point would be to check the bulbs to see if they are bad. These bulbs are a bit hard to get to, though, so other, easier, tests should be performed first. With the key on but the engine not running, pull the white/brown wire from the oil pressure sender and connect it to ground. If the lights come on, you have a bad oil pressure switch. If not, either one or both of the bulbs are bad, no power is getting to the bulbs, or there is a break or bad connection in the wiring, which will need to be repaired. Go to step 2.

Step 2). Replace the W/N wire from the oil pressure switch, and remove the white/black wire from the pressure differential warning actuator (PDWA) switch. Connect this wire to ground. If the brake failure lamp now lights, the problem was in the oil pressure switch wiring or a bad bulb. If not, the brake warning bulb is bad, no power is getting to the bulbs, or there is a break or bad connection in the wiring. Go to step 3.

Step 3). If the bulbs didn't light in either of the above tests, the next step should be to test the brake warning light bulb. To do this, you will have to remove either the speedometer or the tachometer to get access to the lamp. If the bulb is good, you have a break in the white wiring to the lamp holder, or the lamp holder is bad, and will need to be repaired or replaced. See the lamp wiring test section later in this chapter for further testing details.

1976 TR6 only

Oil pressure warning lamp:

Unlike the earlier models, which had no way of operating the warning lamps for testing if the oil pressure switch failed, both of the failure warning lamps on the '76 model are tested every time the engine is started, and the brake failure warning lamp is tested every time the hand brake is operated. Consequently, the testing for this model has two directions - one if neither of the lights work, and another if only one of the bulbs is inoperable.

A). If neither light works when you turn on the key, crank the starter, or operate the hand brake, there is a problem in the wiring from the ignition switch to the lamps. As stated previously, it is assumed that the other loads fed from the ignition switch via the white wire are working properly, therefore, there must be a break or a bad connection in the white wire from the ignition switch to the warning lamps, which will need to be repaired. It is, of course, possible that you have multiple problems, so if the white wire isn't the problem, proceed with the individual steps outlined below for each warning lamp.

B). Only one lamp is inoperable:

Low oil pressure warning lamp:

Step 1). With the ignition key on, remove the white/brown wire from the oil pressure switch, and touch it to ground. If the light comes on, the pressure switch is bad. If not, go to step 2.

Step 2). Remove the oil pressure warning light bulb and test the bulb. If the bulb is good, there is a break or a bad connection in the wiring to the lamp. See the lamp wiring test section below for further testing details.

Brake warning lamp:

Step 1). Does the EGR lamp work properly? If not, go to the EGR repair section. If so, go to step 2.

Step 2). Does the brake light come on when the handbrake is operated (with the ignition key on)? If so, there is a break or a bad connection in the purple/slate wire to the bulb test relay. If not, go to step 3.

Step 3). Remove the brake warning light bulb and test the bulb. If the bulb is good, there is a break or a bad connection in the wiring to the lamp. See the lamp wiring test section below for further testing details.

EGR SERVICE WARNING LAMP

The EGR warning lamp receives power from the "green" fuse. The WS wipers, WS washer, turn signals, gauges, and heater fan all receive power from this fuse, so if ***ANY*** of these items work, then you have power at the fuse. If ***NONE*** of these items work, go to the power distribution chapter and resolve the power issue before proceeding.

Step 1). With the hand brake off, start the engine and observe the brake warning lamp. If neither the brake warning light nor EGR lamp works while the starter is engaged, there is a problem with the bulb test relay circuit. Go to step 2. If the brake lamp works but the EGR lamp doesn't, go to step 4.

Step 2). Remove the white/orange wire from the relay and lay aside. There will be no power on this wire during this test, so there will be no danger of sparks unless you forget to replace it before you start the car later. You ***MUST*** remove this wire before proceeding with this test, however, as severe damage may result to your wiring if you don't. The other end of this wire is attached to the starter motor. The internal resistance of the starter motor is near zero, approximately ½ ohm, which will look like a short circuit to ground for the test lead you will be hooking up to the relay.

Turn the ignition key on and connect a short jumper from the green wire side of the "green" fuse to the terminal where you just removed the W/O wire (should be the W1 terminal, but this very easily could have been swapped at some time in the past by a previous owner). If the relay circuit is working OK, you should hear the relay click, and see both the brake and the EGR lamp light up. If the relay doesn't click, go to step 3. If it clicks, but the lamps don't light up, go to step 4.

Step 3). If the relay didn't click, find the "W?" terminal on the relay with the black wire (should be W1, but may be W2) and connect this terminal to a good ground with a short test lead and repeat the above test. If the relay clicks, you have a bad ground to the relay. If not, the relay is defective.

Step 4). If the relay did click in step 2, but the lights didn't operate, or if only the brake light operated in step 1 remove the LG/W wire from the relay and connect it to ground with the key on. If the light doesn't work, there is a problem in the wiring or the bulb is bad. If the light does work, go to step 5.

Step 5). Reconnect the LG/W wire to the relay, and connect a short test lead between the C? Terminal with the black wire and ground (should be C2, but could be C1 or C4). Repeat test 2. If the bulb now lights, there is a problem with the ground wire to the relay, If not, the relay is bad.

Step 6). If the EGR light works in the above tests, but doesn't work when the mileage has exceeded the 25,000 mile set point, either the counter is defective or there is a break in the wiring from the lamp to the counter. With the key on, pull the wiring connector from the counter and short the pin with the LG/W wire to ground. If the bulb lights, the problem is the counter. If not, the problem is in the wiring.

PRESSURE DIFFERENTIAL WARNING ASSEMBLY (PDWA)

At the time of this writing, a new PDWA costs in the neighborhood of $350 - $400! Not something to be purchased on a whim. Fortunately, the PDWA is a very simple piece, and repairs are quite simple to make. In construction, the PDWA is nothing more than a double ended piston sliding in a simple tube. Each end of the tube is plumbed to the hydraulics of one of the dual brake systems - one end connected to the front brake lines, and the other end connected to the rear lines. See **photo 1** below for details on the construction.

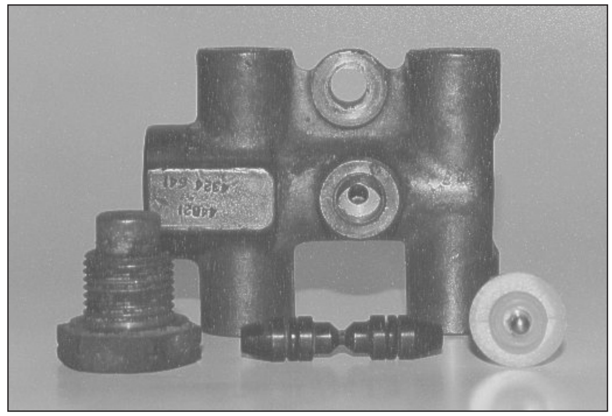


PHOTO 1

In operation, the PDWA is also quite simple. As long as each of the brake systems - front and rear - are intact, pressing on the brake pedal will pressurize each system equally. If, however, one of the systems should lose fluid, either through a slow leak or a brake line rupture, pressing on the brake pedal will not pressurize that system. In this case, the pressure in the intact system will cause the piston to move towards the un-pressurized system. As shown in **figure 11**, below, when the piston is moved off-center, it operates the switch plunger, grounding the wire lead to the switch. As stated in the previous sections, grounding of the switch lead causes the warning light to operate.

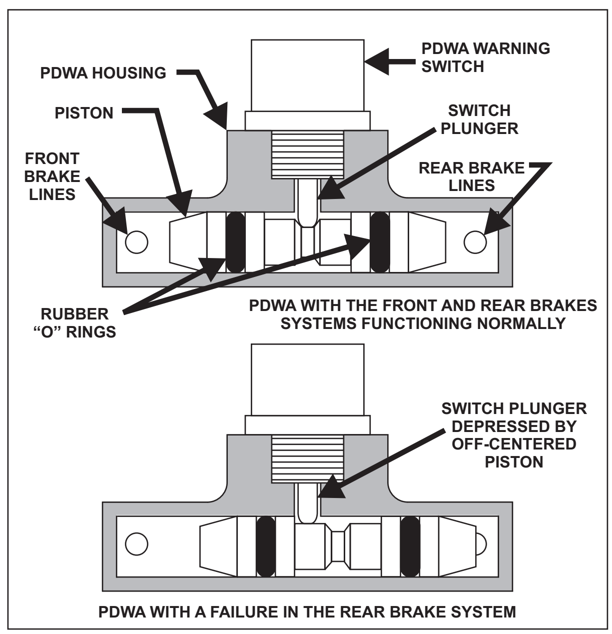



FIGURE 11

The most common problem with the PDWA is misadjustment of the piston, usually after doing brake work that requires the brakes to be bled. As you open the brake bleeders to remove air, the low pressure in that side of the brake system causes the piston to move off center. In this case, all that is needed is to open one of bleeders in the opposite brake system while pressing the brake pedal just enough to cause the piston to re-center.

If the PDWA does need work, all that is normally required in the way of repair is a disassembly and a thorough cleaning. In severe cases of internal corrosion, it may be necessary to bore out the cylinder and re sleeve it. The condition of the piston is usually of no real concern, as it will never, hopefully, be operated again, at least not until the next time you bleed the brakes. It is only important that the rubber “O” ring fit well, both to the piston and to the bore. The “O” rings are the only things that rub within the cylinder. As long as they make a good contact with both the cylinder and the piston, and provide a pressure seal between the two brake systems, all is OK.

REPLACEMENT UNITS

If you don’t have a PDWA, or if yours is really beyond repair, replacements are usually easy to come by from another make of British car. There is nothing marque specific about them, other than the mounting details and type of fittings - metric vs SAE. An MGB unit will fit a TR quite nicely. As a matter of fact, it would not be at all difficult to have one manufactured for you, if you know a reasonably priced machine shop, or have your own shop.

ELIMINATING THE PDWA

Often, out of frustration, owners are tempted to lift the lead to the PDWA to get the warning light to go out, rather than trying to get the piston re-centered. Or, if the PDWA is really bad, it might be tempting to just eliminate it altogether. Personally, I don’t recommend this approach for a couple of reasons. First of all, if you are driving your car at low speeds, especially as you drive it in and out of the garage and around the neighborhood while working on it, it doesn’t take much braking power to stop the car. You might not even notice that one of the brake systems has failed. Once you get out on the highway, and at highway speeds, and you need to make an emergency stop, the loss of one of the brake systems will be very much noticed, especially if the front system is the one that failed. The advance warning that the PDWA gives you could save your life.

Secondly, if the piston is off-centered, causing the light to stay on, and you just disconnect it, you have no reason at all to believe that the “O” rings are still good and the two brake systems are indeed isolated from one another. If not, and you have a failure of one system, just as soon as you put your foot down hard on the brake pedal, leakage through the “O” rings will quickly reduce the pressure to the good side, leaving you with no brakes at all!

If you do eliminate the PDWA, it is ***ABSOLUTELY VITAL*** that you ensure complete separation of the two braking systems, front and rear! Either remove the PDWA altogether, and reconnect the brake lines - front to front, and rear to rear - or plug the cylinder between the two systems. As a matter of fact, anytime you do brake work on your car, it would be a good idea to check the operation and isolation function of the PDWA. You should be replacing your brake fluid on a regular basis anyway, so that would be a good time to check the PDWA. It isn’t very hard to get to, and disassembly is not at all difficult.

LAMP WIRING TESTS

Testing the warning lamp wiring can be a bit difficult, as the wiring is bound up in the wiring harness, and there is a rubber boot over the bulb holders. **Photo 2** below shows a bulb holder that has been removed from the car, and the rubber boot pulled back. As you can see, one of the wires is connected to the shell of the lamp holder, while the other wire is connected to the center conductor, or “bullet” assembly. By pushing the center wire into the holder, the bullet can be pushed out for access.

The prongs which hold the lamp in place are isolated from the body of the holder (shell) so the wire that is connected to the shell is also insulated from the tachometer, speedometer, or other bulb holder.

Once you have the bulb holder out, and the wires exposed, it is a simple matter to use a voltmeter or test lamp to look for the presence of power, or an ohmmeter to test for continuity on the wire.

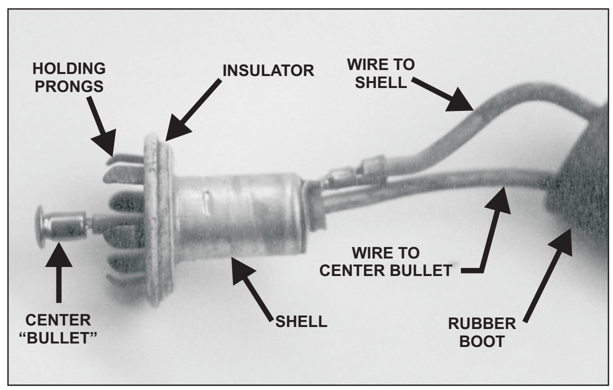
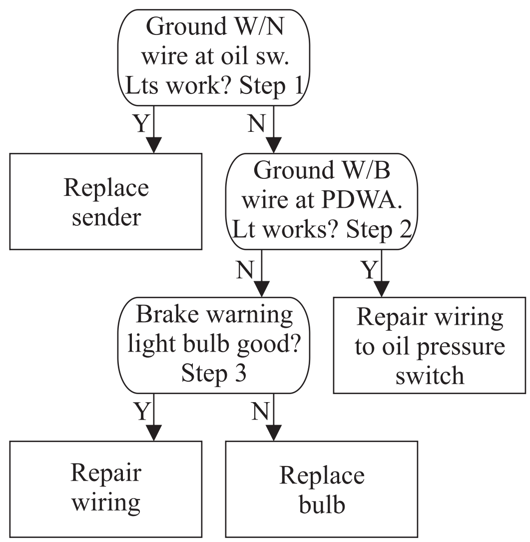



PHOTO 2

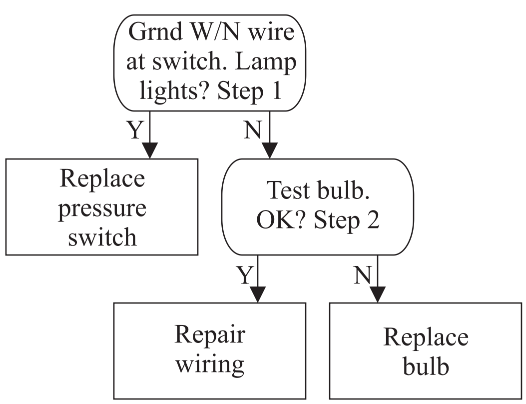
# TROUBLESHOOTING
# FLOW DIAGRAMS

## OIL AND BRAKE WARNING LAMPS
TR 250 - '75 TR6

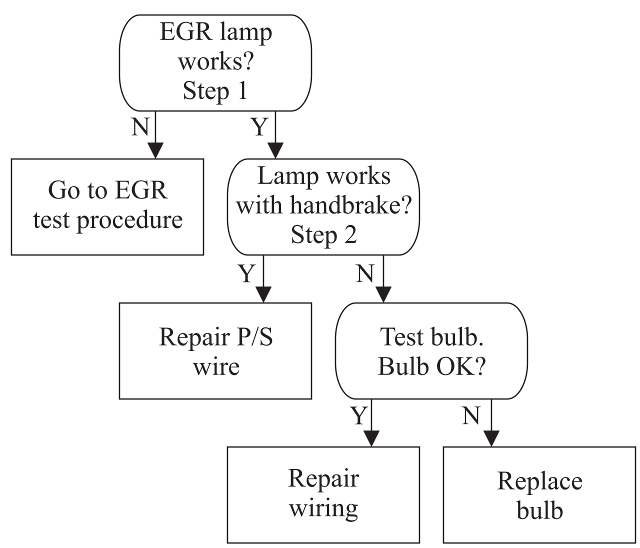



## OIL AND BRAKE WARNING LAMPS
'76 TR6

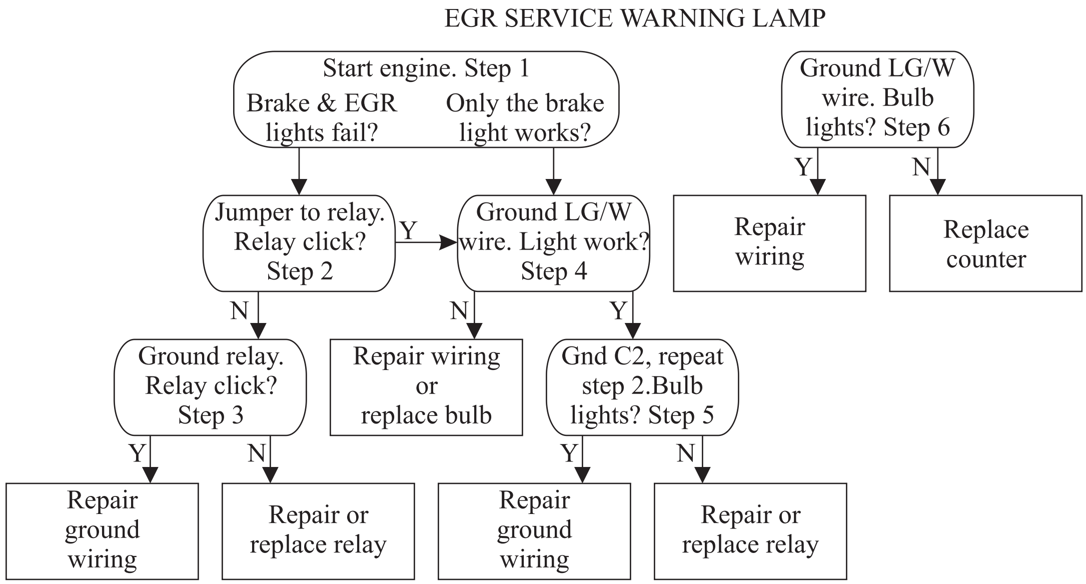
### OIL PRESSURE LAMP




### BRAKE WARNING LAMP



# TROUBLESHOOTING FLOW DIAGRAMS



# 22
# OVERDRIVE

OVERDRIVE TYPES

There were two types of overdrive units used in the TR250/TR6 range - the earlier models had the “A” type, which was replaced at the start of the ‘73 model year with the “J” type. The earlier “A” type used a dual coil solenoid for engagement - a very heavy duty pull-in coil, and a smaller holding coil. The heavy duty pull-in coil was needed to pull the OD into engagement, and, at the end of it’s travel, operated a cutout switch to switch itself off. The smaller coil then held the OD engaged until the OD was switched off. The later “J” types had hydraulic assist on engagement, and didn’t need the heavy duty pull-in coil. Because of the heavy current draw by the pull-in coil, the “A” types required the use of a relay to handle the extra current. The relay was eliminated on the “J” types, as the solenoid on these units had a moderate current draw.

The “A” types were operable in second, third, and fourth gears, while the “J” type operated only in third and fourth. Two transmission switches were required to allow the “A” type to operate in all three gears, whereas only one was needed for the “J” type to operate in only two gears. One of the switches used with the “A”type was closed only when the transmission was in second, and the other was closed only when the transmission was in third or fourth. The last switch was carried over to the “J” type, allowing operation only in those two gears. **Figure 1**, right, shows the electrical diagrams for both units.

In order for the solenoid to engage the OD, and to keep it engaged, the manual driver’s switch must be on, and one or the other of the transmission switches must be closed. None of the switches are closed in reverse, as severe damage can be done by operating the OD in reverse.

TROUBLE SHOOTING

“A” type with Relay:

Step 1). With the key on, and the transmission in one of the appropriate gears, operate the OD selector switch. Using your voltmeter or test lamp, check for the presence of voltage at the relay terminal with the yellow/purple wire on it (should be the C2 terminal, but could be the C1, or even a C4 if the relay has been swapped out some time in the past). If you have voltage here, go to step 2. If not, go to step 3.

Step 2). Crawl under the car and repeat the above test on the Y/P wire at the solenoid. If you have voltage here, either the solenoid is bad, you have a bad ground on the solenoid, or your problem is a mechanical one. If you don’t have voltage here, there is a break or a bad connection in the Y/P wire from the relay.

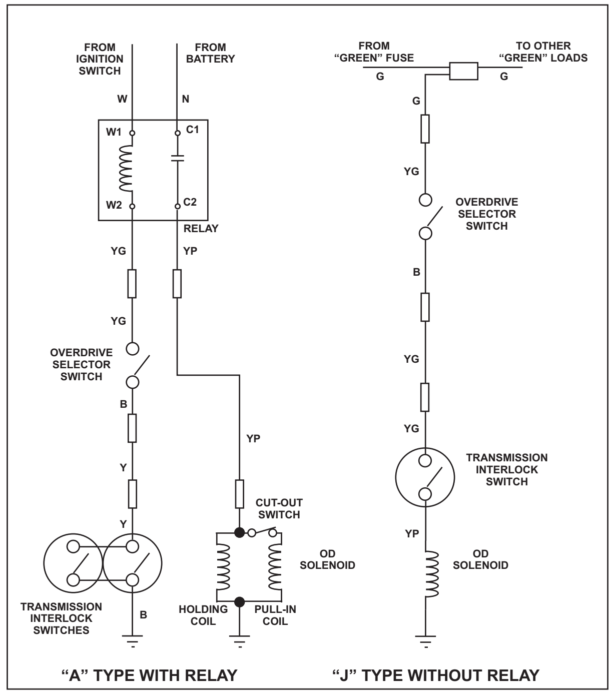



FIGURE 1

Step 3). Check for voltage on the relay terminal with the brown wire (should be C1, but could be C2) if you don’t have voltage here, there is a break or a bad connection in the brown wire from the battery, which will need repair. If you do have voltage, go to step 4.

Step 4). Check for voltage on the relay terminal with the white wire (should be W1, but could be W2) if you don’t have voltage here, there is a break or a bad connection in the white wire from the ignition switch. Repair as needed. If you do have voltage, go to step 5.

Step 5) Using a short test lead, connect the relay terminal with the yellow/green wire (should be W2, but may be W1) to ground, with the ignition key on. Do you have voltage now on the Y/P wire at the relay? If not, your relay is bad. If so, go step 6.

Step 6). Find the bullet/sleeve connector from the OD selector switch with the yellow wire on one side and a black wire on the other (the switch wiring may have been reversed by a previous owner, and instead of the black wire, you may find the yellow/green wire opposite the yellow wire). Without disconnecting the bullets, short this connection to ground. Does the solenoid now operate? If not, either your switch is bad or there is a break or bad connection between the switch and the relay. Repair as needed. If so, there is a break or bad connections between the selector switch and the transmission switches, or the transmission switches are bad or misadjusted. Go to step 7.

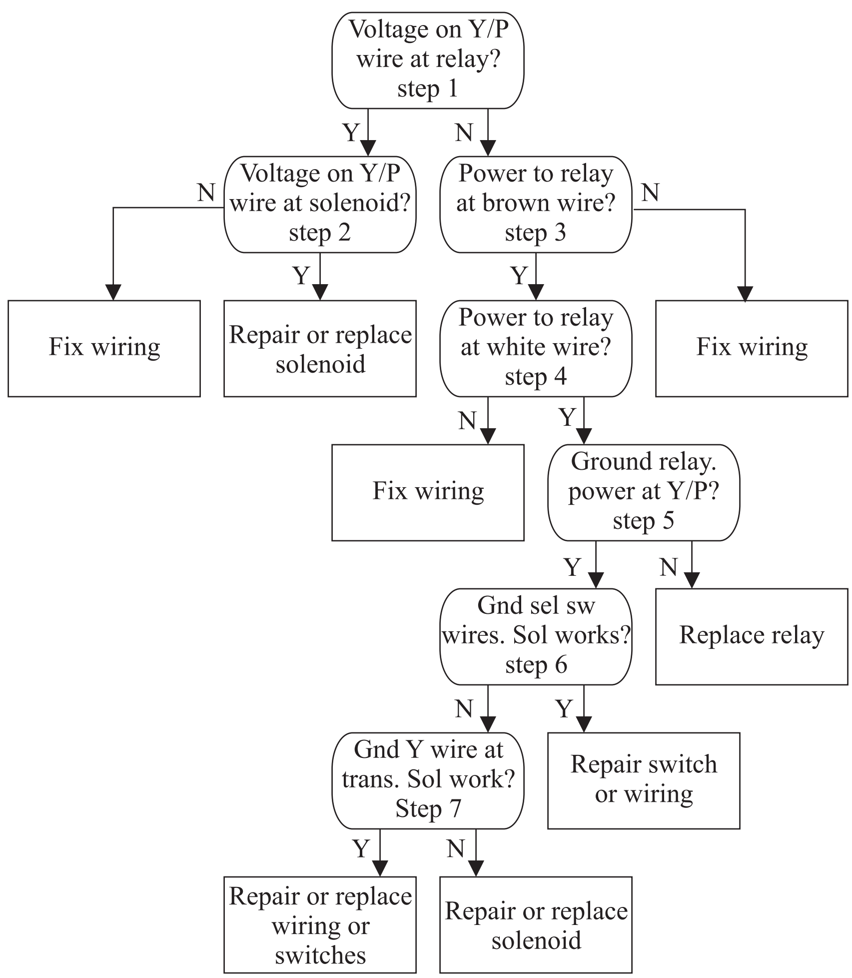
Step 7). With the key still on, and the OD selector switch still on, crawl under the car and remove the yellow wire from the transmission switches and touch it to ground. If the solenoid energizes when you do this, the switches are bad or misadjusted. If the solenoid doesn't energize, there is a break or bad connection in the wiring to the selector switch, the wiring from the selector switch to the relay, or the selector switch is bad.

"J"type without relay:

The overdrive circuit receives power from the "green" fuse, as do the windshield wipers, windshield washer, turn signals, gauges, and heater fan. If ***ANY*** of these items work, then you have power at the fuse. If ***NONE*** of these items work, then you need to go to the chapter 23, Power Distribution, and resolve the power issue before proceeding. If you have power, then you can proceed with the troubleshooting.

The wiring for the "J" type overdrive is a simple series circuit - a break in the wiring or a defective component any where in the line will prevent the circuit from functioning. With the key on, the OD selector switch on, and the transmission in third or fourth gear, use your voltmeter or test lamp to check for voltage at the bullet/sleeve connection where the green wire connects to the Y/G wire from the OD switch (may be the B wire to the switch instead, as the wires may have been swapped in the past). If you don't have voltage here, there is a break or a bad connection in the green wire somewhere, which will need repaired. If you do have voltage here, proceed to the next connection. Continue in this fashion till you reach a point where you no longer have voltage. The problem will be somewhere between the point where you don't have voltage and the last point where you did. Repair as needed.

TROUBLESHOOTING FLOW DIAGRAM FOR "A" TYPE



# 23
# POWER DISTRIBUTION

At first thought, it would seem the first place to look when a device isn't working would be the fuse. Actually, though, it is seldom necessary to check the fuse, as you can usually determine the condition of a fuse without touching a piece of test equipment, at least in a simple car such as the TR250 or TR6. There are only four fuses in one of these cars, and one of these is a spare. As only three fuses are all that are used to protect the wiring, it stands to reason that more than one device is attached to each fuse. If ***ANY*** device on a particular fuse is working, then there must be power to that fuse. For example, the "purple" fuse (so called because the wires leading from it are purple) feeds the horns, high beam flasher, hazard flasher, and, on the later models, the courtesy lamps. If the horns don't work, try your high beam flasher, check your courtesy lamps, or try your hazard flasher. Only if none of these items work do you need to check the fuse.

OK, suppose you have determined that the fuse is good, and, after trying the detailed testing described elsewhere in this manual, you find that even though the other devices are getting power, the circuit you are working on isn't. Then it's time for power distribution testing to find the reason for no power.

As presented in chapter 2, General Procedures, power distribution in a TR 250/TR6 can be divided into four major groups, identified by the main color of the wires involved. **Figure 1** below illustrates the basic division of power.

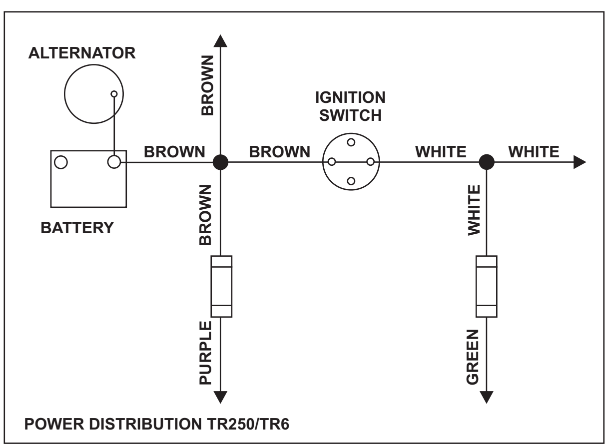



FIGURE 1

In the following figures, I have drawn the representation of the actual routing of the wiring in the cars, according to the color code described above, Brown wire, White wire, Purple wire, and Green wire circuits. If, after you've done the troubleshooting outlined in the appropriate chapter, you've determined that your circuit isn't receiving power, the diagrams can be an aid in determining where the problem might be. Using these diagrams, and the process of elimination, you can narrow down the area of search, possibly eliminating a lot of work ripping into the wiring harness. For example, suppose you find that you have no power to the headlight switch in a TR250, but you do have power to the rest of the car. Looking at Figure 2 below, you see that the power from the alternator/battery (ammeter connection), via a brown/white wire, goes to a bullet connector, where it splits into two paths: one to the headlight switch and one to the ignition switch which powers the remainder of the car.

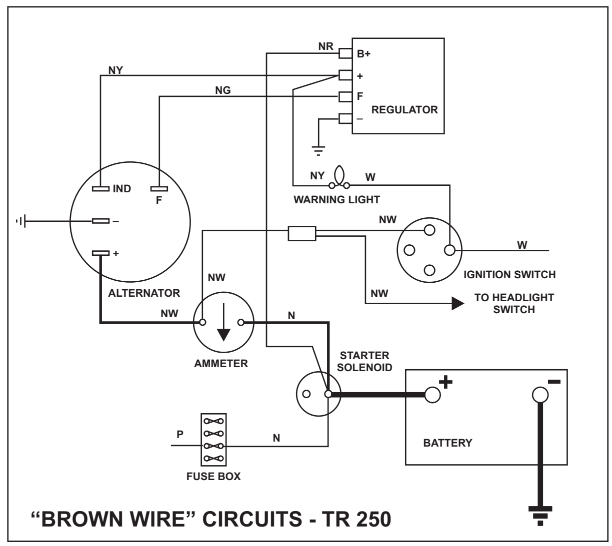



FIGURE 2

If the remainder of the car is getting power, but not the headlights, this bullet connector is the most likely place for the problem to be. It is possible, of course, that the N/W wire from this bullet connector to the headlight switch is broken somewhere, but the odds are that the connector is the problem. Using your voltmeter or test lamp, insert the tip of the test lead into the connector sleeve such that it touches only the bullet for the headlight wire, and not the sleeve itself. If you have power here, then the problem really is a broken wire. If you don't have power, then the bullet isn't making good contact with the sleeve. The bullet will need to be pulled out and both the bullet and the sleeve cleaned with steel wool or fine sandpaper. This same approach can be taken with the other power groups as well. You may find broken wires, especially if the car has been wrecked or abused, but the most common problem is bad connections. Sometimes a good cleaning is all that's required, but in severe cases, the terminals or connectors will have to be replaced.

CAVEAT:

For the most part, the wiring diagrams supplied by Triumph do a pretty good job of depicting the physical wiring connections, but not always. The diagrams may show a bullet/sleeve connection, for example, whereas the actual car may have a splice instead. The factory may have made undocumented changes, or a previous owner may have made modifications, perhaps even replaced a burned out wiring harness with a harness from a different year (or, I may have simply made an error). If your evaluation doesn't seem to make sense, based on the diagrams, you will have to do a physical examination of the wiring to clear up the discrepancy.

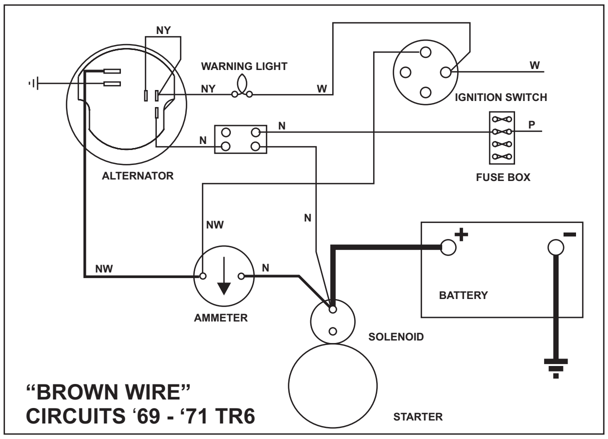



FIGURE 3

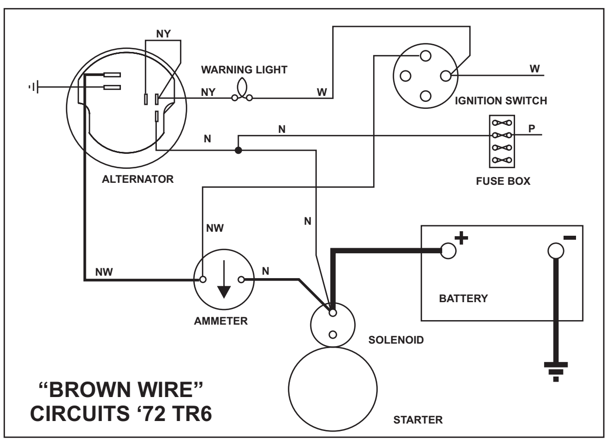



FIGURE 4

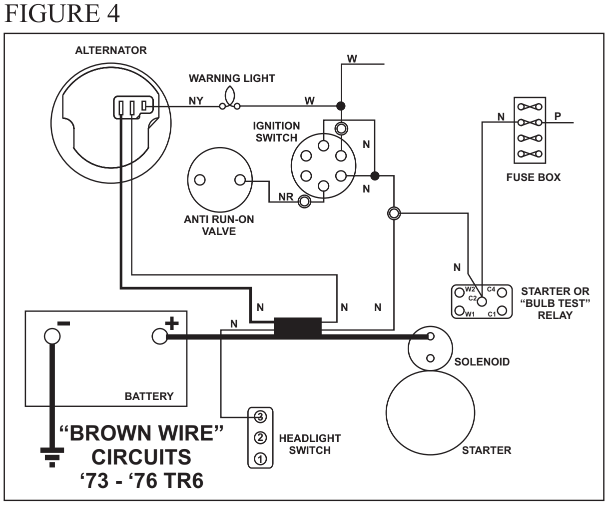



FIGURE 5

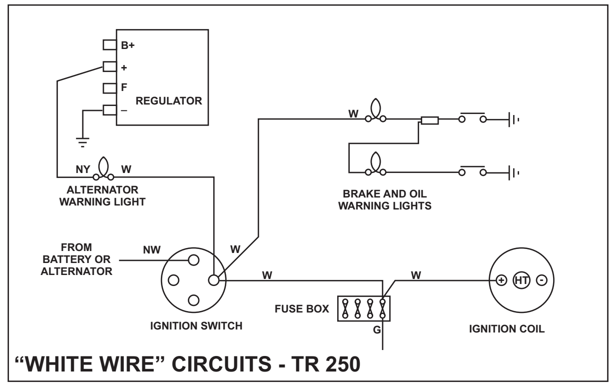



FIGURE 6

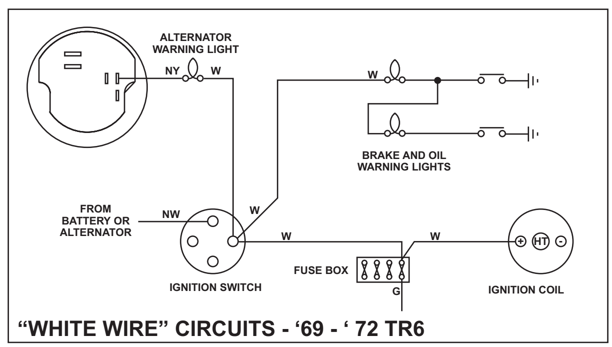



FIGURE 7

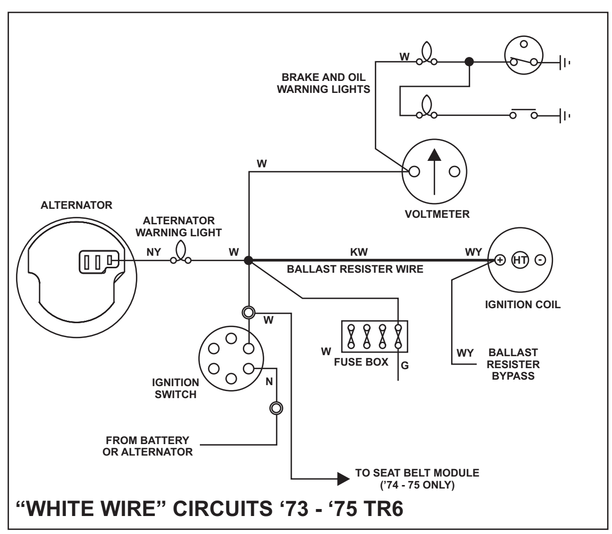
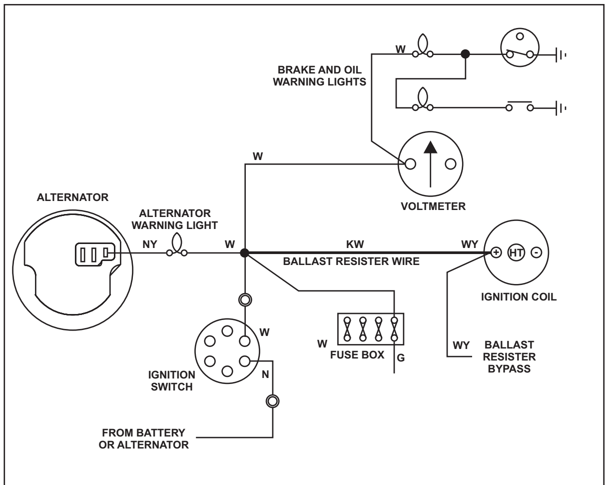
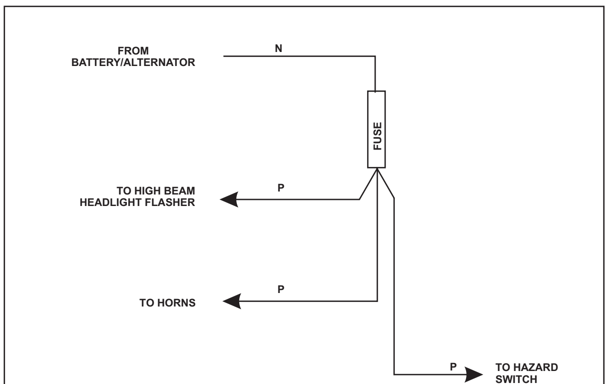



FIGURE 8



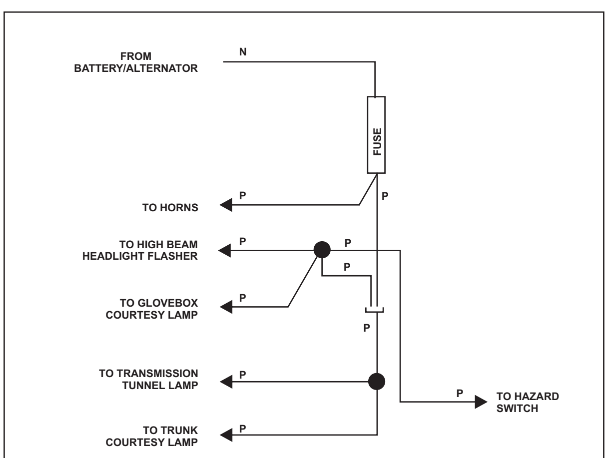

**"WHITE WIRE" CIRCUITS '76 TR6**

FIGURE 9



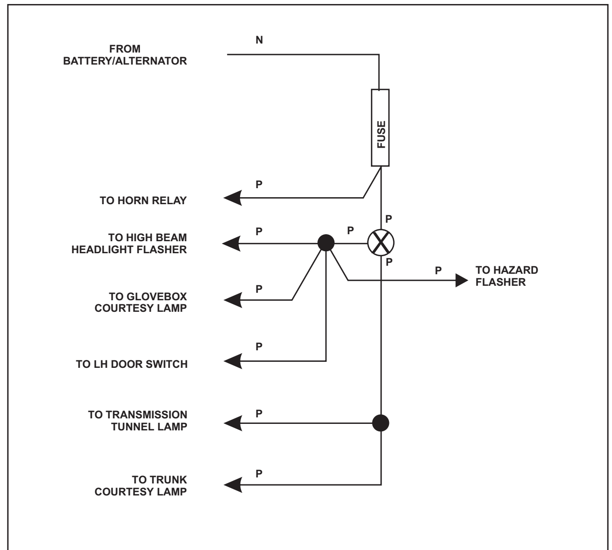

**"PURPLE WIRE" CIRCUITS - TR250**

FIGURE 10



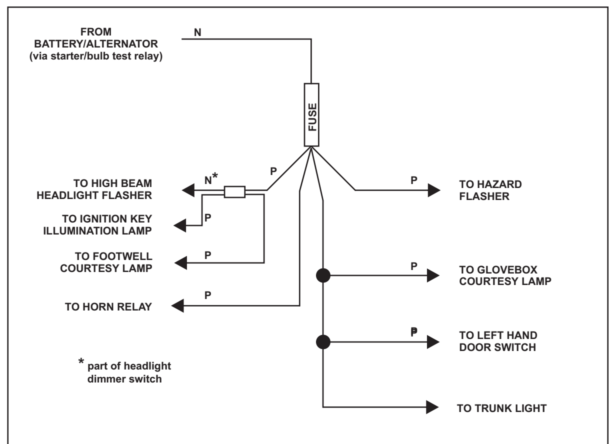

**"PURPLE WIRE" CIRCUITS - '69 TR6**

FIGURE 11



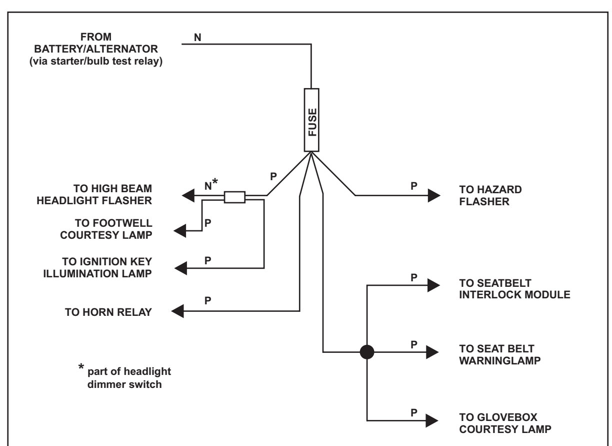

**"PURPLE WIRE" CIRCUITS - 70 - '72 TR6**

FIGURE 12



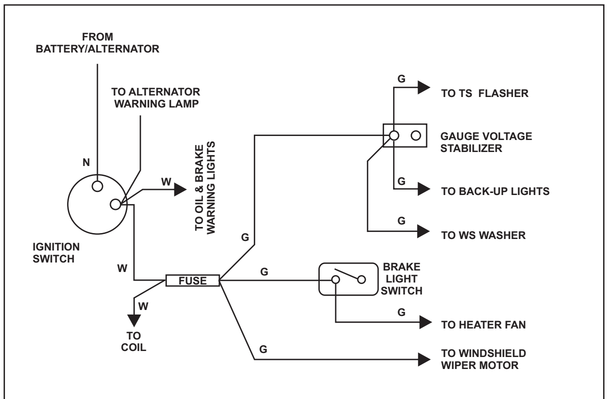

**"PURPLE WIRE" CIRCUITS - 73 TR6**

FIGURE 13



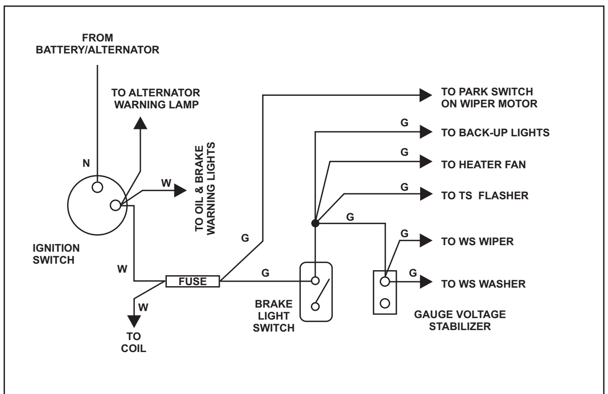

**"PURPLE WIRE" CIRCUITS - 74 - 76 TR6**

FIGURE 14



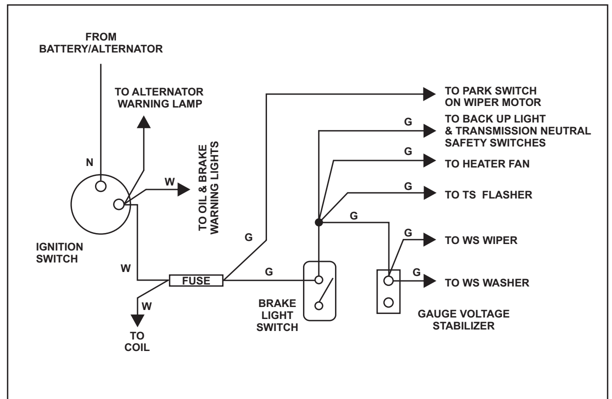

"GREEN WIRE" CIRCUIT - TR250

FIGURE 15



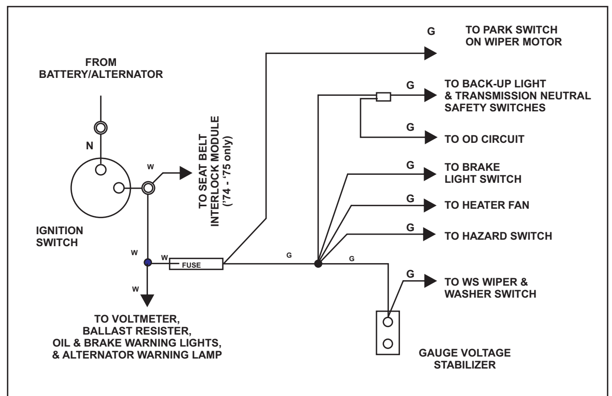

"GREEN WIRE" CIRCUIT - '69 - '71 TR6

FIGURE 16




"GREEN WIRE" CIRCUIT - '72 TR6

FIGURE 17




"GREEN WIRE" CIRCUIT - 1973 TO 1976 TR6

FIGURE 18

# 24
# SEAT BELT INTERLOCKS

Beginning with the '72 models, Triumph began installing seat belt warning systems, which evolved into a seat belt/starter interlock system for the '74 model year. By the time the '75 models were introduced, the seat belt system had once again gone back to just a warning system, the starter interlock being bypassed. For the '76 model, the system was further simplified, and was, in many ways, actually a simpler setup than was used in the '72 models.

