ERA EXCHANGE

YOUR GUIDE TO ELECTRICAL REBUILDING

April 2022 $12.95

AUTO ELECTRIC CORNER

Clutch Pulley, Semi-Solid Link Solenoid, Bosch 24V Alternator, Another Aero Unit

WHEN A MOTOR IS ACTUALLY A GENERATOR

SPECIAL EVENT PLANNED!

ERA Technical Conference

A WORD FROM THE PRESIDENT
New Technical Training Event



The ERA recently received correspondence from the city of Seattle regarding the lifting of Covid related restrictions pertaining to group gatherings. The Executive Board then had a brief and candid telephone conversation about the possibility of rescheduling the 2022 ERA Trade Show Expo in the fall. But majority opinion was that the fall harvest season would not be a good time for members to be away from their shops.

At the February Board of Directors meeting, I relayed our discussion to the complete board and suggested that we postpone the ERA Trade Show Expo to the spring of 2023 which included the caveat that the event be held at the same venue in Seattle with Romaine Electric as the official event host. I informed the board that I had spoken with Nick Staub of Romaine Electric. He understood our concerns and was in complete agreement with that decision. A vote was taken and it was unanimously approved.

I, along with some other board members, felt that we should at least try to provide our members with some kind of technical training event. So, on Feb 28th a Trade Show Committee meeting was held to begin planning such an event. It was agreed that the location should be centrally located to allow for many of our members to drive to the event.

I will tell you that our Trade Show Committee is one heck of a dedicated group of people. Within a week they had picked a location, a date, and a list of seminar presenters for a one-day Technical Training Conference. I again called a special meeting of the Board of Directors on March 9th to present the information and planning submitted by the Trade Show Committee. After discussion of the proposed event the Board of Directors approved it unanimously. Our very first ERA Technical Training Conference will be held on August 12th and 13th in Carmel, Indiana.

Information and registration procedures regarding this Technical Training Conference is included in this issue. Please do not hesitate to make your decision on attending this event as it may have limited registration space. I want to thank all board and committee members for their time and effort in putting this event together on such a short notice.

On other ERA business, it is that time of year for our annual election of officers and board members. Our Nominating Committee is hard at work assembling a slate of candidates for the annual election, which most likely will be held at our June Board of Directors conference call meeting. The Nominating Committee welcomes anyone from the membership who would like to become more involved. We need people who can bring new ideas and solutions to our monthly meetings. If you have any interest or questions, please feel free to contact me, nominating chairperson Larry Hagemeister, or any other Board of Directors member that you may know. Contact information for all board members is listed on our website's Association - Contact Page found near the top of the left side menu.

Ken Plourde

NEW ERA MEMBERS

Smith Alternator Service
Hope, Arkansas

ABOUT THE COVER

11026 alternator on Ford Crown Vic

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AUGUST 12-13TH, 2022
INDIANAPOLIS, INDIANA

ERA TECHNICAL CONFERENCE

Due to extended COVID-19 restrictions, the ERA has cancelled the 2022 trade show and will conduct a first-ever ERA Technical Conference.

This event will start on Friday evening and run all day on Saturday. Friday evening will kick off with a Supplier Showcase meet-and-greet, your chance as a rebuilder to meet one-on-one and speak with our industry's suppliers. Saturday will be jampacked with technical seminars, starting at 8am and continuing throughout the day, culminating with an ever-popular roundtable discussion.

Stay tuned for more information!!

The industry's suppliers have graciously offered to cover the $100 per person registration and luncheon expense fee for the first 50 rebuilder members to register!

DON'T DELAY; CALL THE ERA OFFICE NOW TO REGISTER!!
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TENTATIVE SCHEDULE

Friday:
6:00-9:00pm - Supplier Showcase
Saturday:
8:00-12:00pm - Seminars (TBA)
12:00-1:00pm - Buffet Luncheon
1:00-3:00pm - Seminars (TBA)
3:00-5:00pm - Roundtable Discussion
5:00 - Adjourn

AUTO ELECTRIC CORNER — Clutch Pulley, Semi-Solid Link Solenoid, Bosch 24V Alternator, Another Aero Unit



BY MOHAMMAD SAMII

Clutch Pulley

This 2009 Ford Grand Victoria that belonged to a small nearby community's police department was towed in due to a completely run-down battery. The given information described the battery being new, and the charging system had checked out to be working fine. This typical police car was equipped with all the necessary attachments that are commonly seen on police cruisers. (*Figure-1*)

The Chief of Police, who exclusively drives this car, explained to me that on a call while attending to a case with the usual loads on, the headlights and the strobe lights got dim, the radios dropped off, the computer shut down, and the car died. Obviously, this caused a delay in writing a citation for the violator who was pulled over!

The 11026 alternator common to police Crown Vic's is a robust alternator with excellent output and functions well in police car applications. This is one of the earliest alternators equipped with an overrunning clutch pulley built by INA. (*Figure-2*)

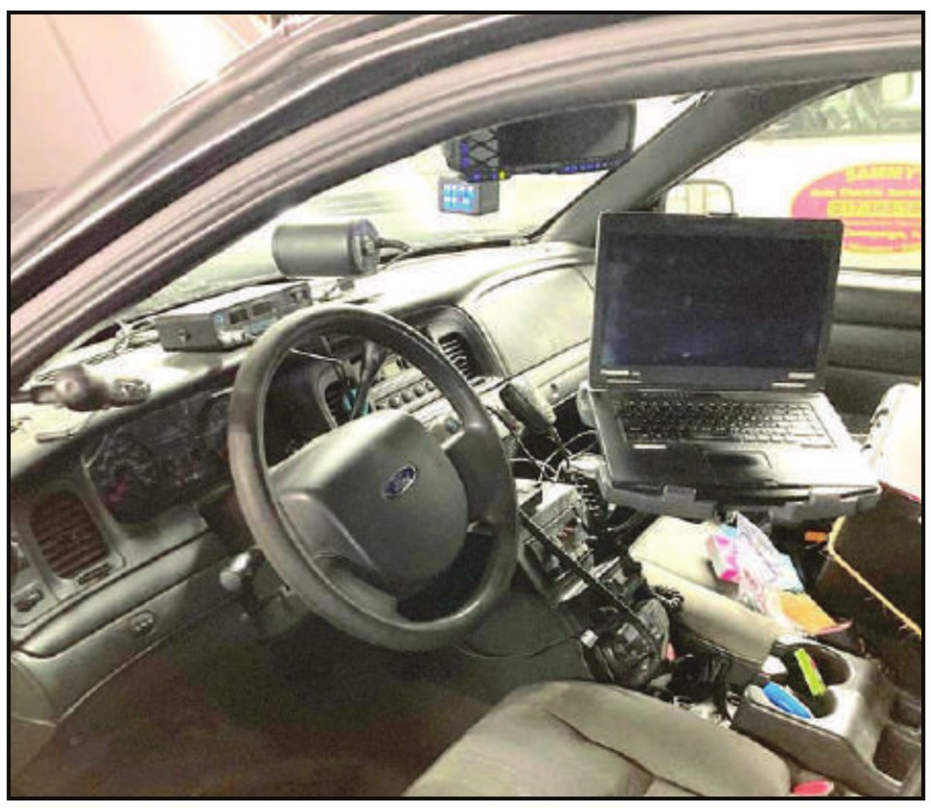


Figure 1 – Equipment inside the police car



Figure 2 – 11026 alternator on Ford Crown Vic



After a deep-cycle charge of the battery, we ran the car noticing initially that the alternator had plenty of output and was working fine. After raising the load to a certain level and maintaining it for a while, I noticed that the amps were dropping off and the battery voltage was going down. Taking a closer look at the alternator, it became partly obvious that the rotor was not spinning as fast as the pulley. Obviously, the clutch pulley's internal mechanism was worn out to a point that it was slipping while going in the forward direction, where it should not have.

