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AUTO ELECTRIC CORNER
Retirement of sort, Harley Trike Reverser, Replacement Starter, 10SI-SE...!

Custom Alternator, Repairing Armature Lip

A WORD FROM THE EXECUTIVE DIRECTOR
Inventory — How much?



My shop is just like many of you reading this, classified as a small rebuilder! Although I have a 5400 square foot shop, I still am out of space in the parts room and have been putting boxes of parts and units on the floor in front of the shelf that it belongs on. Well, I'm finally starting to attempt to fix the problem. When we built this shop in 1995, we assembled steel shelving purchased from a parts store that went out of business, spacing the shelves a foot apart top to bottom. We are now re-spacing and adding two shelves to each unit to give us more shelf space. Wow! What an undertaking! In 1995 it was easy, but now we have to find a place for all this stuff while we are modifying the shelving.

Which brings me to the subject. I am now touching all the inventory I have, getting to see it all up close for hours and putting it in its new home! At the completion of this project, that I presume will take me well into wintertime, I intend to complete a physical inventory of each part that my computer system says that I have, over 45,000 parts and units on hand. Physically touching all these parts made me more aware of how much "dead" inventory I own. I can only hope that some of it will reach a point of being "obsolete" which hopefully will drive the price up. Lol!

We are very fortunate to have a computer system with software that helps us manage our inventory, not only can we set our "min and max" on each part but we can also see sales history as well, which helps us adjust the stock levels. Even with a sophisticated computer system we sometimes find ourselves overstocking with some parts and yes, we run out of parts as well.

Another part of the equation that our computer can't tell us is which vendor has the parts we need. With longer lead times from their suppliers, they may be waiting longer than anticipated to receive their new stock. Our suppliers call that "forecasting." Properly named, it's like hitting a moving target or predicting the weather. In today's environment, I find myself over-purchasing products just so not to run out of something we may be selling a lot of. If I'm lucky I will sell everything I order before it becomes a "slow mover", which is part of the reason why I'm adding more shelving! Lol!

I'm anything but an expert on inventory, but I do feel more "in control" knowing how many of what we have. I did graduate from using the "want list" tablets that Ace, WAI, Romaine and other suppliers furnish to us for orders and have surpassed the "used one, replace one" method of management. I have often said that if you take my computer, I won't come to work! While we all start somewhere, always strive to be better at what you do even managing your inventory! Afterall, it is **your** money!

Mike Schroeder

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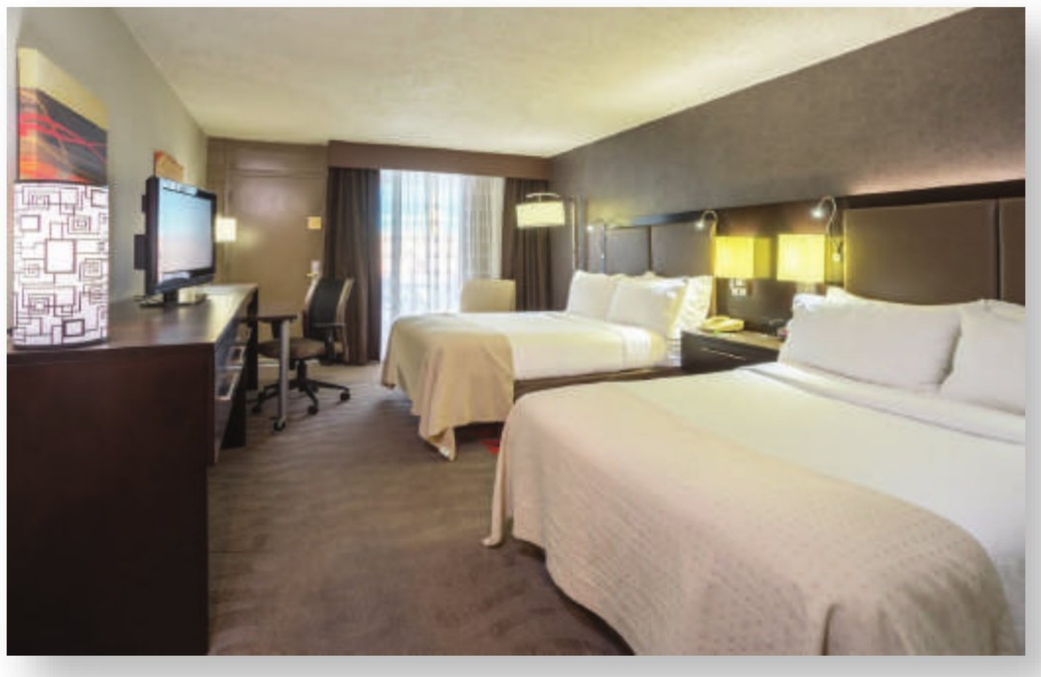

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AUTO ELECTRIC CORNER — Retirement of sort, Harley Trike Reverser, Replacement Starter, 10SI-SE...!



BY MOHAMMAD SAMII

My business auction is finally over, almost all my equipment, machinery, testers, service parts and completed units (about 700 of them) are all gone, and the shop is nearly empty. Perhaps another 5% remains that will be sorted out, sold, or somehow disposed of so I can deliver the building to their new owners by the end of December.

I am hanging on to some hand-held testers, test boxes, meters and such for now. My scope and enhanced scan tool are PC based on my laptop and are used for some diagnostic and on-vehicle work. Now that the test benches are gone, this is for the first time since 1973 that I am not able to run an alternator to see if it is working or not! This is a change that I will have to get adjusted to but as they say, the life goes on…!

Sales of the units are now only on replacement basis, and I source them out via our industry suppliers and other online sources, accepting I have no control on their quality except some visual clues, making sure the all the hardware are in place and are tight.

My shop work from now on until the end in the middle of December is mostly diagnosing and wiring repairs and other related electrical such as lighting, blower motors, power windows but mostly finding parasitic drains, their instances are increasing daily which constitutes the bulk of our shop work. Some such case studies are earmarked for next Spring's ERA Show in Harrisburg, PA.

Harley Reverser Motor

This Hitachi-based starter, which is actually a cranking motor is used in some Harley-Davidson Tri Glide trikes and has been discussed on the website. To reach more readers or the members who do not access the Forums on the website, I will discuss it here for the interested rebuilders and for its peculiar design features as compared to a regular starter. (*Figure-1*)

The ones who have repaired/rebuilt these motors know the brush wear and sticking brushes are the problem problem in the most of these units. The sticking brush can be related to vibration that is an inherent characteristic of Harley engines. The normal use and oil leak saturating inside of the unit is another major contributor to excessive brush wear. An aftermarket brush kit such as J&N's 151-48022 (Wagner W505-66) or equivalent is used to replace the whole brush assembly.

The teardown of this unit is simple and straight forward but requires some finesse. The thru-bolts are not difficult to remove but if they are frozen in place, extreme caution should be observed as not to break the boss that they are screwed in. Once broken, repairing the unit would be nearly impossible (*Figure-2*)

The solenoid, albeit a Mitsubishi design is made by ZM (ZM892) and is readily available at our suppliers.

