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AUTO ELECTRIC CORNER
Powder-Coating Issues, 4-G Alternators, 17841 Denso Starter

A USEFUL POWER SUPPLY
For Bench Testing Small Components



Electrical Rebuilder's ERA FOUNDED 2001 ASSOCIATION

A WORD FROM THE PRESIDENT
Dealing With Supply Chain Issues



With the current US supply chain issues, most of our industry's suppliers are having a hard time fulfilling our orders for units or parts, items we need to be successful. We all have our own preferred brands of components that give our rebuilt products the advantage of quality, something that our customers have learned to appreciate.

Yes, we may be able to obtain a lesser quality component from our suppliers, but I am not willing to forfeit my reputation by using parts that are sub-standard. Most of us rely on about five major industry suppliers for all of our daily purchases of units and parts. When none of them can fulfill an order, what do you do? With the hustle and bustle of our daily operations, we forget about the smaller suppliers that are not only members of the ERA, but may also have the quality component part that you need.

The cost of shipping and time it takes to get parts across the country can be daunting. But it doesn't have to be. Many of our supplier members provide great freight pricing and delivery incentives. I am currently working on providing ERA members with a list of telephone numbers and website links to ERA supplier members on our website. It will be listed on the left side menu of the homepage for easy access. Hopefully it will help you in securing needed quality units and parts during these difficult times.

Another option is using the ERA Website's Forums. The Wanted Forum is where fellow members can help you to source a part that you need. As an example, I was looking for a Transpo IN220SE that none of our major suppliers had in stock. I posted my request on the Wanted Forums, which was quickly answered by Jack Isom of IMI Performance Products Inc. in California. He said he happened to have a half a dozen on his shelf and was willing to sell one to me. I also received a response from another ERA Rebuilder member, Chips Auto Electric in East Hartford, Connecticut, one town over from my own shop. They also had the regulator and were willing to trade something for it, or replace it with another regulator, to which I agreed to. The following week, he was in need of a 54-9128 Robert Bosch starter drive for a John Deere application, and we agreed to an even swap. Why not? I needed the regulator for my job and he needed the starter drive for his job. Yes, we are competitors, but we are also both members of the ERA and believe in working together.

I along with the Board of Directors want to remind you of the benefits that you have available to you as part of your Electrical Rebuilders Association membership. We along with you incur the same hardships and challenges. The Board of Directors and I are constantly looking for ways to provide opportunities to decrease or eliminate these hardships.

Ken Plourde

NEW ERA MEMBERS

Classic Auto & Marine Electrics
Sandusky, Ohio

Raul Williamson
Crosby, Texas

Jon's Alternator & Starter Service
Vilas, North Carolina

ABOUT THE COVER

WAI-1000 showing lack of FR (DFM) signal

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Rebuilding *is* Recycling!

AUTO ELECTRIC CORNER —
Powder-Coating Issues, 4-G Alternators, 17841 Denso Starter



BY MOHAMMAD SAMII

A conversation with a caller on the ERA Help Line about how to test a Bosch alternator that had been installed on a street-rod did not come to a conclusion due to lack of specific information. The type of engine and its supposedly Bosch alternator were not known to the caller and he had no access to the vehicle or his customer. He was merely helping him out remotely.

Finally, he asked if his customer (an individual) would be able to call me for my direct help, to which I agreed, given that this is not exactly the purpose or the policy of the ERA Help Line.

In talking to the car owner, he failed to describe the unit to me clearly as all he knew was the system voltage was the battery voltage at 12.4, and it did not change with RPM. He asked if he could send me the alternator for inspection and possible repair, which I reluctantly agreed but with a stipulation that any repair beyond bench-testing would be in addition to the shipping cost for returning the unit.

A few days later UPS dropped off the alternator (*Figure-1*). It turned out to be a single wire (Self-Exciting) CS-130 alternator with modified housings and not a Bosch at all. It was nicely put together with modified hardware for the output post to exit from the side, and was very heavily powder coated black.

It did not self-excite regardless of the RPM, and after tear-down and component inspection, it showed that it had two open diodes in the rectifier. Our new rectifier would not fit properly. The modified rectifier in the unit had its 5.5mm hole drilled out to about 7mm to allow the screw and insulator for the modified output post go all the way through. So, our new rectifier had to be drilled out to allow this. (*Figure-2*)

Now the rectifier was replaced and the unit was assembled with the stator wire snugly secured to the rectifier (but not soldered yet) to run on the test bench, just in case it had to be taken apart again. This was a good move…the alternator did not charge and it had to be disassembled again…!

After disassembly I checked the new rectifier again which was fine but when the diode test lead was put on the case of the alternator, I could not detect any connection, meaning that the rectifier was not grounded to the SRE case through its negative heatsink. The heavy powder coating was so thick that it had actually worked like a thick insulator, not allowing the negative heatsink to be connected to the case. (*Figure-3*)

Scrubbing the thick black powder-coating from the inside of the SRE frame restored the ground connection (*Figure-4*). After a full assembly, this custom-built unit that had a Regitar D694SEL regulator energized and worked fine. Like many such CS-130 inspired alternators, the baffle plates were not used by the manufacturer, and I left it as such. The alternator was shipped back promptly to a very happy owner.

