Rewinding a Three-Phase Alternator Stator

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I knew something wasn't quite right with my '86 GV1200 Suzuki the last time I went to ride. As I got a few miles away from the house, the bike started misfiring and generally running poorly -- and then it stopped! The battery had gone flat, which meant that the electronic ignition could no longer fire the spark plugs properly. Modern high-energy ignition systems draw a considerable current from the 12 volt bus -- several amperes in the case of the GV1200. If the battery isn't charging, these ignition systems will drain it in short order!

There are only two components in the charging system of most motorcycles, an alternator (located underneath an engine cover) and an integrated rectifier / regulator unit (usually located next to the battery).

The alternator provides 3-phase AC to the rectifier and regulator unit, which converts the AC to DC and regulates the charge being applied to the battery. According to the Suzuki GV1200 service manual, each phase of the alternator should provide a minimum of 54 VAC open circuit at 5,000 rpm. My unit read 2 VAC per phase -- meaning that the alternator stator wasn't producing the rated output at all!

I looked up the component to find out its availability and cost. It happened to be a discontinued, no-longer-available item. The local dealer had one on hand, for a cost of $207.00 (plus tax). For that kind of money, it wouldn't hurt to repair the old one! Here are the steps in the process.

Removing the Defective Stator

Before doing *any* work, disconnect the negative battery terminal!

The wire from the stator leading up to the under-seat rectifier/regulator is first removed from the bodywork. (This is important to do first, since you won't want to do it while holding the engine cover in one hand!) Make careful note of how the wire is routed -- you'll want to put it back *exactly* the way you found it.

The stator is located under the left-hand engine cover on the GV1200. Since this is an internally-lubricated area with circulating engine oil, the oil should first be drained from the unit. Figure 1 shows the stator within the cover.