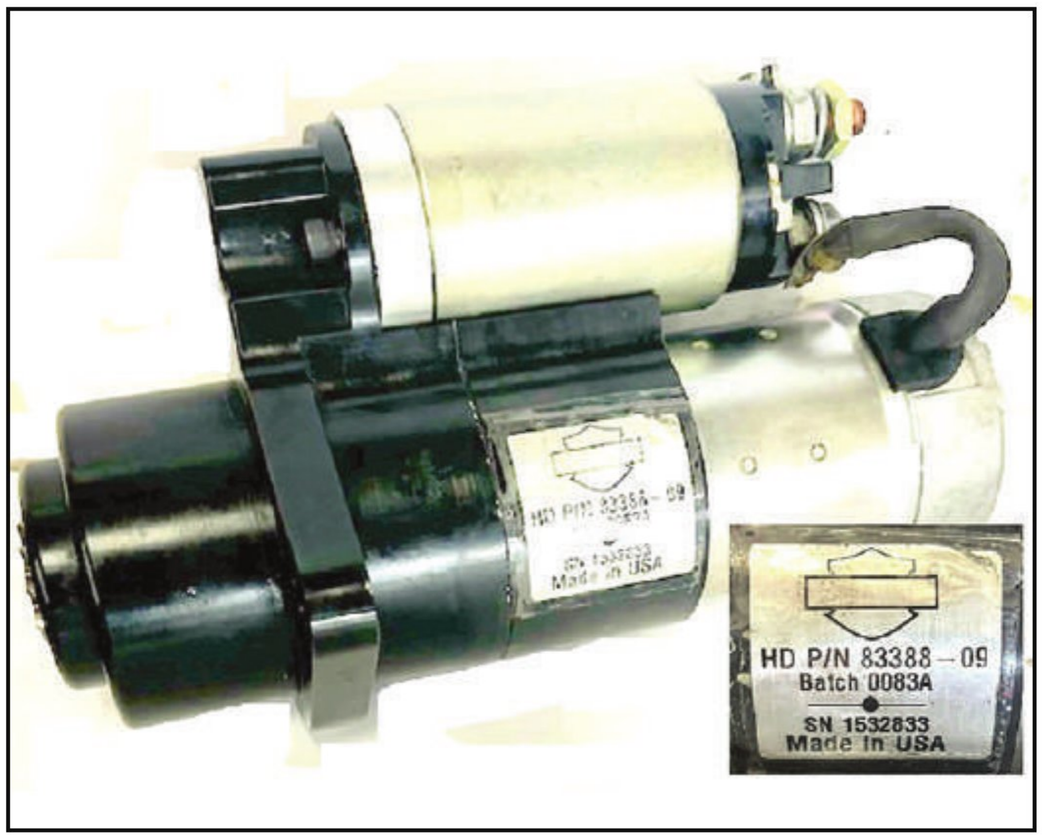

Figure 1 – Harley-Davidson Tri-Glide Reverser Motor

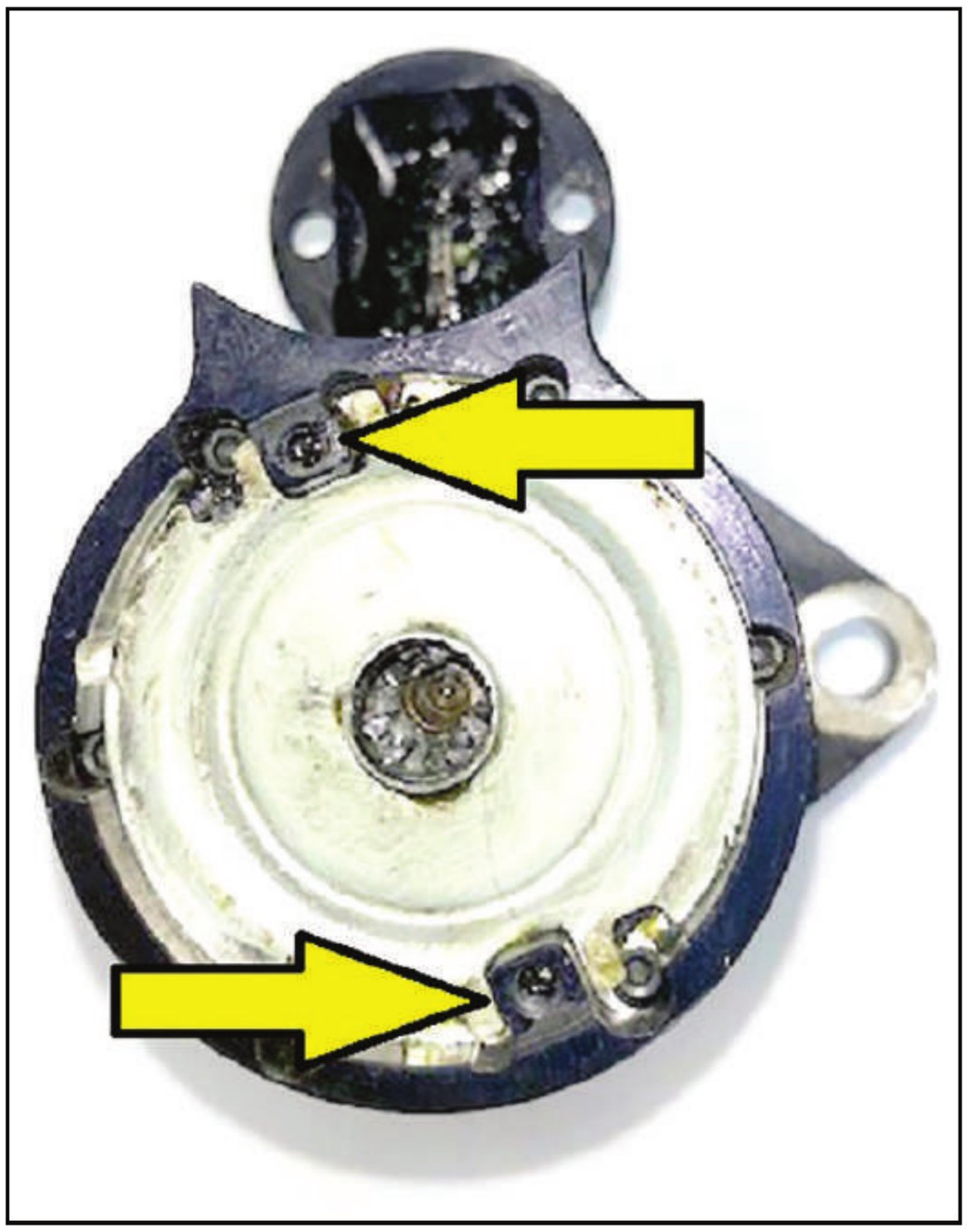

Figure 2 – Thru-Bolts Boss

For the rebuilders who are equipped to rebuild import solenoids and service it, it is a very straight forward job which basically needs cleaning of the contacts and disc.

With the field, armature and gear cover plate removed, the 6 Allen head screws (7/64) should be removed to access the reduction gears and the drive assembly. (*Figure-3*)

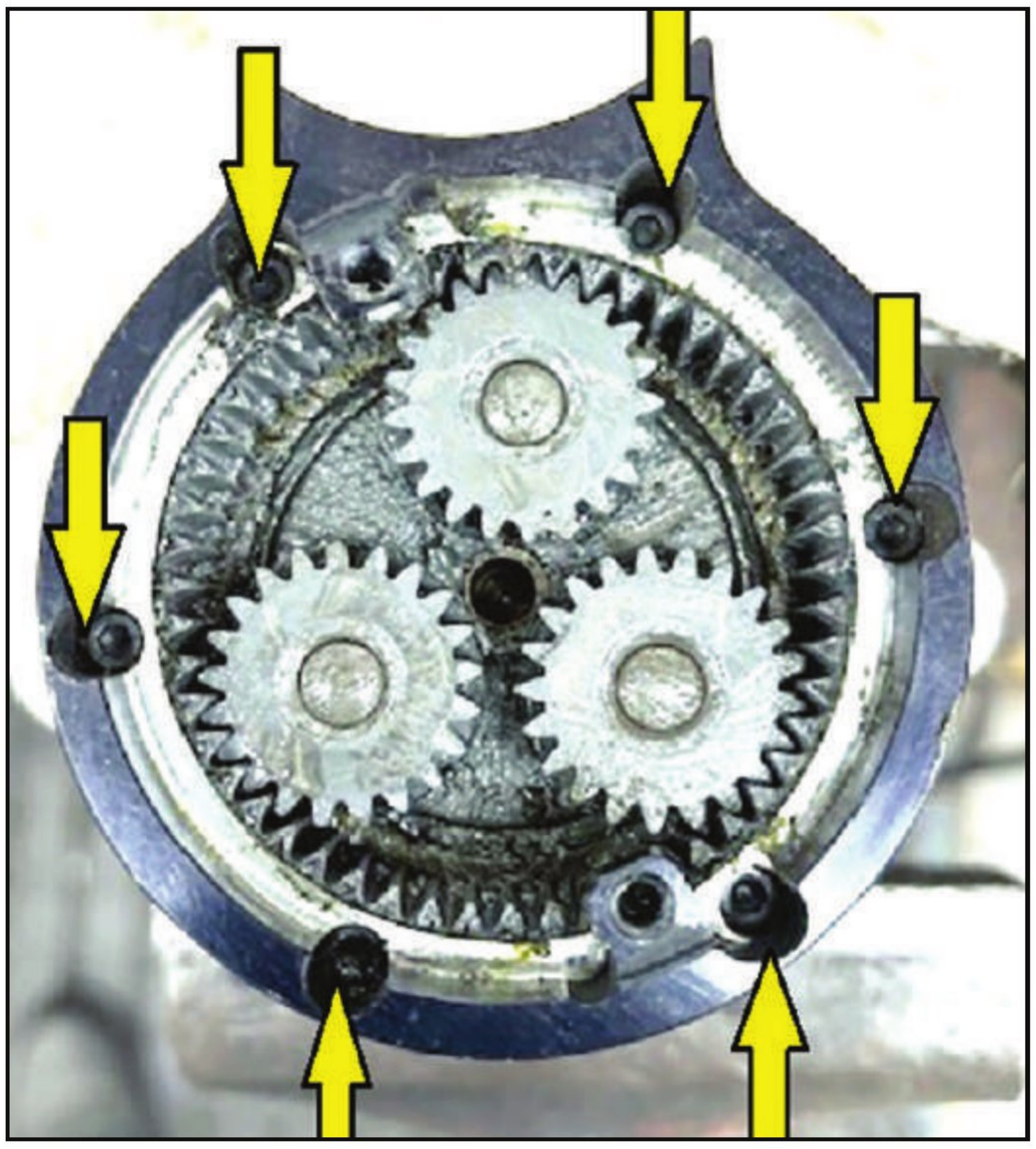

Figure 3 – Upper Gears and 6 Allen Screws

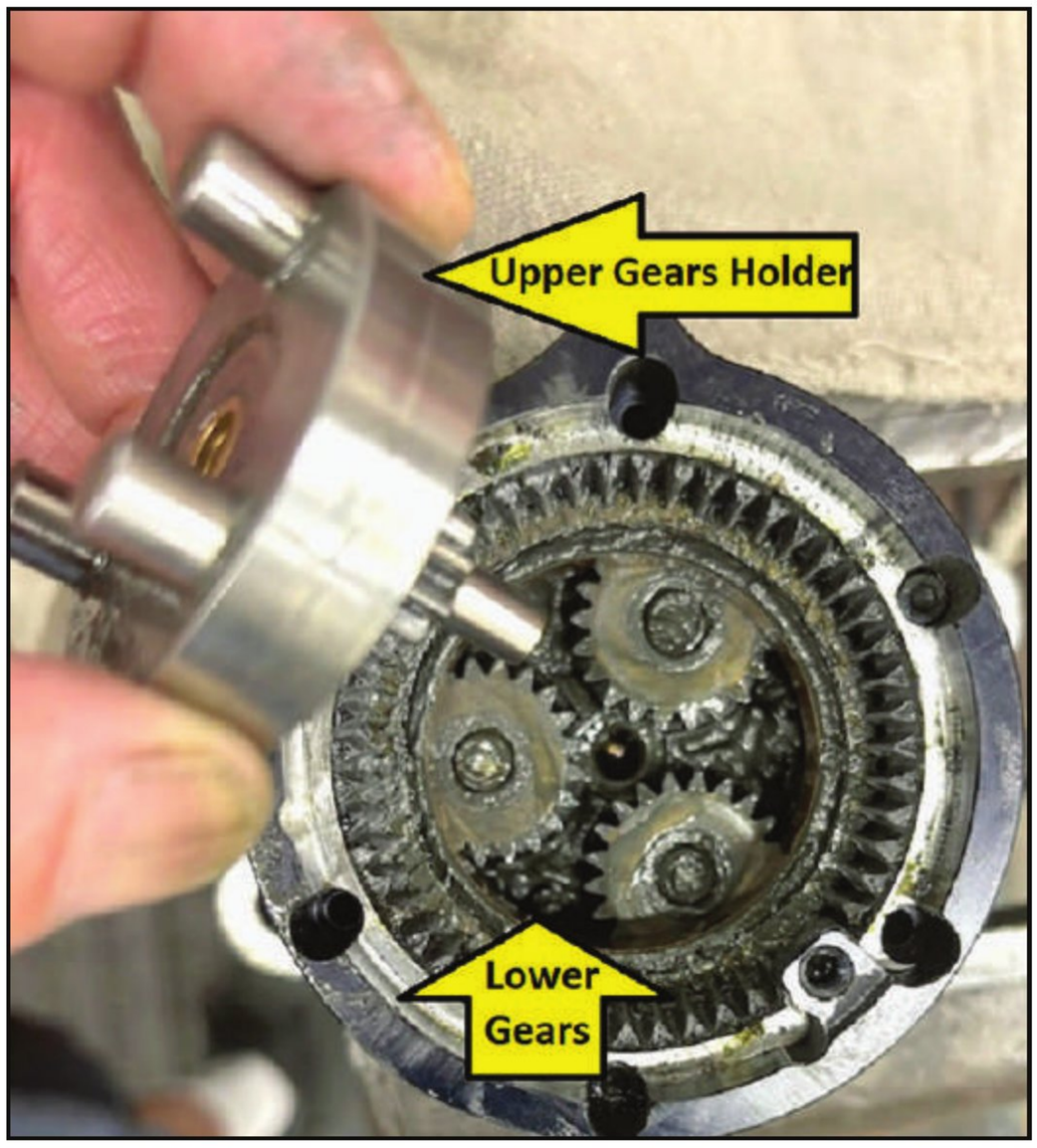

Figure 4 – Lower Gear Set

The reduction gear mechanism has a very robust design and is built in two stages, an upper and a lower section, consisting of 6 planetary gears. The upper stage is driven by the armature and an intermediate gear transfers that power to the lower stage of the reduction gear. These two stages combined doubles up the reduction ratio, causing the drive to turn very slowly but with much higher torque (*Figure-4*). And that's why this