CIRCUIT OPERATION

'72 - '73 MODELS:

If the seat belts aren't "properly" fastened, a dash warning light is lit, and the buzzer will sound, the same buzzer used to warn the driver that key is still in the ignition lock if the driver's door is opened.

The first item to notice in this circuit, shown in **figure 1** below, is the diode. The purpose of this diode is to prevent power from the "purple' fuse from back feeding through the seat belt circuit to the "green" fuse. When the driver's door is open, the door switch is closed, applying power from the "purple" fuse to the key warning buzzer. The seat belt circuit is also wired to the driver's door switch, so if the switches in the seat belt circuit are not in the correct position, all of the switch contacts between the door switch and the green wire feeding the transmission neutral safety switch will be closed. Normally, the green wires have power only if the key is on, but, without the diode, power would be applied even if the key is off.

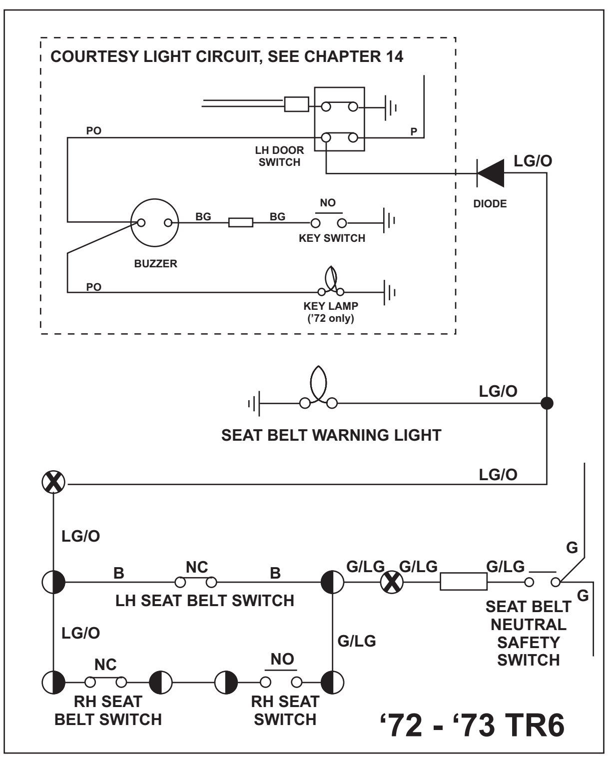



FIGURE 1

The diode acts like a check valve, allowing current to flow in one direction only. Power from the green wire will flow to the door switch, but power from the door switch will not flow back to the green wire.

To help visualize the operational logic of this circuit, I have redrawn portions of the circuit in **figure 2** below. The warning buzzer will sound IF:

*The key is in the ignition **AND** the key is on **AND** the transmission is in any gear other than neutral **AND** either **[**the driver's seat belt is unfastened **OR (**there is a passenger in the passenger seat **AND** the passenger seat belt isn't fastened**)]***

**Figure 2A** shows the situation with only the driver in the car, the driver's seat belt unfastened, and the key on.

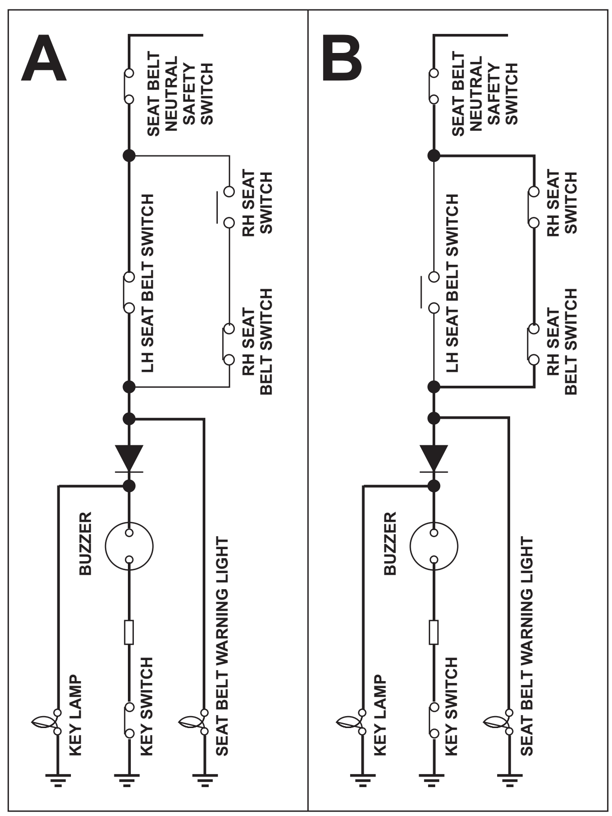



FIGURE 2

**Figure 2B** shows the situation with the driver's belt fastened, but the passenger is seated without fastening the seat belt.

In both cases, the current path is illustrated by the heavy line. There are another couple of items of note about this circuit. 1) the key illumination light will be on when the seat belt criteria haven't been satisfied, even if the driver's door is closed, and 2), the passenger seat sensor can't tell the difference between a passenger and a heavy bag of groceries. If you set a heavy item in the passenger seat, you will have to buckle it in to stop the buzzer.

'74 MODELS:

The circuit used in the '72 - '73 models was not a sterling example of the art of electrical engineering. As is often the case when a feature is retro-fitted, too many compromises were made to utilize existing wiring. For the '74 model, the designers got the chance to start clean, and design a new circuit for the seat belt warning system. Unfortunately, they were also required to meet more stringent governmental requirements. For this year, the seat belt circuit was tied to the starter circuit such that the car couldn't be started until the seat belts were fastened and the transmission placed in neutral.

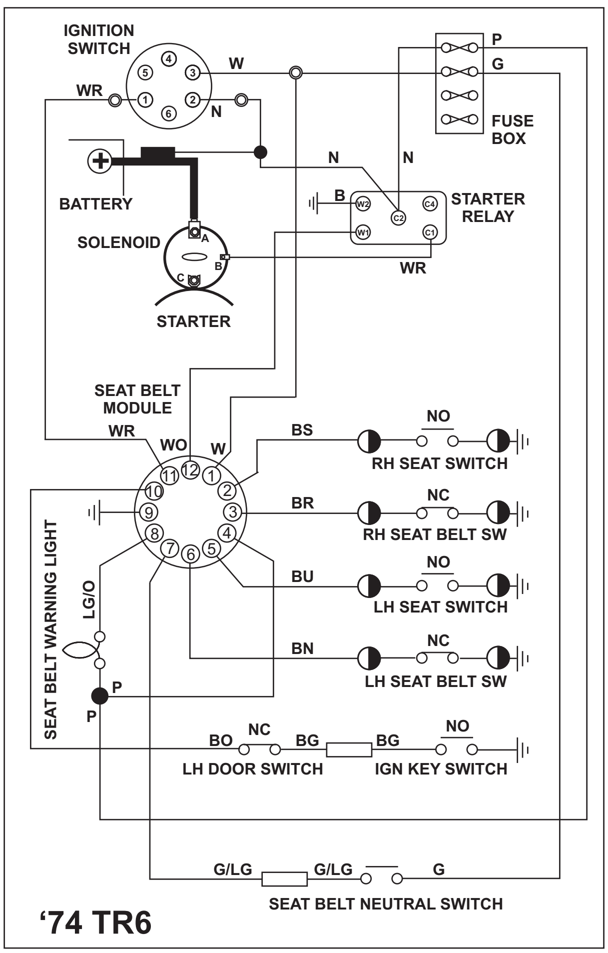



FIGURE 3

**Figure 3**, below left, depicts the circuit for this model year. This circuit operates quite a bit different than the previous scheme. The logic for this scheme is contained on a printed circuit board, using solid state components, and mounted inside a metal container. The ignition key warning buzzer is also inside the container, but it still does double duty, serving as belt warning buzzer as well.

The operational logic for this year differs from the previous year, in that a seat sensor for the driver has been added, a time limit has been placed on the buzzer, and, most significantly, the starter is interlocked with the system such that it will not operate if the seat belt interlock criteria haven't been met. The buzzer will sound until the seat belts have been properly fastened, or for 8 seconds after the key is turned on, whichever comes first. The warning light will operate indefinitely if the seat belts aren't fastened. The starter interlock also operates indefinitely, unless both the passenger's and the driver's side seat belts are fastened,.

The seat belt system will be active as long as:

*The key is in the ignition **AND** the key is on **AND** the transmission is in any gear other than neutral **AND** either **[(**the driver is in the seat **AND** the seat belt is unfastened **OR (**there is a passenger in the passenger seat **AND** the passenger seat belt isn't fastened**)]***

'75 MODELS:

With one exception, the '75 circuit is identical to the '74 circuit. For this year, the starter interlock has been eliminated by removing the white/red and the white/orange wire from the seat belt module, and connecting them together as shown in **figure 4** below. This modification can be back fit to the '74, if desired.

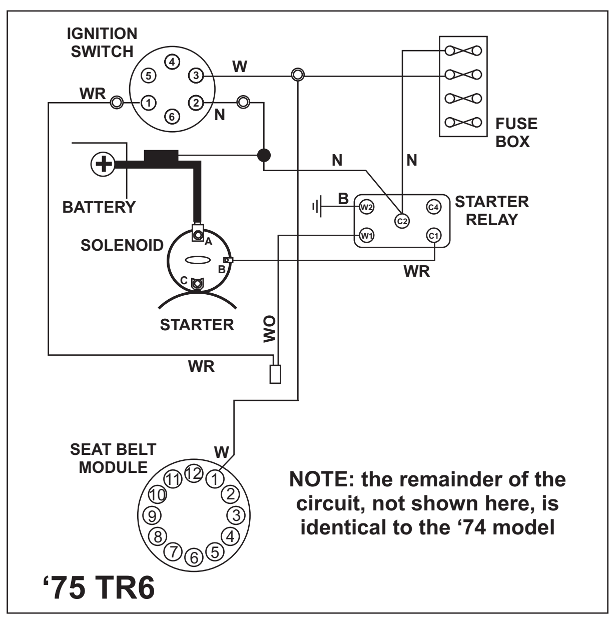



FIGURE 4

‘76 MODELS:

The ‘76 version of the seat belt interlock systems was greatly simplified over the previous designs. The ignition key warning buzzer function was retained, but only one input to the seat belt system itself was retained, that being the driver’s seat belt switch. The buzzer sounds for 8 seconds, or until the driver fastens the seat belt, which ever comes first. The warning light, just as on the previous models, stays on until the belt is fastened. The circuit diagram for this is shown in **figure 5** below.

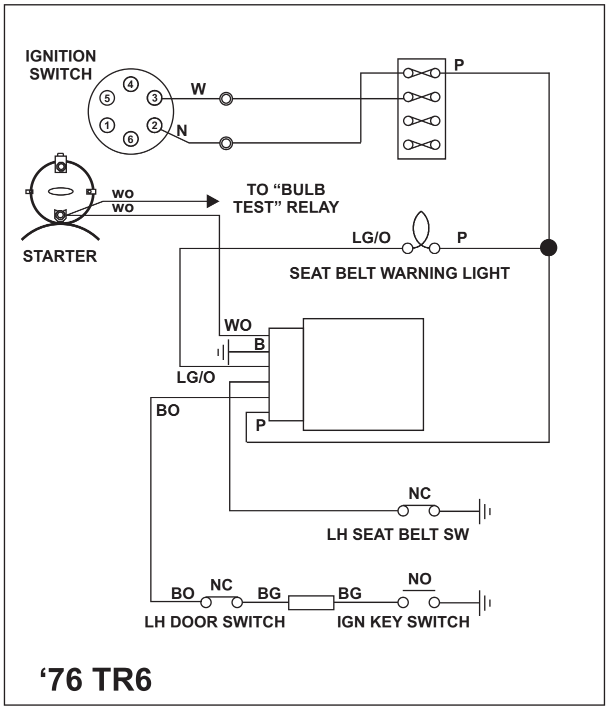



FIGURE 5

TROUBLESHOOTING

‘72 - ‘73 MODELS:

Before beginning the actual troubleshooting, a little analysis will help. Does the warning buzzer work when the key is in the ignition and the driver’s door is open? If so, we know the buzzer works, so we can concentrate our efforts elsewhere. If the buzzer doesn’t work with the ignition key, the troubleshooting procedure should start with the courtesy lights, and the buzzer circuit fixed from that circuit. Refer to chapter 13 for details.

Does the fasten seat belt light work? If it works, but not the buzzer, chances are the diode is bad. We know the seat belt circuit works up to the light, so any troubleshooting that needs to be done will only apply to the wiring from the light to the driver’s door switch.

Does the buzzer work, but not the light? If so, the most likely problem is a bad bulb, but there could also be a ground problem.

If it is determined that the problem is indeed in the seat belt circuit, then the troubleshooting procedures below should be followed. Keep in mind that the seat belt interlock system is powered from the “green” fuse, as are the WS wipers, WS washer, gauges, heater fan, brake and reverse lights, and the turn signals. If ***ANY*** of these are working, the fuse is good; if ***NONE*** of them are working, the fuse is most likely bad, and should be replaced, or the wiring to the fuse repaired.

Step 1). Locate the green/light green wire where it enters the cockpit from the transmission. Using your voltmeter or test lamp, and with the ignition key on and the transmission in any gear other than neutral, check for voltage on this wire, checking on both sides of the bullet/sleeve connector. If you have voltage here, go to step 2. If not, go to step 3.

Step 2). Locate the light green/orange wire where it connects to the seat belt and seat sensor switches, and check for voltage on this wire with the ignition key on and the transmission in any gear other than neutral. If you have voltage, there is a break or a bad connection in the wiring to the warning light and buzzer which will have to be repaired. If there is no voltage present, either the switches are bad, or there is a break in the wiring. Use your continuity tester or the ohms scale on your multi-meter to locate the problem. Disconnect the wiring harness before testing, to make sure you don’t get a bogus reading, as explained in chapter 2, General Procedures.

Step 3). You will now have to crawl under the car, and look for voltage on the green wire to the transmission neutral safety switch with the ignition key on and the transmission in any gear other than neutral. If you have voltage here, go to step 4. If not, there is a break or bad connection in the green wire between here and the fuse box, which must be repaired.

Step 4). While still under the car, check for voltage on the green/light green wire at the switch. If you have voltage here, there is a break in the G/LG wire to the seat belt switches. If not, the switch is bad, and must be replaced.

‘74 - ‘75 MODELS:

Unlike the earlier models, the seat belt system for these years requires power from the “green” fuse, the “purple” fuse, and from the white wire circuit. Before proceeding, you should verify that the green, purple, and white circuits are hot by analyzing the other systems that also receive power from these sources. Refer to chapter 7, Fuses, and chapter 23, Power Distribution, to see which items are powered from each of the sources.

The circuit is a bit complicated, and doesn’t lend itself well to the typical step-by-step troubleshooting procedure, so the troubleshooting will be divided up into four segments: power, key warning buzzer, the seat belt switching circuit, and the starter interlock circuit. As the starter interlock function is critical to the operation of the car, it is assumed that if the starter isn't operating, you would want to fix that problem before worrying about the seat belt system, so that portion of the circuit is covered in chapter 25, Starter. The remaining items will be covered here.

A). Power:

Step 1). Pull the plug from the seat belt module (located inside the car over the passenger's foot well, on the left side), and check for voltage on the white (pin 1) and purple wires (pin 4), using your voltmeter or test lamp. You should have power on the purple wire with the key on or off, but the key will have to be on to measure power on the white wire. If you have power on both of these wires, proceed to the other test procedures below. If power is not available on either of the these, there is a break or a bad connection in the associated wiring between the module and the fuse box for the purple wire, and between the module and the ignition key for the white wire. Refer to chapter 23, Power distribution for help in tracing down the wiring.

B). Ignition key warning buzzer:

Step 1). Pull the plug from the seat belt module, and check for continuity to ground on the black/orange wire on pin 10 of the plug with the door open and the key in the ignition. If you are using a multi-meter, set it on the lowest ohms scale (reading X 1) ohms scale. If you are using a test lamp, connect the alligator clip to the positive post of the battery, and insert the tip into terminal 10. You should get very low ohms reading on the multi-meter, less than one ohm, or the test lamp, if that's what you are using, should glow at full brilliance. If so, the module is defective, and will need to be replaced. If not, go to step 2.

Step 2). With the plug still removed, use your ohmmeter or test lamp to check for continuity to ground on the black/green wire coming from the ignition switch, with the key inserted in the lock. The B/G wire exits the ignition lock just under the dash, and the green stripe on this wire spirals around the wire, rather than running lengthwise as on all other wires. This spiral tracer wire connects to another B/G wire, with lengthwise stripe, at a bullet/sleeve connector. Be sure to check both sides of the connector. If you have continuity to ground here, go to step 3. If not, the key switch is faulty, and the entire ignition lock assembly will have to be replaced, as the switch is in-accessable for repair.

Step 3). Locate the B/O and the B/G wires at the driver's door switch. With the plug still removed, the driver's door open, and the key in the ignition lock, check for continuity to ground on each of these wires. If you have continuity on the B/G wire, but not the B/O wire, the switch is bad. If don't have continuity on the B/G wire, there is a break in the wire to the connector mentioned in step 2, or the connection to the door switch is bad.

If the switch is bad, it can be repaired, although new ones are quite inexpensive if you prefer to replace it instead. Refer to chapter 9, Switches, Relays, and Solenoids for details.

C). SEAT BELT SWITCHING:

Step 1). Pull the plug from the seat belt module, and use your test lamp or voltmeter to check for the presence of voltage on the green/light green wire at pin 7 of the plug. For this test, the ignition key must be on, and the transmission in any gear other than neutral. If you have voltage here, go to step 4. If not, go to step 2.

Step 2). Locate the bullet/sleeve connector connecting the G/LG wire from the transmission switch to the G/LG wire to the module. Check for voltage on this connection with the key on and the transmission out of neutral. If you have power here, there is a break in the G/LG wire from here to the module. If not go to step 3.

Step 3). Crawl under the car and locate the neutral safety switch. Check for voltage on both the green and the G/LG wires. If you have voltage on the G wire but not on the G/LG wire, the switch is bad. If you don't have voltage on the G wire, there is a break or bad connection in the G wire between the neutral switch and the fuse, which will need to be repaired.

Step 4). Using your ohmmeter or test lamp as described in step B1 above, check for continuity to ground on each of the seat belt/seat sensor inputs. These are the black/slate, black/red, black/blue, and black/brown wires, connecting to pins 2, 3, 5, and 6, respectively (note: if your wire colors do not agree with the colors listed, go by the pin locations instead of colors. There have been discrepancies reported between the colors actually used by Triumph, versus colors shown in official factory documents). There should be continuity to ground on the seat belt switches only when the belt is un-fastened, and there should be continuity to ground on the seat sensor switches only when the seat is occupied. If you get any results other than that, either the switch is defective, or the wiring to that switch is defective - either open or shorted to ground.

Step 5). With the plug still removed, use a short piece of wire to short the light green/orange wire, pin 8, to ground. If the warning light doesn't come on, and you had power to the purple wire in step A1, either the bulb is bad or there is a break or bad connection in the wiring. Go to step 6. If the light does come on, but doesn't come on under normal operation, and you have resolved all the steps above, the module is bad, or there is a bad connection at the module plug.

Step 6). Check for voltage on the purple wire at the bulb. If you have voltage here, either the bulb or the bulb holder is bad, or there is a break in the LG/O wire to the module. If not, there is a break in the purple wire, which will have to be traced and repaired.

'76 MODELS:

The seat belt system for this model year requires power from the "purple" fuse, Before proceeding, you should verify that the purple circuit is hot by analyzing the other systems that also receive power from this fuse. Refer to chapter 7, Fuses, and chapter 23, Power Distribution, to see which items are powered from each of the sources.

This circuit is much simpler than the previous years, but it still needs to be broken into three segments for troubleshooting - power, key warning buzzer, and the seat belt switching.

A). Power:

Step 1). Pull the plug from the seat belt module (located inside the car over the passenger's footwell, on the left side), and check for voltage on the purple wire, using your voltmeter or test lamp. The purple wire should be hot all the time, ignition key on or off. If you have power on this wires, proceed to the other test procedures below. If power is not available, there is a break or a bad connection in the associated wiring between the module and the fuse box. Refer to chapter 23, Power distribution, for help in tracing down the wiring.

B). Ignition key warning buzzer:

Step 1). Pull the plug from the seat belt module, and check for continuity to ground on the plug pin with the black/orange wire with the door open and the key in the ignition. If you are using a multi-meter, set it on the lowest ohms scale (reading X 1) ohms scale. If you are using a test lamp, connect the alligator clip to the positive post of the battery, and insert the tip into the plug terminal with the B/O wire. You should get very low ohms reading on the multi-meter, less than one ohm, or the test lamp, if that's what you are using, should glow at full brilliance. If so, the module is defective, and will need to be replaced. If not, go to step 2.

Step 2). With the plug still removed, use your ohmmeter or test lamp to check for continuity to ground on the black/green wire coming from the ignition switch, with the key inserted in the lock. The B/G wire exits the ignition lock just under the dash, and the green stripe on this wire spirals around the wire, rather than running lengthwise as on all other wires. This spiral tracer wire connects to another B/G wire, with lengthwise stripe, at a bullet/sleeve connector. Be sure to check both sides of the connector. If you have continuity to ground here, go to step 3. If not, the key switch is faulty, and the entire ignition lock assembly will have to be replaced, as the switch is in-accessable for repair.

Step 3). Locate the B/O and the B/G wires at the driver's door switch. With the plug still removed, the driver's door open, and the key in the ignition lock, check for continuity to ground on each of these wires. If you have continuity on the B/G wire, but not the B/O wire, the switch is bad. If don't have continuity on the B/G wire, there is a break in the wire to the connector mentioned in step 2, or the connection to the door switch is bad.

If the switch is bad, it can be repaired, although new ones are quite inexpensive if you prefer to replace it instead. Refer to chapter 9, Switches, Relays, and Solenoids, for details.

C). SEAT BELT SWITCHING:

Step 1). Pull the plug from the seat belt module, and, using your ohmmeter or test lamp as described in step B1 above, check for continuity to ground on the seat belt input wire (you will have to trace this wire from the seat belt to determine the color code, as it isn't listed in Triumph documentation - perhaps black/???). There should be continuity to ground on this wire only when the belt is unfastened. If you get continuity to ground when the seatbelt is fastened, there is a short to ground on the wire from the switch. If you don't have continuity when the seatbelt is unfastened, there is a break or a bad connection in the wiring from the switch.

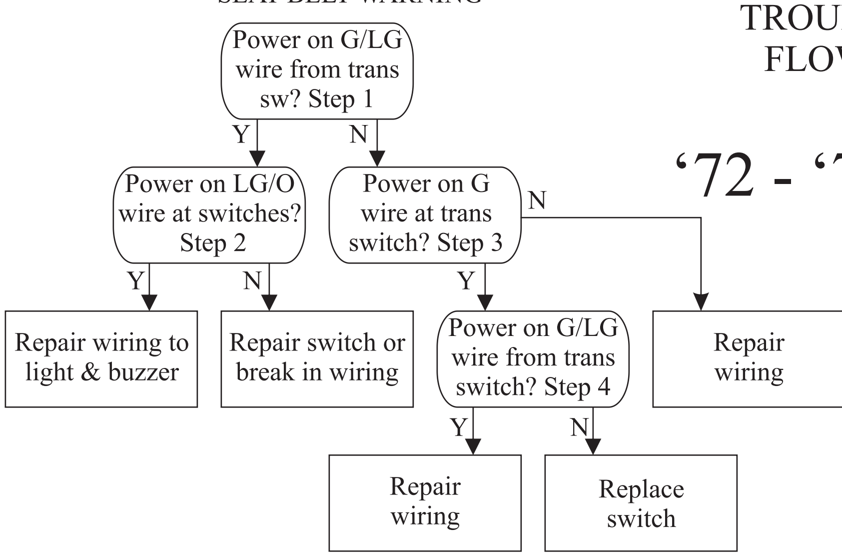
Step 2). With the plug still removed, use a short piece of wire to short the light green/orange wire to ground. If the warning light doesn't come on, and you had power to the purple wire in step A1, either the bulb is bad or there is a break or bad connection in the wiring. Go to step 3. If the light does come on, but doesn't come on under normal operation, and you have resolved all the steps above, the module is bad, or there is a bad connection at the module plug.

Step 3). Check for voltage on the purple wire at the bulb. If you have voltage here, either the bulb or the bulb holder is bad, or there is a break in the LG/O wire to the module. If not, there is a break in the purple wire, which will have to be traced and repaired.

# TROUBLESHOOTING FLOW DIAGRAMS

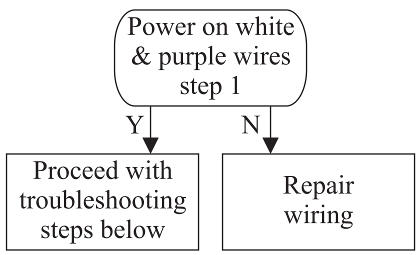
# ‘72 - ‘73 MODELS

SEAT BELT WARNING

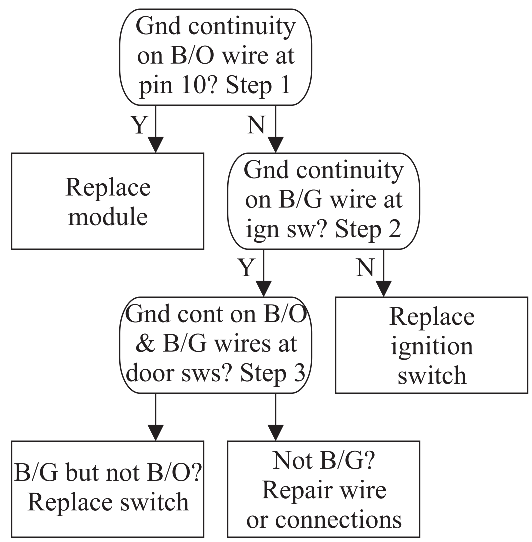



# ‘74 - ‘75 MODELS

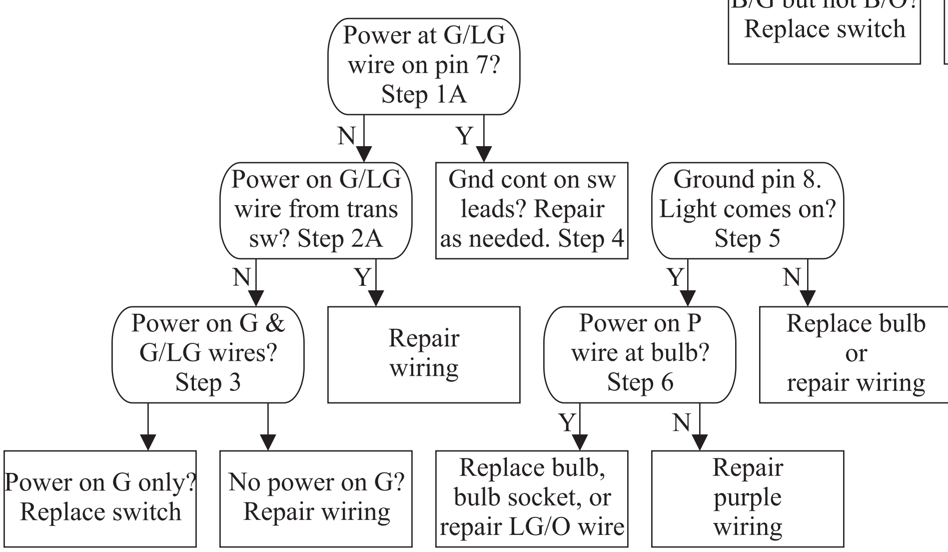
POWER




IGNITION KEY WARNING BUZZER

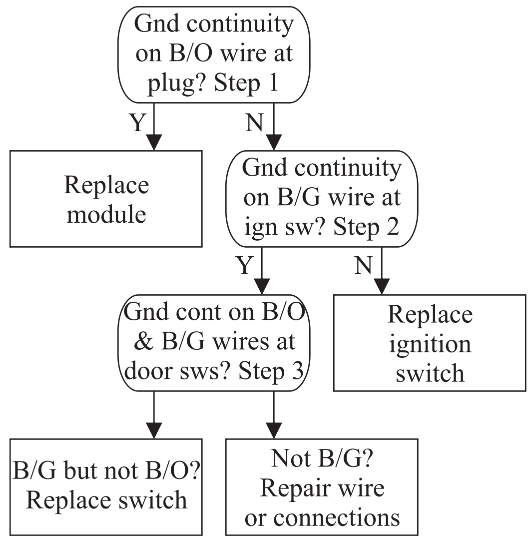



SEAT BELT SWITCHING

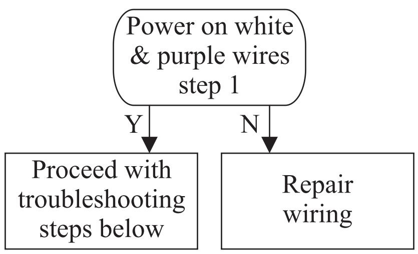


# ‘76 MODELS

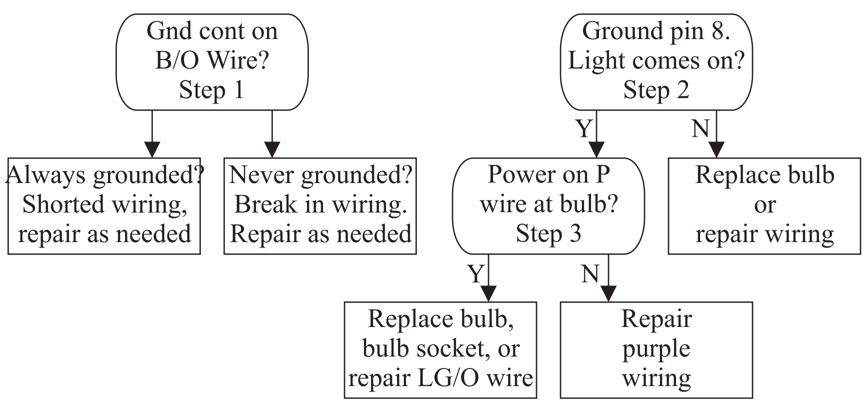
IGNITION KEY WARNING BUZZER




POWER




SEAT BELT SWITCHING



# 25
# STARTER

STARTER TYPES

Triumph used two different types of starters for the TR250/TR6 range: inertia and pre-engaged.

INERTIA: In this type starter, the solenoid is separate from the starter itself, and is only used to switch power from the battery to the starter, acting like a heavy duty relay. (See **figure 1**, below for a cutaway view of an inertia starter) When the motor starts, the armature spins, and the "inertia' of the spinning armature moves the drive gear forward, via mechanical action (Bendix), into contact with the teeth on the flywheel. The gear is already beginning to spin when contact is made with the flywheel.
.

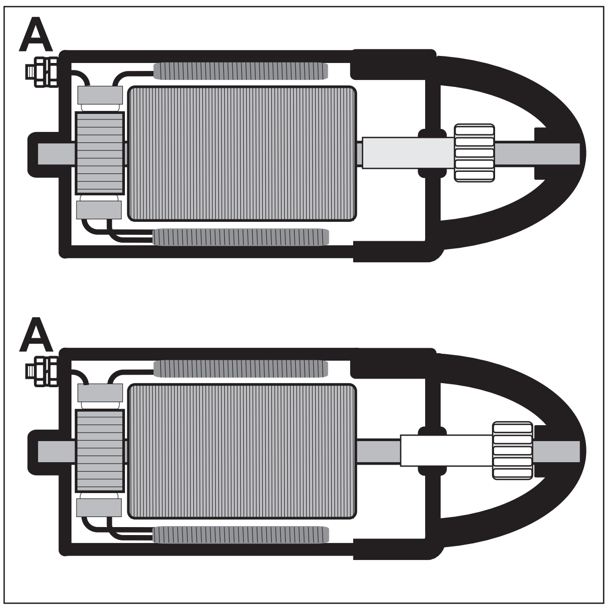



FIGURE 1

When the starter solenoid is energized, power is applied to terminal A in **figure 1**, energizing the starter motor. In the top cutaway, the motor is not energized, and the drive gear is shown in its rearward, or retracted position. In the bottom view, power has been applied, the armature is spinning, and inertia has forced the drive gear into position for contact with the flywheel.

PRE-ENGAGED: In this type starter (See **figure 2**, right), the solenoid is mounted on the starter itself, and serves a dual function. When the solenoid is energized, it first pulls a lever, which in turn moves the drive gear into contact with the flywheel. As the drive gear reaches the end of its travel, a contact on the solenoid bridges the gap between terminals A and B, and then the motor starts to turn. The motor doesn't turn until the drive gear is engaged, hence the term "pre-engaged."

In the top view of **figure 2**, the solenoid is de-energized, the spring in the solenoid has returned the lever to its rest position, and the electrical contacts are open. In the bottom view, power has been applied to solenoid terminal S, and the solenoid is now energized. In this position, the lever has moved the drive gear to its full engaged position, the contacts are closed, and power is applied from the battery, via terminal A, to the starter motor, via terminal B, and the starter is now turning.

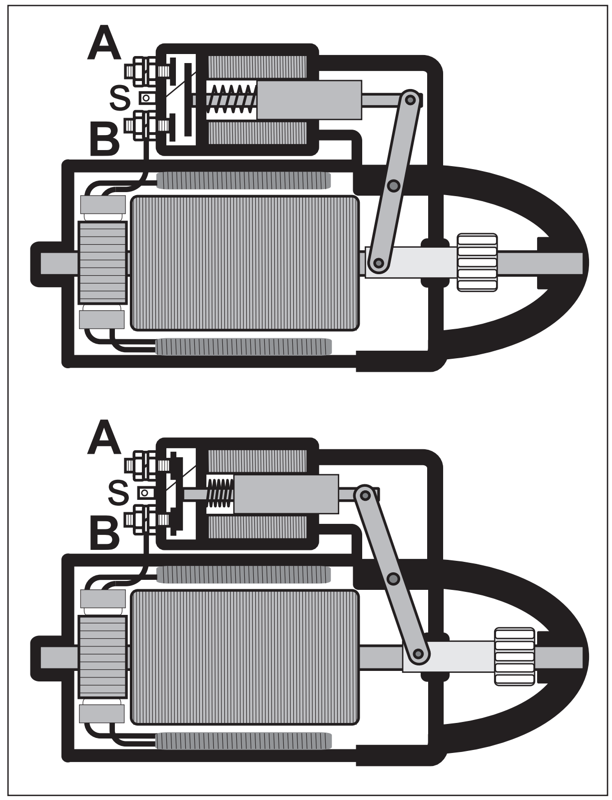



FIGURE 2

When the ignition key is released, and power is no longer applied to terminal S, the solenoid, lever, and contacts will all return to the normal state, with the motor off and the drive gear retracted from the flywheel.

ELECTRICAL CIRCUITS

**Figure 3**, overleaf, top, shows the wiring configuration for the TR250. The labels for the solenoid terminals in this diagram (and all others in this chapter), are purely arbitrary, as they are not often actually marked on the solenoids themselves.

Terminal A on the starter solenoid is used as a convenient junction point for routing battery power to other circuits in the car, as well as being the connection point for the starter power, thus all the "brown" wires radiating from it.

When the ignition switch is closed power is applied from the ignition switch to terminal S, energizing the solenoid. When the solenoid is energized, internal contacts close, connecting terminal A with terminal B, providing power to the starter itself. The starter, being of the inertial type, begins spinning, and the drive gear engages the flywheel, starting the engine.

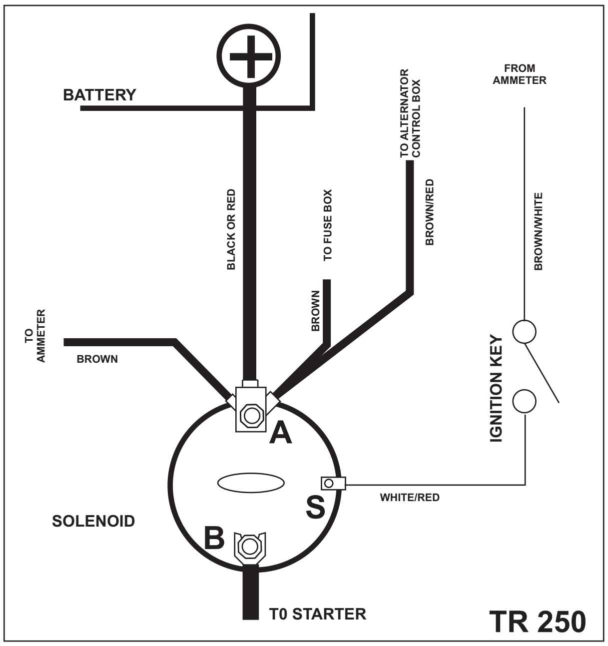



FIGURE 3

**Figure 4**, top right, is the circuit for a '69 through '72 TR6. Electrically, this circuit is the same as the TR250, except the solenoid is mounted directly on top of the starter, so there is only a very short piece of wire between it and the starter. Mechanically, there is quite a bit of difference between this setup and the TR250, in that this starter is the pre-engaged type.

**Figure 5A,** right, is the diagram for the '73 TR6 starter circuit. Beginning with this model year, Triumph added a ballast resistor for the ignition coil. The ballast resistor circuit is discussed in chapter 20, Ignition System, so only the starter portion of the circuit will be discussed here.

**Figure 5B**, right, shows the circuit in operation. With the exception of the I contact on the solenoid, which is used to bypass the ballast resistor, this circuit is identical to the earlier models. The I contact on the solenoid is connected internally to the A and the B contacts whenever the solenoid is energized.

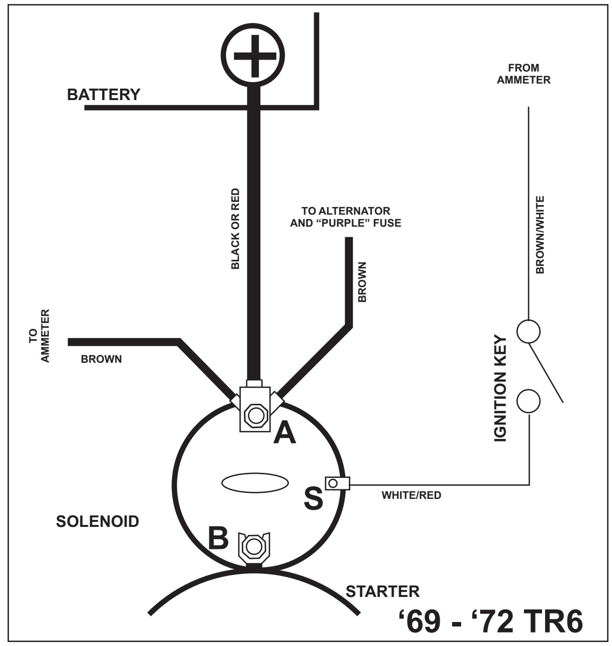



FIGURE 4

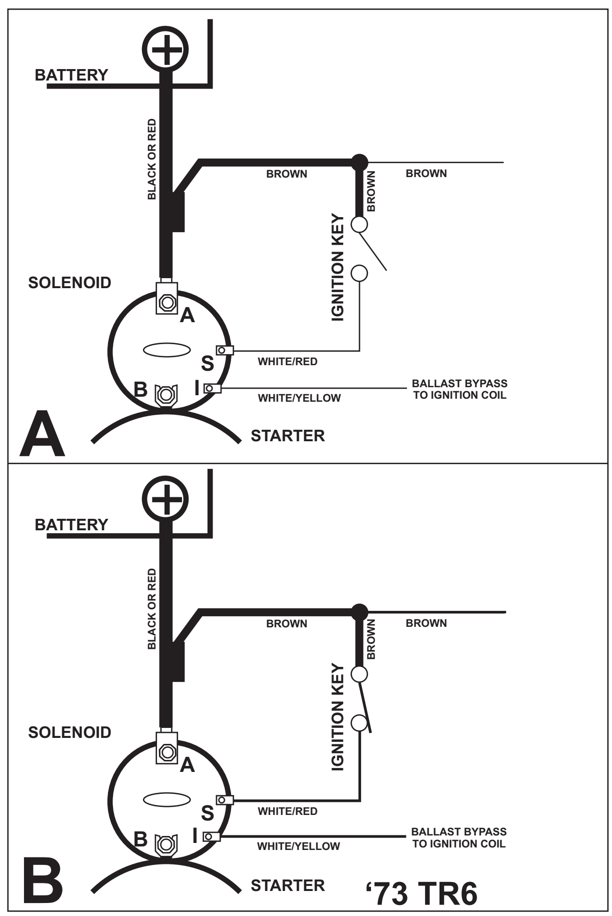



FIGURE 5

**Figure 6A**, opposite, is the diagram for the '74 - '75 TR6. For these two years, Triumph added a seat belt interlock module to the cars, in addition to the ballast resistor. The operation of the seat belt module is covered in chapter 24, Seat Belt Interlocks, and the ballast resister circuit is discussed in chapter 20, Ignition System, so only the starter portion of the circuit will be discussed here.