Police cars are one of the best examples for the use of clutch pulleys. In a rapid acceleration, even a solid pulley will function fine. But where its use becomes important is in rapid or sudden deceleration. The massive rotor gains so much momentum that it wants to keep going, while the belt is now trying to pull back the pulley. This adds additional pressure on the belt, causes slippage, and forces the belt tensioner (*Figure-3*) to go from one extreme to the other.

This car was fixed by replacing the alternator and installing a new belt and belt tensioner which fixed the problem and the car was returned to service. I believe there is a Litens IDP (920004) for this application that replaces the overrunning–only clutch pulley.

The interesting thing was at no time the "BAT" light came on when the alternator had stopped charging, I suppose since electronically the regulator was fine. The PCM failed to recognize the malfunction immediately, or needed more time to analyze the falling voltage to turn the light "ON."

Bosch Alternator

This 24V Bosch alternator was sent in for rebuilding. This customer is a large crane rental/service company who subcontracts to various construction projects locally and regionally and owns a large number of cranes of various sizes and models.

Since there is literally not much official information or data available these days on such Bosch units, I try to extract some information when I run into such parts, and pass it along for the ones who may be looking for info on such or similar units one day.



Figure 3 – Belt tensioner for 4.6L engine



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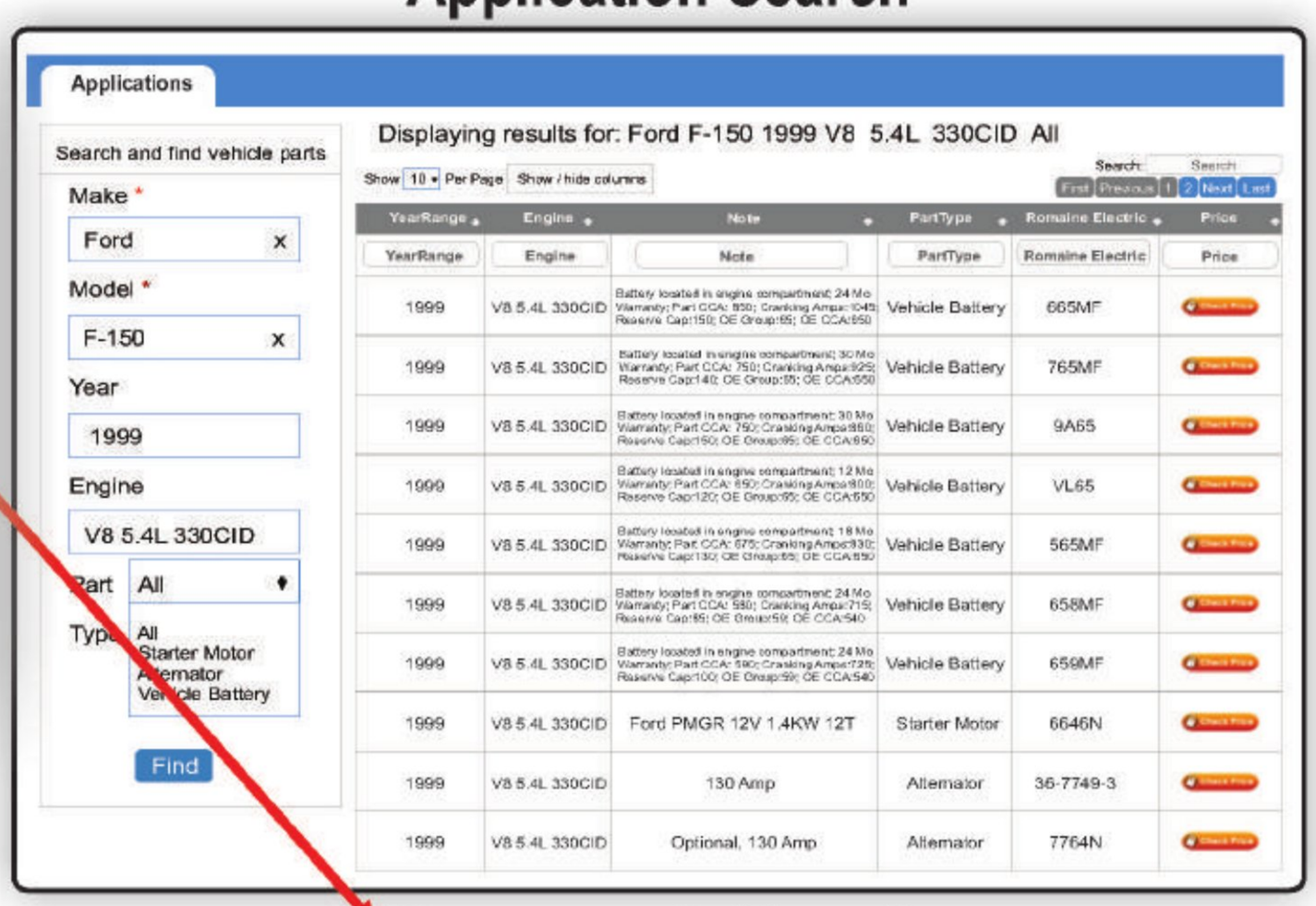
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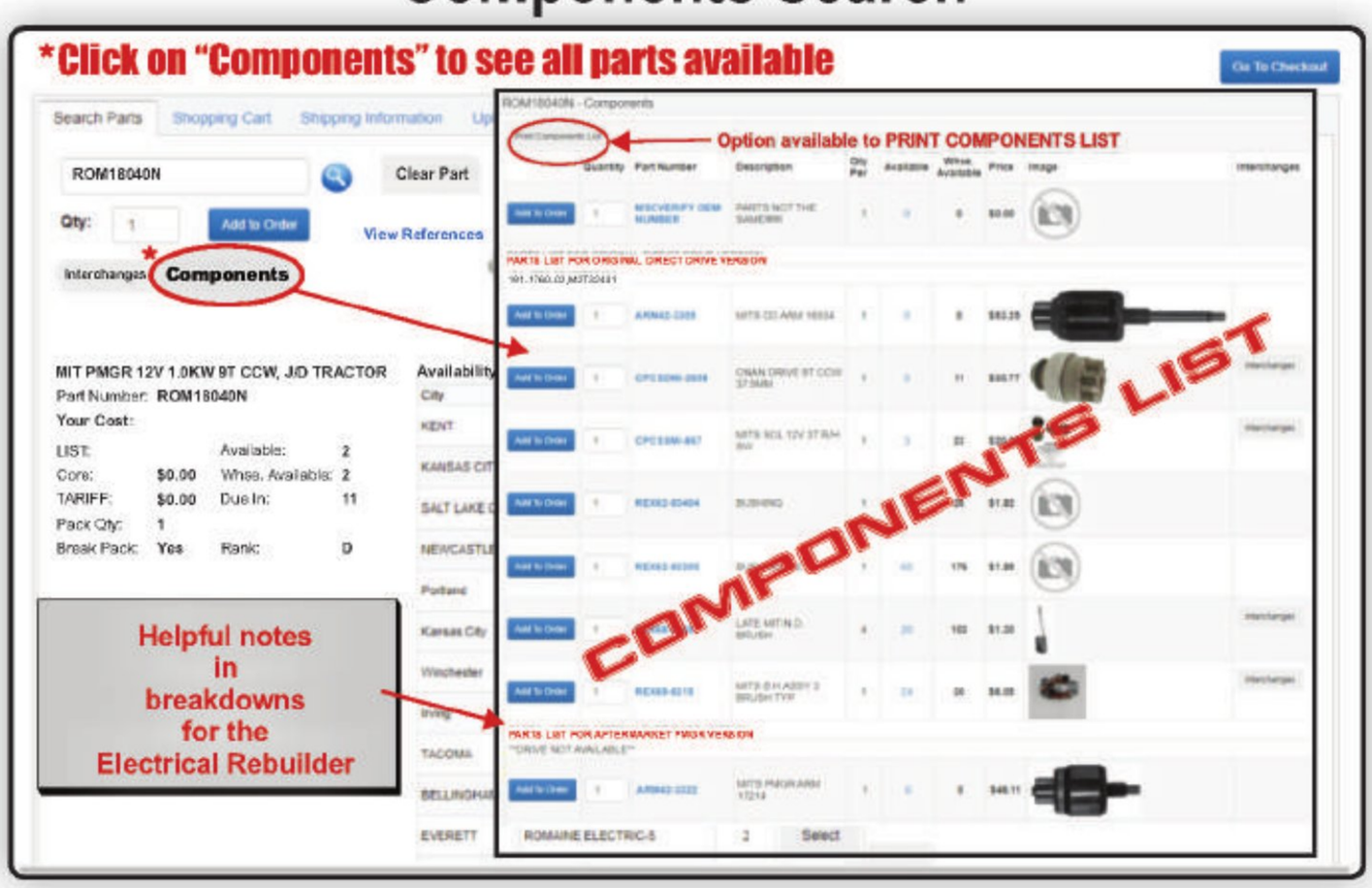
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This alternator (*Figure-4*) is a Bosch 24V 100–Amps unit that is used on a Grove 275 crane (275 Ton capability) and probably used on many other Industrial/Construction equipment applications. Crossing the numbers shown in the picture did not result in any specific crossover but a search indicated it could be something close to a Bosch 0-123-525-501 alternator, but not quite exactly.

