ERA EXCHANGE

YOUR GUIDE TO ELECTRICAL REBUILDING

August 2022 $12.95

AUTO ELECTRIC CORNER

Wrong Alternator, RLO, Marginal Stator, High Demand

SOLVING THE HIGH-RPM CUT-IN PROBLEMS

Electrical Rebuilder's ERA FOUNDED 2001 ASSOCIATION

A WORD FROM THE PRESIDENT

A Challenge For All Members



Well, it's been three and a half years since I became the President of the Electrical Rebuilders Association. One of my goals when accepting this position was to enhance and grow the association. Not only its membership, but also its technical training programs and information programs that benefit the association and its membership.

I have tried a number of projects to increase the awareness of our association within North America and also globally with very little success. With the help of my team of volunteers we revamped our website's guest membership program to ensure that any new guest member could have a good experience by seeing what our association has to offer, for both North American rebuilders, but also for rebuilders and suppliers from around the world.

I will admit I was looking for better results from this project than it produced. I have been continuously reaching out to other industry related associations both in North America and in Europe to discuss opportunities to share, offering our technical information programs to their membership, but again with very little or no interest.

Luckily, I have been able to partner our association with a business-related saving program that provides benefits to our membership that can offset or sometimes exceed your annual membership dues. But again, this benefit has provided very little results toward my goal of growing the association. My only hope is that it helps us to retain members.

Sorry for being a Debbie Downer here, but I have one more new idea that I would like to try. After speaking with our office recently about the registration count for our Technical Training Conference this month, I was informed that three rebuilding shops have registered for the conference that are not members of our association. These shops, it seems, would rather pay the $100.00 registration fee for the conference than join our association and have the fee waived. By joining, they would not only get their registration fee waived, but they would also receive access to all of the technical information provided on our website, twelve monthly issues of the ERA Exchange, and hundreds of years of industry experience from the regular users of our website's forums.

For the last half of my second term as President, I challenge you to help me in reaching one of my goals. That is to increase the rolls of membership. My challenge to each and every one of you, is to reach out to fellow industry peers in your area, some of which may be your competitors, and briefly explain the benefits along with a suggestion to visit our website to sign up for a free 30-day guest membership.

With our industry's recent issues with supply chain problems, I along with two other local rebuilding shops have been borrowing and/or trading component parts to provide our customers with the prompt service that they have been accustomed to. Both of them are also ERA members. If you believe in the value of ERA membership, please share that thought with other rebuilders in your area.

The future of our association is in our hands. If we all work together, I am sure that the ERA will thrive. Your cooperation will be greatly appreciated.

Ken Plourde

ABOUT THE COVER

Special round-cell battery. Notice the size of power cables.

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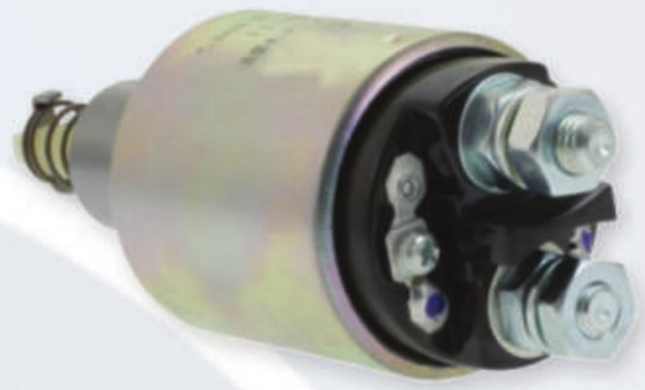
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AUTO ELECTRIC CORNER —
Wrong Alternator, RLO, Marginal Stator, High Demand



BY MOHAMMAD SAMII

The story of two alternators being identical looking but not interchangeable has a long history in automotive and light truck applications. We recall CS alternators that had "I" or "F" terminals, or the CS regulators that were either Light or PCM activated which caused all kind of misapplications and diagnostic challenges. We also remember Ford 4-G and 6-G regulators that were either standard or PCM-controlled and when interchanged improperly, they caused hard-to-find charging or indication issues.

Similarly; we have not forgotten the Mitsubishi alternators with similar looking plugs that had "S – L" or "D – P" terminals. When interchanged, we could see severe and undetectable charging issues that we had to sort out. A recent experience proved that such problems may still appear at times when a poorly marked reman unit with a wrong regulator threw curve balls at diagnostics.

The 11195 and 11201 Denso alternators are identical in appearance, dimensions, and the shape of the regulator plug, and both are equipped with 7-Groove Litens Isolating Decoupler Pulleys (*Figure-1*).



Figure 1 – 11195 and 11201, identical but not interchangeable

The misleading element is the regulators used in these two identical looking alternators, their plug-codes, and their function. The 11195 alternator uses a Denso 126600-3010 (WAI IN-6301) regulator (Plug-code 917) and the 11201 alternator uses a Denso 126600-3320 (WAI IN-6302) regulator (Plug-code 297). The plugs look identical but their function differs. (*Figure-2*)

The plug-code 917 is a common Toyota/Lexus application. The "S" terminal is a +B input to the regulator for "Sense" and if not there (perhaps because of a blown alternator fuse) the alternator will charge but the warning light would not go off. The identical looking plug-code 297 does not have an "S" terminal but an "RLO" terminal. Its function will be discussed later.

The vehicle in question was a 2007 Toyota RAV-4 with 2.4L engine that requires an 11201 alternator. A supposedly reputable shop had installed a factory reman alternator and was confused why the warning light

