The Charging Mod...and Current Flow Through The System

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This article is going to explain why the charging mod is so important, and how it functions in the circuit. I will also explain how current flows through the system so you can better understand it all.

Electron Current

This article is going to use electron current in the examples. Electron current flows from a more negative place to a more positive place.

"Ground" is the negative battery terminal and anything connected to it. The negative battery terminal is considered zero volts.

The positive battery terminal will be 12 volts in our diagrams. 12 volts is more positive than zero volts. When you first turn the key in the ignition, but before you start the bike, all current will flow from the negative battery terminal, through the loads, and is attracted to the positive battery terminal.

After you start the bike the charging system comes into play. The voltage on the positive side of the charging system (at the R/R) will be at 14 volts in the diagrams. 14 volts is more positive than 12 volts. All current on the positive side of the electrical system will flow toward the R/R because that is the most positive point in the system. This means not only will the load current flow toward the R/R, but current from the positive battery terminal will as well. This is how the battery gets charged.

Confused? Don't be. That's what the diagrams are for. A picture is worth a thousand words.

The Numbers

I'm going to explain the numbers we're going to use in the diagrams. They were chosen to keep things simple.

As we said, battery voltage will be 12 volts. One thing that confuses people is that battery voltage doesn't really change much. (unless you discharge the battery) The battery voltage should always be thought of as the at rest battery voltage. (typically 12.7 volts) When you start your motorcycle and take a voltage reading at the battery what you are measuring is the *charging system voltage* the battery is seeing and not the battery voltage itself. The battery is held at this voltage even as the charging current tapers off. Once you turn off the bike the battery will have a certain amount of what's referred to as surface charge. This eventually bleeds off and the battery returns to its at rest voltage.

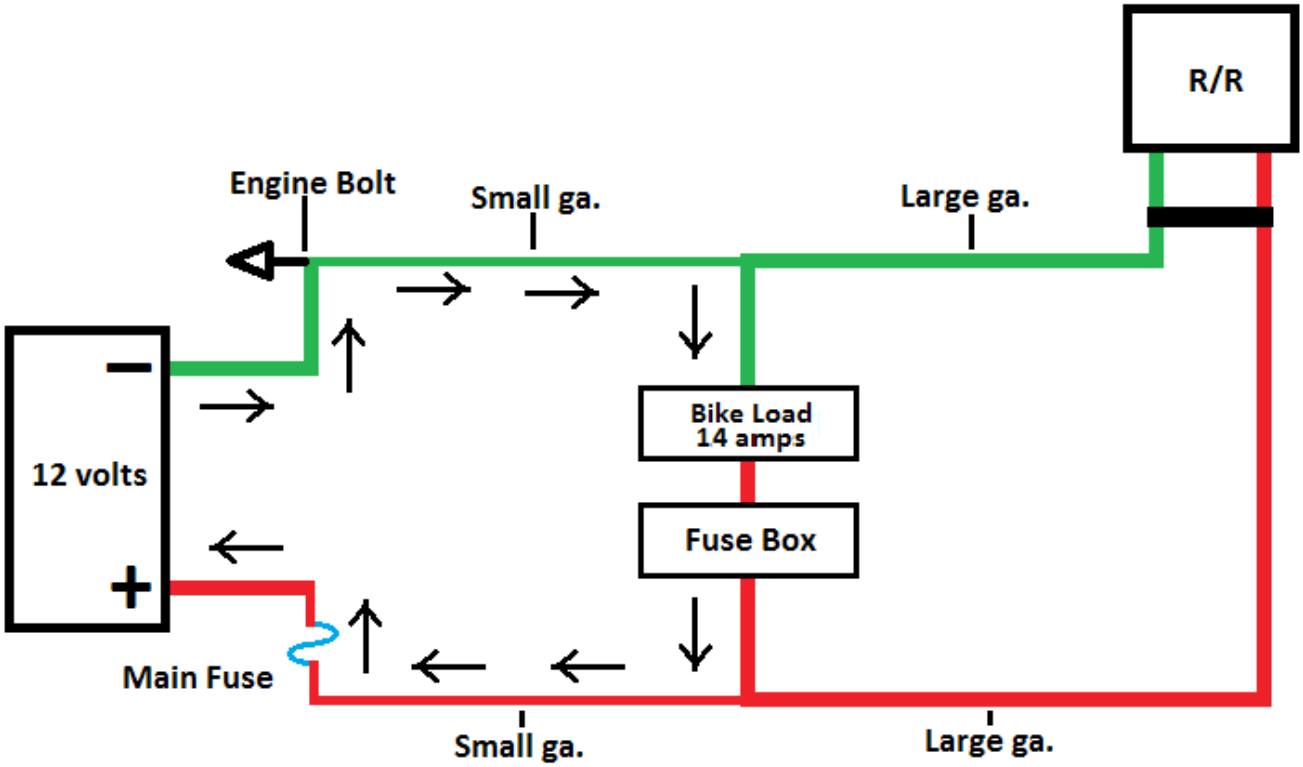
The charging current will be 2 amps in the diagrams. This is considered the "average" charging current for a motorcycle battery. More current flows right after start up but tapers off as the battery charges. We're trying to keep it as simple as possible for everyone to follow so our battery charging current will always be 2 amps in the diagrams.