The teardown was routine and required de-soldering the stator leads from the rectifier as it is common on such units. The stator is wound with each phase separate (6-leads), each phase drawing 50 amps@12V, as per our SR200 Jimco tester (*Figure-5*). It could be wired in either "Delta" or "Y" configuration depending on the rectifier's lead-frame arrangement. In our case it was wound in a "Y" which I determined after all of the leads were soldered and assembled. Here is more information about this alternator:

• The 6-diode rectifier is equipped with avalanche diodes with an avalanche voltage rating of 37.5 volts, as measured by my equipment.

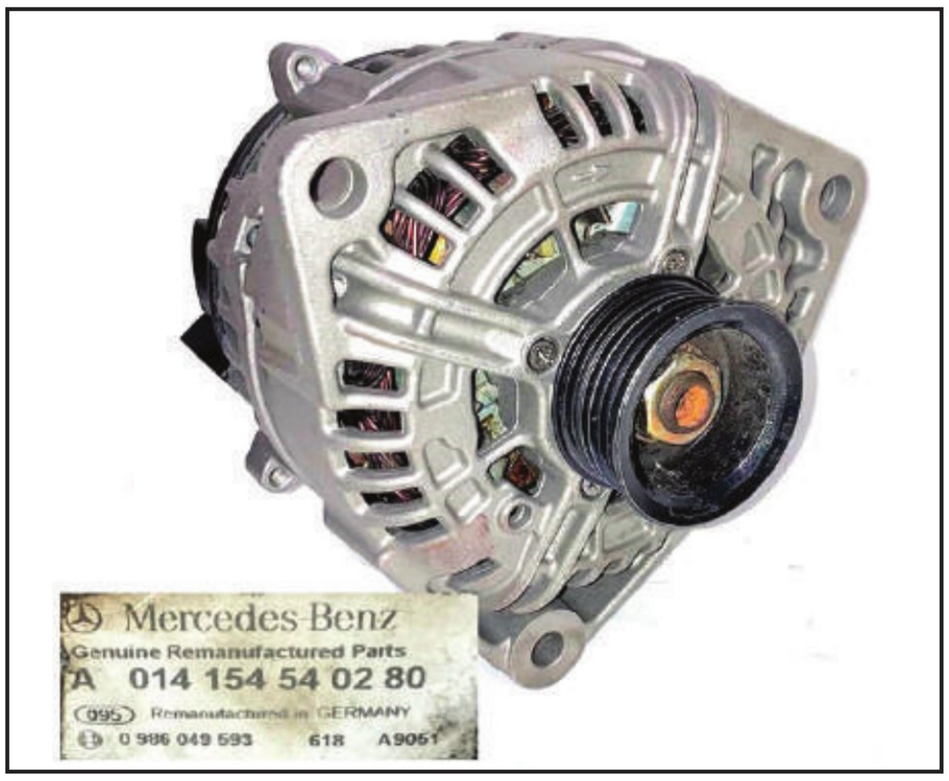


Figure 4 – Bosch 24V alternator

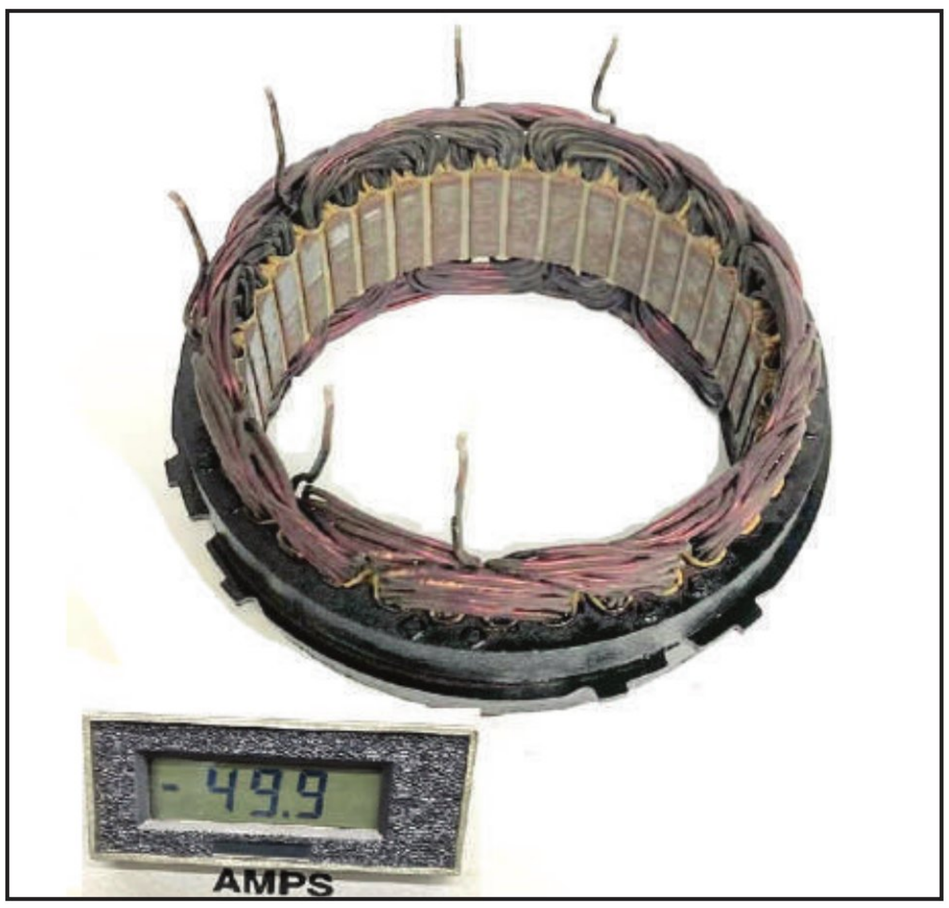


Figure 5 – Bosch stator phase amps

• The regulator is a Bosch F00M144123, a B-circuit regulator. Therefore, the alternator lacks a diode trio. The 5-pin regulator plug code is **#923** as shown in the picture (*Figure-6*). The "L", "IG" and "S" are the pins necessary for running the alternator on a test bench.

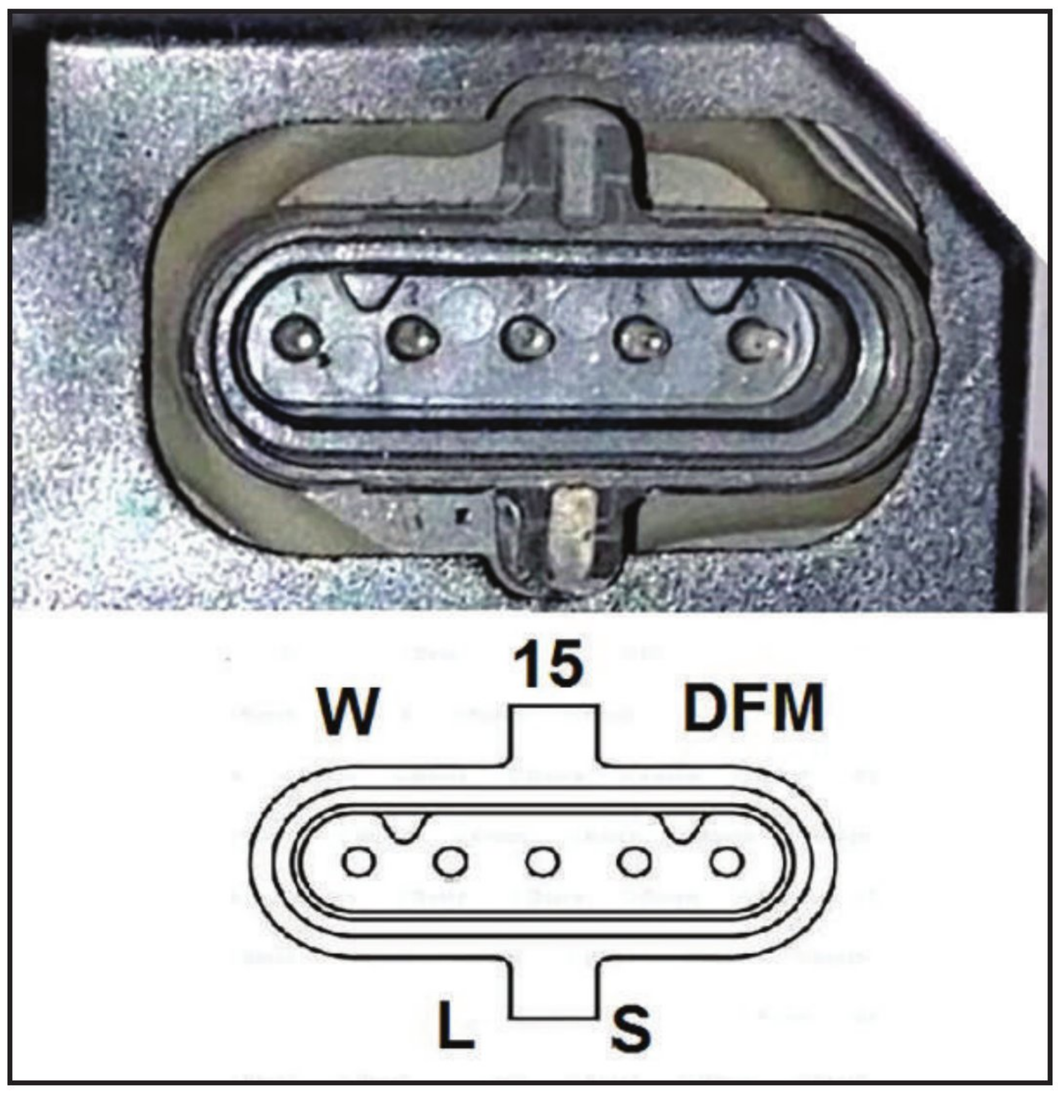


Figure 6 – Plug Code # 923 (5-pins)

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• The rotor uses a common and available slip-ring such as Wagner's W160-02 with some minor modifications. The minimum diameter for a reasonable service life should not be lower than 0.570.

• Bearings are typical sealed ball bearings. DE bearing measures 17mm-52mm-17mm and the SRE 17mm-35mm-10mm (6003-2RS) for ID, OD and width respectively. The bearings are common and available via our suppliers.

Since this alternator is not readily available and is expensive, rebuilding it can be highly profitable if billed according to its value.

Semi-Solid Link or Not…?!

There has been some debate over the advantages of using semi-solid link Delco solenoids on 37, 41 and 42-MT starters over the normal solenoids that have been used for many years.

Some claim use of the Semi-Solid Link solenoids eliminates the chance of sticking contacts and the built-in spring pressure helps in pulling the disc away from the contact studs, thus less chance of sticking. My experience in our business has been completely opposite of this theory and belief. (*Figure-7*)

When the Semi-Solid Link equipped starters started coming in for rebuilding, we were hopeful that we would get better service off this type of solenoid. But what we noticed was quite the opposite. Nearly every such starter had a failed Semi-Solid Link solenoid. After thinking about it long and hard, we realized we would be better to stick with high quality standard solenoids, preferably better brands that are USA-made, such as those made by Just Parts, and leave the idea of Semi-Solid Link solenoids behind.

I understand there are varying opinions about this and some believe that the Semi-Solid Link solenoid is just the answer. I respect that and believe everyone needs to stick to something that works best for him or her. Whatever provides the best results for you. But the use of Semi-Solid Link solenoids has not accomplished this for my business.