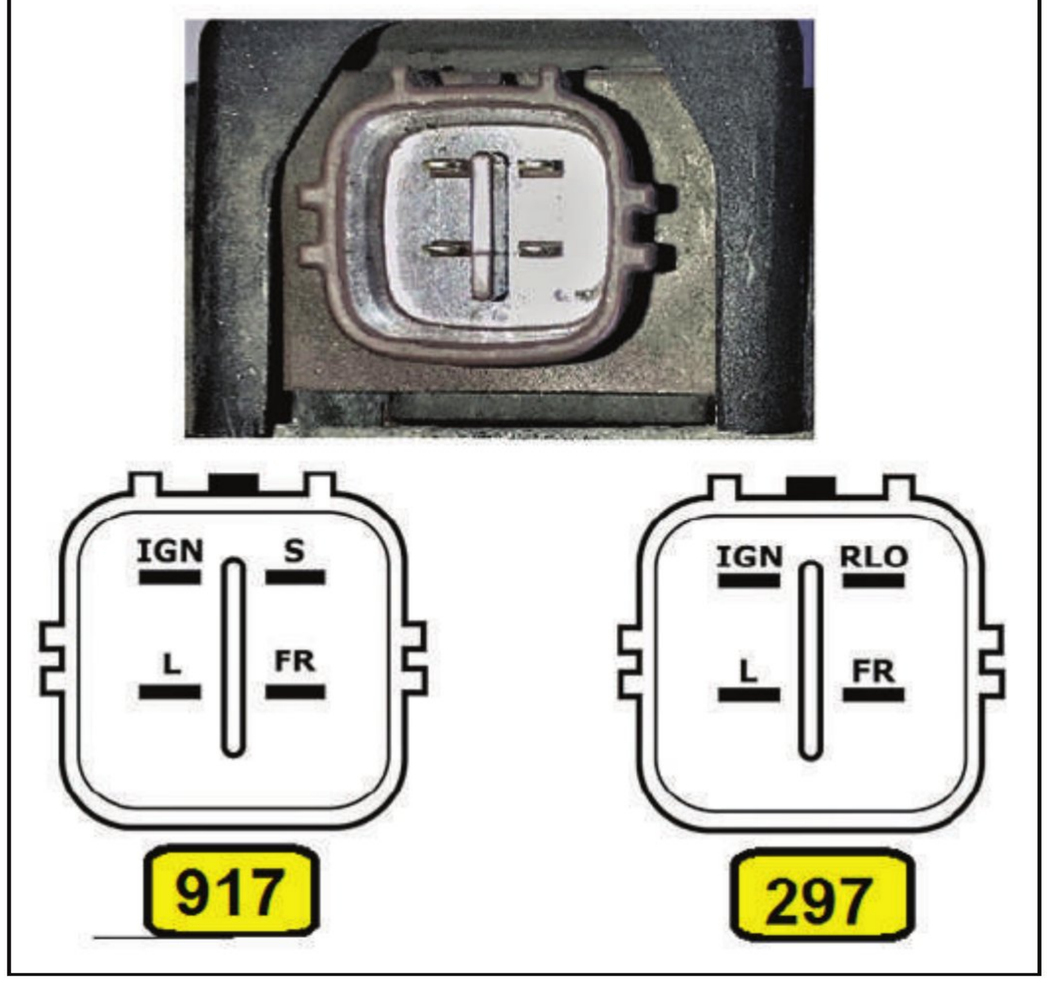
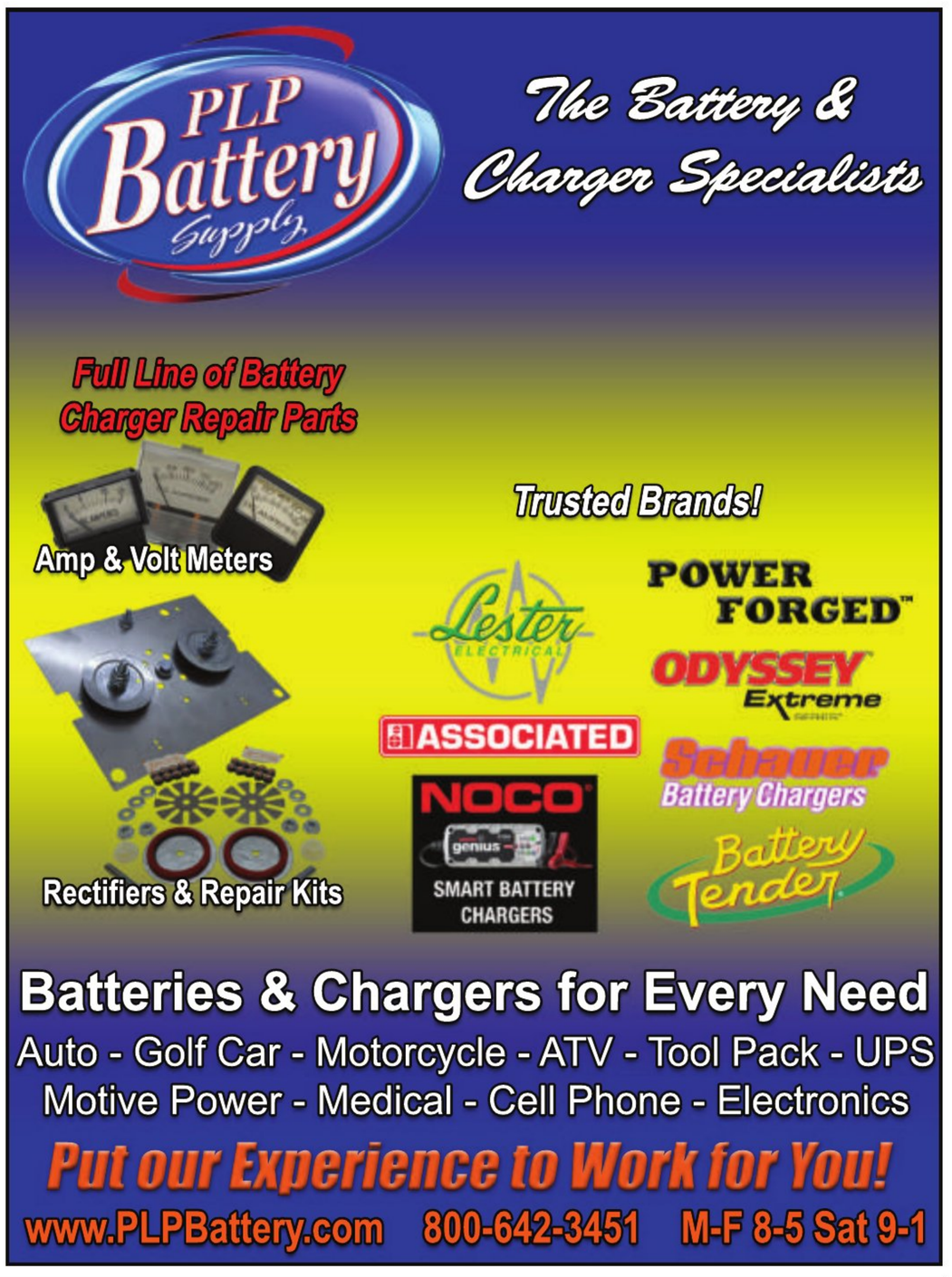


Figure 2 – Similar looking but different functions



would not go off while the system voltage was a normal 14.2V. They suspected a wiring issue and that's why the vehicle was sent to us for repair.

Upon a close inspection finding everything to be okay on the vehicle, I had a hunch perhaps the correct regulator was not installed. Using an appropriate pigtail often used for diagnostic, we connected our pigtail to the alternator and with a couple of jumper wires connected to "S" and "IG" terminals and a test light from +B to the "L" terminal. I noticed that the alternator indeed worked and does turn the test light off. Since the marking on the alternator indicated it was supposedly an 11201 part number, then it became obvious the unit was marked or boxed wrong at the factory and sold as such. It was in fact an 11195, sold in place of an 11201. Installing the correct alternator solved the problem. The car and its alternator were returned to the customer to solve his warranty issues with the repair shop who is not our regular customer and/or their supplier.

RLO (Regulated Load Output) is basically a very low speed signal at only 7 Hz, supplied by the PCM and applied to the regulator to adjust the output voltage setting based on load, temperature and a few other factors that are in the computer's program. (*Figure-3*) The main source of information for RLO signal is the Battery Temperature and



Figure 3 – 2RLO signal from PCM to alternator

Load Sensor that is attached to the battery's negative post (*Figure-4*). RLO function is sort of like GM's RVC that varies the voltage setting of the alternator depending on the load and battery's State-Of-Charge (SOC), but a lot less elaborate and simpler without having various modes of operation. I will post an article I wrote about RLO a few years back on the ERA Forums.

Stator Condition

We had a call form a shop for an alternator to fit a 1998 Saab 900 equipped with a 2.0L turbocharged engine. The application charts narrowed it down to two alternators, 13609 and 13610 with 120 and 90-amps output respectively. I had an13609 on shelf which probably had not moved more than once in the last 15 years, thus I was excited to get rid of it. What I found out was these two alternators that go on the same application are not interchangeable. They have different mounting configuration and require different mounting brackets on the engine. This is particularly unusual because in such cases—like a lot of Volkswagen applications—the larger alternator will usually fit, but this case being an older Saab was obviously not one of them. So the choice was to rebuild the unit and since it could not be easily found locally, the shop gave me a day to turn this around.



Figure 4 – Battery current and temperature sensor

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The 13610 alternator or Bosch 0-123-335-005 (*Figure-5*) is a rare alternator but major components like the rectifier, regulator and slip rings are available. After running the alternator a few seconds for initial testing to get an idea about its possible problem, it showed it was working fine. The light went off, scope pattern was acceptable, and it was holding the 50-60 amps load with no growling. Having the regulator (IB-387) in stock as well as bearings and slip-ring made me feel confident that I could have this unit rebuilt by end of the day.