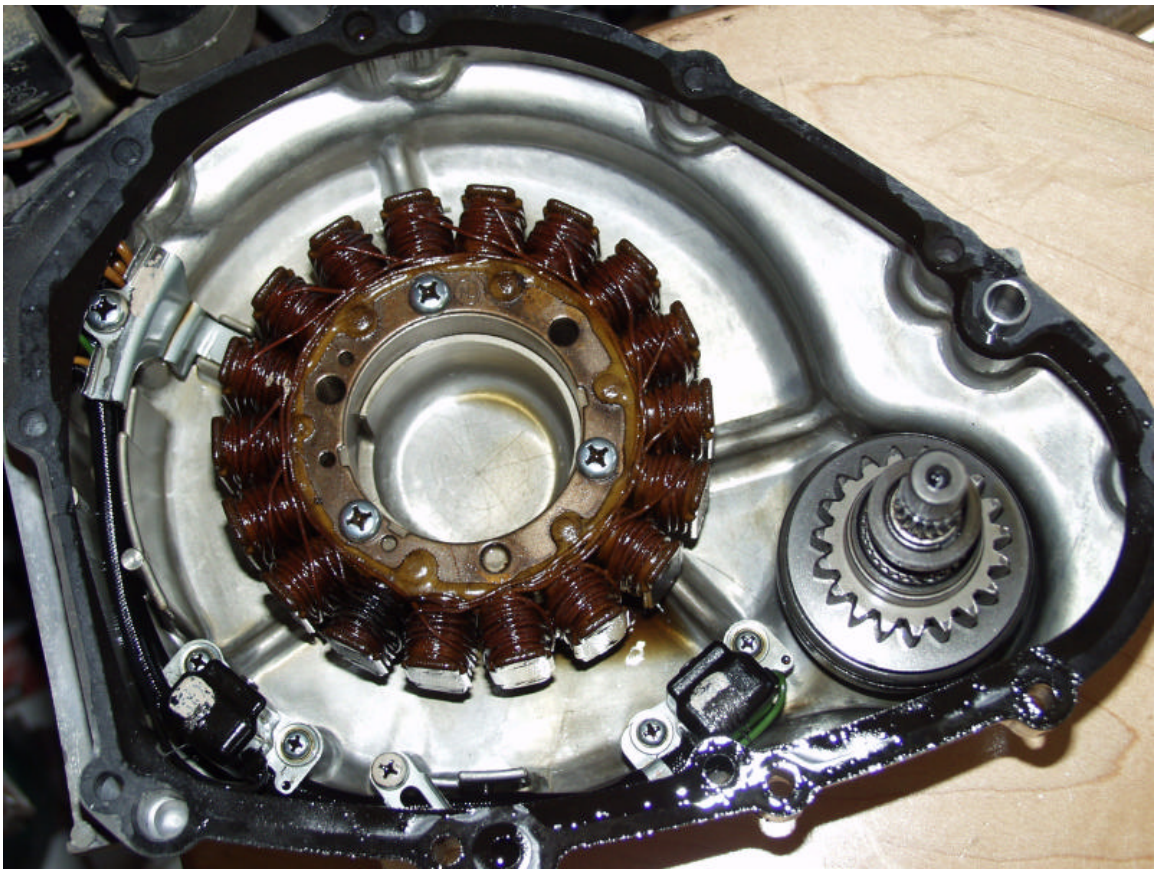

Figure 1: Stator Mounted in Engine Cover.
Note that part of the starter pinion assembly adhered to the cover when it was removed. The pinion assembly was returned its correct location prior to reassembly.

The stator is attached to the cover with three screws, and the cable is fixed in place with an internal clip (fixed with one screw). Be careful to avoid damaging the ignition timing pickup coils when removing the stator from the casing. Also take note of how the items are positioned; you'll want to duplicate this during reassembly.

Repairing the Stator

To repair the stator you first need to do some careful reverse engineering. Specifically, you need to know the following information:

- ?? The electrical configuration of the stator (Wye, Delta, or other)
- ?? The number of turns of wire per pole
- ?? The wiring scheme

Figure 2: The Removed Stator on the Bench, Partially Discombobulated

The GV1200 uses a Wye configuration to generate the three-phase AC power, as shown below in Figure 3.

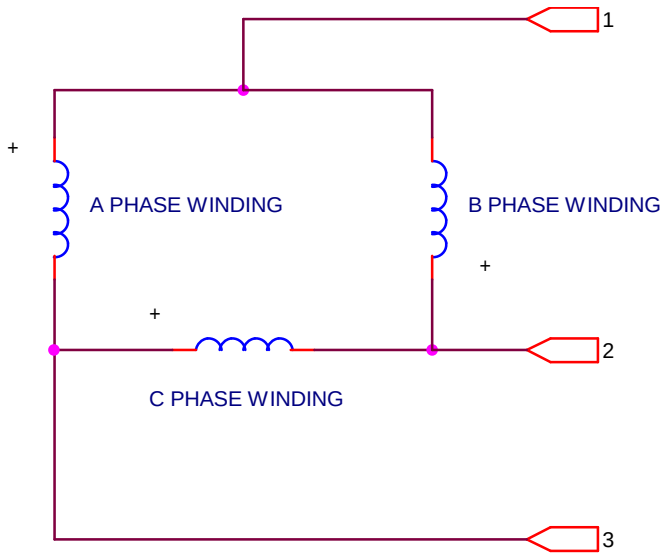

Figure 3: GV1200 Stator Electrical Circuit

To determine the number of turns per pole, simply unwind the wire from one pole and count the number of turns. Do this for several poles to make sure that the count is correct.

The wiring scheme is determined by unwinding the stator pole by pole. Make a drawing as you do this so that you can reproduce the wiring later. Figure 4 shows the wiring configuration of the GV1200 stator.