I also agree that solenoid failures are highly dependent on batteries, cables, connections and most of all, the

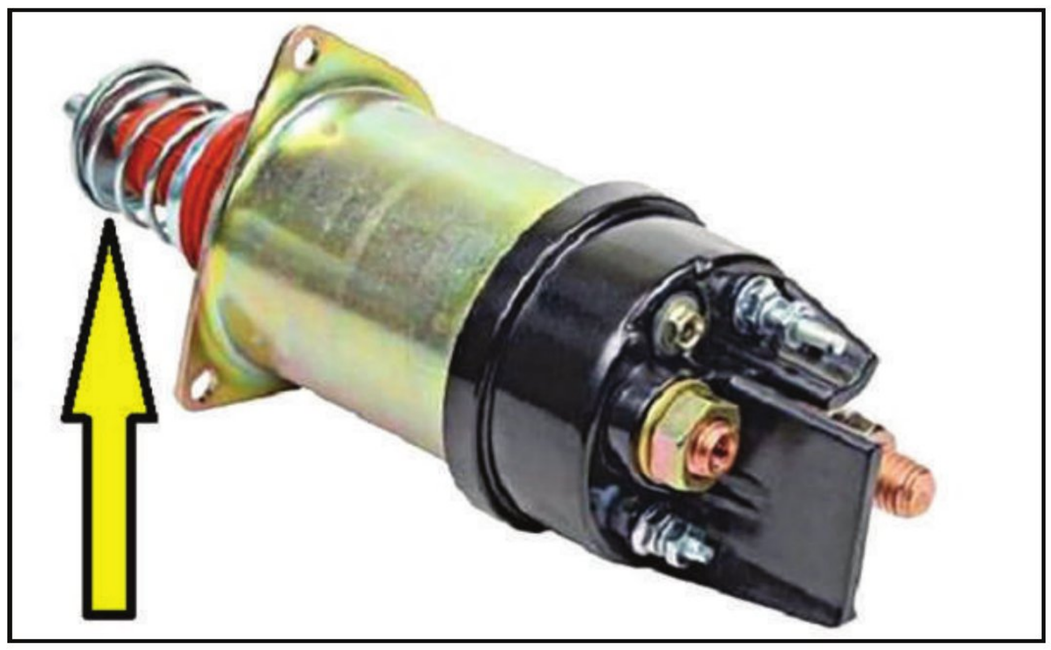


Figure 7 – Solid-Link Delco solenoid with attached plunger



operators. But given nearly all of my 37-41-42-MT starter customers are local construction, excavating, and cement companies as well as the implement dealers, we have not been able to confirm the superiority of the Semi-Solid Link over a high-quality standard solenoid.

Case in point: While rebuilding this 37-MT 10478957 (6465) starter that goes on a John Deere 644D loader, the teardown showed no major component failure inside the unit. The armature, field coil, brushes and brush–holder as well as the drive did not show any signs that could stop this starter from cranking. Once the cap of this 1115695 solenoid (OE Delco) was removed, the problem was obvious. The contact disc's insulator was gone, and the burned disc was barely hanging on to the stem. (*Figure-8*)

The starter was serviced, assembled and a new 1115609 solenoid with appropriate plunger was installed and adjusted to complete the job.

This is not an isolated case. We have seen so many Semi-Solid Link solenoid failures within last few years that we do not use them on 37- 41, and 42-MT starters. I am also aware that some rebuilders have quite the opposite opinion, but for now we are hanging on to something that I believe is working best for us.

More Aero…!

Another Aero alternator that came in for testing was this nearly new alternator that went on a Piper Saratoga, which is a high-performance single-engine 6-seat airplane, equipped with a 300 HP Lycoming injected IO-540 engine.

The new alternator came in from a newly installed engine with only a few hours on the Hobbs (*Figure-9*). This airplane uses an electrically operated hydraulic pump to raise or lower the landing gear. The complaint was during approach and landing, when the gear selector is turned to down position, the voltage gets low and the low-voltage light comes on.

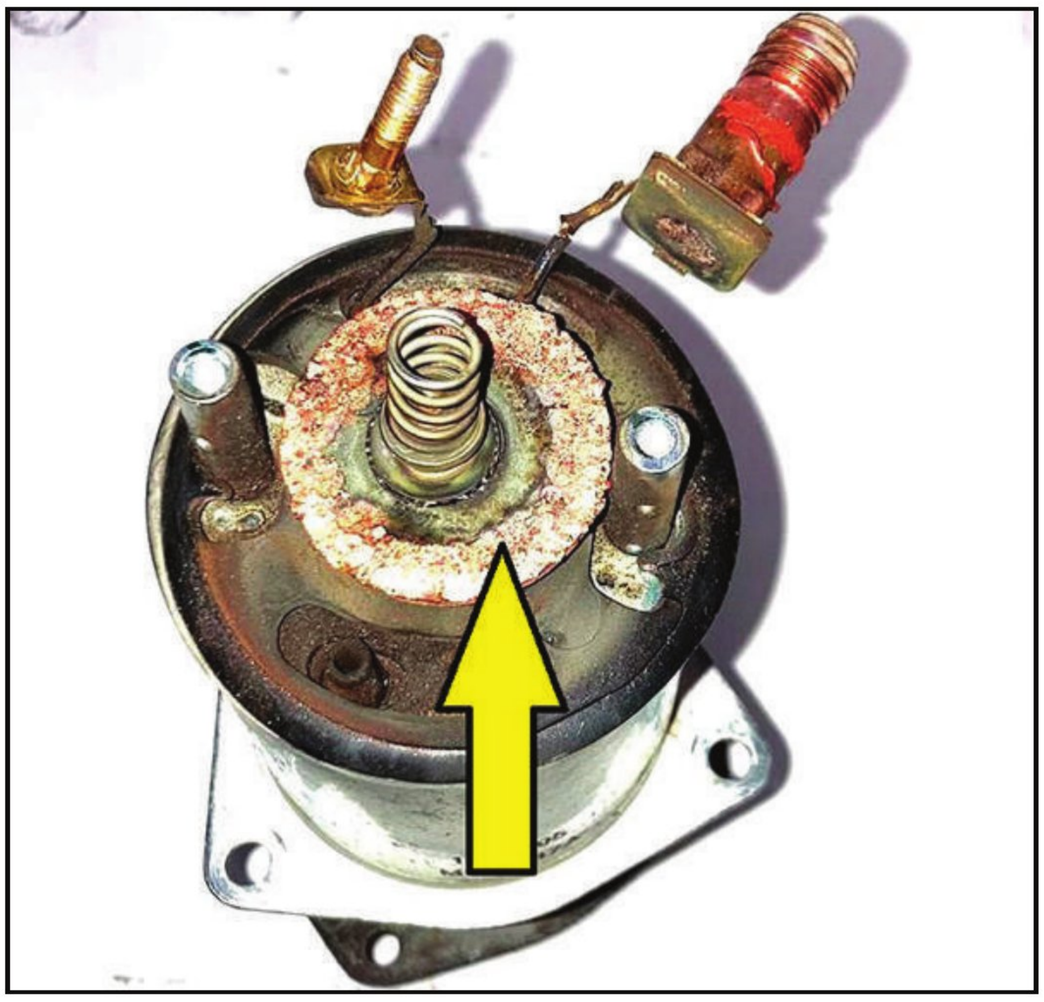


Figure 8 – Burned solenoid disc

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As you see in Figure 9, the alternator is based on a Ford 1G large frame alternator that was originally designed strictly for automotive. This one was modified, PMA certified in a 24V (28V in AV lingo) version with 90 amps rated output. The alternator had a very high cut-in speed. It basically did not charge much at speeds lower than 3000 RPM.