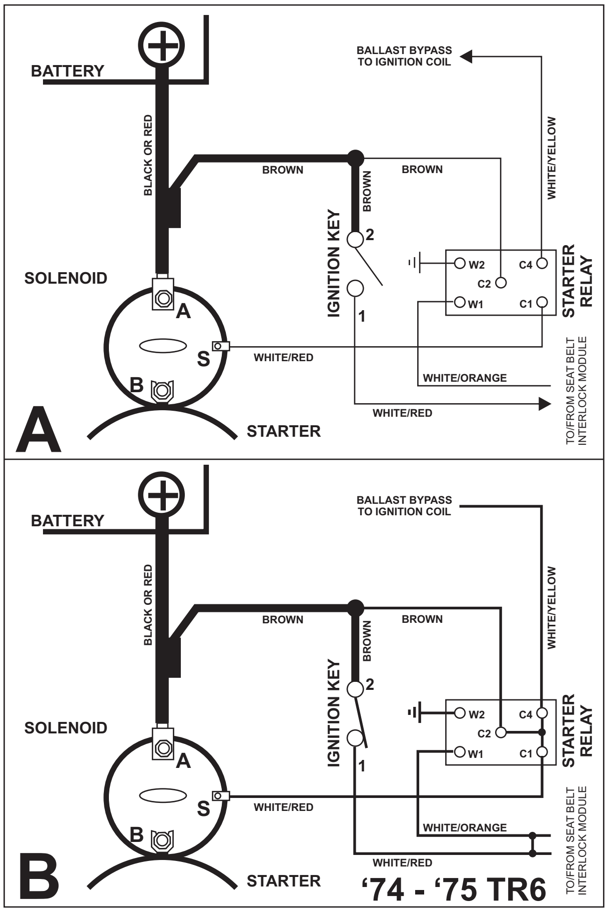



FIGURE 6

When the seat belt is fastened in the '74 model, the white/red wire from the start position of the ignition key is connected, inside the seat belt module, with the white/orange wire to the relay coil, terminal W1. If the ignition key is then turned to the start position, the relay is energized to operate the solenoid. The current path for this is shown in **figure 6B** above. If the seat belt isn't fastened, the two wires are ***NOT*** connected, and the relay does not operate, preventing the car from starting.

For the '75 model, after the Federal government dropped the starter interlock requirements, Triumph defeated the seat belt/starter interlock circuit. They did this by removing the white/red and the white/orange wires from the seat belt module and permanently connecting them together. If you are annoyed with this feature on your '74, you can do the same thing. Just cut the above mentioned wires and connect the two wires together, using an insulated connector, as the white/red wire will be hot when the key is in the start position. You don't want a hot wire hanging around under the dash!

**Figure 7**, below, is the diagram for the '76 TR6. The two white/orange wires have no impact at all on the operation of the starter, but I have shown them anyway, to prevent possible confusion, as they are there, and you might wonder why. Their purpose is to operate the "lamp test relay," which will be covered in chapter 21, Oil Brake and EGR warning lamps.

Excluding those two wires, this diagram looks remarkably like the original TR250 diagram. The only addition being the white/yellow wire from the I terminal on the solenoid. This wire is used to bypass the ballast resister, and its function is covered in chapter 20, Ignition System.

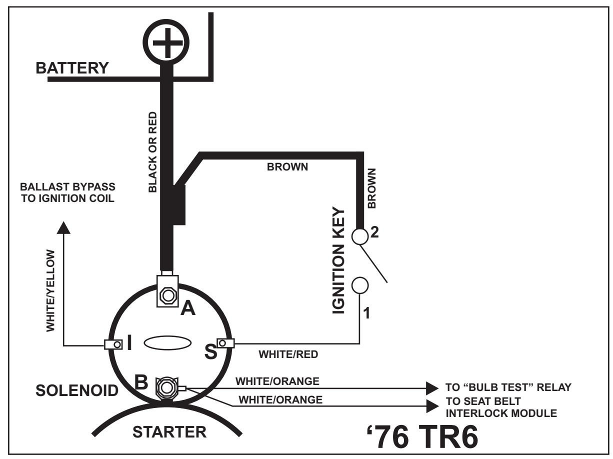



FIGURE 7

When the ignition key is turned to the start position, power is applied to the S terminal, energizing the solenoid, just as for the earlier models. When the solenoid is energized, all three of the other terminals - A, B, & I - are connected together inside solenoid, and power is then applied to both the starter motor and to the ballast bypass circuit.

TROUBLE SHOOTING

A. STARTER WORKS, BUT TURNS THE ENGINE OVER VERY SLOWLY:

There are two possible causes for this - mechanical or electrical. Mechanical problems could be from binding in the starter gear/flywheel interface, or something in the engine binding. Usually, if it is a mechanical problem, it is in the gear/flywheel interface, rather than in the engine, as an engine binding problem would most likely show up elsewhere and you would already be working on it. Quite often, though, the starter will be slightly out of alignment (usually after an engine rebuild/starter replacement), and the drive gear just binds up. Mechanical repairs are outside the scope of this manual, however.

If it's an electrical problem, the first thing to check is the condition of the battery. Before any other tests are made, the condition of the battery must be determined and corrections made if needed. Refer to chapter 5, Batteries and Battery Charging for information on batteries and battery testing.

If it's not the battery, it's most likely bad connections in the battery cables (especially the ground cable), the cables themselves are defective, or you have a bad solenoid. It is also possible that the wiring to the S terminal of the solenoid is bad. To determine which of these is the problem, you will need to bypass them as follows:

**WARNING:** FOR ALL OF THE FOLLOWING TESTS, MAKE SURE THE TRANSMISSION IS IN NEUTRAL, THE IGNITION KEY IS OFF, AND THE HANDBRAKE IS ON. IF THE ENGINE SHOULD START WHILE PERFORMING THESE TESTS, IT COULD BE FATAL TO YOU OR YOUR HELPERS.

Step 1) For the first test, connect one end of a battery jumper cable to the positive post of the battery, making a good, solid, connection. Then, very firmly connect the other end to terminal B on the starter solenoid. Don't be timid, really jam the jumper cable on there. If you press it on lightly, you will get a lot of sparks, and a lot of welding of the terminal. If the starter doesn't spin freely, your starter motor is bad (except for the TR250, with an inertia starter, the engine will not turn over during this test, as the solenoid is not being engaged - the jumper cable bypasses the solenoid). If the starter motor spins satisfactorily, the problem is either in the cables/connections/wiring, and they will have to be repaired or replaced as required, or the solenoid is bad.

Step 2) The next step is to test the wiring to the S terminal. To do this, remove the existing wire(s) to the S terminal. Connect one end of a piece of wire (at least 14 ga, 12 ga preferred) to the positive post of the battery, and the other end to the S terminal. If the starter now operates as it should, the problem is in the wiring to the S terminal. For details on evaluating this wiring, see part C

Step 3) If the starter still didn't operate as it should, we have one more test to make. Using your jumper cable, connect one end to the positive battery post and the other end to terminal A on the solenoid. Repeat the test just above, connecting a wire between the battery and the S terminal (this test must be repeated to make sure we don't have two problems - bad cables and bad wiring). If the starter works satisfactorily, the solenoid is OK. If not, the solenoid must be replaced.

B. ENGINE DOESN'T TURN OVER AT ALL:

This is just a more severe case of the symptoms of part A, so the testing will be similar, although the order will be a bit different. In this case, step 2 above should be the first step, followed by steps 1 and 3, depending on the results of step 2.
Step 1). Remove the existing wire(s) to the S terminal. Connect one end of a piece of wire (at least 14 ga, 12 ga preferred) to the positive post of the battery, and the other end to the S terminal. If the starter now operates as it should, the problem is in the wiring to the S terminal. For details on evaluating this wiring, see part C.

Step 2)If the starter didn't work, did you hear the solenoid engage? If not, the solenoid is bad. If the solenoid clicked, but the starter didn't operate at all, proceed with step 3.

Step 3). For this test, connect one end of a battery jumper cable to the positive post of the battery, making a good, solid, connection. Then, very firmly connect the other end to terminal B on the starter solenoid. Don't be timid, really jam the jumper cable on there. If you press it on lightly, you will get a lot of sparks, and a lot of welding of the terminal. If the starter doesn't spin, your starter motor is bad (except for the TR250, with an inertia starter, the engine will not turn over during this test, as the solenoid is not being engaged - the jumper cable bypasses the solenoid). If the starter motor spins satisfactorily, the problem is in either in the cables or the cable connections, and they will have to be repaired or replaced as required, or the solenoid is bad. Proceed to step 4.

Step 4). If the starter motor worked when you performed step 3, then either the cable from the battery to the solenoid is bad, the battery cable connections are bad, or the solenoid is bad. To determine which is the problem, connect one end of a battery jumper cable to the positive battery post, and the other end to the solenoid terminal A, and repeat test 1. If the starter now works properly, the problem was in the battery cable or the cable connections. If not, the solenoid is bad.

C. SOLENOID DOESN'T GET A START SIGNAL:

As shown in **figures 3, 4, 5, 6,** and **7**, power to the starter solenoid comes from the ignition switch. Power to the ignition switch comes directly from the battery. Power to the "green" fuse also comes directly from the ignition switch. Therefore, if ***ANY*** of the "green" fuse loads operate when the key is on, there is power to the ignition switch. Proceed with the following troubleshooting steps. If ***NONE*** of the "green" loads work, either the ignition switch is faulty or there is a problem in the wiring to the switch. Refer to chapter 23, Power Distribution, to resolve this problem.

Previous testing in A and B above have shown the starter to be operable, or have identified the problem so repairs can be made. If power were getting to the S terminal, there would be no need to proceed further, so we now need to find out why power isn't getting to the starter solenoid.

All models *except* '74 - '75:

Step 1). Locate the white/red wire coming from the ignition switch. With your voltmeter or test lamp, check for the presence of voltage on this wire (at the switch) as you turn the key to the start position. If you have voltage here, there is a break or bad connection in the W/R wire between the switch and the solenoid. If you don't have voltage here, the ignition switch is defective.

'74 - '75 models:

Step 1). Using your voltmeter or test lamp, check for voltage on the starter relay terminal with the white/orange wire on it (should be the W1 terminal, but could be the W2), as you turn the ignition key to the start position. If you have voltage here, proceed to step 2. If you don't have voltage, go to step 6.

Step 2). When you turned the key to the start position in step 1, did the relay click? If so, go to step 4. If not, go to step 3.

Step 3). Remove the black wire from the relay terminal W2 (could be W1, if the W/O wire is on W2), and, using a short test lead with alligator clips on each end, connect the relay terminal to a good ground, and turn the key to the start position again. Did the relay click? If so, the black wire (ground wire) is broken, or the connections are bad, and must be repaired. If the relay didn't click, the relay is bad, and must be replaced. Did the starter turn over when the relay clicked? If not, go to step 4.

Step 4). Check for power on the brown wire to terminal C2 of the starter relay (could be C1or C4). This wire should have power on it at all times, key on or off. If you have power here, proceed to step 5. If not, there is a break or bad connection in the brown wire, which will need to be repaired.

Step 5). Check for power on the white/red wire on terminal C1 (could be C2 or C4) of the relay, as you turn the key to the start position. If you have power, there is a break or a bad connection in the W/O or W/R wire to the starter solenoid. If not, the relay is bad, and must be replaced.

Step 6).

'74 models: If you didn't have power on the W/O wire in step 1, there is a break or a bad connection in the W/R wire to the seat belt module, or the module is defective. Pull the plug from the seat belt module (located on the left, just above the passenger's footwell), and connect the W/R and the W/O wire terminals together with test lead. Be sure to make a good connection, as the solenoid draws a good bit of current. Try to start the car again. If the starter now operates, the problem is in the module. It could be a defective module, or some of the input switches (seat belt or transmission neutral switch) are not operating properly. Go to Chapter 24, Seat Belt Interlocks to determine if it is the module or the switches. If all the switch test pass, it is the module that is the problem. Unless you are a real stickler for originality, I would recommend that you just connect the W/R and the W/O wires together permanently, rather than attempting to repair or find a replacement for the module. Triumph did just that for the '75 model year, so originality isn't sacrificed much by this modification.

If the starter doesn't operate, there is a break or a bad connection in either the W/R or the W/O wire, which will need to be found and fixed. Go to step 7.

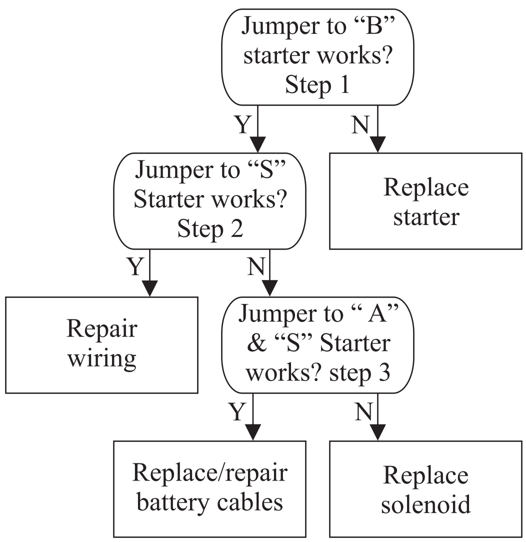
'75 models: for the '75 model year, the factory pulled the W/O and the W/R wire from the seat belt module and connected them together; therefore, if the starter still doesn't work at this point, there is a break or a bad connection in either the W/R or the W/O wire, which will need to be found and fixed. Go to step 7.

Step 7). To determine which wire is at fault, the W/O or the W/R, place your voltmeter or test lamp module plug pin with the W/R wire (with the plug removed) if you have a '74 model, or at the connection of the W/R and the W/O wire near the module if you have a '75 model. Turn the key to the start position. If you have voltage, the problem is in the W/O wire. If not, the problem is in the W/R wire. Go to step 8.

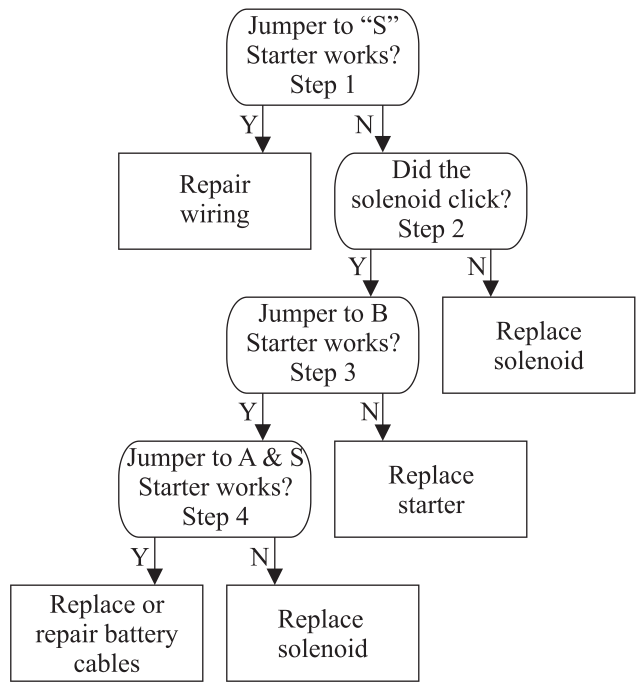
Step 8). Locate the W/R wire as it leaves the ignition switch, and check for power on this wire when the key is turned to the start position. If you have power, there is a break or a bad connection in the W/R wire. If not, the ignition switch is defective, and must be replaced.

# TROUBLESHOOTING FLOW DIAGRAMS

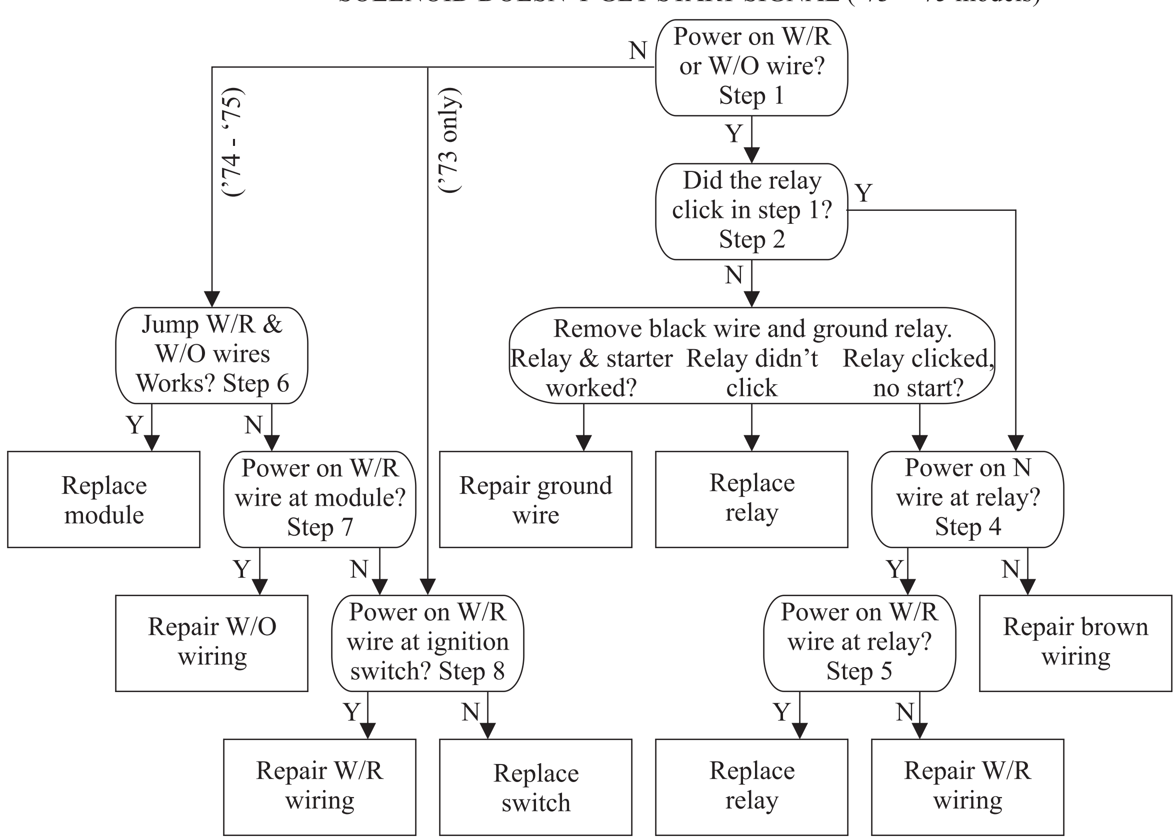
## STARTER OPERATES POORLY




## STARTER DOESN'T OPERATE




## SOLENOID DOESN'T GET START SIGNAL ('73 - '75 models)



# 26
# TURN SIGNALS AND HAZARD FLASHER

TURN SIGNAL FLASHERS VERSUS HAZARD FLASHERS

Even though the serve identical functions, and they both operate on the same principle, there is a significant difference in the two. Each has a heat element and a bimetal strip. Current through the heat element elevates the temperature of the bimetal strip, causing it to bend. On one end of the strip is a set of contacts. When the strip bends, these contacts either open (turn signal flasher) or close (hazard flasher). The current that flows through the heat element also flows through the light bulbs.

Functionally, the differences between the two types are:

1) A hazard flasher will flash at the same rate regardless of the load, as long as the load doesn't exceed the flasher capacity. One 2 watt bulb will cause the flasher to operate at the same rate as four 21 watt bulbs.

The flash rate of a turn signal flasher will vary, depending on the load. The current through one 21 watt bulb is not enough to cause the flasher to work (the lights will stay on), and four 21 watt bulbs will cause the flasher to operate at a high rate (till the flasher burns up).

There is an excellent reason for this difference, and it is not unique to Lucas -- most manufacturers do this. The reason is one of safety. If you turn on your turn signal flashers and one bulb is out, the flasher won't work, giving you notification that something needs to be fixed. On the other hand, when you need to use your hazard flasher, you need to use whatever bulbs you have. If one is out, you still want to be able to use the other three. You won't have any indication that a bulb is out, but the next time you use the turn signals, you will.

2) The flash sequence of a hazard flasher starts with an OFF, i.e., OFF--ON--OFF--ON. The flash sequence of a turn signal flasher starts with an ON, i.e., ON--OFF--ON--OFF. This difference in sequence was not a design goal, it just worked out that way.

Electrically, the differences are:

1) HAZARD FLASHER: The resistance of the heat element in a hazard flasher is very large compared to the resistance of the light bulbs, (approximately 45 ohms, as compared to approximately 2 ohms for the four flasher bulbs). To the heat element, the light bulbs look like a short to ground. As shown in **figure 1A**, when the heat element raises the temperature of the bimetal strip, the strip bends and the contacts close. The contacts are wired such that they short circuit the heat element when they close. When the heat element is shorted, all current flows

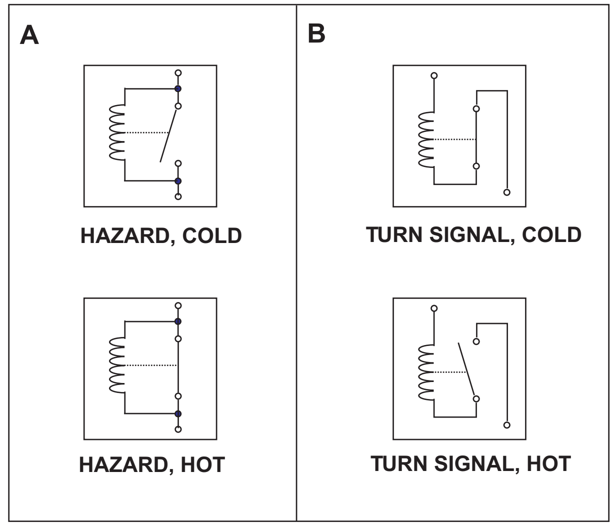



FIGURE 1

through the switch contacts and none through the heat element. As a result, the element cools off and the contacts reopen. Current again flows through the element, and the cycle starts anew. The current that flows through the heat element also flows through the bulbs, but because of the high resistance of the element, the current is much less when the contacts are open than when the contacts are closed -- not enough to light the bulbs.

This operation is depicted in **figure 2**, below. Side "A" shows the condition when the hazard switch is first turned on. A very small current flows through the heat element,

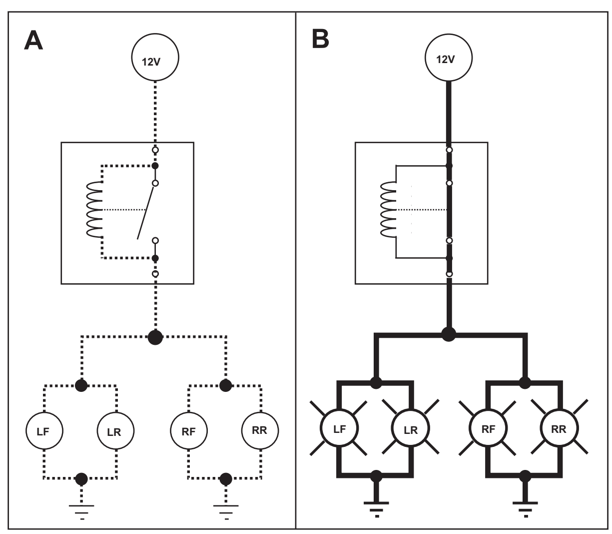



FIGURE 2

and then through the bulbs, but this small current is not enough to light the bulbs. Side "B" shows the situation after the element has had time to heat up. The contacts close, providing a direct path from the power source to the bulbs, and they are now lit at full brilliance.

2) TURN SIGNAL FLASHER: The resistance of the heat element in a turn signal flasher is sized very carefully to the specified bulb wattage for that particular car, and is very low, less than ½ ohm. See **figure 1B**. If the correct bulbs are used, the current through the element is exactly the right amount to cause the bimetal strip to bend at just the right rate for the flasher. Lower wattage causes the strip to bend too slow, and higher wattage bulbs cause the strip to bend too fast. Just as in the hazard flasher, the current through the heat element is the same current as through the bulbs. The resistance of the element is so low that it offers minimal additional resistance over that provided from the bulbs -- the bulbs light almost as bright as if the element were not there. As shown in figure 3, below, the flasher contacts are wired in series with the bulbs. When the strip bends, the contacts on the strip open, cutting off current flow to the bulbs.

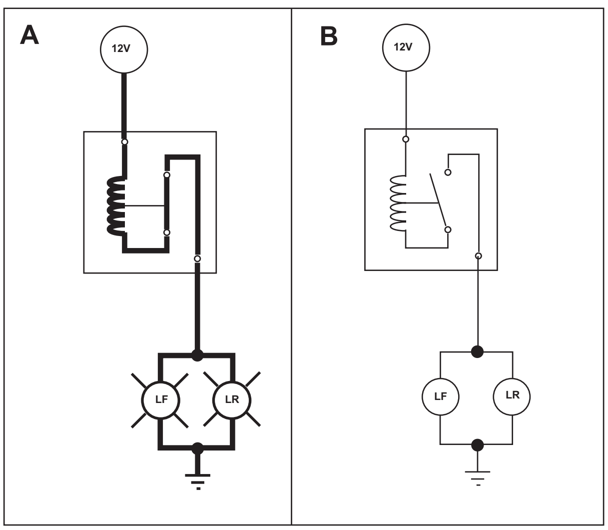



FIGURE 3

Because the operation of the flashers is dependent on the current flow through them, any change in the voltage applied will also have an effect on the flash rate. An increase in voltage will cause a corresponding increase in the current, which will cause a corresponding increase in the flash rate. A decrease in voltage will have the opposite effect.

Circuit resistance also has an effect on the flasher rate. More resistance reduces the current flow, and less resistance increases it. Barring a short circuit, the only way to reduce resistance in the circuit it to replace the normal bulbs with bulbs of a higher wattage rating. Higher wattage bulbs draw more current than lower wattage bulbs. This is one way of solving a slow turn signal flash rate problem -- replace the 21 watt bulbs installed by the factory in most British cars with 27 watt bulbs used in most American cars, bulb # 1156. Increased resistance is the most common problem, leading to a slow flash rate, or to not flashing at all. Typically, this is caused by bad connections, either in the circuit wiring, internal switch contacts -- particularly the hazard switch, or in the ground connections at the bulbs.

TROUBLE SHOOTING

FLASHER UNITS

I know of no way to test the flasher units other than by hooking them up to an appropriate load and seeing if they work For the hazard flasher, any bulb will do, but for the turn signal flasher, the load must consist of the correct number of bulbs of the correct wattage. In my shop, I keep a pair of bulbs handy for this purpose. I have soldered wire leads to them, and wired them in parallel. See **photo 1** below.

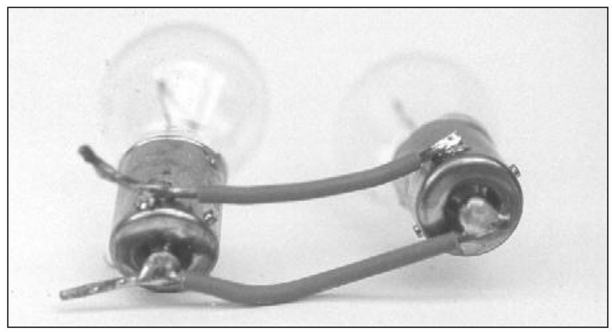


PHOTO 1

HAZARD SWITCH

Next to bad grounds or bad connections, the single most common problem with the turn signals in a Triumph, particularly the TR 250 and the earlier TR6 models, is the hazard switch. In order for the turn signals to work, the hazard switch must be installed, and in the OFF position. When the hazard switch is off, power from the "green" fuse feeds through the turn signal flasher, through the hazard switch, through the turn signal switch, and then to the turn signal lamps. When the hazard switch is on, power is cut to the turn signals and power from the "purple" fuse is fed to the hazard flasher circuit.

Like most switches, the hazard switch has contacts that have a wiping acting as the switch is operated. When the contacts close, they wipe across each other in a self cleaning action. The hazard flashers, being primarily an emergency operation, are seldom used, so the self cleaning action of the switch is seldom exercised. As a result, the contacts become dirty or corroded with time, so that when you do operate the switch and then turn it back off, the contacts for the turn signals don't make as cleanly as they should. The added resistance of the switch slows the turn signal flash rate, often to zero, as described earlier.

If your turn signals are going to quit, it is often just after you have used the hazard flasher. If so, all that is often needed is to repeatedly operate the hazard switch till the self cleaning action can clean the contacts a little. Sometimes this is enough to restore the turn signals back to working order.

Sometimes, though, this is not enough, and the switch will have to be taken apart and cleaned. Repair procedures for the rocker type switch, as used up through the '72 TR6, are covered in chapter 9, Switches, Relays, and Solenoids. The switch used in the later models is quite different, being a pull type switch. It is, though, almost as easy to disassemble and clean. Each of the contact/terminals can be removed for cleaning, which will then allow access to the other parts of the switch. To remove the contacts, insert a small screwdriver into the area marked "A" in **photo 2** below. Each terminal has a small tab, marked "B", which retains the contact in the switch. Pressing down on this tab releases the contact, which can then be pulled out for cleaning. To clean, use a pencil eraser and rub until the metal is shiny. After cleaning, insert the contact into the switch body till the tab engages, preventing the tab from backing out. While you have the contacts out, you can also clean the moving contact, using an eraser as well.

Although not obvious in the photo below, there are two sizes of contacts - two short ones and four long ones. When the switch is off, pushed in, the inner contact connects the two short contacts together, allowing power from the green fuse to flow to the turn signal circuit. When the switch is on, pulled out, the inner contact shorts the four longer contacts together, as well as the high side contact of the indicator lamp. In this position, power from the purple fuse is applied to the hazard flasher, both sides of the turn signals are connected together, and power is applied to the hazard indicating lamp. The function of this switching arrangement will be discussed later in this chapter.

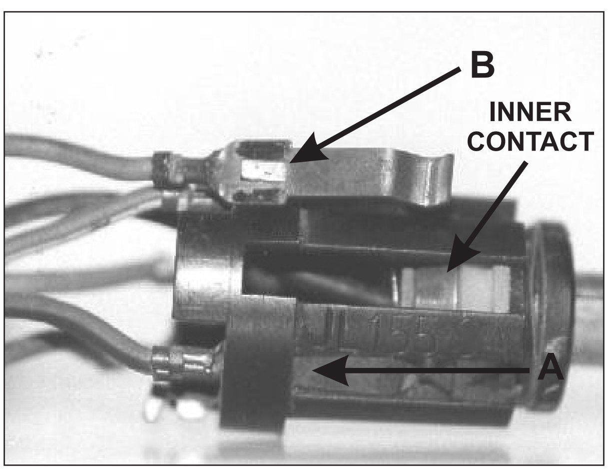



PHOTO 2

Given all the problems the hazard switch causes, the question immediately comes to mind "why on earth did Triumph run the turn signal circuit through the hazards switch?" A good question, and there is a good answer for it. Here's the situation: you are driving home late at night, in the winter time, and it is raining. You have the radio on at high volume to help keep you awake, and the heater going to keep you warm. You hear a funny noise from the rear of your car, so you pull over to investigate. Being the considerate driver you are, you signal your intentions by using the turn signals. When you get off to the side of the road, you turn off the key. Knowing that all of the electrical loads you have on will go off with the key, you don't bother to turn them off as you are distracted by your concern over the strange noise. As a safety measure, you then turn on the hazard flasher. Without the turn signals being routed through the hazard switch, you would now have real problems! You would have just overloaded your electrical circuits, and probably blown a fuse, as the radio, heater fan, and windshield wipers all turn on and off with the flasher.

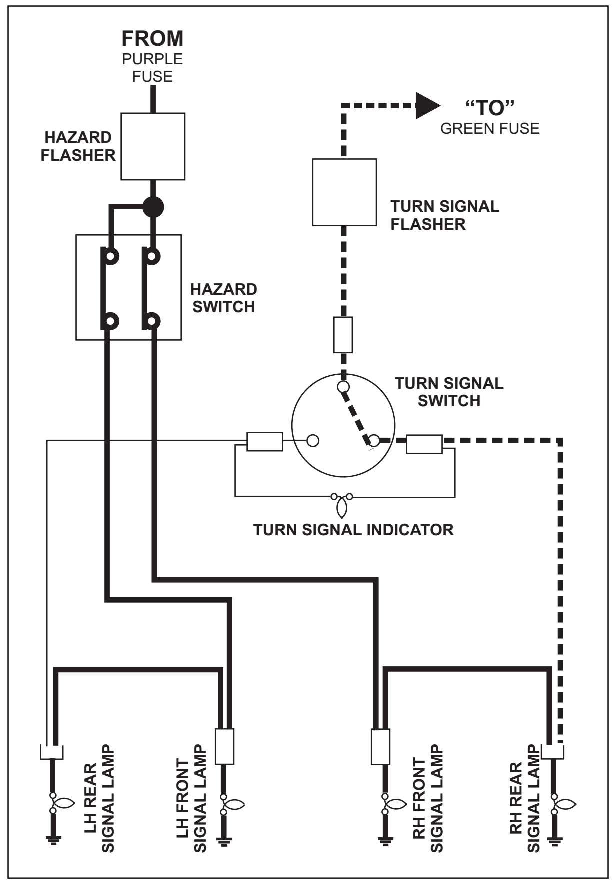



FIGURE 4

In **figure 4** above, I have drawn a very simplified diagram of what the turn signal and hazard circuits would look like if they were wired separately. For safety reasons, the hazard flashers must be operable at all times, ignition key on or not, so they are powered from the "purple" fuse, which is hot all the time. The turn signals, on the other hand, are only needed when the car is in operation, so they are powered from the "green" fuse, which is hot only when the key is on.

When the hazard switch is turned on, it performs two functions: it connects the turn signal bulbs on both side of the car together, and it applies power to them. The heavy lines in figure 4 depict the flow of current through the circuit when the hazard flasher is on. Notice what happens if the turn signal switch should also be on. Power from the hazard switch not only flows through the bulbs, it also flows "backwards" through the turn signal switch to the "green" fuse, as shown by the heavy dotted line. Applying power to the green fuse this way has the same effect as turning on the ignition key! The resistance of the turn signal flasher is around 0.5 ohms, so current will flow almost un-impeded through it to the fuse.

This then is the reason for routing the turn signal power through the hazard switch, - to prevent the hazard flasher from back feeding through the turn signal switch, if it should happen to be left on, and powering every thing that is powered when the key switch is on.

***Note:** Beginning with **figure 5**, this page, and **continuing through figure 13**, page 124, I have drawn three schematics for each of the three wiring configurations used in this series of Triumph TRs. One diagram in each series shows the schematic alone, , one shows the wiring configuration and current flow when the turn signals are operated, and the other shows the configuration and current flow when the hazard switch is operated. As you read the following material, refer to the appropriate diagram.*

To determine if the hazard switch is the problem, it will be necessary to bypass it.

TR250 - '71 TR6:

Step 1). Make up a test lead long enough to reach from the turn signal switch wiring under the dash to the turn signal flasher (located on the inner fender wall, inside the car, and just above the passenger side footwell), with an alligator clip on each end. Remove the LG/N wire from the flasher, and connect one end of the test lead to the terminal where the LG/W was attached.

Locate the LG/N wire from the turn signal switch, as it exits the steering column under the dash. Connect the other end of the test lead to this wire. You may be able to make the connection without pulling the wire and its bullet connector from the sleeve, and you may not, depending on your particular

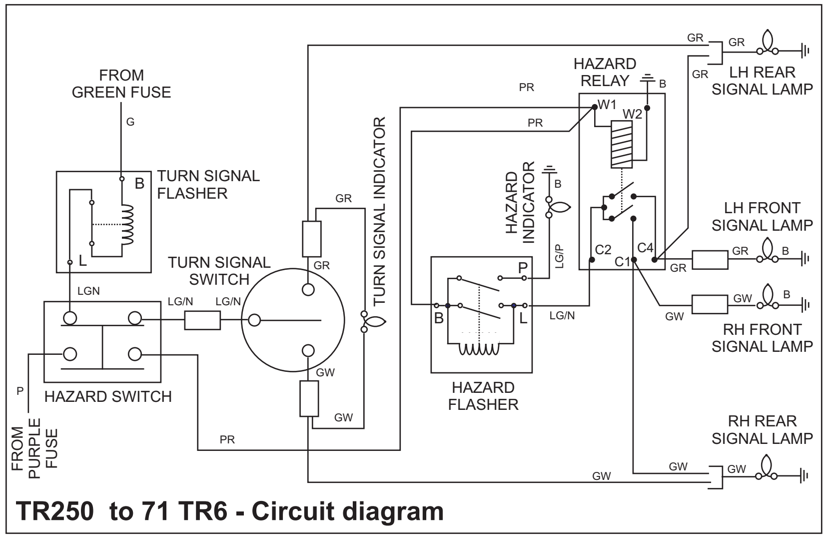



FIGURE 5

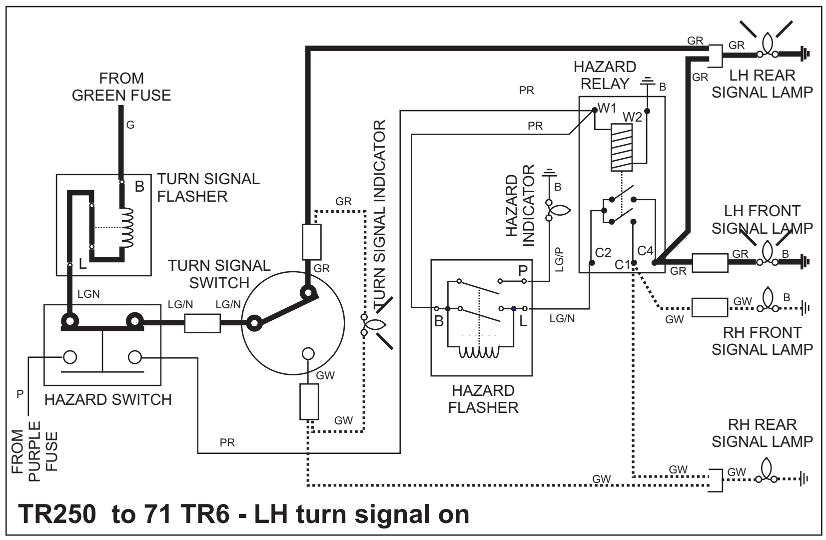



FIGURE 6

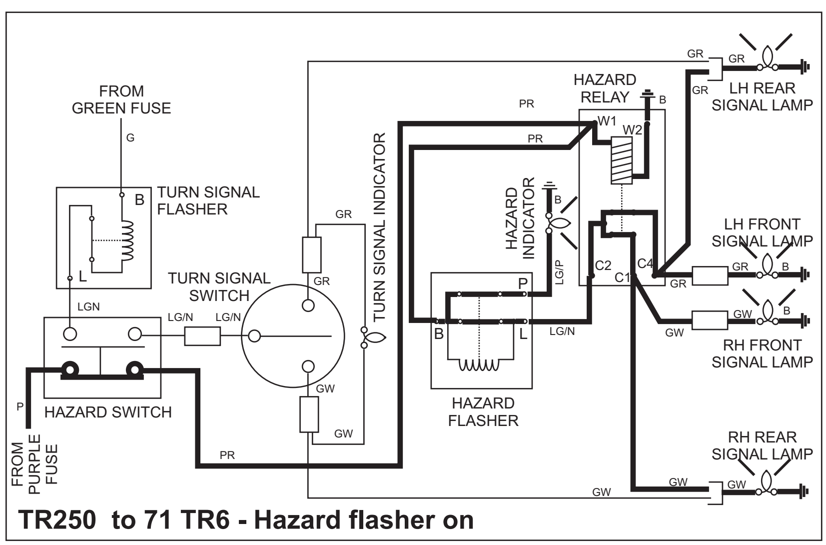



FIGURE 7

circumstance. If you have to pull the wire, make sure you connect your test lead to the LG/N wire going to the turn signal switch, and not the LG/N wire going to the hazard switch.

Turn on the ignition key and try the turn signals. If they now work, the hazard switch is the problem. If not, you have high resistance in the circuit. Go to step 2 under "all models."

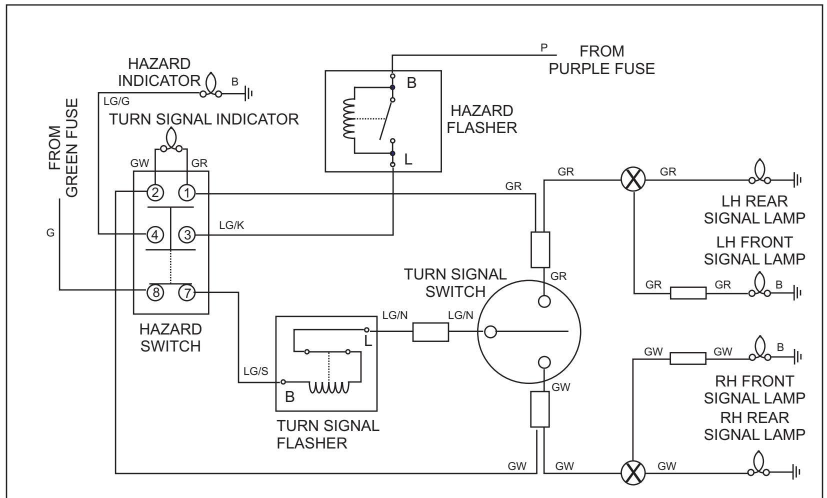
To gain access to the hazard switch, it will be necessary to remove either the speedometer or the tachometer. To remove either of these items, first unscrew the drive cable connection at the rear and pull the cable out of the way. Next, remove the illumination and the various indicating lamps. There are two clamps holding the meter in place, and these are held onto two studs at the back of the case by knurled nuts. Remove these two nuts, and any ground wires, and slip the clamps off. The meter can then be pulled out the front of the dash.

'72 - 76 TR6:

Step 1). Make up a test lead long enough to reach from the battery to the turn signal flasher (located on the inner fender wall, inside the car, and just above the passenger side footwell), with an alligator clip on each end. Remove the LG/S wire from the flasher, and connect one end of the test lead to the flasher terminal where the LG/S wire was connected. Connect the other end of the test lead to the positive post of the battery, and try the turn signals again (no need to turn on the key, as the flasher is now connected directly to the battery). If they now work, the hazard switch was the problem. If not, you have high resistance in the circuit. Go to step 2, under "all Models."

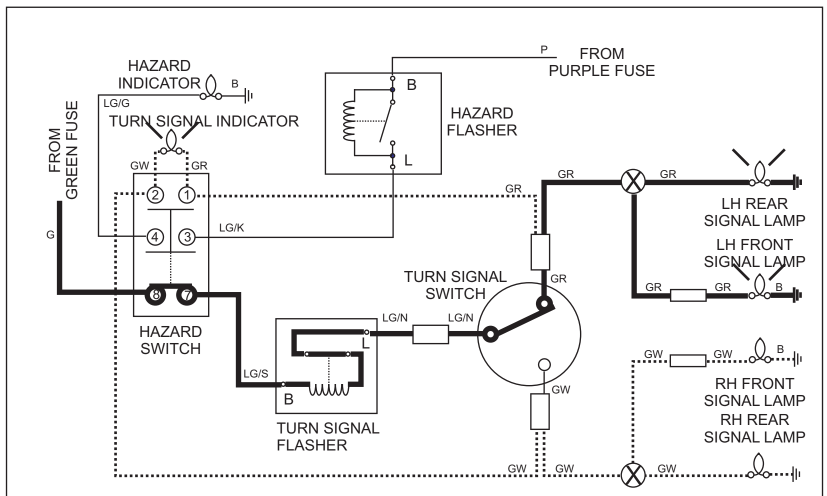
ALL MODELS:

Step 2). If it turns out that the problem is in your wiring, you are going to have to do some detective work to find it. The first place to look is at the ground connections at the turn signal bulbs themselves. Most of the time, that is where the problems are. Whether it's a problem with grounds, or bad connections, the treatment is the same - clean, clean, clean! Go through the wiring, item by item, with steel wool or fine sandpaper, and polish all metal to metal contact points. If your budget



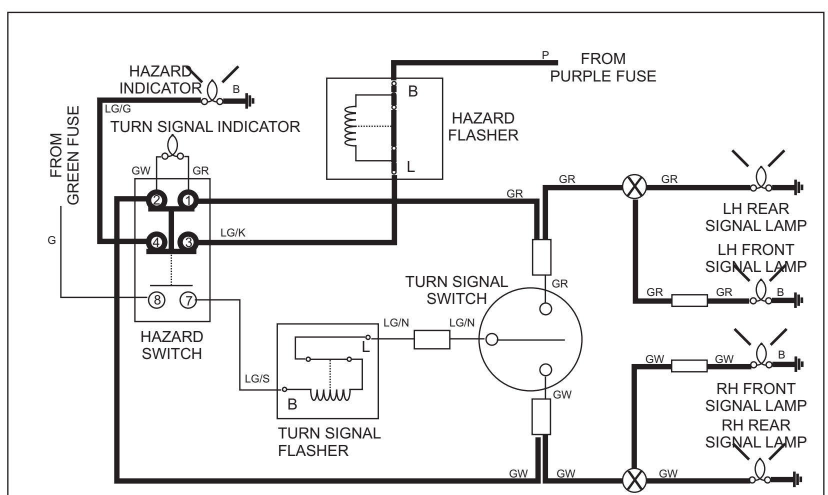

1972 TR6 - Circuit diagram

FIGURE 8




1972 TR6 - LH turn signal on

FIGURE 9




1972 TR6 - Hazards flasher on

FIGURE 10

allows, I strongly recommend replacing all of the sleeve connectors in the circuit. For some reason, the metal sleeves inside these things have a habit of becoming brittle with age, and often break into pieces. When this happens, compression is lost, and they no longer make good contact with the bullets.

