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Ford Dual Alternators, Bosch 24V Alternator, Denso Aston-Martin Alternator

THE DIFFERENCE BETWEEN 12V AND 24V STARTERS

Electrical Rebuilder's ERA ASSOCIATION FOUNDED 2001

A WORD FROM THE EXECUTIVE DIRECTOR
A Milestone!





The dictionary's definition of a "milestone" is **"Having reached or achieved a significant event or stage in the life, development or the like of a person".** All of us have reached milestones in our lives, starting all the way back with learning how to walk and talk, graduating from a class in school or receiving a degree in college. Another definition for milestone is **"A stone or pillar set up to show the distance in miles to or from a specified place".** While this definition defines the distance as a mile, which we are familiar with as a certain distance, other milestones are defined by time or achievements in life that we feel are worthy of our recognition.

We all achieve milestones simply by enduring a certain time period, a 25th or 50th wedding anniversary, having reached a certain age, 16th or 21st birthday. Other notable milestones in our lives may be having owned or worked at a certain business, being a member of a group or organization for a certain length of time.

Michele and I were invited to share in the celebration of a "milestone" of a very good friend of not only her and I but to all of us in the ERA! Mohammad Samii was the recipient of a "surprise" birthday party in honor of his 80th birthday on May 22nd, 2023, in Champaign, Illinois. This is a special achievement not all of us will get to enjoy. Surrounded by his wife of 51 years, Colleen along with his son, daughters, grandchildren and many close friends, a light luncheon and good conversations made the afternoon an enjoyable celebration!

Mohammad has reached many milestones to be proud of in his life. Obtaining his US citizenship in 1978, owning and operating his business "Sammy's Auto Electric" for 44 years, writing his column for 31 years, the last 6 years in the ERA Exchange for us to enjoy, just to name a few!

Happy Birthday Mohammad! You have certainly earned it!

Mike Schroeder

NEW ERA MEMBERS

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Twin Falls, Idaho

Diesel Works
Sagle, Idaho

ABOUT THE COVER

Regitar's Replacement RN-57 Rectifier
Photo Credit: Mohammad Samii

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INDUSTRY NEWS
& ANNOUNCEMENTS

WAI ANNOUNCES NEW HIRE MARK HOOGTERP AS DIRECTOR OF REBUILDER SALES



Miramar, FL – May 12, 2023 - WAI, a leading parts manufacturer and distributor for the automotive aftermarket, is pleased to announce the hiring of Mark Hoogterp as Director of Rebuilder Sales. Mark is an automotive aftermarket industry veteran with extensive rotating electrical experience.

Throughout his impressive 40-year automotive career, he worked for Motorcar Parts of America, Dixie Electric Ltd., WAI, and DuBois Marketing. With Mark's sales background and demonstrated success in increasing revenues, strategic planning, and project management, he will be a great fit for the growing WAI team.

"We are excited to welcome Mark back to the WAI family. Mark's experience in the rebuilder channel will help bolster WAI's leading position in that segment and further enhance our Rotating Electrical expertise. WAI is a privately owned family business in a strong financial position, which enables us to make strategic investments in our workforce and tap into valuable expertise" stated Ron Bernstein, SVP of North America.

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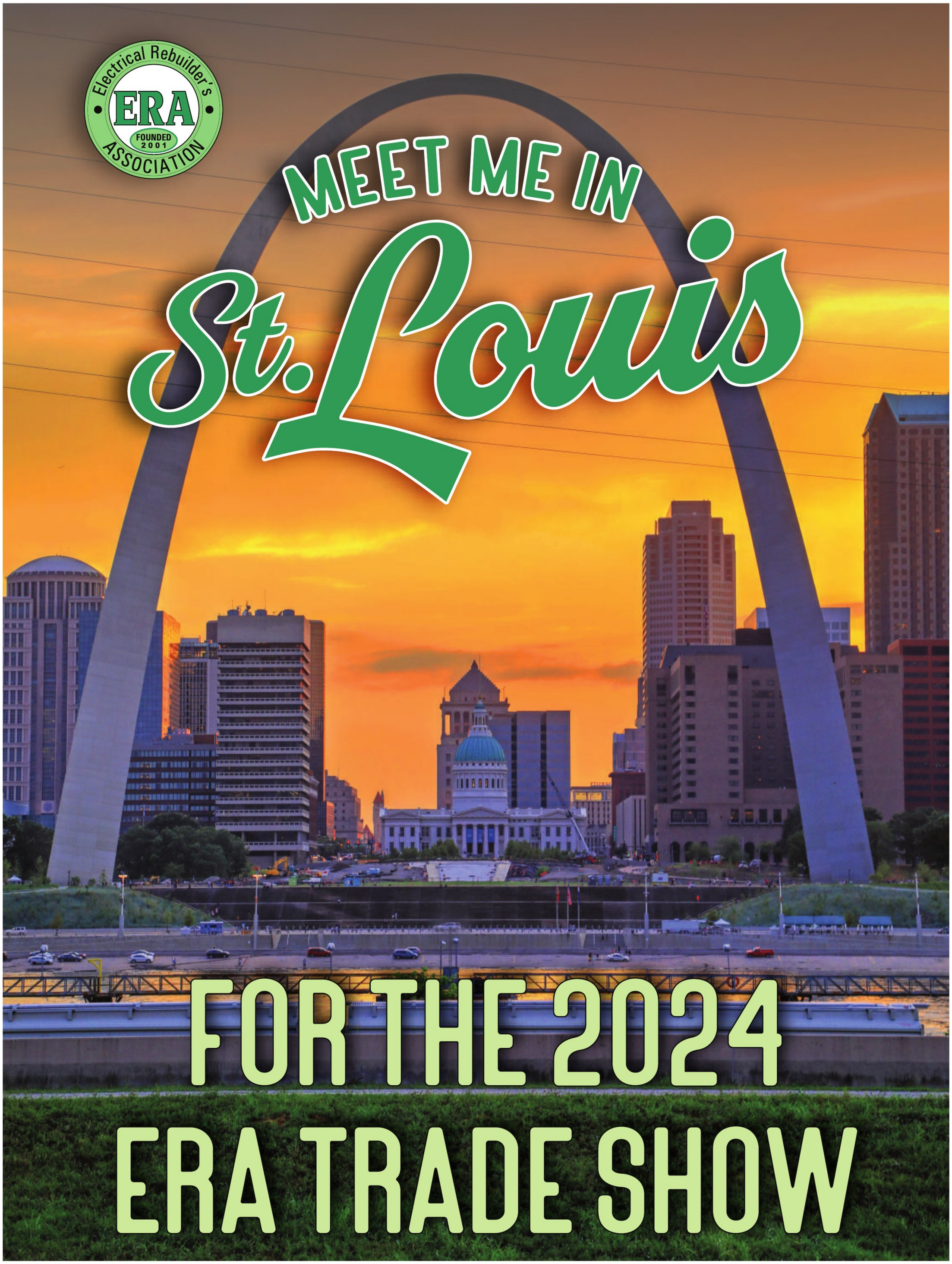
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AUTO ELECTRIC CORNER — Ford Dual Alternators, Bosch 24V Alternator, Denso Aston-Martin Alternator



BY MOHAMMAD SAMII

A common complaint about Ford PCM driven alternators used on variety of cars and truck is the fact the replacement alternator charges but does not turn the warning light off.

This problem is not something only electrical rebuilder's encounter. The pro sites such as i-ATN (International Automotive Technicians Network) and a more professional one called Diagnostic Network (Diag.net) are full of posts regarding the same problem. Of course, generally speaking, technicians cover this issue with a broad brush, blaming the aftermarket unit for everything, especially voltage regulators that are not compatible. This may be partly true in some cases but not always. Especially when one tries a dealer alternator and finds it does not solve the problem… but more about that later.

We had a recent experience with a shop in a small community in the country some 50 miles away from us. The case was a 2008 Ford F-350 Super Duty truck with 6.4L diesel engine and dual alternators.

The technician/shop owner had purchased the reman units from two different parts store due to unavailability of both in one. They were installed and charged but the warning light would not go off. Of course, the part stores were blaming each other for the cause of alternator light staying on.

A word about the installation of these alternators: The very crowded and tight engine compartment makes access to both alternators nearly impossible. To facilitate this, most technicians, even at the Ford dealership remove the cab by disconnecting all the connectors and fasteners, including the steering column and lift it with an overhead crane. Some have gotten so good at it they can remove and lift the cab from the chassis in less than an hour!

The upper alternator (8522) is 4-G unit rated at 120 Amps and the lower, a Denso 11290 is rated at 200-amps. He removed and sent me both cores and his new ones for inspection and verification to see if we can help. Considering this as a learning experience, I set out to try to help him and perhaps learn something from this experience. Access to twin alternators is rare and experimentation is easier when someone else is doing the R&R on his own time...!