Aero alternators of this size and category have a very shallow power curve. Given their most common operating range is in near hi-speed such as the engine's cruise or climb speed. They do not have any problem handling loads while cruising. But when the landing gear is being lowered, there is a hi-demand for the power to run the electric–hydraulic pump, and that's where any shortcoming becomes evident—high electrical demand when the engine is throttled back to prepare for a landing. Additionally, we noticed signs of belt slipping, evident by discolored and an overheated pulley.

Our customer informed us that the single V-belt driving this alternator has contact for less than 180 degrees going around the pulley. Now you can imagine driving a 90-Amp 24V alternator (equivalent to 180 amps in 12V) with a single V-belt belt that does not have enough contact with the pulley.

I simply recommended to the owner to tighten and re-tighten the belt several times after installation and running the engine for a while, hopefully to get better results.

Well, that's all for this issue. Until I see you again, remain 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

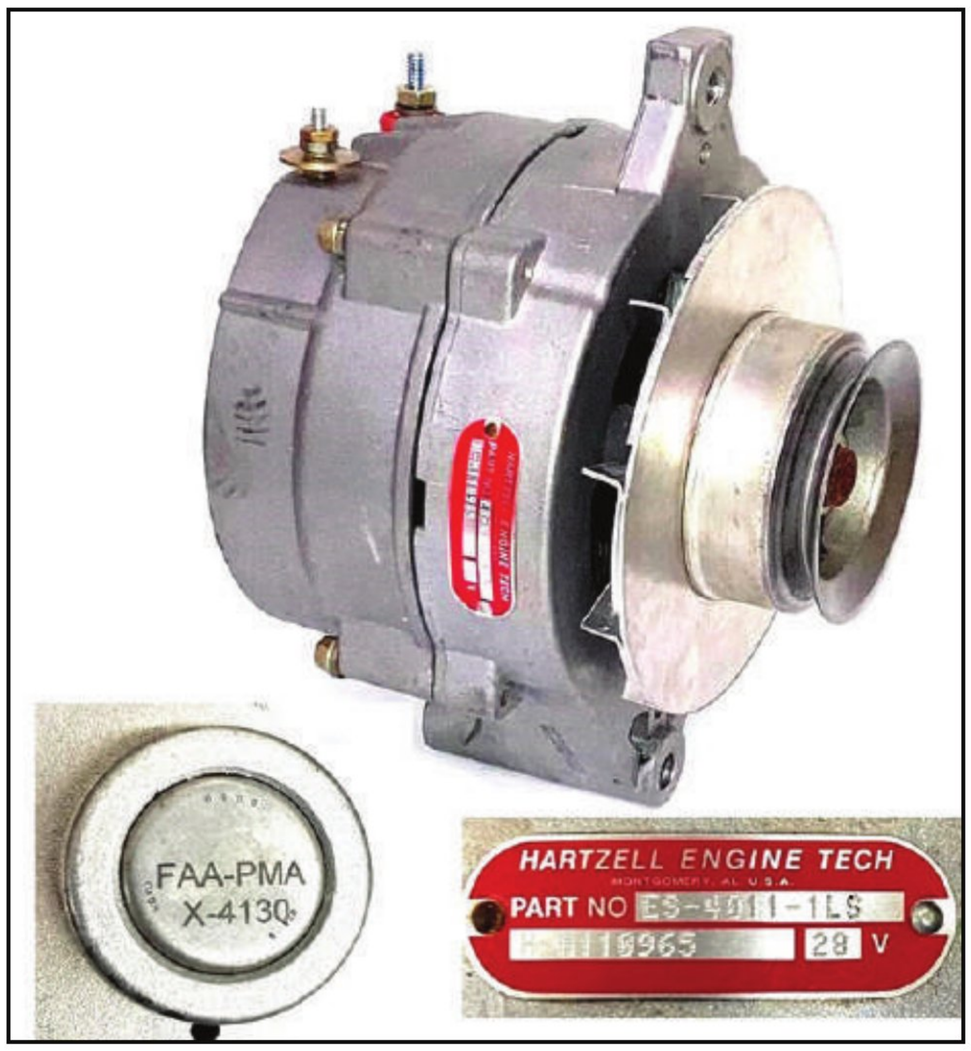


Figure 9 – Aero alternator shown with tag and rear bearing



WHEN A MOTOR IS ACTUALLY A GENERATOR



BY NATHAN UNGER

Just after Christmas my wife and I purchased an all-electric Kia Soul (*Figure 1*). We are "Soul-mates"! A bit of a learning curve at first, and although some of you have already "been there, done that" for years, I'm going to share some of my observations.

- We get to drive past all the high gas prices now.

- Since torque is the greatest right at start-up, when I tromp on the accelerator, it takes off like a jackrabbit. No engine revving up first, and no shifting. No torque converter to waste power either.

- Servicing the vehicle is way simpler too. No internal combustion engine (I.C.E.) maintenance; engine oil changes, air/ fuel/oil filters, ignition components, IAC, EGR, spark plugs & wires, O2/MAF/Crank/IAT/TP sensors, fumes, oil/fuel/vacuum/exhaust leaks, emissions systems, catalytic converter… (I could go on, but you get the point)

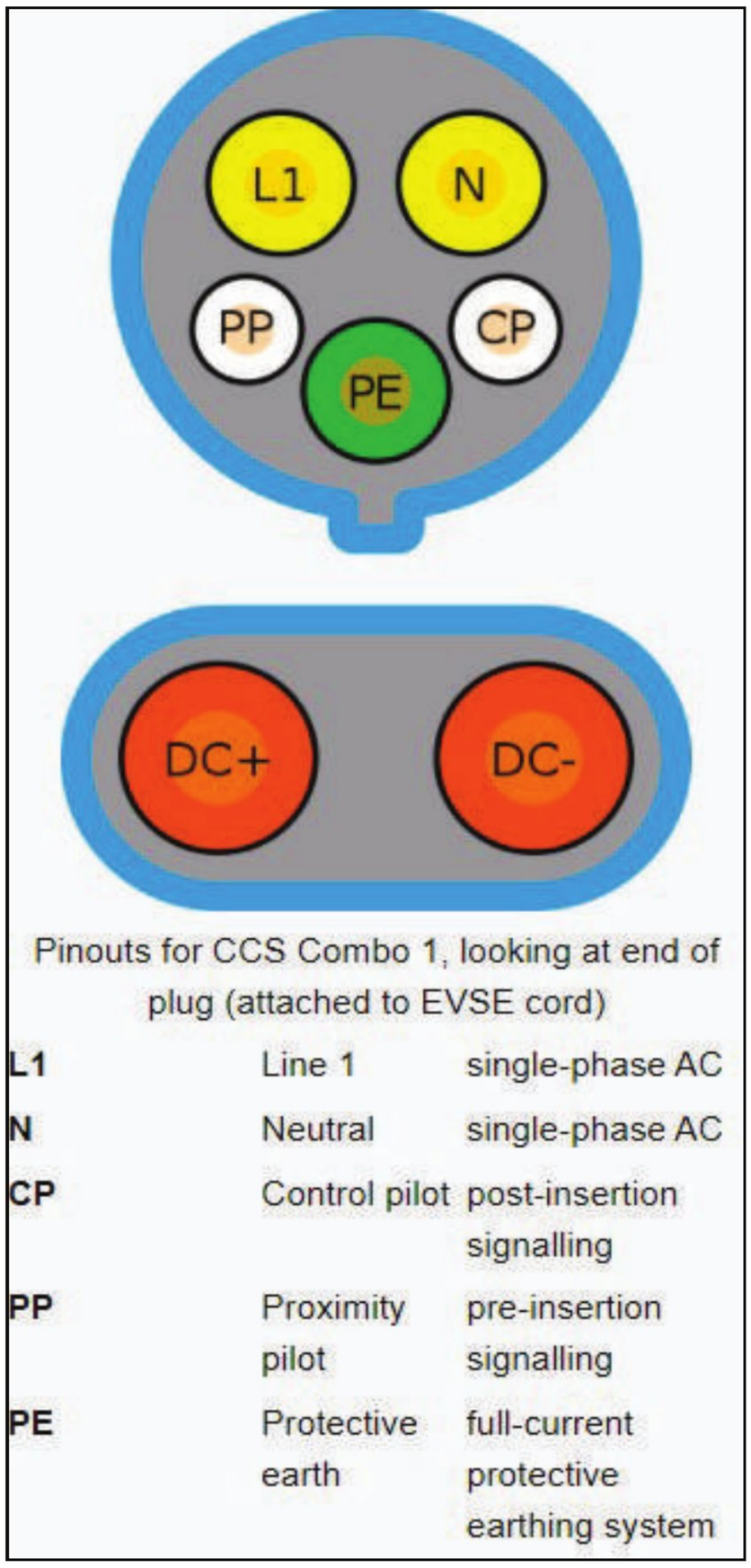
- We won't need to service the brakes as often either because the energy of slowing the vehicle gets converted into stored battery energy. Kia calls it one pedal driving. Of course, you can still step on the brakes if you need to, although the car will do that for you too, under certain circumstances.