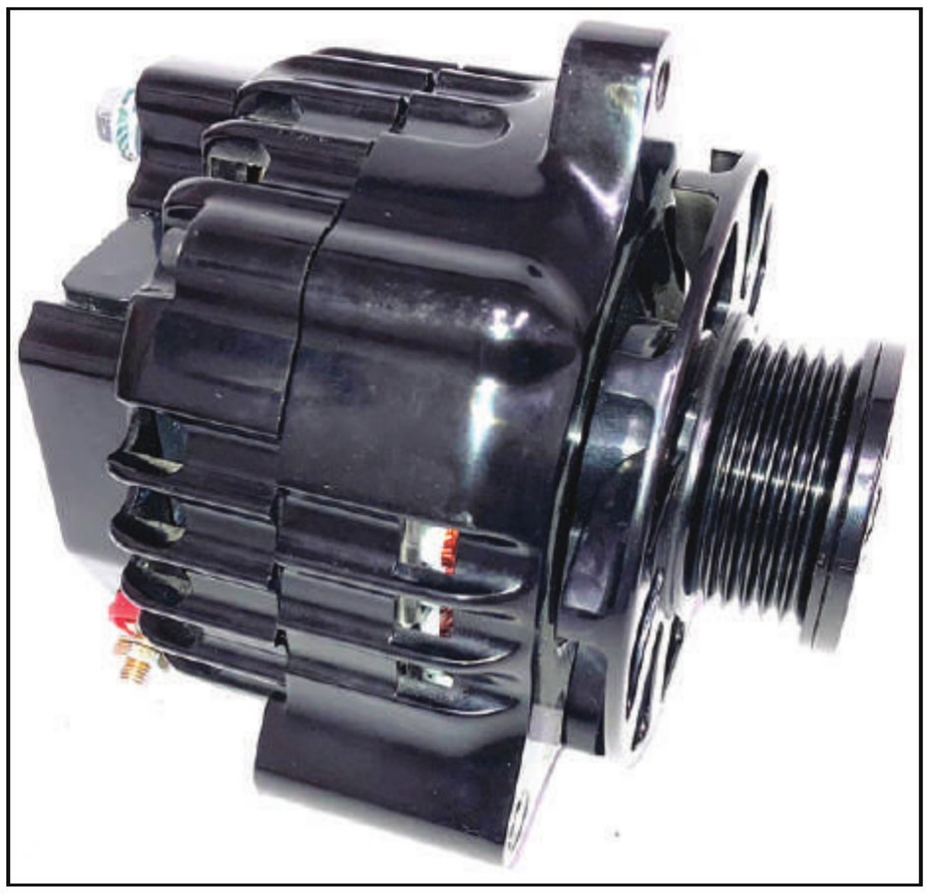

Figure 1 – Modified alternator based on a CS-130SE

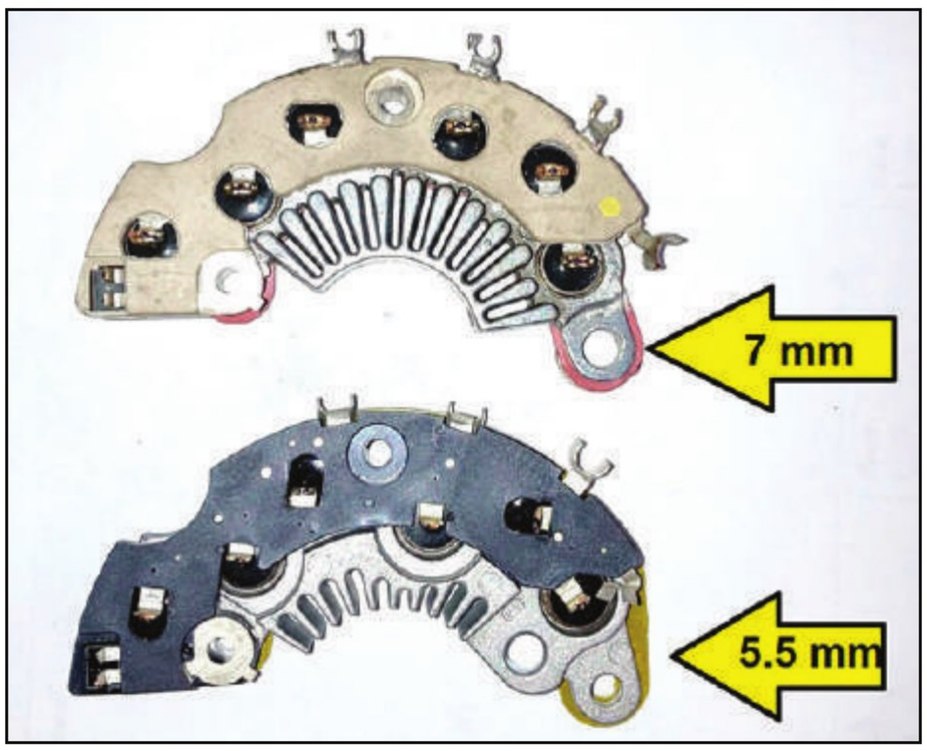

Figure 2 – Mod rectifier with the larger hole than standard

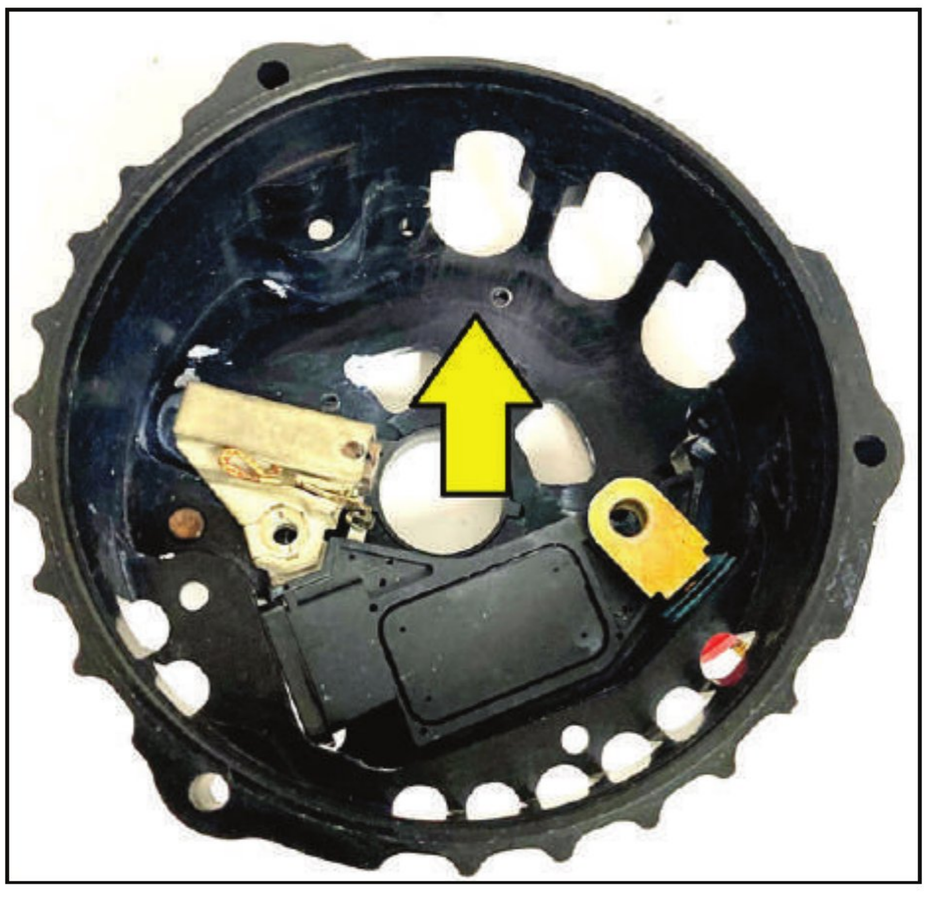

Figure 3 – Insulated SRE due to heavy powder-coating

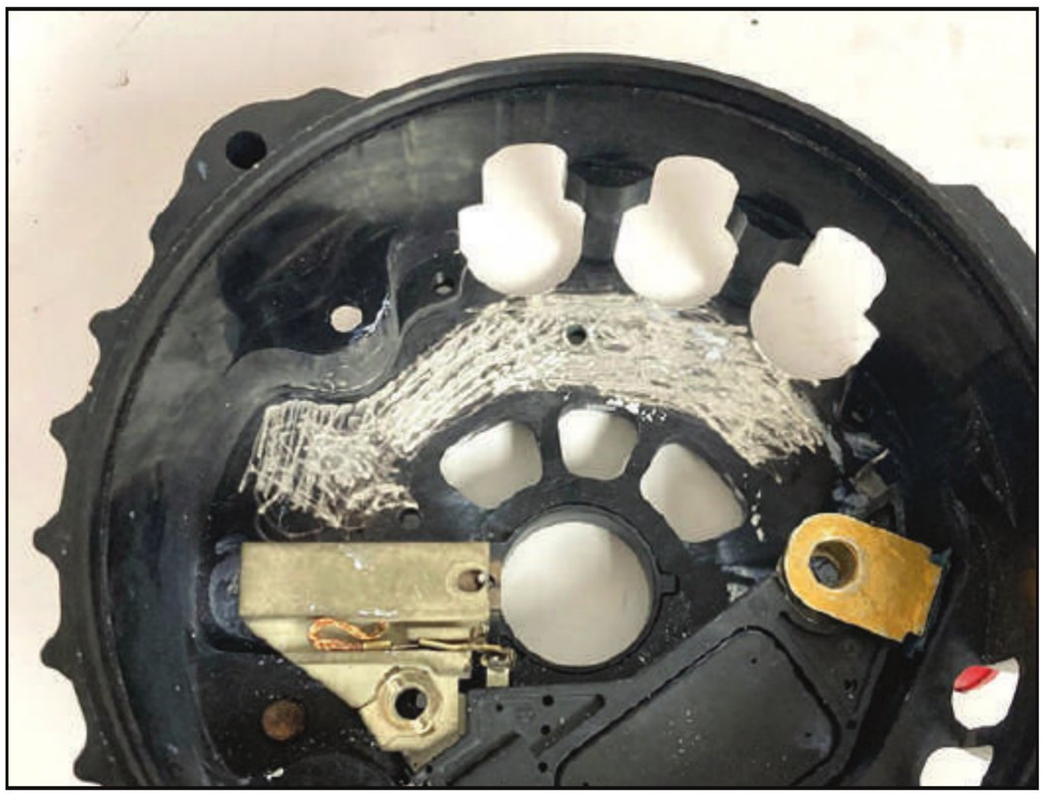

Figure 4 – Scrubbed paint from the SRE housing

4-G Alternators

This Family of Ford alternators that were introduced around 2001 have been in service now for over 20 years. Their basic design has not changed and they are used in a variety of Ford applications. Most rebuilders first saw them when they appeared on some early 2000 Ford Explorers and Mercury Mountaineers. Since then, they have been used on and off in some Ford/Mercury products which the manufacturer (Ford) in a confusing manner went from using 3-G to 4-G and 6-G, then went back to using 4-G or even 3-G in certain applications. There is no known consensus for this back-and-forth changeover that I am aware of. I have never understood the reason for these changes, and I don't think that I am alone in this. These 4-G alternators have even shown up as the second alternator (bottom unit) on some E-series vans and F-series trucks with dual alternators.

The way the earlier OE rectifiers were made, bench testing required for the output nut be tightened snug to the output stud so the battery cable could make a positive connection to the rectifier. This has been corrected since and most aftermarket rectifiers no longer require it. (*Figure-5*)

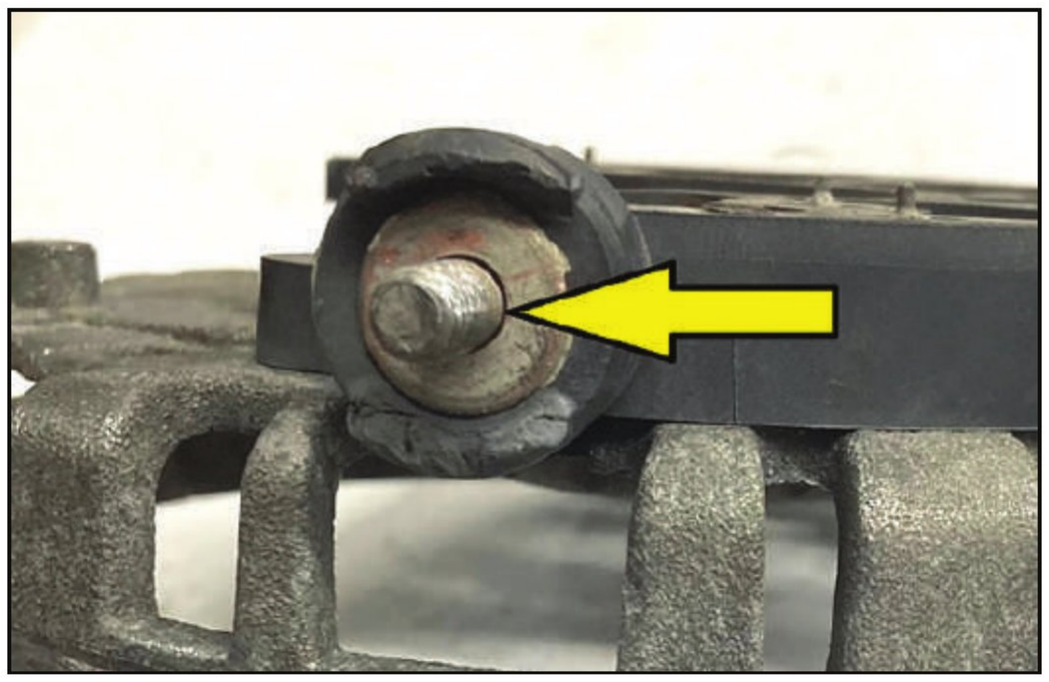

Figure 5 – The stud and ring may not be connected



