Converting a 1975 Honda CB125S2 from 6 Volt to 12 Volt

Overview

This article describes the electrical conversion from an old 6V system to a 12V system in a 1975 Honda CB125S2. The conversion described herein may find utility in a number of other smaller Honda models that use the internal rotor, six-pole alternator. This conversion allows the original headlamp (6V, sealed beam, 25W/25W) to be replaced with a standard halogen H-4 bulb (12V, bulb, 55W/60W). This conversion also made use of LED replacement bulbs in both the instrument and taillights. The use of the LED bulbs reduced current draw compared to their standard 12V incandescent counterparts and dropped the engine speed needed to supply normal electrical load (i.e., headlamp switched on lowbeam) from approximately 4500 rpm to 1800 rpm.

The last two pages of this document are wiring diagrams. The first is the original wiring diagram of the 1975 Honda CB125S2, the second is the wiring diagram of the modified 12V system.

It is recommended to read though this entire document prior to jumping into the project. Assuming that all parts are made available prior to starting the project, the conversion can likely be accomplished in two to three days if a person makes a dedicated effort: this includes time for epoxy curing of the stator.

The cost of the conversion in this example may be a deterrent factor for some. Parts in this example cost $245 USD in 2009. If the cost of the conversion is considered too expensive, the next best thing is to keep the bike at 6V and to simply replace the old selenium rectifier with a modern silicon rectifier. More details are supplied below. Finally, a couple of strategies to reduce the installation cost are discussed at the end of the article.

Magnet wire (the wire used in winding stators) is readily available from numerous suppliers. Perform a Google search on “magnet wire.” The wire used to rewind the stator in this project was 18 AWG. Spools are usually sold in 1 lb amounts. A 1 lb spool of 18 AWG is very close to 200 feet. The stator in this project required slightly less than 100 feet. The parts and their associated cost are provided immediately below:

Magnet wire (18 AWG)	$25
Battery	$42
Resistors (for ignition)	$2
Headlamp Conversion	$61
Turn signal lamps	$5
LED lamps:	$27
Turn signal winker	$13
Voltage Regulator/Rectifier	$40
Fasteners and gaskets:	$20
Electrical Connectors, solder, wire	$ 10
Total	$245

Two costs were not included in the list above: capacitor and slave relay. A 4700 µF electrolytic capacitor was purchased from RadioShack and installed across the rectifier/regulator output. The purpose of capacitor was to reduce alternator-supplied voltage pulses with the intent of increasing battery life. This capacitor is probably not necessary to the conversion. Also, a simple automotive relay was purchased from RadioShack with the intent of installing it to replace either the headlamp switch or ignition switch. This relay has not been installed and is also likely unnecessary to the project.

The conversion from 6V to 12 V entails the following tasks:

- Rewind the alternator stator.
- Install a 12V rectifier/regulator.
- Install a 12V Battery.
- Replace all lighting bulbs.
- Install ignition system resistors (to keep ignition coil current at ~3.3 Amp).

Each of these tasks is described in some detail below. The most labor intensive task is the stator rewind: approximately 50% of the entire project's labor is taken up with the stator rewind.

Change the Rectifier if Converting to 12V is Too Expensive

If the cost of converting from 6V to 12V is too high, the next best thing is to change out the bike's old selenium rectifier for a modern silicon rectifier. The cost is around $5, including new electrical connectors. A suitable new rectifier can be purchased from RadioShack, part number: 276-1185

New Rectifier Installed in Place of Old One.
RadioShack 276-1185

The original rectifier used in the Hondas of the mid-1970s used selenium as its semi-conductor. It worked but was quite inefficient compared to modern silicon-based designs. That's why the old ones required cooling fins: they lost energy internally and required cooling. By comparison, a modern rectifier is so efficient that it basically is just a solid block and does not lose any significant amount of electricity internally. Although I haven't measured the energy loss in the old rectifiers, it is probable that a good 20W was consumed internally. That's quite a lot of power compared to the gross generation coming from the alternator. And that's when they're good! When they go bad, they get worse. Modern silicon rectifiers likely lose less than one Watt of power.

My suggestion is to run down to your local Radio Shack and pick up a new one. The new one will have four stub terminations for spade-type connectors. Each one is marked. You'll terminate the red-white (that's the DC positive lead) on the stub marked "+." And you'll terminate the green (ground DC lead) on the stub marked "-." Then there are two stubs with wavey lines next to them, and they are for the two alternator outputs: pink and yellow. It does not matter which one you connect to which. The photo at the right shows a new rectifier hooked up in place of the old one.

Note: A point to make here is that if you are going to convert to a 12V system, do not purchase a RadioShack 276-1185 rectifier. Although it will work just fine as a rectifier (converting AC to DC), the new 12V system uses not only a rectifier, but a voltage regulator as well. After I purchased the rectifier shown in the photo and installed it, I made the decision to convert to 12V, and removed the rectifier in order to replace it with a combination rectifier/regulator as explained in the text below.

Tools Required for the 12V Conversion Project

Tools required for the job are mostly common: screwdrivers, pliers (needle-nosed and regular), and metric wrenches. A table vise is very useful for holding parts such as the stator during de-winding and re-winding. In addition, one should have a soldering gun and electrical solder, and a propane torch for removing the old wiring. Electrical tools include crimp and wire stripper/cutters. Finally, a rotary grinder like a dremel is needed to remove material from the headlamp bezel: the new H-4 lamp doesn't quite fit into the old sealed beam headlamp bezel and needs to be enlarged by about 2 mm.