- And it's quiet! No engine sounds or vibrations. Very restful to drive. My wife really likes that!



Figure 1 – Kia and charger

Honestly though, despite all the advantages, it's going to take awhile to see the savings. There was also the expense of getting a level 2 charger wired in at our home. As many of you already know, there are three levels: the level 1 charging cord, which puts out AC at 12 amps max and plugs into your standard 110VAC household plug. The AC gets converted into DC by the vehicle's own inboard convertor. The level 2 charger must be installed at the house by an electrician, and it puts out 30 amps max, also AC. It can charge the car in like, 1/3 of the time. These are SAE J1172. (*See Figure 2*)



Pinouts for CCS Combo 1, looking at end of plug (attached to EVSE cord)

L1	Line 1	single-phase AC
N	Neutral	single-phase AC
CP	Control pilot	post-insertion signalling
PP	Proximity pilot	pre-insertion signalling
PE	Protective earth	full-current protective earthing system

Figure 2 – SAE J1772

Then there's the level 3. But that system is so costly, you mainly see them only at businesses and public places. The level three charger puts out DC so it can charge a vehicle in as little as 1/4 hour, depending on various factors. It has its own version of the connector (CCS SAE) and does not need the car's inboard AC-DC converter.

https://blog.evbox.com/ev-charging-levels

Range anxiety turned out different for us than I originally thought it might. The car, which becomes yet another app on your iPhone (learning curve here), lets you know how your range is affected when you turn on the defrost, blowers, heated seats, or any accessory. It's like, tmi. (too much information). e.g., "Oh no, I turned on the defrost & heater, now I lost 8 miles of range!!!!!"

I did not worry about going all-electric as compared to hybrid, because our local area is well populated with

recharge stations. Besides, the car has a 110 VAC (level 1) charging cord with it. You can plug it into a normal household socket anywhere. Yes, it takes longer, but at least you're not going to be stuck.

But there is also this 'regen' thing that I as a rebuilder find fascinating.

It's also called regenerative braking. In stop and go traffic, you 'never' need to touch the brakes. The car's electronics puts the electric motor to work as generator, recharging the battery. The effort of storing energy in the battery takes energy from the car's momentum, (slowing the car). This reduces the amount of maintenance the brakes need and gives you back energy that is otherwise completely wasted as heat. Of course, the effect is really significant when you go down a long steep hill. You can also set the stiffness of the regen 'braking' action.

Here's a funny incident:

One friend told my wife that on their electric car, they went up a hill which lessened the charge in the battery and shortened the computer-predicted range a bit. Then they went down the same hill with the regen activated and claimed that the computer showed that they now had more predicted range than when they started out!!!

I pointed out that nothing is 100% efficient, so you are losing energy (let's say it's 84% efficient) converting it from battery energy to mechanical power going up the hill, and then you are losing yet more energy (again assume



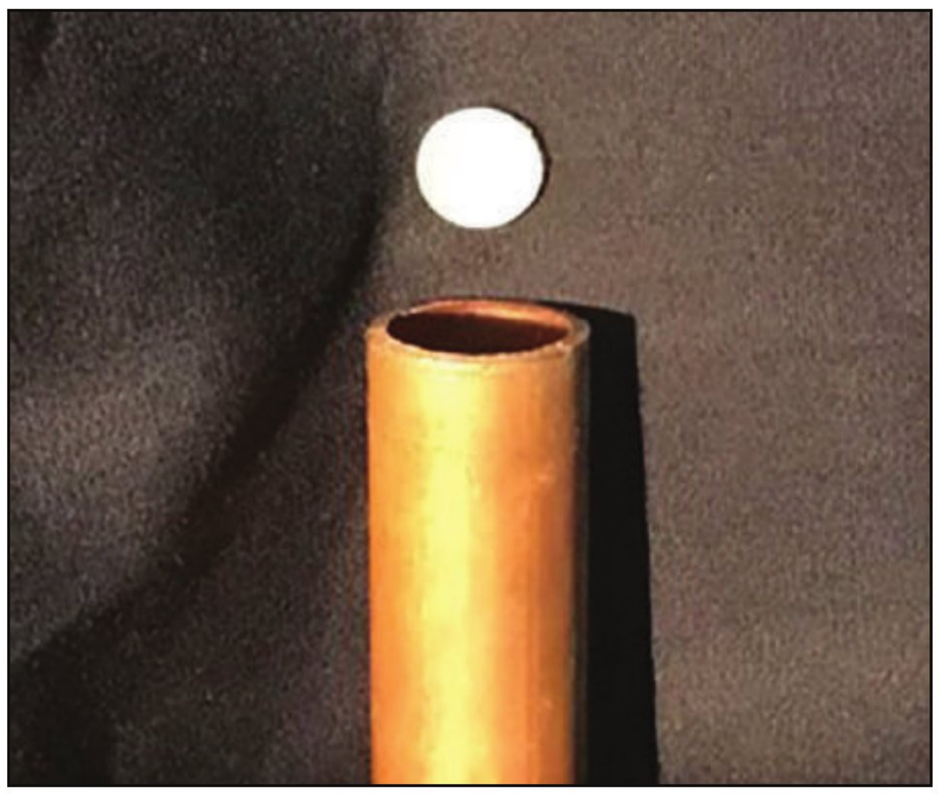


Figure 3 – Magnet and pipe

84% efficient) converting it from mechanical energy to battery energy going down the same hill. I seriously doubt anyone could end up with even 70% of the energy they had to begin with. (84% of 84% is 70%) Maybe our friend just forgot that he switched an accessory off as he was on the way down. Or maybe he accelerated on the way up. Or more likely, their exaggerated result had to do with how the computer calculated its range predictions based on average driving – which would include mostly level ground.

