TROUBLESHOOTING GUIDE

EconoKIT® Electrical Diagnostic and Repair Kit

EKEL1

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EL-1 TROUBLESHOOTING GUIDE

The following guide should help you better understand your electrical system, which in turn will greatly improve your ability to diagnose and repair problems. Electrical failures are the cause of many roadside problems, so a little time spent in understanding your system can be a very worthwhile investment. NOTE THAT ELECTRICAL SYSTEMS ARE DANGEROUS AND POSE A SIGNIFICANT HEALTH HAZARD. DO NOT ATTEMPT TO TEST OR MAKE REPAIRS WITHOUT TAKING APPROPRIATE SAFETY PRECAUTIONS.

By Kip Woodring

INTRODUCTION

The CruzTOOLS EL-1 Electrical Diagnostic and Repair Kit is designed to help you get back on the road after the electrical gremlins strike. It comes with a crimper/stripper, needlenose pliers, wire, fuses, connectors, tape, a 12-volt test light for troubleshooting, and much more – most of what you'll need to take care of anything except the catastrophic cell phone/tow truck situation. It is not, however, a substitute for knowledge and preparation.

FIRST, SOME BASICS

Here's a little primer on the basics of electricity as applied to motorcycles:

AC: Alternating current. Provided by the AC generator or alternator. As the name implies, an AC waveform varies between a range of two values, repeating continuously (called a "sine" wave). A motor easily generates alternating current, and you can think of it as the local power station. Alternating current is not of

much use to your motorcycle, however, without being converted.

DC: Direct current. Virtually all electrical and electronic devices operate from a constant, non-varying current. Therefore, the AC signal must be converted or "rectified" into DC for use in your motorcycle's electrical system.

Voltage: The *potential* for power to flow through your system. To better understand voltage, consider your water system at home. Voltage is similar to the pressure that exists in the plumbing, whether water is flowing or not. Similarly, voltage will exist in your system regardless of whether current is flowing or not. While automotive voltages are typically referenced as 12 volts, you will observe anywhere between 12 and 14.4 volts in a properly functioning system.

Current: The *volume* of electricity flowing through your system, measured in amps. Referring again to the water example, water flows when the faucet is opened, the amount of which will depend on the valve opening, pipe diameter, water pressure, and other factors. The greater the current, the larger the demand on the system.

Resistance: The size of the "pipe" the current is trying to flow through, measured in ohms. The higher the number, the greater the resistance. Extremely high resistance is virtually the same as an open circuit, while zero resistance equates a short circuit.

It's important to understand that there is a vital and fundamental interrelationship between voltage, current, and resistance. Current requires voltage in order to flow, and some resistance must be present to control its flow. Keeping this relationship in mind while troubleshooting will become an invaluable aid.

Finally, note that voltage is measured across the terminals of a component (such as a bulb, regulator, or battery), while current is measured in-line. In order to test current, then, one must disconnect the component under test, and reconnect with the test device in-between.

BE PREPARED

It's a good idea to buy a shop manual and study the wiring charts and electrical sections, then match them up with the layout and function of each item on your machine in order to be familiar with your system. Do this in the comfort of your garage so you won't be frantically trying to figure it out in the middle of nowhere. And don't be too shy to check with mechanically inclined friends who have similar models, or friendly mechanics with enough experience to help you learn where any potential troubles are likely to be found before they actually catch up with you. Alternator plugs working loose, battery connections corroding, wires pinched under the seat, and so on may all need to be taken into account as known troublemakers. And, if you have any non-standard connectors, fuses, or bulbs on your machine, buy spares and add them to the kit.

Consider packing an inexpensive multimeter – it can be a valuable addition to your instrument set. The digital variety will stand up to the rigors of the road much better than the old-fashioned needle style. Failing that, though, the 12 volt test light included with the kit will provide most of the information that you need to know for troubleshooting purposes.

THE ELECTRICAL SYSTEM

Figure 1 shows a generic electrical system. Note that there are four basic subsystems: Charging, Ignition, Lightings, and Starter. The other major component is the battery. Current flows from the battery's positive terminal, through various subsystems, and back to the

negative terminal of the battery via ground (which includes your frame and motor).