Both of his cores were defective. The 11290 was worn out with practically no brushes left and burned diodes. The 4-G (8522) had the rear housing worn out, not being able to support the bearing and spin freely.

I decided to use his own reman units and use the OE regulators that came off the cores and put them in his units, going by the assumption that they obviously had worked a long time until the alternators failed. (*Figure-1*)

Replacing the 11290's regulator was obviously not difficult. Incidentally his part store alternator had an OE Denso regulator but I replaced it with the old one anyway. Both had a CG5-3430 number on them which made them identical. The 4-G's regulator (*Figure-2*) a VP6L8U-10C359-AA with white body and black cover had worn brushes that I replaced and put in his. His reman 4-G had an aftermarket regulator that its tag was unfamiliar to me and did match any of our known suppliers' part number that I know of. (*Figure-3*)

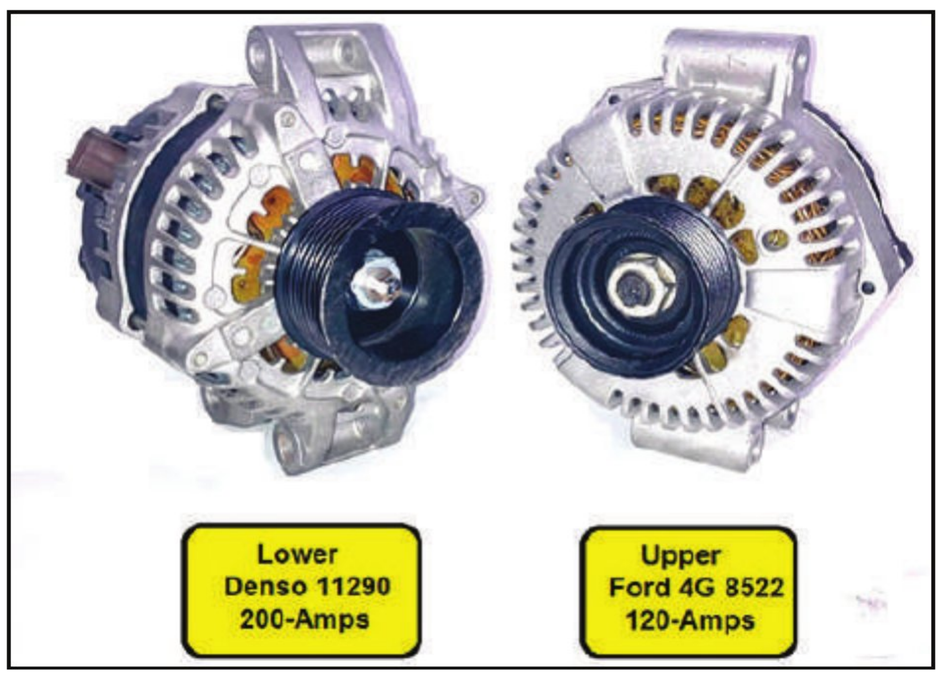

Figure 1 – Dual Alternators of the F-350

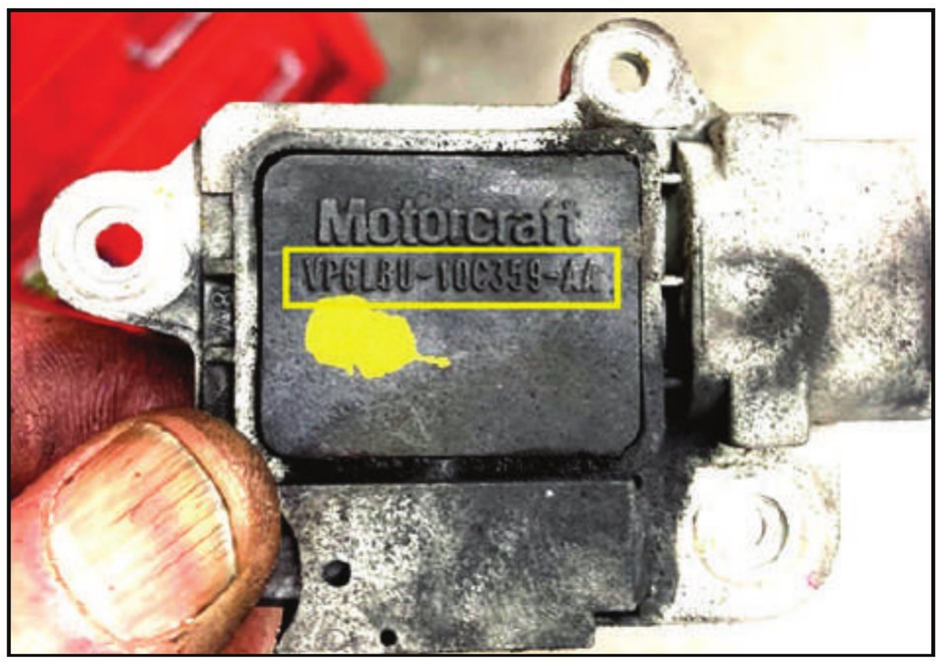

Figure 2 – OE but Used Customer's Regulator

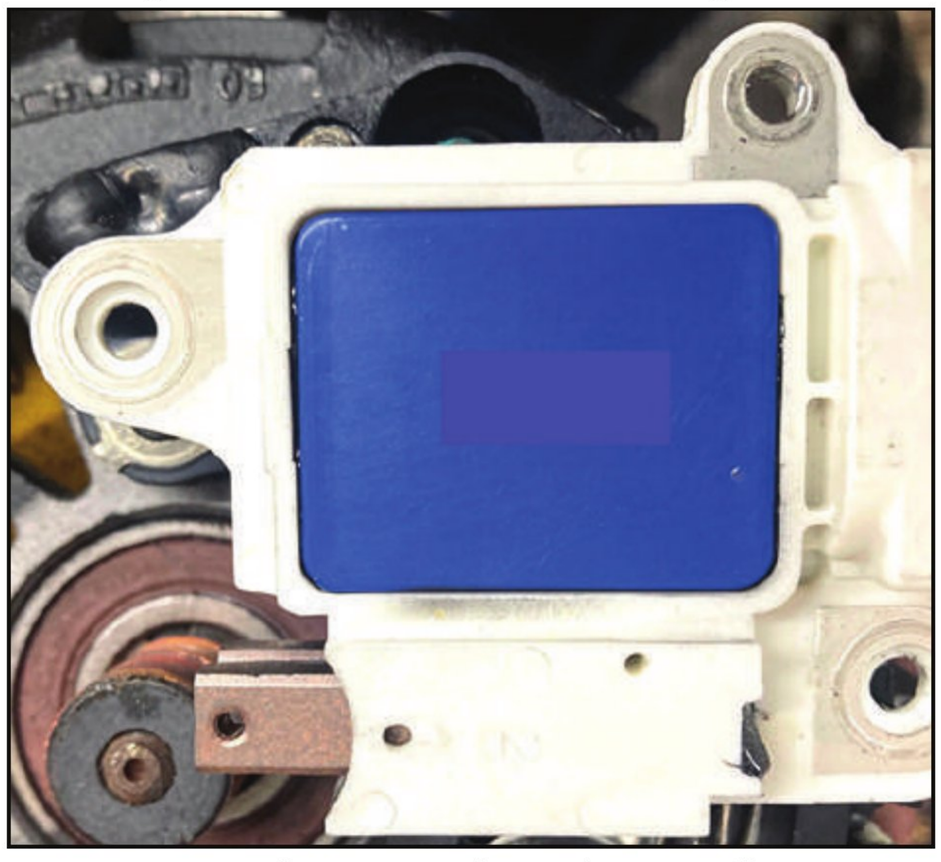

Figure 3 – Unknown Regulator of Reman Alternator

The alternators were picked up and installed. A subsequent call from the shop owner confirmed this took care of his problem and the warning light went off.

I did not do anything special in this case except putting used OE regulators in a couple of store-bought alternators. My effort went to document any differences between the OE Ford (Motorcraft) alternator and the aftermarket version because the shop owner told me the codes he sees on his scan tool relates to the upper alternator which was the 4-G that contained the aftermarket regulator.

While testing Ford's PCM-Controlled alternator, at the last stage, I set the voltage at 15.0V and run it at 2000 RPM and monitored the DFM (FR, or Feed-back) as shown by the WAI-1000 test box that I use for this purpose. This figure usually hovers around 20% which is the duty-cycle of the regulator's ON-Off switching shown in *Figure-4.* Then I slowly decrease the RPM. Consequently, the DFM will rise as the regulator is trying to work harder to maintain the same output. What I have observed is the OE regulators turn up the DFM (Feedback) as much as 95% and no more. (*Figure-5*)

With the aftermarket regulator that came from the parts store alternator, this figure went up to only 92% before it stopped functioning. Now, whether this difference or the overall FR value is what the PCM sees and detects for light operation is a question that I cannot answer, but the fact is the aforementioned aftermarket regulator, however fully functioning, did not turn the warning light off but the OE ones did, and that is all I was trying to do for the frustrated garage owner.