The load current refers to anything on the bike that needs electricity to operate. (lights, horn, ignitor, etc.) Our load current will always be 14 amps. Pretty close to what a typical stock bike would use.

As said earlier, the charging system voltage is 14 volts. It's the most positive point in the system.

Key On, Bike Not Running

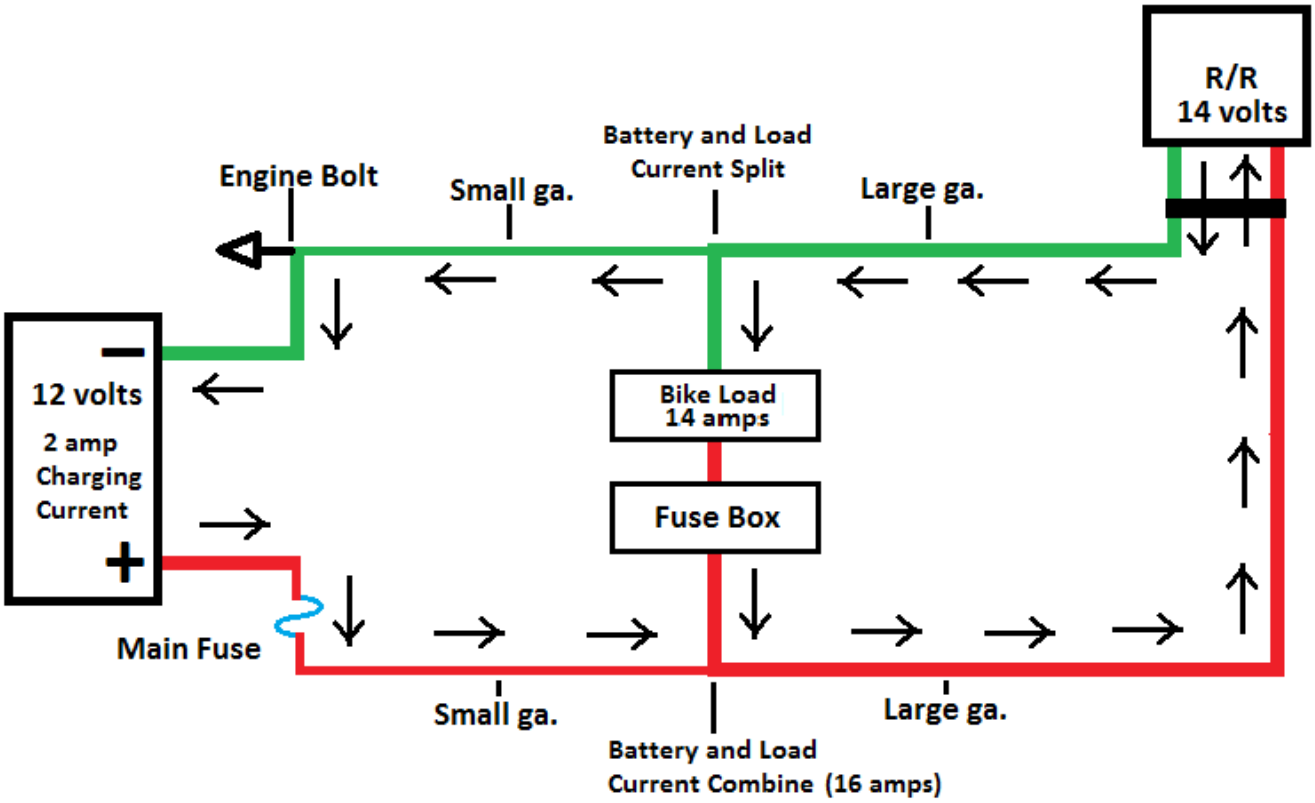
We're going to start with a stock bike. The block diagram below shows how the current flows in the system when the key is on but the bike isn't running.