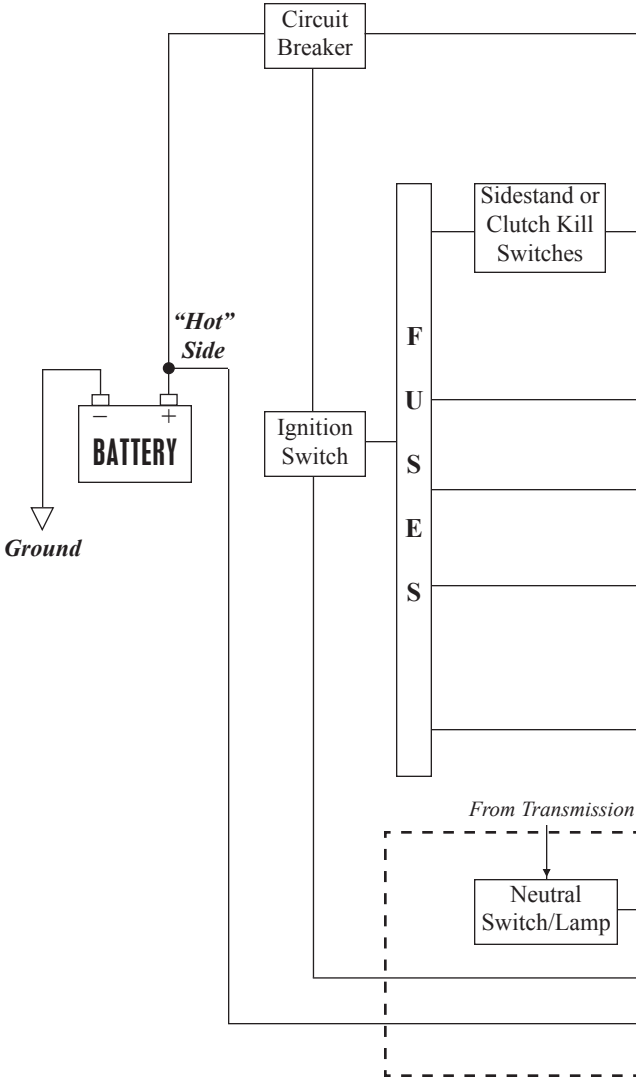
You have alternating current (AC) coming from the generator/alternator. It runs directly to the rectifier/regulator, which turns it into something the motorcycle can actually use, namely direct current (DC). It's this DC current that powers everything from the spark plugs to the lights. The system also returns DC current to the battery, so it will be ready the next time you need it. It is a balanced system. That's an important concept to grasp, since virtually all electrical troubles amount to an out of balance condition. Too much, too little, or no current are all contributors to such an imbalance.

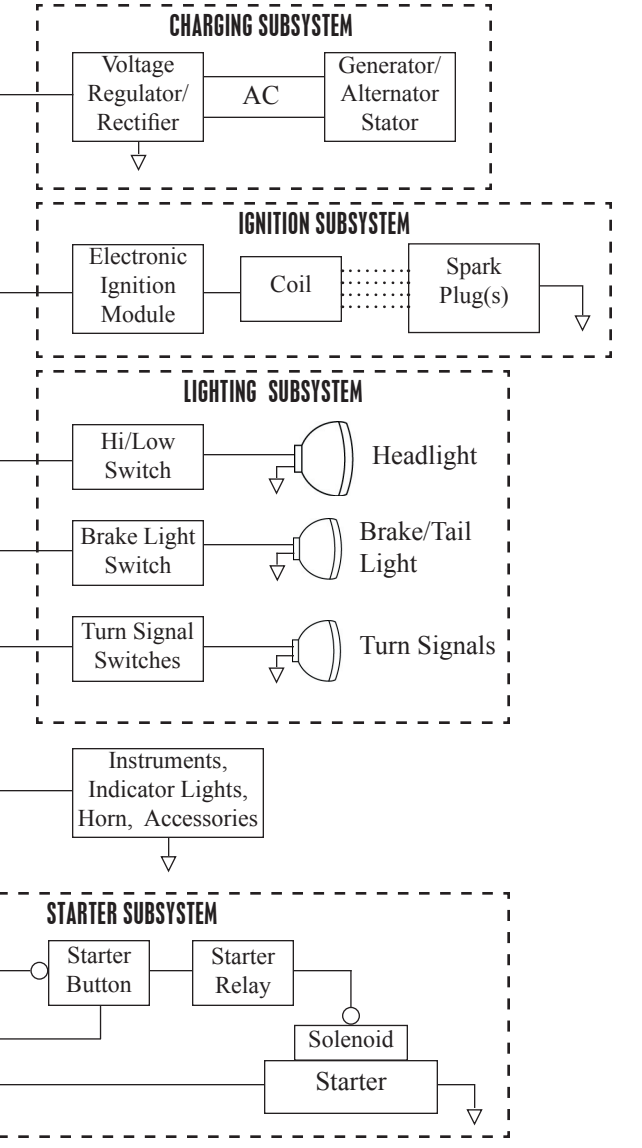
PARTICULARLY the battery! The heart of the system has a black heart indeed, typically the least trustworthy major component on the motorcycle. Never trust a battery that's over two years old – they can die, go flat, blow up and boil dry, and they hold acid (Remember common sense, eye and hand protection and safety FIRST whenever you get near one of these things)! They also lie about what condition they are in. The best way to get along with them is to keep the connections clean and tight, check the fluid level carefully and frequently, and use the test light to check for drains [see "Testing" below]. As a simple test, use your headlight as a charging indicator – as you rev-up a running engine, your headlight should get slightly brighter. If it doesn't, you may have a charging problem.