In an emergency, you can often get recalcitrant turn signals working by substituting a heavy duty flasher module. These are not really turn signal flasher, but hazard flashers. This means that they will flash even if the total resistance of the circuit is high, or even if one bulb is out. For this reason, you don't want to use them on a regular basis, because you lose the warning feature mentioned earlier. Ask for a model 552 at your local parts store, or even at your local K-mart.

TURN SIGNAL INDICATOR LIGHT:

An interesting item of note in the diagram in **figure 4**, page 121, is the location and wiring of the turn signal indicator lamp. It appears to be an unworkable connection scheme. With one side of the lamp wired to the left hand turn signal lamps, and the other side wired to the right hand turn signal lamps, it appears as if the lamp would never light up, as there is no ground connection for it. Actually, there is, although it's not immediately apparent. Refer to **figure 14** below.

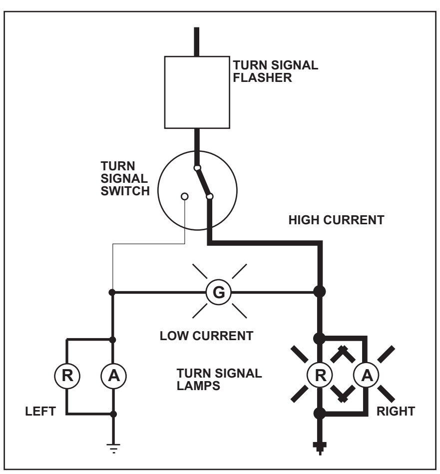



FIGURE 14

The indicator lamp is a very low wattage bulb, about 2.2 watts. The turn signal bulbs are 21 watts. A 2.2 watt bulb has a resistance of about 65 ohms, compared to about 6.8 ohms for the turn signal bulbs.

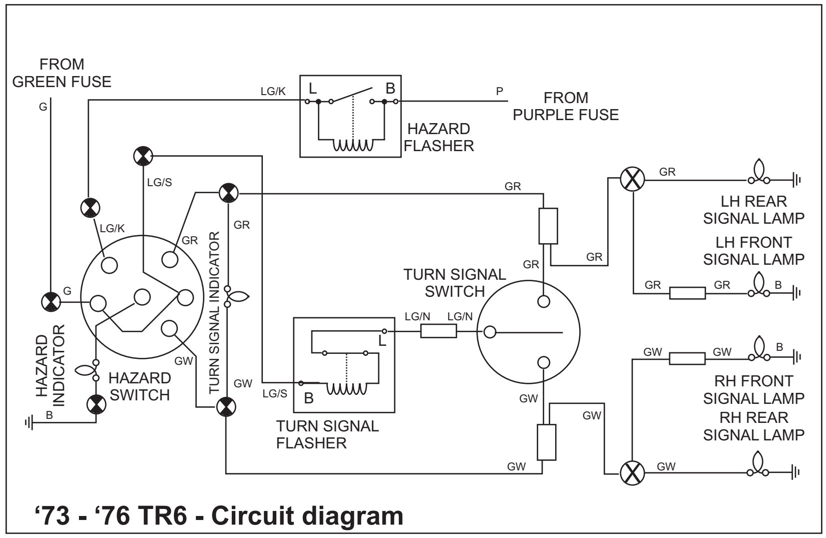



FIGURE 11

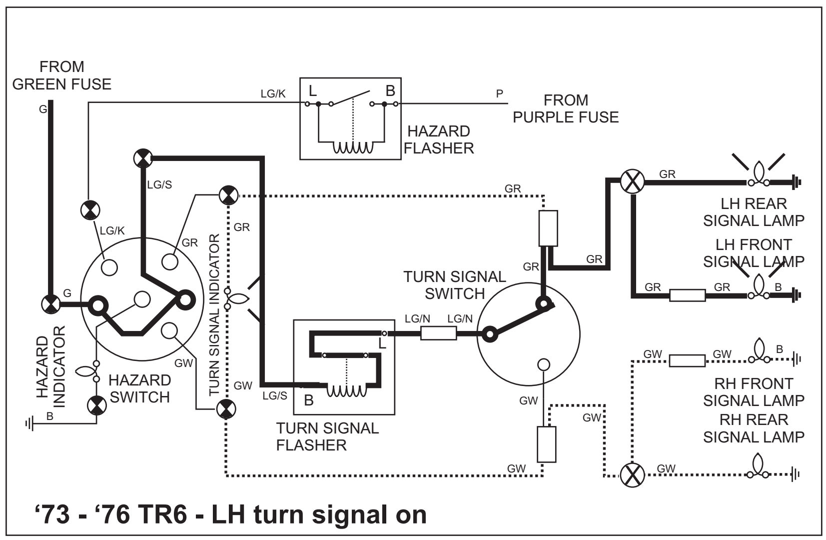



FIGURE 12

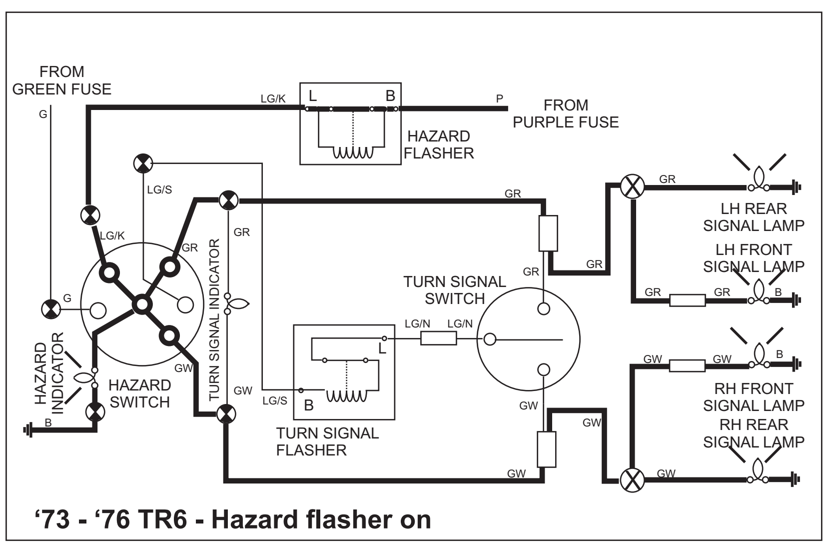



FIGURE 13

The turn signal bulbs are in parallel, which gives a combined resistance of 3.4 ohms. Adding the 65 ohm resistance of the indicator lamp to the 3.4 ohms of the combined turn signal bulbs gives a total of 68.4 ohms. This is only five percent more than the indicator bulb by itself, so it will light almost as brightly as if it were in the circuit by itself. On the other hand, this is ten times the resistance of the individual turn signal bulb, so the current through them is no where near enough to light them. Current flows from one side of the turn signal circuit , through the indicator lamp, and through the turn signal bulbs on the other side, as shown by the medium weight line, and, concurrently, through the operating turn signal bulbs, as shown by the heavy line.

TURN SIGNALS:

ALL MODELS:

The turn signals receive power from the "green" fuse, as do the windshield wipers, windshield washer, gauges, brake lights, back up lights, and the heater fan. If ***ANY*** of these devices work, you have power to this fuse. If ***NONE*** of them work, you have a problem in the wiring to the "green" fuse, or the fuse is blown. Repair this problem before proceeding with the following steps.

Do the turn signals come on and burn steady (don't blink on and off as they should), or do they not turn on at all? If they don't operate at all, follow the appropriate steps below. If they burn steady, you know that the wiring is intact, or the lights wouldn't come on at all. Only two things will cause the lights to come on but not blink - a faulty flasher unit or high resistance in the circuit. As explained earlier, the operation of the turn signal flasher requires a certain amount of current in the circuit. If the overall resistance of the circuit is too high, the flasher will pass enough current to turn on the bulbs, but not enough to cause it to flash.

Remove the flasher unit and test as described on page 120. Or, if you have a replacement flasher, you might try replacement as the first step. If the flasher is bad, replace it. If not, there is a problem with your wiring. To resolve this problem, you will have to go through ***ALL*** of the turn signal wiring, connection by connection, ground by ground, until you find the source of the high resistance. Unfortunately, there is no sure-fire method for finding the bad connection or ground, so you will need to clean each and every connection and ground, using fine sandpaper or steel wool, starting at the switch and working your way through the wiring to the ground connections at each bulb. Tedious work, but necessary work.

TR250 - '71 TR6:

Step 1). Make up a short test lead, with male ¼" spade connectors on each end. Remove the green and the light green/brown wires from the turn signal flasher, and connect the two wires together with your test lead. Turn on the ignition key and try the turn signals. If the turn signal bulbs burn steady, your flasher is defective, and must be replaced. If not, go to step 2.

Step 2). With the ignition key on, use your voltmeter or test lamp to check for power at the green wire to the flasher. If you have power here, go to step 3. If not, there is a break or a bad connection in the green wire between here and the fuse, which will need to be repaired.

Step 3). Replace the green wire on the flasher if you removed it for test 2, and check for power on the flasher terminal with the light green/brown wire. If you have voltage here, proceed to step 4. If not, the flasher is bad, and must be replaced.

Step 4). Locate the light green/brown wire from the turn signal switch, which exits the steering column just under the dash. This wire from the switch connects to the light green/brown wire from the hazard switch with a bullet/sleeve connector. Check for the presence of voltage on the LG/N wire at this connection. If you have voltage here, proceed to step 5. If not, there is a break or bad connection in the wiring from the turn signal flasher to the hazard switch, from the hazard switch to the turn signal switch, or the hazard switch is bad. Refer to the hazard switch section of this chapter, page 120, For replacement/repair instructions for the hazard switch. If the switch proves to be good, you will have to repair the wiring to/from the switch.

Step 5). In the same bundle of wire coming out of the steering column that had the LG/N wire you just tested in step 4, there will also be a green/white and a green/red wire. The G/W wire powers the right side signals, and the G/R wire powers the left side signals. With the ignition key on, operate your turn signal switch and check for voltage at each of these wires. If you have voltage here, proceed to step 6. If not, the turn signal switch is bad, and must be repaired or replaced. This switch is repairable, but it's a bit harder to do than for the rocker type switches. Repair procedures are covered on page 121.

Step 6). Does the hazard flasher circuit work? The turn signals and the hazard flasher both use the same bulbs, and the two circuits connect together at the wiring to the bulbs. In the TR250 - '71 TR6, this connection takes place at the hazard relay (terminals C1 and C4). If the hazard circuit works, you know the turn signal circuit is also operable from this point onward to the lights, so no need to check further than the hazard relay. If you've gotten this far without finding the trouble, and the hazard circuit works, it's pretty certain, then, that the problem lies in the wiring from the turn signal switch to these connections, and repairs to this portion of the wiring will be needed. If the hazard flasher circuit doesn't work, proceed to step 7.

Step 7). With the key on, operate the turn signal switch while monitoring for voltage on the GW wire (for a RH turn) and the GR wire (for a LH turn) at the terminals C1 and C4 of the hazard relay. If you have voltage, there is a break or a bad connection in the wiring from this point to the lights, or, quite likely, the ground connection to each bulb is bad. Clean or repair as needed. If not, there is a break or bad connection in the wiring between the turn signal switch and the connector, which will need to be repaired.

‘72 - ‘76 TR6:

Step 1). Make up a short test lead, with male ¼” spade connectors on each end. Remove the light green/slate and the light green/brown wires from the turn signal flasher, and connect the two wires together with your test lead. Turn on the ignition key and try the turn signals. If the turn signal bulbs burn steady, your flasher is defective, and must be replaced. If not, go to step 2.

Step 2). Using your voltmeter or test lamp, check for the presence of power at the LG/S wire at the turn signal flasher. If you have power here, proceed to step 5. If not, remove the test lead, reconnect the flasher wires, and proceed to step 3.

Step 3). Check for the presence of power on the hazard switch terminal with the LG/S wire. To gain access to the hazard switch, it will be necessary to remove either the speedometer or the tachometer. To remove either of these items, first unscrew the drive cable connection at the rear and pull the cable out of the way. Next, remove the illumination and the various indicating lamps, There are two clamps holding the meter in place, and these are held on by two studs at the back of the case by knurled nuts. Remove these two nuts, and slip the clamps off. Remove ground wires, if any. The meter can then be pulled out the front of the dash. If you have power here, there is a break or a bad connection on the LG/S wire between the hazard switch and the turn signal flasher. If not, proceed to step 4.

Step 4). Do you have power on the green wire to the hazard switch? If so, the hazard switch is bad, and will need to be repaired or replaced. If not, there is a break or bad connection between the hazard switch and the “green” fuse, which must be repaired.

Step 5). With the test lead still in place from step 1 (to ensure that a defective flasher won’t mask the results of the test - you may have more than one problem), locate the light green/brown wire from the turn signal switch, which exits the steering column just under the dash. This wire from the switch connects to the light green/brown wire from the hazard flasher with a bullet/sleeve connector. Check for the presence of voltage on the LG/N wire at this connection. If you have voltage here, proceed to step 6. If not, there is a break or bad connection in the wiring from the turn signal flasher to the hazard switch, from the hazard switch to the turn signal switch, or the hazard switch is bad. Refer to the hazard switch section of this chapter, page 120, for replacement/repair instructions for the hazard switch. If the switch proves to be good, you will have to repair the wiring to/from the switch.

Step 6). In the same bundle of wire coming out of the steering column that had the LG/N wire you just tested in step 5, there will also be a green/white and a green/red wire. The G/W wire powers the right side signals, and the G/R wire powers the left side signals. With the ignition key on, operate your turn signal switch and check for voltage at each of these wires. If you have voltage here, proceed to step 7. If not, the turn signal switch is bad, and must be repaired or replaced. This switch is repairable, but it’s a bit harder to do than for the rocker type switches. Repair procedures are covered on page 121.

Step 7). Does the hazard flasher circuit work? The turn signals and the hazard flasher both use the same bulbs, and the two circuits connect together at the wiring to the bulbs. In the ‘72 - ‘76TR6, this connection takes place at the hazard switch. If the hazard circuit works, you know the turn signal circuit is also operable from this point onward to the lights, so no need to check further than the hazard switch connections. If you’ve gotten this far without finding the trouble, and the hazard circuit works, it’s pretty certain, then, that the problem lies in the wiring from the turn signal switch to this connection, and repairs to this portion of the wiring will be needed. If the hazard flasher circuit doesn’t work, proceed to step 8.

Step 8). With the key on, operate the turn signal switch while monitoring for voltage on the GW wire (for a RH turn) and the GR wire (for a LH turn) at the rear harness connector. If you have voltage, there is a break or a bad connection in the wiring from this point to the lights, or, quite likely, the ground connection to each bulb is bad. Clean or repair as needed. If not, there is a break or bad connection in the wiring between the turn signal switch and the connector, which will need to be repaired.

HAZARD FLASHER CIRCUIT:

ALL MODELS:

The hazard flasher circuit receives power from the “purple” fuse, as do the horns, high beam flash-to-pass, and the courtesy lights. If ***ANY*** of these devices work, you have power to this fuse. If ***NONE*** of them work, you have a problem in the wiring to the “purple” fuse, or the fuse is blown. Repair this problem before proceeding with the following steps.

TR250 - ‘71 TR6:

Step 1). With your hand on the hazard relay, located under the hood next to the fuse box, operate the hazard switch. Does the relay click? If not, go to step 10. If it does, go to step 2.

Step 2). Using a short test lead with alligator clips on each end, jumper from the “purple” fuse to the hazard relay terminal with the Light green/brown wire (should be the C2 terminal, but may be C1 or C4), and operate the hazard switch. Do the lights come on and burn steady? If so, go to step 4. If not, go to step 3.

Step 3). With the jumper from step 2 still in place, and the hazard switch still on, check for voltage on the GW and GR wires at the hazard relay. If you have voltage on these wires, go to step 8. If not, the relay is bad, and must be replaced. Remove the jumper.

Step 4). Remove the jumper from step 2, and, with the hazard switch on, check for voltage on the purple/red wire at the hazard flasher, (located just ahead of the fuse box). If you don’t have voltage here, there is a break or a bad connection in the P/R wire between the flasher and the hazard relay, which will need to be repaired. If you do find voltage here, proceed to step 5.

Step 5). Make a short test lead with ¼" male spade terminals on each end. Remove the wires from the hazard flasher, and insert one end of your test lead into the wire terminal with the P/R wire, and the other end into the wire terminal with the LG/N wire. Operate the hazard switch. Do the lights come on and burn steady? If so, the flasher is bad and must be replaced. If not, leave the jumper in place and proceed to step 6.

Step 6). With the hazard switch still on, and the test lead jumper from step 5 still in place, check for voltage on the LG/N wire at the hazard relay. If you don't have voltage here, there is a break or bad connection in the LG/N wire from the flasher to the relay. If you do have voltage, go to step 7.

Step 7). With the hazard switch still on, and the test lead jumper from step 5 still in place, check for voltage on the GW and GR wires at the hazard relay. If you don't have voltage here, the relay is bad, and must be replaced. If you do have voltage, go to step 8.

Step 8). Do the turn signals work? The turn signals and the hazard flasher both use the same bulbs, and the two circuits connect together at the wiring to the bulbs. In the TR250 - '71 TR6, this connection takes place at the bullet/sleeve connectors where the GW and GR wires from the turn signal switch exits the steering column under the dash. If the turn signals work, you know the hazard circuit is also operable from this point onward to the lights, so no need to check further than the plug/socket connection. If you've gotten this far without finding the trouble, it's pretty certain, then, that the problem lies in the wiring from the hazard switch to this connection, and repairs to this portion of the wiring will be needed. If the turn signals don't work, proceed to step 9

Step 9). With the hazard switch still on and the jumper still in place, check for voltage on the GW wire (for a RH turn) and the GR wire (for a LH turn) at the rear harness connector. If you have voltage, there is a break or a bad connection in the wiring from this point to the lights, or, quite likely, the ground connection to each bulb is bad. Clean or repair as needed. If not, there is a break or bad connection in the wiring between the hazard relay and the connector, which needs repair. Remove the jumper

Step 10). With the hazard switch on, use your voltmeter or test lamp to check for the presence of power at the purple/red wire at the hazard relay. If you have power here, go to step 11. If not, go to step 12.

Step 11). Using a short piece of wire with an alligator clip on each end, connect the relay terminal with the black wire (should be W2, but may be W1), to ground. Turn the hazard switch on, and check to see if the relay clicks. If it does, the black wire to ground is open, or there is a bad connection. Repair as needed. If the relay doesn't click, it is defective, and must be replaced.

Step 12). If you had no power on the P/R wire at the relay, you will need to check for power on the P/R wire at the hazard switch, with the switch on.

To gain access to the hazard switch, it will be necessary to remove either the speedometer or the tachometer. To remove either of these items, first unscrew the drive cable connection at the rear and pull the cable out of the way. Next, remove the illumination and the various indicating lamps. There are two clamps holding the meter in place, and these are held onto two studs at the back of the case by knurled nuts. Remove these two nuts, and any ground wires, and slip the clamps off. The meter can then be pulled out the front of the dash.

If you have power on the P/R wire, go to step 13. If not, there is a break or bad connection in the P/R wire between the relay and the switch, which will need to be repaired.

Step 13). If you had power on the P/R wire, check for the presence of power on the purple wire at the hazard switch. If you have power here, the switch is bad, and must be repaired or replaced. If not, there is a break or a bad connection in the purple wire from the fuse to the switch.

'72 - '76 TR6:

Step 1). Remove the wiring from the hazard flasher (located just in front of the fuse box), and check for the presence of power on the terminal with the purple wire, using your voltmeter or test lamp. If you have power here, go to step 2. If not, there is a break or bad connection in the purple wire from the fuse box to the flasher, which will need to be repaired.

Step 2). Using a short test lead with ¼" male spade terminals on each end, connect the purple and the light green/pink wires together. Do the lights come on and burn steady? If so, the flasher is bad and will need replacement. If not, go to step 3).

Step 3). With the jumper still in place, check for voltage on the LG/K wire at the hazard switch.

To gain access to the hazard switch, it will be necessary to remove either the speedometer or the tachometer. To remove either of these items, first unscrew the drive cable connection at the rear and pull the cable out of the way. Next, remove the illumination and the various indicating lamps. There are two clamps holding the meter in place, and these are held onto two studs at the back of the case by knurled nuts. Remove these two nuts, and any ground wires, and slip the clamps off. The meter can then be pulled out the front of the dash.

If you have power here, go to step 4. If not, there is a break or bad connection in the LG/K wire between the flasher and the switch.

Step 4). With the jumper still in place, check for voltage at the hazard switch on the GW wire (RH bulbs), the GR wire (LH bulbs), and the LG/G wire (hazard warning indicator). If you have voltage on these wires, go to step 5. If not, the hazard switch is bad, and will need to be repaired or replaced.

Step 5). Do the turn signals work? The turn signals and the hazard flasher both use the same bulbs, and the two circuits connect together at the wiring to the bulbs. In the '72 - '76TR6, this connection takes place at the bullet/sleeve connectors where the GW and GR wires form the turns signal switch exits the steering column under the dash. If the turn signals work, you know the hazard circuit is also operable from this point onward to the lights, so no need to check further than these connectors. If you've gotten this far without finding the trouble, it's pretty certain, then, that the problem lies in the wiring from the hazard switch to this connection, and repairs to this portion of the wiring will be needed. If the turn signals don't work, proceed to step 6

Step 6). With the hazard switch still on and the jumper still in place, check for voltage on the GW wire (for a RH turn) and the GR wire (for a LH turn) at the rear harness connector. If you have voltage, there is a break or a bad connection in the wiring from this point to the lights, or, quite likely, the ground connection to each bulb is bad. Clean or repair as needed. If not, there is a break or bad connection in the wiring between the hazard switch and the connector, which will need to be repaired.

EMERGENCY OR TEMPORARY TURN SIGNAL REPAIRS:

If your turn signals are sluggish, or if they come on but don't flash, you can often get them to work again by replacing the turn signal flasher with hazard flasher. Purchase a model 552 flasher from any auto parts store, or most department stores, such as Wal-Mart or K-Mart, and install it in place of the existing Lucas unit. The 552 is a round unit, so it won't fit the stock flasher holder, so you will have to tie it in place with cable ties, or similar. Remember, though, with a hazard flasher, you won't get a warning if one of the bulbs should burn out, so it isn't a good idea to consider this a permanent fix. If you don't know your turn signals aren't working, you won't be as careful as you would be if you did know, so you may put yourself at an increased risk of a tail-ender!

If your turn signals typically fail to blink after you've used your hazard flasher because of dirty contacts in the hazard switch, and you have a TR250 -'71 TR6, you can replace the hazard switch with a DPDT switch from Radio Shack or other electronic supply house. These switches have the advantage of being sealed from the elements, so they won't be as prone to mis-operation as the stock Lucas switch.

Purchase a switch rated for 6 amp or better. If you buy one from an automotive store, make sure it does NOT have a center off position, as do most switches sold there. If you should use a switch with a center off position, in the center position neither the turn signals nor the hazard flasher will work. This is more of a nuisance than a real problem.

Find a suitable location for the switch. I recommend hiding it under the dash where it can be easily reached but out of sight. Of course, this is a personal choice, and if many people drive your car, you might want it in plain view, and maybe even labeled.

Remove the wires from the existing hazard switch, and leave the switch in place for appearance sake. Other wise, you will be faced with the task of filling the hole. The easiest way to access the switch is by removing the tachometer, as described previously in the troubleshooting section. Be sure to disconnect the ground lead from the battery before doing any work under the dash.

Attach extension wires to the existing wires, long enough to reach your new switch. I recommend cutting the terminals from the existing wires, solder the extension wires and insulate the connections with heat shrink tubing. However, if you wish to maintain the option of returning your car to stock sometime in the future, you might choose to use male spade connectors instead. Just be sure to insulate them well, and tie them to a good support so they don't work loose.

Attach the extension wires to the new switch as shown in **figure 15** below. It doesn't matter which way the switch is orientated, nor which LG/N wire goes to which terminal. As long as the back of the switch looks like that shown, it will be right. With the switch in one position, the turn signals will be operable, and in the other position, the hazard flasher will be on. You choose whether you want up or down to be the position for the hazard flasher, and mount the switch accordingly.

Insulate the unused switch terminals. Under certain conditions, these terminals can have 12v on them.

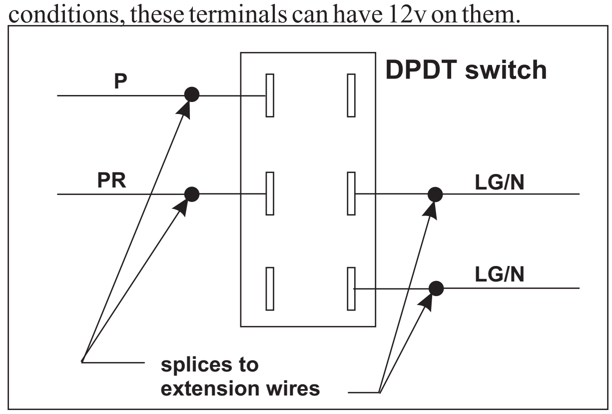



FIGURE 15

Unfortunately, the later models of the TR6 have a wiring arrangement that doesn't lend itself to this fix. Without a major revision to the wiring, you're pretty much stuck with what you've got.

TURN SIGNAL SWITCH REPAIR:

A bit difficult to do, but the turn signal switch can be repaired. Repairing it is not difficult, but a little ingenuity is required to reassemble it after the repairs have been done. As shown in **photo 3**, next page, the moving portion of the switch is held to the fixed portion by a long rivet. This rivet will have to be drilled out to get the switch apart. Once you have it apart, clean the contacts with a pencil eraser or similar abrasive, and reassemble. Use a good electrical grease if you can find it, or assemble dry if not. You should be able to get a good electrical grease from an electrical supply house.

Replacing the rivet will be the tricky part. A long, skinny screw might do, but you will have to peen the threads after putting the nut on to keep it from working loose, or a bit of epoxy or Loctite may work.

**Photo 4** below shows the other side of the switch. You will notice the two cams on the switch (A), and the spring clips next to the cams (B). The cams are operated by a clip on the steering column to return the switch to its normal position after a turn. The clip is shown in **photo 5**.

**Photo 6** shows the turn signal switch in a right turn position. Pressing on the cam in direction A (as the wheel turns to the right) does nothing, but pressing the cam in direction B (as the wheel returns from the right) trips the spring clip, moving it from the notch in the switch (C), and the switch returns to neutral.

**Photo 7** shows a disassembled switch. The wiper arm is a two-pronged affair, and is narrow enough that the two prongs rest entirely on the common segment of the brass plate when in the neutral position. Turning the lever for a right turn causes one of the prongs to contact the right turn segment, while the other prong maintains contact with the comment segment.  The wiper and the brass plate often become very corroded, and a good cleaning will do wonders to restore the switch to operation. Rubbing the contact points with a pencil eraser will often be all that is required (after cleaning out the old grime and grease).

Repairing these items might be  a bit of a challenge, but at least you can see how they work and maybe you can get the switch to return to neutral by adjusting the steering column clip. If not, its good to know just how the darn thing works.

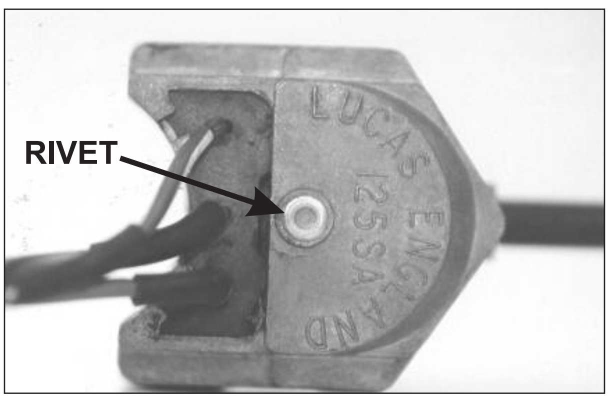



PHOTO 3

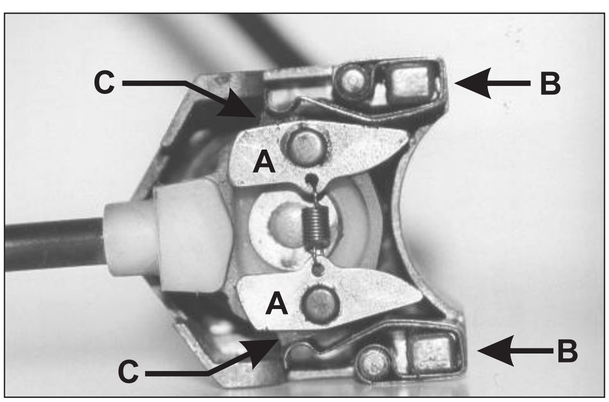



PHOTO 4

PHOTO 5

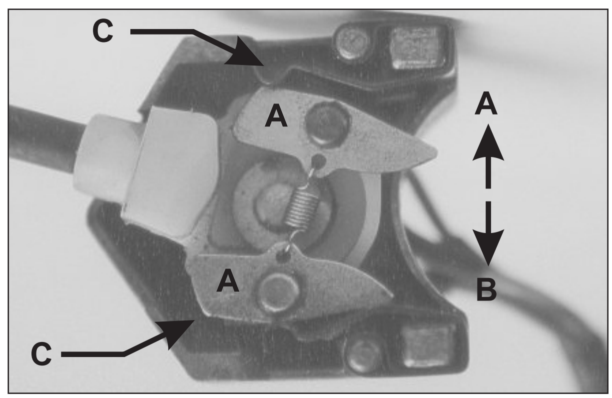



PHOTO 6

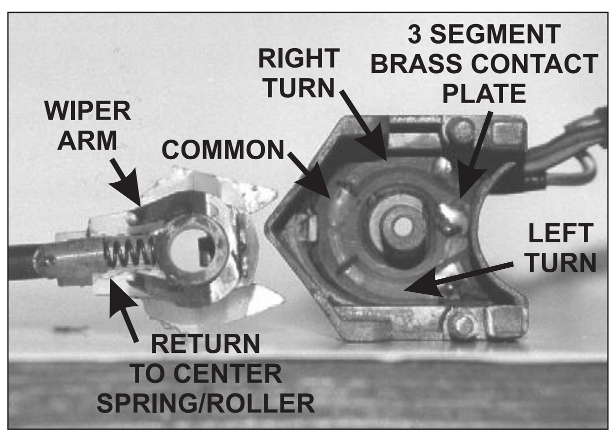


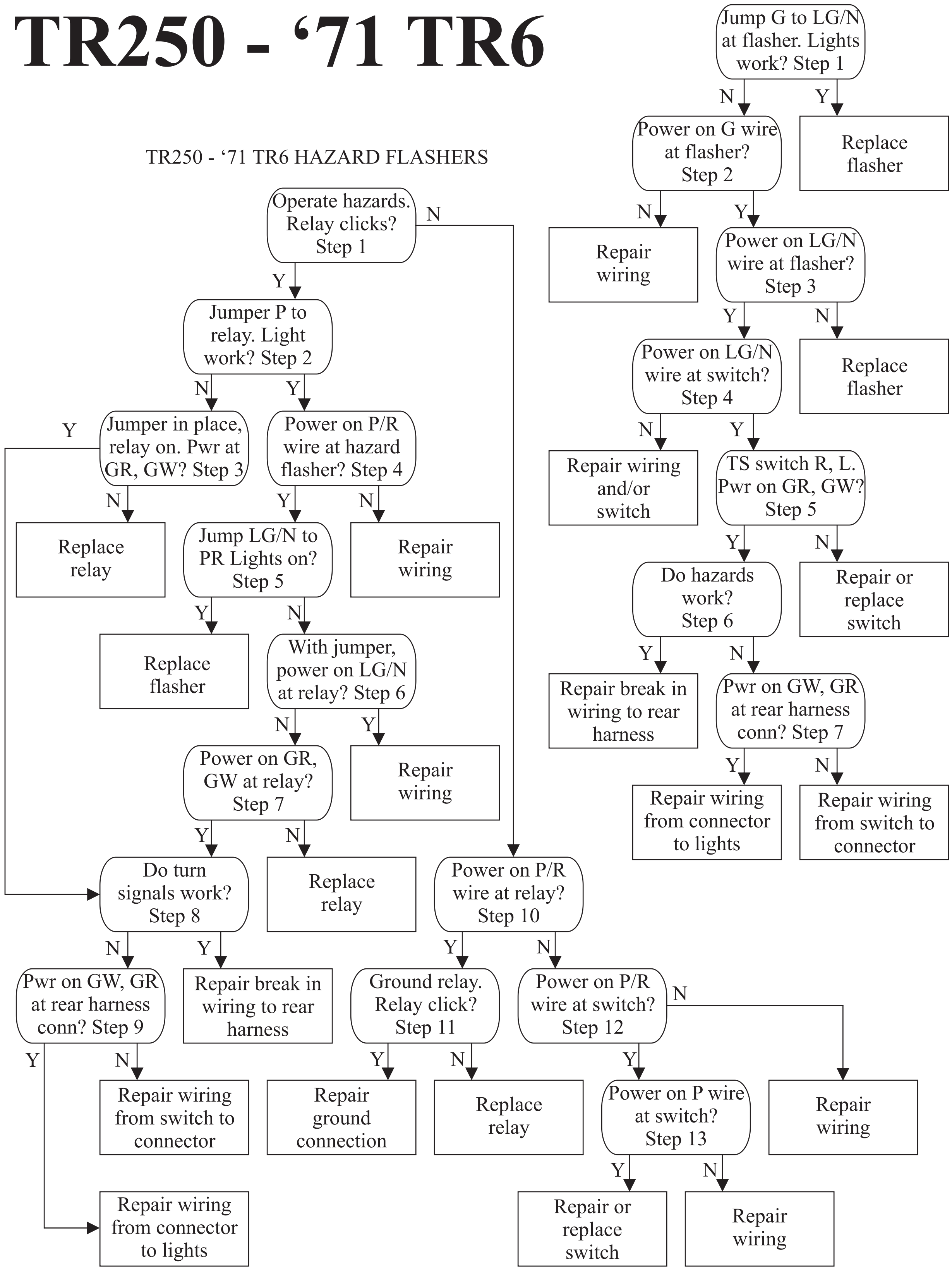

PHOTO 7

TROUBLESHOOTING FLOW DIAGRAMS

# TR250 - '71 TR6

TR250 - '71 TR6 TURN SIGNALS

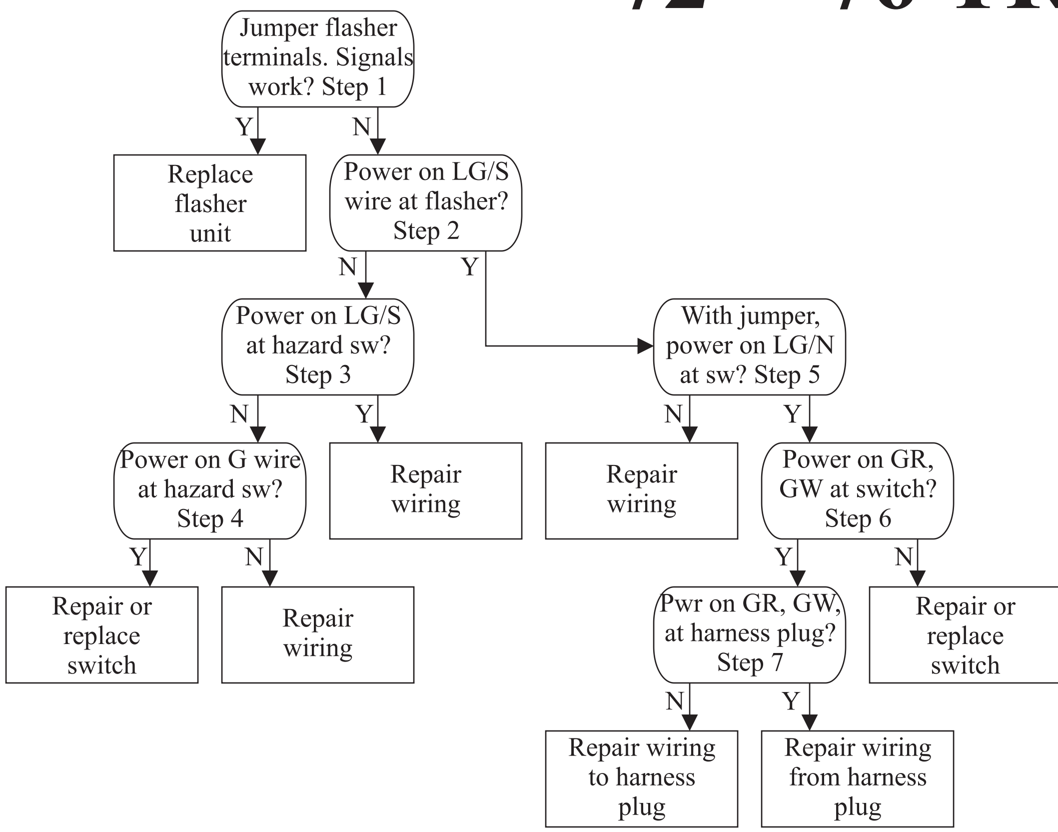
TR250 - '71 TR6 HAZARD FLASHERS



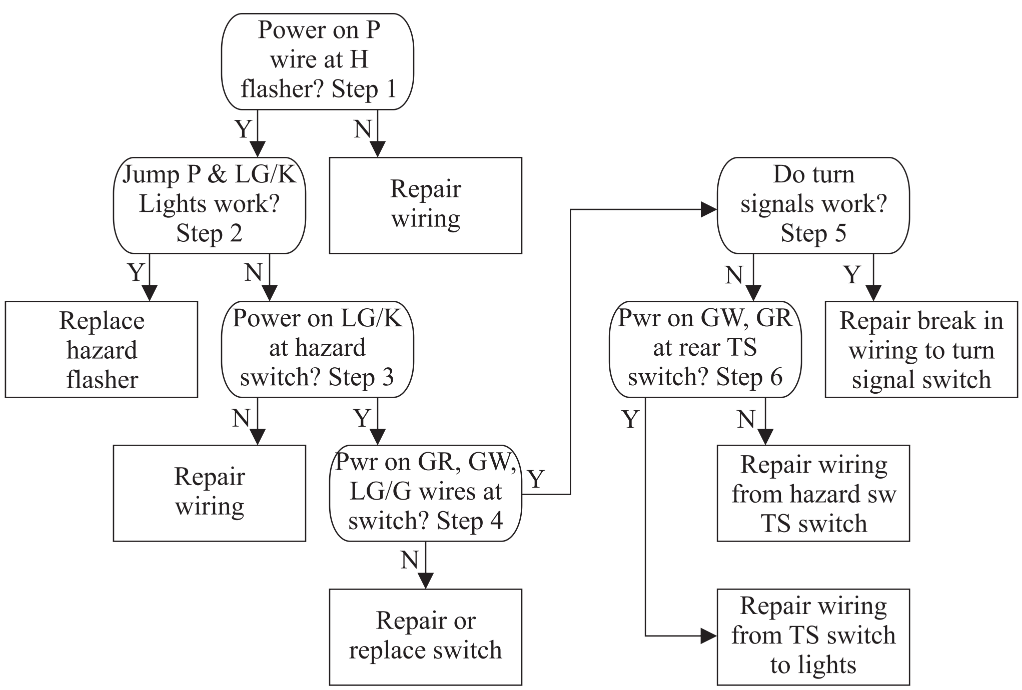
# TROUBLESHOOTING FLOW DIAGRAMS

# ‘72 - ‘76 TR6

‘72 - ‘76 TR6 TURN SIGNALS




‘72 - ‘76 TR6 HAZARD CIRCUIT



# 27
# WINDSHIELD WIPERS AND WASHERS

WINDSHIELD WIPER OPERATION:

There are three major components to a wiper motor assembly, as used in a TR250 or a TR6: the motor, a rotary to linear motion converter mechanism, and a parking switch.

The motor is a 12 volt DC, 2 speed motor, rated at 14 watts. The motor in the TR 250 is an electromagnetic field type, while the motor in the TR6 is a permanent magnet type motor.

The mechanism to convert rotary motion to linear motion is very straight forward, and its functionality is apparent from a visual inspection of a disassembled motor assembly. **Photo 1** below shows this mechanism.

The parking switch in a TR6 is a simple SPST, momentary switch, operated by a cam on the wiper arm drive gear, and is also shown in **photos 2 & 3**, page 137. The TR250 used a metal plate mounted to the housing assembly, and a contact arm mounted on the drive gear. The contact arm makes contact with the metal plate, maintaining a ground connection to the motor, until the wiper arms are in the park position. See **photos 4 & 5**, page 137.

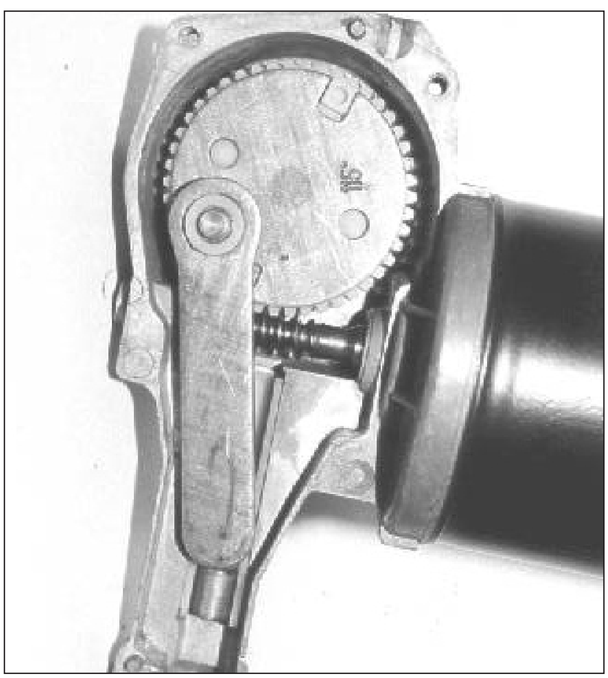


PHOTO 1

WIPER ELECTRICAL CIRCUITS:

TR250:

Power is applied to the wiper motor at all times when the ignition switch is on, and the motor is grounded by the operation of the dash switch. As soon as the wiper blades move to some position other than the park position, the parking switch inside the wiper applies ground to the motor. Thus, when the dash switch is turned off, the motor will continue to operate until the blades reach the park position, the ground is interrupted, and the motor stops

NORMAL OPERATION: Refer to **figure 1** below. With the dash switch in the low speed position, switch terminal "S" is connected to ground, the motor field windings are grounded, and the wipers are operating. The position of the insulated segment with respect to the park switch is immaterial, as the motor is already grounded by the dash switch; if the wipers are not in the park position, the park switch just provides an additional ground path. The current path in this condition is shown by the heavy lines. ***Note:*** the parking switch and insulating plate are not as drawn here. In actuality, the plate is fixed, and the switch contact rotates. It's easier to visualize when drawn this way in a two dimensional representation.