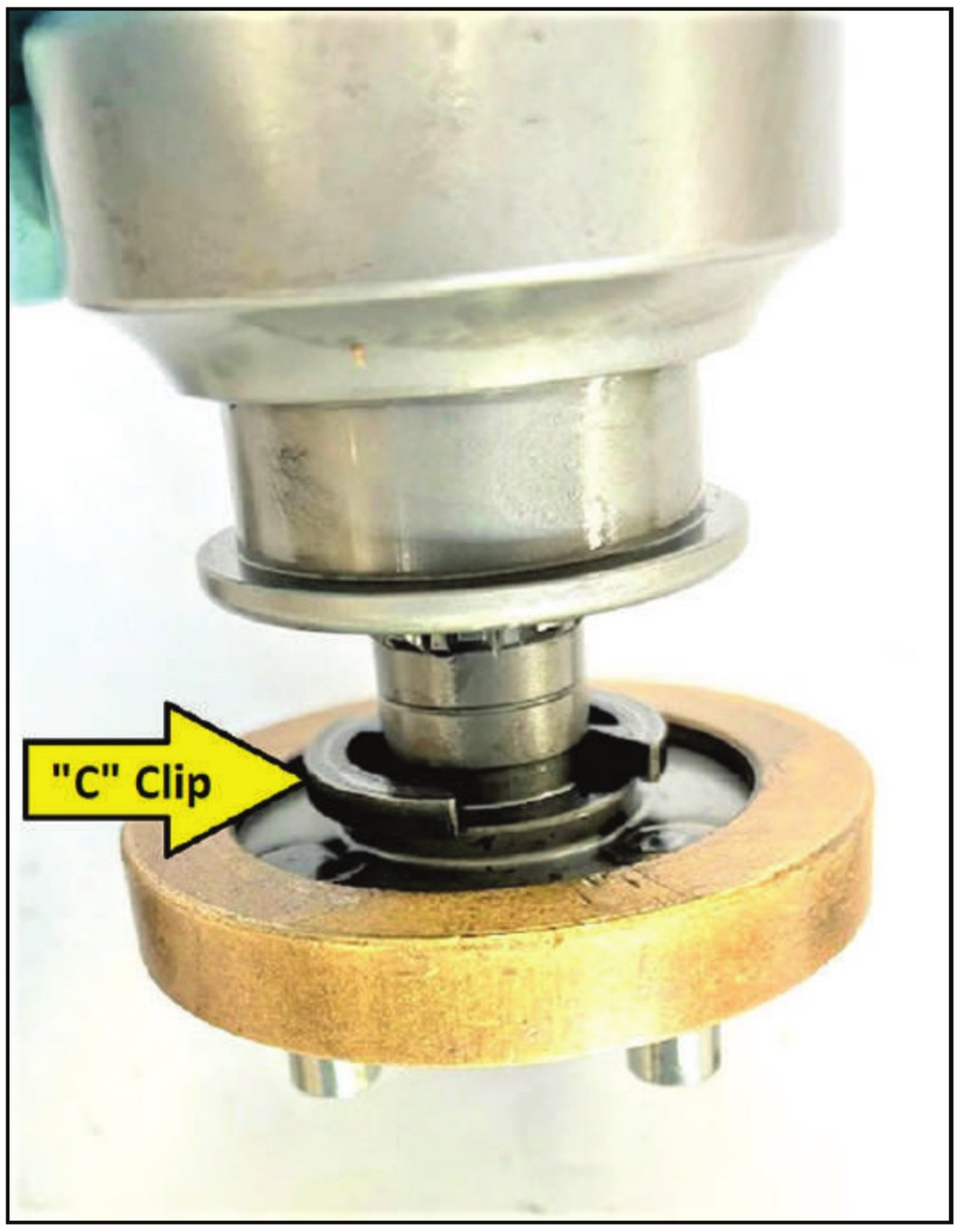

Figure 5 – "C" Clip Holding the Drive

motor is designed to act as a reverse gear to move the trike backward without using the engine and its transmission. Once the gears are removed, the drive assembly comes off. The drive is held on to the shaft with a very strong C-clip (*Figure-5*) which by its removal and sliding the drive all the down the shaft and slightly turning it, it comes off the shaft as shown in *Figure-6*.

This motor turns counterclockwise (CCW), a fact that is easy to mix up because the Permanent Magnet (PM) field case can be easily installed 180 degrees off, causing the motor to run in CW rotation. A partial



Figure 6 – The Drive Assembly and Shaft



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breakdown is presented in *Figure-7* without showing the field case, armature, or the solenoid.

These motors command a very high price at the motorcycle dealership, something around $1200 to $1500. The aftermarket versions offered online are not inexpensive either. So, make sure if you can service and repair it into a functional unit, you get enough for its market value, meaning not only parts and labor.



Figure 7 – Exploded View of the Cranking Motor (Partial)

Older Starters

I do very little rebuilding due to retirement and difficulty to access any equipment or service parts since they are almost all gone. But when this customer came from 45 miles away who had exhausted all of his options and was even turned down by the dealer, I reconsidered and accepted the job, and hoped I could find a replacement unit with reasonable prices to meet customers expectation and budget.

This 20-MT starter that was from a 1970 Case 580B Construction King loader/backhoe was original and had never been rebuilt. Going by the OE number on the field case it was an 1107584 (Lester 4500) starter. A search to find a replacement starter which were available showed a slightly different DE housing (*Figure-8*) which is actually a

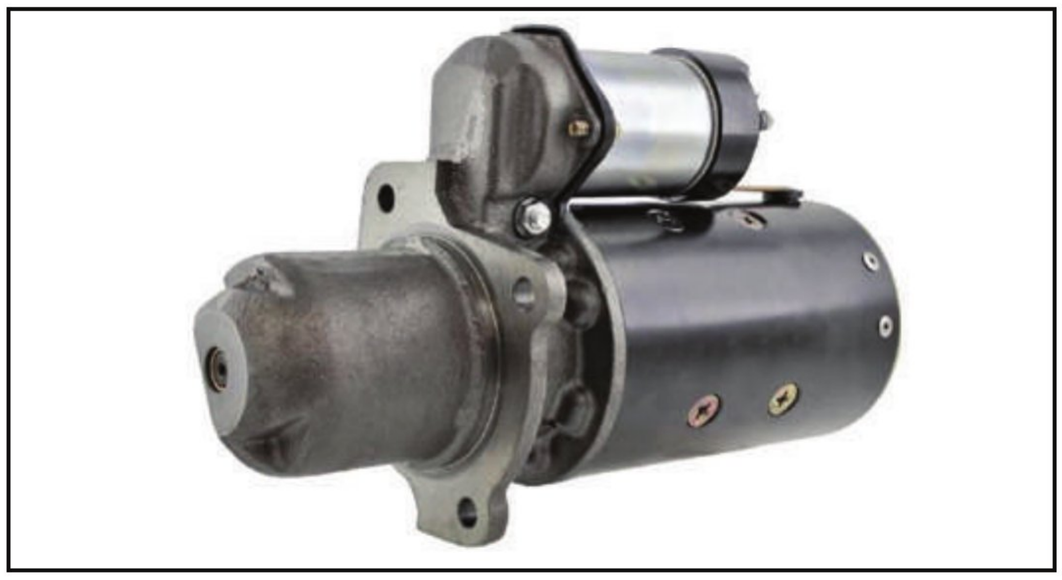

Figure 8 – A suggested replacement for 1107584 starter (Lester #4283)

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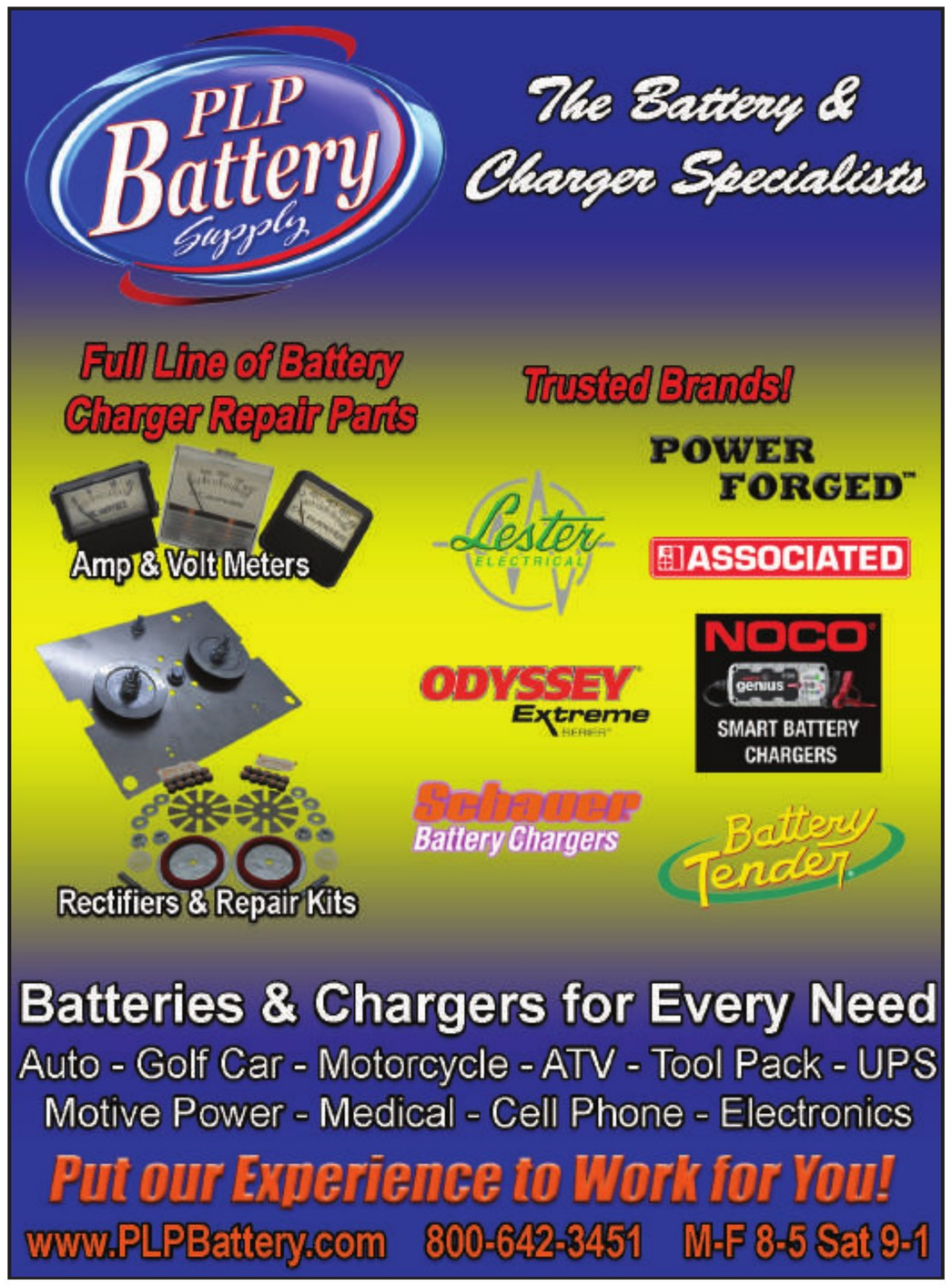

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4238 starter while my customer's DE looked like the one shown in *Figure-9*. Could they have been interchangeable? Possibly yes...but based on my guess, I had to take a chance, assuming they would. And if wrong, this customer had to take another 100-mile roundtrip, adding to his dilemma to search for this starter that already has taken a lot of his time.