Tools/Materials Required

Removal and Dewind of Old Stator
Propane torch (preferred is a trigger operated type with pencil flame)
Pliers (regular and needle-nose)
Phillips Screwdrivers
Vise, to hold the stator

Stator Winding
Vise, with curved holders (described below)
Work gloves (sheer, e.g. golf gloves)
Golf tees (for prodding windings)
Thin cable ties
Side-cutter (or similar, to remove cable-ties after use)
Soldering gun (to reconnect to old output wires)

Voltage Regulator
Electrical pliers (crimp/stripper/cutter)
Metric wrenches

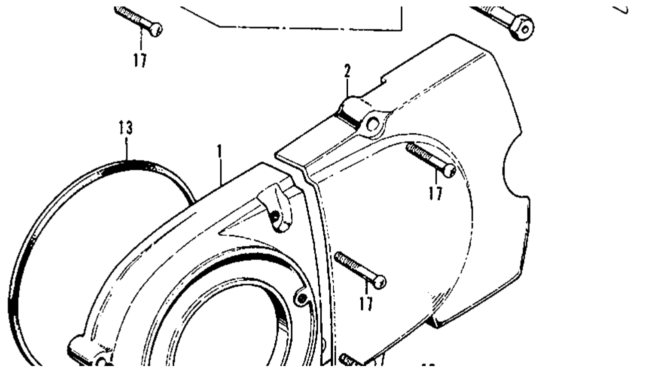
Ignition Resistors
Electrical pliers

Materials
Magnet wire (18 AWG, 100 feet needed, usually purchased in 200 ft lots)
Electrical solder
Cable ties, small ones.
Epoxy, automotive
Electrical Insulating Paint (e.g., Liquid Electrical Tape), and/or shrink tubing, and/or electrical tape.
Wire (preferably color coded 16 AWG Green, Black, Pink, Yellow, Red/White)
Electrical connectors: spades, bullets, splice
Aluminum angle, ¾ inch (for regulator brackets and headlamp stanchions)
Metric bolts and nuts (6mm x 1.00mm x 10mm) for regulator and headlamp stanchions)

CB125S Stator Rewind

The 1970's era smaller Honda bikes often used an alternator with two separate stator windings: an ignition winding (that also generated sufficient power to drive occasional use of the ancillary electrical equipment (turn-signals, etc.)), and a separate lighting winding that generated additional electrical power when the lights were turned on. This lighting coil was switched in simultaneously when the headlamp was turned on. A review of the wiring diagram shows that the headlamp switch is actually a double-pole, double-throw (DPDT) type switch that switches both the lighting coil (an alternating current (AC) source), and the headlamp itself (a direct current (DC) source). Use of this method avoided the need for a voltage regulator, as the generated power was somewhat matched to its load by switching in additional generation as the headlamp & taillight were turned on. The system worked "OK" but over the years it has become harder to find 6V equipment. It is desirable to modify these old bike's electrical system to generate a full 12V so that contemporary equipment, such as 12V winker relays and halogen lamps may be installed.

The instructions contained in this article enable a person to modify the old 6V system to 12V. This particularly involves removing the old alternator stator, de-winding it, and re-winding the stator so that a full 12V are output from the new stator. Further, some instructions on installing a voltage regulator are given. The amount of time required in installing the new winding depends on the individual, but the author wound his stator in approximately 6 hours with 2 hours taken up for breaks: about 4 hours were spent in the actual stator winding.

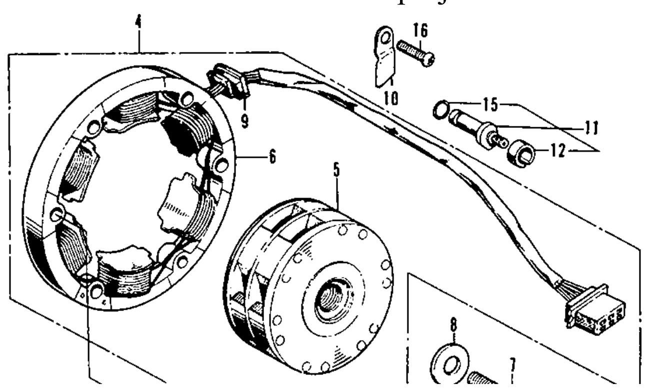


Remove the left side engine case and countershaft sprocket cover.

Removing the old stator

Drain the oil from the engine. Refer to the schematic drawings at right to reference parts. Remove the left side engine cover (1). Remove the countershaft sprocket cover (2). Disconnect the exit cable (9) from the rectifier. Remove the exit cable hold-down in the countershaft sprocket housing (18). Disconnect the neutral switch wire (light-green/red) by depressing its spring retainer. Loosen the three Phillips head machine screws holding the stator (6) to the engine and then pull the stator free from the engine. Leave the rotor in the engine: there is no need to remove the rotor in this project.

Note: when you remove the stator, pay careful attention to its position. When finished with the rewinding, you will need to put it back in exactly the same way. Also note the tang on the back side of the stator at the 3 o'clock position. Note how it indexes into the engine near the cam-chain tensioner.



The alternator's stator and rotator from a Honda CB125S2

Removing the old windings

Take a soldering gun and de-solder the connections between the stator windings and the 3-wire cable comprised of the pink, white and yellow wires. This cable is referred to in this article as the "exit cable." Set the exit cable aside: it will be used later when the re-wound stator is ready to be hooked up again. Make sure the de-soldered butt splice connections remain attached to the wires of the exit cable: not the old stator wires. Before you remove the old windings note that the beginning and ending of the wiring are at the poles at the 12 o'clock and 2 o'clock positions: you will need to replicate this with the new windings.

Removing the old windings is surprisingly easy. There is a plastic material cementing the wires in place. This material behaves similarly to hot glue in that when heated, it softens. Clamp the stator in a vise so that it is vertical Hold one end of a stator wire with a plier and using a propane torch, heat this covering plastic directly with a flame. The plastic material softens quickly and the wire can be pulled through it readily. Continue heating and de-winding. As the first row of windings is pulled free and unwound, most of the plastic material comes off with the windings. Eventually the windings beneath the plastic material are exposed and most of these can simply be unwound. Only occasional use of the torch is needed for the interior windings. The entire stator can be unwound in this manner. Unwind the stator until all windings are removed and the six stator poles are completely barren of wire. Discard the old wire: it is not reused in this project. For the curious, my stator had 52 turns of 17.5 gauge wire on each pole of the four poles used for lighting coil. The ignition coil (two poles) each had 190 turns of 22 gauge or 24 gauge wire.


Stator being de-wound.

The above described method of de-winding a stator should not damage the epoxy coating protecting the stator core iron. However, it is prudent to take the opportunity of a winding-free stator to re-coat the surfaces with an additional epoxy coating. You will want to coat the stator poles and also the "cross-over" section of the stator's rim between the poles. The cross-over is where the stator wire runs from one pole to the next pole. Do so at this time and wait for the epoxy to cure reasonably hard: often twelve hours. While the epoxy is curing, one could work on some of the other tasks, such as installing the voltage regulator, the ignition resistors, and/or the headlamp.

