TUNING YOUR PERMANENT MAGNET ALTERNATOR CHARGING SYSTEM

by Pete Snidal (C)2001

Not Just A Good Idea.....

$$I=E/R$$

Not just a good idea; it's The Law. - Ohm's Law

Ohm's Law tells us that increasing Voltage (EMF) applied to a given resistance (R) will give us a corresponding (linear) increase in current flow (I) through that resistance.

Keeping this in mind, if we're having trouble with dead or dying batteries, we must determine whether our charging system is applying enough E - charging voltage - to the R - the resistance of the system, - ignition, lights, line resistances, and battery, to force enough charging current (amps) - I - into the battery.

We do this by using a Voltmeter - many of the more enlightened heh heh) vehicles have a voltmeter on the panel, since in many cases it's the most important thing to know about. If you're not so lucky, you can check your charging voltage in the driveway by connecting a voltmeter on the 0-15V DC scale to your battery. It should read just over 12V with bike not running. When you start the bike, the reading should increase, ideally to 13.8V. In the real bike world, we often have to settle for anything approaching 13 - my '69 Triumph goes about 13, and has never let me down for charging. I use a halogen headlight, but for daytime running only a white truck clearance light under the regular headlight.)

If you're not getting at least 13, you'll have to get in there and twiddle wires. Here's how:

1. Alternator Output

First, a qualification: there are 2 kinds of permanent magnet alternators: single phase and 3 phase. Single phase, the kind we'll discuss here, may be distinguished by their two output wires. Three phase, coincidentally enough, have 3 output wires. This article deals mainly with the two-wire kind, although the careful reader may be able to deduce a pearl or two to aid in troubleshooting the three-phase system as well.

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                   __________  + OUT TO VR
                  |
                 / \
               /     \
 AC IN ______ /        \ _______ AC IN
              \        /
               \     /
                 \ /
                  |___________  - OUT TO VR
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The way a bridge rectifier is wired - this is the kind in cases of two wires exiting the alternator. This may only be the first stage of an integrated rectifier/regulator unit.

First measure the alternator output, independently of the rest of the system. Disconnect the rectifier input wires and connect them to the voltmeter on AC (!) setting, the 0 - 30V (or higher) scale. AC doesn't have the horsepower of DC, so you need a higher voltage to start with. The AC output should be >20V - rectifying it will pull the voltage down to .606 (I think I remember) of original, or >12 VDC.

Less than 20V AC? Click Here

If you're getting >20VAC from the alternator, since 20 X .6 = 12, you should have _some_ charging ability. More than that means a greater capability for your system. Now let's check the DC output from the rectifier.

In the case of the 3-wire alternator, you want to see the same voltage from all 3 possible combinations of output wires. It could be quite high - my SR500 amazed me with open voltages of over 90 VAC! If all three voltages are about equal, reconnect the alternator output wires and do a voltage check at the output of the regulator/rectifier unit. If this closed voltage is less than 12.5VDC, try replacing the unit - the following procedures don't apply to 3-phase/3-wire alternators.(It is of course possible to homebrew a 6-diode rectifier for the 3 phase alternator (see your shop manual), but the off-the-shelf "quick fix" as with the RS Bridge Rectifier isn't there. Am I wrong? Click here to tell me!

Is Your Rectifier Integrated With The Voltage Regulator?

Your rectifier changes the AC - Alternating Current - output of your alternator to DC - Direct Current. AC is a two-way flow; the back-and -forth current flow will light bults, but it won't charge batteries. (Sort of like trying to blow up a balloon by suck-blow-suck-blow.) The alternator "cancels out" current in one direction, by turning it into heat, passing the current in the other direction, converting the AC to what is known as "pulsating DC."

This PDC is of a lower voltage than the AC input, and will vary, as will the AC, with engine speed. If the output voltage is lower than that of the battery, the rectifier, because of its "one-way" diodes, will not pass current from the battery to the alternator. If the output voltage is higher than that of the battery, current will pass from the rectifier into the electrical system and battery.

Voltage Regulation

This output voltage must not be too high. A voltage in excess of standard charging voltage - 13.8 volts - will overcharge the battery, causing the acid to boil, and will shorten the life of the bulbs and other components of your electrical system. Consequently, the output voltage must be "held down" to a maximum of 13.8 VDC. The component in charge of this function is the Voltage Regulator, or VR.

Two Kinds

There are two kinds of voltage regulator - Series, and Parallel, so named because they are wired into the circuit either in series - the output current passes through the regulator, which will only pass voltages up to the maximum, or in parallel - the regulator monitors the output voltage and "holds it down" below the maximum by, in effect, short-circuiting, or "shunting" the output when it gets over the limit. The "shunts" are of very short duration, during which time the VR converts the excess voltage to heat, as with the diodes in the rectifier.

Which Is Best?