All the current in the system at this time flows from the negative battery terminal, through the bike load, through the main fuse, and to the positive battery terminal. The bike load is 14 amps. Notice that there are small gauge and large gauge wires in the system. At this time the entire 14 amp bike load current is flowing through the small gauge wires. This is one of the issues that contribute to the red wire connection in the relay plug failing. That connection is too small to deal with that amount of current for any long length of time. Why did Suzuki do this? One of the reasons could be because under normal circumstances the load current only flows through this path for a very short amount of time until you start the bike. Once you start the bike all current takes a much different path.

Current Paths With The Bike Running

Here are the current paths on a stock bike while it's running. The charging system is now in play.



First thing to note here is current is no longer flowing *from* the negative battery terminal, or *toward* the positive battery terminal. 2 amps of charging current is now flowing *out* of the positive side of the battery toward the 14 volt *more positive* R/R. The load current flows toward the R/R as well. Notice at the bottom of the diagram where it says "battery and load current combine." This is a junction where the small gauge wire meets the large gauge wire. Here the 2 amp charging current from the small gauge wire combines with the 14 amp load current at the large gauge wire. The total current of 16 amps now flows through the large gauge wire toward the R/R. This wire is properly sized to carry the total electrical system current.

On the negative side the total 16 amp current flows out of the R/R. It flows to a junction marked "battery and load current split." Here the 14 amp load current for the bike load splits off and again takes the path through the bike load. The remaining 2 amps of charging current is absorbed by the negative side of the battery. This completes the cycle of current on a stock bike.

Any current pulled from the positive side of the system must equal the current delivered to the negative side of the system. There is always be a balance.

Take note that only the battery charging current is flowing through the small gauge wires. The majority of the current in the electrical system flows through the large gauge wires. This becomes an important point as we go on.

Why Do We Need To Do The Charging Mod?

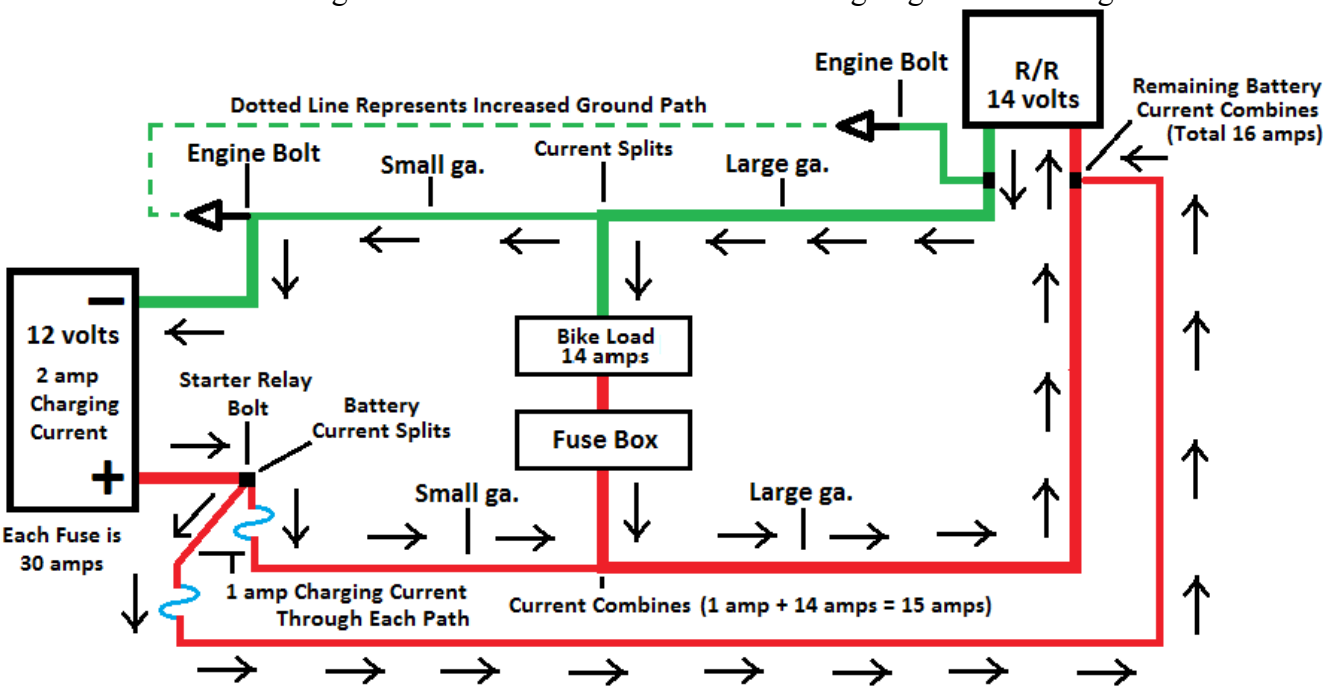
There are some connectors/connections in the wiring harness that introduce some resistance for the charging circuit. The two most trouble-prone spots are the red wire connection in the starter relay plug, and the stator-R/R plug under the lower left rear bubble cover. These are some of the connections can create enough of a voltage drop that the battery doesn't see the full charging system voltage. A lower charging system voltage at the battery means less current is drawn from the positive side of the battery and delivered to the negative side of the battery. Less current equals lower battery charge. Low battery charge equals your bike not starting. The way to correct this is to bypass the bad connections by cutting out the plugs and hard-wiring, and adding a new low resistance path between the battery and the R/R. This low resistance path is known as “The Charging Mod.”