<u>Winding the stator.</u>

The stator winding used in this project is a single, continuous wire that starts at the first pole and then alternates winding direction every adjacent pole until the wire concludes the final winding on the final pole. That is, if you start winding the first pole in the clockwise (CW) direction, then the pole next to it must be wound counter-clockwise (CCW). This pattern runs throughout the entire stator. The reason for it is that the rotor has six magnets in it, and each magnet alternates its polarity compared to the magnet next to it: North, South, North, South, North, and South. In order for the voltage induced in each pole in the stator to be additive, the winding direction in each stator pole must also alternate. It does not matter if you start winding in the clockwise direction or the counter-clockwise direction. The only thing that matters is that each pole must have its winding direction opposite from the pole adjacent to it: e.g., CW, CCW, CW, CCW, CW, and CCW. For each pole, you will attempt to wind twelve turns within each layer for six layers. In practice, it is hard to achieve twelve turns for each layer; some layers end up with only eleven turns. Ideally, each pole would have seventy-two turns, but in practice sixty-nine or seventy turns result for a well-wound pole.

The photo on the next page shows that changing winding direction for each pole causes the wire to "cross-over" when proceeding from one pole to the next. When you understand this, the general concept of the stator winding becomes simple. Another necessary feature is that the number of layers of winding on each pole must be an even number, because the winding wrapping needs to climb up the pole, and then back down the pole to end in a suitable position to proceed to the next pole. Ergo, the number of winding layers on each pole in this project totals six (6) layers.

Note crossover of wire between poles.

When winding the stator, every pole must have its winding in the opposite direction of the two poles adjacent to it. This means that the wire "crosses-over" between poles.

A major goal of good winding practice is to get the winding wraps as tight and uniform as possible. A perfectly wound pole will have the highest density and greatest number of wraps possible in the available space. Conversely: a messy winding ultimately means fewer wraps and this translates into weak alternator output.

The target number of wraps (a synonymous term for wraps is "turns") per layer is twelve. Thus, a very carefully wound pole will have a total number of 72 turns: twelve turns per layer, times six layers equals 72 turns. In practice, you will find that it is very challenging to get a full 72 turns per pole. Even carefully and tightly placed turns sometimes results in only eleven turns per layer. You'll see when you get into doing the actual winding that sometimes you just cannot get that twelfth turn packed in there before it starts to lift up into the next layer. Not to worry, if you can get a total of 69 to 70 turns per pole, you'll be doing just fine. You'll also notice that the first three or four layers can be wrapped with nearly machine-like precision, whereas the fifth and sixth layers are hard to keep very orderly: it's just the way it goes. Luckily there is not a seventh and eighth layer: it would turn into a real mess. Also, it is not of critical importance if one pole has 69 turns and the next pole has 70 turns. Since all these turns are monotonously voltage-additive, there is no great concern for deleterious effects like inducing circulating currents. The only real penalty is that reducing the total number of turns in the stator below what can be considered a practical maximum number of turns simply reduces the stator's output. Again, a poorly wound stator results in a poorly functioning stator. If you can get 420 turns total (6 x 70) on your stator, award yourself a "job well done."

Winding station with stator held in vise, and wire spool held in stand clamped to workbench.

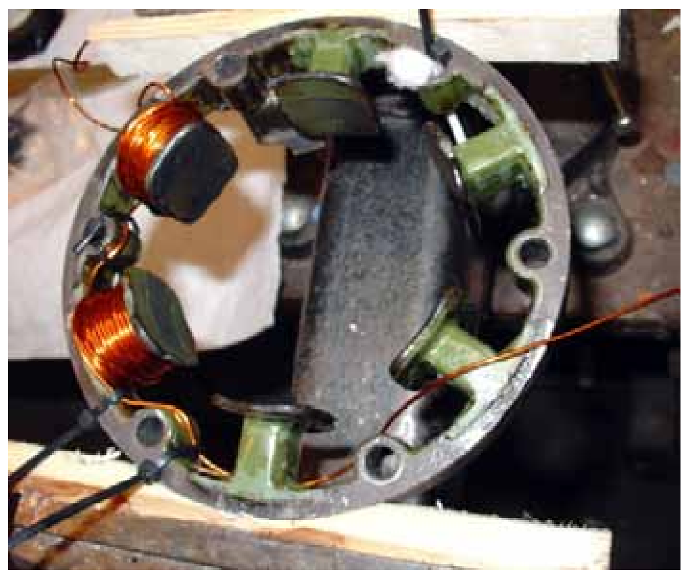
You'll want to set up a simple winding station. See the photo at the right. It does not need to be anything fancy. In this example, the stator was held horizontally in a vise that had a couple of wooden slats with a crudely cut circumference shape to better hold the stator. The winding spool was placed a couple feet to the right and was held in place with an available stand that is fixed in place with a C-clamp. That's all that's needed.

The wooden stator holders I used were simply some scrap wood of the approximate size for the jaws in my vise. With the two pieces of wood sitting on my work bench and spread apart to support the stator, I placed the stator on top of them with about ¼ inch of wood sticking out below the stator. Then I inked a line around the stator onto the wood, and used a jig-saw to cut out some of the wood to approximate the stator's circumference for a couple inches of the wood slats. Next I glued the wood slats into the vise with some "Household Goop" (a wonderfully useful adhesive). The wood slats adequately held the stator without damaging it. And after the job was done, the slats pulled right off the vise jaws.

Empty stator held in vise with radiused wood slats.

The only other "tools" needed are a pair of closely fitting gloves and a prodder to get problem windings prodded into correct placement. Being a golfer I found that golf gloves and a golf tee were nearly ideal for these purposes. I started working on my winding wearing some work gloves but quickly found that bulky gloves are a liability. You want something that does not interfere as you get into tight spaces. Also, it had been suggested to me that a wooden Popsicle stick worked well as a prodder, but I found that a golf tee was really hard to beat for utility: you can use either end of it depending on what you are trying to do.