Figure 9 – OE Housing for 1107584 (4500) Starter

So, I decided to rebuild it as difficult as it was considering my very limited access to my equipment. A new starter drive, solenoid, shift fork and brushes were ordered and the job was done while I was sure this starter will work for him properly and there be no chance of misalignment due to different DE housings.

A couple of weeks before the above starter was this John Deere 1108950 starter (*Figure-10*) that came in to be rebuilt. This was off of a John Deere model 60 tractor of 1952 vintage, meaning something that is near ¾ of a

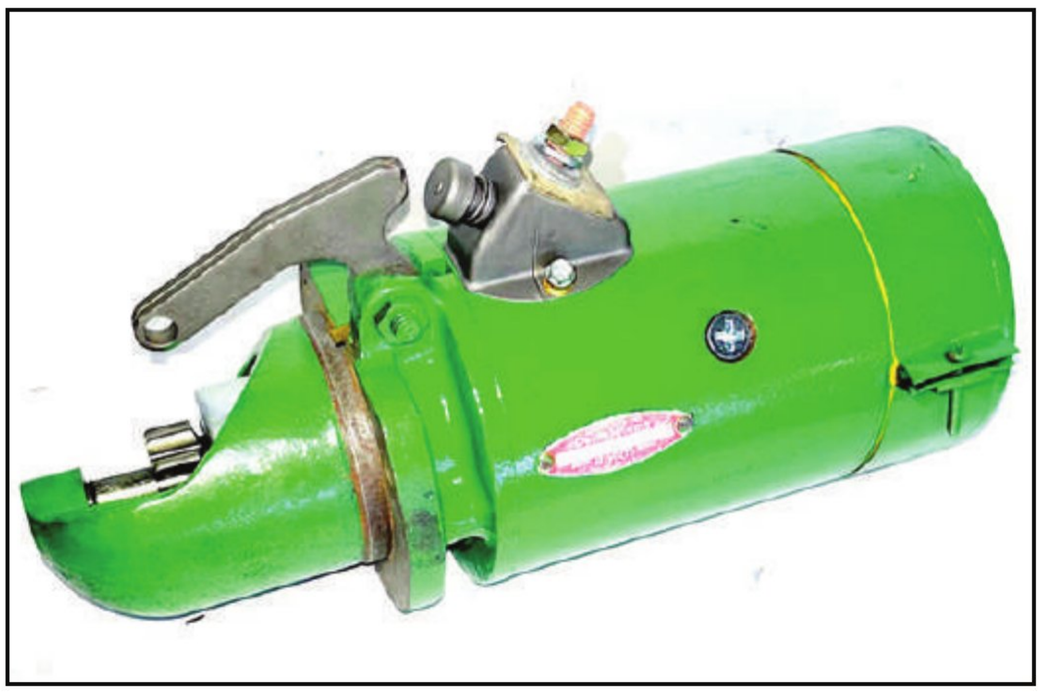
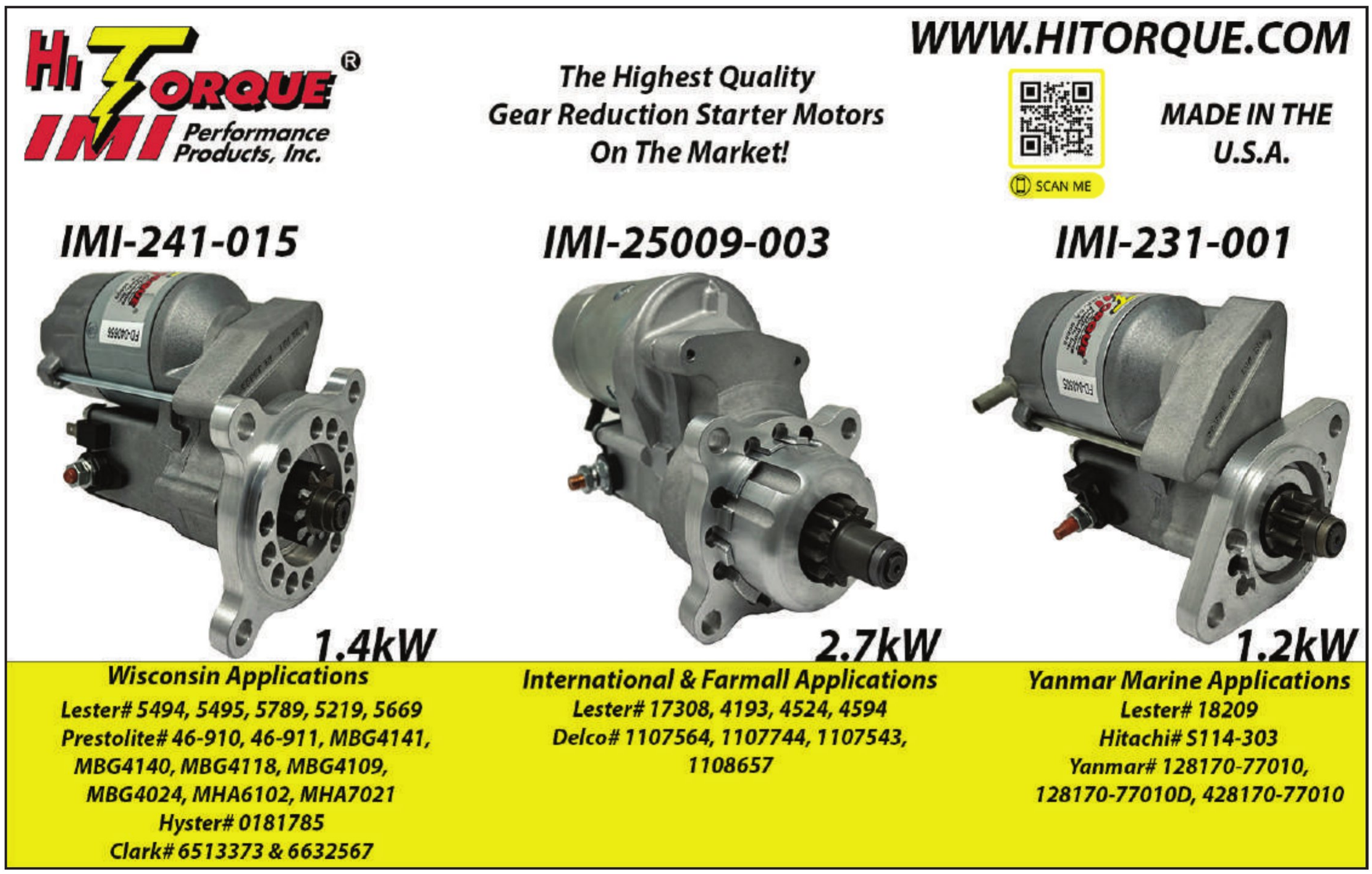


Figure 10 – John Deere 1108950 (4678) Starter Rebuilt



century old! Its condition showed its long hard life and the unit seemed to have been preserved in a bath of mud. (*Figure-11*)

At that time, I still had my cleaning equipment, lathes and shot blaster but very limited access to parts. So, the starter was torn down, cleaned, parts such as field coil, post, brushes, and a drive were ordered and the unit assembled and painted as pictured.

Much like the Harley Trike reverser motor explained above, these starters due to being rare command a very good price anywhere they can be found. Again, make sure you get what you deserve for putting life into a 75-year-old unit.

10SI-SE

SI series of alternators, particularly 10SI have been around for ages and changing them into a single wire self-energizing one is one of the most common modifications that rebuilders do. This way they can be used as a replacement for older tractor generators, variety of industrial machinery, or racing applications. Since calls on the ERA Help-line occasionally is regarding this modification, here I would like to explain a few words about the process.

Initially a single wire modification was accomplished by replacing the OE regulator with a specially designed aftermarket version. The early ones may have a higher cut-in speed but it was the only thing that was required then. By coming of MOSFET into the automotive application, the SE regulators using the newer technology became a lot more sensitive and were able to turn on at lower speeds, still retaining the diode trio and worked as a A-circuit regulators.