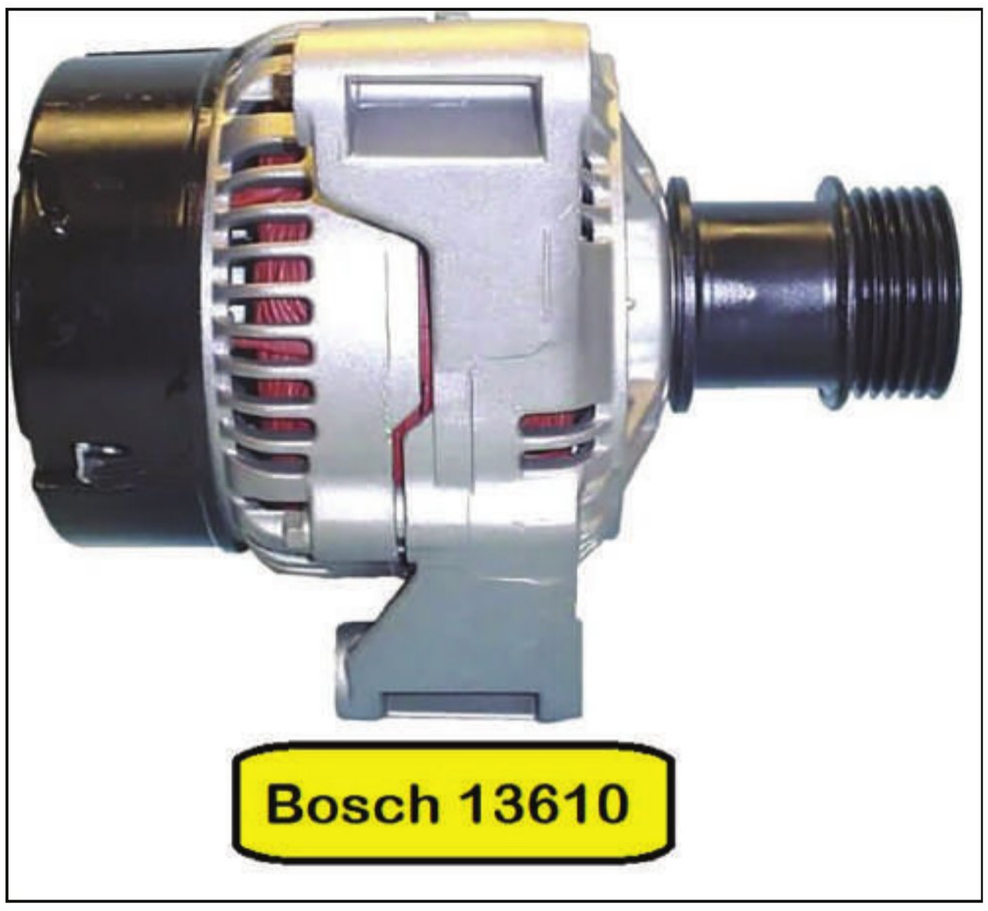


Figure 5 – Bosch 0-123-335-005 (13610) alternator

After teardown and a little clean up, I became suspicious of the stator's condition. A couple of bare spots on the front side of the stator could have been touched up with insulating varnish but I felt I needed to look at the hidden SRE side of it which required removing 6 stator wires from a tightly crimped rectifier connection. It is a tedious job on these older Bosch alternators, especially if you are going to reclaim the rectifier and stator. (*Figure-6*)

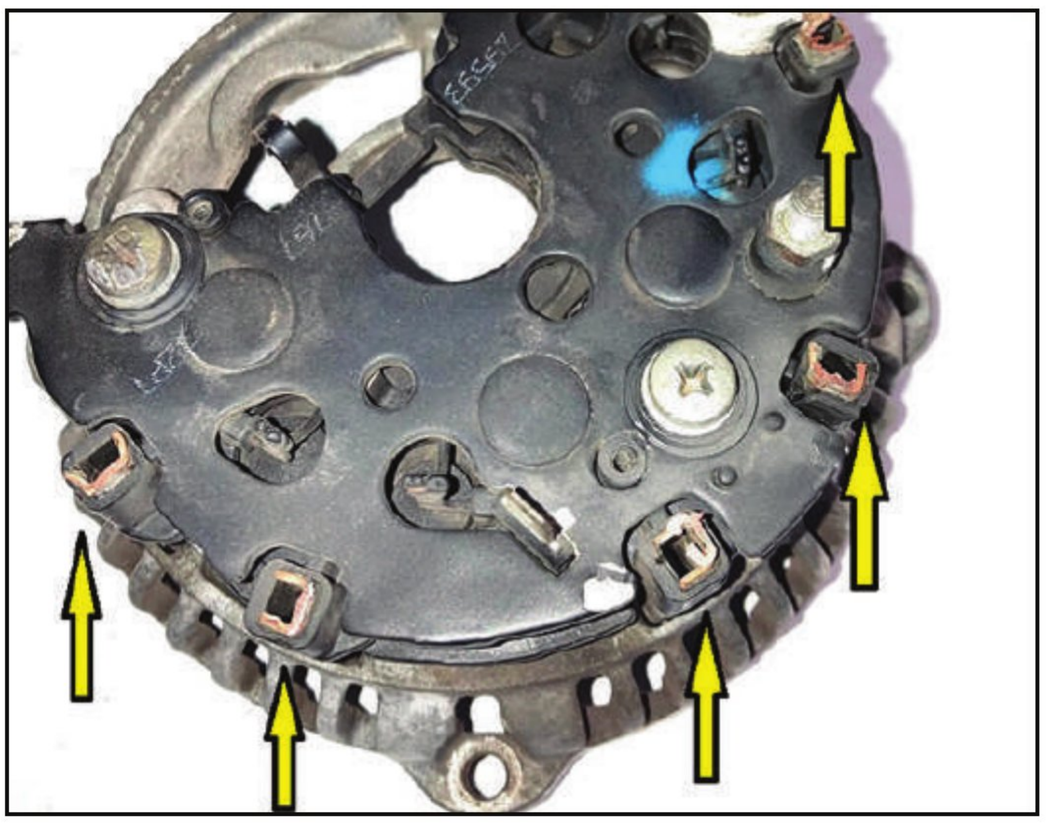
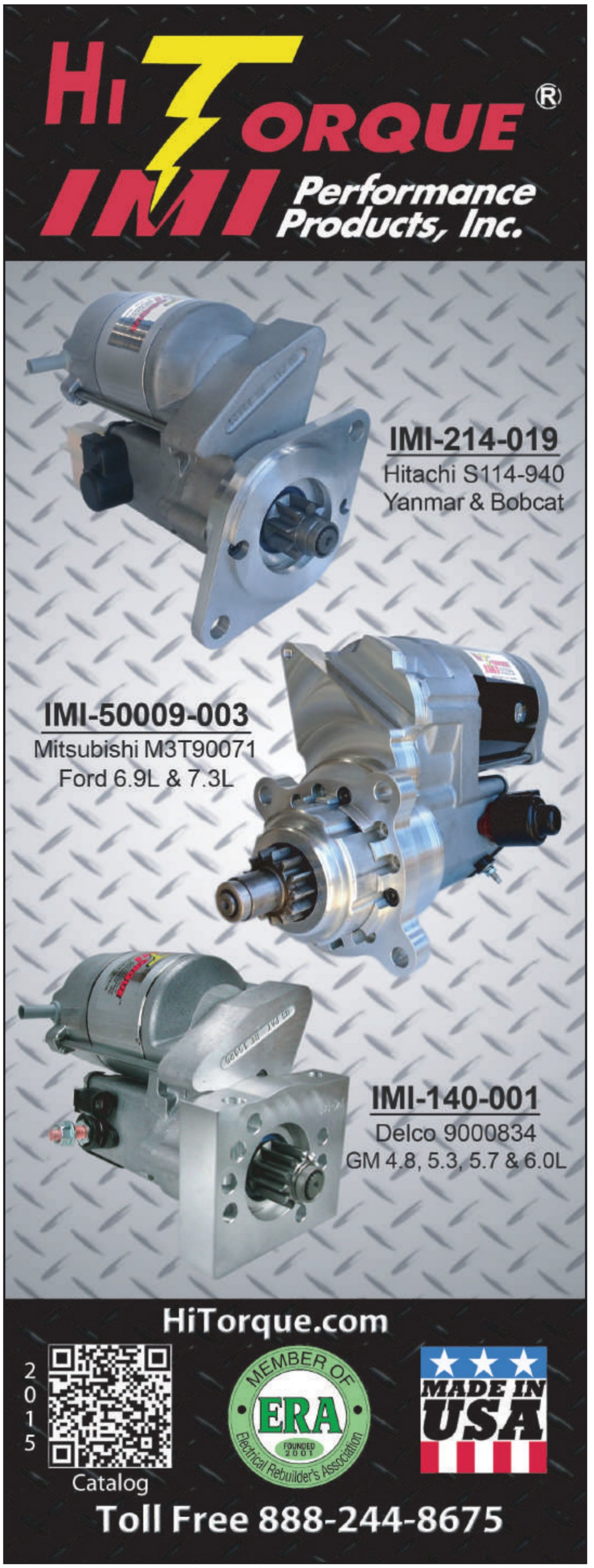


Figure 6 – Bosch rectifier assembly



Once the stator was removed, I noticed a lot more bare spots on the winding. Going over it with a light shot of glass beads, more spots became bare and wires visible, indicating the deterioration of the varnish (*Figures 7 and 8*). I could not convince myself to use it, given the very time-consuming R&R and difficult installation, even if it tested okay before teardown. Since this stator is unavailable except for one from Alfa Auto Electrique in Montreal, Canada, thus not practical for overnight shipping, the choice was a replacement alternator. One was obtained overnight from J&N and delivered the next day.