Finally, a very useful technique is to use small nylon cable-ties for holding the wire tightly against the stator rim when you finish winding one pole and proceed to start the next pole. You can see this in the photo to the right. At first I tried using the bolt holes in the stator's rim to hold the wire, but quickly found that to get the wire really tightly held against the rim, you want to use the cable-tie around the rim itself. You can leave these cable-ties in place until you finish the entire stator, or snip them off with a side-cutter as you proceed with the winding. The cable-ties should be removed before you coat the finished stator with epoxy.



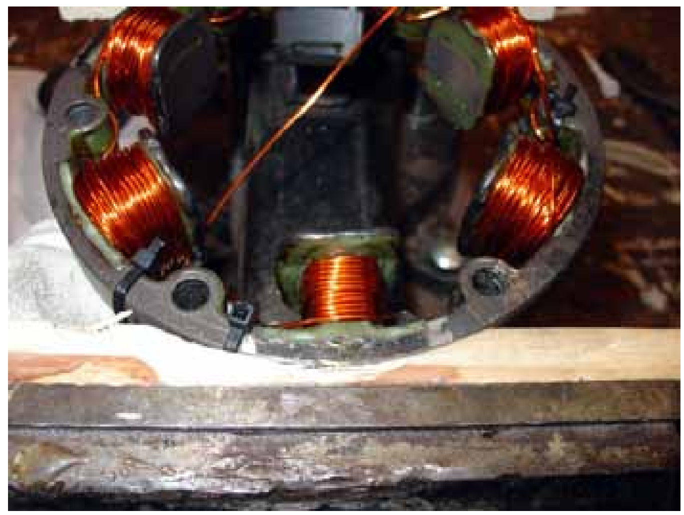
Note small cable-ties holding wire tightly against rim. Also note that second pole is more neatly wound than first pole.

The first pole and the last pole to be wound should be the ones at the 12 o'clock and 2 o'clock positions. This is near where the exit cable comes into the stator from outside the bike. It does not matter which of the two poles (12 o'clock or 2 o'clock) you start with at as long as the second pole you wind is "away" from the other pole. That is, if you start at the 12 o'clock pole, your second pole must be the 10 o'clock pole. Conversely, if you start at the 2 o'clock pole, your second pole must be the 4 o'clock pole. In this way, you insure that the last pole ends up back where it is needed: the two wire ends of the stator winding need to be in the gap between the 12 o'clock and 2 o'clock poles.

Position the first pole to be wound in the vise in a comfortable location. In my case, I chose the pole closest to me as I was looking down at the stator clamped in my vise: i.e. the pole nearest to my stomach.

Start winding the first pole

Take about six inches of excess wire in one hand and simply start winding the wire around the pole beginning at the base of the pole near the rim. Make sure you have a good six inches of excess wire beyond the first wrap: it would be a disaster to not have enough wire extending out to make the connection to the exit cable. Hold the wire firmly and get the wire wrapped around the pole as neatly and tightly as possible. You don't have to go overboard with the wiring tension: you'll soon see what works. Tight is tight and putting an additional 100 lbs of tension on it won't make any difference. Use your golf tee prodder to nudge any turns that need to get pushed firmly against the winding that preceded it. Make sure you get 12 turns in on the first layer and then let the 13th turn lift up on top of the first layer and then wrap your way back down the pole: the turns will naturally fit into the tops of the first layer if you are diligent keeping them pushed tightly together. Keep winding the pole in this way until there are six full layers and you're ready to move onto the second pole.



Last pole coming into the home-stretch.

Continue winding the poles

Take a small cable tie and use it to pull the wire tightly against the stator rim (see picture at right). Use a second cable tie on the opposite side of the bolt hole in the stator rim. Make sure you have "crossed-over" so that the winding of the second pole is in the opposite rotation of the first. If you wound the first pole clock-wise, you must wind the second pole counter-clockwise. Just before you begin winding the second pole, shift the position of the stator in your vise to make winding easier.

Winding the second pole is just like the first, but in the opposite direction. It actually gets to be a bit of a game to see how good you can get the winding job done. My second pole was better than the first. I got a really good third pole in, and then the fourth wasn't quite as neat as the third as I lost focus. That's when I took a break to let my hands and mind rest. It was dinner time anyway.

It took me roughly 40 minutes to completely wind a pole. All told, including breaks, it took me six hours to wind my stator. Your winding time will vary but probably not be too greatly different. My hands were sore the next day from both the exercise and skin compression. One definitely needs to wear some hand protection, and even then the hands definitely get a workout.

Wind the stator to completion with all six poles wound and a six inch tail left hanging for connecting to the exit cable. The end job should look like the stator in the photo at right. Note the two wire tails coming out from adjacent poles.

Coat the windings with epoxy when finished winding

Although it is probably not necessary to coat all the poles and windings with epoxy, you'll soon realize that the final pole you wound has its wire tail "hanging out in the breeze." The other wire tail coming from the initial pole has its wire tail buried in the windings and cannot unwind. As a result, you will definitely want to coat the final pole with epoxy to fix the windings in place. It most certainly would not be a good idea to have those windings coming loose during operation. In my case, mixing up even a small batch (about an ounce?) of epoxy left so much after I coated the necessary final pole that I just continued on and coated all of them. And then I still had some left over and coated the wire cross-over points: holding them in place. Probably not the best logic for doing it that way, but there it is.

As before, set the stator aside to allow the epoxy to cure. Continue to work on other tasks. When the epoxy has cured, the exit wiring cable can be connected to the two stator wire tails.

Connect the stator wires to the exit cable

You have probably already noticed that the old wiring cable had three wires: Pink, Yellow, and White. The White wire was the output from the old lighting coil. When the headlamp was switched on, the White wire was switched into the AC system parallel with the Yellow wire. It did not change system voltage, but added additional current into the rectifier. This White wire is no longer needed and is not connected with the new system.

Take the wires coming from the stator and trim them down to three inches. Abrade off about ½ inch of insulation coating the stator wires from their ends: use sandpaper or steel wool to get a clean surface suitable for soldering. Using the old butt splice solder connections still attached to the exit cable; solder onto the Yellow and Pink wires the two wires coming from the stator. It does not matter which one is connected to which. Just do not connect anything to the White wire. Trim the White wire flush with the rubber cable holder: if you get it really short you probably don't need to insulate it. But painting it with a splash of insulating paint is still a good idea.

Next, insulate the stator wire connections (the Yellow and Pink wires). I used both shrink tube and insulating paint. No idea if it will hold up long term, but that's what I've got on my stator.