The first VR to be developed for motorcycle use was the "shunt" type - the Zener Diode. It is a cruder and less efficient form of VR, wasting as it does the excess electricity produced by the system, rather than just failing to pass it. As technology developed, the series regulator has taken over, it's more modern and efficient design wastes less output power, as it just intermittently "turns off" the current flow to keep the final output voltage within prescribed limits, wasting less power than the ol' zener in the process. In either case, the next step is to check the DC output voltage "downstream" of the VR.

"Open" and "Closed-Circuit" Voltages

The output of the Alternator, and hence of the VR, will vary with engine rpm. It will also vary with load - the voltage will be higher when the circuit is "open" than when it's connected to a load, such as the lights, ignition, and battery. Measuring the "open" output first, and then the "connected," "load," or "closed" output will tell you different things about your system.

Separate and Integrated Rectifier/Regulators

If you have a system with separate rectifier/regulator, you can check the output of the rectifier separately, then play with the regulator. If you have an integrated setup, you'll have to settle for checking them as a unit. So first, let's check the DC output voltage of your system as a whole, both open and closed.

Connect the input wires again (no polarity consideration, since this is AC) and disconnect the rectifier output line. Change your voltmeter to the 0-15V DC scale, and measure the output voltage with motor running at ~1000 rpm.

The DC Voltage will be less than the AC input. But if it's much less than .606 of the AC, then the rectifier needs replacement. Put in practical terms, if you had an AC output greater than 20VAC, but your DC output is less than 12.5, your only hope is to try a new rectifier and/or regulator.

So Which Is It?

If you have a separate rectifier/Voltage Regulator setup, you can first measure the rectifier output, replacing this unit if necessary. If they are integrated, you'll have to replace them both as a unit to correct any voltage passing deficiency. Or you can replace them separately, starting with the rectifier.

But in either case, you can test your system's ability to make DC output by an inexpensive substitution. They are available, at least on North America, from Radio Shack (TM). All you need is a 4-diode Bridge Rectifier, with a peak voltage rating of 20V and current rating of 10 Amps or more. Your local Radio Shack (TM) has them for less than 5 bucks. (Your location may vary; don't know that they have Radio Shacks, or even bucks, in Karachi or Adelaide, but you get the picture. Any electronic supply store will have something of the sort.)

Connect the AC input wires from the alternator to the terminals marked AC - one to each; no polarity considerations with AC. Start the motor and measure the DC output at the DC terminals, marked + and - on the rectifier. If you get a healthy "open" reading, - over 13VDC, then you can connect the + and - wires to your system - watch the polarity - and check again for a "closed" reading. If your "closed" reading exceeds 13.8VDC, you'll need a Voltage Regulator as well.

This is not said to be funny. In the case of marginal alternator output, you may not have enough excess voltage to require a VR, yet stil have the snoose to keep your lights and ignition working. Especially if you "fudge" a bit on the lights - if you have the output, keeping the lights on may be required to avoid overcharging the battery, but if you don't, you may find that your system will stay above 12.5 VDC with them off, but not with them on.

If you can't get a reasonable system-under-load reading with the lights on, try disconnecting the headlight. If this gets you to a decent charging voltage (>12.5), then the 'lectric goblins are telling you that you don't get to run a headlight full time. (They especially dislike halogens) You can beat this one by installing a law-enforcement-friendly alternative lamp close to the headlight. I've been using "bullet-type" truck clearance lamps, mounted under the regular headlight for years. They have a magnifier in the tip you can point at oncoming traffic, and since I've been using them, have never had a minion do a 180 and make it necessary to give him sob story 3B: Lucas, Prince of Daylight Darkness. And, if you're worried about the safety factor, ie the less bright light failing to deter cage pilots from murder by bumper or door, forget it; you're no less invisible either way; disregard this at your peril.

In most cases, however, your system will be healthy enough to require a VR. If this only applies with your "new" bridge rectifier, then it's choice time. You'll have to find a series or parallel type VR. The only one of which I am aware is the stock Zener diode, supplied through the various manufacturers by Lucas. I'm not presently aware of a part no. or source for a 13.8 VDC series regulator of 10A or greater capacity - I'd appreciate hearing from anyone who's found one. click here to email me

Or you may elect to pop for a "Tympanium" unit. This is an aftermarket integrated unit, using modern solid-state electronics all the way, and works great. I use them myself, Luddite that I am. But I don't in cases in which the alternator output is marginal, since in these cases a regulator isn't even necessary - the question becomes one of whether or not to use the full headlight to keep the charging voltage within reasonable limits, and an RS rectifier is all that's required. Be sure to "heat sink" your new VR when you mount it permanently, since it does its work by converting some of that AC to heat which must be dissipated. (Hmmmmm - how about an electric vest rectifier? Electronic whizzes, take note)

Next, check the system voltage at the battery. If there's any difference between battery terminals and Rectifier output, jump the + and - leads from VR to battery with good quality #16 copper stranded automotive wire. Use appropriate colours - red for + and black for - and be sure to fuse the battery ground.

That's all there is to it! Hope it helped. Lemme know.