4-G rotor slip-rings can be severely worn if the unit has been in service for a while. Nearly every high-mileage unit needs their slip-rings to be replaced. This was not an easy task when only the OE-type rigid slip-rings were available. That required cutting the rotor's rear fan to make a groove to lay down the new slip-ring. This process became a very easy task when the slip-rings with flexible lead were introduced, thus cutting the fan is no longer necessary. (*Figure-6*)

In case you ever get a 4-G slip-ring that has enough thickness left to be turned and cleared, the minimum practical thickness of the used slip-ring cannot fall below 0.595" in order to provide a satisfactory service life.

Subsequent changes of this alternator's regulator from Light/PCM activation to full PCM-controlled charging system requires using a rectifier that has a +B feed built into the lead frame to serve as the source of field current as shown in Figure-7. So, the older rectifiers that lack this provision cannot be used in alternators that have a PCM-type regulator. PCM-controlled regulators in 4-G alternator applications are white in color.



Figure 6 – 4-G rotors slip-ring with flex and solid lead

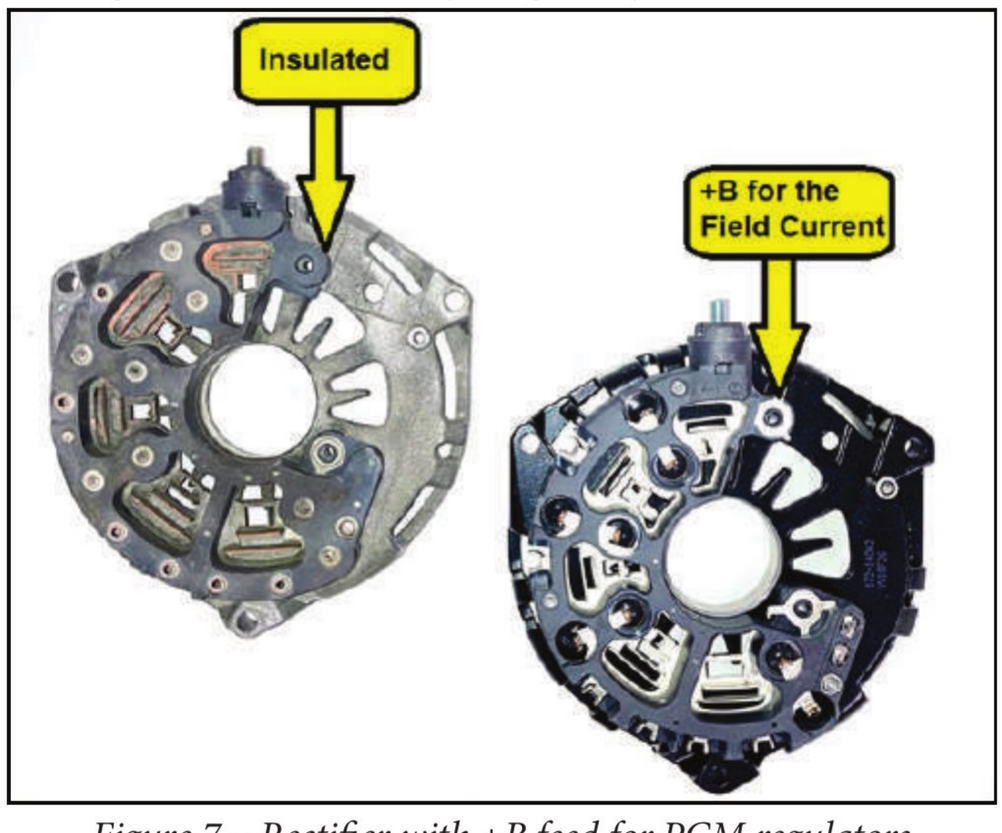

Figure 7 – Rectifier with +B feed for PCM regulators



DE housings for 4-G alternators come in a few distinctive shapes made for various car and truck/SUV engines. Some of these alternators may have a bolt-on dust cover or heat shield that requires special through-bolts with extensions for attachment of the cover, such as the 8403/8474 used on the Ford Escape and Mercury Mariner with 3.0L engines. The identical looking 8442 is nearly the same unit without the extended through bolts. It was used on the Ford Five Hundred, Freestyle, and Mercury Montego. (*Figure-8*)