The point is, sometimes your gut feeling can be true and relied upon. Had I sent this unit out with the same stator, it most likely would not have lasted long when heated and exposed to moisture and vibration in actual operation.

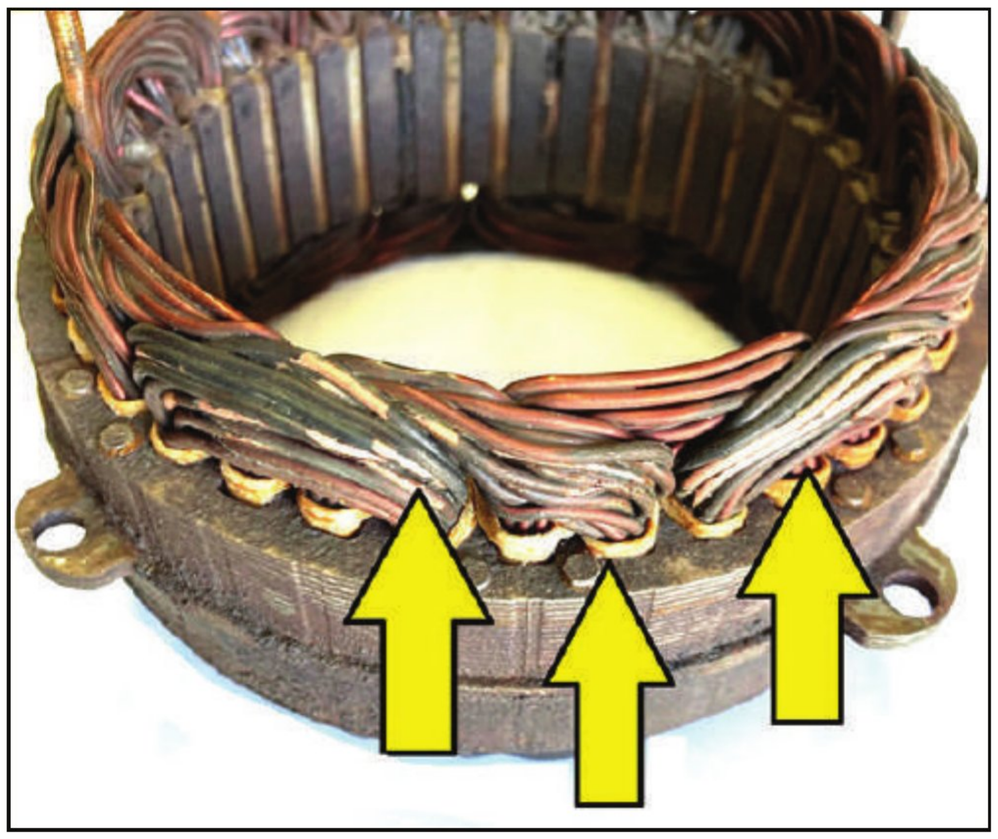


Figure 7 – Heated and distorted wiring varnish

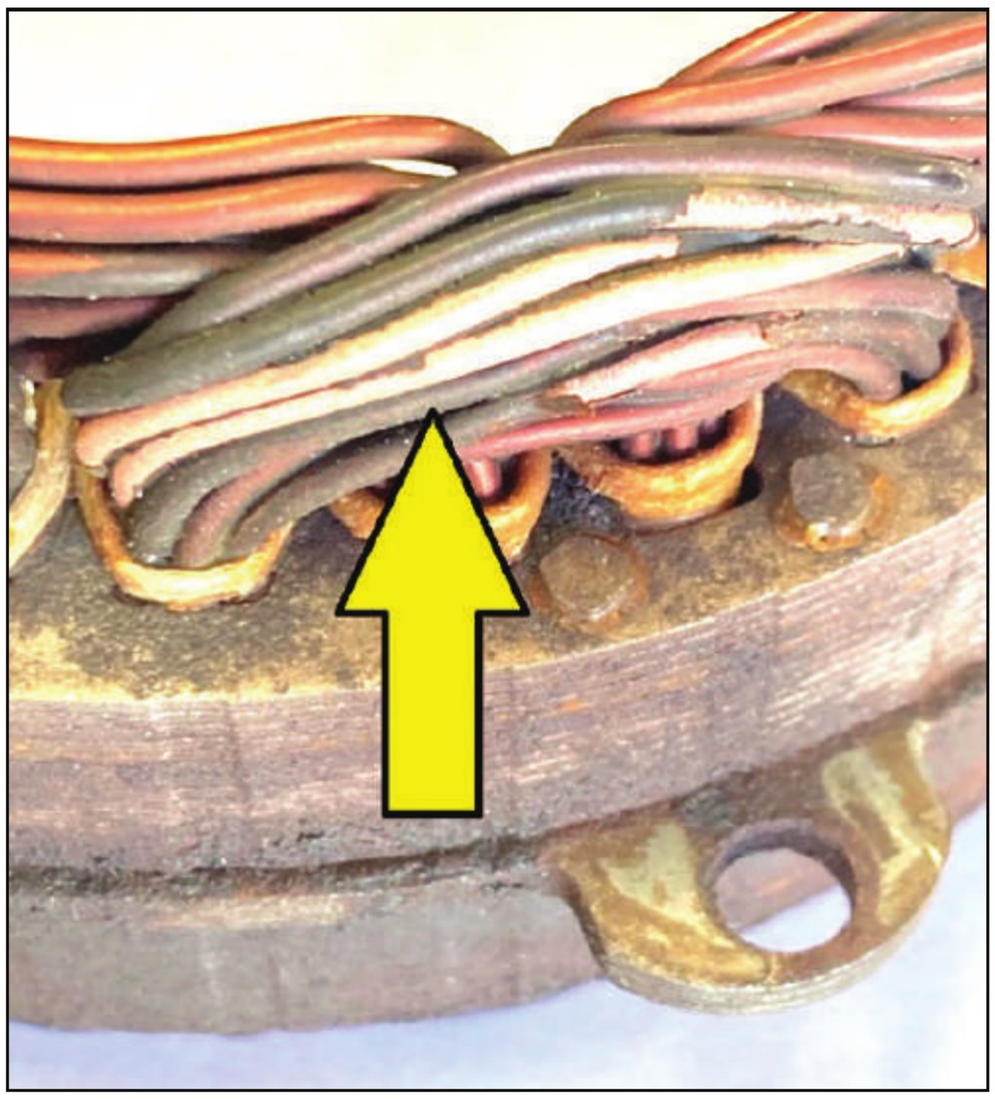


Figure 8 – More burned off varnish, not acceptable





High Demand…!

The owner of a 1984 Chevrolet Monte Carlo called, informing us that his car was being towed to us due to a dead battery and his guess was that his alternator had failed. He mentioned that he wanted us to rebuild his alternator and not replace it with anything else because it was a special high-output alternator made for this car. What accidentally or intentionally he failed to tell us was the fact this so-called special alternator was an ordinary chromed 10-SI with a slightly bigger stator and nothing really special. (*Figure-9*)

What he also failed to tell us was, and we discovered it on our own later, that he had a very sophisticated amplifier and speaker network built into the trunk of the car that filled the entire available space there (*Figure-10*).