Figure 4 – OE Ford Regulator Maxed Out FR @95%



Figure 5 – Aftermarket Regulator's Max FR Percentage

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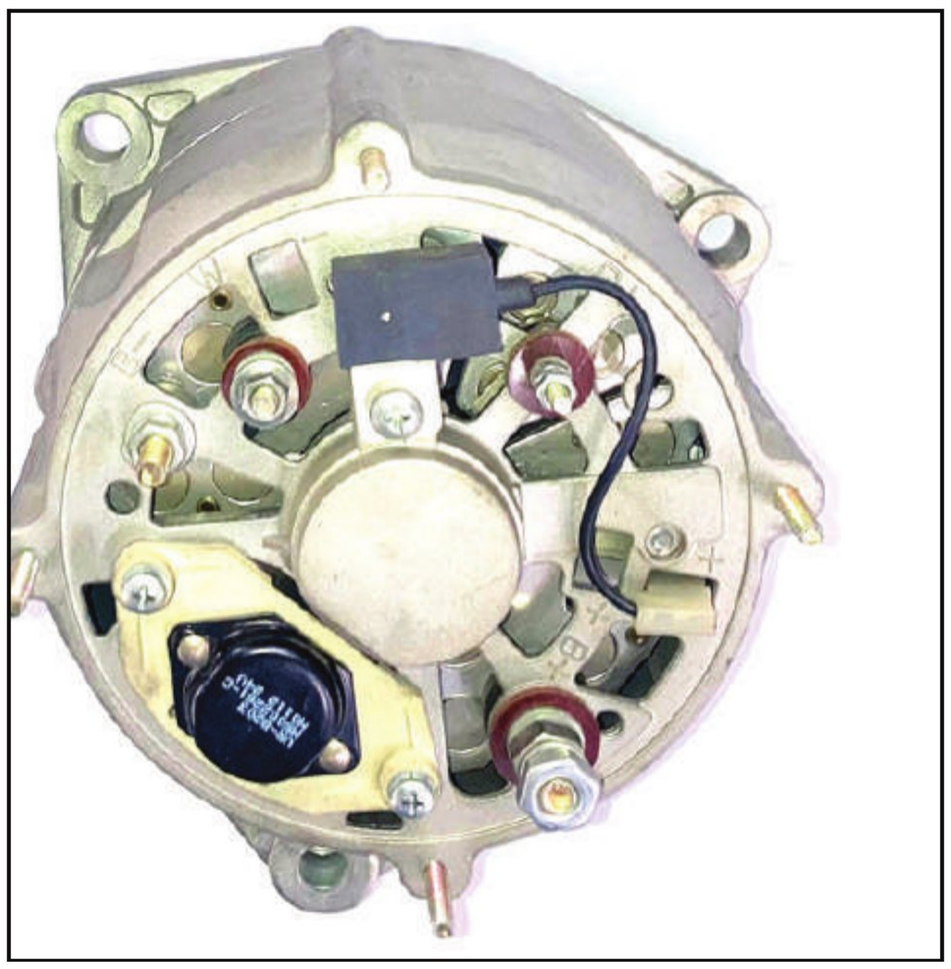


Figure 6 – Bosch 24V-100Amp Alternator of a Crane

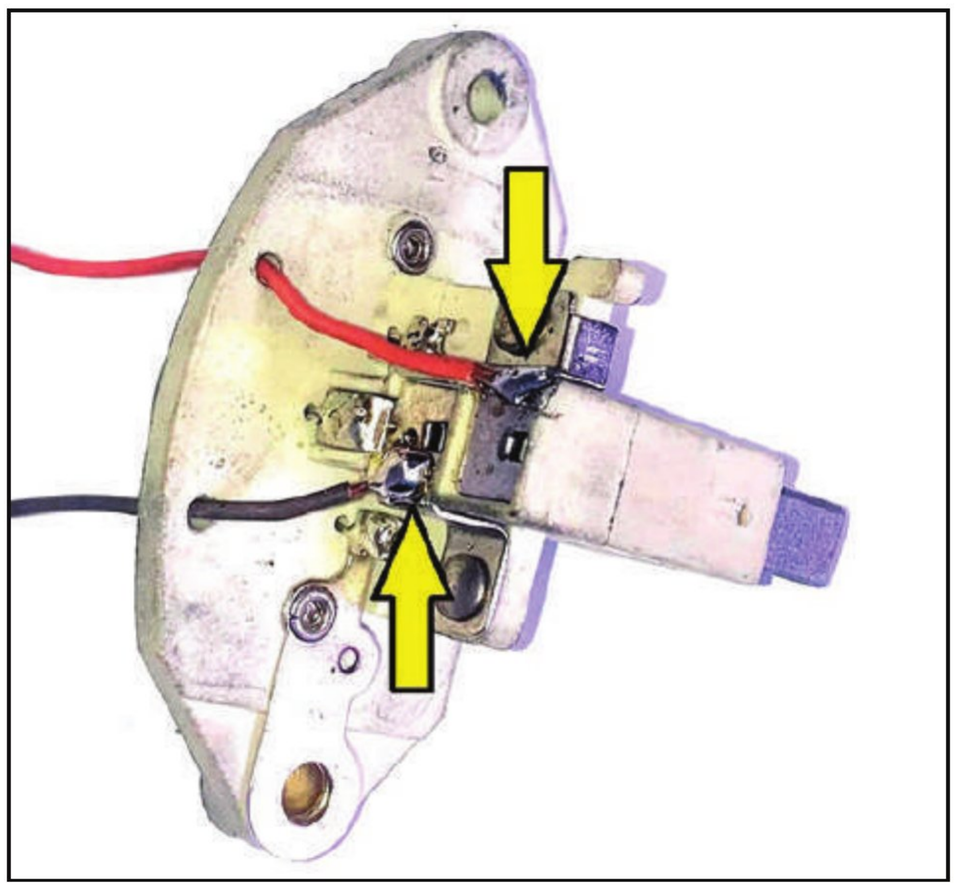


Figure 7 – Bosch Regulator with Added-on wires (1)

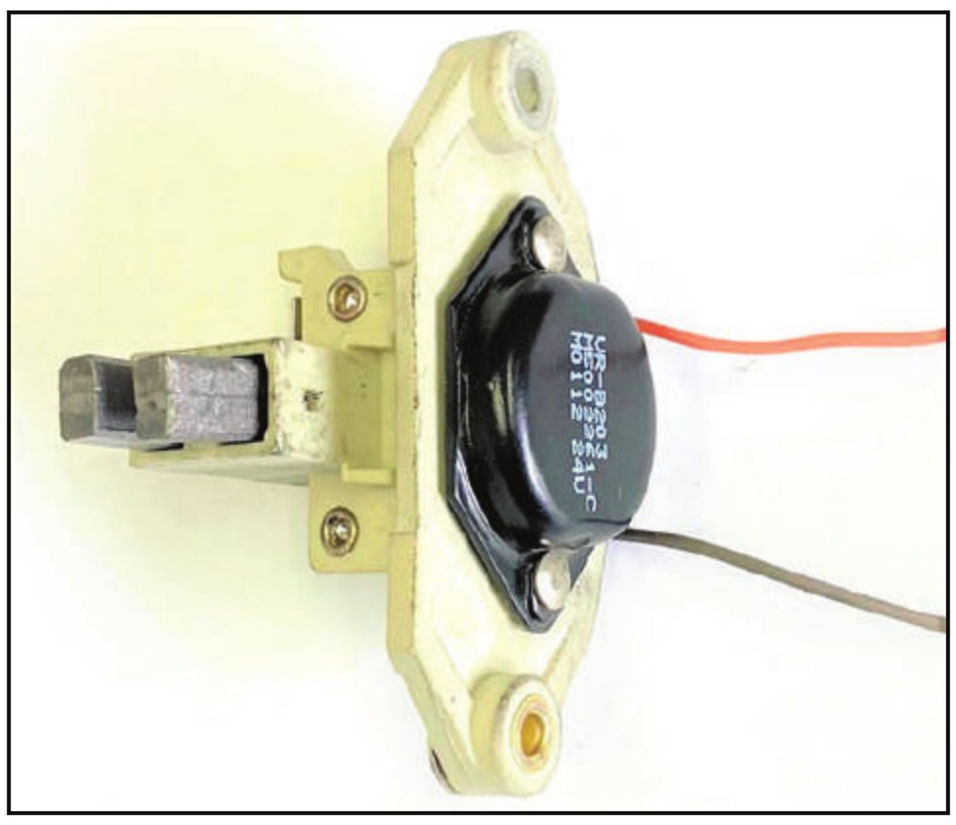


Figure 8 – Bosch Regulator with Added on wires (2)

Bosch 24V Alternator

We had this Bosch 24V 100-Amp alternator that came off a Grove 175 crane that is installed on its upper motor that is a Mercedes 6.4L Diesel engine. They have two engines. (*Figure-6*)

This crane company who is a good customer of ours who has rather unusual and mostly 24V units, had this alternator replaced by the dealer and claimed it cost him over a $1000 but it would not work and he needed a solution as quickly as possible.