The new stator is ready to go back into the bike.

Install the new stator in the engine

Installation is the reverse of removal. Carefully insert the new stator back into the engine case paying attention to inserting the tang on the back right-hand of the stator correctly into the cam-chain adjusting area. Then fasten it in with its three fasteners. I replaced the old Phillips head machine screws with Allen head drives. Fasten the exit cable in place with the little metal guide and re-install both the countershaft sprocket cover and the left-side engine cover. Re-connect the neutral-switch wire. Don't forget to refill the engine with motor oil.

New stator installed in the engine.

Once the new stator is installed in the bike, the remaining tasks focus on getting the new 12V system wired up correctly and working correctly.

INSTALL A VOLTAGE REGULATOR

The new stator generates enough power to require a voltage regulator. If you just hook up the alternator to a rectifier only, the battery will likely experience short life from overcharging.

Combined rectifiers/voltage regulators are commonly available and I understand that they can be purchased through a number of sources, particularly dirt bike part suppliers. These are single phase rectifiers/regulators and should work just fine as long as they are designed for 12V systems. I had a spare 3-phase rectifier/regulator available from a Honda CM-400, so it is used in this project description. These are also readily available and can be purchased through ebay.com. Search on "CM-400 voltage regulator." They can vary in price anywhere from $10 to $70: it is entirely market dependent. The CM-400 voltage regulator also contains a rectifier, so the part's more correct description is a rectifier/regulator. As such, the existing rectifier can be removed/bypassed. It turns out that bypassing the original rectifier makes for simple and easy wiring. This is explained in more detail below.

One key point is that a three-phase rectifier/regulator has three wires leading into it (the three Yellow wires) from its intended three-phase alternator. However, a single-phase AC source can be used as well. Simply connect the two wires from the single phase alternator to any two of the three wire input: one wire on the rectifier/regulator is left unconnected. It does not matter which two Yellow wires you connect to.

The output wires from the rectifier/regulator are essentially the same as the old rectifier: the Green wire connects to frame ground (or battery negative -- same thing), and the Red/White wire connects directly to the battery's positive pole. There is a third wire, however, coming from the regulator's output that needs to be connected. This is the voltage sensing wire (Black) and in my project I connected it to the Black wire coming from the ignition switch because it was nearby and made for a simple connection. For the Black wire I used a splice connector commonly available at auto and/or hardware stores that carry electrical supplies.

A very nice feature of this wiring scheme is that the mini-connector that plugs into the old rectifier mini-plug can be re-used. Notice that this plug contains the four essential wires: Green, Red, Yellow, and Pink. As mentioned above, the Black wire coming from the regulator is spliced into the Black wire exiting the ignition switch. More detail is provided below, along with photos.

Mounting the voltage regulator

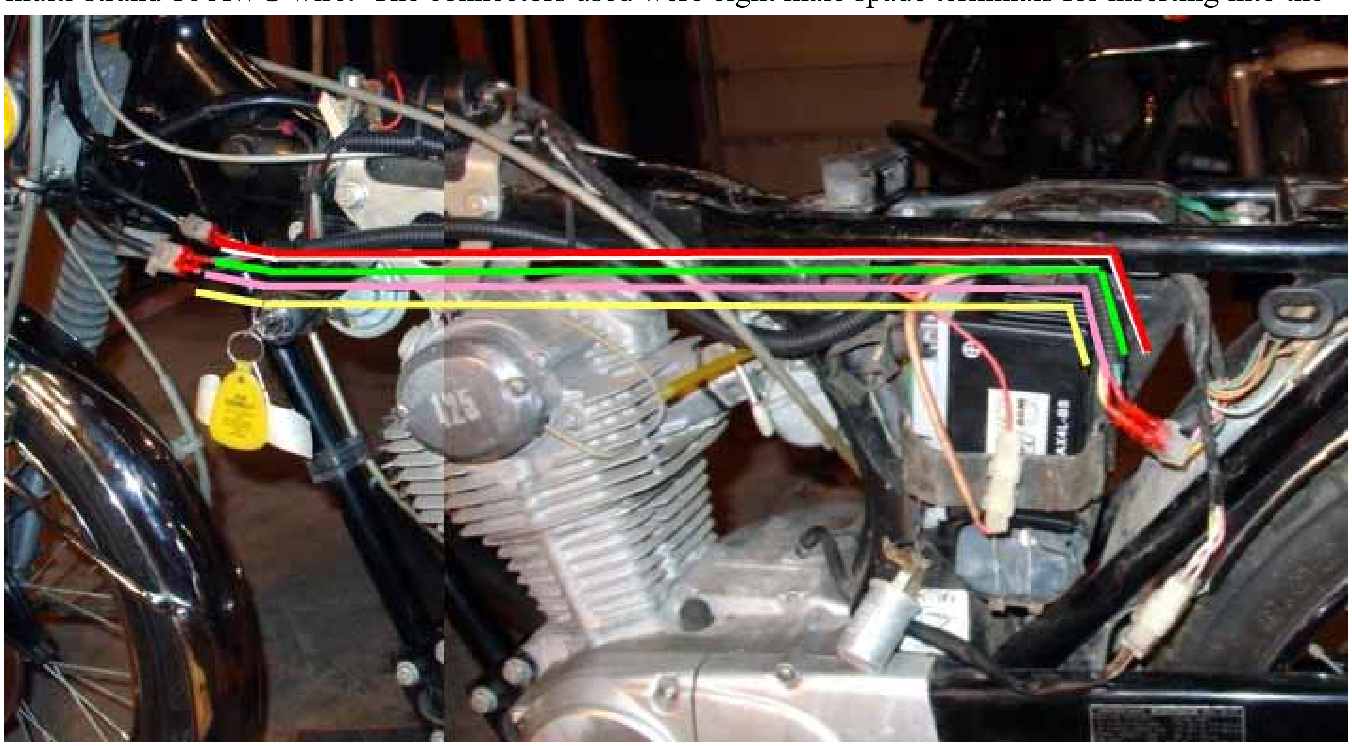
A good place to mount the voltage regulator is below the headlamp on the lower triple clamp. Look at the photo to the right to see the CM-400 voltage regulator mounted. It just so happens that there are two threaded holes in the triple clamp that are located nearly ideally for mounting the CM-400 voltage regulator. The threads are for standard 6mm x 1.0mm bolts (the ubiquitous 10mm wrench size so common on these bikes). If you don't have a couple spare bolts sitting around from a previous project, they can be purchased anywhere there are metric fasteners for sale. Many hardware stores have them in bins. I used two bolts with a 10 mm shank length. The threaded hole on the left fork leg already has a fastener threaded into it from the bottom: the bracket for holding the brake line. But there is enough thread in the top of this threaded hole to do double-duty. As long as you don't use too long of a bolt, it'll thread right in and tighten up.