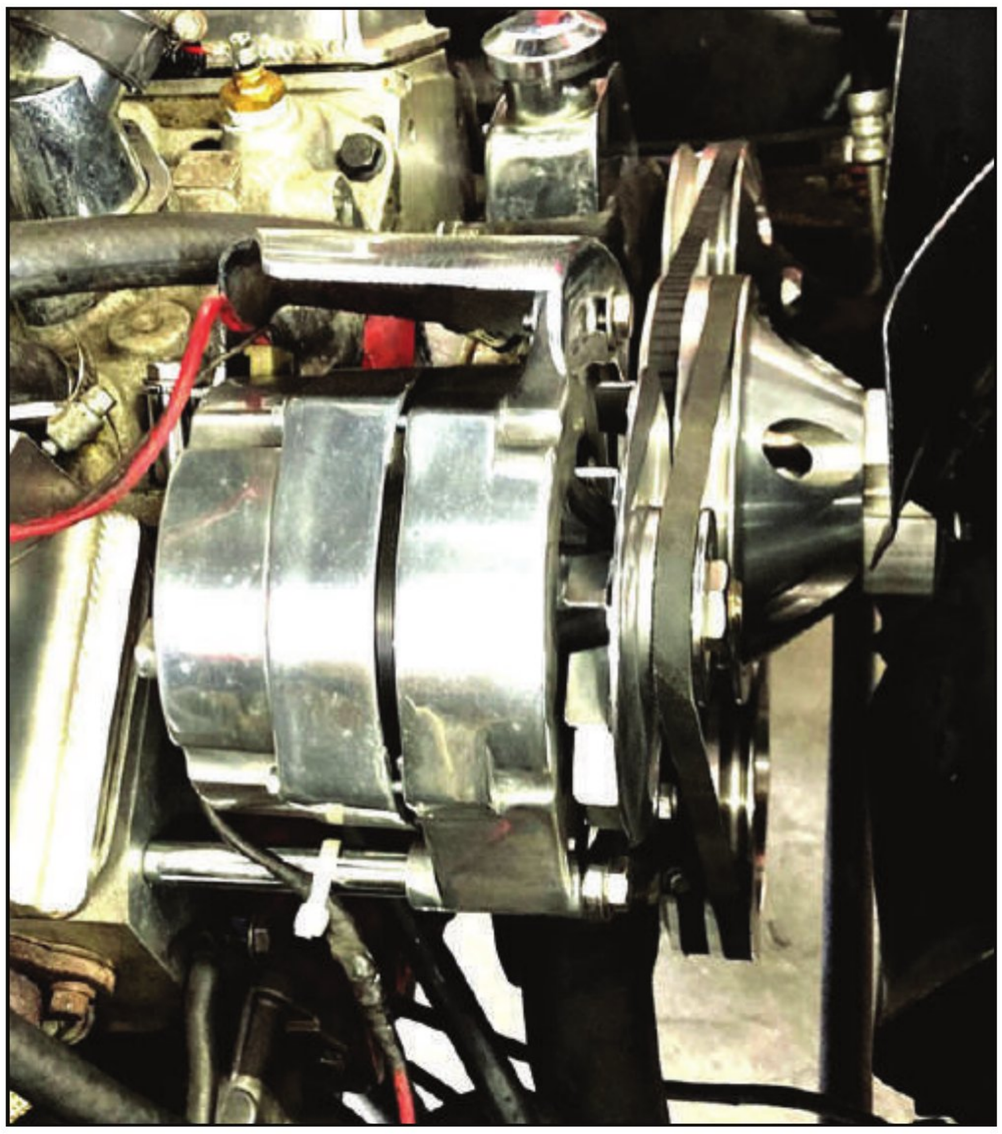


Figure 9 – Chromed 10-SI with 80-Amps output and single 3/8 V-belt



Figure 10 – The massive sound system in the trunk

The enormity of the amplifiers can be seen in Figure-11. Additionally, there was also a very hi-tech cellular 12V battery with cylindrical cells (*Figure-12*) wired to power the sound system which its design and construction reminded me of Honda Insight hybrid HV battery cells. (*Figure-13*)

After charging the batteries overnight and starting the car, we noticed that the alternator was indeed defective. This so-called hi-output alternator was basically a chromed 10-SI with slightly larger stator driven with a single belt. After repairing it (blown rectifier and regulator), I could measure no more than 80 amps of output at maximum RPM.

The alternator was repaired and installed. The next ordeal was dealing with his questions. Would he have any problems in the future, and can I beef up his alternator to 200 amps…?!

My answer to the first part was probably yes, given the audio amplifier I saw in the trunk. And the answer to beefing it up to 200 amps was a NO, as a single 3/8 belt has only so much pull, which probably the 80 amps is the upper range of its capability.

That is one of the issues we deal regularly with audio enthusiasts, trying to make them understand unless the entire accessory drive system has changed into multiple groove pulleys, any attempt to beef up the alternator that exceeds 100 amp is futile. As soon as the volume is turned up and the bass starts thumping, a single V-belt would slip, eventually burn off, and fly off the pulley. I have trouble getting some audio enthusiasts to understand this simple point.

Well, that's all for this issue. Until I see you again, keep up the good work and please remain virus-free!