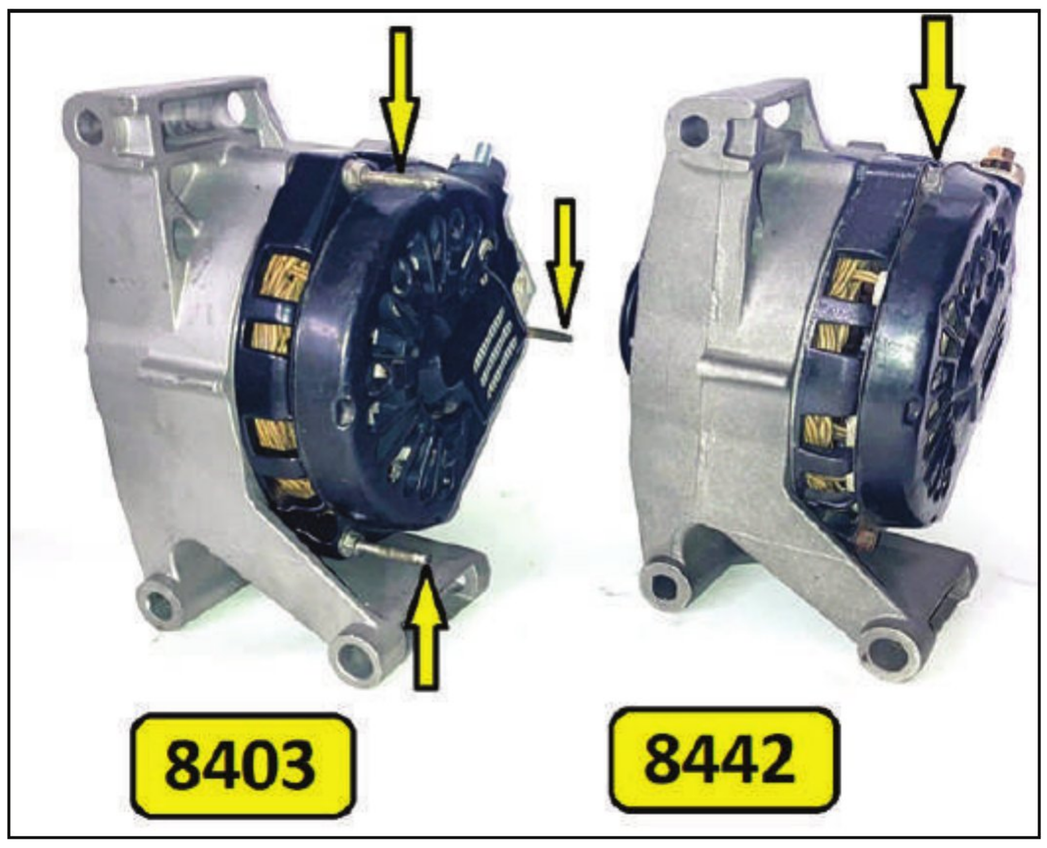

Figure 8 – Two identical 4-G with and without the extensions

The 8403 core that I was rebuilding for our stock was a clean core that an automotive parts store had sold to a repair shop. It was charging okay but the battery light was staying on. The vehicle in question was a 2007 Ford Escape with 3.0L engine, and our unit took care of the light issue.

So naturally I was interested to know what was wrong with the core that it would not turn the light off on the vehicle. Running the unit on the test bench, WAI-1000 indicated lack of any feedback signal (FR or DFM) from the regulator while the Vset and Vread where within acceptable 0.4V of each other as shown in Figure-9, thus the reason for the warning light staying ON. A new regulator solved this problem and after rebuilding, the unit was added back to our stock.



Figure 9 – WAI-1000 showing lack of FR (DFM) signal



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17841 Denso Starter

This starter that has been used for a period of 6 or 7 years on Toyota Corolla and its re-badged sister, Pontiac Vibe, has been a good mover for us. There are nearly 1.5 to 2 million such applications still on the road. Given most of our market is 15 to 20 year old vehicles, the chances of running into one is not far-fetched. (*Figure-10*)

This PMGR starter uses an axial brush and armature set-up, and is kind of unique in this category of light automotive starters. The armature commutator is flat and

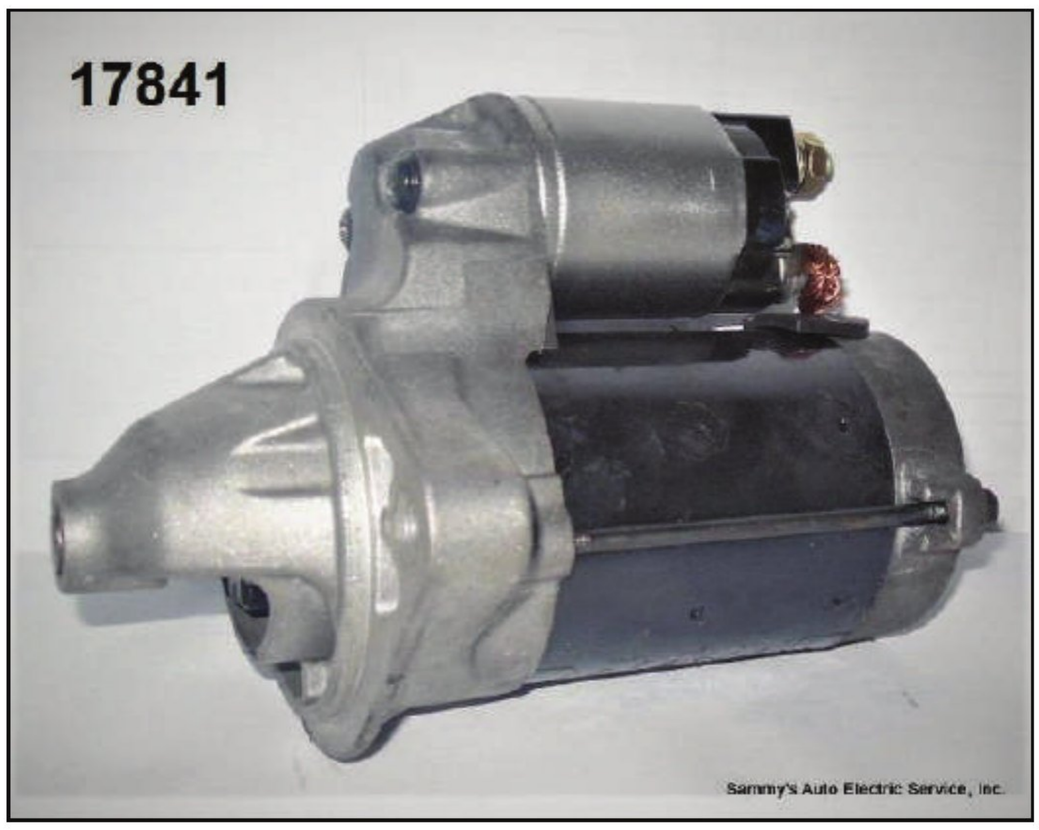

Figure 10 – A 17841 starter

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the brushes and brush-holder which are imbedded into the CE housing sit tightly against it to make the connection, much the same way as some Lucas, Valeo, and Untitled Technology starters of the past. (*Figure-11*)