Back side of voltage regulator. Mounted with 3/4 inch aluminum angle.

A pair of brackets must be fabricated to facilitate the regulator's mounting. The brackets pictured were made from ¾ inch aluminum angle stock. A three foot long section was purchased at Menards: i.e. it is readily available from most hardware stores. Each bracket was formed from a 3 inch long segment and then holes were drilled for the voltage regulator and lower triple clamp. A box-end was made out of the bottom by cutting a ¾ inch section out of one side of the angle and bending the remaining tab over and soldering the joint. I used an aluminum solder. It's possible that common solder might wet the aluminum enough to work. Finally, a radius was put on the protruding lip to reduce the tendency for things to snag on it. Once installed, the voltage regulator looks like it was an original design.

<u>Wiring the Voltage Regulator</u>

<u>General:</u> The regulator is inserted into the bike's normal wiring. This is surprisingly easy to do. I wanted to be technically correct, so I purchased four feet of Yellow, Pink, Red/White, Green, and Black multi-strand 16 AWG wire. The connectors used were eight male spade terminals for inserting into the



Voltage regulator wired in with four colored wires and one black wire (not shown). Note flex-conduit behind the illustrated wires where actual wires are contained.

existing mini-plug connectors, and one splice connector. Since the location for the new voltage regulator is in the front of the motorcycle, I also used two feet of spiral flexible conduit available at Menards. This flex conduit was used to house the four wires running from the front of the bike to the battery's location. The regulator has seven wires coming out of it: grouped into input and output mini-plugs. Six wires of the seven coming out of the regulator are used in the wiring connection. The connectors used were primarily male spade terminals. I took the extra precaution, after crimping the connector, of soldering the wire end onto the spade. There are two wiring connector locations: near the voltage regulator, and in the vicinity of the battery. A four-wire cable can be run from the voltage regulator's mini-plugs to the mini-plug used to hook up the existing rectifier, the old rectifier now being removed. In short, you make up a four-wire cable with Green, Red/White, Yellow, and Pink wires of the correct length with male spade terminals at both ends: i.e. eight male spade terminals are used. The Black wire has slightly different wiring: a male spade terminal at one end, and a splice connector at the other end. If there is any confusion, look at the wiring diagram at the end of this document.

Regulator Input: The CM-400 voltage regulator is designed for a 3-phase alternator output. However, a single-phase alternator can be hooked up to it. The input wires to the CM-400 voltage regulator are three yellow wires contained in a single mini-plug. The electrical hookup is simple: connect the CB125s' alternator output wires (Yellow and Pink) to any two of the three yellow wires going into the voltage regulator. It can be any two of the three. The Yellow and Pink wires leading up from the alternator should have male spade terminals crimped on them.

Regulator Output: The regulator's output consists of three wires grouped into a mini-plug connector: Green, Black, and Red/White. Following normal Honda practice, the Green is the ground wire, the Red/White is an unswitched hot (leading directly to the battery for charging, i.e. the business end of the regulator), and the Black is a switched hot that is used as a reference voltage to control the output of the regulator. Since we are connecting the voltage regulator's output to the existing system, the Green and Red/White wires can be run in the flex conduit to the mini-plug used to hook up the old rectifier near the battery. The Black wire has a male spade terminal attached at one end and is inserted into the regulator's mini-plug. The Black wire's other end is spliced into the Black wire coming out of the ignition switch. Since the ignition switch is close by to the end of the regulator's mini-plugs, the Black wire length is short: only about six inches.

Ignition Resistors

The original 6V system uses an ignition coil that has 1.8 Ohm resistance. This limits the current through the ignition to approximately 3.3 Amp. Doubling the voltage to 12V would double the current. Now, this might at first seem like a good idea: a very hot spark would result. But the downside of it is twofold: the ignition points would have sharply accelerated wear (probably last only 25% as long as the old system), and the current drain from the system will be excessive and the new alternator probably could not supply it along with an H-4 headlamp (one of the primary goals of the project). As a result, it is necessary to add resistance to the ignition circuit to keep the ignition current the same as before. Since the voltage is being doubled, keeping the ignition current the

Ignition resistors wired in, but not folded in to fit within the gas tank enclosure.

same requires approximately doubling the resistance. In this case nearly ideal resistors can be purchased from RadioShack. Their part number is: 271-131. Two one ohm resistors come in the package and you use both of them. The cost is $2.

These two resistors need to be wired into the ignition circuit in series. That is, they need to be connected end-to-end. If you connect them in parallel, you reduce the effective resistance to half an ohm, which is definitely not what is needed. I crimped (and then soldered) a male bullet connector onto one end of a resistor, and a female bullet connector onto the end of the second resistor. Then I joined the two free ends together with another set of bullet connectors (male/female) and soldered them.

This allows the two series-connected resistors to be inserted into the existing ignition circuit by unplugging the wire leading to the coil's primary and inserting the new series-connected resistors. This bullet connector is located next to the coil itself. One wire leading into the bullet connector is Black/White, and the wire leaving the bullet connector is Black. Disconnect the bullet connector and insert the resistors and that is almost all that is required. The only other requirements are insulation and physical location. The wires on the resistors are bare: it won't do to leave them electrically un-insulated. You can insulate them in any of several ways: electrical tape, heat-shrink tube, paint-on insulation. I happened to have a bottle of "liquid electrical tape" handy and just painted them. Next, one needs to carefully fold the wires and new components out of the way so that the gas tank can still fit over the ignition coil area. The resistors should not be thermally insulated.