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

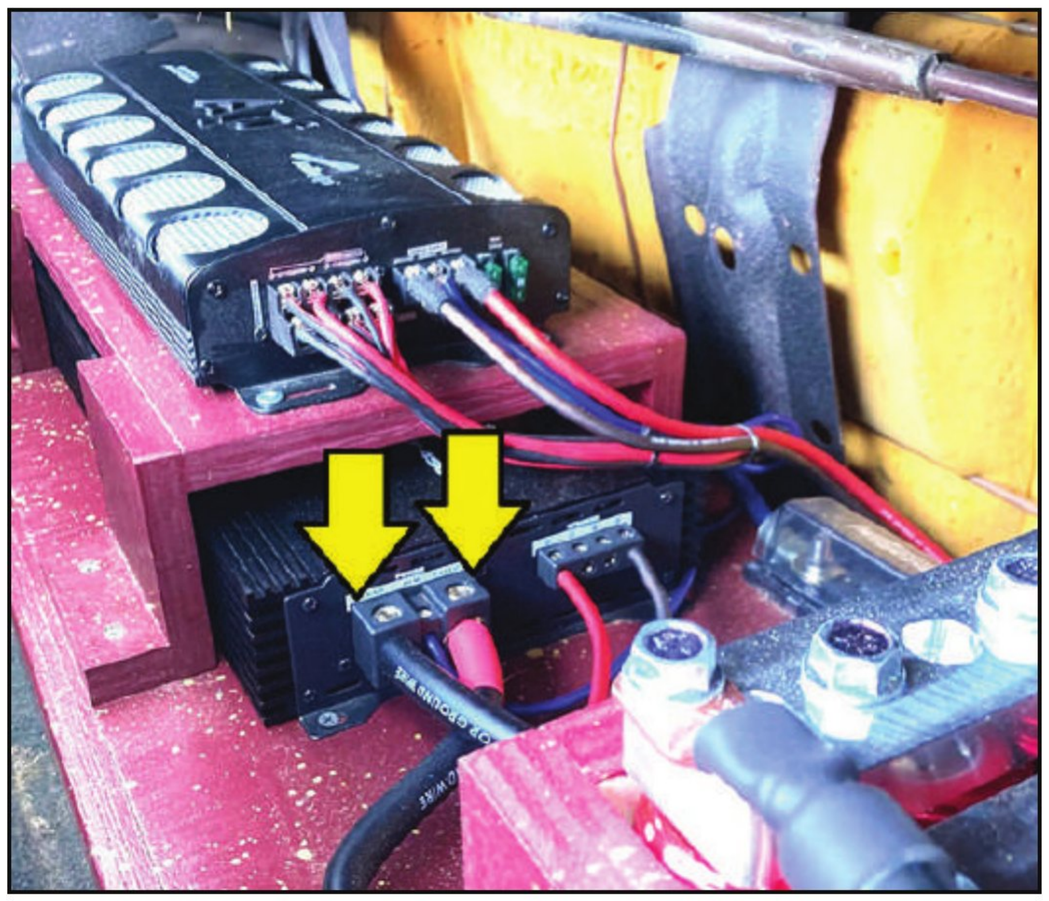


Figure 11 – The amplifier and its power feed

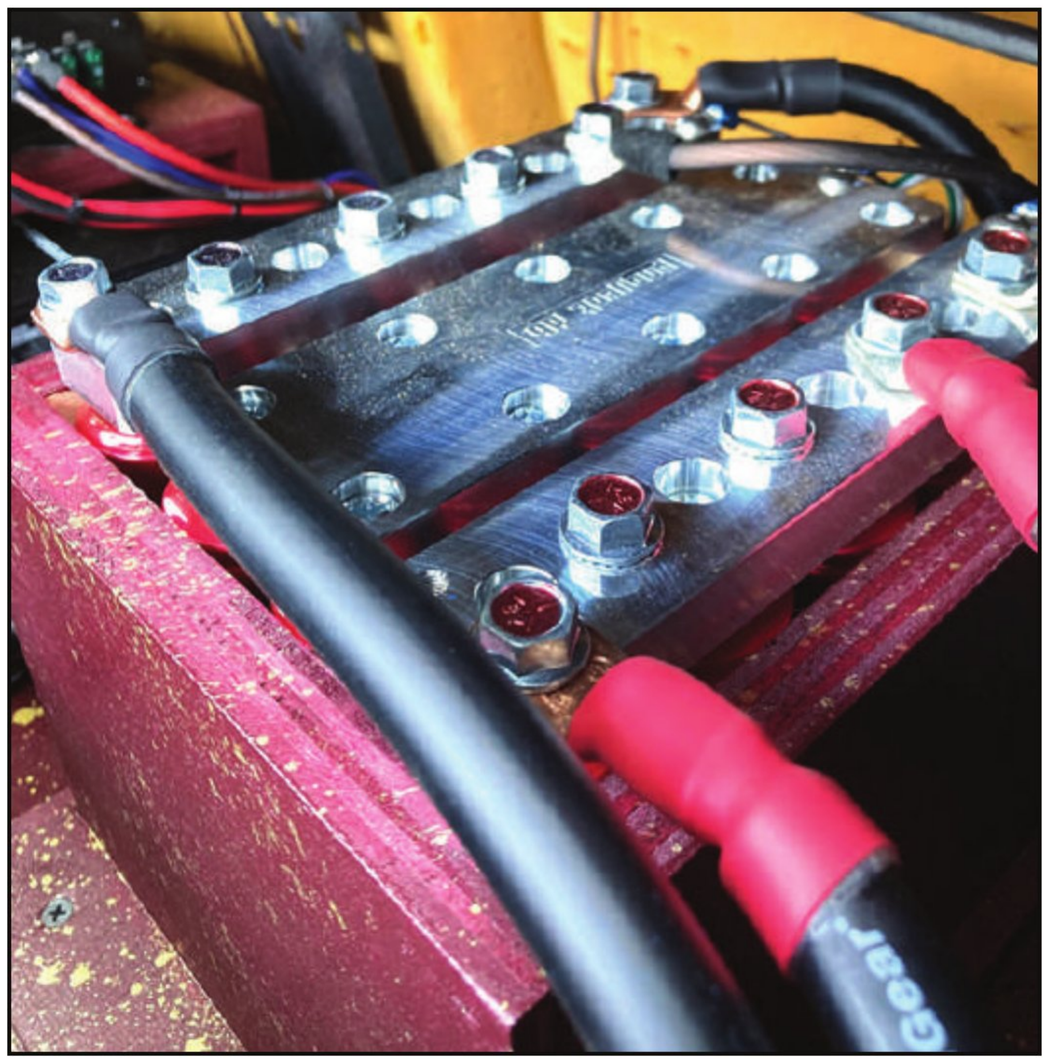


Figure 12 – Special round-cell battery. Notice the size of power cables.

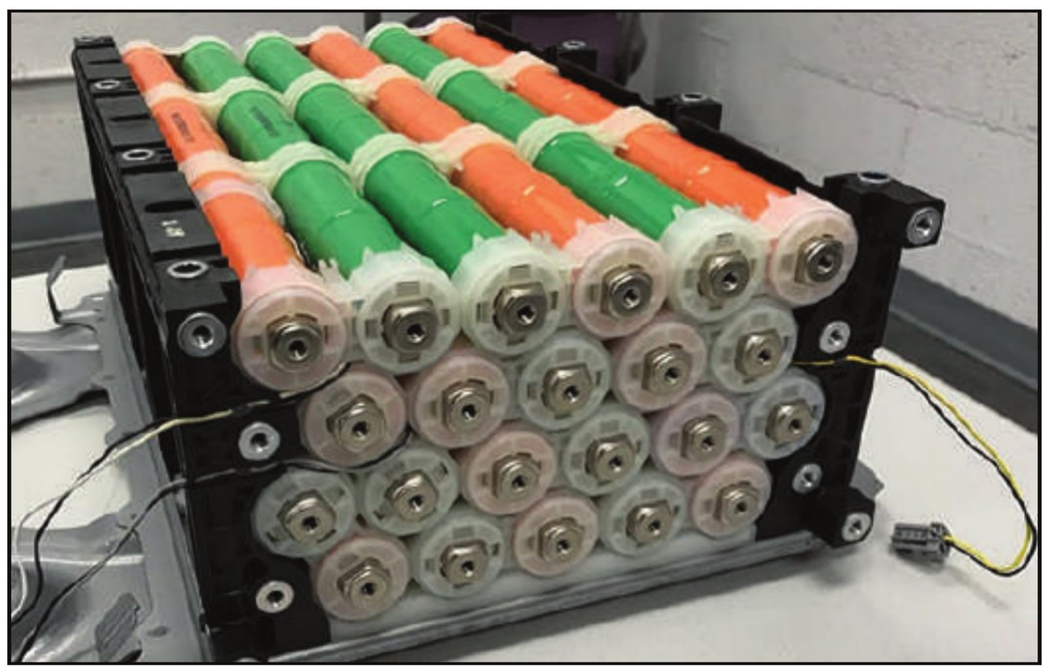


Figure 13 – A Honda hybrid HV battery (Photo: Open source)



SOLVING THE HIGH-RPM CUT-IN PROBLEMS



BY NATHAN UNGER

When I first started in this trade back in 1981, some of these Leece Neville and Delco 27si-200 truck alternators would give me stress because the regulator would not start charging until an excessively high rpm. The 31SI alternator was my least favorite! Customers complained that they had to rev up the engine to get the indicator needle to go from discharge to charge. Once it was charging however, it would keep charging, even at the lower idle rpm.

So here's what I discovered from reading articles, asking experts, and lots of 'tinkering'. (Plus, I am always open to learn.)

The alternator must turn on at an rpm below engine idle. Some engines idle at 600 rpm, so if they have a 2.5:1 pulley ratio, that means the alternator must turn on below 1500 rpm. For alternators that are excited through the "L" or "IGN" terminal, that's usually not a problem, but if the alternator is self-excited, it can be tricky. As an aside, when discussing rpm, make sure the customer doesn't confuse the engine rpm with the alternator rpm.

First of all, you have to test all the components to make sure they are good. Test them for leakage to ground, voltage drop under load (including the diodes), correct current rating, winding balance, etc. Diode leakage is another important issue.

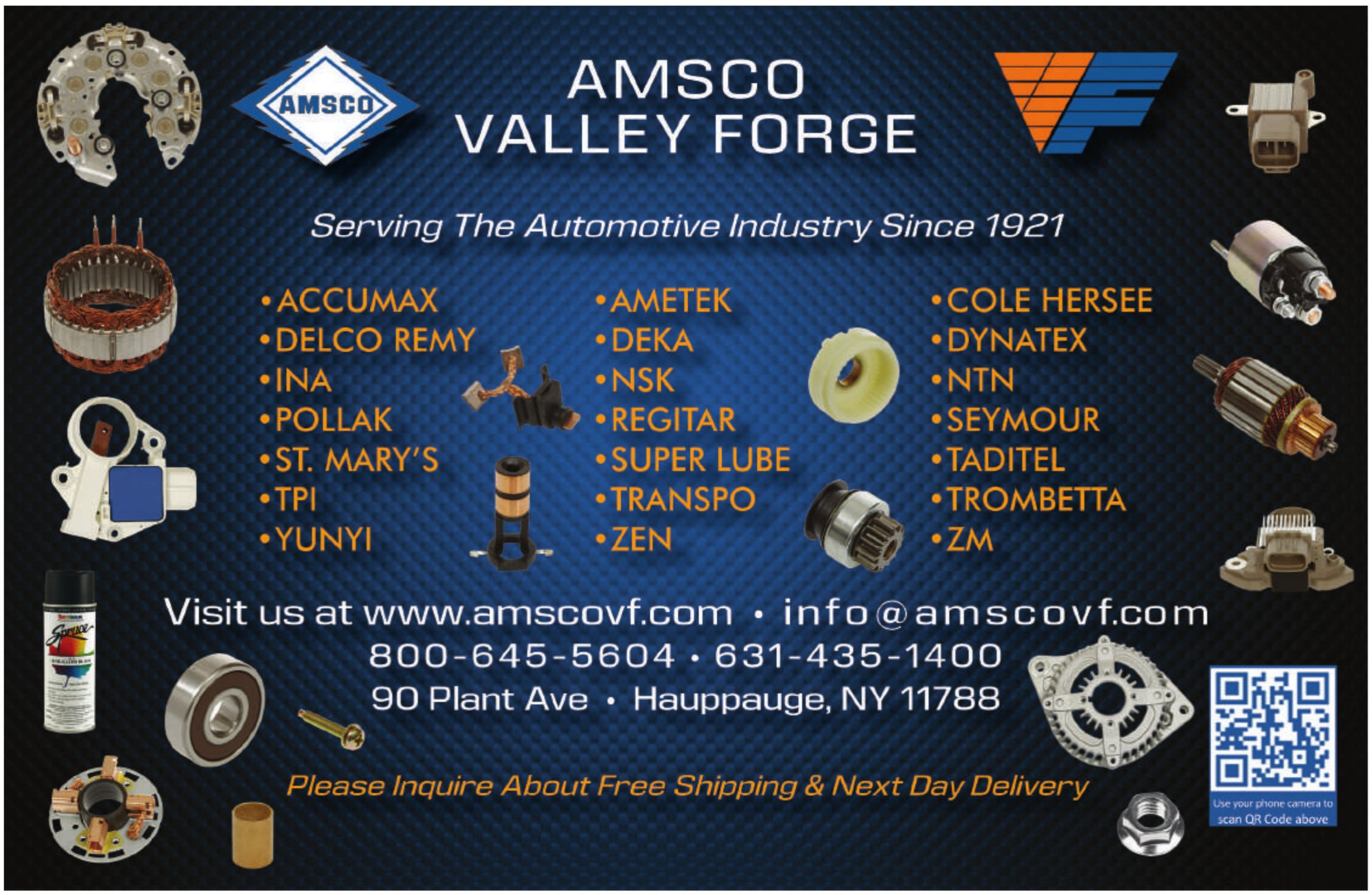
Then you have to make sure there are no mismatched parts. Using a rotor designed for low amperage stators would often give trouble if you put a higher amperage stator with it.