Removing and installing the small snap-ring from the armature's shaft to remove the end-cap is a delicate matter, but is doable with a little patience and a good quality pair of snap-ring pliers. Holding the armature and end-plate tight in a vise allows enough clearance so the snap-ring can be removed or installed. (*Figure-12*)



Figure 11 – Armature and end plate

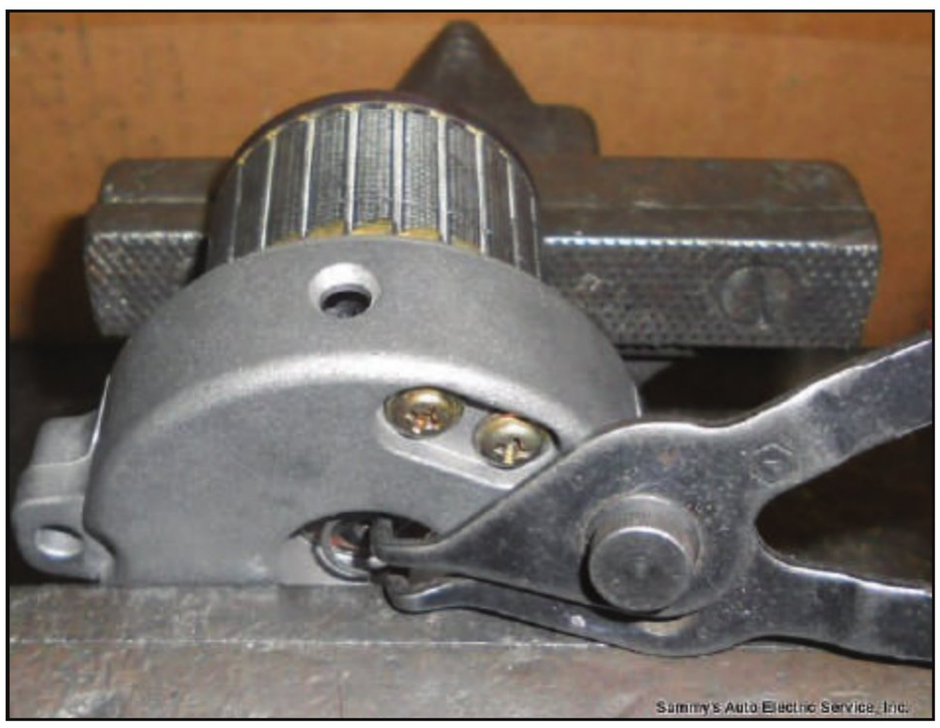

Figure 12 – End plate snap-ring removal

The complete brush-holder assembly is available which I prefer to use rather than replacing cumbersome brushes individually. The solenoid and drive are available but the starter drive rarely requires replacement. A little clean up and lubrication will usually restore it to an acceptable service life if the gear is not damaged.

The 17825 is in a similar starter family as the 17841 but with an open nose DE housing and CCW rotation. They were used on many Toyota Camry, Scion, and Lexus vehicles with nearly a million still in use. An important point is not to mix up the field cases, armatures or brush-holders between the CW and CCW starters as they look very similar. They need to be marked accordingly to avoid a mis-match, which would be difficult to figure out later. (*Figure-13*)

These starters can be purchased easily if your suppliers have them, but for me the high demand of these units justifies rebuilding them quickly in–house using minimal service parts.

Well, that's all for this issue. Until I see you again, stay healthy and keep up the good work.

You can contact Mohammad Samii by email at: sammyselectric@sbcglobal.net, or by calling the ERA Tech Help Line at 636-584-8324



Figure 13 – CCW and CW armatures and brush-holders

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A USEFUL POWER SUPPLY
For Bench Testing Small Components



BY NATHAN UNGER

Voltage drop testing is a necessary skill for diagnosing electrical problems. Basically, you run a current through your item to be tested, (called DUT, device under test) and then measure the voltage drop across it. This follows Ohm's law, and will tell you if your connection is good enough. I am going to be introducing a concept that is surprisingly useful but not familiar to many of our local mechanics: a power supply that *regulates current.* It jacks the voltage around to keep the current constant at the level you decide. It's like a voltage regulator which has a voltage setpoint, except this regulates the current at a current setpoint instead.

Many folks talk about the necessity of 'checking' your connections, but here is the scientific way to actually measure a connection.

Think of it like the difference between using a test light versus your DVOM to measure voltage. "How bright is your bulb?" versus "What voltage does it read"? Now you will actually know how much resistance a connection has rather than just saying, "It looks good to me."

If you already know all the details, you can just skim the article. Throughout, I have some skill testing questions, to be answered at the end.

Many rebuilders use a combination of batteries to test alternators and to free-run-test starters, but for the small stuff, it would be nice to have something more stable so you can do comparison testing. From Ohm's law we see that if your test current stays constant, then your voltage readings will (proportionately) track the resistance values.

What kind of power supply would be suitable? See figure 1 for an example.

- It would have to be <u>reasonably priced,</u> even for a small shop.

- It would have to include <u>voltage regulation</u> that you can adjust say, from 0.5 volts all the way to 30 volts. It could therefore test generator and rotor coils, even the 24v ones. The voltage you set would stay there no matter if you are drawing 0.5 amps or 30 amps.

- You would want <u>current limiting.</u> Set the maximum current you want for what you are testing (let's just call it the device under test: DUT) – like fuses, trio diodes, connections, harness plug connections, conductor sizes, brush lead packing, relay contacts, mechanical regulator contacts, all kinds of coils, overall starter milliohms, etc. That way you can ensure that you won't short or burn something out while you are trying to measure voltage drop.