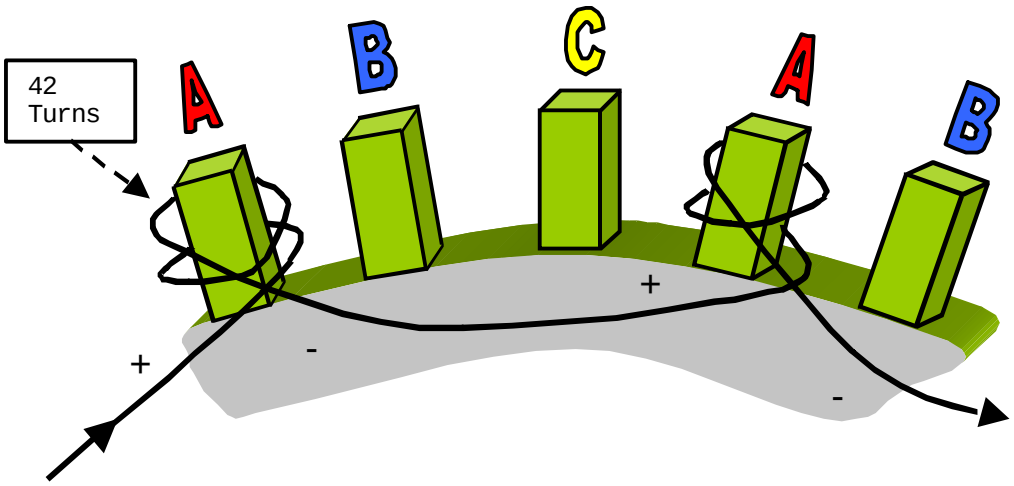

Figure 4: Wiring Configuration of the GV1200 Stator

Rewinding the Stator

Use good quality wire of identical size to that originally used to rewire the stator. The GV1200 rotor used 18 AWG wire, so Belden 8075 "Thermaleze" wire was used to do the rewinding. There should be no splices in the work, so obtain an adequate quantity of wire. (About 1 1/2 pounds was required for the GV1200 rotor.)

Resist the urge to dump the empty stator core into a parts cleaner. You may end up knocking off the epoxy finish that insulates each pole surface!

Carefully inspect each pole to make sure that the insulating finish (epoxy paint) isn't missing on the corners. This finish prevents the pole corner from cutting into the wire, creating an electrical short circuit to ground. Any missing epoxy should be replaced (thoroughly clean the surface before applying epoxy.)

It is important to wire all the stator turns in the same orientation so that all the windings in each phase will be series-aiding. Each pole has a "+" and "-" side. Arbitrarily, the "+" side can be considered to be the inside bottom start of a counter-clockwise pole winding. Like flashlight batteries, the windings need to be connected with the negative side of one pole connected to the positive side of the next pole so that the total voltage will be the sum of all poles in the winding for that phase.

Make an ohmmeter check between the stator body (ground) and the phase wiring after you wind the first 10 turns of each pole. This is where you're most likely to see a short develop. Do this for *every* pole. You don't want to discover a short after winding six poles and then wonder which one has the short!