Delta-wound stators usually cause more of these issues than wye-wound. You also need to look at how many turns are in each coil. But a really big issue is the air gap between the rotor and the stator.

Unfortunately, as the gap **distance** increases, the magnetic loss increases as the ***square of the distance.*** So it's a lot worse than even a simple proportion, and just a few thousandths more gap makes the turn-on rpm significantly higher. For more info, see "Excessive Air Gap and Its Adverse Effect" in the ERA technical docs section.

Another issue is using parts that are not made from the best kind of electrical steel. Some do not have the correct magnetic properties. Interestingly, the rotor steel is different, I believe, than the stator steel. I think this is because the stator makes use of AC magnetism and needs to have less reluctance (magnetic resistance), whereas the rotor only makes use of DC magnetism, which does not go through magnetic reversals. See Bob Thomas' article "Magnetic Permeability" in the ERA technical docs section.

Since steel has residual magnetism, then as soon as the alternator is turning, the residual magnetism in



the rotor acts on the stator coils and produces a small AC voltage.

This voltage is related to the rpm of the rotor. The faster the rotor is spinning, the higher that voltage becomes. (Faraday's law) By the time the rpm gets to where this voltage reaches up to about 0.5 volts ac, most regulators should have already turned on. The regulator senses this small AC voltage through a stator-to-rectifier 'P' connection. Note: do NOT connect the regulator's stator connection to the wye neutral or 'N' of the stator, most are not designed for that. These types of regulators are isolated from the battery via the positive diodes of the rectifier, but some are vulnerable if there is leakage through the positive diodes – so make sure you check all the rectifier diodes for leakage.

Sometimes during rebuilding, the rotors and stators get sanded aggressively to clean off rust and/or excess varnish. This can increase the air gap unnecessarily.

Some regulators have a connection to an isolated set of diodes called the diode trio. The trio diodes have their own connections to the stator, and so are isolated from the main rectifier. At the trio (D+) terminal, the regulator is then activated from the ignition switch usually through an indicator light. This system is not used much on late model units.

It is a point of interest to connect a DVOM set to AC volts and measure the AC voltage to see how high it gets before the regulator turns on. Connect your meter from ground to a stator/rectifier connection.

To give even lower rpm cut-in, some regulators sense the voltage from two of the phases. This gives the advantage of being able to sense not only AC voltage, but (as I understand it) also the 120 degree phase shift. This also prevents a regulator from turning on if the diodes are allowing some leakage, but the alternator is not producing.

Solutions

In the interests of maximizing your salvage, you may decide to use stators and rotors that would normally give high rpm cut-in problems. Let's say the alternator is just going on an old tractor where the performance curve is not critical, so you **only** have to deal with the cut-in issue. If you have a troublesome alternator that you have to really rev up to get it to charge, sometimes you can fix the problem by putting a resistor from the diode trio to the B+. Regardless to how you do it, you have to make sure that you measure the overall alternator leakage afterwards to make sure you are not activating the regulator when the alternator is not turning. This should be checked immediately before revving the alternator while it's all hooked up, and also again immediately when you have stopped the alternator, to make sure the regulator actually turns off again. If the regulator does not turn off, you may see as much as the rotor current amount as leakage. So if your rotor current is 4 amps, then the leakage of the now stopped alternator will be around 4 amps discharge,



SOLVING THE HIGH-RPM CUT-IN PROBLEMS

if the regulator has not turned off. **(I wrote about this in the June 2022 issue).** This much discharge will leave you with a dead battery, if left like that overnight. I have read somewhere that 0.05-0.08 amps is tolerable, but even that could be a problem if the machine has to sit a long time in between uses.

The resistor should not allow more than 0.08 amps leakage, so 150 ohms for a 12v system, and 300 ohms for a 24v system. Use a 2-watt rated resistor. But some customers will complain because they notice a slight spark as they connect the battery cable (if they are working after dark). I personally have not always found this method to make enough difference, and sometimes it's not even that reliable in the long term, so then we want to look at better ways.

Here's something that really works if you have a high rpm cut in problem with a stator activated regulator! Pick a phase that is different from where the regulator's phase connection is attached and put a 2.2 microfarad capacitor (172-24000) from there to ground. (This is a technique I read about in Jimco's material). This artificially jacks the AC voltage. (*See Figure 1*)

A customer who had a 1968 'Cuda with a custom Chrysler square-back alternator wanted me to replace the faulty self-exciting regulator. (*See Figure 2*) I used a 230-12077 regulator which cut in at about 0.015VAC at 667 rpm. (*See Figure 3*) I had the stator wire hooked up to P1 as you can see in Figure 2. Which is just fine, but then I tried it with the 172-24000 capacitor…