- And then there's current <u>*regulation.*</u> Technically, it's called a "constant current source"

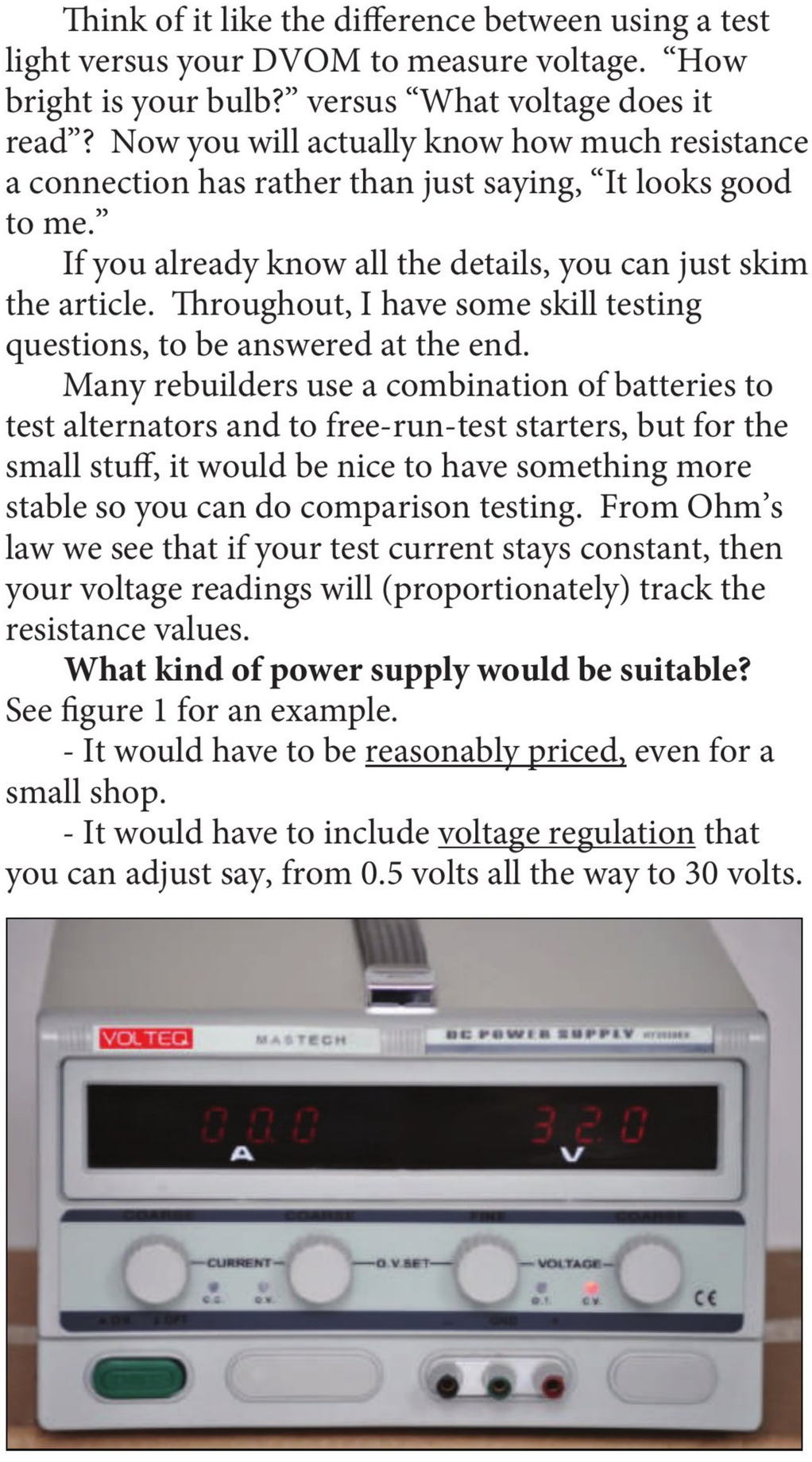

Figure 1 - Power supply example

Rule 1

It can be shown that you will read the same current no matter where in the wiring you clip your amp probe – if it's a series circuit. A guy named Kirchhoff figured out that the current in must equal the current out. So, if the power supply gives you 5 amps of regulated current, you will see 5 amps through all points in your testing, even if there are bad connections – because they are all in series from the positive output of the power supply back to the negative of the power supply. This is because the voltage loss of any bad connections has been compensated for by



the power supply. It automatically adjusts the voltage to maintain the regulated current you set. (*See figure 2*)

Figure 2 is an example of a rotor, brushes, and regulator driver, A circuit. All are in series, and the current measured at each point is the same as at every other point. (Or to put it another way, if I change the current setting at the power supply, it will change at all current-clamp points simultaneously.)

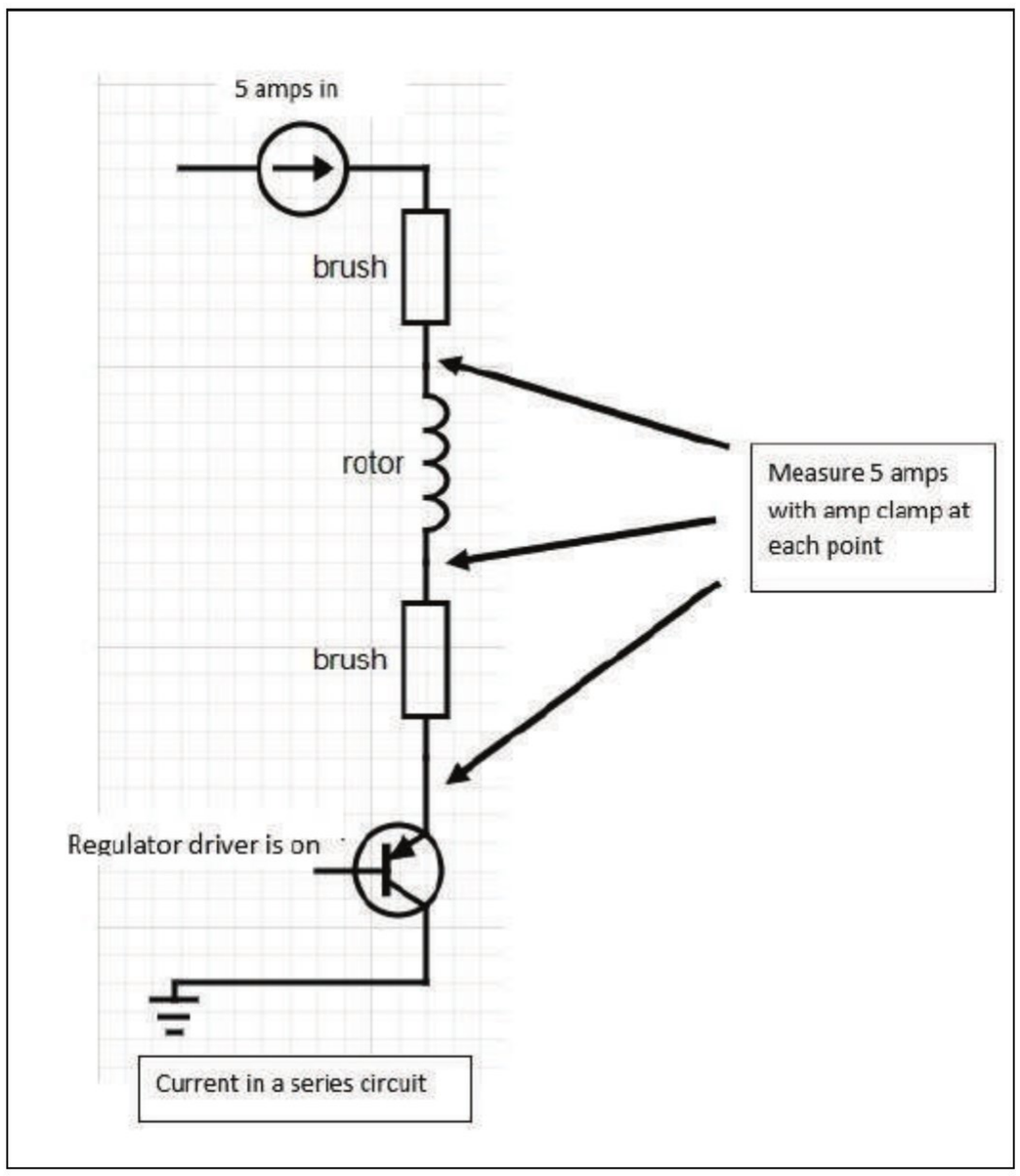

Figure 2 - Current in series circuit

So if your cables are too thin, and your connections and alligator clips (or pointy probes) are not consistently connected and you have some unwanted voltage drops; as I mentioned, the power supply will automatically adjust the applied voltage so you always have the same current.