After confirming that the alternator was indeed not working, I proceeded with teardown to inspect its internal components. The regulator, a new Regitar VRB-203 (0-192-053-011) checked fine, so did the rotor with new slipping that showed no sign of any problem.

The stator/rectifier combination that were both new were also tested with Jimco's SR-200 which showed perfect balance between the phases. With all of this information on hand, there seemed to be no reason for this unit not produce any output. So, a kind of out-of-the-box approach was necessary to figure out the problem.

I temporarily soldered two small wires to each brush on the regulator and run them out through the two existing holes that were somehow already on the body of the regulators (*Figures 7 and 8*). The regulator was installed and now the two wires gave me access to determine to see what was missing that made the unit not to charge.



After installing the regulator on the alternator and running it, I noticed there was no warning light and no voltage on the red wire that I had attached to the positive brush. That's where the regulator is fed the +D which is the output of the diode trio.

Once this wire was fed externally, the alternator started charging. Grounding the second wire (Field brush) bypassed the regulator and made the output go wide open. Since the rectifier was new, I could not see any reason to think all three diodes (The diode trio) be open. After removal of the regulator (again) I noticed that the spring-loaded tab that connects the trio output to the Positive brush had lost its contact to the rectifier and was not receiving the trio's output. Once this simple connection got soldered and the extra attached wires to the regulator removed, the warning light came on and went off as soon as the alternator speed was increased and the output showed on the test bench ammeter. (*Figure-9*)

So, this little unusual approach helped to isolate the problem and the minor repair restored the alternator for service.

Rare Denso Alternator

It is not often I get a call for alternators from exotic cars, but a local garage who work on such vehicles sent this Denso104210-4080 (Pic# 290-694) alternator that came off of a 2009 Aston-Martin DB9 vehicle…! (*Figure-10*)

The alternator was completely dead as a result of bad rectifier assembly due to multiple failed diodes. There is not much parts information available for this rare unit but a Regitar RN-57 that I had in stock fit the bill just right. This is a rectifier with copper heatsink and 12 50-Amp avalanche diodes rated at 24V. It physically and electrically matched the OE rectifier perfectly. (*Figure-11*)

This alternator was equipped with a clutch pulley that was in perfect shape and was easily reusable due to low mileage of the vehicle which had less that 40K miles on the odometer. I was very glad I did not have to search for it as it could have been challenging.

The interesting thing about this alternator was the regulator. It had a 6-G plug which given a lot of Ford products are used in the engine controls of the Aston-Martin, I assumed to be a PCM-controlled Ford regulator but it was not…! Going by the description on the ID tag of the alternator, this regulator had **S – L – AM** pins which makes it a 342 plug-code. To the best of my knowledge this plug-code was only used on 13978 Denso