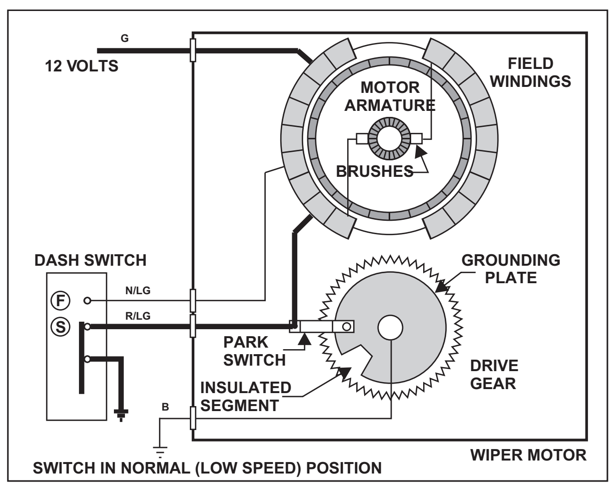



FIGURE 1

HIGH SPEED OPERATION: Refer to **figure 2**, next page. In this mode, both terminal "S" and terminal "F" of the dash switch have been shorted to ground. The wiper switch has actually shorted out a portion of the field winding, reducing the field strength. Though an explanation of why is well beyond the scope of this manual, reducing the field strength actually increases the motor speed. While this seems totally contradictory to common sense, it is true.

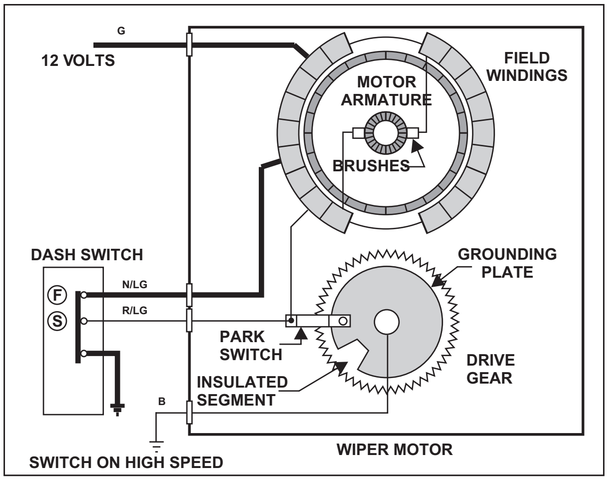



FIGURE 2

WIPERS OFF, BLADES NOT IN THE PARK POSITION: Refer to **figure 3** below. With the dash switch off, the ground path is through the park switch. As long as the wipers are not parked, the motor will continue to run, as if in the low speed position. The current path in this condition is shown by the heavy lines.

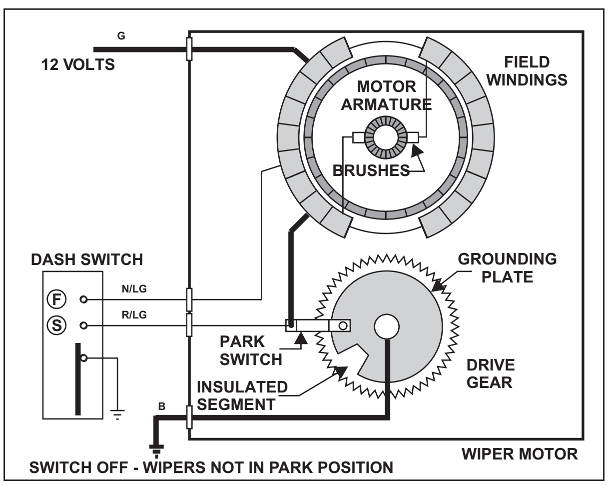



FIGURE 3

WIPER SWITCH OFF, WIPERS IN PARK POSITION. Refer to **figure 4**, top right. With the dash switch off, and the park switch open, there is no ground path for the motor. When the park switch opens, the blade motion stops and the wipers are parked.

TR6:

NORMAL OPERATION: Refer to **figure 5**, right. This diagram is for an early TR6, but the principles are the same for the later models, only the physical configuration of the switch has changed (see **figure 15**). In this mode of operation, the dash switch is in the normal, or low speed, position, and internally, terminal 2 of the switch is connected to terminal 3. Current flows through the motor as shown by the heavy line. The operation of the parking switch has no effect in this mode, as terminal 4 of the dash switch is not connected to any other terminal.

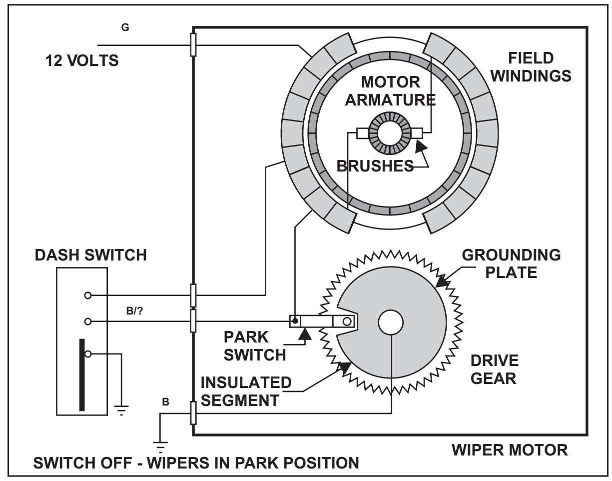



FIGURE 4

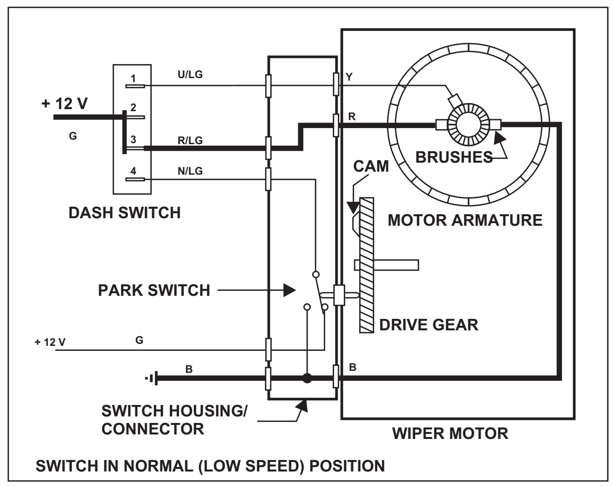



FIGURE 5

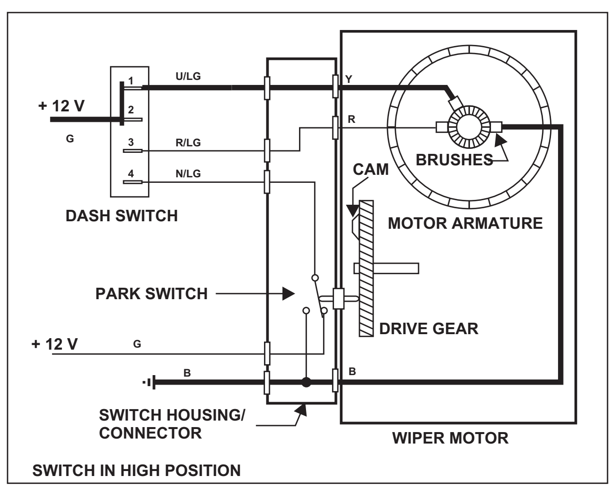



FIGURE 6

B). HIGH SPEED OPERATION: Refer to **figure 6**. In this mode, the dash switch is in the high speed position, and current flow is as shown. This is basically the same configuration as the normal mode, except the power flows through the high speed brush rather than the normal speed brush. Internally, terminal 2 of the dash switch is connected to terminal 1.

C) WIPERS OFF, BLADES NOT IN THE PARKED POSITION: Refer to **figure 7**. With the dash switch off, power is supplied to the motor through the contacts of the parking switch, and the motor continues to operate. Until the drive gear rotates to the point where the cam operates the switch plunger, the motor will operate at the normal, or low speed, just as if the dash switch were still on.

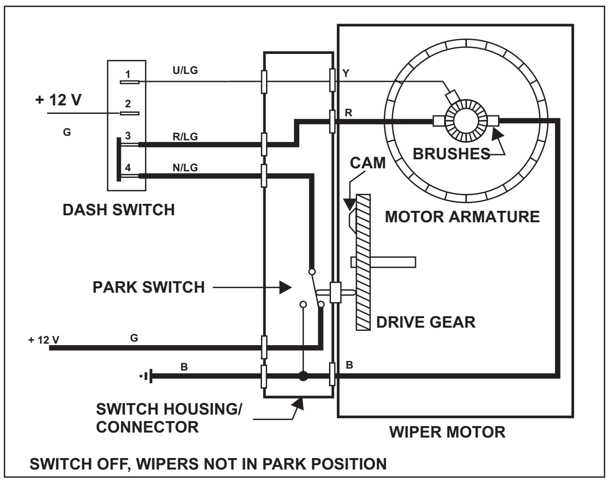



FIGURE 7

D) WIPERS OFF, BLADES IN THE PARKED POSITION: Refer to **figure 8**. When the drive gear has rotated to the point that the blades are in their parked position, the cam button on the drive gear depresses the parking switch plunger, operating the switch. Now, rather than the 12 volts as before, ground is applied to the low speed brush, shorting out the armature windings.

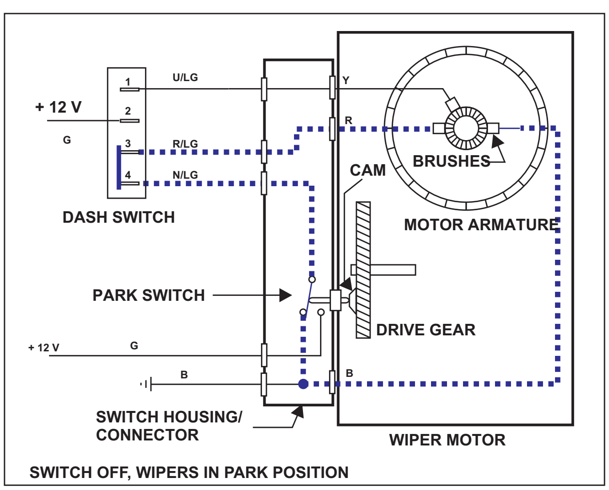



FIGURE 8

The magnetic field that had built up in the windings when 12 volts was applied will now discharge through the switch contacts, in very much the same manner as the operation of the primary windings in the ignition coil.

This discharge current, shown as a heavy dotted line, will be in the opposite direction as the normal current flow, and will tend to reverse the rotation of the motor. Because the windings are now short-circuited, the discharge takes place very quickly, and the reversing energy lasts just long enough to stop the motor. The energy in the discharge is such that the motor will stop immediately! In fact, if you are holding the motor while testing this operation, hold on tight, because it stops so quickly that it will jump out off your hand if you are not careful.

TROUBLE SHOOTING:

TR250:

A) WIPERS DON'T WORK AT ALL:

Step 1) Verify that the problem is electrical, and not mechanical - binding in the wiper wheel boxes, etc., before proceeding with the electrical tests. This may be difficult to do, but, if it is a mechanical problem, you may be able to notice a slight movement, or feel a slight jerk, of the motor and/or the wiper mechanism as the motor tries to operate.

If it is determined to be an electrical problem, the next step is to determine if there is power at the “green” fuse. The windshield wiper receives power from the this fuse, along with the windshield washer, turn signals, gauges, back up lights, brake lights, and heater fan, so if ***ANY*** of these items work, then you have power at the fuse. If ***NONE*** of these items work, then you need to go to the power distribution chapter and resolve the power issue before proceeding. If you have power, then you can proceed with the troubleshooting steps.

Step 2) With the ignition key on, use your voltmeter or a test lamp to check for voltage on the green wire at the wiper motor. If you have voltage, proceed to Step 2. If not, there is a break or a bad connection in the green wire between the wiper motor and the fuse box, which will need to be repaired.

Step 3). With the ignition key still on, use a short piece of wire to ground the red/light green wire at the wiper motor. If the wiper motor operates, go to Step 4. If not, the wiper motor is defective, and you will need to repair or replace it.

Step 4). Locate the R/LG wire at the back of the dash switch for the wipers. Using a short piece of wire, and with the ignition key still on, ground this wire to a good ground point. If the wipers work, the dash switch is defective, or there is a break or bad connection in the black grounding wire to the switch. Go to step 5 . If not, there is a break or a bad connection in the R/LG wire between the switch and the motor, which must be repaired.

B).WIPERS WORK ON ONE SPEED ONLY:

Step 1). With the ignition key on, use a short piece of wire to connect the appropriate from the wiper motor to a good ground. If only the low speed works, ground the terminal with the N/LG wire. If only the high speed works, ground the R/LG wire. If the motor doesn't work in the proper speed when the terminal is grounded, the wiper motor is defective, and will need to be repaired or replaced. If it does work, go to Step 2.

Step 2). Locate the appropriate wire at the back of the dash switch for the wipers - N/LG if for a high speed problem, R/LG for low speed. With the ignition key on, connect this wire to a good ground. If the wiper motor now operates properly, the dash switch is defective, and must be replaced or repaired. If not, there is a break in the wire between the switch and the wiper motor.

C) WIPERS WORK, BUT WON'T PARK:

Step 1). Using a short test lead with alligator clips on each end, connect the wiper motor ground terminal (with the black wire) to a good ground point, and operate the wipers. If the wipers now park the ground connection is faulty, and must be repaired. If not, the parking switch assembly inside the wiper motor is bad, and must be repaired or replaced.

TR6:

A) WIPERS DON'T WORK AT ALL:

Step 1) Verify that the problem is electrical, and not mechanical - binding in the wiper wheel boxes, etc., before proceeding with the electrical tests. This may be difficult to do, but, if it is a mechanical problem, you may be able to notice a slight movement, or feel a slight jerk, of the motor and/or the wiper mechanism as the motor tries to operate.

If it is determined to be an electrical problem, the next step is to determine if there is power at the "green" fuse. The windshield wiper receives power from the this fuse, along with the windshield washer, turn signals, gauges, back up lights, brake lights, and heater fan, so if ***ANY*** of these items work, then you have power at the fuse. If ***NONE*** of these items work, then you need to go to the power distribution chapter and resolve the power issue before proceeding. If you have power, then you can proceed with the troubleshooting steps.

Step 2). With the ignition key on, use your voltmeter or test lamp to determine if there is power available on the green wire at the back of the wiper switch on the dash. If you have power, proceed to step 3. If not, there is a break or a bad connection in the green wire between the wiper switch and the fuse box, which must be repaired.

Step 3). With the ignition key still on, operate the wiper switch to the low speed position, and check for power on the red/light green wire at the back of the switch. If you have power here, proceed to step 4. If not, the wiper switch is bad, and must be repaired or replaced.

Step 4). Remove the plug from the wiper motor. With the ignition key on, turn the wiper switch to the normal position, and check that 12 volts is present at the plug terminal with the R/LG wire. If you have power here, proceed to step 5. If not, there is a break or a bad connection in the R/LG wire between the dash switch and the wiper plug, which must be repaired.

Step 5). With the plug still off the wiper motor, check for ground continuity on the black wire. If you are using a voltmeter, wedge the positive voltmeter lead between the positive battery post and the cable clamp, and touch the tip of the negative lead to the black wire in the plug, if there is ground continuity, you will read battery voltage on the meter. If you are using a test lamp, fasten the alligator clip on the test lead to the positive battery post, and touch the tip of the lamp to the black wire in the plug. If the ground connection is satisfactory, the lamp will light.

If the ground connection proves to be good, then your wiper motor will have to be repaired or replaced. If the ground connection is faulty, there is a break or bad connection in the black wire somewhere that will need to be repaired.

B) WIPERS WORK ON ONE SPEED ONLY:

Step 1). Remove the electrical plug from the wiper motor, turn the ignition key on, and turn the wiper switch to the speed position for the speed that is not working. Using a voltmeter or a test lamp, check for voltage on the appropriate wire in the plug -- R/LG for low speed, U/LG for high speed. If you have voltage here, the problem is inside the wiper motor, which will need to be repaired or replaced. If not, go to step 2.

Step 2). Replace the wiper plug, keep the ignition key on, and the wiper switch in the position for the non-working speed. Locate the appropriate wire at the back of the wiper switch, and check for the presence of voltage on this wire. If you have voltage, there is a break or a bad connection in this wire, between the switch and the wiper plug. If not, the switch is bad.

C) WIPERS WORK, BUT WON'T PARK:

Step 1). Remove the electrical plug from the wiper motor and turn the ignition key on. Using a voltmeter or a test lamp, check for presence of voltage on the green wire. If you have voltage here, proceed to step 2. If not, there is a break or a bad connection in the green wire circuit between the wiper motor and the fuse, which will need to be repaired.

Step 2) Replace the plug and turn the dash switch to either the normal or the high-speed position. Using a voltmeter or a test lamp, check for voltage on the brown/light green wire. Voltage should be present at all times EXCEPT when the wiper blades are in their normal park position. That is, the voltage should turn off as the blades pass through the park position, and turn back on again as the blades leave the park position. There should be a long on, followed be a short off, long on, short off, etc. It may be difficult to measure the voltage on this wire. You may need to use a fine needle to pierce the insulation, and check the voltage at the needle. If you have the on-off voltage on this wire, proceed to step 3. If not, the park switch is not operating properly and will need to be replaced, or the grease has hardened inside the motor, not allowing the plunger to release as it should. You may be able to repair this switch, but it will be a lot more difficult than the other switches. If it's a plunger problem, cleaning is quite simple. All of the old grease should be removed from the gear housing and replaced.

Step 3). Locate the N/LG wire at the dash switch for the wipers, and repeat the tests in step 2. You should see the same on-off voltage action here as well. If not, there is a break in the N/LG wire between the wiper motor and the switch. If you do have the correct voltage here, the dash switch is bad, and will need to be repaired or replaced.

WIPER MOTOR REPAIR:

If the above tests show that the wiper motor assembly is faulty, either the motor itself or the parking switch, repairs are often possible. There are three electrical components to consider - parking switch, brushes, and the armature.

PARKING SWITCH: New parking switches for the TR6 are readily available at a reasonable price. This switch is a sealed unit, and would be quite difficult to get apart to repair, so a replacement would be the best choice here. To remove the switch, slide it away from the motor to release the clip, shown in **photo 2** below, or, remove the two securing screws as shown in **photo 3,** top right, depending on how your particular model is made.

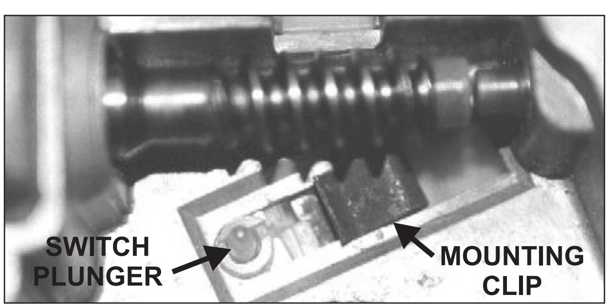



PHOTO 2

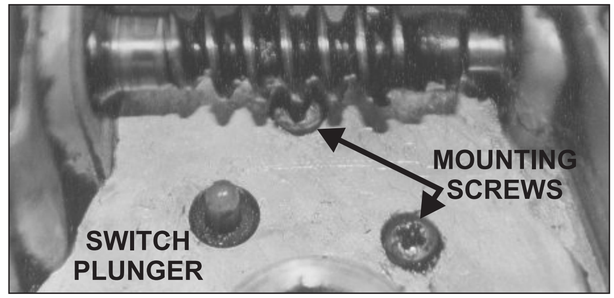



PHOTO 3

This switch (grounding contact) is no longer available for the TR250, but it should be fairly easy to make one. See **figures 4 & 5** below for details.

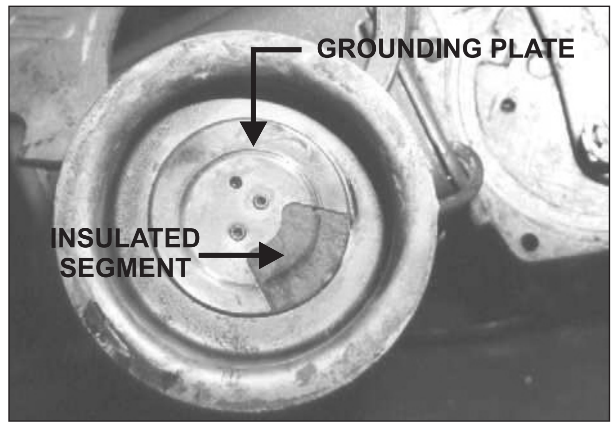



PHOTO 4

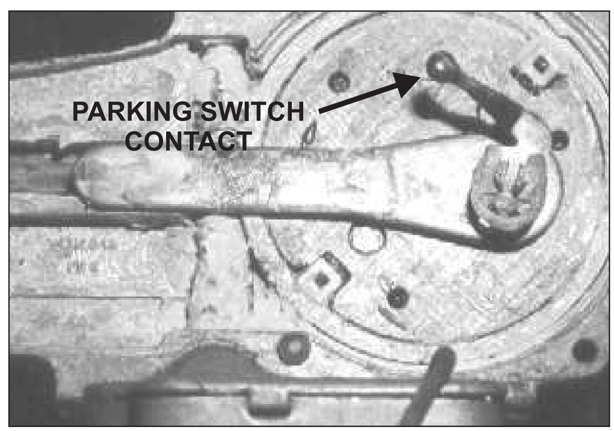



PHOTO 5

BRUSHES: examine the brushes, shown in **photos 6 & 7**, next page, for signs of excessive wear or other damage. If the are worn out or broken, new brush assemblies are also available, and at a reasonable price. Removal and replacement of the brushes is a straight forward operation, and will be obvious from an examination of the unit.

ARMATURE: inspect the commutator rings, **photo 8**, next page, for signs of damage. If they are scored, you may be able to salvage them by polishing the scoring out with fine emery cloth.
Inspect the armature winding, and the winding

connections to the commutator for signs of damage. Chances are, if there is any damage, you will have to replace the armature, but it may be possible to make repairs if the damage isn't too bad. Of course, if you really want to, you can buy the proper wire from a motor repair store, and rewind the armature, making sure to make the windings exactly as original, Check with your motor repair shop for the correct type and size of wire to use, showing them your old armature as a guide.

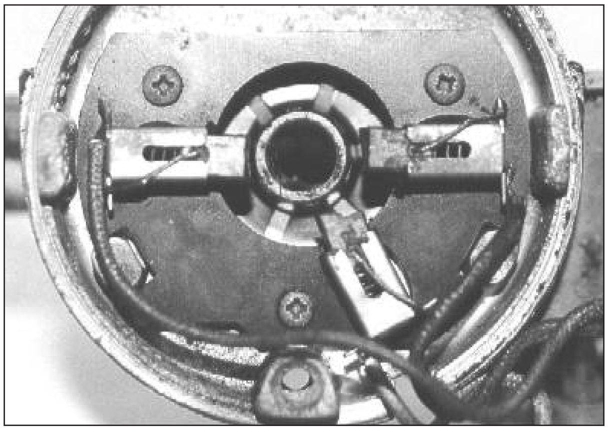


PHOTO 6

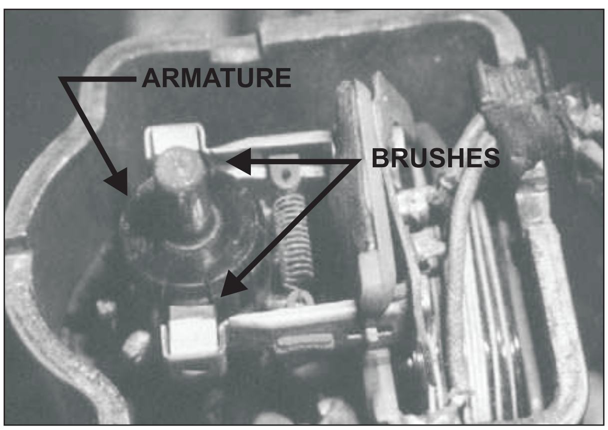



PHOTO 7

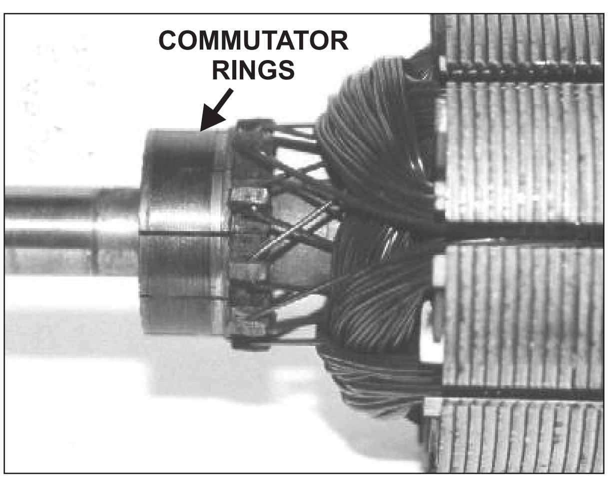



PHOTO 8

When you reassemble the unit, make sure to put a small drop of oil on the end of the armature shaft that goes into the small felt bearing at the bottom of the motor housing, and liberally grease the drive gears and the wiper linkage with a good grade of grease.

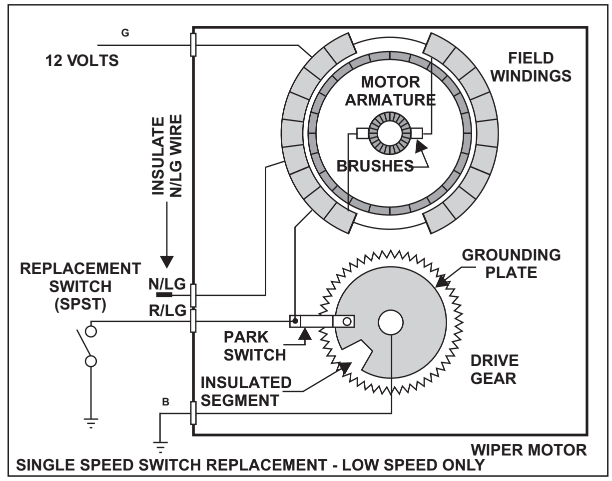



FIGURE 9

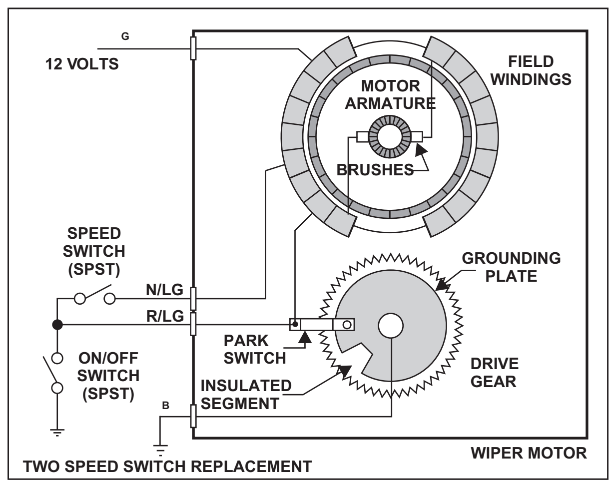



FIGURE 10

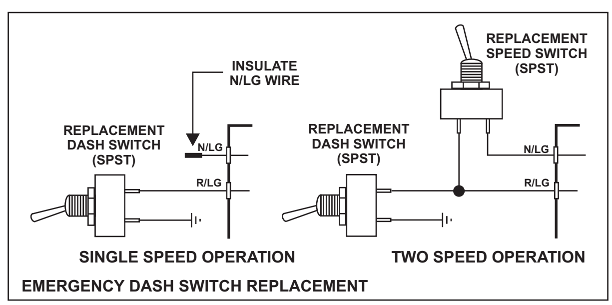



FIGURE 11

EMERGENCY SWITCH REPLACEMENT:

If it turns out that your wiper switch is defective, and is beyond repair, you may want to rig up an emergency repair. If so, follow the diagrams in **figures 9 through 14** , above and belowbelow. You will be using the existing wiring, so wire sizing is not a concern, but make sure the switches are rated at least 10 amp. For the SPDT switch used for the TR6, don't use the typical switch as found in most auto parts stores, as these nearly always have a "center off" position, i.e., ON-OFF-ON. The switch required for this application has only two positions: ON-OFF. If you should use one of the ON-OFF-ON type, it will work, but you will need to pass through the center OFF position when switching the wipers on or off. With the switch in the OFF position, neither the motor nor the park function will work.

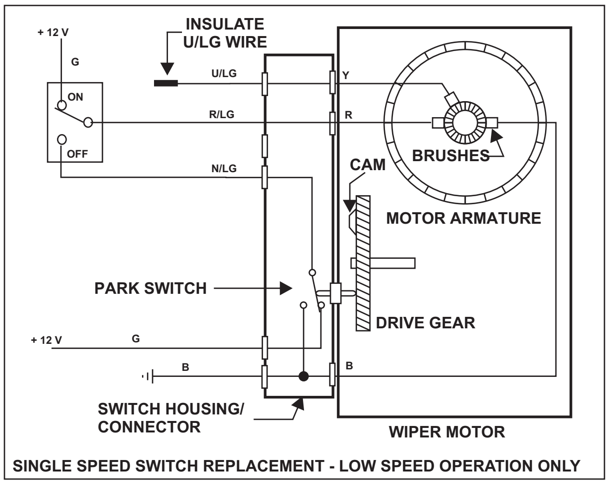



FIGURE 12

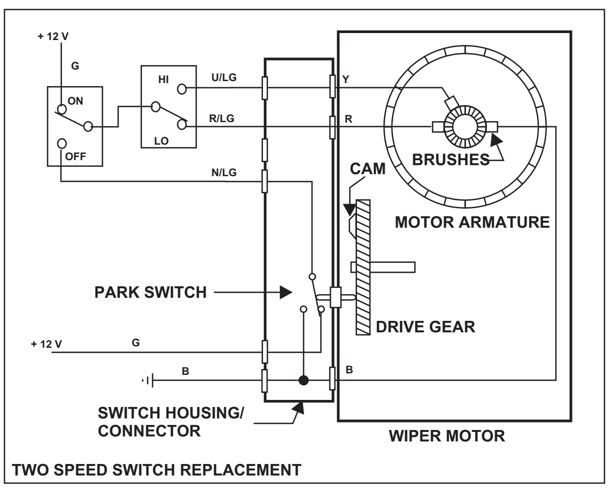



FIGURE 13

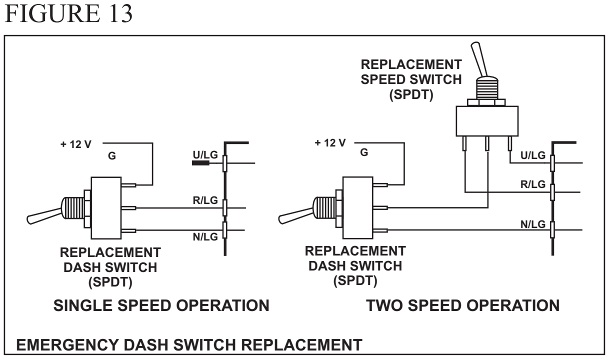



FIGURE 14

CONVERTING FROM RH TO LH OPERATION (OR VICE VERSA):

TR6: If you have a wiper motor from a RH drive car, converting it to park for LH drive is quite easy, and takes only a few moments. Refer to **photo 9** below. After you've removed the plastic drive gear, use a small screwdriver to pry the parking switch cam out, and replace it in the two holes on the opposite side of the gear. The wipers will now park on the correct side of the car.

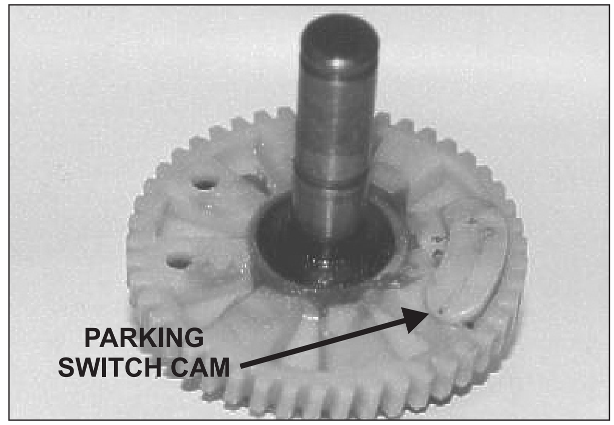



PHOTO 9

TR250: Resetting the parking position on a TR250 couldn't be any easier. Just loosen the cover and rotate the hat 180 degrees and re-tighten the cover. See photo 10 below for details.

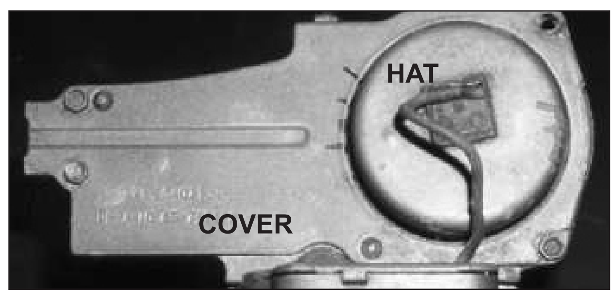



PHOTO 10

USING A WIPER MOTOR FROM ANOTHER MAKE:

For the most part, a Lucas wiper motor from another make will work quite well in a TR250/TR6. If you have an un-repairable wiper motor, you might just be able to use an MGB motor, as an example. The biggest difference between a Triumph motor and the MGB motor is the "sweep" range of the wiper blades. On a TR250/TR6, the blades sweep through a 115º range, while on the MGBGT, they sweep through a 105º degree range. I'm not sure what the range is on an MG Roadster, but whatever it is, the same situation exists. Notice the degree markings on the two gears in **photo 11** next page. Just swap the 115º TR 250/TR6 gear into the MGB unit, and you're done.

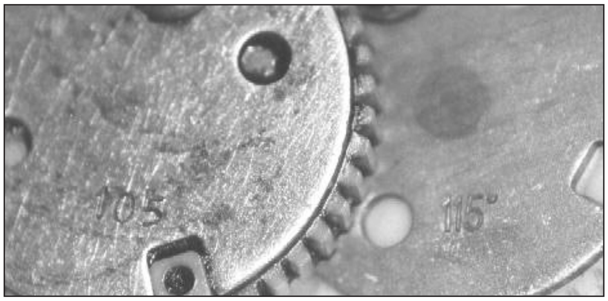



PHOTO 11

WINDSHIELD WASHER:

The windshield wiper circuit is quite simple, consisting of nothing more than a simple momentary, SPST switch, and the washer motor - push the switch and the washer motor operates, release the switch, and it quits. See **figure 15** below for wiring details.

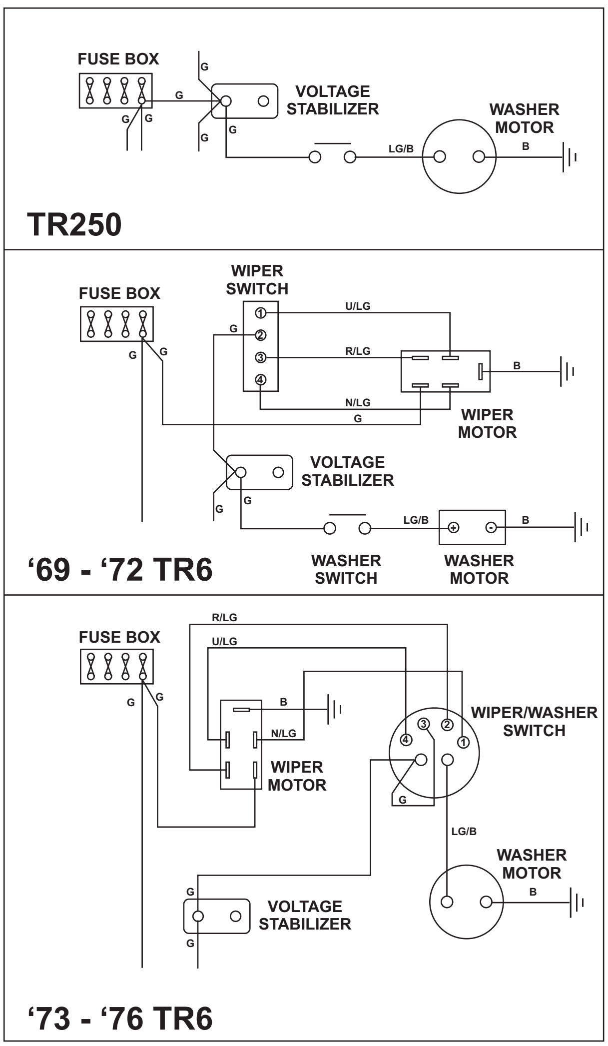



FIGURE 15

TROUBLESHOOTING:

The windshield washer motor gets its power from the "green" fuse, same as the wipers. Before proceeding with the washer troubleshooting steps, ensure that power is available at the green fuse. Refer to the wiper troubleshooting instructions for more info on checking for power at this fuse.

Step 1). With the ignition key on, have someone operate the washer switch while you monitor the light green/black wire at the washer motor. Using your voltmeter or test lamp, you should see 12 volts on this wire when the switch is operated. If you have power here, proceed to step 2. If not, proceed to step 3.

Step 2). Using a short piece of wire, jumper from the motor terminal with the black wire to a good ground. If the motor now operates, you have a break or a bad connection in the ground wire, which will need to be repaired. If not, the motor is bad and will need repair or replacement.

Step3). If you did not have power on the LG/B wire at the motor, locate the same wire at the back of the dash switch, and check for voltage there. With the key on, you should have 12 volts here when the switch is operated. If you don't proceed to step 4. If you have voltage, there is a break or bad connection in the LG/B wire between the switch and the washer motor.

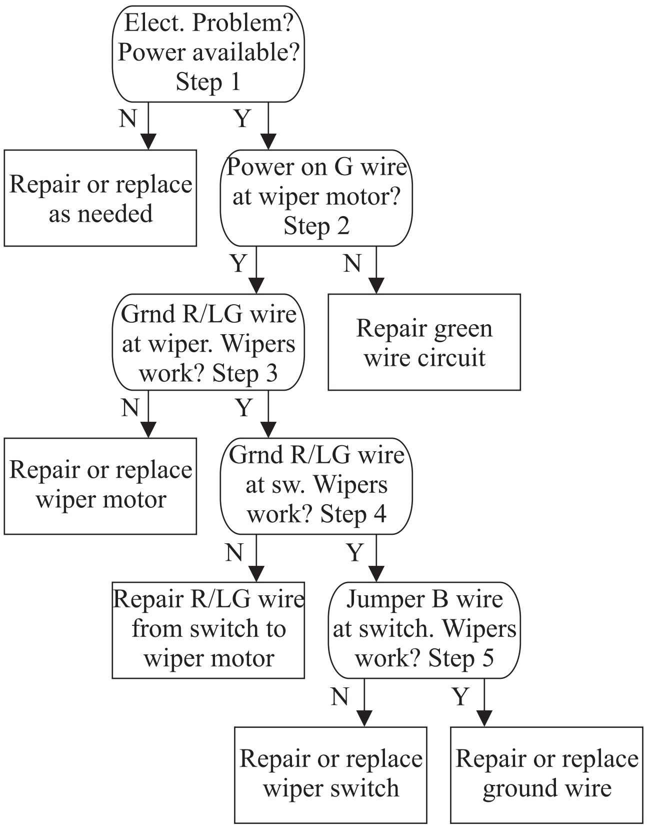
Step 4). With the key still on, check for 12 volts on the green wire at the switch. If you have voltage here, the washer switch is bad, and must be repaired or replaced. If not, there is a break or bad connection in the green wire.

***Note:*** if you have a '73 -'76 model, and the wipers work, you have power on the green wire at the combined wiper/washer switch, but the short jumper between the two sections of the switch is your problem. It is either loose, or there is a bad connection at the switch. This bit of knowledge might reduce the amount of searching required to find the problem with the green wire.

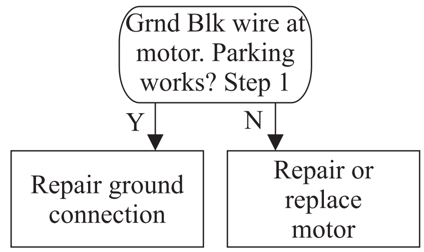
# TROUBLESHOOTING FLOW DIAGRAMS

# TR250

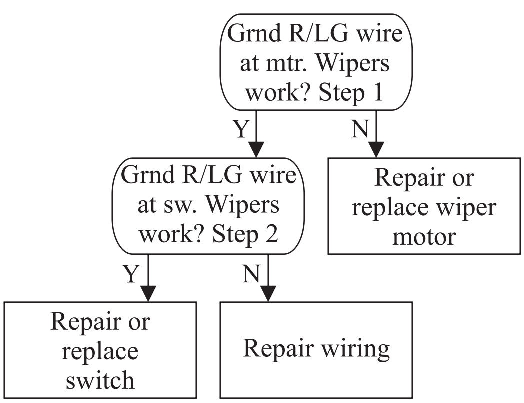
## WIPERS DON'T WORK AT ALL



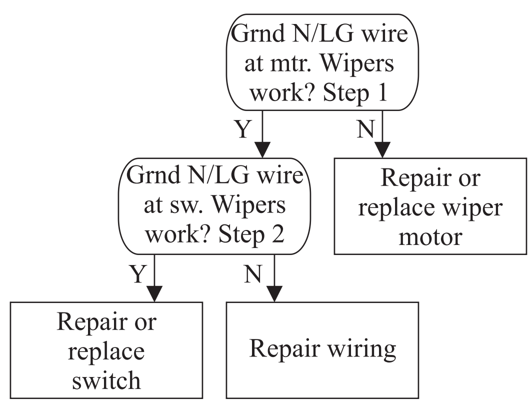

## WIPERS WORK, BUT DON'T PARK




## WIPER WORK ONLY WITH SWITCH IN LOW SPEED POSITION



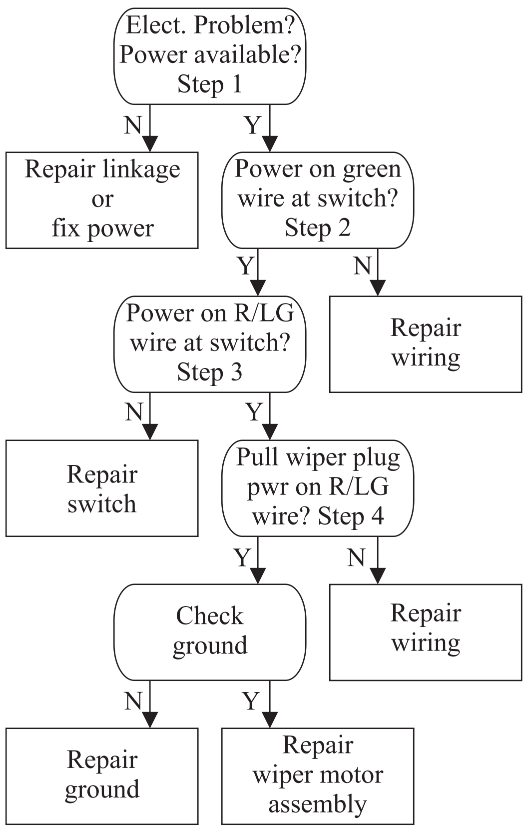

## WIPER WORK ONLY WITH SWITCH IN HIGH SPEED POSITION



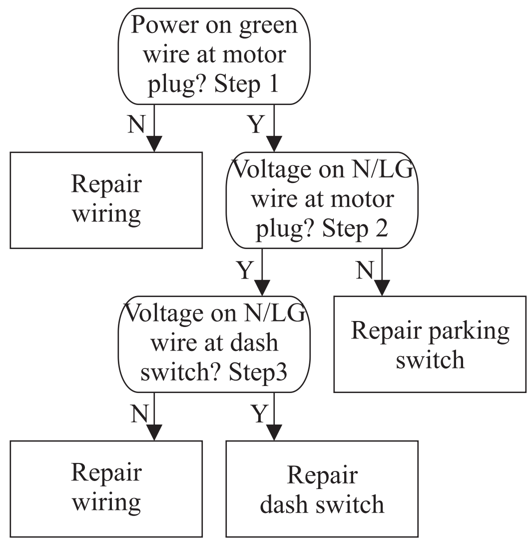
TROUBLESHOOTING FLOW DIAGRAMS

# TR6

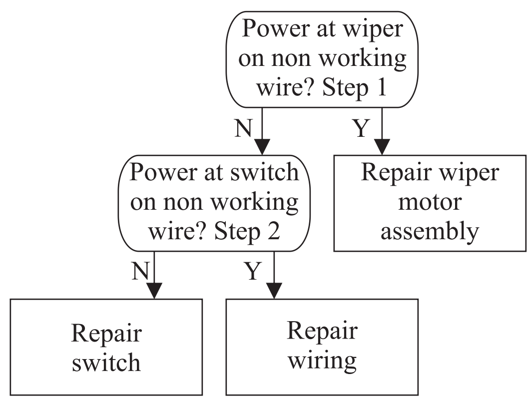
## WIPERS DON'T WORK AT ALL



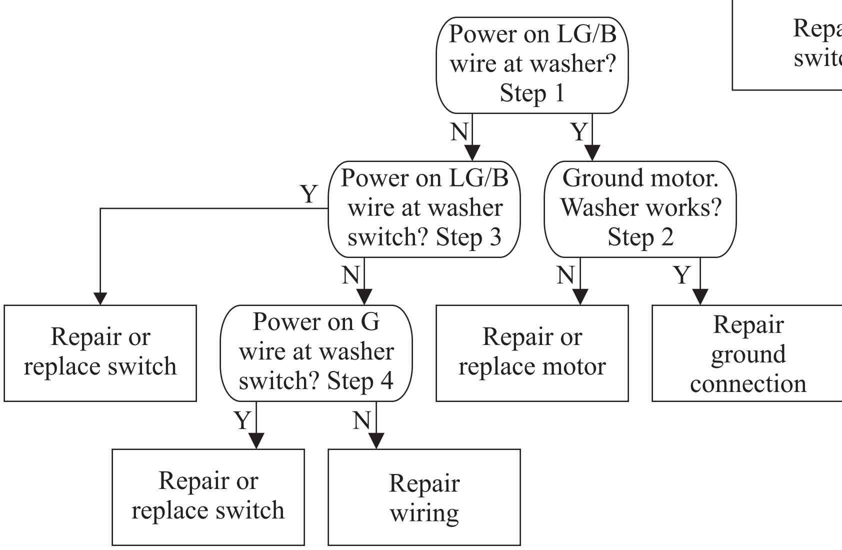

## WIPERS WORK, BUT DON'T PARK




## WIPERS WORK ON ONE SPEED ONLY




## WINDSHIELD WASHER



# 28
# ADDING AIR HORNS

ADDING AIR HORNS, SWITCH SELECTABLE

The following material describes a method of adding air powered horns to your car, while still retaining the original horns. This gives you the option of using your original horns around town, while having the louder air horns available when circumstances warrant it. With the selector switch in one position, your original horns operate when you push the horn button in the steering wheel; in the other position, the air horns operate. I recommend keeping the switch in the “air horn” position in normal usage, as you won’t have time to switch in an emergency. If you are only wanting to get someone’s attention, you can then switch to the standard horns.