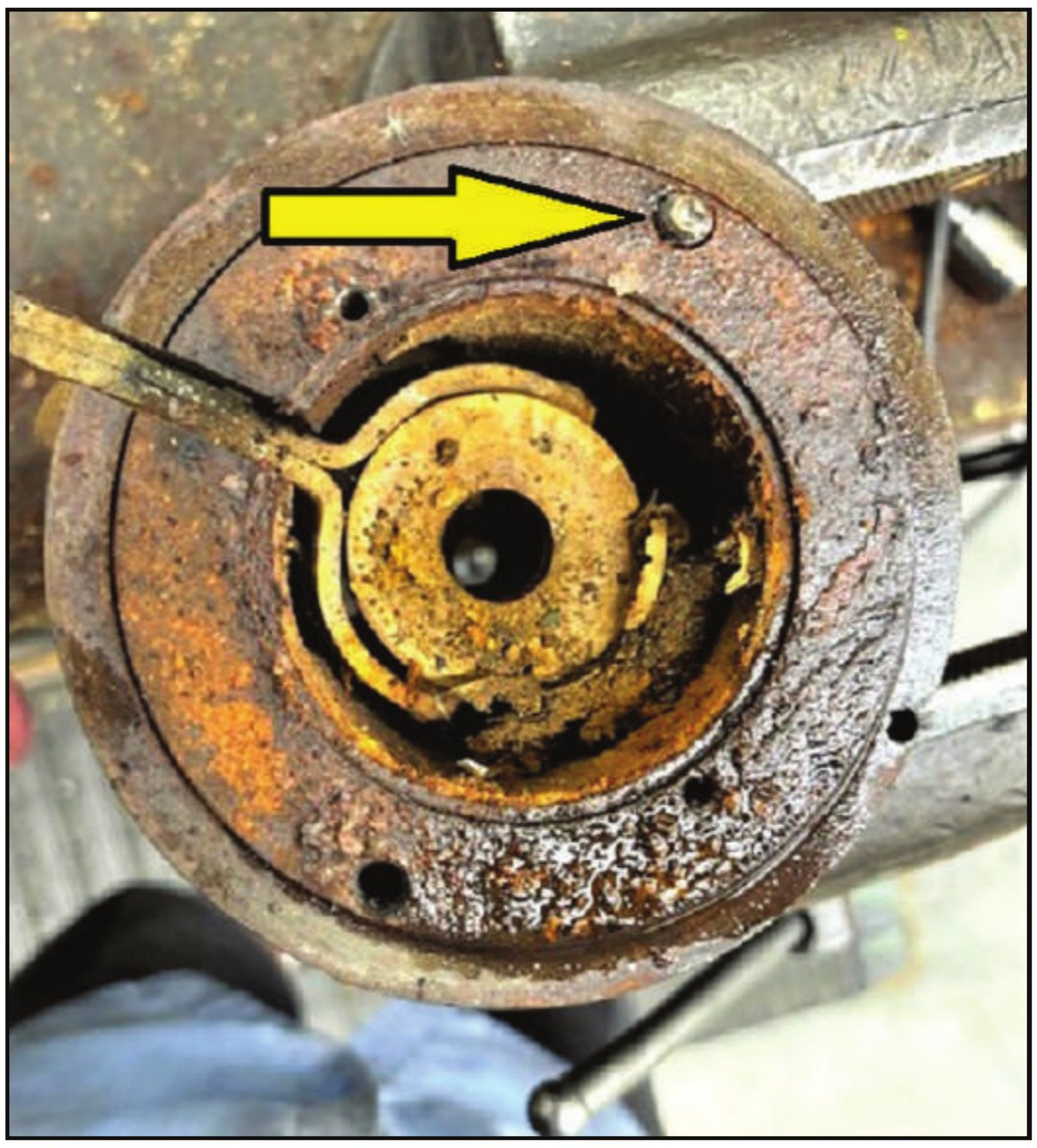


Figure 11 – Starter saturated with rust, mud, and a missing thru-bolt



Now with use of much more advanced electronics, aftermarket has introduced a very sensitive AC activated regulator such as WAI's D10-AC or Regitar's D713 that have a low cut-in speed and contrary to the traditional SI regulators, they run on B-circuit. Meaning one brush needs to be grounded and the other brush (the Field) is fed a controlled +B for the alternator to operate. In the most common tradition of the B-circuit regulators, these regulators do not require a diode-trio and it needs to be discarded. (*Figure-12*)

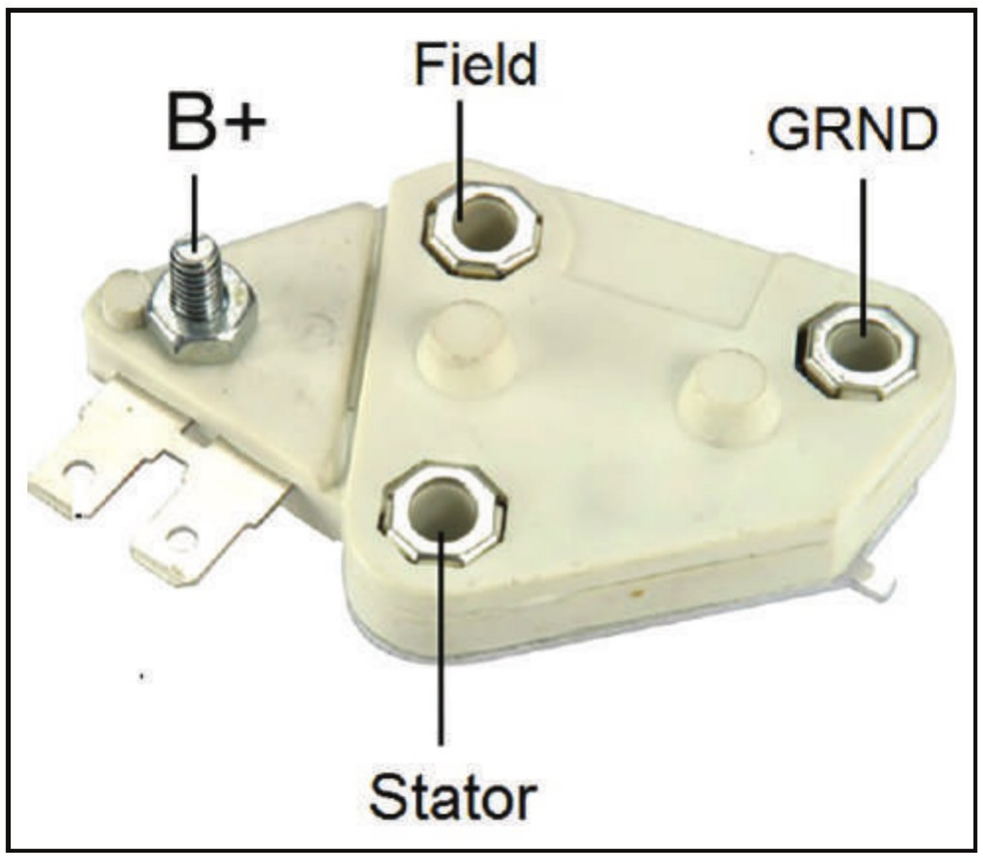


Figure 12 – SE Regulator Pin-out

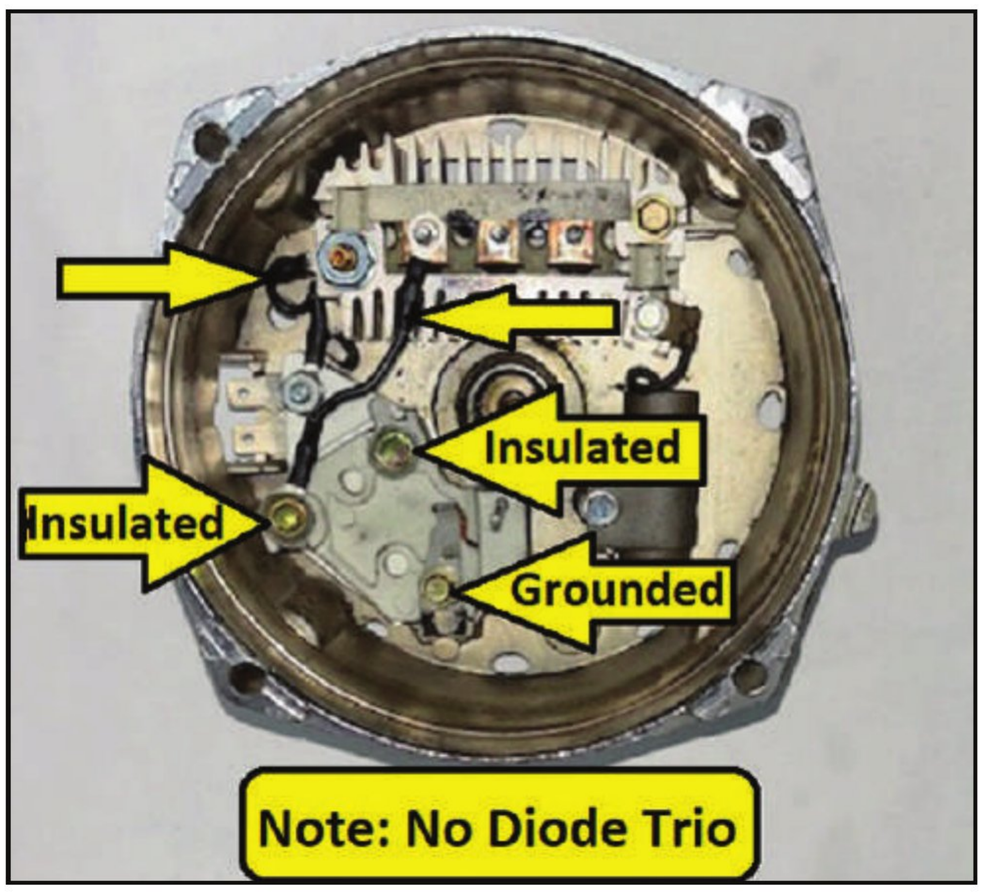


Figure 13 – Inside Connections of a 10-SI SE

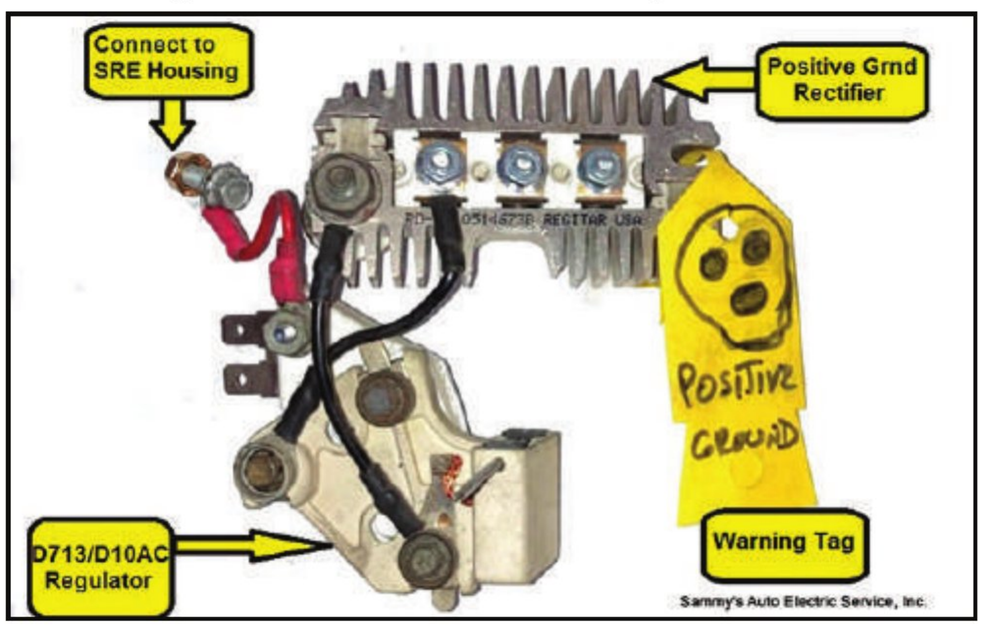


Figure 14 – Quick-Build Kit for Positive Ground 10-SI SE

The position of the insulated brush-holder screws are also different than the regular 10-SI regulator but the regulator kits come with full instructions and the two needed jumper wires. (*Figure-13*)

Like any self-exciting alternators, the quality of the steel in the rotor and the rotor/stator air gap plays a big role in the turn-on speed. By and large, the OE cores with good rotor and stators provide a much better performance, but finding OE rotors is difficult thus we are at the mercy of the available imported rotors with dubious steel quality.