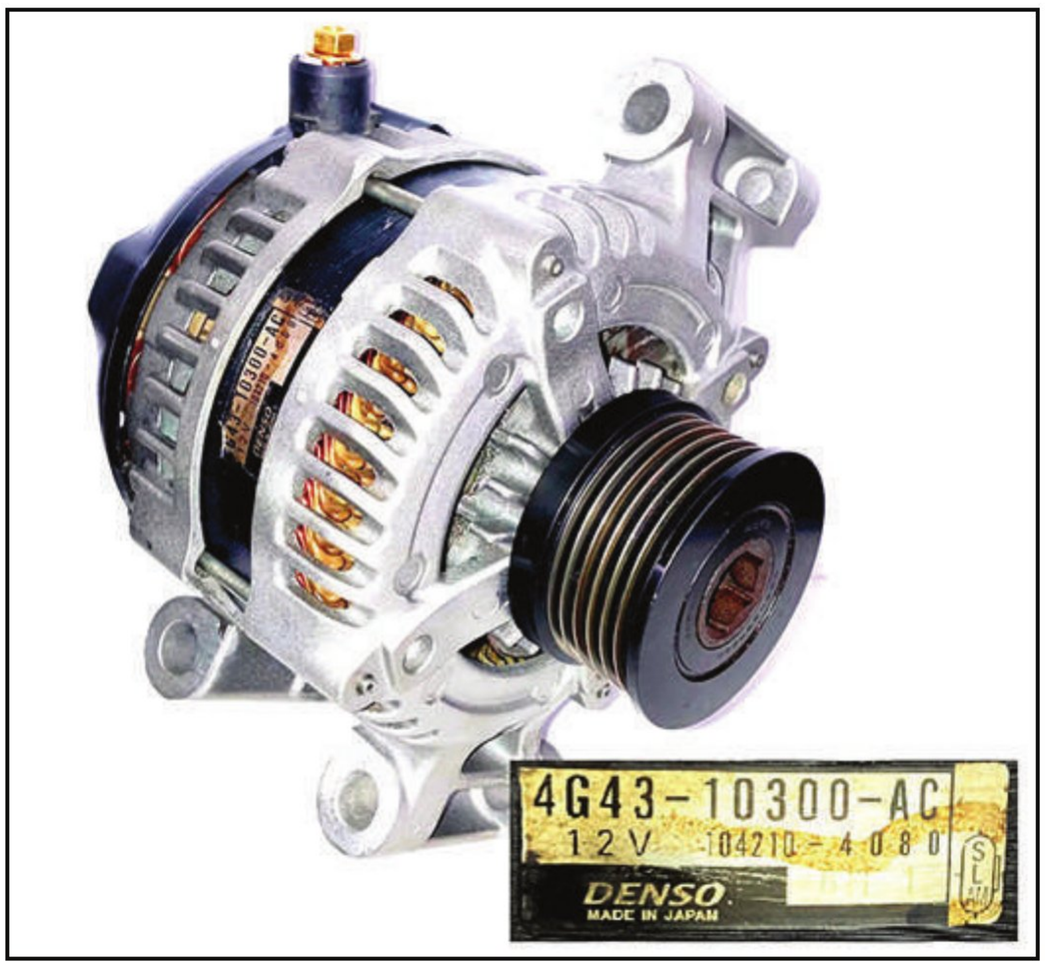


Figure 10 – Denso 104210-4080 Alternator for Aston-Martin

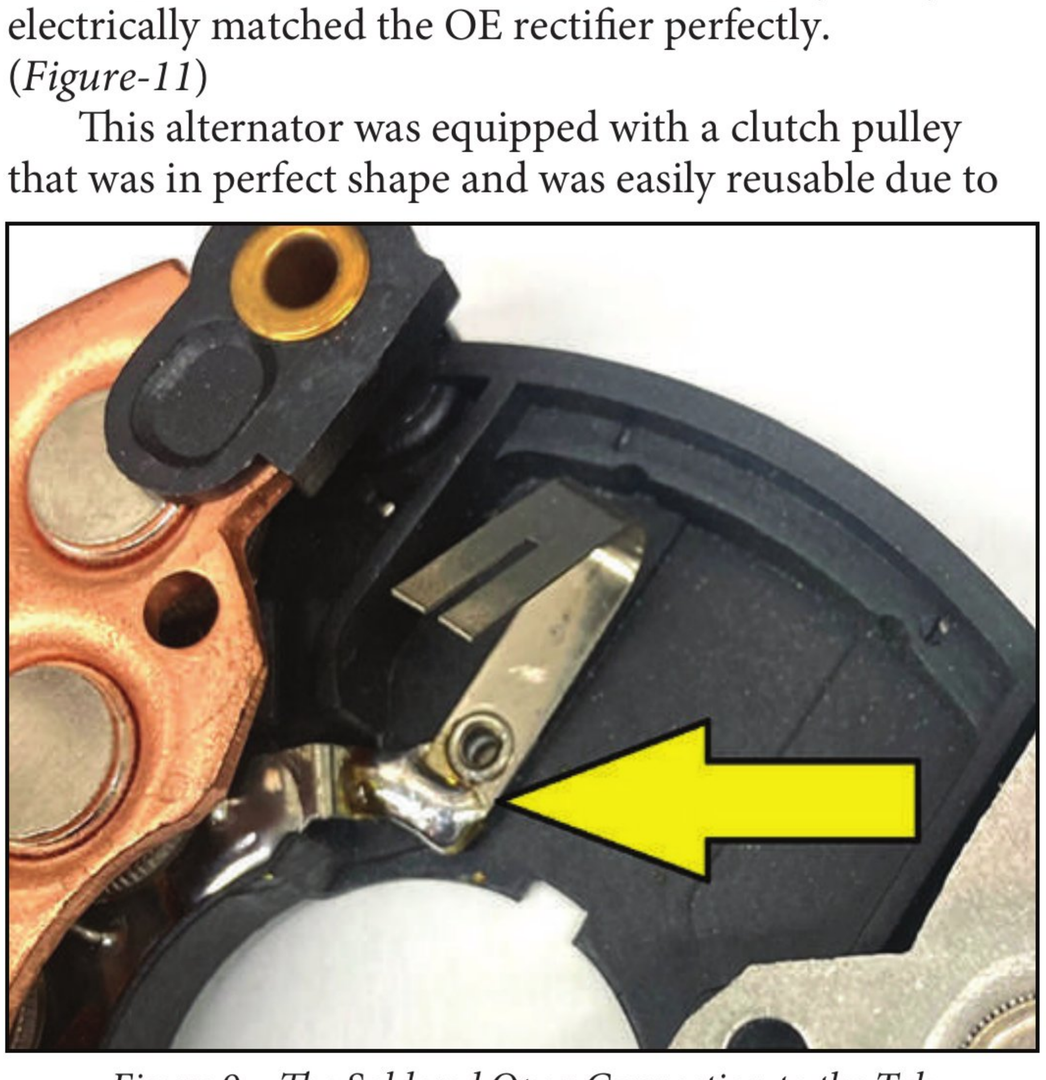


Figure 9 – The Soldered Open Connection to the Tab



Figure 11 – Regitar's Replacement RN-57 Rectifier

alternator on 2003-2005 Ford Thunderbird and Lincoln LS, both with 3.9L V-8 engine. (*Figure-12*)

The "S" is of course the source (+B), "L" terminal is a weak signal coming from PCM to activate the alternator, and AM is a feedback signal going to PCM to convey the load. When these two signals match the programmed parameters written into PCM, an appropriate signal will be put on the SCP bus (Standard Corporate Protocol) which is Ford's medium speed bus before CAN, to turn the warning light off. So, the light on the dash has no direct connection to the "L" terminal of the regulator. Our customer was very pleased he could get this alternator locally and within a day.

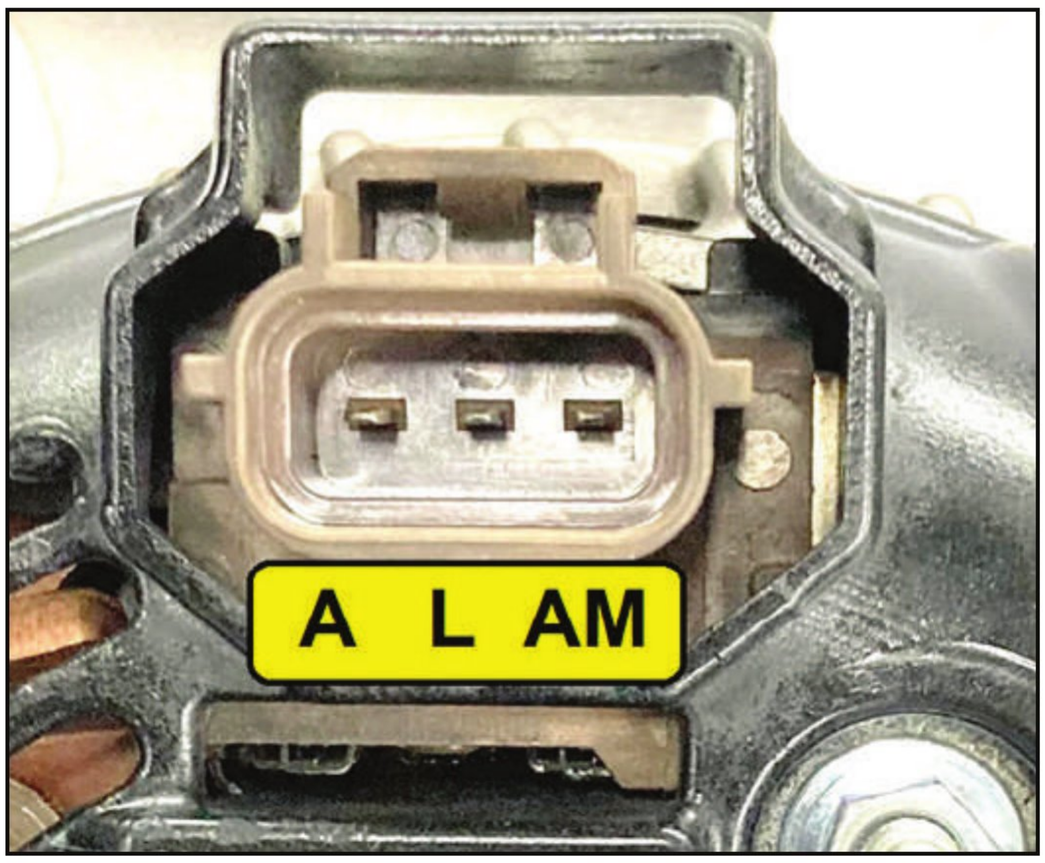


Figure 12 – Plug-code 342 for Denso Alternator

At final test, I run this alternator as a PCM-controlled 6-G but since it is not a PCM-controlled regulator, changing the voltage setting had no effect of the output but the AM signal (DFM) could be read and confirmed by the test box. (*Figure-13*)

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

Mohammad Samii can be reached via email at sammyselectric@sbcglobal.net, or by calling the ERA's Help Line at (636) 584-8324.



Figure 13 – AM (Feedback/DFM) Signal of the Denso Alternator



THE DIFFERENCE BETWEEN 12V AND 24V STARTERS



BY NATHAN UNGER

A question came up on the forums: How do you tell the difference between 12 and 24v starters? In that forum thread, those were 37, 41 and 42mt, but the following principles generally apply to most starters.

- If you have a known starter to compare to, that makes it easy.

- We are assuming that the starter has the correct parts in it, not a mix & match unit. One example of mix & match is when an armature or field coil is rated for 12v and 24v. In that case it might not be obvious what it was intended for. I've even heard of some cases where the starter may have a "high-torque" field coil which is simply a field coil engineered for a lower voltage application.

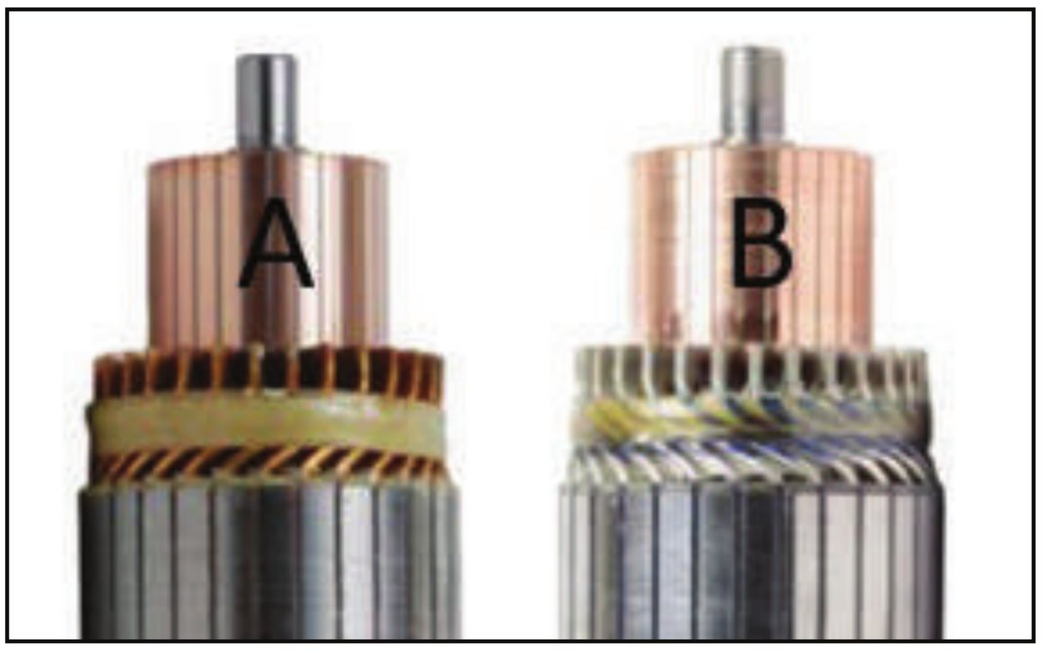


Figure 1 - Armatures

Difference In Armatures

I think the easiest way to tell is by looking at the armature winding. *Figure 1A* shows the hairpins going to the right as they connect to the com. This is a 12v armature. The windings are lap wound. (*See Figure 2A*) If you study the sketch, you will see that the windings are overlapped, each hairpin advancing just one slot. I measured from bar to bar on a 12V, 42MT armature and got 0.6 milli-Ohms. **

Figure 1B shows the hairpins going to the left as they connect to the com. This is a 24v armature. The windings are wave wound. Wave winding requires a higher voltage to achieve the same current through the windings overall.