There are two versions of this mod that have been done over the years. I have also come up with a new third version. Each version improves upon the previous one. I'll show you all three versions explaining what's good or bad about each one, and you can decide which one you want to perform on your bike.

The following diagrams assume the “Red Wire Mod” has been performed at the starter relay. It also assumes you are cutting out the plug at the R/R and hard-wiring the connections.

Charging Mod 1st Version

Below is the original version of this mod. There is a lot going on in this diagram.



First thing to notice is the new low resistance path added that goes from the starter relay bolt, through a new inline fuse holder, and ties in at the junction of the positive R/R-harness wires that have been removed from the plug and hardwired together. On the negative side of the system a new wire has also been added to where the negative wires were cut from the R/R-harness plug and hardwired. The new wire gets connected to an engine bolt. This increases the ground path and lowers resistance on the negative side of the system as well.

Because there is now a low resistance path between the positive side of the R/R and the starter relay bolt an interesting thing happens. Not only is the battery seeing the higher charging system voltage, but the small gauge wire that originally had the lower charging system voltage is now also at the higher voltage as well. Part of the battery charging current will flow through the old path as well as the new path. For our purpose here to keep it simple we will say the current splits evenly.

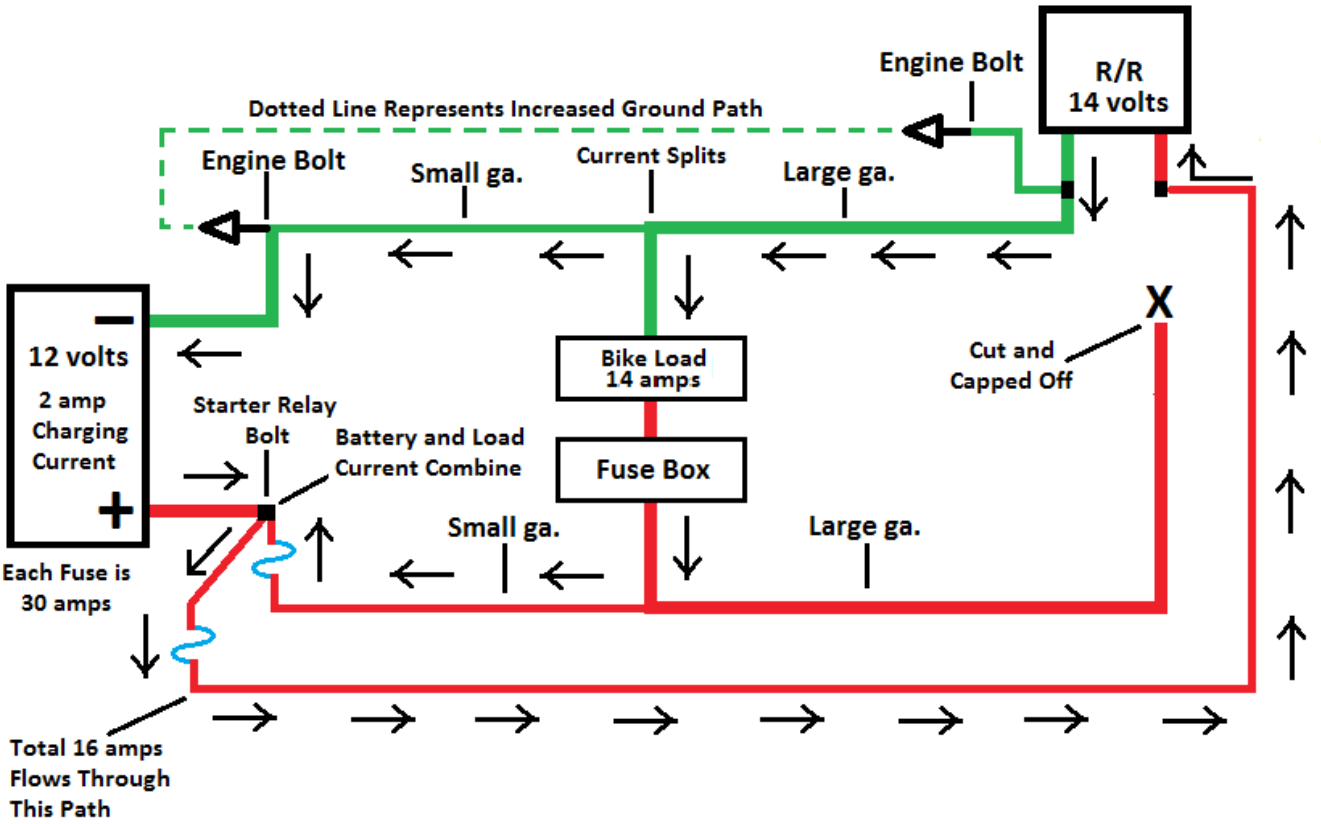