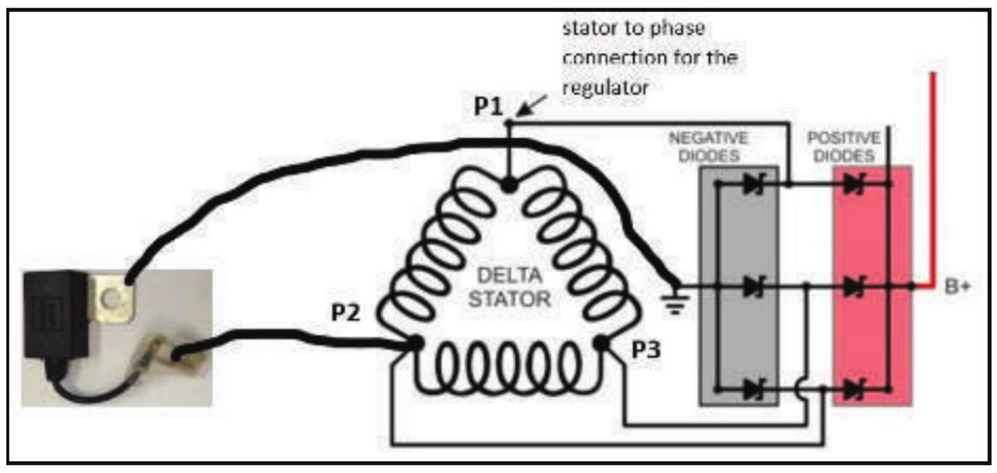


Figure 1

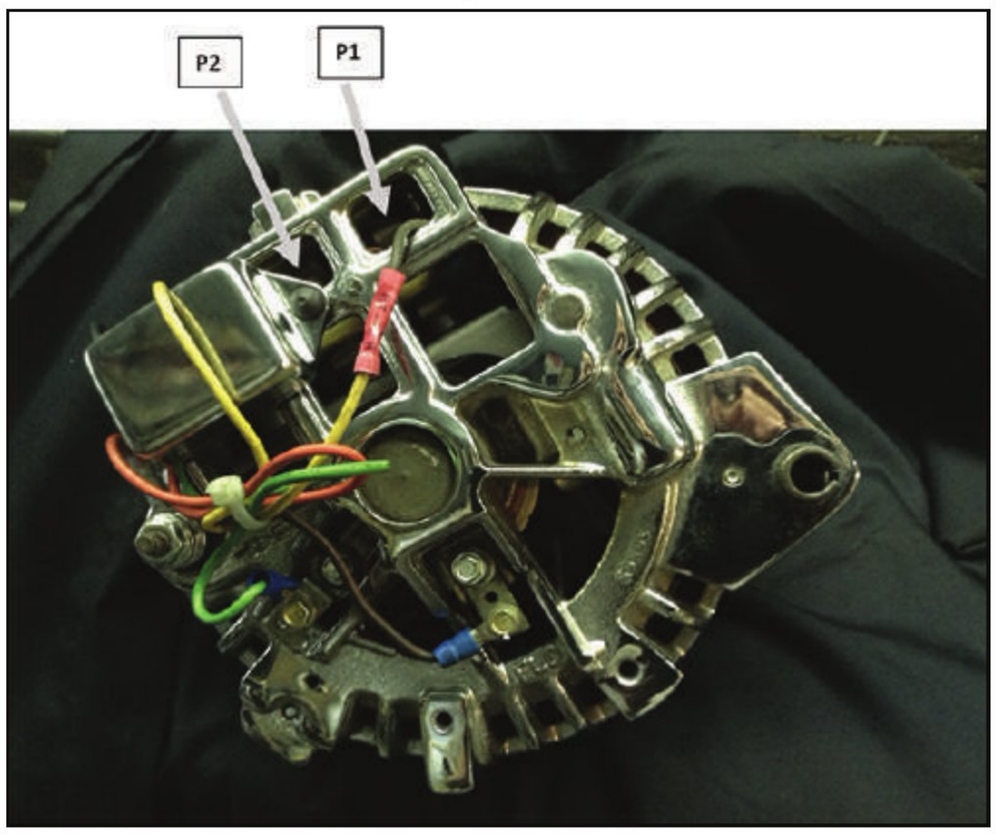


Figure 2

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Figure 3



Figure 4

With the capacitor from a different phase terminal (P2) to ground, it increased the AC voltage to 0.035VAC and lowered the turn on to 299 rpm! (*See Figure 1 and Figure 4*)

This capacitor method will not work with trio activated regulators, but if you are having problems with high turn on rpm in some cases, you can swap out a stator activated regulator for a trio activated kind. Just clip out all the trio diodes on the rectifier lead-frame, then run a jumper from a phase terminal to what used to be the trio output. This will make the formerly D+ terminal into a P1 terminal. For a list of some of these regulator swaps, see the ERA technical documents page and look up "Trio-Activated vs. Stator-Activated Voltage Regulators."

Low Cut-in Modules

Note: (These are not regulators, only low-rpm cut-in aids)

These hang off a through-bolt:

- Transpo D7022QS12 for 12v
- Transpo D7022QS24 for 24v.

In an emergency, you can also 'MacGyver' a 22si auto-start (for use with A circuit) by clipping the trio off and drilling some holes to solder wires on. (*See Figure 5*)

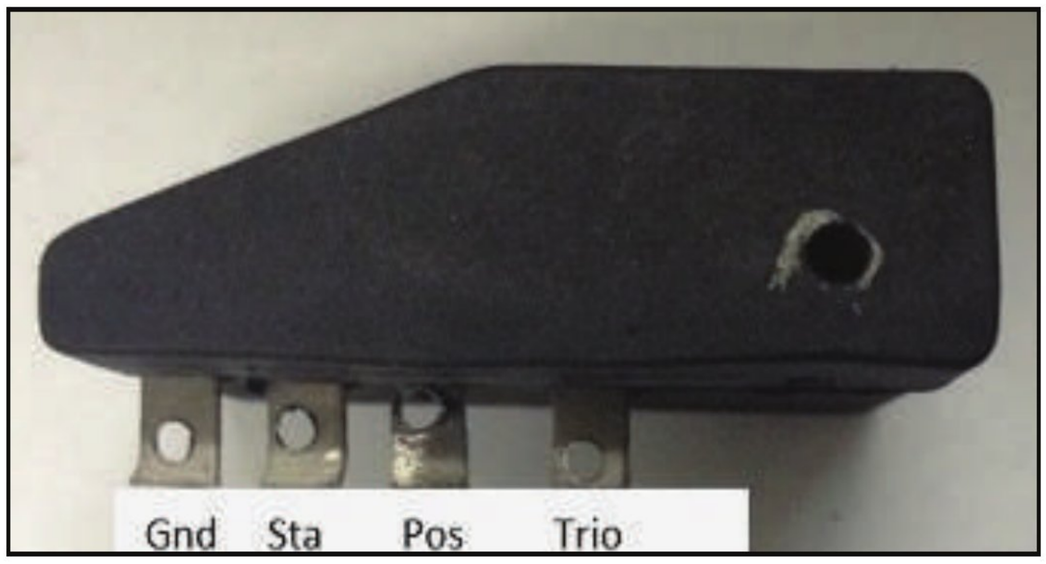


Figure 5



Just glue the rubber block in place somewhere inside or outside the alternator.

Self-Exciting Regulators

Look to see if there is a self-excited regulator version that replaces yours. Then it's a simple bolt-in procedure, no extra wiring. Here are some examples of direct bolt on types:

D33QS - Here's the answer for 27si and 27si-200's (and others): Transpo version - used with diode trio and gives super low rpm cut-in.

Motorola 8rg2043s - This one is dual-stator activated, but make sure you are really connected to different phases considering the way those leads come out of the stator!

Leece Neville L99920 - This replaces the early L79000 which needed a trio, and which always used to give me problems. This replacement cuts in well under engine idle. On the flip side, it does not provide an indicator light function.

D411se or D694sel - use in CS130 alternators

D702se or D702sel - Fits CS130D

D10se12 or D689 - Fits 10SI with trio

D10ac or VR-D713 - Use in 10SI but eliminates diode trio and uses stator sense. This Bcct, AC turn on regulator can be used on the 10si, 12si, 15si, 17si, and 27si instead of whatever was in it. They usually give you wiring instructions with the regulator, otherwise look it up on WAI.

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230-12217 or D235sel - fits AD230, AD237, AD244 F794se or GR786se Fits Ford 3G

In6324se or VRH2005-101sem - Fits Denso hairpin

M5-151SA12 - Fits old small Motorola – also eliminates isolation diode plate because it has voltage adjustment.

In220se or VRH2005-4se - Fits Denso "pineapple" style.

IB357SE12 - Fits older Bosch

For some types where the brush holder is part of the original regulator, if you hang on a self-excited regulator like 230-12077 (B circuit) or 230-12073 (A circuit) then just disconnect the original regulator at the brush holder.

Refer to my article in the ERE October 2021 for more ideas. On some of these, you have to make sure you connect them to a "P" connection of the stator to the rectifier, and not the wye neutral connection, even if the wye is connected to its own pair of diodes. (e.g. 8 diode rectifier)

If a customer brings an alternator that will not self-excite, but begins working normally after flashing the R terminal, it is highly likely that the machine has been sitting a long time and the batteries are at least discharged if not totally bad – information the customer needs to know.

So to recap, you can improve high-rpm cut-in by using a resistor, a capacitor, or a module. Alternately, you can change to a stator activated regulator, or else by changing to a dual-stator activated regulator, depending on what's available.

There is some amazingly useful information on the ERA website. You may have to try a few different search terms before these will show up, or else just scroll down through the alternator section of the ERA Technical docs section.

- New Look At Diode Leakage
- Excessive Air Gap And It's Adverse Effect
- Beware of Stator Activated Regulators
- Phase Activated Regulators
- Testing the Auto Start Trio
- Trio-Activated vs. Stator-Activated Voltage Regulators
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Many thanks to Bob Thomas, Larry Hagemeister, and Mohammad Samii for their assistance on this article.

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Have you had an experience or learned something new that you'd like to share with other members? Call or text Bob Thomas at: 904-673-7301 or drop him an email.ere.bobt@gmail.com.

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