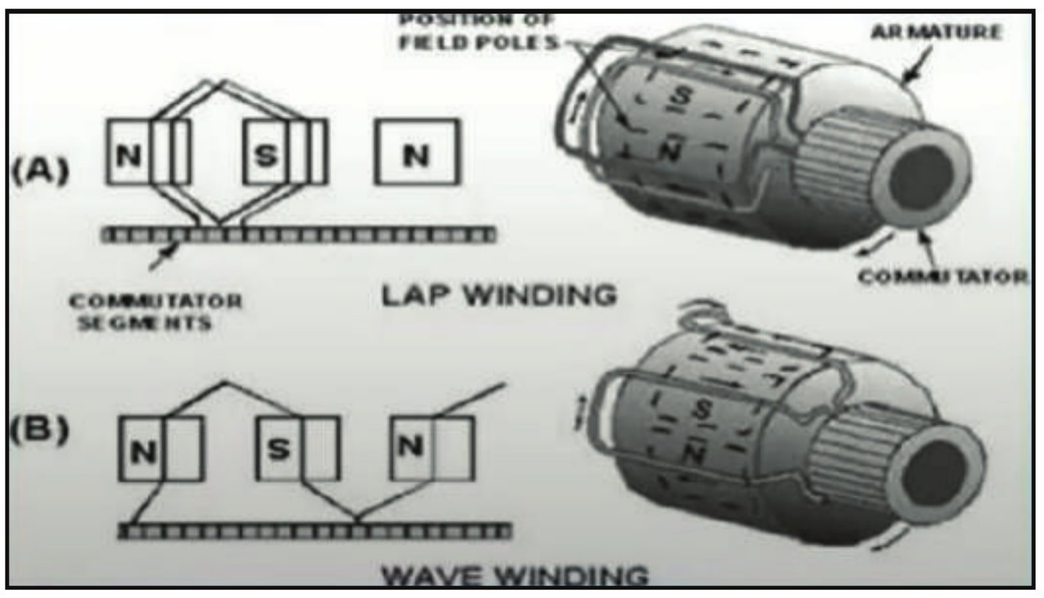
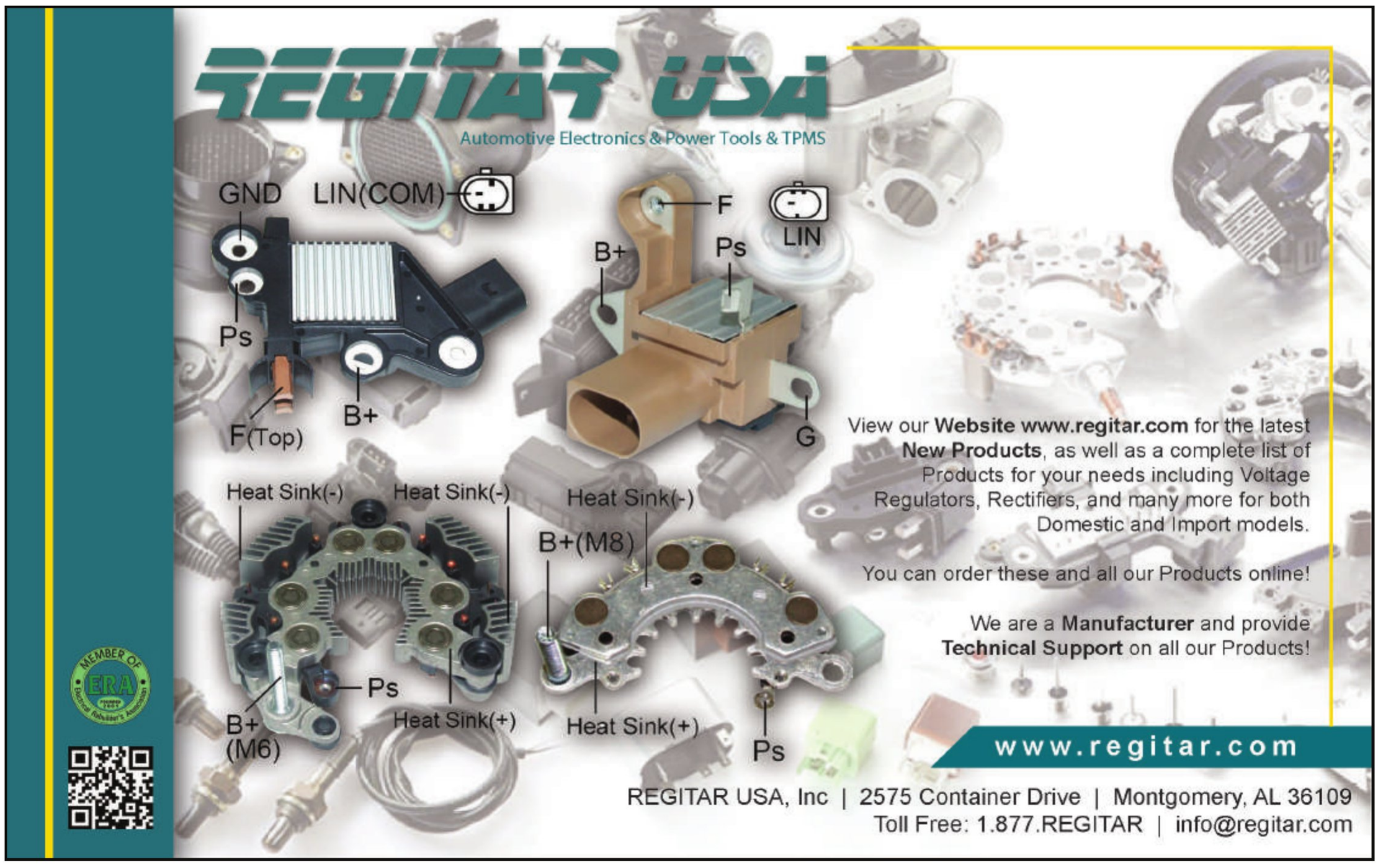


Figure 2 - Lap Wave



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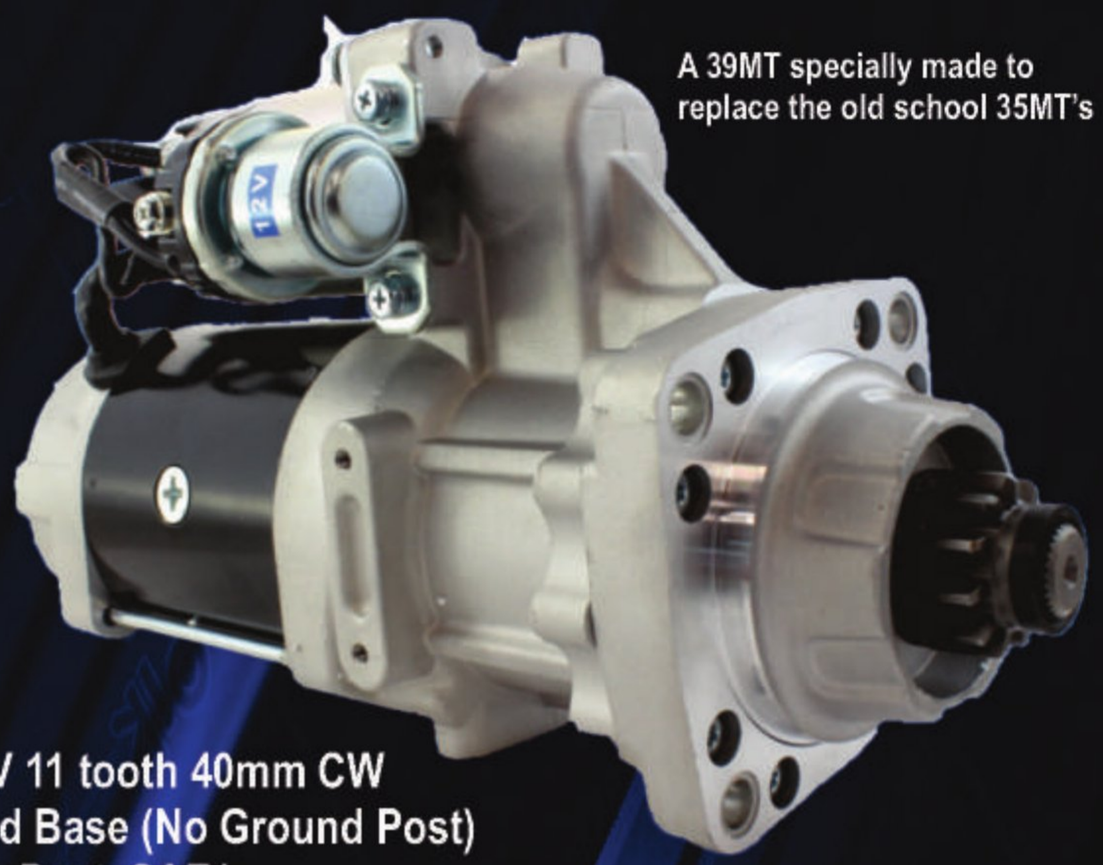

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But the 24v armature does not use thinner wire, nor does it have a different number of turns. So how is this increased resistance accomplished?