The end result is an ignition system that uses the same amount of current as originally. One downside of this is the unavoidable inefficiency it puts into the system: the heat dissipated by the resistors is simply a loss, and it's right about 20 W. The entire ignition system consumes an egregious 40W. This is a large amount considering the alternator system might produce all of 120W @ 5000 rpm. It would be nice to get rid of the ignition points-based system and go to a CDI system, but that will have to wait for another project. As it is the new system with the additional two ohms of resistance functions well: the bike runs fine with it as built.

Battery

The old 6V battery can be recycled and a new 12V battery purchased and installed. The only 12V battery I was able to find that would fit in the same space was a 12V gel-cell and this was turned on its side to allow installation. The battery used was an Extreme, model XTAX4L-BS gel-cell.

Headlamp with H-4 fixture installed. Note the two aluminum stanchions bolted into the bezel's old pivot stanchions. Also note the socket wiring arrangement.

Headlamp

Much of the reason for making the conversion from 6V to 12V is to access modern lighting equipment. A 12V H-4 lamp 5.75 round fixture was purchased from Candlepower.com (Model H402212). It was also necessary to order a three-prong socket from the same supplier. The standard H-4 bulb is rated at 55W/60W.

The new H-4 fixture "almost" fit into the old headlamp shell. As it turned out, the chrome bezel was just a little too small in diameter for the new H-4 fixture to slide in properly. It took me nearly an hour of concerted grinding with a dremel and rotary stone to open the bezel up by approximately 2mm for the new H-4 lamp to fit inside properly.

The next problem overcome was the method of mounting the new fixture into the shell. A simple solution was to use the two "lateral movement" pivot stanchions for the old headlamp (located at 12 o'clock and 6 o'clock) as fixing points. Using the same ¾ inch aluminum angle stock as used in mounting the voltage regulator as a starting point, two short, flat sections of the proper length were cut off. A hole was drilled in the end of each. This created two small, flat brackets for holding the H-4 fixture in place. Finally, the entire H-4 fixture was first glued in place with Household Goop, and then the little aluminum brackets were bolted in place on the pivot stanchions with small machine bolts and nuts. The new H-4 fixture is very solidly mounted in place. The lateral movement adjustment was obviously abandoned with this mounting.

Next, the new H-4 plug was wired in. I used the supplied crimp connectors, but also soldered the wires to the connectors for the best possible connection. See photo on previous page for the finished product. Make sure you locate the green, white and blue wires as follows: the blue wire is for the high beam. If you look at the prongs coming out of the H-4 bulb, they form a horseshoe pattern with the open end of the horseshoe on the bottom. The top prong is horizontal and this is the low-beam (White). The left-side vertical prong is the ground (Green). The right-side vertical prong is the high-beam and this is the Blue wire.

Instrument lights

The old instrument lights (there are five total) are designed for 6V application. The first time the bike was started up with the 12V system, they did not burn out, but illuminated extremely brightly. While this may seem like a benefit, the current required to run them is four times the current with a 6V system. This is an unacceptable current draw on the system. White LED replacement bulbs were purchased from "superbrightleds.com." They are style BA9s-W4. In practice, it has been found that these bulbs are too bright for instrument lights. They work OK for the gauge illumination lights, but for the neutral, high-beam, and turn signal lights they are annoyingly bright. Dimmer LED bulbs would be preferred, but have not been selected at the time of this writing.

Taillight

Originally, the old 6V taillight bulb was replaced with a standard 1157 bulb. The current draw from this bulb was considered too large and was replaced with an LED replacement bulb from the same source as above. It is model "BA15 12-LED bulb – White 1157-W12 2.00 Narrow."

In practice, it has been found that this LED bulb is marginal for illumination on the CB125S2. It closely matches the standard 1157 incandescent bulb, and the standard bulb should be considered marginal illumination for current usage. Taillight bulbs with more than twelve LED's can be purchased, and it is highly recommended to go this route. The additional current draw for a "super LED taillight" will be insignificant in regards to the overall electrical load, and the improved illumination could well be a life-saver. As with the instrument bulbs above, however, a replacement bulb has not at this time been selected.

Blinkers

The old 6V turn signal bulbs were replaced with common 1156 incandescent bulbs. Although electrically inefficient, they were considered to be acceptable due to the fact that they are used very little. The old 6V blinker relay was discarded and a new 12V electronic unit was purchased. The 12V electronic is superior to conventional thermal units in that it operates off a resonant circuit and does not change blinker pace with system voltage (as in sitting at a stop light while idling). The data on the winker relay is: Tridon Stant, EL12, Variable Load, Electronic 2 terminal Flasher. The base of the relay has two spade terminals. One is labeled "L" (for Load, I assume). The Gray wire gets hooked to the L terminal, the Black wire to the other terminal. The turn signals now operate as well as any automobile: bright and metronomically pure in their cadence.

Results

The new 12V system works correctly. With the electrical system setup as described above, the system voltage is at 13.0 V at an indicated 1800 rpm with the headlamp switched to low-beam. System voltage increases to 13.5 V @ ~3500 rpm and further increases to 13.9 @ ~6000 rpm. With the headlamp switched off, system voltage is essentially constant at 14.6 V for all engine speeds (i.e., the voltage regulator is working). Turning on the high-beam raises the 13.0 V benchmark to around 2000 rpm. The turn signals flash at a metronomic rate: this is due to the electronic winker relay. All instrument lights function correctly (albeit too brightly). In conclusion, the motorcycle is fully functional and the H-4 headlamp can be used at all times during normal motorcycle operation without concern regarding discharging the battery.

It works! With H-4 headlamp on low-beam, system voltage achieves 13.0 V at 1800 indicated rpm.

The voltage regulator performs the important function of limiting system voltage. Voltage regulators limit system voltage excursions, but they do not completely eliminate voltage variations. Without a voltage regulator in place, the battery would be forced to perform voltage regulation; a task it is not designed for. Without a voltage regulator, system voltage excursions into the 17V to 20V range could be expected under either high engine rpm and/or with the headlamp load switched out. This would undoubtably lead to a short battery life.

With the new 12V H-4 lamp in place but before installing the LED's, a voltage check showed the system voltage to be at 12.3V with the headlamp switched in and the engine running at 2500 rpm. The system voltage increased to 13.0V at around 4500 rpm according to the stock tachometer on the bike. Although marginally acceptable, this was a bit high of an engine speed for comfort. As a result, the LEDs were purchased and installed. Installing the LEDs in place of the standard bulbs resulted in the 13.0 V benchmark being achieved at an 1800 indicated rpm. This was an unexpectedly large drop in engine rpm required to achieve the 13.0 V benchmark, but it has been verified by repeating the test several times.