Rule 2

Since you are using your constant current source, then your voltage drop measurements will track with the resistance of your DUT. They will always be proportional. All you do then is compare it to a 'golden sample'. If you compare things one against another, like the ol' bar to bar test on an armature, it would be a 'piece of cake' to find bad solder joints. Find one good com connection or one good armature, and you compare everything to that. No calculations necessary. More on that another time.

If you like you can make yourself a chart to use.

Rule 3

Now the current may be the same at all points in the series circuit, but the voltage is not. You add up the voltage drops (in a series circuit) and you will end up with the amount of voltage you applied to the total circuit. (*See figure 3*)

(If it doesn't add up, then you have missed a measurement somewhere.)

Skill testing question 1: Sometimes I encounter a replacement regulator which enables the alternator output to be greater than when it had the first regulator in it. The setpoint voltage and the rpm is the same, yet the amperage is more. Why would this be? Hint: Think about the driver.

Rule 4

Wherever there is a conductor, joint, a resistance, or something, with current flowing through it, there will be a voltage drop, no matter how slight.

Take note: This includes the leads and alligator clips from your power supply! Your panel voltmeter will *not* tell you accurately about your DUT (device under test). And another thing, there is no such thing as a dead short. If it has current through it, it will have a voltage drop, even if it is a small one. More on that later too.

In figure 3 all these voltage drops add up to equal the battery voltage. I compare it to a ladder. The battery voltage is like the height of the roof above the ground, let's say. Each voltage drop adds on top of the last one, just like each step up on the ladder. Now obviously the voltage drops will not all be the same 'height' from each

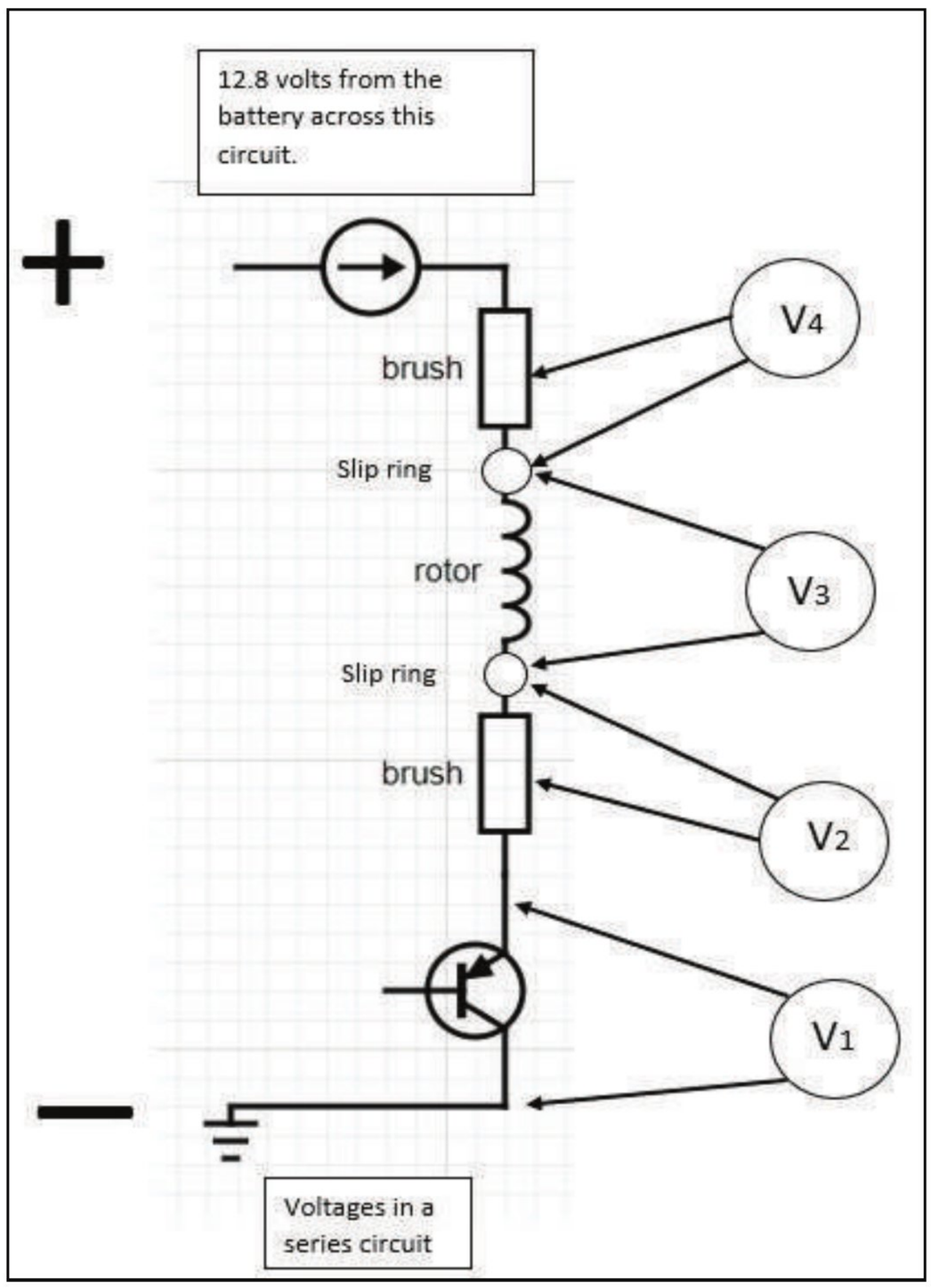

Figure 3 - Voltages in a series circuit

other, but you know what I mean – they add up to the applied voltage. That's Kirchhoff at it again.

Rule 5

Any time you measure voltage, you always have two leads. A voltage is always referenced to something. For example, you would never say, "voltage through"; you say "voltage across". In school, we called it WRT. "With Respect To".

For example; "The technician measured 12.8 volts at the battery positive WRT battery negative." Current goes 'through'. You never have current 'across'. Example: "The technician measured 8 amps of current *through* the vehicle headlight." (An amp clamp does not directly measure current, it senses magnetic field, which is proportional to current, but the meter is calibrated as if it is current.)

Interesting Analogy: Remember the old amp gauges with the shunt? (*See figure 4*)



Figure 4 - Amp gauge

The scale on the gauge said charge/discharge amps with zero in the middle, but the meter was actually measuring voltage across the shunt. This is because of Ohm's law. You had a *constant resistance* (the shunt), so therefore, the voltage was always proportional to the current. That's why your meter face could be scaled according to the current, even though needle was responding to the voltage drop. The resistance was constant, but the current was always changing, so the voltage drop did too, proportionally.

Now with our current regulation, Ohm's law still applies, but in a different way. The current is the constant thing now, so the voltage is always proportional to the resistance.

The beauty of series circuits is that the current is the same throughout. And again, because you are using regulated current, a few bad connections will not affect your constant current. I always set my power supply to give me at least 3 volts to play with when I am doing low resistance (aka high conductance) measurements.

Back to figure 3. I can measure each voltage drop with reference to ground, or with reference to a previous point (rung on the ladder). Here's what I found:

0.32 V (saturation) voltage across the driver transistor V1

(I connected the D+ of the three-terminal regulator to the battery as well, and so the regulator activated because the applied voltage was below the regulator setpoint)

+0.29 V lower brush to slip ring V2

+11.9 V rotor V3

+0.29 V top brush to slip ring V4

= 12.8 V which equals the applied voltage.