Don't make assumptions by wire color on your bike. It's common, for instance, for manufacturers to use black wire for hot (positive) and ground connections. Take care to identify wires by following them from their source.

FIGURE 1: GENERIC ELECTRICAL SYSTEM

Some blocks may not apply to all systems




CHARGING SUBSYSTEM
Voltage Regulator/ Rectifier
AC
Generator/ Alternator Stator
IGNITION SUBSYSTEM
Electronic Ignition Module
Coil
Spark Plug(s)
LIGHTING SUBSYSTEM
Hi/Low Switch
Headlight
Brake Light Switch
Brake/Tail Light
Turn Signal Switches
Turn Signals
Instruments, Indicator Lights, Horn, Accessories
STARTER SUBSYSTEM
Starter Button
Starter Relay
Solenoid
Starter

SOME GENERAL POINTERS

First and foremost, exercise great care when poking around a "hot" electrical system. Don't make your problems worse by getting shocked!

Use common sense. Consider your symptoms before deciding what to test for and why. For instance, many sudden failures on the road will involve "juice" not going where it belongs, or prevented from continuing it's journey through the system (in other words, loss of continuity). So, if a light quits working, begin by checking the bulb, then the socket, then the wire, then the switch, and so on. Visualize the relevant part of the system that might be affected (refer to Figure 1 if necessary).

Nine times out of ten the problem, if not the battery, isn't a major component failure. Instead, it'll turn out to be a chafed wire, a bad ground, or a ten-cent connector. Don't overlook simple faults as the culprits.

Note that current flows down the path of least resistance. For example, if presented with two paths, one of very high resistance and another of very low resistance, virtually all the current will flow through the low resistance path. This is not a problem if the manufacturer designed the system this way, but an imbalance caused by a short, for example, will divert needed current to the zero resistance path.

Lastly, the next thing to go wrong might have something to do with the last thing you did. If you plug in heated gloves for your next ride and start blowing fuses, it's not likely that the problem is the headlight. Make sense?

TESTING

The test light included in this kit can tell you things you really need to know since the troublemakers are mostly 12 volts DC. There are four basic tests you can perform

with the test light. Note that some tests require your key switched to the "on" position, or the suspect component turned on, otherwise you have an open circuit!

1) Battery Drain. Disconnect the battery ground cable and reconnect through the test light. If everything is turned off, the test light should not glow at all. If it does, begin disconnecting or removing fuses and circuit breakers until the light goes out. This will indicate the circuit that is draining the battery.
2) Broken (Open) Circuits. Connect test light clip to a ground point (the frame, for example). Begin to follow the wire in question from the energized end. Prod through wire insulation at small intervals towards the "dead" end. The light will stop glowing at the break in the wire or component. Use wire, tape and/or shrink tube from this kit to fix chafed insulation, connectors to replace bad ones, and repair broken wires. Use the jumper wires as both a diagnostic aid and a temporary fix.
3) Continuity. Trace the flow of current through the system with one end of the test light connected to a known "hot" circuit, and the other – occasionally an inch at a time – probing for the spot at which power ceases to flow. As another test, connect the test light clip to the "hot" or positive lead from the battery and prod various ground points. The light will glow at good ground points. If not, check ground connections for corrosion, looseness, or break in wire and/or connector. Again, use the jumper leads to run a "bypass" if need be, or to replace burnt or damaged lengths of wire.
4) Shorts. Connect the test light clip to the "load" or a known good side of the blown fuse or circuit breaker (the side leading to the item you want powered). Connect the test light to the hot side of the battery. While the test light is glowing, begin disconnecting wire terminals until the light dims or goes out. This will identify the shorted circuit. The kit has fuses in case you guess wrong a time or two.