Two sets of instructions are given - one for cars that already have a horn relay to operate the existing horns, and one for cars that operate the horns directly from the horn pushbutton, without a relay. To determine the setup for your particular car, refer to chapter 18, Horn Circuit.

A: IF YOUR CAR HAS A HORN RELAY

Refer to the schematic diagram below, **figure 1**, for wiring details.

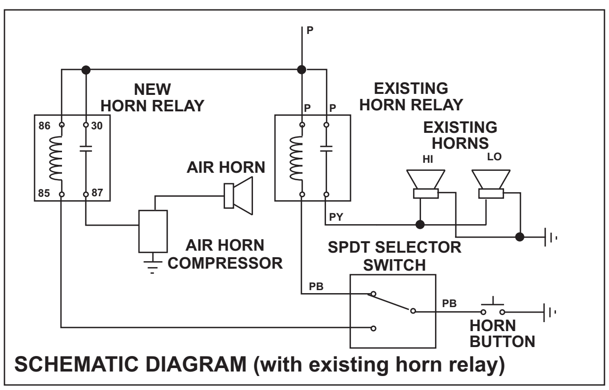



FIGURE 1

MATERIALS REQUIRED:

<u>SPDT switch</u>. These can be found at most Home Depot, Lowes, or similar stores, but they won't have the typical "car" look. If you can't find a SPDT switch that looks like you want, you can use half of a DPDT switch, which are readily available at most automotive supply stores. Just be sure NOT to get one with a "center off" position -- most of those sold in an auto parts store are of this type, so use care when buying. If you use a switch with a center-off position, neither horn will work if the switch is in the center position. Contact rating is not a concern, as this switch will only be switching the relay coils -- less than ½ amp.

<u>Relay.</u> A simple SPST relay, readily available in most auto parts store. Current ratings on these are usually 30 amps, which is more than adequate. Often, the relay is included with the air horns, especially if you buy a kit.

<u>Miscellaneous wire</u>. Wire size from the switch to the new relay is not important, as the relays are low current. The wire from the new relay to the horns, and from the relay to the power source, should be 14 gauge at least, unless the maker of the horn recommends larger. The remainder of the wire can be as small as 16 gauge with no problems.

PROCEDURES:

Mount the air horn and its compressor per the manufacturer’s instructions.

Mount the relay in a convenient location. I recommend putting it next to the existing relays located near the fuse box, using one of the relay mounting screws to hold it. If you use a relay with a metal mounting tab, you can bend the tab 90º and the relay will be almost invisible. See **photo 1** below for an example. If you mount the relay here, you can pick up a purple wire at the fuse box, or perhaps at one of the relays.

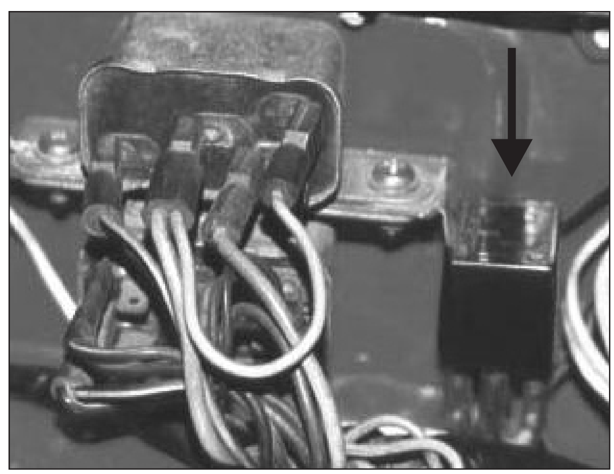


PHOTO 1

Install the selector switch in a location that is easily reachable by the driver. The dash support is a good location for the switch if you want it to be visible. If you prefer to maintain originality, you can make a metal bracket with a hole for the switch, and mount the bracket to one of the holes in the bottom lip of the dash.

Wire pins 30 and 86 of the new relay together, and connect them to the nearest purple wire, using at least 14 gauge wire. Refer to **figure 2**, for physical wiring details.

Wiring to the relay must be as shown. Orientation of the switch is not important, as long as the wiring looks like that shown. Wired one way, the switch toggle will be "up" for the existing horns, and "down" for the new horn. Wired the other way, the switch function will be just the opposite. The switch can be turned after wiring to make "up" and "down" functions as you wish.

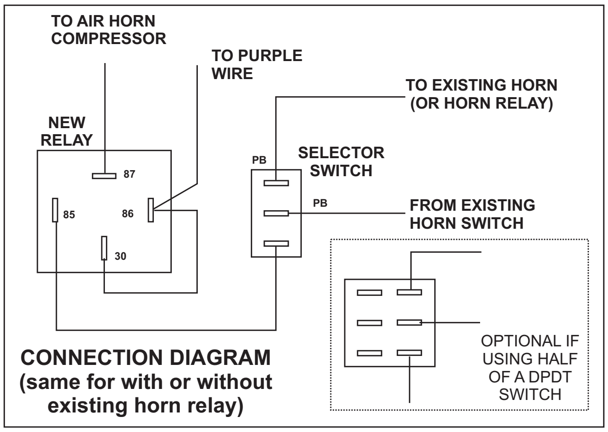



FIGURE 2

Run a wire from pin 85 of the new relay to the selector switch, using 16 gauge wire.

Run a wire from pin 87 of the new relay to the power input terminal on the horn compressor, using 14 gauge wire minimum. Ground the compressor, using either its mounting screws or a short piece of 14 gauge wire, depending on its construction.

The horn push button wire (purple/black) runs from the steering column to a bullet/sleeve connector just under the dash, adjacent to the column, and from here to the existing horn relay. Disconnect this bullet/sleeve connector from both of the purple/black wires. Splice extension wires to each of these, using crimp or solder terminals, or lineman's splices and heat shrink tubing, and route the extensions to the selector switch, per the diagram above.

Use care when running the new wires, making sure that they do not come into contact with sharp edges, or rub against a moving component. As much as practical, follow the routing of the existing wire harness, making liberal usage of cable ties.

B: IF YOUR CAR DOES NOT HAVE A HORN RELAY

Refer to **figure 3**, above right, for the schematic, and **figure 2**, above, for wiring details.

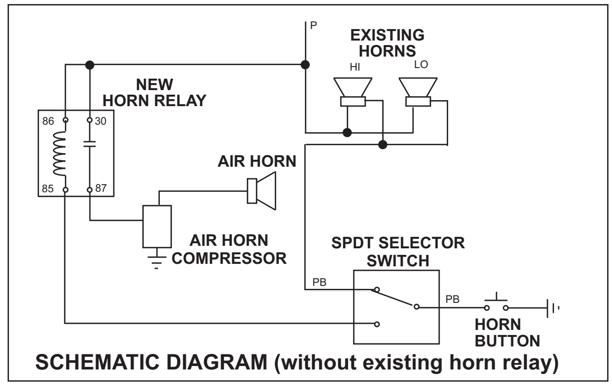



FIGURE 3

MATERIALS and PROCEDURES

These are the same as above for the "with relay" installation, except for the current rating of the selector switch. This switch will have to carry the full current of the existing horns when they are selected, so it will have to be rated accordingly. 10 amps should be sufficient, as long as you don't operate the switch while the existing horns are actually blowing.

STAND ALONE AIR HORNS

You may wish to add a set of air horns using a separate switch from the factory horn switch. This would allow you to toot the horn of your choice without having to preselect it. Hit the horn push button in the center of the steering wheel, and the factory horns sound; hit another switch, and the air horns sound.

To install air horns using this scheme, refer to the schematic and connections diagrams in **figure 4**, below.

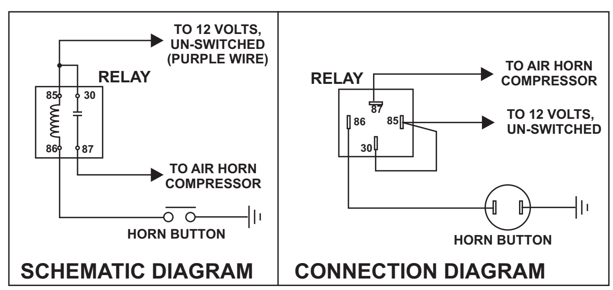



FIGURE 4

MATERIALS AND PROCEDURES

The materials and procedures for this installation are very similar to the instructions for the previous circuits.

The wire from terminal 86 of the relay to the horn button can be just about any size, as this wire only carries the load of the relay coil, and it is switched to ground. A short on this wire will just cause the horn to blow, but will not cause a fire hazard.

The other wires carry the full load of the horns, and should be sized according to the manufacturer's directions - at least 14 gauge.

HORN REPLACEMENT

You might just want to do away with the stock horns altogether, and just use a set of air horns instead. This would make life a bit simpler, as you would only have one button to be concerned with.

A: IF YOUR CAR HAS A HORN RELAY

In this case, the horn relay is already mounted for you, so all that is required is to reroute the purple/yellow wire from the relay to the new air horn compressor. The horn on the left side of the car will have two P/Y wires, while the horn on the right side will have only one. The second wire on the left side is the wire that goes to the right side horn. See **figure 5**, below, for more information.

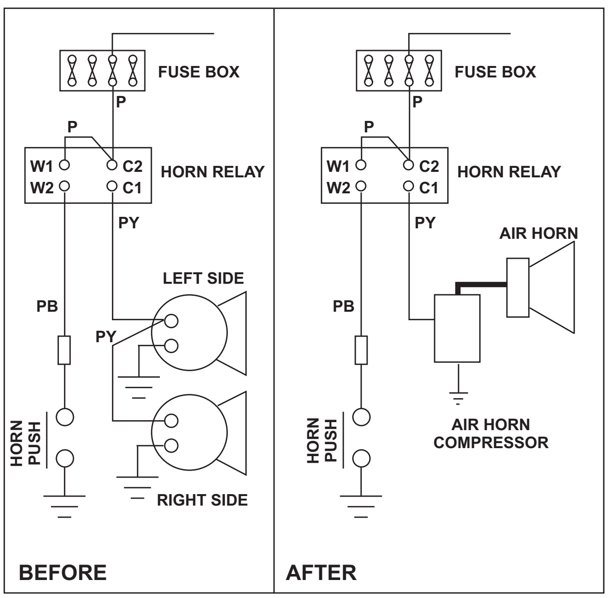



FIGURE 5

Disconnect the P/Y wires from the left side horn and separate them if necessary (depending on the particular model of horn your car has). Connect a voltmeter or a test lamp to one of the leads while someone presses the horn button. If you have voltage, this is the wire from the relay; if not, it is the wire to the right side horn.

Once you have identified the correct wire from the relay, reroute this wire to the positive terminal of the air compressor for your new horns. Depending on where you mount the compressor, you may have to splice an extension wire onto this wire. The wire from the left side horn to the right side is now a dead wire, and can be simply left in place. If the ends of the wire hanging from the harness are very long, you may want to tie them up out of the way, and, just to prevent possible confusion in the future, you may want to put insulated terminals on them. Ten years from now, long after you've forgotten the installation details, seeing bare wire connectors hanging about may give you a bit of needless concern. The existing horns may be removed or just left in place (if you leave them in place, you can also just leave the crossover wire connected).

If your air horn compressor doesn't draw excessive current, over 15 Amps or so, you can get by with the existing wiring. If you should, however, use a heavy duty compressor, drawing much more than 15 Amps, you will need to upgrade the wiring. In this case, use a short piece of wire (14ga minimum) with ¼" female spade terminals on each end to jumper from the brown wire on the "purple" fuse to the spare fuse position in the fuse box. Run a 14 gauge minimum wire from this fuse to the relay, and bypass the purple/yellow wire to the old horns in the harness with a 14 gauge or larger wire. Route the wire from the relay to the compressor very carefully, following the routing of the existing harness as much as possible, and support it liberally with cable ties

B: IF YOUR CAR DOES NOT HAVE A HORN RELAY

Because the related wiring is tied up in the wiring harness, with no convenient way to get to it, I recommend placing the relay up front near the existing horn location. The horn on the left side of the car will have two purple and two purple/black wires, while the horn on the right side will have only one of each. The second wire of each pair on the left side is the wire that goes to the right side horn. See **figure 6**, below, for more information.

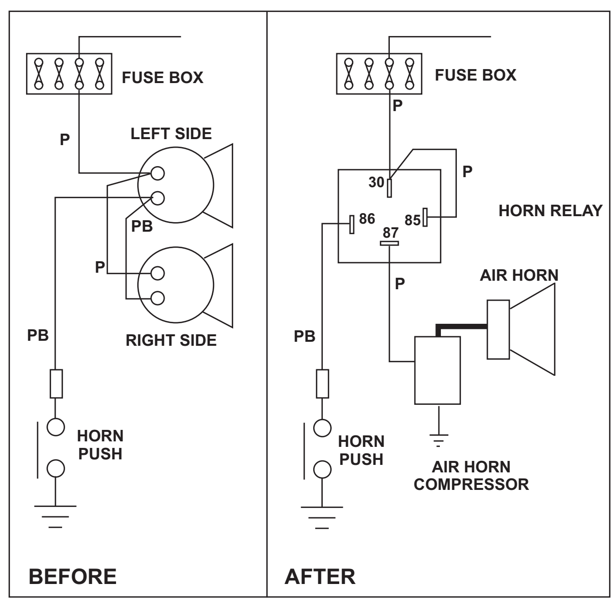



FIGURE 6

Remove the purple wires from the left side horn and separate them if necessary, depending on the model of horn in your car. Use caution, as the purple wires are hot at all times, key on or off, and you will need to have the battery connected for the next step. Using a voltmeter or a test lamp, determine which of the two purple wires has voltage. The one with voltage on it is the wire from the fuse box, and the other wire is the crossover connector to the right side horn. Once you have identified the wires, I recommend removing the negative battery cable for safety sake, as you will be moving several wires that may be hot.

Next, you will need to identify which of the purple/black wires is the one coming from the horn pushbutton. Probably the best way to do this is to disconnect the purple black wire from the right side horn as well, and use an ohmmeter or continuity checker. The two horns are close enough together that this is a one man operation, and no helper is needed.

Once you have identified these two wires, the two right/left crossover wires can be attended to. After these two wires have been disconnected from the left side horn, they are dead wires, and can be simply left in place if you wish, or, if you are leaving the stock horn in place, they can remain terminated on the horns as found. If you remove the horns, I recommend putting insulated connectors on the wires, and tying them out of the way, especially if the ends are very long. As stated above, ten years from now, after you've forgotten the installation details, it may be a bit disconcerting to see bare wire connections flopping around.

Reroute the purple and the purple/black wire from the left side horn to the horn relay, as shown in **figure 6**, previous page. Depending on where you mounted the relay, you may need to splice extension wires to reach the relay. Connect the purple wire to terminal 30, and connect a short jumper wire from terminal 30 to terminal 85. Connect the purple/black wire to terminal 86.

Run a 14 gauge wire from relay terminal 87 to the air compressor for the air horns, and ground the compressor with a 14 gauge wire.

If you are using a high powered air horn, one that uses a very heavy duty air compressor, and it requires a wire larger than 14 gauge, you will need to run a new wire all the way from the fuse box to the relay, bypassing the existing purple wire. The end of the purple wire at the old horn will also have to be insulated, and tied off out of the way. If you prefer, you can cut the purple wire at the fuse box, rather than insulating the horn end. In many cases, though, the purple wire to the horn is in the same push-on terminal as another purple wire, so you will have to cut off the terminal, separate the wires, and use an ohmmeter or continuity checker to determine which wire is for the horn. The remaining wire will then have to be re-terminated, along with the new wire. The old wire will now be dead at both ends, so no insulation is needed, but you may want to insulate it anyway for the reasons given above.

If you choose this approach, I recommend you mount the relay close to the fuse box for convenience sake. The new wire should be routed alongside the original harness, and well supported with cable ties at frequent intervals.

# 29
# ALARM SYSTEMS

GENERAL THEFT PROOFING PHILOSOPHY

The first thing you need to keep in mind is that it is virtually impossible to prevent a theft if the thief is clever enough, and determined enough, and wants ***YOUR*** car. What you can do, though, is make it difficult enough for him that he will skip your car and steal someone else's car. Cold, perhaps, but those are the facts of life -- better your neighbor's car than yours.

If the thief wants "A" car, it's fairly easy to discourage him. If he wants a car "like" yours, it's a bit harder. If he wants "your" car, it is very difficult to stop him. In either situation, time is your best weapon, as time is the thief's worst enemy. The longer it takes him to steal a car, the better his chances are of being detected. Every thief knows about hidden kill switches, how to defeat most alarm systems, and the fact that many people take their distributor rotor with them when they leave the car. What you have to do is to design and install your theft-proofing system such that it takes time for the thief to figure out what type of system you are using, find the components, and defeat them, all without drawing attention to his activities.

If you have one switch that must be operated to start your car, and you've hidden it in a very easily detected location under the dash, it won't take him long to find it. If you have three switches that must be operated, as an example, and you've placed one under the dash, one in the locked glove box, and another in the locked trunk, he will most likely move on, as he cannot afford the time it would take to find them all.

Fortunately, thieves rarely target TR6s. When they do, the theft usually falls into one of two categories: A theft of opportunity by someone taking a joyride, or a theft by someone who is familiar with TR6s and is specifically looking for one. Most often, it's the former, making our job of theft prevention a bit easier. In either case, your job is to conceal your theft proofing efforts as much as possible, forcing the thief to spend more time looking for them.

THEFT-PROOFING METHODS

REMOVING THE ROTOR

A very common technique, but one that has a lot of drawbacks. First of all, it is a real pain to have to raise the hood, pop off the distributor cap, and remove the rotor. It's a pain again to go through the same routine to replace the rotor when you get back to your car. It's also quite dirty -- not something you want to do when going to dinner in a fancy restaurant in your best clothes.

It is quite effective if your thief is out for a joy ride, but virtually worthless if the thief is in the market for a TR6. If he wants your TR6, he will have a spare rotor with him, and enough wire, alligator clips, etc, to hot wire it, and, most importantly, the knowledge required to do it.

It is not at all effective if you fail to remove the rotor. You are not very likely to remove it if you are just going to step into a convenience store for a moment to pick up a couple of items, yet that may be just the time it takes for a joy-riding teen to get your car.

KILL SWITCHES

Very easy to install, and easy enough to use that you will most likely use it even for short stops, a kill switch is fairly effective against joy-riders, but nearly worthless against a professional thief. Professional thieves are well acquainted with all the varieties of kill switches, and know how to defeat them with little trouble, and very quickly. How successful they are in preventing a theft depends entirely on how determined the thief is to steal "this" car, as opposed to "a" car.

There are two different types of kill switches generally used. One type bypasses the points and shorts the coil to ground, while the other type interrupts power to the coil. See the **figure 1**, below, for details. In both views, the kill switch is shown in the "kill" position. On the bottom, the kill switch is closed, shorting the negative post of the coil to ground. This is exactly what the points do when they close, so in effect, the kill switch acts as if the points never open. On the top, the kill switch interrupts power to the coil, which is the same as if the ignition switch were in the off position.

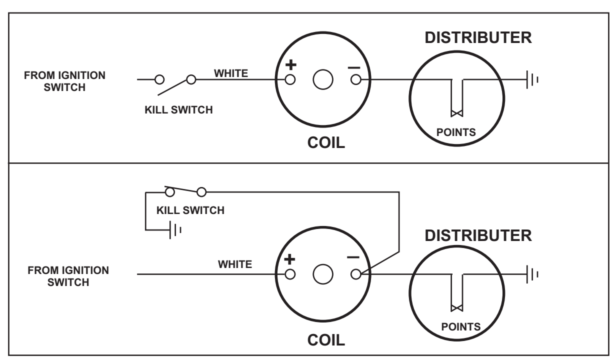



FIGURE 1

Of course, either of these schemes can be easily defeated.

Merely cutting the wire to the switch in the lower figure will do it, while jumping directly from the battery to the coil will defeat the scheme shown on the top.

STEERING COLUMN LOCK

Supplied by Triumph from about the start of the '71 model year, a steering column lock is, in my opinion, more of a nuisance than a help. A professional thief can defeat one in 30 seconds or less, if he has the right tools (and he will have). Unless your car is finished to the point that it requires no work at all, having to use the key to allow you to turn the front wheels can be a pain. Both of my TR6s have had this feature removed by previous owners, but if they hadn't, I would have. Chances are your steering column lock has already been deleted by a previous owner as well.

FUEL CUTOFF DEVICES

a) Electric fuel pump:

Replacing the mechanical fuel pump with an electric unit provides an opportunity to install additional theft-proofing to your car. By adding a means to interrupt power to the pump, the thief will not be able to drive the car more than a block or two before the fuel in the carburetors runs out, and the car stalls. As much as a thief hates to spend time in your driveway, he hates it even worse stuck in the middle of the street somewhere. Few things attract attention quite like a disabled car in the middle of the road.

Interrupting power to the pump can be as simple as adding a hidden switch, or can be more complicated by tying the power interrupt scheme into a sophisticated alarm system. Tying it into an alarm system will be discussed later, but a simple scheme for using a hidden switch is shown in **figure 2**, right.

Just like the thief, you are not going to be very happy either if you find yourself stranded in the middle of the street because you forgot to reset the fuel pump cutoff switch before driving off. For this reason, I like to add a chime, or buzzer, that will sound if I turn on the ignition key without resetting the cutoff switch. This feature is also shown in the figure above.

For safety purposes, it's a good idea to have an automatic shutoff feature on the fuel pump in case of an accident. Unlike a mechanical pump, an electric pump will still function with the engine off, and can spill a lot of gas on the ground if a fuel line has been broken. Some folks like to use an oil pressure switch to shut off the pump when the engine dies, but I don't prefer that method for a couple of reasons. First of all, it's unnecessary if the engine has died but the car has not been overturned, as the needle valves in the carburetors will shut off the flow of fuel. Secondly, if you let your car sit for lengthy periods of time between driving it, such as in the off season, the fuel will evaporate from the float bowls, making it hard, if not impossible, to start the car. A mechanical pump will pump fuel while the starter motor is turning to prime the bowls, but if the electrical pump is shut off due to low oil pressure, the starter motor may not produce enough oil pressure to reset the pump. In this circumstance, you want to be able to turn the key to the on position long enough for the pump to fill the bowls before turning to the start position.

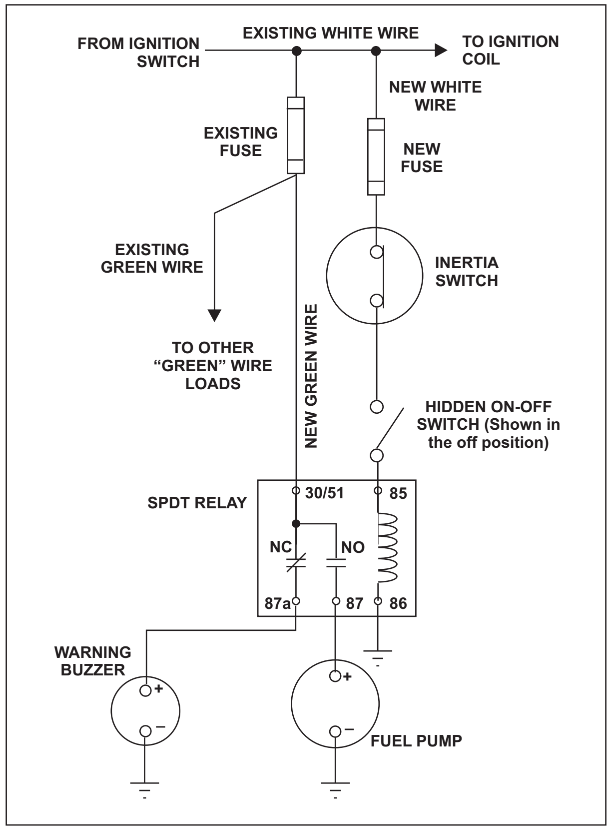



FIGURE 2

My preferred safety shutoff method is to use an inertia switch, wired to shut off the pump in the event of a crash, whether the car has overturned or not. Any accident that jolts the car hard enough to rupture or break a fuel line will certainly operate the inertia switch. Unfortunately, a hard jolt from hitting a pothole can sometimes operate the inertia switch as well. For this reason, I prefer to mount the switch in the cockpit where it can easily be reached and reset by the driver without stopping the car, and I also wire it to sound the chime or buzzer should this happen. This way, there is no need to wonder if that last pothole you hit shut off the fuel pump -- if you don't hear the chime, you're OK. This is also shown in the wiring diagram above.

b) Fuel flow cutoff valves:

Another method of providing theft security by cutting off fuel flow is to add a valve in the fuel line. This can be either a mechanical or an electrical valve, and can be used with either an electrical or a mechanical fuel pump. With the fuel flow shut off, the car will only operate for a block or two, and the results will be the same as shutting off the fuel pump as described above.

Mechanical valves can be mounted under the floorboard with just the handle or key protruding into the cockpit, in the trunk, or under the hood. The two most important concerns here are safety and accessability. You do ***NOT*** want the fuel line/valve located such that there is even a remote possibility of a line break allowing fuel to get into the car. If you are in an accident and injured enough that you can't get out of the car, the last thing you want is to have gasoline pouring over you. One "good Samaritan" coming to your aid with a lit cigarette, and.......! Not a pleasant thought. I have seen this happen first hand.

You want to have the valve control handy for yourself, but not easy for the thief to find. This isn't easy to do, especially if the thief should be watching you get out of the car and set the valve. If he has in mind stealing your car, he will be watching your hands for clues to any theft-proofing devices you may have. If you can get a valve with a removable handle, and I believe they are available with a removable key/handle, you won't have to worry too much. Even if he does find the valve, it will be difficult for him to operate it if it is installed correctly.

Electrically operated valves can be mounted anywhere you choose, leaving only the switch to worry about hiding. It can also be tied into a sophisticated alarm system, making its operation automatic when the alarm is set. More details on that later.

Electrically operated valves come in three typical configurations - apply power to open, apply power to close, and set/reset. The set/reset valves require a momentary application of power to one terminal to open the valve, and another momentary application of power to the same terminal to close the valve. This would be the preferred type, as they consume no power after they have been operated -- just a momentary surge of power while the valve changes state.

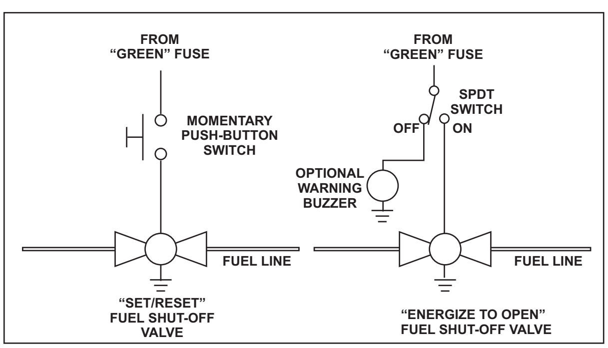



FIGURE 3

If you prefer to use a valve that requires the constant application of power, it is much better to use one that requires power to open, as the car will be running when the valve is open, and the alternator will be supplying power. If you use a power to close valve, the valve will be drawing power all the time the valve is closed. This could easily drain your battery over a period of time.Refer to **figure 3**, left, for wiring details for both types

You'll notice I've added a buzzer to the "energize to open" circuit, for the same reason mentioned above for the fuel pump cutoff switch. If you should forget to open the valve, the buzzer will sound as soon as you turn the key on, and will continue to buzz till you open the valve. Unfortunately, there is no way to monitor the position of the set/reset valve, unless you can find one with a built-in limit switch. If you can get a valve with a limit switch that closes when the valve is closed, just wire it between the green wire and the positive side of the buzzer. Ground the negative side of the buzzer.

You may wish to tie the operation of the set-reset valve into a commercial alarm system such that it is automatically operated each time you actuate the alarm unit. If so, refer to the battery cut-off remote control section on the next page for installation details.

You may have trouble finding a suitable valve, as they are not normally carried by auto parts stores. One place to look is a recreational vehicle dealer, as these valves are often used to switch between two fuel tanks. You could just cap off one of the input ports, and use it as a simple open/close valve. Boating supply houses would be another possible source. If either of these fail, try contacting the maintenance department of any industry or utility in your area, and ask them for a source of supply. These types of valve are used extensively in industrial applications, and they can direct you to a source. They may be a bit pricey, though.

BATTERY CUTOFF SWITCHES

The typical battery mounted cutoff switches are more of a convenience/maintenance tool than a theft deterrent. If you have the type that has a removable section, they are a bit better than the other types, but are still fairly easy to defeat by a competent thief.

Much better are the electrically operated cutoff switches, operating much like the starter solenoids used in early Spitfires and TRs, except they are of the set/reset type. These can be hidden from view, which means a thief will have to find it or use jumper cables to bypass it -- well within the capability of a thief, but it does consume time, providing a degree of discouragement.

To operate these, a momentary pulse of current is sent to a terminal to open it, and another pulse is sent to the same terminal to close it. This opens up a world of possibilities for theft deterrent schemes.

On-off momentary toggle or pushbutton switch: This is the simplest way to control the cutoff switch. Just mount the switch in a hidden, yet accessible location and hit it once to disconnect the battery when you leave the car, and hit it again when you return.

Momentary key lock switch: Operating the same as above, but it requires the use of a key. The key switch can simply be hidden from view or mounted in plain view, either inside or outside the car. If you mount it in view, you must ensure that the back side of the switch isn't accessible without removing a fender or other panel. Otherwise, a knowledgeable thief will just jumper it, and in a very short time.

Magnetic switch: The magnetic switch is mounted behind a non-ferrous panel, and is operated by simply waving a magnet in front of it. Being mounted behind a panel, it would take a thief a long time to find the switch, if he were to be looking for it. It may be difficult to find a location accessible from outside the car to mount one on a TR6, as there are no non-ferrous panels available. A possible location is under the cover for the top, or behind the top. There is no reason to mount it outside, as you don't need the battery until you are inside the car anyway.

Pressure switch: This scheme uses a pressure sensitive switch, one that requires very little pressure to operate. The switch can be hidden behind a slightly flexible surface, an upholstery panel, for example, making if absolutely invisible to prying eyes.

Remote control: The cutoff solenoid can be wired to operate from either an alarm system, or as part of a stand alone remote control setup. If you wire it to one of these units, you must ensure that the output signal is either a single pulse, or an odd number of pulses. If, for example, your alarm system sounds two beeps from the siren when it is activated, and you use this output to set the solenoid, it will be turned off and then right back on again by the second beep. When counting the number of pulses, keep in mind that some alarm systems have a "memory" function, which will adjust the number of pulses to provide an indication of which alarm zone was violated - three pulses for a door switch, and four for a shock sensor, as an example. If your alarm has such a feature (and most do) you may have to arrange for a manual "reset" scheme to turn the switch back on after you've reset the alarm.

FLASHING LED

A flashing LED, even if it is not part of an alarm system, can be a deterrent by making the thief think it ***IS*** part of one. LEDs are available that flash when you turn on a switch (typically as you leave the car), or that can be wired to come on automatically when you turn the ignition key off. These are commercially available, and come with wiring instructions and all wiring components needed for installation.

The effectiveness of these as a theft deterrent depends almost entirely on the thief's motivation. If he is looking for a Chevy Cavalier, and yours is just one of two dozen in the parking lot, he will most likely move on to another one when he sees the LED. On the other hand, if he has his mind set on a TR6, and yours is the only one in the area (as it usually will be), the LED will probably not even slow him down.

COMMERCIAL ALARM SYSTEMS

In spite of the fact that false alarms have become so common that no one pays attention to an alarm siren anymore, a commercial alarm system is still one of the best anti-theft devices you can use. Especially so if combined with some of the other devices discussed above, and a little ingenuity is used in the design and installation of the system. Even though most folks no longer are disturbed by an alarm, the thief never knows but what a security guard or a policeman may be just around the corner when the alarm goes off, and will come to investigate. If he can complete the theft in a hurry, he may not be put off by the alarm, but he certainly won't hang around long, unless he is ***VERY*** bold and really wants your car.

Although each brand/model of alarm system is different, they all have common inputs and outputs, and there are some "gotchas" that impact most all systems.

INPUTS:

Power:

This is a power source that is hot all the time, and should be fused. The alarm system will come with its own fuse for this purpose, but if you connect this input to a purple wire, the additional fuse is not needed. The purple wires are hot all the time, and are fused.

Set/Reset:

All alarm systems require a signal from the ignition key to enable it to be switched on when the key is off, and to reset any remembered alarms, etc, when the key is turned back on. In a Triumph, this input should be connected to a green wire. No additional fuse is needed, as the green wires are already fused, and they are only hot when the key is on.

Negative input (dome light):

When you open the doors on a TR6, switches in the door jams make a connection to ground (negative) and turn on the courtesy lights (in most sedans, the courtesy lights are mounted to the headliner, and are called "dome" lights, hence the terminology). This alarm input is intended to be connected to these switches, along with the existing courtesy lights. On a TR, the existing wires for the lights are purple/orange. If you also connect this input to other switches, such as the trunk switch, glove box switch, or a hood switch, all of the lights will come on whenever any of the switches are operated. If you open the trunk, for example, the interior lights and the glovebox light will come on along with the trunk light. For this reason, you may want to use new switches in the door jams, and use the input below. These wires connect to ground, so there is no need for a fuse. The worst case if they short is a false alarm.

Negative input (accessories):

This input triggers the alarm whenever the switches attached to it close and make a connection to ground. This is the input you use for shock sensors, motion detectors, and the switches discussed above. You can add as many devices/switches as you wish to this input. No fuses are needed in this input either.

Positive input:

This input is intended for use in some American vehicles, such as some Fords, that switch power to the dome light rather than ground. This input is not needed in a TR, unless you should have some type of sensor that switches power. There are few if any commercially available sensors that switch power. If you should use this input, ensure that the wires are properly protected by a fuse.

Valet switch

This is a switch supplied with the alarm, and is used to bypass the alarm when you have to leave your car with a valet or mechanic. It switches ground, so no fuse is needed.

Antenna

Usually a short piece of wire hanging from the alarm unit, the antenna needs to be as high as possible and as far away from sheet metal as possible. The lower the antenna or the closer to sheet metal it is, the less the range of the remote unit. A long range is not really needed in most cases, as you normally want to be able to see your car before you operate the remote unit. This is especially true of the family car, as a rapist or kidnaper could open the door and hide in the back seat between the time you shut off the alarm and the time your wife and children get to the car. A longer range is desirable if you use an optional pager, described below, as you may want to operate the remote from your motel room to verify that the pager transmitter is within range of your room, or to reset a false alarm.

OUTPUTS:

Siren

Although not necessary, I recommend fusing this lead anyway. It would be a very simple matter for a thief to find your siren, cut the lead to it, and connect this lead to ground. Then, all the he has to do is open a door, setting off the alarm and blowing the fuse to the alarm - no noise, no alarm, no problem. Goodbye car.

Starter cutout

This lead is grounded when the alarm is set, and operates a relay in the lead from the ignition key to the starter. When the relay is operated, a normally closed contact inside the relay opens, and power to the starter solenoid is interrupted. With care, this output can be used for other things as well, such as interrupting power to the fuel pump. See the "gotchas" section below for some of the problems you may encounter doing this. Interrupting power to the fuel pump will provide protection if the thief should jump start the car. The current capacity of this output will depend on the manufacturer, but it is adequate to drive a few relays, as they are low current devices.

Door locks

Most alarms have a pair of wires that operate the electric door locks - one to open the door locks when the alarm is shut off, and another to lock the doors when the alarm is set. In most cases, it requires a seperate set of relays to perform the lock/unlock function, and additional relays can be used for other purposes, such as operating a battery cutout switch or a fuel flow cutout valve. These outputs are grounded momentarily when they operate, just right for this application.

Trunk release

You probably won't have a trunk release solenoid on a TR6, but this grounding output can be used to drive other devices instead. Usually, this output is triggered by a separate push button on the remote control module, or by operating two buttons at the same time.

Others

Some of the higher scale alarm units will have other output that may be used. Like the trunk release, they are usually grounding outputs, and are triggered from the remote control unit.

Parking lights

Most units have an output that flashes the parking lights when the alarm is set or turned off. I recommend fusing this output for the same reasons stated above for the siren output. The parking light output is a 12 volt signal, and usually consisted of two or more pulses, so it's use for anything other than it was intended for is limited.

LED warning light

Mounted in the car where it is easily visible from the outside, the LED flashes when the alarm is set, warning a thief that you have an alarm. This can be a good thing or a bad thing, depending on circumstances. As stated above, if you have a common car, the thief may very well move to an easier target if he sees you have an alarm. If he wants ***YOUR*** car, a warning that you have an alarm may not be good. If he doesn't know, he will not take steps to defeat it, and it will go off as planned. The noise of the siren may be enough to send him on his way. If, on the other hand, he knows you have an alarm, he might be able to defeat it or otherwise work around it, and it may not do you any good to have the alarm.

GOTCHAS:

The installation of commercial alarm units is pretty straight forward, but there are a few things that can be tricky for a first time installer. I've itemized a few of them here to save you some time and possibly a lot of frustration.

Starter cutout

The instructions that come with your alarm unit will most likely tell you to connect the power side of the starter cutout relay to the "start" position of your ignition switch. This is fine if you haven't added other functions to the cutout grounding lead. If you add an additional function/relay on this lead, power to both relays must come from the same point, which will be the "run" position of the ignition switch (on a TR6, this should be a green wire, as the green wires are all hot only when the key is on, and they are already fused). The "run" position of the ignition switch is also hot when the key is in the "start" position, so it will kill the starter just the same as if the relay were wired to the "start" position.

Why do this? If you have the starter cutout relay wired to the "start" position, and the other relays wired to the "run" position, both of the relays will be energized every time you put the key to the "run" position, alarm activated or not. Compared to the resistance of a relay, the starter solenoid resistance is virtually zero. Current will flow through one relay, then through the other, and through the solenoids as if the solenoid were a good ground connection. The relays will be effectively wired in series, and they will operate just fine that way. The current path through the solenoid is what is referred to as a "**sneak circuit"** -- current going somewhere other than where you wanted or expected it to. Sneak circuits are the bane of electrical engineering departments every where (and usually occur when modifications are being made, rather than in the original design). Most large engineering offices have a special section just looking for such problems. See the **figures 4** and **5** for details.

**Figure 4**, right, illustrates how you would wire the starter cutout along with the fuel pump cutout, if you followed the alarm instructions and used common sense. Alas, this is the ***WRONG*** way to do it.

**Figure 5**, right, shows the problem with wiring it this way. When the ignition key is released to the "run" position after the engine has been started, current will now flow from the run position of the ignition switch, through the fuel pump cutout relay, through the starter cutout relay, and through the starter solenoid. The relative resistance of the relays and the solenoid are such that both relays will be energized in this situation, as the "grounding" lead from the alarm will ***NOT*** be grounded.

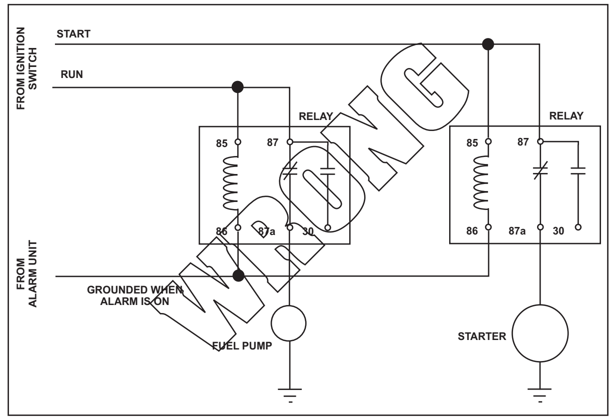



FIGURE 4

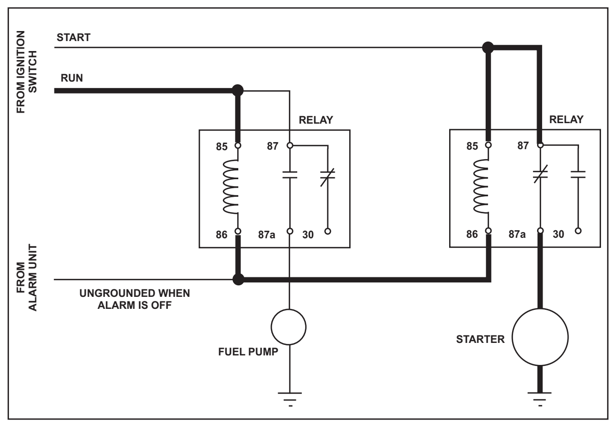



FIGURE 5

**Figure 6** below represents the correct way to wire the relays. The lead from the "run" position of the ignition switch is hot in both the "run" and "start" position, so the starter relay will be energized while the engine is cranking and the alarm is on, just as before, but with 12 volts applied to the starter cutout relay, there will be no path for current flow through either relay when the alarm is off.