If you look at *Figure 2B,* on the right side, you will see that the windings go around the armature like a 'square' wave. This also means that the current encounters a longer stretch of copper, which means more resistance. I measured from bar to bar on a 24V, 42MT armature, and got 1.2 milli-ohms, exactly twice as much as the 12v armature.

That also means you must have the higher voltage in order to get the same current. The current determines the torque of the starter armature. So if you use a 24v armature in a 12v application, it won't have as much torque. If you use a 12v armature in a 24v application, it will have more torque, but it will also draw more current and there will be more sparking and more heat.

Difference In Solenoids

In general terms, the magnetic field of any winding is proportional to the number-of-turns and also the current through it. This means that you can increase the torque of a starter or the strength of a solenoid by either increasing the number of turns, or by increasing the current through the coil. You can increase the current by using thicker wire (which has less resistance) or by increasing the voltage.

If you increase the resistance of the winding by using finer wire (same number-of-turns) but then increase the voltage to still drive the same current, then the winding's magnetism will stay the same. Solenoids don't need to have different magnetic strength just because you are using a different system voltage. So a 24v solenoid will typically have finer wire than a 12v solenoid.

However, using thinner wire also means that you can wrap more turns because the wire doesn't take up as much room. Increased number of turns means you don't actually need quite as much current to get the same magnetic strength. Having less current has the side benefit of not generating as much heat.

The current draw of the pull coil varies somewhat from one design to another because sometimes the pull coil current is used to slowly rotate the armature and starter drive to clear abutment. I wouldn't necessarily use the pull coil current to compare 12v to 24v solenoids, just to avoid confusion. But you still need to know that value for the particular starter you are working on, to make sure you have the correct one.

I think that checking the hold coil rather than the pull coil current (or the wire size) is a better basis for comparing 12v and 24v solenoids. To compare the wire size, you can use a gauge like in *Figure 3,* or just use your calipers. When testing with 12 volts, the 24v hold coils will draw only half as much current as 12v hold coils.

Difference In Solenoid Contact Material

Some older 24v solenoids will sometimes have silver inlay contacts, as opposed to the 12v versions which have only copper. However, some newer starters just use a different copper compound, so you can't really go by that. Besides, some 12v aftermarket solenoids have silver inlaid contact(s) and then are called 'heavy duty'. Nevertheless, if you see silver inlays on the contacts, then check to see what voltage the starter is designed for and rebuild it accordingly.

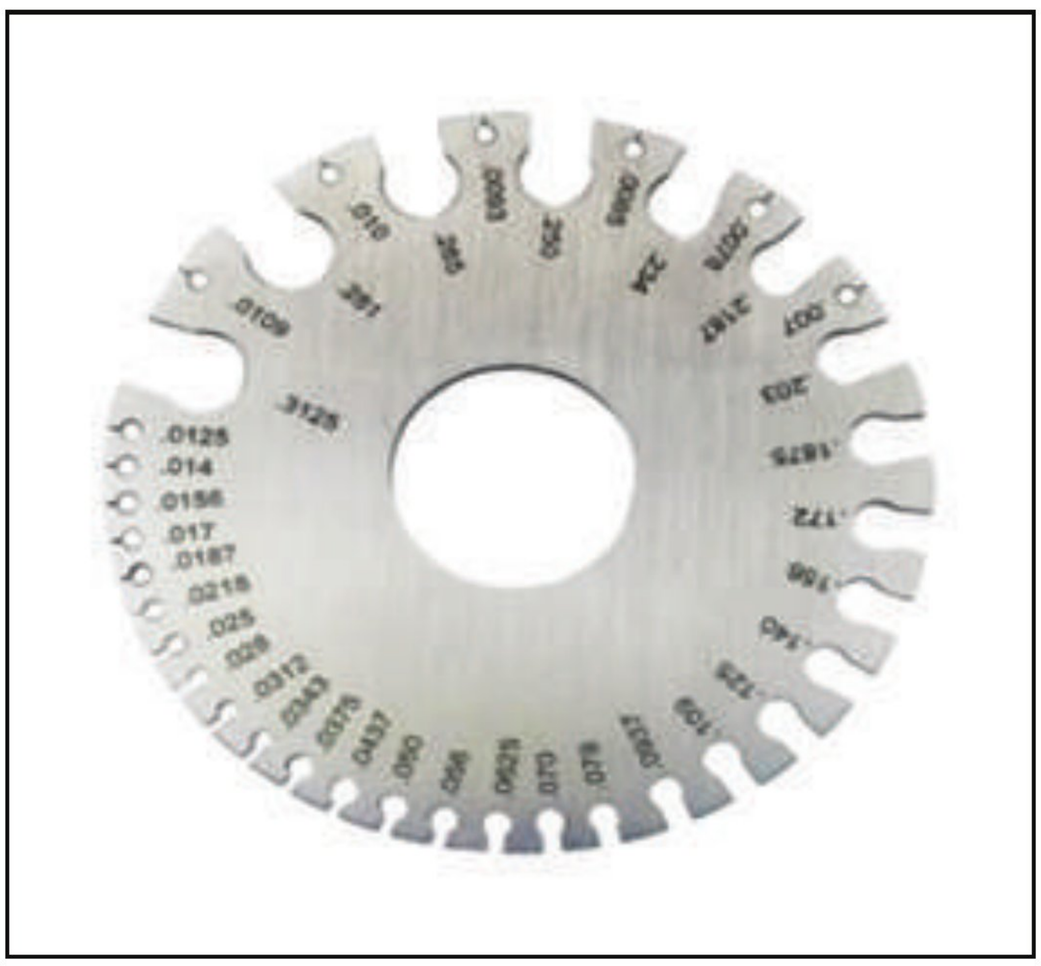

Figure 3 - Gauge

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THE DIFFERENCE BETWEEN 12V AND 24V STARTERS

Difference In Brushes

24v brushes will generally have higher carbon or graphite content. They will look more like pencil lead, and not so copper-colored. (*See Figure 5A and Figure 5B*)

I measured 210 micro-Ohms and 21 micro-Ohms across the brushes, respectively. The 12v brush has only one-tenth of the resistance because of the high copper content. There will be a lot of variation in composition, depending on your supplier, but good quality brushes for large 12v starters will typically also contain some iron, and weigh slightly more than the 24v equivalent. You can verify this by putting the 12v brush on a magnet – to feel the slight attraction. 24v brushes will often have thinner leads as well.

Difference in Field Coils

When you have 4 coils to work with, you can connect them in all-series, all-parallel, or two-in-series paralleled with the other two-in-series. Some starters also have individual or else embedded shunt coils.

Because there are so many options, I wouldn't necessarily decide the rated voltage from the field coil configurations. But often, if the coils are all in parallel, it's probably a 12v starter. Even then, you should compare the thickness of the copper to a known 12v set. If it has thinner copper, it could be a 24v. If the fields have exactly the same configuration as your known sample, another way to tell is by measuring the milli-Ohms from the motor stud to one of the field connections and compare.