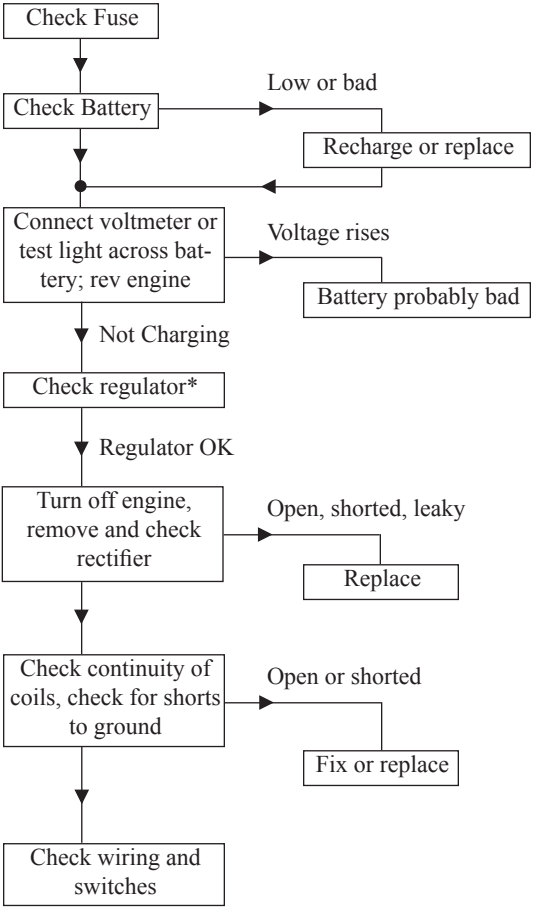
Just remember: patience is a virtue and understanding a requirement when it comes to electrical systems. Read about it. Think about it. Try it!

TROUBLESHOOTING CHARTS

Some blocks may not apply to all systems

AC Generator

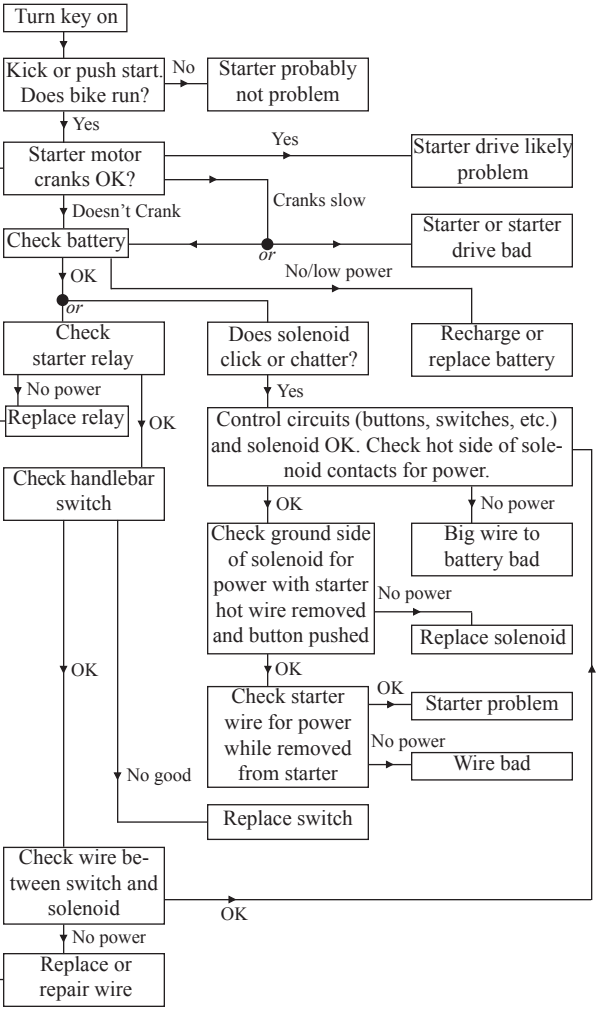
Complaint: battery goes dead; system not charging



*Regulator operation must be diagnosed indirectly, as follows:

1. Disconnect regulator, and check if stator terminal is at ground. If so, it's shorted and must be replaced.
2. If not at ground, check stator output for 19VAC per 1000 RPM. If not, stator is defective. If proper voltage is observed, regulator is likely defective.

Starting Subsystem



Enjoy life – get out and ride more often, but please ride safe and sober. Always wear protective gear and watch out for other motorists. And ride with CruzTOOLS.

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THE GREAT AMERICAN TOOL KIT™

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