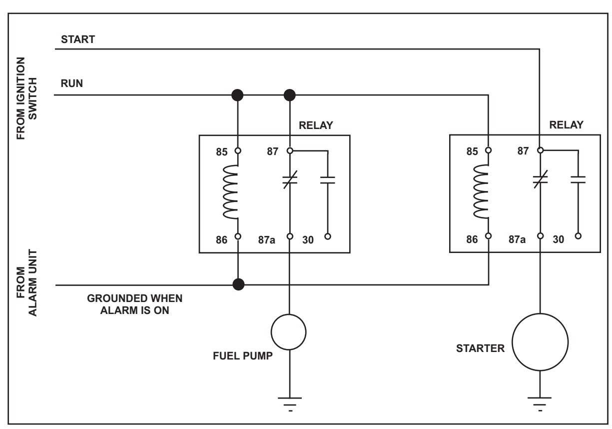



FIGURE 6

You can't wire the fuel pump relay to the "start" lead, because the pump would still be operable after the engine started. Usually, there is enough fuel in the float bowls for a thief to jump start the car without the fuel pump running.

Nuisance alarms

There are occasions where you will be expecting to get false alarms, such as on a very windy day when the shock sensor will be frequently activated. You can't prevent the shock sensor from being activated in a strong gust of wind, but you can add a cutoff switch in the lead from the sensor to the alarm unit to prevent nuisance alarms. You lose the benefit of the shock sensor, but under these circumstance, it is lost anyway, so why annoy yourself (and others) by having frequent false alarms that either require you to investigate, or at least, to reset the alarm each time?

You could just shut the alarm off, but then you lose the benefit of the other alarm functions, such as door opening, and the protection of the starter and/or fuel pump cutout.

If you have a roll bar, you will be guaranteed to have false alarms if you have a shock sensor. For some unknown reason, people seem compelled to grab the roll bar and give it a big shake. Their logic behind this completely escapes me, but it's a fact of life I've learned to live with.

It is also desirable on occasions to be able to shut off the siren, while still retaining all other functions of the alarm, especially if you have added an optional pager module. Often, when parking in a restaurant or other public parking lot, complete strangers will open the door to an unusual car such as a TR6 just to have a look. You may not want to annoy others with the siren, but you will be notified by the pager and you can go investigate to see if any action is required on your part. If it is a family of a dozen or so unruly kids, climbing in and out of your car, you will certainly want to put a stop to it. If it's a beautiful young lady (or a handsome guy for you lady owners), you may choose instead to walk over and start a conversation!

One of the more important reasons for having a siren cutout is to eliminate the "chirps" that accompany setting and resetting the alarm. In some locations/situations, it's just better not to have the noise. While the chirp feature can be programmed out by setting DIP switches in the alarm module, or by programming with the remote control unit, it is much simpler just to have a switch.

Time delay

Most alarm systems have a built in time delay to allow shock and motion sensors time to settle down before the alarm is actually in service, usually on he order of 3 - 5 seconds. If you turn on the alarm immediately after closing the door, the shock sensor may still be vibrating from the door closure, and you would get an alarm without the time delay. However, few, if any, alarm unit instructions mention this time delay. If you don't know about the time delay, you might think your unit is defective when you test it after installation. You turn the alarm on, open a door, and nothing happens! It can be very frustrating trying to find out what's wrong if you don't know about the time delay (ask me how I know!).

PAGERS

A useful addition to an alarm system, a pager will notify you if you of an attempted break in, even if you are in a location where you can't hear the siren, or if the thief has cut the wire to the siren. Most pagers advertise a range of up to 2 miles, but in practice, the maximum range is much, much shorter, typically 1000 feet or so. In an open field, in the flatlands, you might get 2 miles or more, but by the time the signal goes through a parking lot with a lot of metal cars, through walls with steel studs, etc., the signal is attenuated quite a bit.

Inputs to the pager can be as simple as a relay driven by the siren output of the main alarm system. In this case, you will get a page if any alarm trigger actuates the alarm, but you won't know if it was a door opening or a shock that set it off. In most cases, that's adequate, but in some cases, you may wish to know which trigger was involved. Some of the fancier pagers accept the same inputs as the main alarm unit, listed above, and will tell you, by the number of beeps or the color of the flashing LED, which input triggered the alarm.

Regardless of which module you use, they will all have the same power input needs as the alarm module - constant power from a purple wire, and "ignition on" power from a green wire to set/reset the pager. As the pager module wiring is completely contained within the cockpit, fusing of the inputs and outputs is not required as an alarm defeat prevention measure, as described above for the alarm unit.

The paging output from the module is sent to the same antenna as your radio, if you have one. The antenna lead is removed from your radio and inserted into the module. A short antenna lead in is then placed from the pager to the radio. When the pager is actuated, it switches the antenna from the radio to the module, and the signal is sent out to your pocket pager.

The pager also has an output to operate an automatic antenna, if you should be using one. I have mixed feelings about using an automatic antenna with a pager. If the thief sees the antenna going up, he may very well realize that you have a pager and immediately break the antenna. You may or may not get a page before he breaks it, depending on the location and distance of the pocket pager. On the other hand, when he sees it going up, he may be afraid that you have already gotten the page and will be calling the police. This may be enough to send him on his way. It's a judgement call, and there is no way to predict just how any given thief will react to the antenna coming up.

**Figures 7** and **8**, below, are wiring diagrams from my own Triumphs, one using a simple pager, and the other with a complete set of inputs.

Of course, absolutely none of the preceding information will help if the thief is really determined, and he has a wrecker or tow truck. He can back up, get your car, and be gone in a matter of seconds. Even if your alarm is screaming its heart out, it will do little to deter the thief. The only thing you can do to help is to keep the car locked in your garage at home, and park it in a very conspicuous place when away from home. Maybe, just maybe, if there are a lot of folks milling about, the thief will pass on by and get someone else's car.

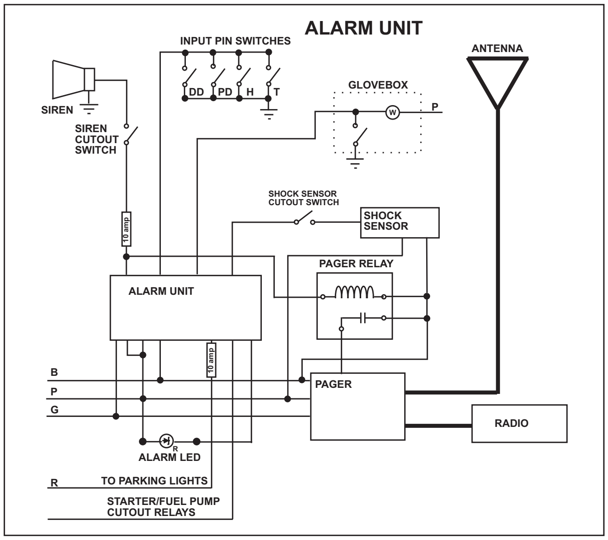



FIGURE 7

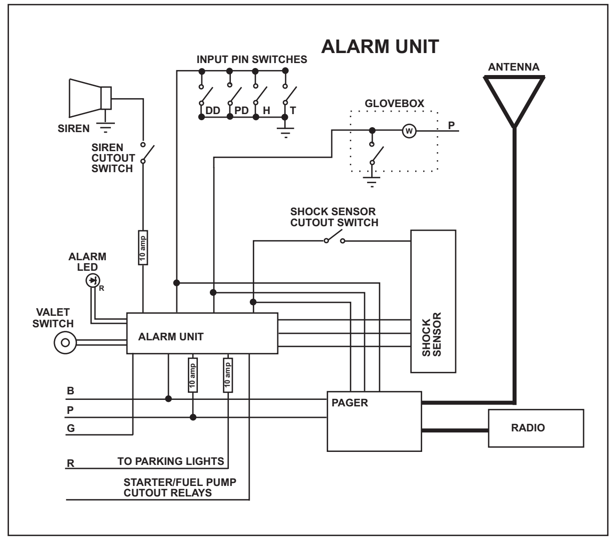



FIGURE 8

# 30
# ALTERNATOR UPGRADES

WHY UPGRADE?

The alternators that came stock with the TR250 and the TR6 are fully adequate for their intended purpose. Add a few electrical accessories such as driving lights, moderately powered stereo, etc, and do a lot of stop and go night time driving in the winter, with all the lights on, heater fan on high, and stereo blasting, and you will soon run the battery down. The stock alternator just isn't up to the task, particularly the units supplied with the earlier models. Upgrading to a mid-80s GM alternator (model #7127) is a very simple task, at least from an electrical standpoint, and doesn't compromise originality all that much. I have a 55 amp unit in my '71 TR6, and I can sit at idle with everything in the car on, and still not see that dreaded alternator warning light glow!

Because of the variations in physical mounting details from year to year, depending on whether or not the car has pollution controls, an A/C unit, etc, no mechanical mounting details will be provided. Normally, the mounting of the GM unit is well within the capability of the average home mechanic. If not, most good repair shops can do the mounting for you at a reasonable cost. It's usually the wiring that creates the real hassles, and this chapter will attempt to supply the necessary details to make that as painless as possible.

WIRING METHODS

Two methods of wiring will be described - one utilizing the existing wiring, and a second method using upgraded wiring. Why two methods?

The factory alternator output ranged from 28 amps on the early cars, to 45 amps on the later cars. The GM units can produce 55 or more amps (they can be bought with over 100 amp capacity if you want to spend the $$$). The wiring in the cars is only designed for the lower rating of the stock alternator. If you add heavy loads, driving lights, high power stereo, etc, you can exceed the capacity of the wires. Also, If you let the battery discharge completely, the alternator can possibly recharge with enough current to overload the wires.

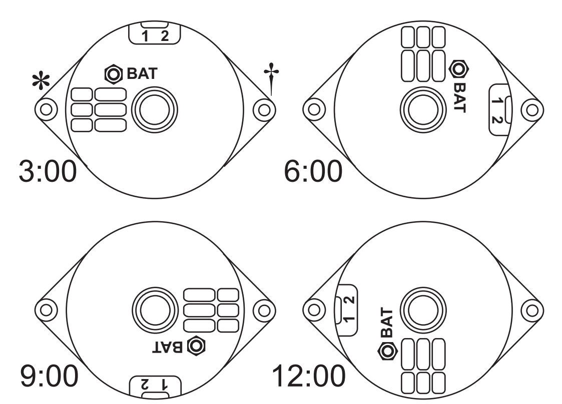
If you use the stock wiring method, and you let your battery completely discharge, you should recharge it with a charger rather than push starting the car and letting the alternator recharge it. If you must do this, and you have an early model with an ammeter, keep a close watch on the ammeter, checking for overcharging. If you have a later model with a voltmeter, feel the wiring harness occasionally to check for signs of overheating.

If you use the upgraded wiring method, you can add loads and recharge a dead battery without any problems, but there is a penalty to pay for this on the early ammeter equipped models. You will either need to replace the ammeter with a higher range unit, add a shunt to it, or bypass the ammeter with the new wiring, in which case you will get an erroneous reading (see chapter 15, Gauges, for details on this). With a later voltmeter equipped model, there is no problem with using the upgrade method, as the voltmeter will work as before.

Unless you add large loads, or wish to be able to recharge a dead battery with the alternator, the stock wiring should not present a problem. The main advantage of the higher output is the ability to provide a higher charge rate at low RPM and idle. The standard loads on the TR6 do not require a higher charge current at normal engine speeds, so the alternator will not be called on to provide enough current to overload the wires.

PHYSICAL MOUNTING DETAILS

Although mounting details are beyond the scope of this manual, **figure 1**, below, may be valuable as you figure out the physical mounting details. All GM alternators have what is known as a "clock" position, that is, the terminals can be located at 3:00, 6:00. 9:00, or 12:00, as shown here. Often, the wiring can be greatly simplified with one clock position versus another. Regardless of the clock your unit comes with, any GM unit can be changed by the owner. Just remove the screws holding the case halves together, separate the case just slightly, and rotate to the preferred clock position.




* belt tension adjustment bolt hole
† block mounting bolt hole

FIGURE 1

GENERAL PROCEDURES

Disconnect the ground lead from the battery before proceeding with any electrical work, and, of course, follow all the rules of proper wiring practices. I recommend using solder connections, and covering them with heat shrink tubing, but crimp type connectors will work quite well also. You will need butt connectors, suitable for the size of wires you are connecting, and a large ring connector for the screw terminal. For more details on wiring procedures, refer to chapter 10, Wiring Harness Repair.

ALTERNATOR CONNECTIONS

The Triumph factory wiring will differ a bit from one model to another, as will the connections at the alternator. The instructions below are all for using a GM alternator as a replacement, so the alternator connections will be the same for all models covered, and these connections will be described here, rather than repeated for each model.

On the side of the case of the new alternator, there are two spade lugs recessed into the body. The lugs are identified on the body of the alternator as either 1 & 2, R & F, or with no markings at all, depending on the particular unit you have. Regardless of the markings, the terminals will be the same, and will be located as shown in the following diagrams. You will need a plug (connector) for these. These plugs are readily available at an auto supply store, usually in a package hanging on the pegboard display rack in the electrical section, and usually identified as an alternator extension connector, or something similar. If not, the counter man will know what you are looking for. There will be two short wires already connected to the plug - one black wire, which goes to terminal #1, and one red wire, which goes to terminal # 2. Your existing wiring will be spliced to these leads. The plug is keyed, so it will only go into the alternator one way.

If you would prefer not to have splices, you can remove the terminals, and the wire, from the plug. Using new terminals of the proper type, connect directly to the existing Triumph wiring, and insert the terminals into the plug. New terminals (and new plug assemblies complete with terminals) can be purchased from, among others:

British Wiring
20449 Ithaca,
Olympia Fields, IL 60461
708-481-9050

The Wire Works
167 Keystone Road
Chester, PA 19013
800-292-1940

On the back of the case, you will find an insulated screw terminal, usually, but not always, labeled BAT. This is the main charging connection.

WIRING CHANGES

METHOD ONE (Utilizing existing wiring)

TR 250

At the alternator regulator (control box), you will find the following wires, as shown in **figure 2** below.

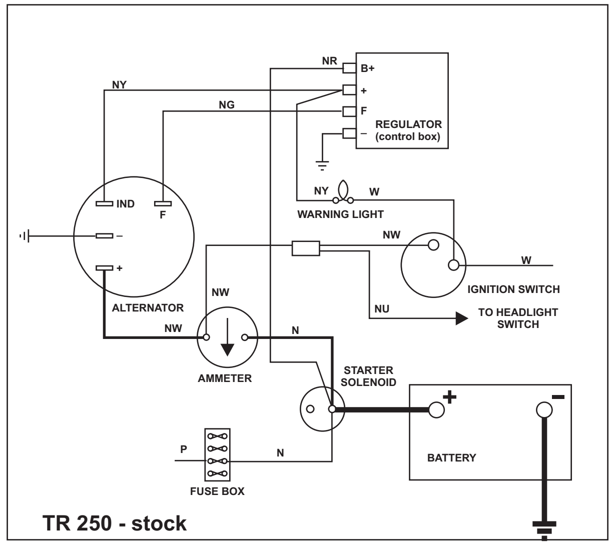



FIGURE 2

One black wire: Remove and discard.

Two brown/yellow wires: Remove and connect together.

One brown/green and one brown/red wire: Remove and connect together. **Figure 3** below shows the wiring changes after the conversion.

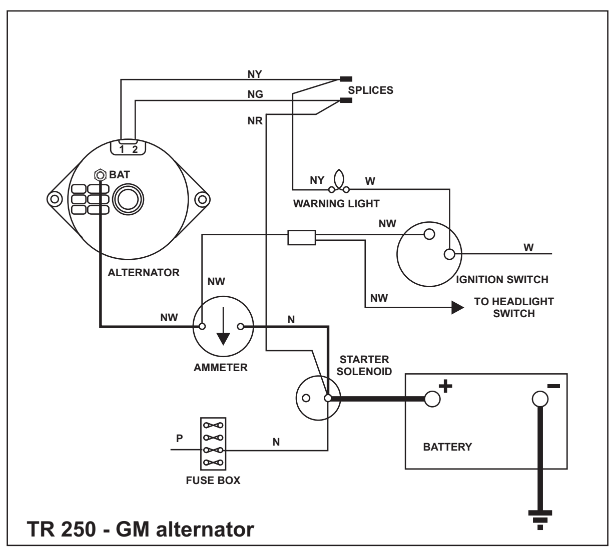



FIGURE 3

At this point, you have two options: you can either remove the control box or gut it and use it as a termination point for the revised wiring. If you gut the box and leave it in places, you can make the wiring changes at the control box by terminating the wiring on the control box terminals, rather than using splices. If you wish to remove the box, you will need to use insulated connectors or solder and insulating tape to make the connections. Either way is satisfactory, but using the control box might be just a bit tidier, assuming you don't prefer to remove the box all together to reduce the overall clutter under the hood. If you leave the box there, and paint the GM alternator black, a concours judge might not even notice the change, if that's of concern to you.

At the old alternator, you will find three wires, one brown/green, one brown/white, and one brown/yellow: disconnect them from the generator, cut off the terminals, and leave in place. Remove the alternator.

At the new alternator, connect the Brown/Yellow wire to the plug wire going to the # 1 terminal, and connect the Brown/Green wire to the other lead from the plug (#2). Connect the Brown/White wire to the screw terminal, using a ring terminal. When you are finished, your wiring should be as shown above in **figure 3**.

TR6

At the stock alternator, you will find either a five, or a three, wire connector. If you have the five wire connector (See **figures 4**, and **5** below for wiring details), you will find a large Brown/White wire, a smaller Brown/Red wire (except for '72, which uses a Brown wire), and what appears to be three Brown/Yellow wires.

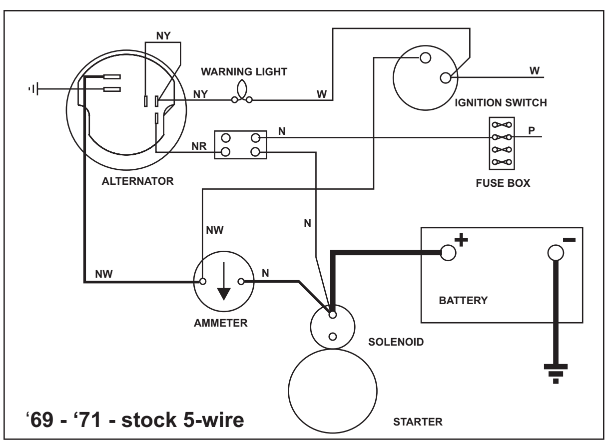



FIGURE 4

What appears to be three Brown/Yellow wires are actually only two. At one terminal, you will find two Brown/Yellow wires, and at another, you will find one. The single Brown/Yellow wire actually goes into the harness for a very short distance, and then turns around and comes back out, where it connects to the terminal with another Brown/Yellow wire. If you pull on the single Brown/Yellow wire, it will pull out of the harness, and you will see what I mean. You may have to loosen the harness a little bit to get it to pull out. That short piece of Brown/Yellow wire is to be discarded.

If you have a three wire connector (see **figure 6**, below), the short piece of Brown/Yellow wire has already been removed - either by the factory, on '73 and later models, or by a previous owner when he replaced the alternator with a later model. For '69 - '72, with an owner modification, the wire colors will be as above. For '73 and later, there will be a large Brown wire, a smaller Brown wire, and a small Brown/Yellow wire.

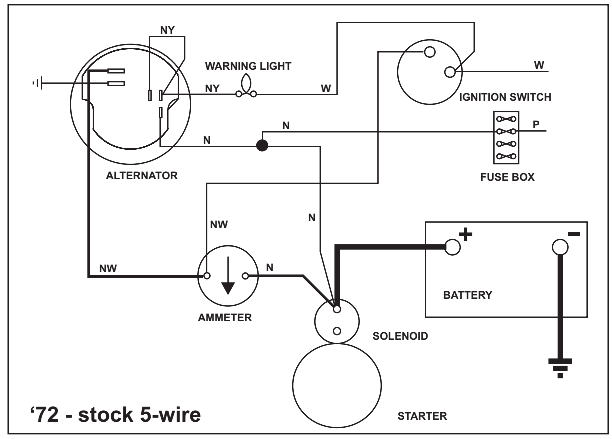



FIGURE 5

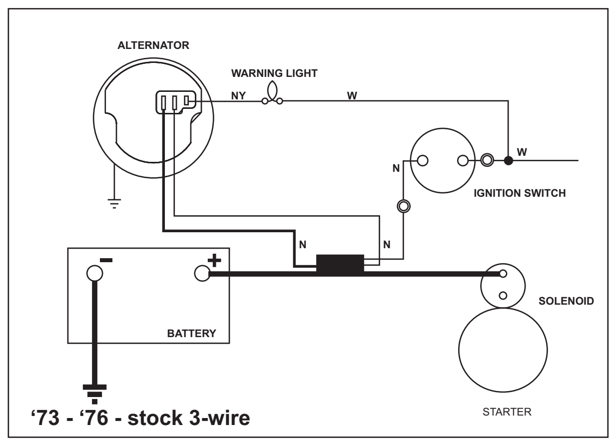



FIGURE 6

The large Brown/White (Brown) wire is the main charging lead. The small Brown/Red (Brown) wire measures the system voltage to tell the alternator how much to charge. The Brown/Yellow wire(s) operates the alternator warning light, and provides the initial voltage to the alternator to start it charging when the engine first starts. Refer to the chapter 4, Alternator Operation for more details on this.

FIVE WIRE MODIFICATIONS: Refer to **figures 7** and **8,** next page, Discard the short Brown/Yellow wire, as above. Cut off the terminals from the remaining Brown/Yellow wire, and from both the Brown/White, and the Brown/Red (Brown for '72) wires. Connect the Brown/Yellow wire to the lead coming from position (1) of the plug and Connect the small Brown/Red (Brown for '72) wire to the other terminal, (2). Connect the large Brown/White wire to the screw terminal. Insert the plug, and you are finished.

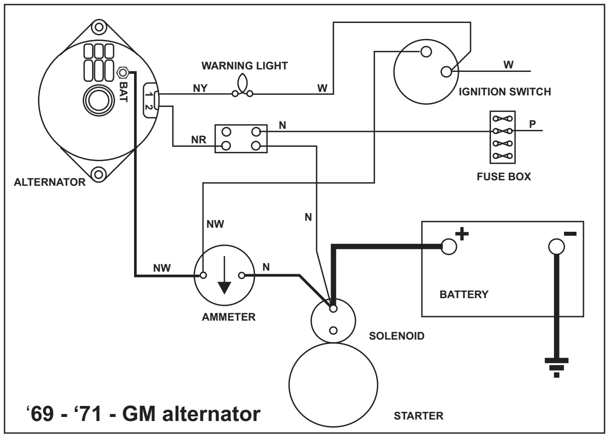



FIGURE 7

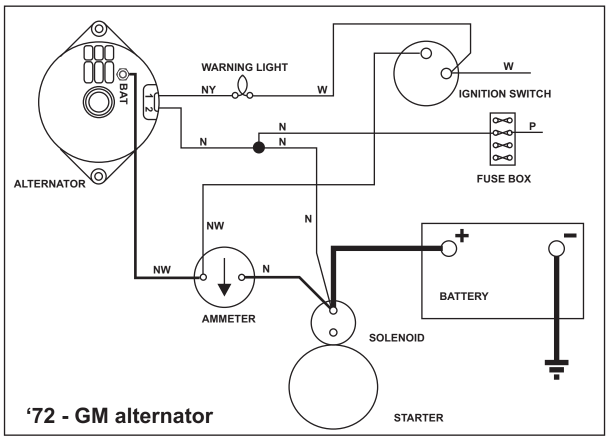



FIGURE 8

THREE WIRE: Refer to **figure 9** below. For '69 - '72, as above, except the short Brown/Yellow wire is not there. For '73 and later, connect the large Brown wire to the screw terminal, the smaller Brown wire to the lead coming from terminal 2 of the plug, and the Brown/Yellow wire to terminal 1. Insert the plug, and you are finished.

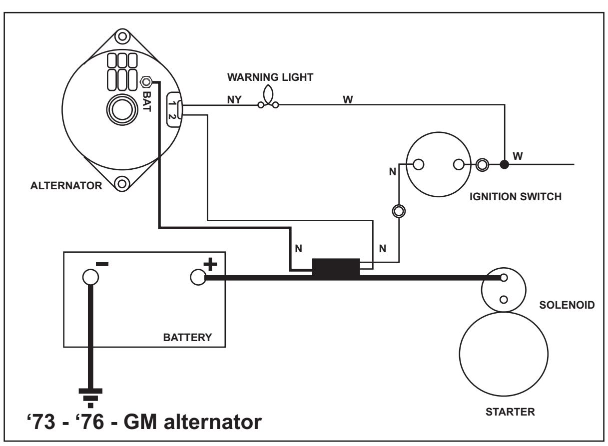



FIGURE 9

METHOD TWO (Upgraded wiring):

TR250/'69 - '72 TR6: For these models, if you wish to upgrade the wiring to take advantage of the higher output, you have two options - replace the existing wiring and replace or shunt the ammeter, or bypass the ammeter with new wiring.

The simplest method is to bypass the ammeter, as shown in **figures 10, 11,** and **12**, below.

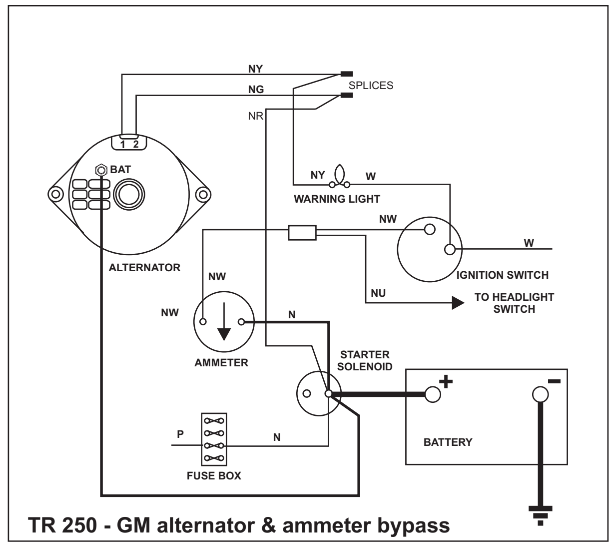



FIGURE 10

To do this, cut off both ends of the Brown/White wire - at the old alternator and at the ammeter - as close to the wire harness wrapping as possible (or, unwrap the harness, and remove the wire all-together). ***NOTE***: there are two Brown/White wires at the ammeter. Use a multi meter, or a continuity checker, to make sure you remove the correct wire. If you remove the wrong one, the car will have no electrical power. The wire you need to remove should be the larger of the two, if there is any size difference. Remove and discard the ends of the wires you just cut.

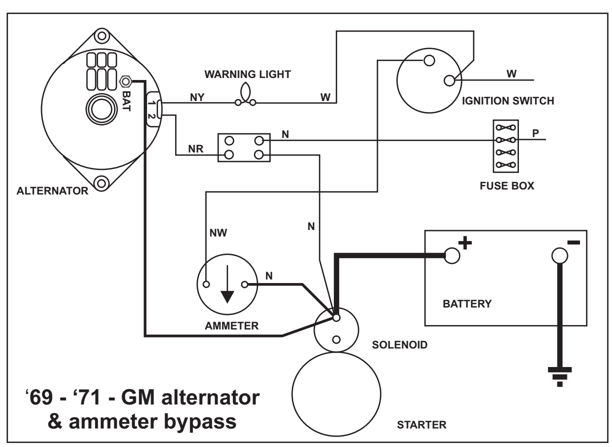



FIGURE 11

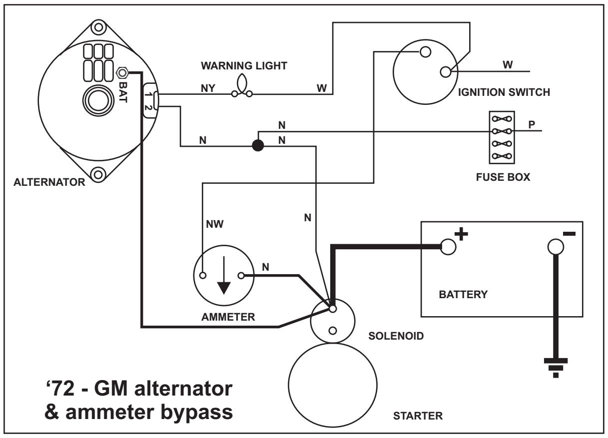



FIGURE 12

Next, instead of connecting the existing brown/white wire to the new alternator, add a new wire of at least 10 Ga (8 Ga preferred). Connect one end to the screw terminal at the alternator, and the other end to the terminal on the starter solenoid where the main cable from the battery is now connected. There are also two brown wires, (and a brown/red wire on the TR250) on this terminal. Leave them in place. Very carefully route the new wire alongside the existing wiring harness, and use cable ties liberally for support. Wired this way, the ammeter will no longer read correctly. See chapter 15, Gauges, for details.

If you wish to add extra loads, such as a high power sound system, connect them directly to the battery, or to the battery connection at the starter solenoid, properly fused, of course. Loads connected directly to the battery will not be indicated on the ammeter either. Again, see chapter 15 for details.

The second approach, although a bit more difficult, is actually a better way of upgrading. For this approach, you will need to replace the Brown wire from the starter solenoid to the ammeter, and replace the Brown/White wire from the ammeter to the alternator. The best way to do this is to open up the wiring harness and remove the wires, replacing them with new wires of at least 10 Ga.(8 Ga. preferred). Alternately, you can just cut and remove the ends of the old wires, as described above, and add new wiring alongside the old.

The next step is to replace or modify your ammeter. There are ammeters available with a 60-0-60 amp rating, but none of them will match your existing gauges. If you can live with the mismatch, this is probably the best way to go. If you want to retain the original gauge, you will need to add a bypass shunt to it. Instructions for doing this are included in at the end of this chapter.

Even if you use this method, it is still recommended that you connect any high power loads to the battery or the battery connection at the solenoid, as the remainder of the Triumph wiring may not be able to handle the load. Any load connected this way will be indicated on the ammeter as a charge current. The reasons for this are also described in chapter 15, Gauges. In this case, when these loads are on you will need to consider the charge indication as your new "zero" point. If the needle drops below this point, you are discharging the battery, while a reading above this point indicates a charging current.

'73 - '76 TR6: For these model years, the upgrade modifications are quite simple, as shown in **figure 13** below. To do this, cut off the ends of the large Brown wire from the alternator to the connector on the main battery lead (or open the harness and replace the wire), run a new wire, 10 Ga or larger, from the large terminal on the alternator to the battery terminal on the solenoid. As the '73 - '76 models did not use an ammeter, there is no drawback to the upgraded wiring method - the voltmeter will still read correctly. As for the other years, and for the same reasons, any high powered loads should be connected directly to the battery, either using the now unused terminal on the battery cable connector, or at the solenoid.

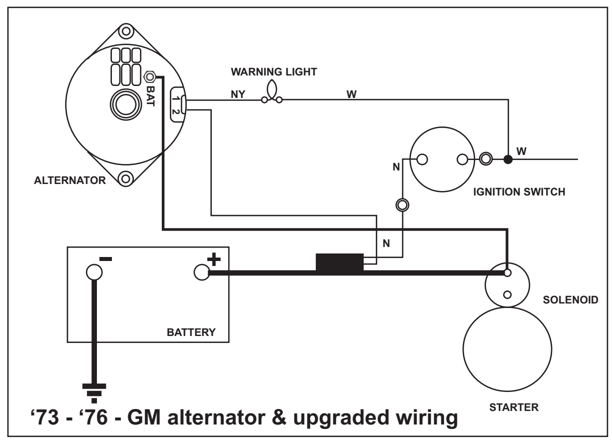



FIGURE 13

OPTIONS:

There are several other ways to do the replacement. For example, you may wish to replace the ammeter with a voltmeter. To do this, just remove the ammeter, and connect all the wires from the ammeter together (excluding, of course, the wires for the illumination lamp). Be very sure that you have a good connection here, as this junction will carry a lot of current. If the connection is not good, a lot of heat can be generated, and a lot of heat is NOT what you want under the dash.

Connect the replacement voltmeter to the wiring, tying one side (the positive post of the VM if your VM is polarity sensitive - most are not. See chapter 15, Gauges, for details) to a convenient green wire, and the other, or minus, side to a good ground. The voltmeter draws very little current, but the wiring used to connect to the green wire should be at least 14 gauge because of the fuse size used in the green wire circuit. The size of the ground wire isn't important, and can be as small as 20 gauge with no problem. Either reuse the old lamp holder from the ammeter, if it fits, or cut and splice the old wires to the new lamp holder.

You may also choose to use a different alternator, rather than the GM unit. If so, it will be wired very similarly to the above, only the connections at the alternator itself will be different. All internally regulated alternators have the same basic connection requirements. Each requires four connections - ground, main charging, sensing, and warning light. The general arrangements of these connections may differ, and in some cases the connections are made internally, but they are all basically the same. If you want to use another make, go to the public library and get a manual for the car which uses your choice, and determine the connection scheme for it in the manual. Mechanical mounting details may differ significantly from one make of alternator to another, but, in most cases, fabricating mounting brackets is well within the capability of most backyard mechanics.

Once you have identified the proper connections, it's a simple matter then to transfer that data over to correlate with the equivalent GM connections as described here. If you are not sure, take your alternator and this manual to an alternator repair shop and ask the folks there to correlate the data for you. Usually, they will not charge you to do this, but even if they do, the cost will be minimal, and well worth it for the peace of mind it will bring.

Although I have no personal experience with them, it has been reported that a Bosch alternator from a Ford Fiesta is a "bolt-on, plug-in" direct replacement for a Lucas alternator with the three terminal arrangement. The part number for these units has been given as (120 489 346) or (120 489 347). The only modifications reported is the need for a slightly longer belt. The Fiesta has an output of 70 amps, but is a bit more expensive than the GM.

WIRING DIAGRAMS

In this chapter, I have included nine diagrams, one before and two after, for each of the three alternator connections used in the TR250 and TR6. These diagram do not depict all of the connections used by Triumph - only those for which documentation has been provided by official Triumph or Triumph approved publications, or for which I am personally acquainted. These cars have also appeared with other configurations at various times. I did not attempt to include every configuration, because of the uncertainty involved. I have no way of knowing if the different wiring schemes are original factory installations or modifications made by previous owners, and, in many cases, it is not possible to determine the exact wiring scheme without tearing up the wiring harness. As you can imagine, not many owners are willing to let me do that!

With the information supplied in this and the alternator operation chapter, it should not be difficult to arrive at the proper wiring scheme for the other situations.

AMMETER SHUNT

If you wish to upgrade to a larger capacity alternator, yet want to retain your ammeter, all is not lost, as there is a relatively simple modification you can make to allow the ammeter to function with as large a current as you choose. Although the modification is quite simple, a little experimentation will be required to implement it.

Ideally, an ammeter has zero resistance; it's in the main lead supplying power to the whole car, so it carries a lot of current, and any large resistance here would drop an excessive amount of voltage. In reality, though, an ammeter has some resistance, just a few thousands of an ohm. Looking at **photo 1** below, you can see that the current carrying portion of an ammeter is nothing more than a piece of wire, thus the resistance of the ammeter is just the resistance of that piece of wire.

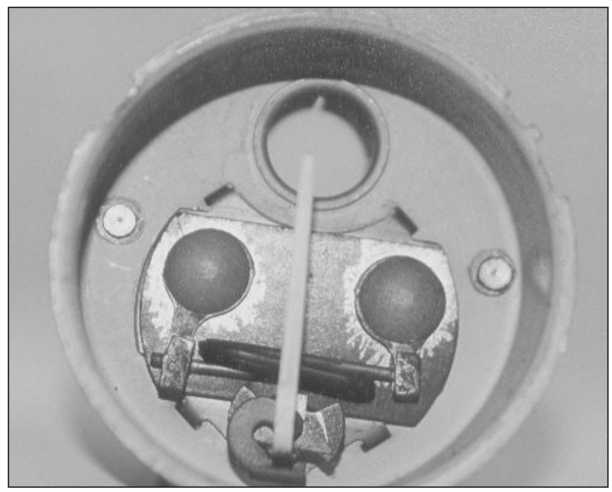


PHOTO 1

The internal ammeter wire may be capable of carrying more than 30 amps, and, although I can't say with any absolute certainty, it appears that no damage would be done to the movement if it were operated well over its range, it would still be nice to have the needle operate within the meter dial range, without banging the sides. One way to bring the ammeter scale into range is to have the excess current shunted around the ammeter. This is shown in **figure 14**, next page.

If you recall from chapter 1, Introduction, the circuit shown is a parallel circuit, and in a parallel circuit, the voltage on each component is the same, while the current is split between the components. If the resistance of the shunt is equal to the resistance of the meter, the current will be evenly split between the two. In this instance, the current capacity of the meter would be doubled to 60 amps. The meter dial would still say 30-0-30, so you would have to mentally double your reading to get the true reading, certainly not a problem.

As the meter is just a piece of wire, another piece of wire of the same gauge and length would have the same resistance as the meter, and the current would be split 50 - 50. The wire in the ammeter shown in **photo 1**, taken from a ‘71 TR6, measures to be an approximately 3 inch long piece of 15 gauge copper wire. A 3 inch piece of 15 gauge wire used as a shunt would then give you 50 - 50 split. Unfortunately, 15 gauge wire is not readily available for use, but a slightly longer piece of 14 gauge, or a slightly shorter piece of 16 gauge, would do nicely. The ammeter wire size measurement was not a laboratory precise measurement, so experimentation will be required to arrive at the actual length and gauge of wire needed. You may prefer to split the current in a different ratio, depending on the output capability of your alternator. If, for example, you have a 100 amp alternator, you may wish to split the current 70:30.

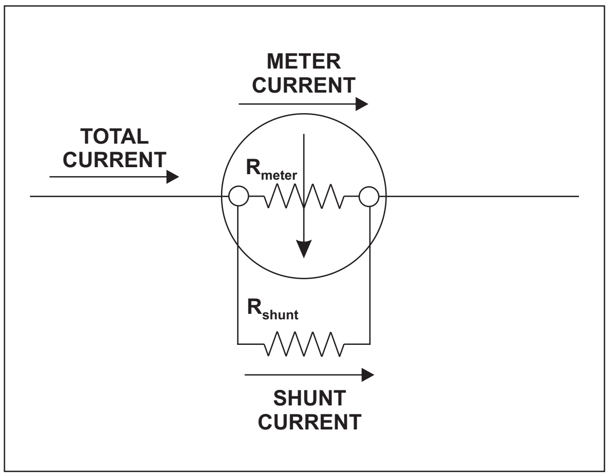



FIGURE 14

Probably the best way to size the shunt would be to set up a load on the ammeter, using a battery or a battery charger as a source of power, and noting the current. The load should be sized to draw near mid-scale current. A few old headlights would do nicely. Starting with a “guesstimated” length of wire as a shunt, adjust the length as needed to arrive at the desired current split. It is not at all necessary that your final reading be very accurate, as the meter dial is not readable with much precision anyway, and a precise value isn’t needed.

Even if you use this method, it is still recommended that you connect any high power loads to the battery or the battery connection at the solenoid, as the remainder of the Triumph wiring may not be able to handle the load. Any loads connected this way will be indicated on the ammeter as a charge current. The reasons for this are described in chapter 15, Gauges.

# 31
# BALLAST RESISTER BYPASS

Many '73 - '76 TR6 owners opt to replace their standard coil with the Lucas Sport coil, to get a hotter spark. Often, though, they neglect to bypass the ballast resistor. Failure to do this will negate the benefit of using the hotter coil, as the Sport coil is designed to be used without a ballast resistor. Refer to chapter 20, Ignition circuit, for a complete explanation of the function and operation of the ballast resistor. This chapter will only cover the means of removing or bypassing the resistor.

PROCEDURE

On a TR6, the ballast resistor is a short length of special resistance wire (pink and white, and looking rather like a shoelace), and is routed in the wiring harness with the other wires. This makes removing the ballast resistor rather difficult. It is much simpler to just leave the ballast resistor in place and bypass it. If you wish to remove it for some reason, you will have to unwrap that portion of the wiring harness to get to it - a lot of work for no real reason.

As for the modifications required to bypass the ballast resistor, it couldn't be simpler - just run a wire from the most convenient white wire you can find (probably at the fuse box), directly to the (+) terminal of the coil (of course, all the rules of good wiring practice should be used, as described in chapter 10, Wiring Harness Repair). There is no need to remove the resistance wire, because it will now be constantly bypassed, just as it was before when cranking. This will work with any model Triumph, but there is an easier way with the '74 - '75 TR6. The resistor bypass wire from the starter relay to the coil (white/yellow) can simply be lifted from the relay terminal and moved to the fuse box terminal where the white wire is attached. The relay is located very close to the fuse box, and, unless someone has modified the car, there should be a spare terminal by the white wire that can be used.

**Figures 1,** and **2** below depict the circuit configuration, before and after the ballast resistor is bypassed, for the '73 model.

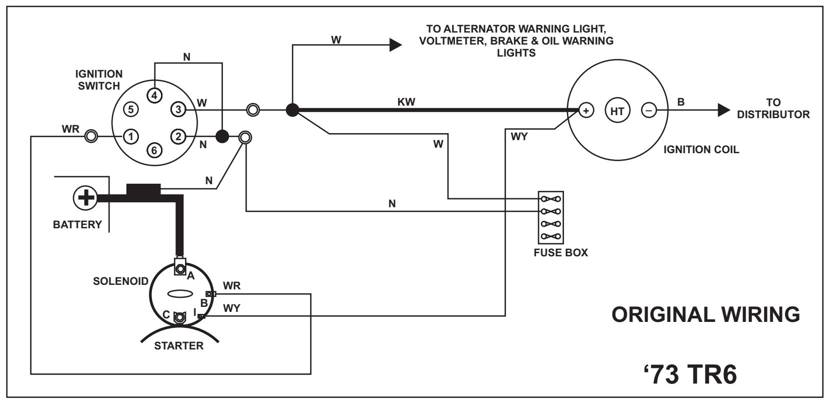



FIGURE 1

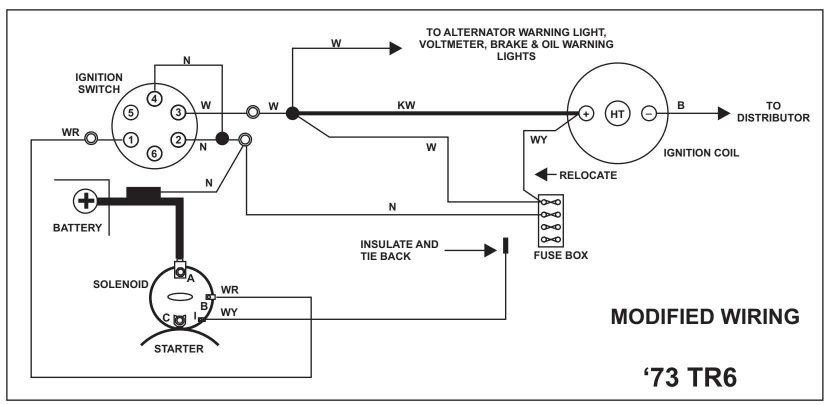



FIGURE 2

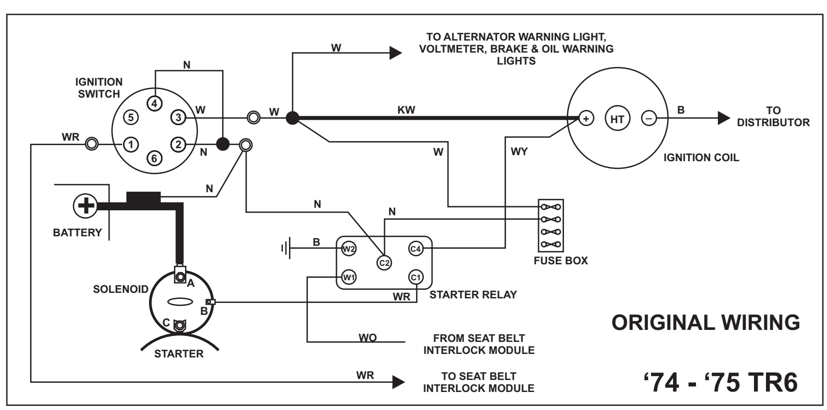



FIGURE 3

**Figure 3,** previous page, and **figure 4,** right, depict the before and after wiring for the '74 - '75 models. **Figures 5** and **6**, below right, depict the before and after wiring for the '76 model.