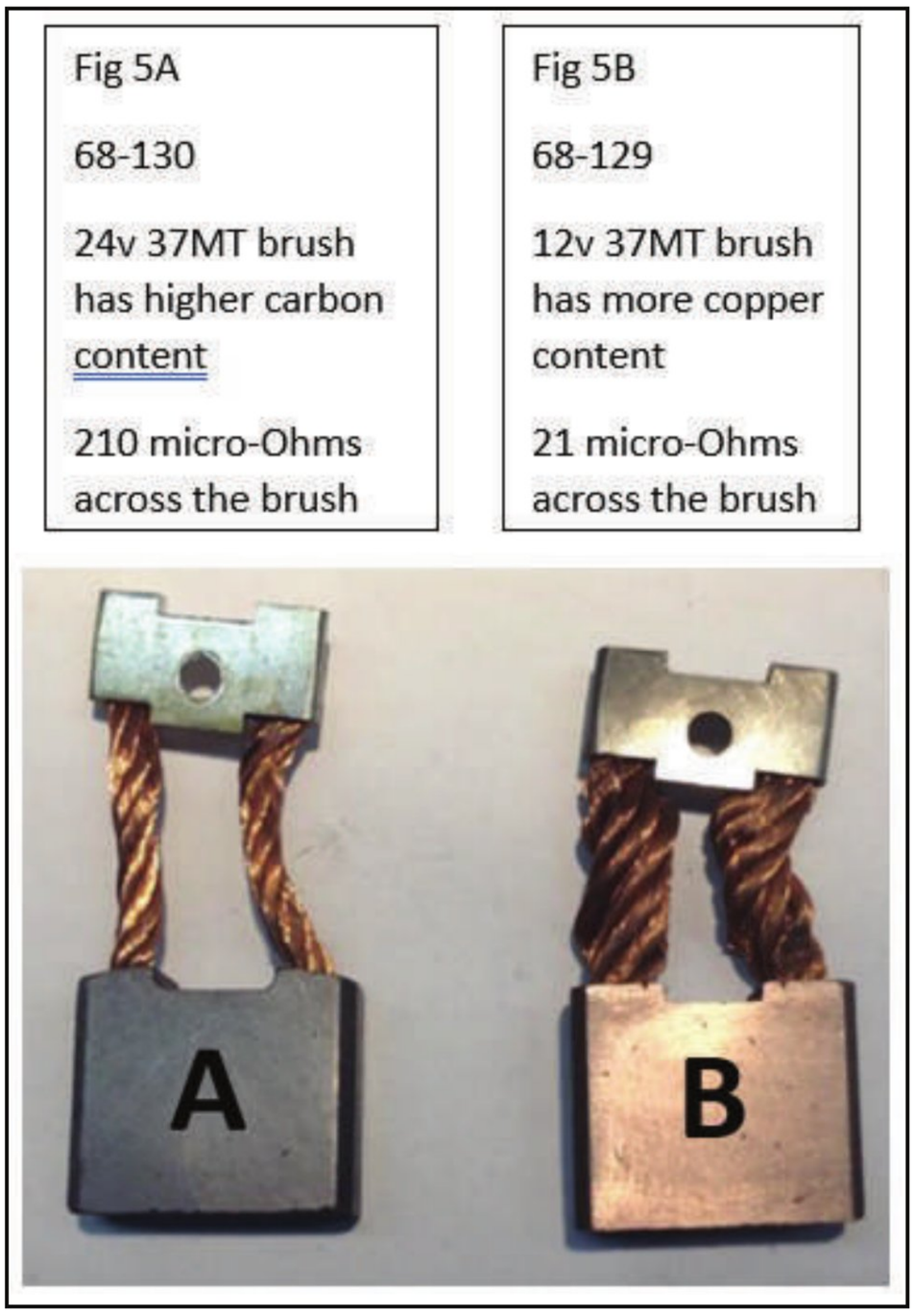

Figure 5 - Brushes

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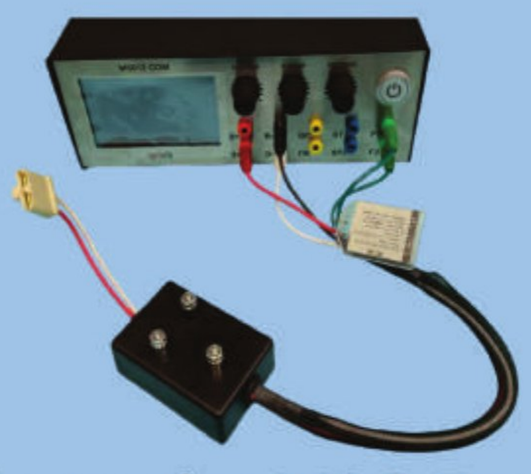



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If you study *Figure 6,* you will see that from the motor stud, there is a connection to each coil, and that the other end of each coil is connected together, with two takeoffs for the brushes. This makes it an all-parallel set.

Here's A Home-Made Amp Clamp Helper

When you are trying to read leakage current, but your test equipment isn't quite sensitive enough, you can improve your signal strength. Wrap ten turns and you will get ten times the signal to your amp clamp. If there is 50 milliamps of leakage, your meter will read 0.5 amps instead. If there is 10 amps of current, your meter will read 100 amps instead.

See Figure 4: I took a short length of wire (which has negligible resistance), wrapped a coil with 10 turns, and now with the same amperage through the wire, I get ten times the reading. You have to interrupt the circuit, insert this coil-shunt (like any ammeter), and then put your amp clamp over the ten-turn coil, in order to read the leakage of your circuit. If you have an amp clamp connected to your scope, you will have a much stronger signal strength compared to electrical noise, because of the 10 turns.

**If you check the ERA website video library, the last one on Conductance Testing will show you how I accomplished these milli-ohm and micro-ohm measurements with good accuracy and repeatability. If you want to purchase a setup like this for yourself, I highly recommend it because of the many practical uses it has. To me it's like having night-vision goggles when you are in the dark. With this, you can actually measure where the current-bottlenecks are, you don't have to guess, nor take stuff apart just to locate the problem area.

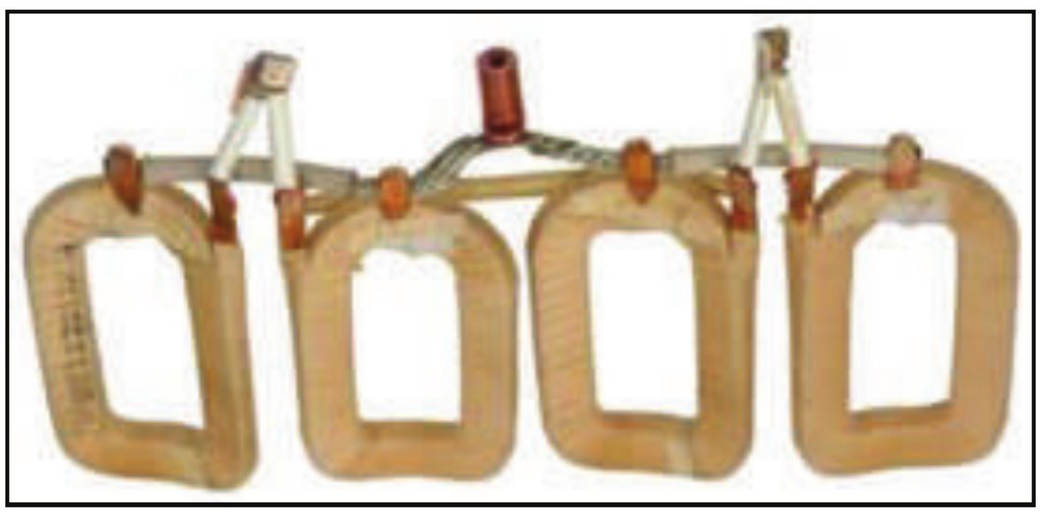

Figure 6 - Fields

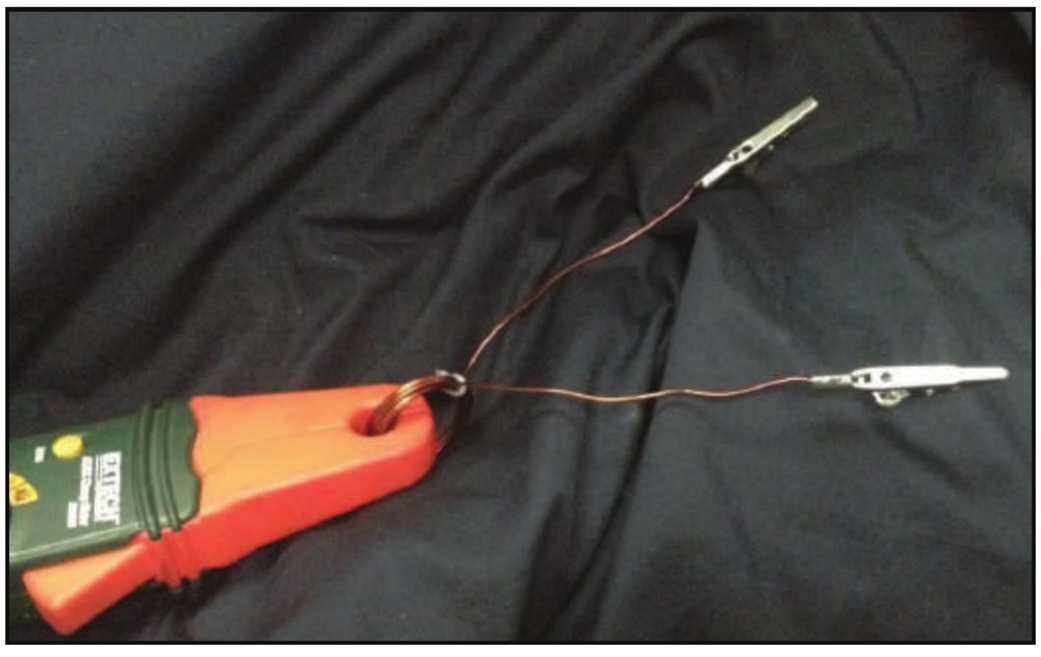

Figure 4 - Amp 10

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