Let's follow the current starting from the positive battery terminal. The two amps of charging current leave the positive battery terminal and come to the starter relay bolt. From here the charging current splits in half. One amp will flow through the original path, and one amp flows through the new path directly to the R/R. The one amp flowing in the original path combines with the 14 amp load current (1 amp + 14 amps = 15 amps) at the junction and flows toward the R/R. The remaining 1 amp of battery current flowing in the new low resistance path also combines with the 15 amps from the original circuit path at the R/R-harness junction (total 16 amps) and flows into the R/R.

On the negative side of the system the current will again be redistributed. How much of the current from the R/R that will take the path through the engine block from the new added ground wire depends on how much resistance there is in the ground wire in the harness. For our purpose here you can think of the current in the negative side of the system flowing as it is marked in the diagram. The important thing to remember is we have lowered the resistance on the negative side of the system just as we have on the positive side of the system.

This version of the mod solved the low charging voltage problem we had, but it created another potentially dangerous situation. Since the two fuses in the inline fuse holders are in parallel and are both feeding the same point at the R/R we have effectively created a single path that could carry double the fuse rating (30 amps + 30 amps = 60 amps) in the event of a short in the positive side of the system. This version should absolutely be avoided. This brings us to the next version that addressed this problem.

Charging Mod 2nd Version

In this version we address the parallel fuse loop problem by eliminating one of the paths.



In this version everything is wired as before except we have cut and capped off the large gauge wire path leading to the R/R. This eliminates the problem with the parallel fuses, but creates another issue.