***NOTE:*** Although not required from an operational standpoint, I recommend that you cut the WY from the coil on a '73 or a'76 model, insulate it, and tie it back out of the way, for safety reasons. The other end of the WY wire is connected to a terminal on the starter solenoid which is hot any time the starter is operating. If you are doing maintenance work on the car that calls for the starter to be operating, and you are bypassing the ignition key and jumpering directly to the starter as outlined in chapter 25, Starter, the engine will start if the WY wire is still attached to the coil. Of course, just as soon as the engine starts and the starter is off, the engine will immediately die, but it could be quite a surprise, and maybe cause injury, if the engine should start when you are not expecting it to.

SPARK PLUG GAP

Bypassing the ballast resistor is only one of the changes necessary to utilize the full advantage of the Sport coil, or any high output coil for that matter. Unless you also increase the spark plug gap, the plugs will continue to fire at the same coil secondary voltage as before, give or take a little, and will not give the hotter spark that you paid for. The voltage rise at the output of the coil secondary, although rapid, is not instantaneous. As the voltage rises from zero, as soon as it reaches the value high enough to jump the plug gap, it will. As the plugs were firing at 20,000 volts with the old coil, they will still fire at that voltage level regardless of the maximum voltage potential of the new coil. As soon as they fire, and the arc begins, the voltage drops to zero. By widening the gap, the voltage must rise to a higher value to jump the gap. Ideally, the plugs should be gapped to the widest setting that will still allow them to fire under all engine operating conditions. Usually, the coil manufacturer will give recommended gap setting, but these should be used as the starting point, and adjusted from there as experience dictates. Lacking manufacturer's data, 0.035" is a good starting point.

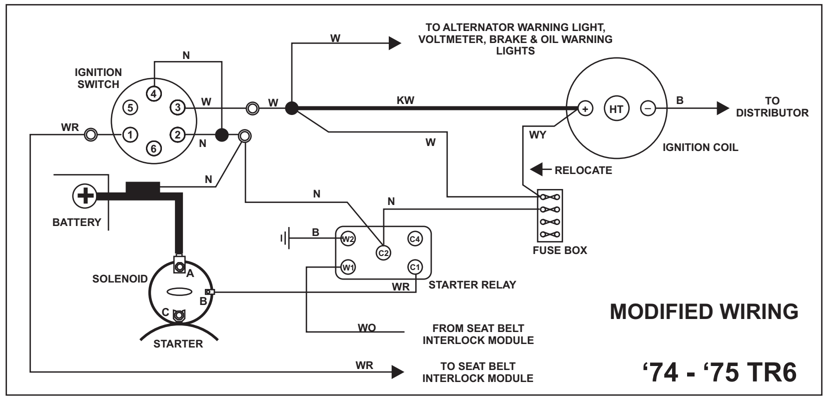



FIGURE 4

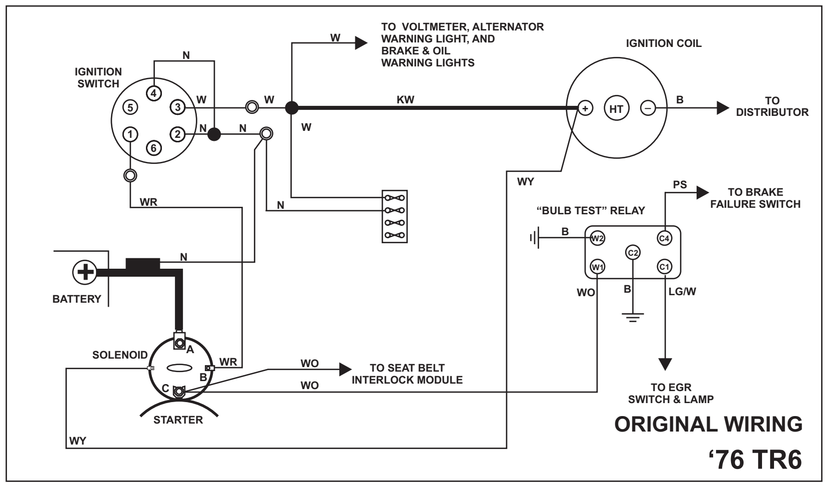



FIGURE 5

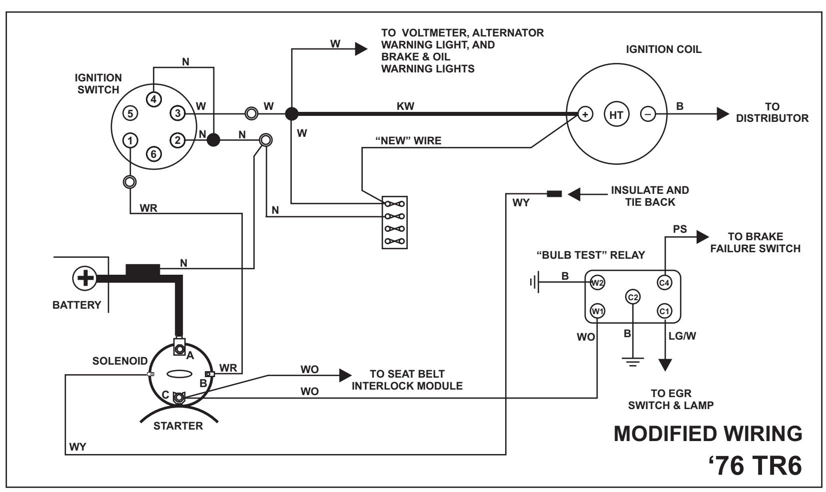
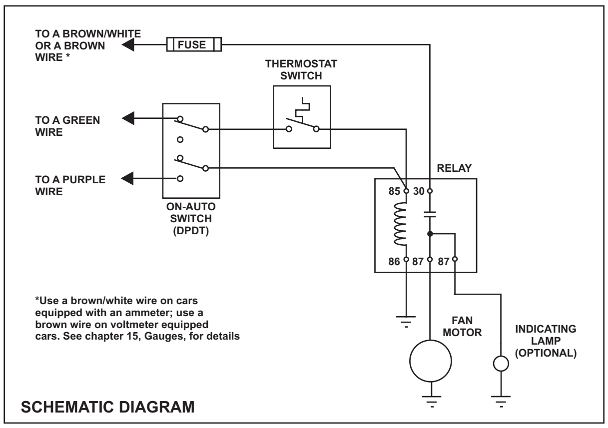



FIGURE 6

# 32
# ELECTRIC COOLING FANS

**Figure 1** below shows my recommended method for adding an electric cooling fan to your car. It has both a manual and an automatic mode of operation. In the automatic mode, the fan will only run when the thermostat is on ***AND*** the ignition key is in the "run" or "start" position. In the manual mode, the fan can be operated with the key switch on or off, and the thermostat is bypassed.



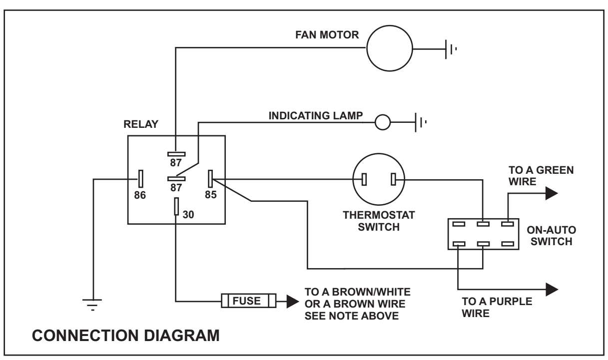




FIGURE 1:

INSTRUCTIONS AND PROCEDURES

1. The relay can be mounted any where that is convenient. The only criteria that is of any concern (other than protection from physical damage) is the TOTAL length of wire from the brown (or brown/white) wire to the relay and then from the relay to the fan motor. This length should be kept short, but as long as you use the proper size wire, it is not really important (assuming you don't intend to mount the relay in the trunk!). In my car, I bought a relay with a metal mounting tab, bent the tab and mounted the relay under one of the screws that fasten the existing relays to the bracket under the hood. See **photo 1**, page 143, for details.

2. Connect pin 30 of the relay to a brown/white wire in a car with an ammeter (this is so that the ammeter will read correctly), or to a brown wire in a car with a voltmeter. The wire I've shown as a brown wire should be connected directly to the battery if your car has a voltmeter. If you have an earlier model with an ammeter, connect the wire I've shown as brown/white to the alternator side of the ammeter if you wish to have the ammeter read correctly. See chapter 15, Gauges, for details on this.

3. The fuse in the lead to the brown (or brown/white) wire ***MUST*** be placed as close to the connection to the brown (or brown/white) wire as possible. If you do this, the remainder of the wire will be protected, and routing becomes less critical. HINT: If you detest un-necessary splices as much as I do, you might try this trick. I buy heavy duty in-line fuse holders from the auto parts store and modify them to suit my purpose. I cut the leads off to about an inch and strip off all the insulation. Next, I remove the fuse contacts, and the wire, from the holder. I place the contacts in a vise and spread the wire strands out in a fan shape. Using a pair of needle nose pliers, I pull the center strand out of the crimp on the contact. After a few of the center strands are removed, the rest come out easily. Once all the wires are removed, I spread the crimp just a little, and insert the end of the wire I wish to use and recrimp, followed by soldering. This way, I get an in-line fuse holder with the correct color coded wires, and each wire long enough to reach the rest of the circuit without splices.

4.The wires used from the brown (or brown/white) wire to the relay and from the relay to the fan should be sized to carry the rated current of the fan with a little margin. I would use 12 gauge -- good for 20 amps -- unless you are using a real horse of a fan.

5. The fuse ***MUST BE NO LARGER*** than the current rating of the wires used in 4). See chapter 7, Fuses, for details.

6. If you wish to use the optional indicating light, you will have to use the same size wire for the light as you use for the fan motor to ensure that it is properly fused (or add a second fuse in the wire to the light, sized to suit the wire gauge. This fuse will have to be sized not larger than the current rating of the wire, and placed as close to the relay as possible). If you prefer, you could connect the indicating lamp to terminal 85, along with the other two wires. This way, no special precautions are required, other than listed in 8) below. Wired this way, the light will tell you that the fan is "supposed" to be on, but not that it is

actually running. The fuse could be blown and you would still get an ON indication, even though the fan is not powered.

7. When you connect to the green and the purple wires, you can use ***ANY*** Green or ***ANY*** Purple wire you find, whichever of these wires is most convenient for you to connect to. Same for the Brown (or Brown/White) wire.

8. Use at least 14 gauge wire for the connections to the green and purple wires, and you won't need to use a fuse in these leads, as the green and purple wires are already fused.

9. You ***MUST*** use a DPDT switch; otherwise, if you have the switch in the ON position and the thermostat switch comes on, the effect is the same as having the ignition key on. In this instance, power would be back-fed from the purple wire through the two switches and then back to the green wire. Since the green wire is connected to the ignition switch, all the loads fed from the ignition switch via the green wires would be powered. By using a DPDT switch, wired as shown, the green wire is disconnected from the thermostat switch when the DPDT switch is in the ON position.

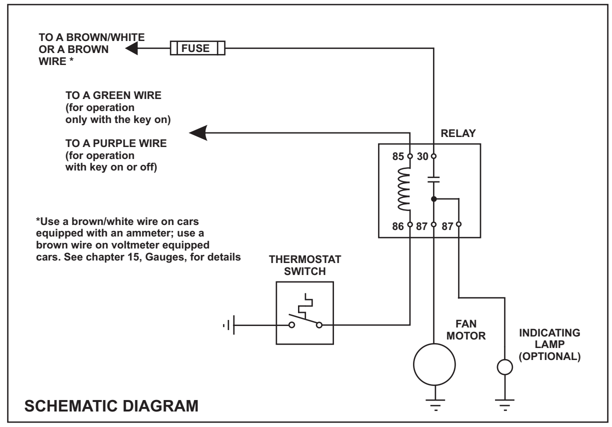
10. There is a problem with the labeling of terminals on relays. They are not consistent in how the 87 terminals are labeled. If you buy a relay with four terminals, there is no problem, but if you buy one with five terminals, the "center" terminal may be labeled 87, or 87a or 87b, depending on who makes it. Sometimes the center terminal, regardless of its label, is a "normally closed" or NC, contact i.e., connected to terminal 30 when the relay is OFF, and disconnected when the relay is ON. The only way to be sure is to look at the diagram on the side of the relay case to see that both the center and the other 87 (or 87a or 87b) terminal are closed only when the relay is energized. Luckily, it is very rare to find a relay with the center terminal as a NC in an auto parts store (I have to special order them, and about half the time, I get the wrong ones!). See chapter 9, Switches, Relays, and Solenoids, for details on this.

11. If you buy a relay with four terminals, and still wish to use the optional indicating light, just connect the wire to the light to the same terminal (87) as the fan motor. The same requirements in 6) still apply.

12. The physical configuration of the DPDT switch as shown in the connection diagram is not important -- only that it looks like that shown when the wiring is completed. Wired one way, the fan will be ON with the switch handle in the down position: wired the other way, the fan will be ON with the switch handle in the up position.

14. If you buy the ON-AUTO switch at an auto parts store, it will almost certainly have three positions - ON-OFF-AUTO. If the third position is undesirable, you will have to go to an electronics store, such as Radio Shack. The only problem with this is that their switches usually don't suit an automobile very well, from an esthetics standpoint. You might want to hide it under the dash somewhere.

OPTIONAL CIRCUIT



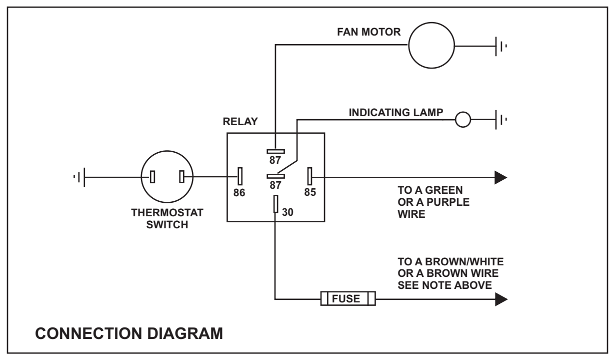




FIGURE 2: *these two diagrams are for installations where the fan has no manual override control.*

You may prefer not to use the manual-auto switch, but just wire the fan relay directly to the thermostat, as shown in **Figure 2** above. This method may be necessary if you are using one of the thermostats that screw directly into the engine block or radiator. In this case, the body of the thermostat is grounded, so the manual/auto scheme won't work.

The general procedures and cautions mentioned above also apply to this circuit, except you can use a smaller wire from the relay to the thermostat. This wire only carries the small relay coil current, and grounds the relay to operate. Should this wire short to ground, the only side effect is to operate the relay, turning on the fan - not a serious problem.

# 33
# ADDING AN ELECTRIC FUEL PUMP

For various reasons, you may want to replace your mechanical fuel pump with an electric pump. This is a fairly straight forward installation, and I have shown three optional wiring configurations for this.

**Figure 1** shows the most basic installation, and is fully adequate if your pump draws less than four or five amps. There is no need to add an additional fuse if you connect to an existing green wire, as the green wires are already fused.

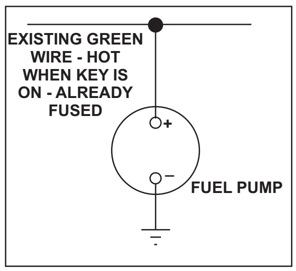



FIGURE 1

**Figure 2** below shows the addition of a relay, and should be used if the pump  draws more than five amps. In this design, you ***MUST*** add a fuse to the line feeding the pump, as the white wires are ***NOT*** already fused in a Triumph. The lead to the pump will probably be routed under the car for at least a portion of its length, where it will be exposed to the elements, making a fuse necessary.

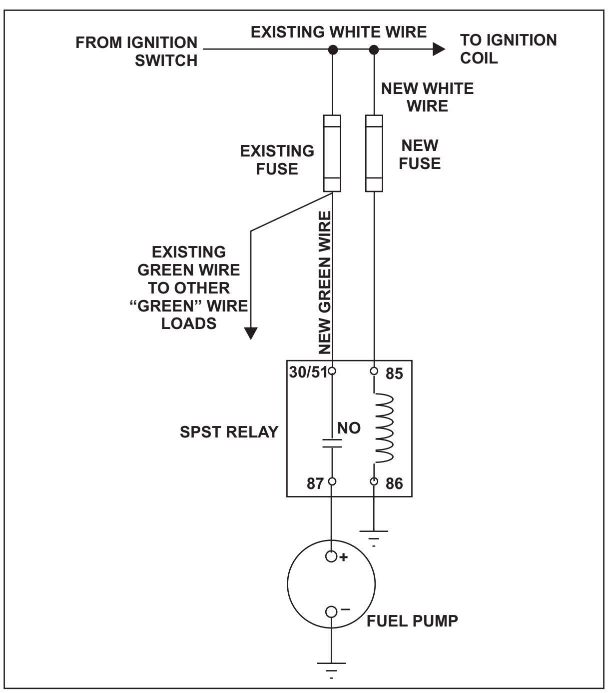



FIGURE 2

For safety purposes, it's a good idea to have an automatic shutoff feature on the fuel pump in case of an accident. Unlike a mechanical pump, an electric pump will still function with the engine off, and can spill a lot of gas on the ground if a fuel line has been broken. Some folks like to use an oil pressure switch to shut of the pump when the engine dies, but I don't prefer that method for a couple of reasons. First of all, it's unnecessary if the engine has died but the car has not been overturned, as the needle valves in the carburetors will shut off the flow of fuel. Secondly, if you let your car sit for lengthy periods of time between driving it, such as in the off season, the fuel will evaporate from the float bowls, making it hard, if not impossible, to start the car. A mechanical pump will pump fuel while the starter motor is turning to prime the bowls, but if the electrical pump is shut off due to low oil pressure, the starter motor may not produce enough oil pressure to reset the pump. In this circumstance, you want to be able to turn the key to the on position long enough for the pump to fill the bowls before turning to the start position.

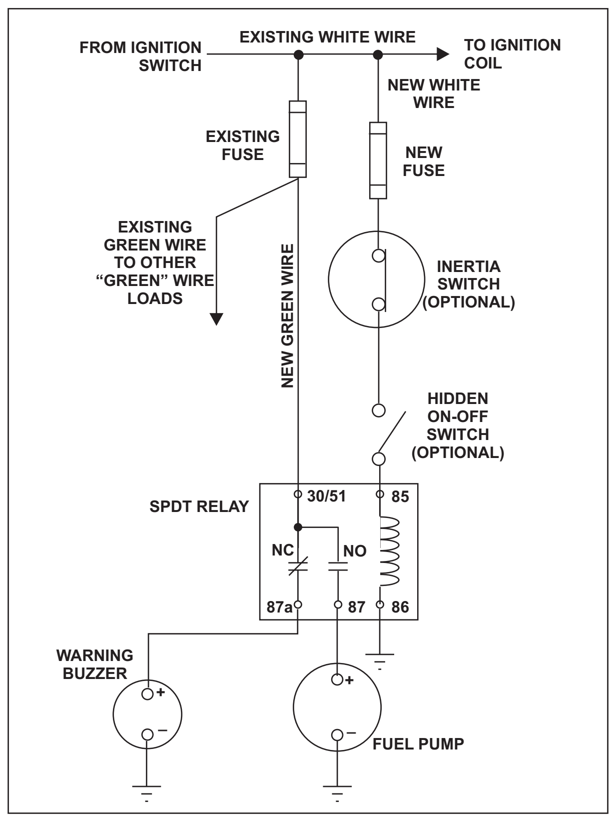



FIGURE 3

My preferred safety shutoff method, shown in **figure 3** above, is to use an inertia switch, wired to shut off the pump in the event of a crash, whether the car has overturned or not. Any accident that jolts the car hard enough to rupture or break a fuel line will certainly operate the inertia switch. Unfortunately, a hard jolt from hitting a pothole can sometimes operate the inertia switch as well. For this reason, I prefer to mount the switch in the cockpit where it can easily be reached and reset by the driver without stopping the car, and I also wire it to sound the chime or buzzer should this happen. This way, there is no need to wonder if that last pothole you hit shut off the fuel pump -- if you don't hear the chime, you're OK. This is also shown in the wiring diagram in **figure 3**. This diagram also shows an optional cutout switch, which serves as a simple theft prevention device and a maintenance aid. It will allow you to shut off the pump while having the ignition on to do maintenance on your car.

Inertia switches can be purchased from most speed parts vendors, such a Summit, JEGS, or even J. C. Whitney, and cost around \$50 -\$60 at the time of this writing. The Roadster Factory, Moss Motors and Victoria British often carry them as well, as do some of the other British parts suppliers. To save a few dollars, you might be able to salvage a working switch from a modern fuel injected automobile at your local salvage yard.

# 34
# ADDING FOG AND/OR DRIVING LIGHTS

OPERATIONAL SCHEME

Here's my preferred method for wiring fog and driving lights: Use one relay for the fog lights, and another for the driving lights, both fed from the same fused lead from the battery. Then, use a three position switch (readily available at most any auto parts store for around $5), wired as follows - with the switch in the up position, the fog lights will be on if and only if the parking lights are on. With the switch in the center position, neither the fog nor the driving lights will be on. With the switch in the down position, the driving lights will be on if and only if the high beams are on.

Reasons for this?

1. You won't have to remember to turn off another switch when you turn off the main lights, as the fog or driving lights will automatically go off.
2. No worry about blinding an oncoming driver, as the driving lights will go off when you dim the main lights.
3. If you really need the driving lights, you also need the high beams.
4. In a very heavy fog, even the low beams may be blinding to you, reflecting off the fog, so you want to be able to have only the parking and the fog lights on.
5. You will never need both the fog and the driving lights on at the same time.
6. One switch will do the function of two, which may make it easier to find a place to mount it.
7. One fused lead will do, as both lights will never be on at the same time.

When you mount your lights, remember the differences in the light pattern from the two types. A fog light has a very sharp cut off, limiting the light to a narrow band just above the pavement. This allows the light to go under the fog, eliminating glare from the light bouncing off the fog. For this reason, the fog lights should be mounted as low as possible.

Driving lights, on the other hand, are intended to have a long, penetrating beam, designed to light up the road as far ahead as possible. For this reason, they should be mounted as high as possible.

At the end of this chapter are schematics for the fog and driving light circuit described above, along with wiring/connection diagrams as well. The wiring/connection diagrams give the physical details for wiring. Actually, there are six sets of diagrams; one each switching the ground leads to the relays, and one each switching power to the relays, for three different configurations - using both driving and fog lights, using driving lights only, or using fog lights only. Functionally, the power switching and the ground switching circuits are the same for each installation, but one or the other will be easier to install, depending on where you mount the relays.

In general, you should choose the one that limits the length of the "powered" wires to the relay coil. That is, if you have the choice of long powered leads and short ground leads, or short powered leads and long ground leads, choose the location that gives the latter. A short on a ground wire will do no harm, whereas a short on one of the power leads can burn a wire or blow a fuse. It is always good practice to limit the exposure of wires that have power on them.

A double pole, double throw (DPDT) switch is shown for both schemes when using driving and fog lights, although you could get by with a single pole, double throw (SPDT) switch for the grounding circuit. The reason I show it this way is because a DPDT switch is the most likely type of switch you will find in the auto parts stores. If you can find a SPDT switch, and prefer to use it, no problem at all - just ignore one half of the switch in the diagrams.

INSTRUCTIONS AND PROCEDURES

The relays can be mounted any where that is convenient. The only criteria that is of any concern (other than protection from physical damage) is the TOTAL length of wire from the power source to the relays and then from the relay to the lights. This length should be kept short, but as long as you use the proper size wire, it is not really important (assuming you don't intend to mount the relay in the trunk!). The wire from the power source should be connected directly to the battery (solenoid connection) if your car has a voltmeter. If you have an earlier model with an ammeter, connect it to a brown/white wire on the alternator side of the ammeter if you wish to have the ammeter read correctly. See chapter 14, Gauges, for details on this.

The fuse in the lead to the power source ***MUST*** be placed as close to the connection to the power source as possible. If you do this, the remainder of the wire will be protected, and routing becomes less critical. Rather than connecting to an existing brown wire, I recommend using a new brown wire, and connecting it as close to the power source as you can. If you do connect to an existing brown wire, make sure it is large enough to handle the existing load as well as the added loads of the lights. HINT: If you detest un-necessary splices as much as I do, you might try this trick. I buy heavy-duty in-line fuse holders from the auto parts store and modify them to suit my purpose. I cut the leads off to about an inch and strip off all the insulation. Next, I remove the fuse contacts, and the wire, from the holder. I place the contacts in a vise and spread the wire strands out in a fan shape. Using a pair of needle nose pliers, I pull the center strand out of the crimp on the contact. After a few of the center strands are removed, the rest come out easily. Once all the wires are removed, I spread the crimp just a little, and insert the end of the wire I wish to use and re-crimp, followed by soldering. This way, I get an in-line fuse holder with the correct color coded wires, and each wire long enough to reach the rest of the circuit without splices.

The wires used from the power source to the relays and from the relays to the lights should be sized to carry the rated current of the lights with a little margin. I would use 12 gauge -- good for 20 amps -- unless you are using very powerful lamps. Remember, only one pair will be on at a time, so the wires should be sized for the most powerful pair.

When you connect to the Red wire, you can use ANY Red wire you find, whichever one is most convenient for you.

Use at least 14-gauge wire for the connections to the Red wire, and you won't need to use a fuse, as the Red wire is already fused.

The physical configuration of the DPDT switch as shown in the connection diagram is not important -- only that it looks like that shown when the wiring is completed. Wired one way, the FOG lights will be on with the switch handle in the up position: wired the other way, the DRIVING lights will be on with the switch handle in the up position.

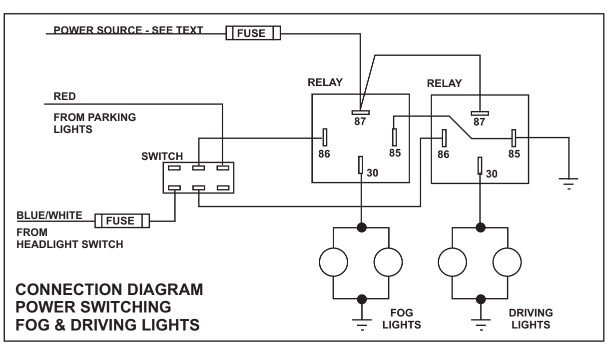
The wires from the switch to the relays in the grounding scheme can be just about any size you want, as they carry only the limited current of the relays. If one of these wires should short to ground, the effect will be exactly that of turning on the switch - no harm done.

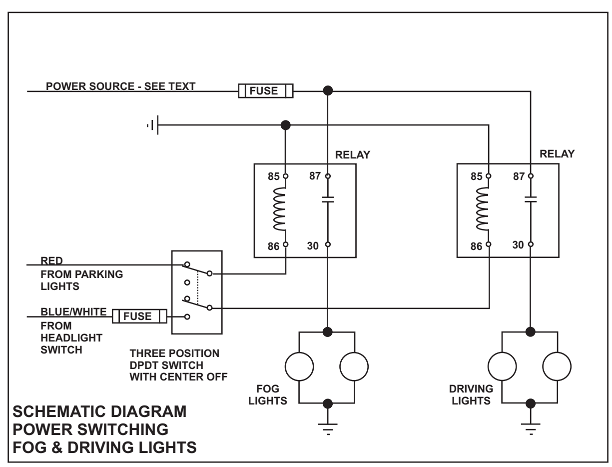
The wires from the switch to the relays in power switching scheme must be sized carefully. Although they carry the same load as those in the grounding scheme, because they are hot under certain conditions, a short here will blow a fuse, provided the wires are adequate to match the fuse. If the wires are too small, they may burn before the fuse blows. The red wire is fused at 17 amps, so the wire must be capable of handling 17 amps. Normally, that calls for 12 Ga., but you could get by with 14. The wire from the blue/white wire can be any size you wish, as long as the fuse is rated no larger than the wire can handle.

The colors for the wires shown are only for existing wires. Use any color you wish for the new wires.

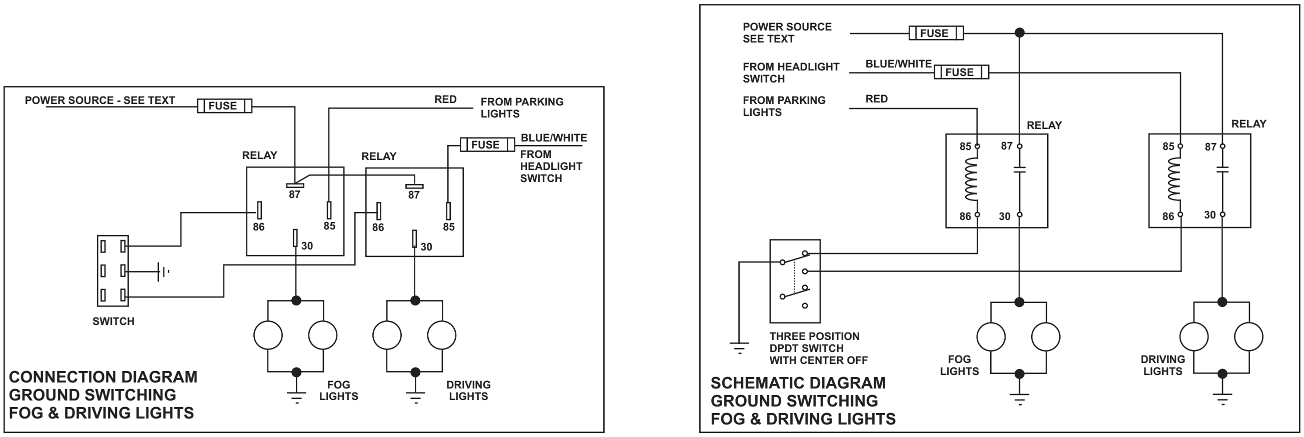
When sizing the fuses, remember that they are there to protect the wiring, so they MUST NOT be sized larger than the current rating of the wiring they are protecting. Refer to chapter 7, Fuses, for more details on fuse sizing.

## SCHEMATICS AND WIRING/CONNECTION DIAGRAMS

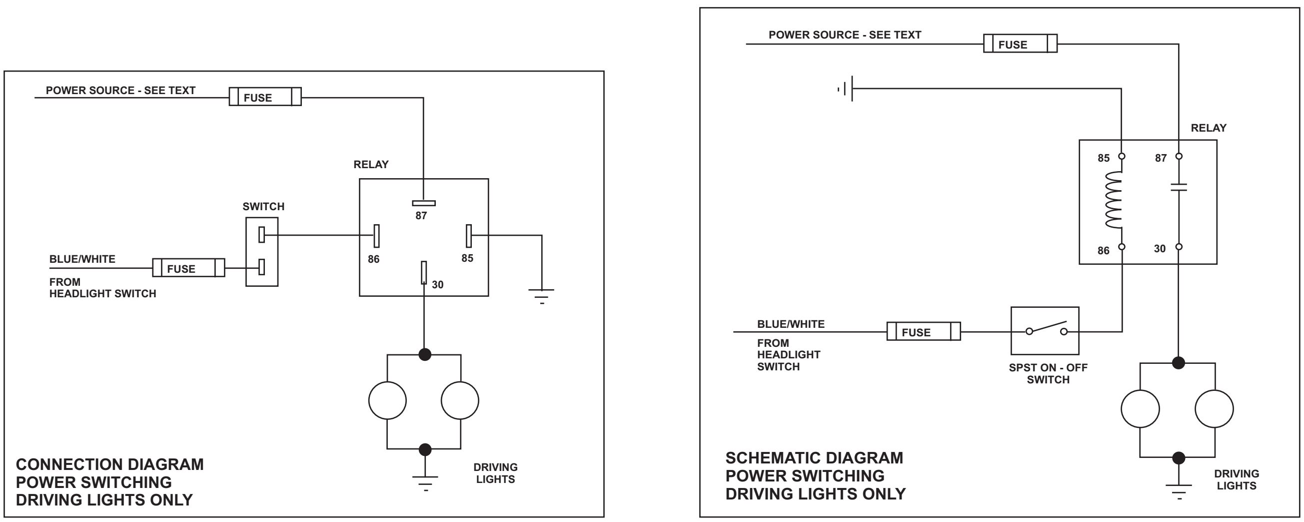


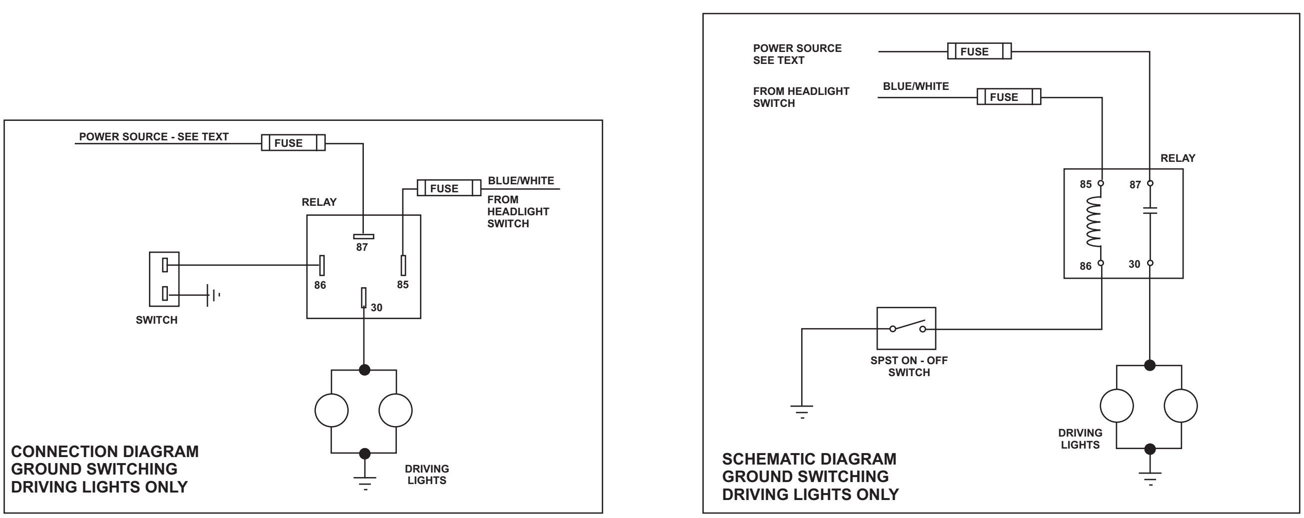

A. Fog and driving lamps, switching the power leads:



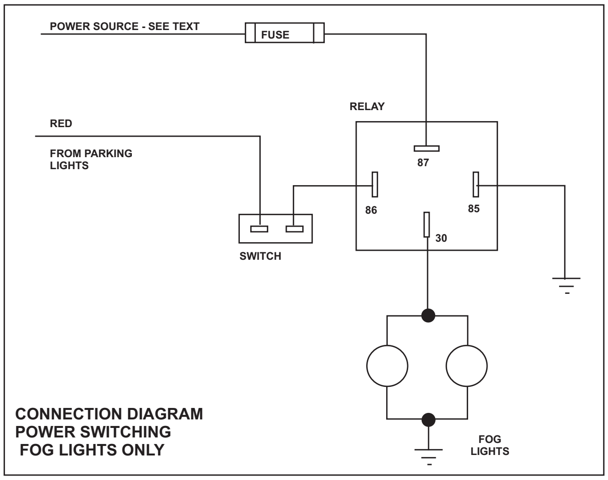

B. Fog and driving, switching ground leads

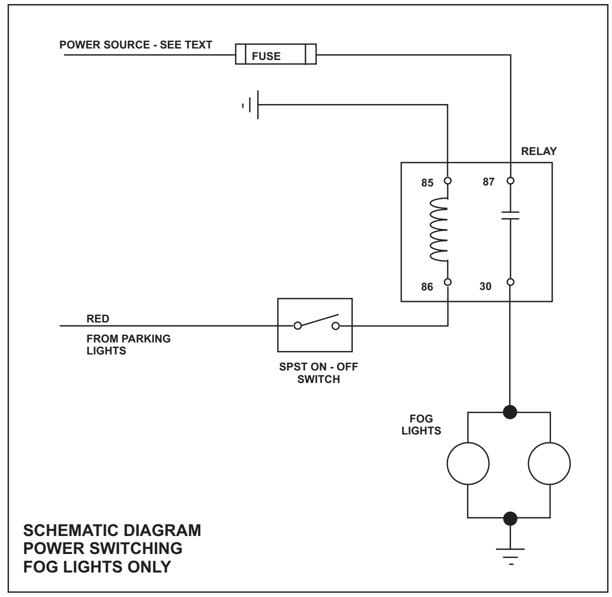



C. Driving lights only, power switching.

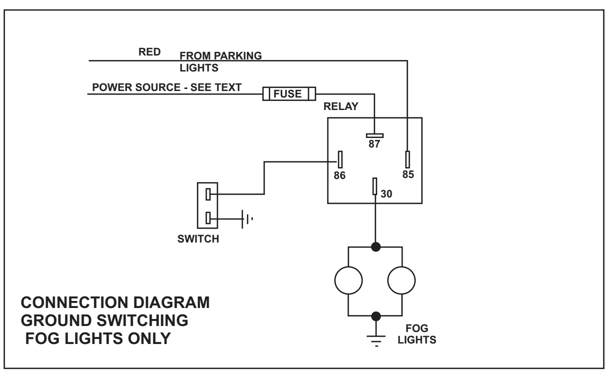


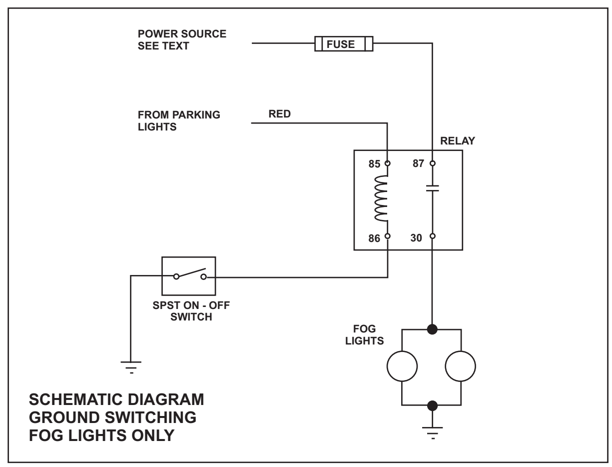

D. Driving lights only, ground switching




E. Fog lights only, power switching.



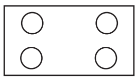
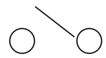
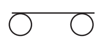
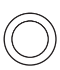
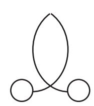
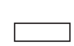
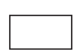




F. Fog lights only, ground switching

# INDEX

# SYMBOLS

Most symbols used in this book are defined as they are used, so they won't be repeated here. Only those symbols which might not be obvious from their usage are included below.

| | | | |
|---|---|---|---|
|  | Four-way power connector block, used only on the '69 - '71 TR6. Located on the driver's side inner fender panel, just in front of the fuse box. |  | Maintained position on-off switch. |
|  | One pin of the multi-pin connector used to connect the rear wiring harness to the main harness in the TR250 thru the '71 TR6. Located near the floor on the drivers side footwell. |  | Momentary position, normally open, on-off switch. |
|  | One pin of the multi-pin connector used to connect the rear wiring harness to the main harness in the '72 thru '76 TR6. Located near the floor on the drivers side footwell. |  | Momentary position, normally closed, on-off switch. |
|  | One pin of the multi-pin connector from the hazard switch to the rest of the wiring harness in the '73 -'76 TR6 only. |  | Ground connection made by the use of a separate grounding wire. (The use of this symbol in documentation by Triumph is not consistent, so verification may be required.) |
|  | One pin of a two-pin connector used in the seat belt circuits in the '72 -'76 TR6, for the seat belt switches, and the seat sensor switches. |  | Ground connection made by the body of the component in contact with the body or chassis metal. (The use of this symbol in documentation by Triumph is not consistent, so verification may be required.) |
|  | One pin of the multi-pin connector from the ignition switch to the rest of the wiring harness in the '73 -'76 TR6 only. |  | Light bulb filament. May be in a single filament bulb, or one of two filaments in a dual filament bulb, such as the headlight or the combined tail/stop lamps. |
|  | Wire connection made by splicing, usually inside the wire harness wrapping. (The use of this symbol in documentation by Triumph is not consistent, so verification may be required.) |  | Two wire bullet/sleeve connector |
| | |  | Four wire bullet/sleeve connector |

# APPENDIX A
# ELECTRON FLOW VERSUS CURRENT FLOW

WHICH WAY DOES ELECTRICITY FLOW?

There are two schools of thought on this subject, with valid reasons and justifications for both. In the "current flow" school of thought, electricity consists of "positive charges" moving from the positive pole, through the conductor, and back to the negative pole. The "electron flow" school of thought says that electricity consists of electrons moving from the negative pole to the positive. They are both correct.

In order to understand the apparent conflict, let's start with electron flow. Electron flow consists, as the name suggests, of the movement of electrons from one atom to another in the conductors. An electron is a physical particle (at least as we understand it today), so it is very easy to visualize. As an electron jumps from one atom to another, it leaves behind a positively charged atom, i.e., an atom that is minus one electron. In effect, there is a "hole" left behind. Immediately, an electron from the next atom jumps in to fill the hole, leaving behind a positively charged atom from whence it came. And so on. As the electrons move from negative to positive, the "hole," left by their movement, moves from positive to negative. In other words, electrons move from negative to positive, while positive charges move from positive to negative. (I used the concept of a "hole" because quite often, writers refer to the current flow theory as "hole theory," Most beginning books on transistor theory use hole theory to explain their operation)

Each line of Xs on the right represents a piece of wire, filled with electrons. In the first line, an electron has moved to the right, off the page, leaving a hole behind. In line two, electron #2 has moved to the right to fill the hole, leaving behind a hole in space 2. In the next line, electron #3 has filled the hole left by electron #2, and so on. If you scan down the page, you can see the "hole" move from right to left, as the electrons move from left to right. In effect, the electrons are moving from minus to plus, while positive charges are moving from plus to minus.

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When you consider that the holes represent a positive charge, then you can see that the point of view that electricity is a "current flow" of positive charges moving in the opposite direction to electron flow is a valid theory.

Why two theories? In the very early days of our study of electricity, no one knew much about it. For lack of any indication to the contrary, current flow from positive to negative was assumed. By the time our understanding reached the point that we knew about electron flow, there was a great body of literature on the market, describing the "current flow theory." By itself, this would not have been a problem, but the symbols in use to depict electrical components had widespread use, and were based on current flow. It would have required a massive mindset change to change all the prevailing thought and symbols.

In reality, except in special cases, it really doesn't matter which method you use, the results are the same. If you should ever encounter a situation where it makes a difference, then you are involved in an area where you must already have the knowledge required to make the change. For the average person, not working in electronics, it is never a concern. However, it is so much easier to use the current flow theory, because it matches so well with the symbology used on schematics. For example, the symbol for a diode is an arrow. The arrow points in the direction of current flow, but is backwards for electron flow. The same is true for the symbols for transistors. About the only place where you will get into trouble with the current flow concept is if you are trying to study vacuum tubes (or "valves" as our British cousins like to call them). In this case, it is mandatory that you use electron flow theory. I find it interesting that the "old fashioned" way of looking at electricity won't work with the old fashioned vacuum tubes, yet works very well with the "new fangled" solid state devices! The "new" theory works well with tubes, but is difficult to apply to modern transistors.

As you can see, both current flow and electron flow co-exist. Both are taking place in any and all electrical circuits - they are but two sides of the same coin. As the old saying goes, you pay your money and you take your choice - whichever theory is most convenient for you, and the particular situation you are evaluating, is the one you should use.

# APPENDIX B
# WIRING DIAGRAMS

**For your convenience, complete, large scale, wiring/schematic diagrams for each model are included in this appendix**

(Note: although every effort was made to insure each wiring /schematic diagram is as accurate as possible, no guarantee is made that any particular diagram will accurately match the wiring configuration of any given car. If the wiring configuration of your particular car doesn't match exactly, the diagrams should be considered general in nature, and used only for general guidance.)