To facilitate for the customer who wanted a fast-cutting self-exciting Positive Ground 10-SI, I used to make a kit (*Figure-14*) using a WAI 5045 rectifier (or equivalent) and wire up the kit with a warning sign indicating it being for Positive Ground. It could simply be dropped in the SRE case and when adding a stator and rotor, it would quickly make a Positive Ground 10-SI self-exciting alternator, ready to go in minutes. Something you may want to consider if you run into a lot of such requests.

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

You can contact Mohammad Samii by email at: sammyselectric@sbcglobal.net, or by calling the ERA Tech Help Line at 636-584-8324 or his business at 217-398-3864

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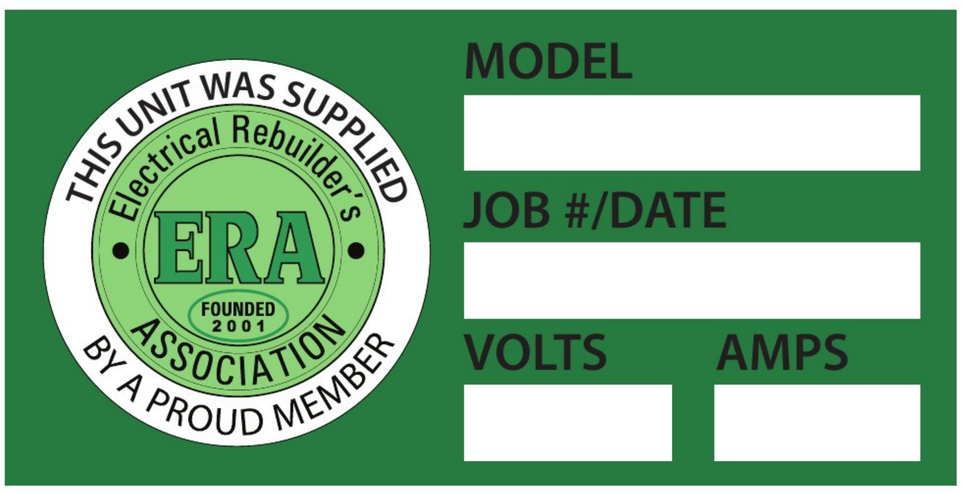

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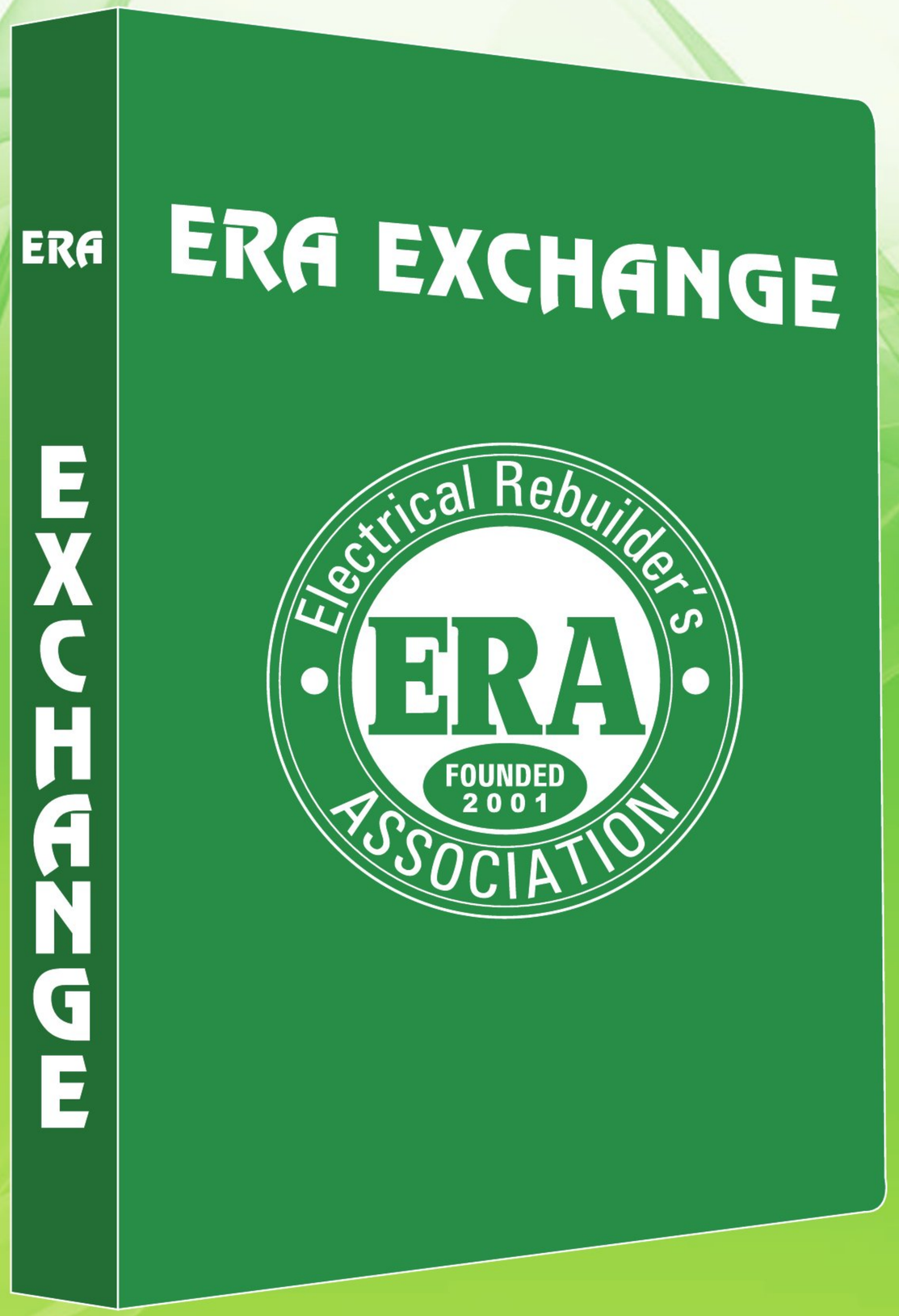

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BY NATHAN UNGER

A business customer in town does custom work on cars for people who have lots of money to spend. His customer had bought a big kit with chrome this and chrome that and wanted it installed on his 1968 Chevelle that he wanted 'tricked out'. *Figure 1A* is a similar car to what he had. The chrome alternator that came to me was brand new but not working correctly. It was a Delco CS130 (like J&N 400-12424) but it was not properly charging the battery in the trunk. The alternator had been customized with chrome housings and a high output stator for 160 amps. It also had a self-exciting regulator, the D694SEL.



Figure 1A

Besides all that, it had also been customized to have the terminal coming out the side, not the back (*See Figure 1B*). *Figure 2* is the normal way.

There is no room for the alternator terminal and cable at the back of the alternator, so the B+ terminal was brought out on the side instead, putting a spacer, a strap, and custom insulators to adapt it. In every single alternator I have seen modified like this, the connection was faulty inside and needed to be re-done, even from brand new. It has to be a solid, tight connection with lots of surface area, otherwise it will get hot and burn.

This unit had a spacer inside consisting of a nut with an attached washer like this. (*Figure 3*) The washer had not been pressed flat. Bad idea. The sharp edge of the conical washer will not conduct 160 amps without turning red hot.

Because the alternator puts out 160A instead of the normal 105A, and also because the battery is in the trunk, like 15 feet away, it needs heavy cables. So going by a handy wire sizing chart I found at the very end of the ERA technical Docs section, I figured if it is 15 feet to the trunk, then he needs at least a one-gauge size wire to handle 160 amps without losing more than about half a volt.

I do not know what size wire he had, but he said the battery was always undercharged. I asked him to tell me the crank pulley size and the idle speed of the engine, and how much current was coming out of the alternator when he had normal loads on it at idle. He couldn't get