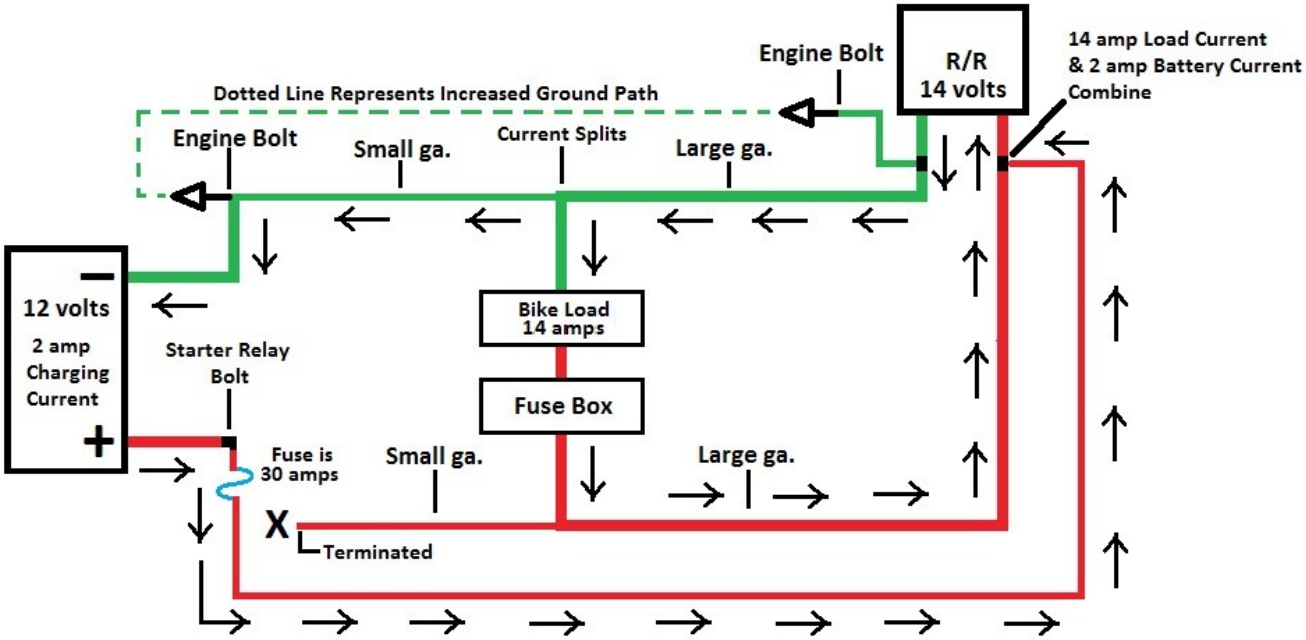
Take note of the direction the load current now takes. In order to get to the R/R the load current now has to take the path through the small gauge wire and the main fuse. At the starter relay bolt the load current combines with the battery charging current and the total 16 amp current now has to flow through the new path to get to the R/R. The large gauge wire was sized to handle the total current better, but it's now been disabled. Having the total current flow through the small gauge wire is not ideal.

Another variation of this version is to cut and cap off the large gauge wire as shown, but run both the positive and negative R/R wires directly to the battery terminals. Doing it this way also creates the same problem in the above diagram. The 14 amp bike load current has to take the path through the small gauge wire in order to get to the R/R. Again, not ideal.

This brings us to the latest version.

Charging Mod 3rd Version

This last version is one I came up with that corrects for all the problems with the previous versions, and is even simpler to do.



In this version we add a new 12 ga. wire to the junction of the R/R-harness connection. This new 12 ga. wire gets run up to the starter relay where it is attached to one end of an inline fuse holder. The other end of the inline fuse holder gets a ring terminal added to it, and it is added to the bolt that holds the positive battery cable on the starter relay. Pull the main fuse out of the starter relay and place it in the new inline fuse holder.

This version restores the correct current flow through the system, while also allowing the battery to see the full charging system voltage. It also solves the problem of having the parallel loop by leaving the small red wire in the relay plug unattached. If you are doing this mod for the first time just leave the small red wire in the plug at the top of the relay untouched. It doesn't need to be connected to anything when you perform this mod.

The 14 amp load current flows from the negative side of the system, through the bike load, and straight to the R/R through the large gauge wires. The 2 amp battery current flows through the main fuse and straight to the R/R through the new 12 ga. Wire. The bike load current and the 2 amp battery current combine at the point where the original R/R-stator/wire harness plug was cut out. The total current then enters the R/R.

Some Things To Keep In Mind

The starter relay bolt is a very popular place to add an inline fuse holder to power other accessories. Keep in mind that if you add accessories at that point in the system the current for that circuit combines with the battery charging current and takes the same path. Doing the last version of the mod means the current through that path is low to begin with. Adding a little bit to it won't affect anything.

The last version of the mod also means when the key is on and the bike isn't running the current from the bike loads will actually flow through the new added charging mod wire on its way to the positive battery terminal. That takes the burden off of the small gauge wire. A nice benefit.

The last version of the mod also keeps the clutter of extra wires off the battery terminals. It will still be just as effective.

Since the small red wire in the relay plug is unused after this mod is done, it could be used to power an accessory circuit. Just keep in mind that the small red wire is live all the time. It is not switched power.

Ride On!