Kirchhoff would have been very happy.

Second question for you: If my circuit in Figures 2 and 3 is drawing 5 amps, and the voltage drop from a brush to the slip ring is 0.29 volts, how many milli-ohms does that connection have?

This is important: the panel voltmeter will not be accurate for voltage drop measurements. I used my own DVOM (you need one that can measure down to 0.01mV or 10uV at least), immediately across each DUT, while the current was flowing through the complete circuit. Technically I had four connections to do this test. Two for the constant current source, two for the DVOM. Kelvin was the guy who gets credit for this idea. (See figure 5)

This is the power supply model I purchased, but there are lots of other options out there too. https://www.mastechpowersupply.com/mastech-variable-power-supply-30v-30a-hy3030e-900w-high-current.html

Or google it: **HY3030EX power supply**

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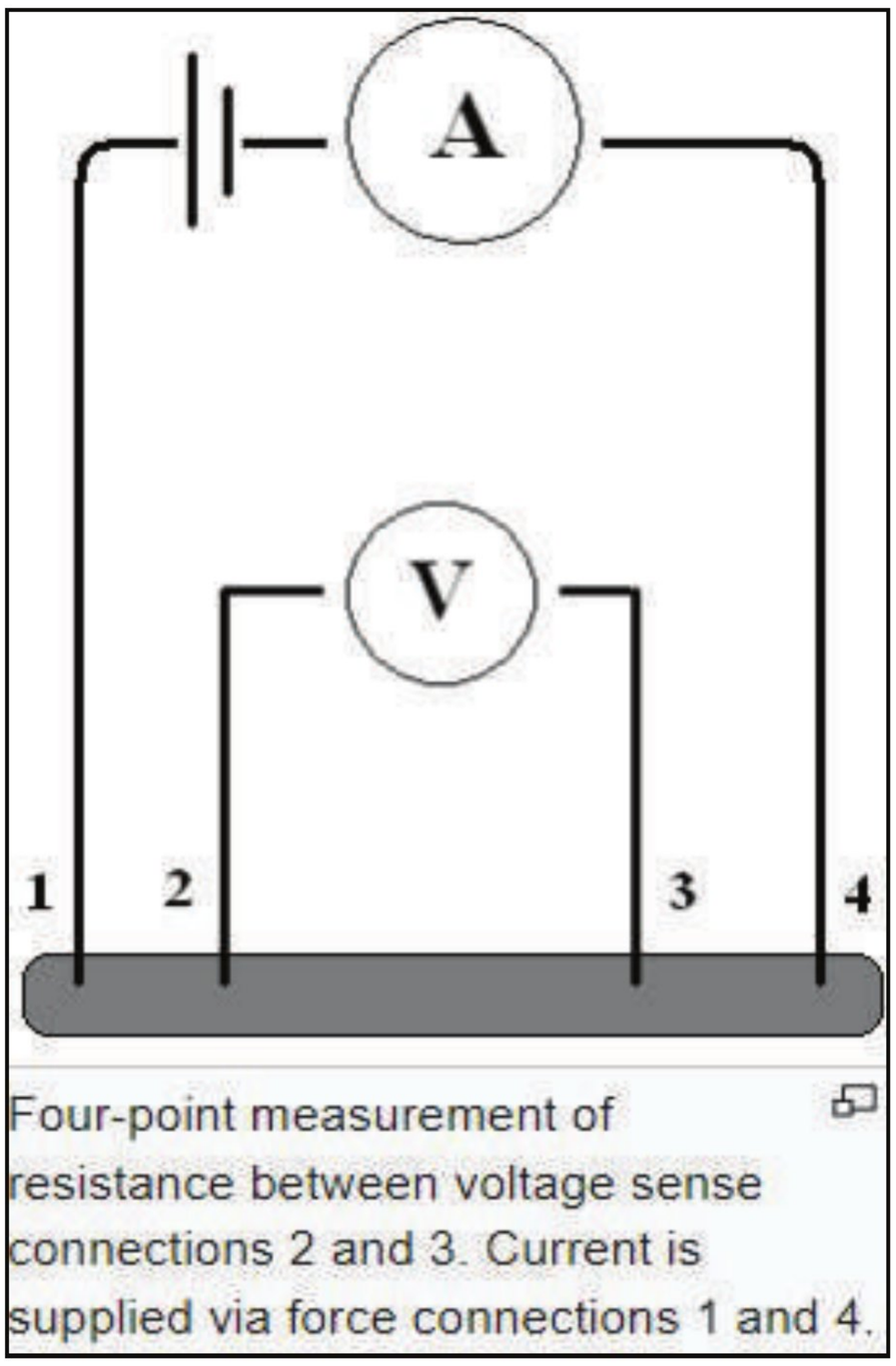

Four-point measurement of resistance between voltage sense connections 2 and 3. Current is supplied via force connections 1 and 4.

Figure 5 - Four wire connections

In another issue, I will explore how to use this voltage drop principle, along with the current regulation principle to measure diodes while still connected to the stator. The current regulation is helpful because it eliminates one of the variables (ie, if you set it for 10 amps, you always have 10 amps). That means your DVOM reading will represent the low resistance of the DUT.

Answers to questions:

1) The saturation voltage is too high, meaning that the rotor gets a little bit less voltage. This may be because it is an incorrect design, or that the transistor is getting ready to fail.

2) Ohm's law Volts / Amps = Ohms. 29V / 5A = .058 ohms: 58 milli-Ohms

To sum up this article:

We will be doing voltage drop testing on the bench. To do this kind of bench testing, we need a stable source of current that is consistent for all our tests. We need a current regulated supply – one that will automatically adjust the voltage to keep the current constant. This power supply will compensate for inconsistencies in the subject and our interconnections to it, to maintain a constant current in the DUT.

You can contact Nathan Unger by email at:
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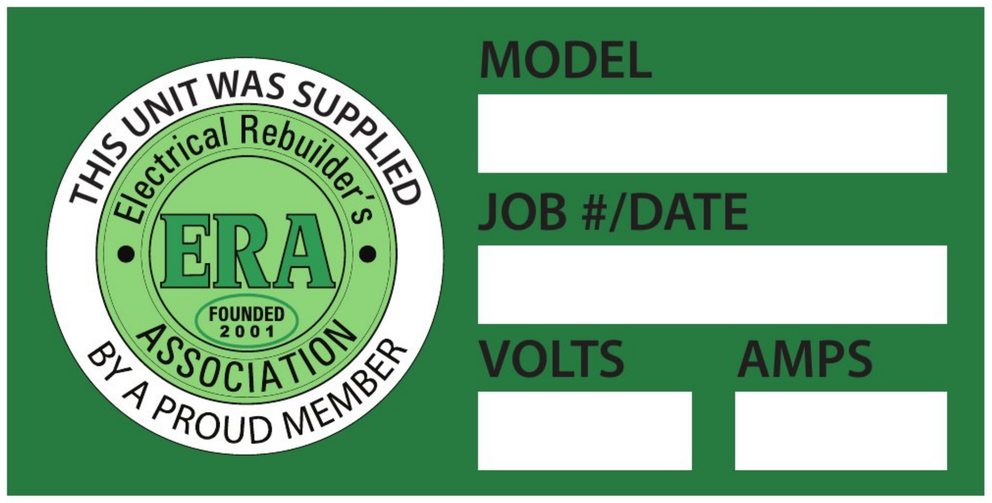



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