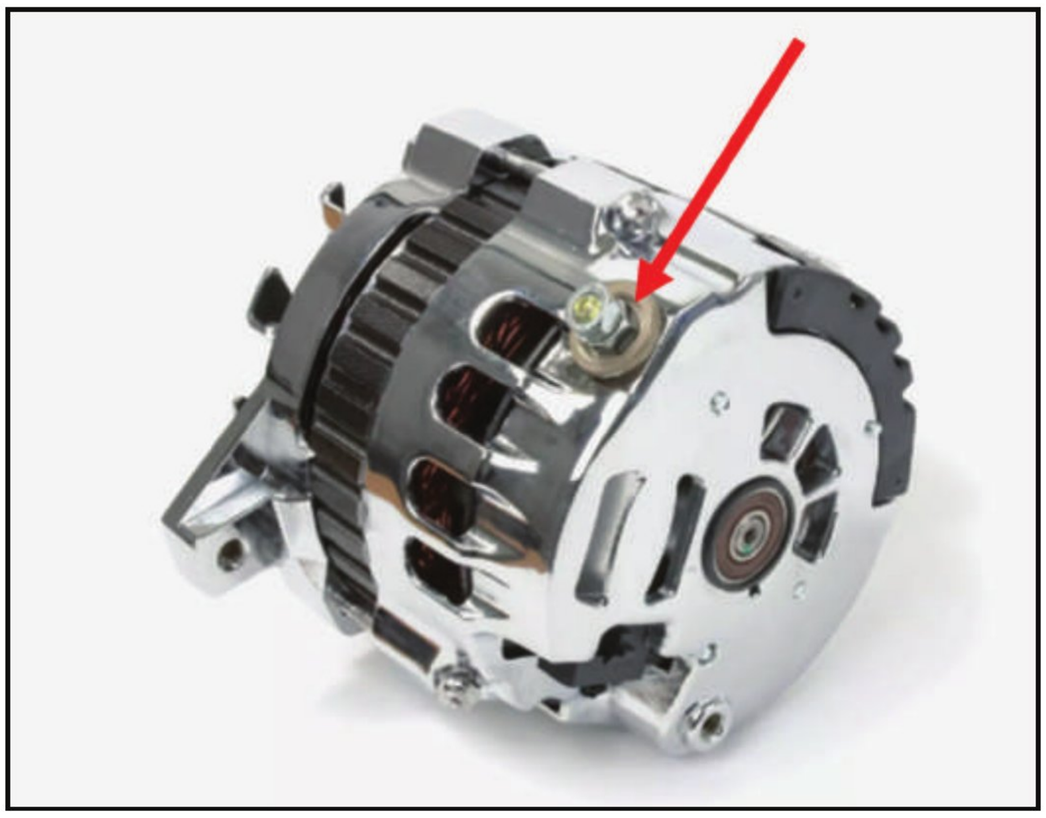

Figure 1B

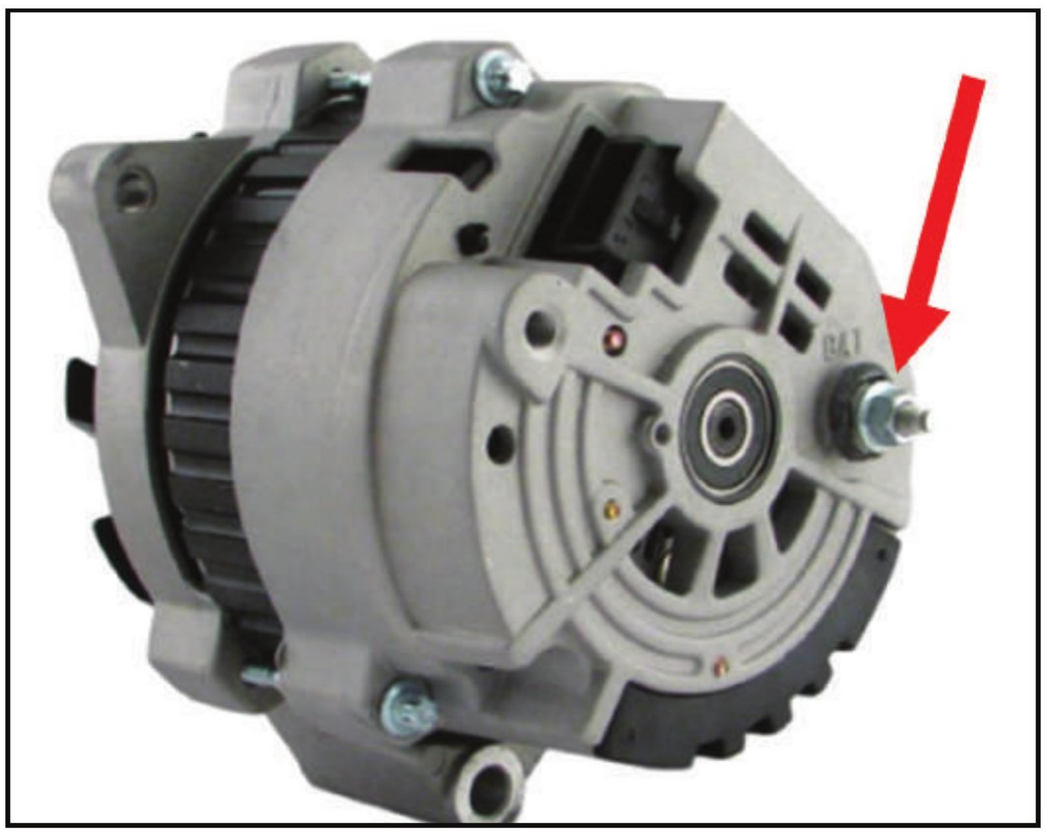

Figure 2

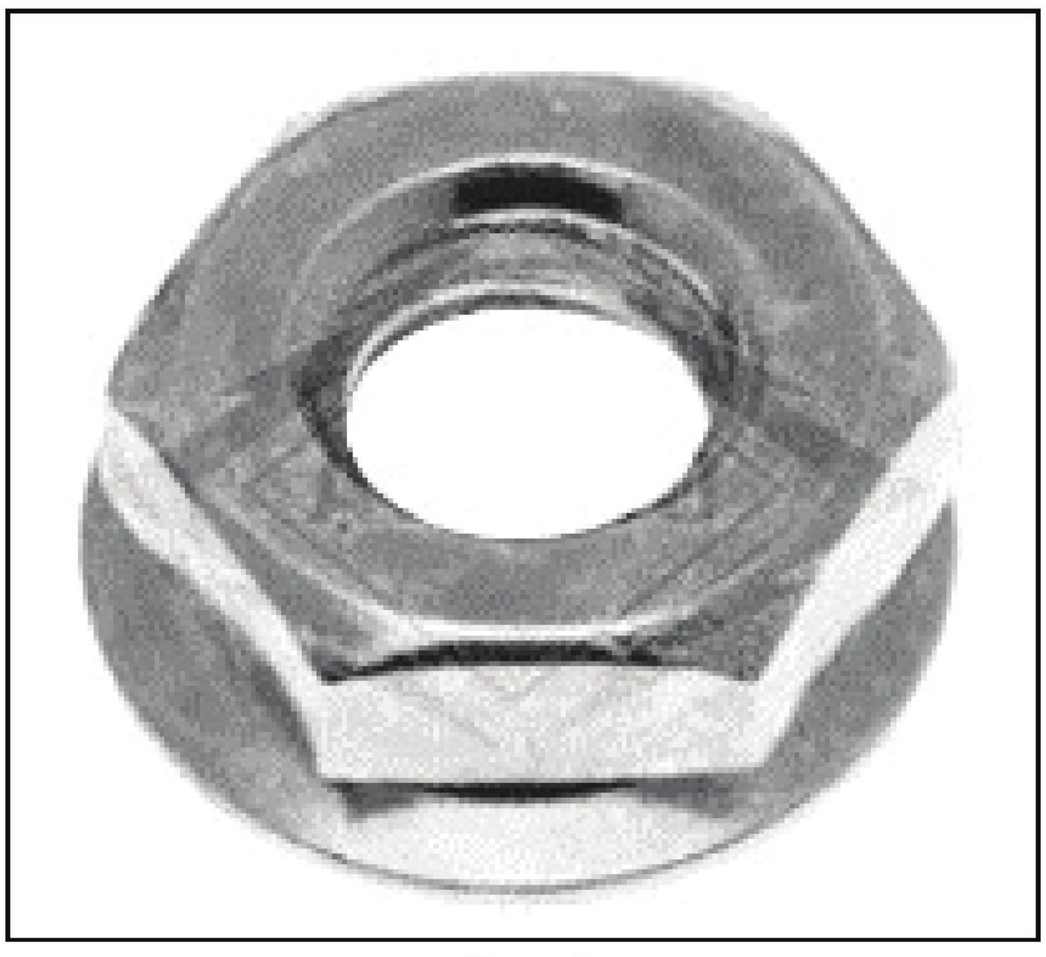

Figure 3

his amp clamp around the alternator cable ahead of the load because there were two big AC fans and other systems connected right at the alternator output stud. He figured that it must be around 60 amps…?? He claimed that the idle speed was around 700 rpm. He also told me that the alternator was only producing 10.5 volts at idle.

As it turns out, this alternator design does not charge at it's rated 160 amps until a much higher rpm. So you have to know what it will do at idle. On a cold night, with the wipers, rear defog, fans, and headlights on, you don't want the headlights to go dim whenever you stop.

I decided to replace the self-exciting regulator with a D694HD (D411HD) regulator (*see Figure 4*) because it includes a sense terminal. Because this one is also NOT self-exciting, he needed to connect it to the ignition switch.

It has P.L.I.S. (Phase/Sta, Light, Ignition, Sense) (*see Figure 5*). You do not need a light to turn the regulator on. I only used "Ignition", "Sense", and ignored the "Phase/Sta" and "L".



Figure 4

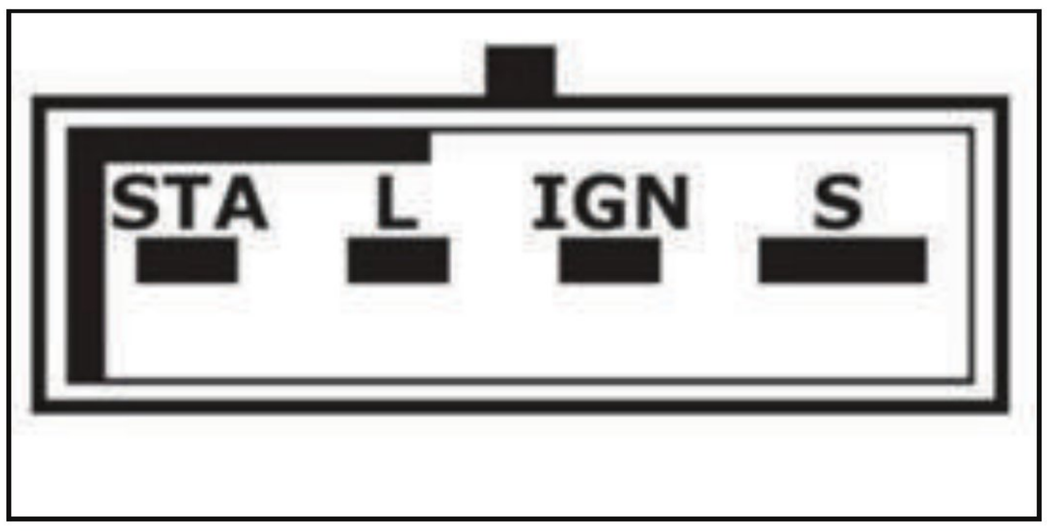

Figure 5

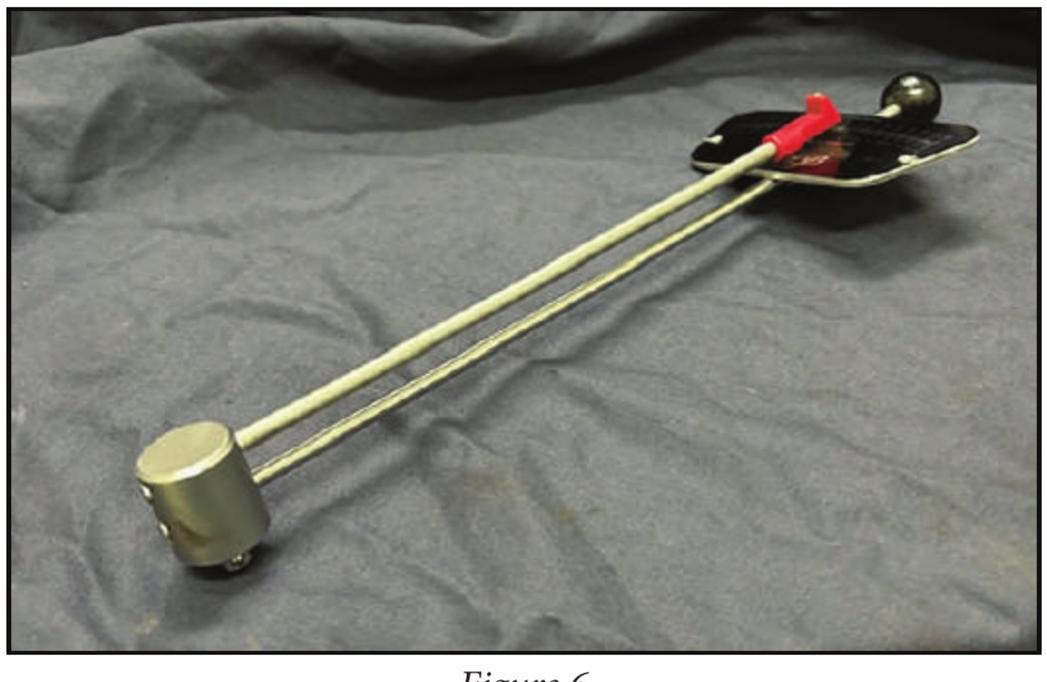

Figure 6

I now present the old-style torque wrench as an analogy to understand the sense wire principle. (*See Figure 6*) The piece at the left is where you attach a hex socket and fit it to the nut you wish to tighten to a specified torque. The bottom bar will flex when you pull on it to tighten the nut. The top bar with the red pointer has no stress on it at all. Therefore, it is useful to measure the amount of flex of the bottom bar which is then calibrated on the black scale.