Reducing the Cost of Installation

The cost of converting from 6V to 12V in this example is fairly high. Originally the thought was that, for the cost of magnet wire ($25) and a few tidbits the old ’75 CB125S2 would get converted to modern electrics. However, as can be seen with the resulting project, all the ancillary equipment pushed the total cost up out of the range from “cheap” to “what am I doing?”

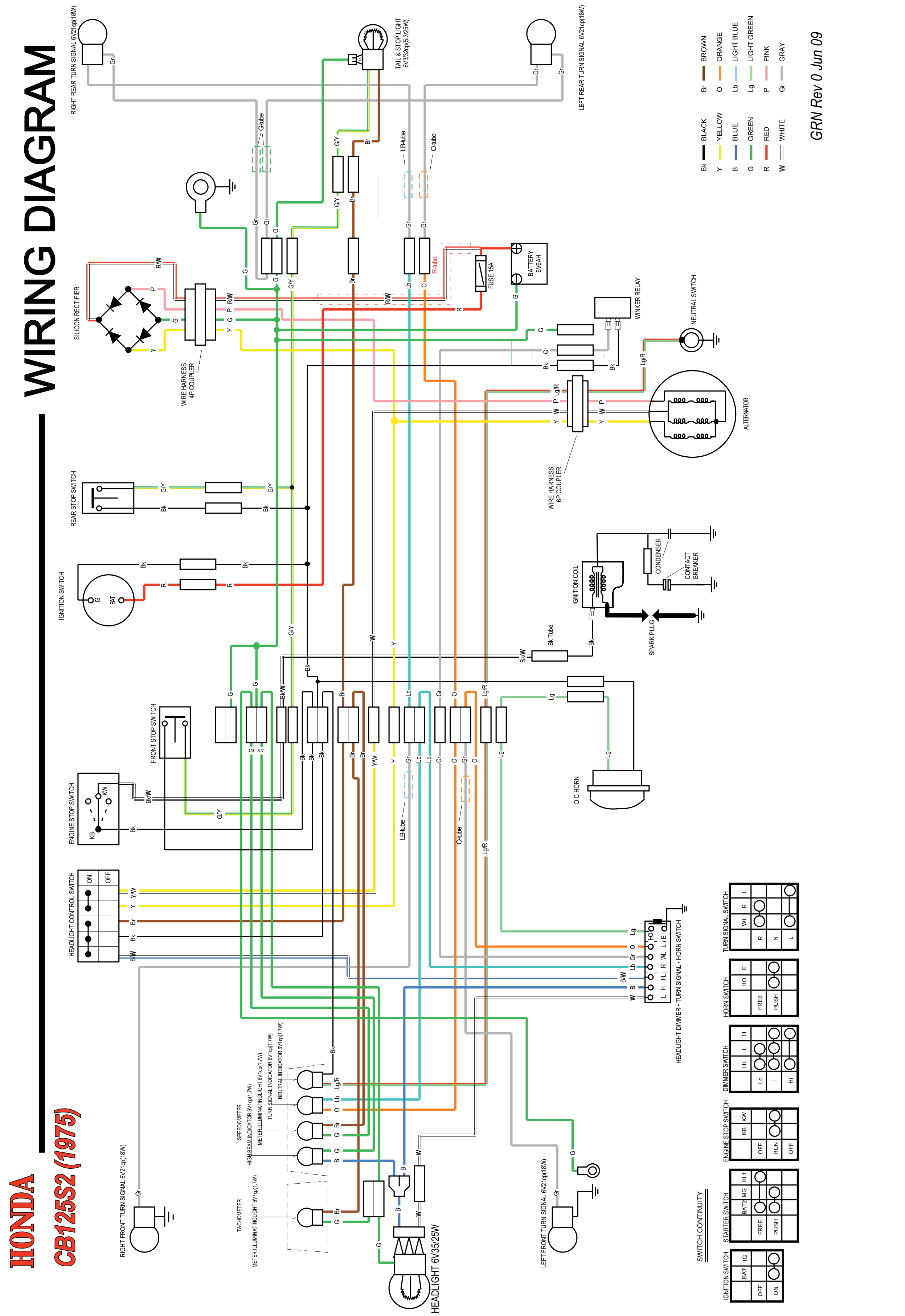
Several options are possible to reduce the total cost of the project for those who are interested in economically converting one of these old Hondas from 6V to 12V. First consider the essentials: the magnet wire, ignition resistors, and the battery are unavoidable. One should consider that at an absolute minimum, about $70 will be required just to provide the 12V structure. Adding in lights and $100 is very likely a practical minimum. The cost of parts used in this project was $245. However there are means of reducing the cost to below $200. One possible lower cost system is described below.

Consider three of the higher priced cost elements: H-4 lamp fixture, voltage regulator, and LED bulbs. These are possibly not needed with careful system design. For my own purpose, I undertook the project with the specific intent of installing a standard H-4 bulb, and this more-or-less forceably directed the project to a voltage regulator and LED bulbs.

However, if a standard incandescent 35W/35W 5.75 inch sealed beam round lamp is used instead of an H-4 bulb, the system has the appearance of electrically balancing out without either a voltage regulator or LED taillight (the instrument lights would still have to be replaced with 12V lamps, and one might as well put LEDs in: they can be purchased for $2 ea.). One would have to test this system to see if it does work out as hoped-for. But if it does work, then nearly $100 could be shaved from the total project cost. Instead of the H-4, voltage regulator, and all the LED’s one would have the cost of a cheap sealed beam (~$10), a standard 1157 taillight, and a few LED instrument bulbs (~$10). This system would not have the benefit of a good 55W H-4, but it might be a reasonable compromise. Without a voltage regulator in, one should pay close attention to having the headlamp switched-on at all times that the motorcycle is in operation to avoid seriously overcharging the battery.

One could also consider obtaining used parts from salvage yards. In the above example, all parts with the exception of the voltage regulator were purchased new. As a result, it may be possible to convert the old 6V system to 12V in the $100 to $200 range.

Honda CB125S2



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