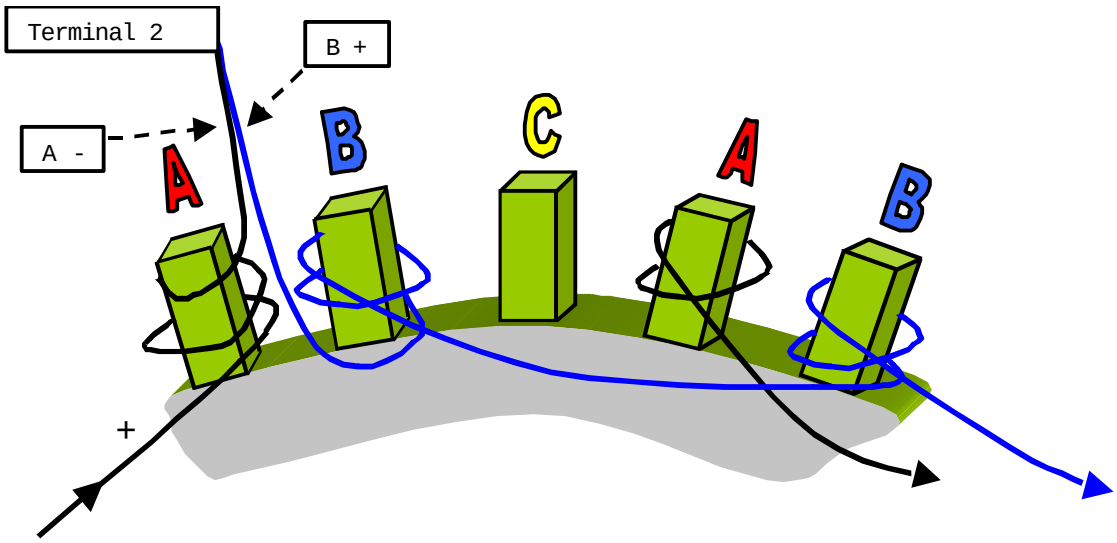

Figure 5: Inter-Phase Wiring

Figure 5 shows how the phases are wired together. Note that the "ending" wire of each phase becomes the "leading" wire of the next phase. No need to cut the wire here; it will help you to keep track of where things are supposed to go to leave the wire ends uncut. Figure 6 shows the GV1200 stator with two of the three phases rewound.

Figure 6: Almost Done!

All three phases must have the same number of turns. This balances the alternator electrically. An imbalanced alternator produces less useful output and self-heats due to the extra circulating current caused by the imbalance, which leads to early failure.

If you feel it is necessary, label wiring while you're working, but remove the labels when the job is done. Do not leave paper tape or any other material on the work that could eventually work its way loose. Remember that this component is oil-bathed. Bits of debris in the engine oil could spell disaster!

Finishing the Job

After winding all three phases, connect the bottom of the "C" phase to the top of the "A" phase; this is terminal 3 in Figure 3.

Solder all connections, reusing the original high-temperature insulating sleeves if possible. Don't use any insulating material that is either intolerant of high temperatures (such as plastics) or soluble in oil (the material will dissolve in operation, and may cause engine damage by reducing the capacity of the oil to lubricate.) To get a good solder joint on the old wiring harness, you'll need to carefully polish the wire ends using fine steel wool. They'll be quite dirty from exposure to heat and engine oil!

Finally, use high-temperature potting compound to secure the wiring to the stator core. (If you wound the coils neatly and used minimum length wiring between poles, this isn't

absolutely necessary; it will prevent the copper wire from moving due to vibration from the motor.)

Checking Your Work

The final work can be checked in the following manner; use as many tests as available:

?? Using an ohmmeter, measure between any phase winding terminal (1, 2, or 3) and the stator body ("ground".) There should be no continuity.

?? Using an ohmmeter, make sure that there is continuity between all three winding terminals (1, 2, and 3). They should all measure with a low resistance, less than 1 Ohm.

?? Using an LCR bridge, measure the self-inductance of each winding. The GV1200 unit measures 1 mH / phase at a frequency of 1 kHz (and very similar at 120 Hz.) This reading is important; it verifies the physical balance of the stator windings. The inductance of all three phases should be within 1% of each other.

?? Use a "megger" (high-voltage ohmmeter) to verify that there is no insulation breakdown. The insulation should be intact to at least 1000 V.

?? Make sure that the wiring components fit properly into the physical space. No wire should rise higher than any pole cap, or it may touch the rotor -- bad news!

Replacing the Repaired Component

After making sure that the part is "good," reinstall it. Refill the engine with oil, but don't connect the stator to the regulator/rectifier assembly just yet. It is possible that the regulator/rectifier has a shorted diode at its input, which will destroy the newly repaired stator.

Using the diode check function on a multimeter, make sure that no input shorts exist at the rectifier/regulator. If this part measures OK, perform the open-circuit output measurement to make sure your "new" stator works correctly. The voltage of any phase should be within 1% of the voltage on any other phase. The amplitude should meet the minimum specification given by the manufacturer.

If the measurements are correct, you're in business! Reconnect the alternator stator to the regulator and verify that the battery is being charged. Of course, inspect underneath to make sure that there are no oil leaks.