It's the same with a long cable from the alternator to the battery in the trunk. The voltage will sag by the time it gets to the battery because of the heavy current and the latent resistance of the cable. In other words, the voltage at the battery will not be as high as the voltage at the alternator. That's why I told him to run a separately connected (unloaded, aka stress free like the red pointer bar) wire from the battery post to the sense terminal on the alternator's regulator. The voltage on that wire will be the true battery voltage, now seen by the sense terminal. The regulator then uses that to compensate the alternator's output so that the battery will end up being properly charged.

For example, if the battery is measured at 13.4 volts when the alternator is charging at 14.4 volts, then the sense wire voltage will influence the regulator, and it will increase the alternator setpoint up an extra volt. This means 15.4 volts at the alternator minus one volt for the cable loss, and that ends up with 14.4 volts at the battery. This is the correct voltage for the battery while it is being charged. As you can see, this is not a complete solution, because that means the output cable is losing a whole volt. Better to put in heavier cable as well as using the sense wire feature. The industry rule of thumb is maximum ½ volt loss.

To my surprise, when I tested the alternator with the replacement D694hd (D411), I found out that it now produced more at idle rpm (on my test bench) than with the self-exciting regulator that was originally in it. This could be partly due to the fact that the D694HD has a higher amp transistor in it which has less voltage drop (saturation voltage) when it is switched on. Additionally, because the alternator would now be running with a higher setpoint, the rotor would be getting more voltage too, which in turn would boost the output of the alternator.

I also provided a CS130 connector plug (46-1803 or 110-12050) so he could run one wire to the ignition and one to separately to the battery for the sense. He then came, paid the bill, took the corrected alternator back, and installed it on the car. But pretty soon I got a call. He still had the exact same problem. Uh oh.

This time he had actually measured the idle rpm and found that it was even lower than 700 rpm. This was a 'high-performance' engine which had sort of a stumbling

idle anyway. Then he discovered that he was actually drawing way more than 60A at idle.

To add to the confusion, it turned out that his glovebox light switch was not turning the light off when he closed the glovebox. This means that the battery would always discharge overnight, loading the alternator even more!

After some discussion over the phone, he then set the idle a little bit higher. This enabled the alternator to put out more. He also switched some of his fans into a different mode so they wouldn't be on at idle. This caused the load to be less so that the alternator could attain its voltage setpoint. You see, if you run the alternator too slow, and load it down too much, it can never work its way up to the voltage setpoint of the regulator. Now at last, the battery was being charged to the correct voltage.

For Review: how I figure the idle rpm of the alternator.

Suppose the engine is idling at 700 rpm and has a 9" pulley on the crank which is driving the alternator. The alternator has the smaller pulley, and the engine has the bigger pulley, so the alternator spins faster than the engine. How much faster? Well, you just measure the alternator pulley size and see how many times that goes into the 9". Suppose the alternator pulley is 2.5" (9 / 2.5 = 3.6) This means that the alternator is spinning well over three times as fast as the engine. Engine idle rpm is 700rpm, so 700 x 3.6 = 2520 alternator rpm.

I set my test bench to spin the alternator at 2520 rpm and loaded the alternator with my carbon pile. I cranked the carbon pile until the voltage came down to 12.8 because that is the at-rest voltage of the battery. Also, the regulator is going 'flat out' and will no longer be switching to reduce the output. I then recorded the amperage.

To recap, I fixed the side mount terminal and installed a different regulator. He had added 'ignition' and 'sense' wires to the harness, installed a heavier B+ cable, reduced the default electrical load at idle, and increased the idle speed slightly. Oh, and he also fixed the glove box light switch.

Repairing a Rare Antique Armature

See how the lip that retains the stop-ring and collar is broken away. (*Figure 7*) I put the armature on V-blocks and attached the work clamp of my good ol' Lincoln 220 Amp AC welder.

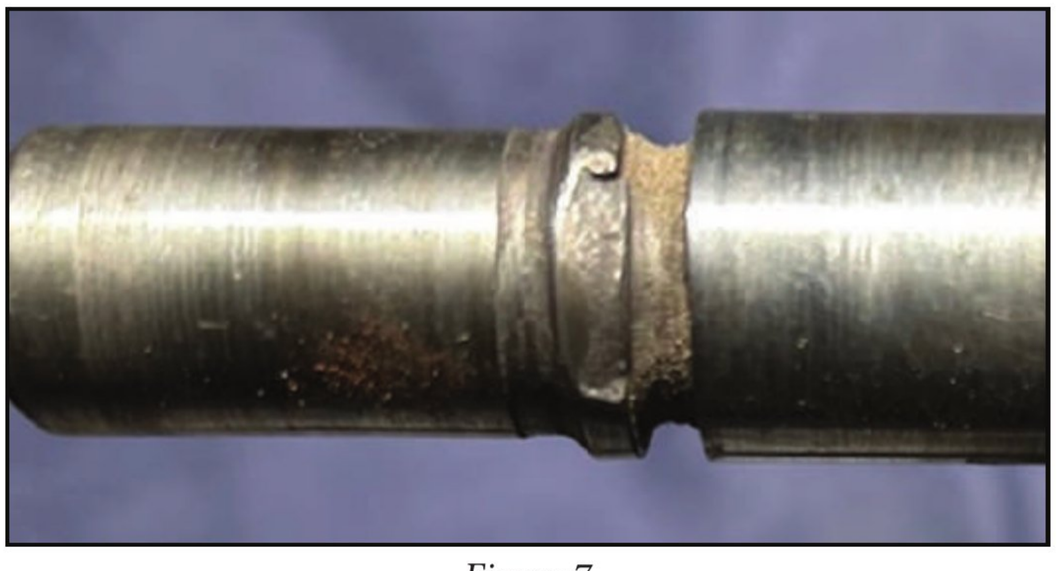

Figure 7

This way I can turn the armature by hand without losing the work connection or twisting a cable. (*Figure 8*) I set it for 60 amps and fitted a 1/16" E6013 welding rod to the electrode holder. I snipped it shorter to like 5" instead of 10" to give myself steadier control.



Figure 8

I also have a footswitch and relay mounted on the electrode cable back at the welder. I can energize it when I'm ready and can de-energize it if the electrode sticks or if I want to put the electrode holder down. After putting on my helmet and gloves, I turn the armature by hand so my electrode stays in one place. It's just as if I were drawing a bead. I keep the stinger close, and don't make another pass without chipping slag first.

Then I lathe off the extra until it will accept the ring and collar like before. This doesn't have to be totally perfect, but it should be done on a lathe, to keep it concentric and even. I also skim out the groove and pre-fit the ring in it. This is so the collar will snap over it, not too loose, not too tight. Then I polish it smooth like new. (*Figure 9*)

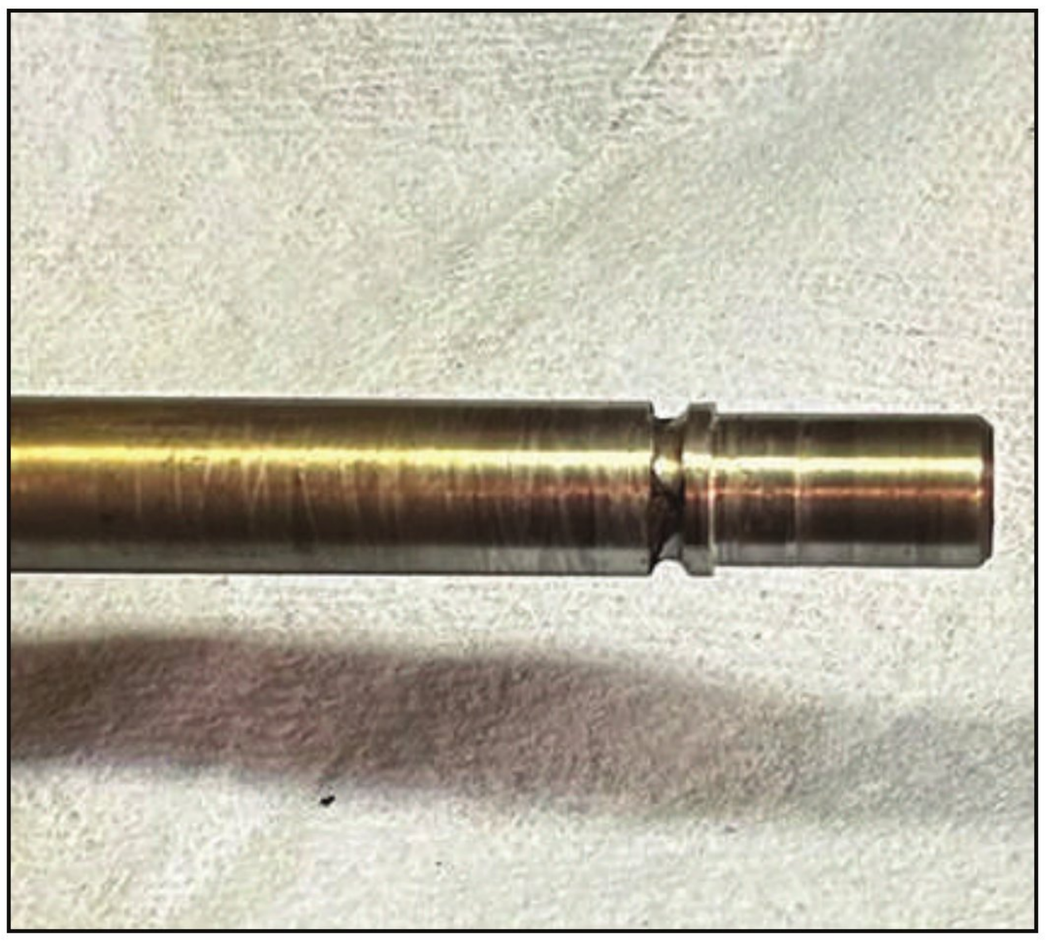

Figure 9

With a little practice and proper set up, this doesn't actually take long.

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