So how does the 'regen' mode slow down the car?

To illustrate this, I have a piece of copper pipe about seven feet long. I hold it vertically, then drop a button magnet down the pipe (*see Figure 3*) and start counting seconds. Can you believe 6 seconds before it hits the carpet? You'd almost wonder if it got stuck somewhere. Compare that to only 2 seconds when I dropped a 8-32 nut down the pipe. And copper is not magnetic.

Here's the explanation.

Copper, while not attracted to a magnet, does conduct electricity, and very well too. Dropping the magnet down the pipe creates a small "generator action"; it makes currents in the copper. This current has its own personal magnetic field.

Now here's the interesting part. This new magnetic field always fights the magnetism that created it. (Lenz's law) That's what slows the magnet as it falls.

This is how the electric motor slows the car when you put it in regen mode. The magnetic field in the rotor that you are spinning (by using the momentum of the car), is inducing an electric current & magnetic field in the stator windings (generator action). This new magnetic field resists the turning of the rotor's magnetic field.

The electric current meanwhile, is being used to recharge the battery! How green is that?

It's like, the work of opposing the new magnetic field is what's driving the charges into the battery.

So how does this "generator action" really work?

I tried this one day in the shop to demonstrate it. (*See Figure 4*)

WHEN A MOTOR IS ACTUALLY A GENERATOR

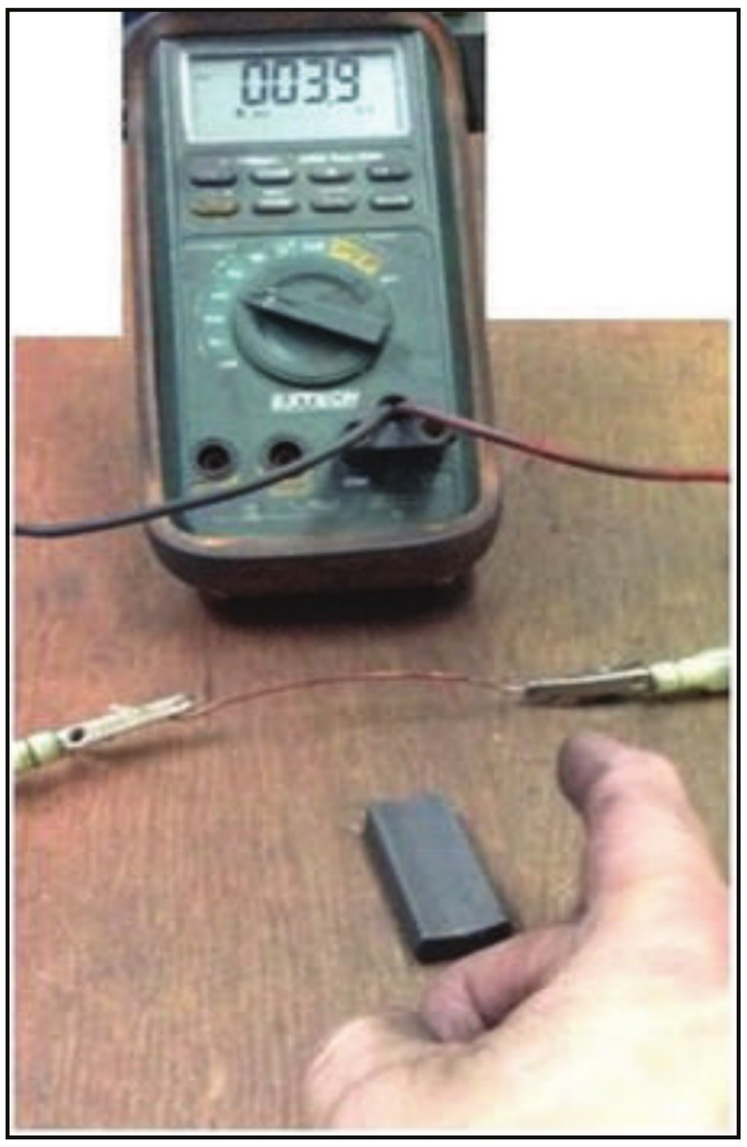


Figure 4 – Flick and meter

I laid a wire across my desk. I then connected my DVOM across the wire, set it to capture the max voltage with the min/max button.

Then I flicked a magnet, so it went under the wire. I noticed that the faster I flicked the magnet, the higher was the captured voltage. (Faraday's law)

It seems that when the electrons (that are busy spinning around their copper atoms) feel this magnet coming, then there is this mass exodus, creating a voltage difference. But they only run away while the magnet is moving (relative motion). As soon as the magnet stops, the 'pressure' is gone and so is the voltage. I mean that's weird right? Just the presence of the force alone doesn't do it. The (magnetic) force has to be actually moving. And the faster it moves, the more the electrons try to get away.

{By the way, it's that "relative motion" thing that really got Einstein thinking. Einstein used to have a framed picture of Faraday in his office!}

If you coil that piece of wire in a loop and add many turns, you are multiplying the effect. Then put those same coils in a round frame and rotate it inside a magnet housing, and you have a generator.

Now I had to see this for myself, so I took a permanent magnet motor like 410-22003, and cut a plastic splined piece down a bit so I could fasten an alternator pulley onto it. Then I ran it on my variable speed alternator test bench. (*See Figure 5*)

At low rpm, with it connected to a battery, the 410-22003 wanted to run the big motor, and it drew lots of current. But as I increased the rpm, then the current draw got a lot less, until about 2600 rpms when it was nearly zero.







Figure 5 – Motor as gen

At even higher rpm, the generator behaviour, (also called back EMF) overtook the motor behaviour, causing the current to reverse, until it was charging the battery instead of drawing from it. Now of course, this motor is not optimized for this, so you can't expect much. But it's enough for "proof of concept".

What happened there is that the faster the motor was spinning, the more it was internally generating and therefore lessening the draw on the battery. This is exactly why the free-run current of any motor is so very much less than the stall current. And then if you impel it even faster, then the motor will completely become a generator, and will begin to put a charge into the battery instead of taking it out. **Note:** It stays turning the same direction and also keeps the same voltage polarity when either motoring or generating. As the rpm increases from zero rpm, only the current reverses. It will become less and less until a certain rpm when it crosses over zero amps and begins charging instead of drawing.

So, there you have it. As soon as a motor is turning, it is already a generator.

It's just that the motor has to be spinning fast enough for the generator effect to overtake the motor action before it will charge the battery. To spin it fast enough however, you must exceed the free-run rpm of the connected motor. This is done by driving it with a mechanical power source like another motor, an engine, or the vehicle drivetrain in 'regen' mode.

This is true not only for permanent magnet motors, but also for motors with field coils in various configurations, and AC induction motors. Even if they are not optimized for generator behaviour, they work on Faraday's principle: the faster the magnetism moves, the more voltage will be produced, and so even when 'motoring', they are generators waiting to come up to speed.

Skill testing question: What is a simple way to measure back EMF? To be answered in next month's issue.

Many thanks to Bob Thomas, Seppo Creiger, Larry Hagemeister, Lesley Unger, and Bob Reimer for proof-reading this article.

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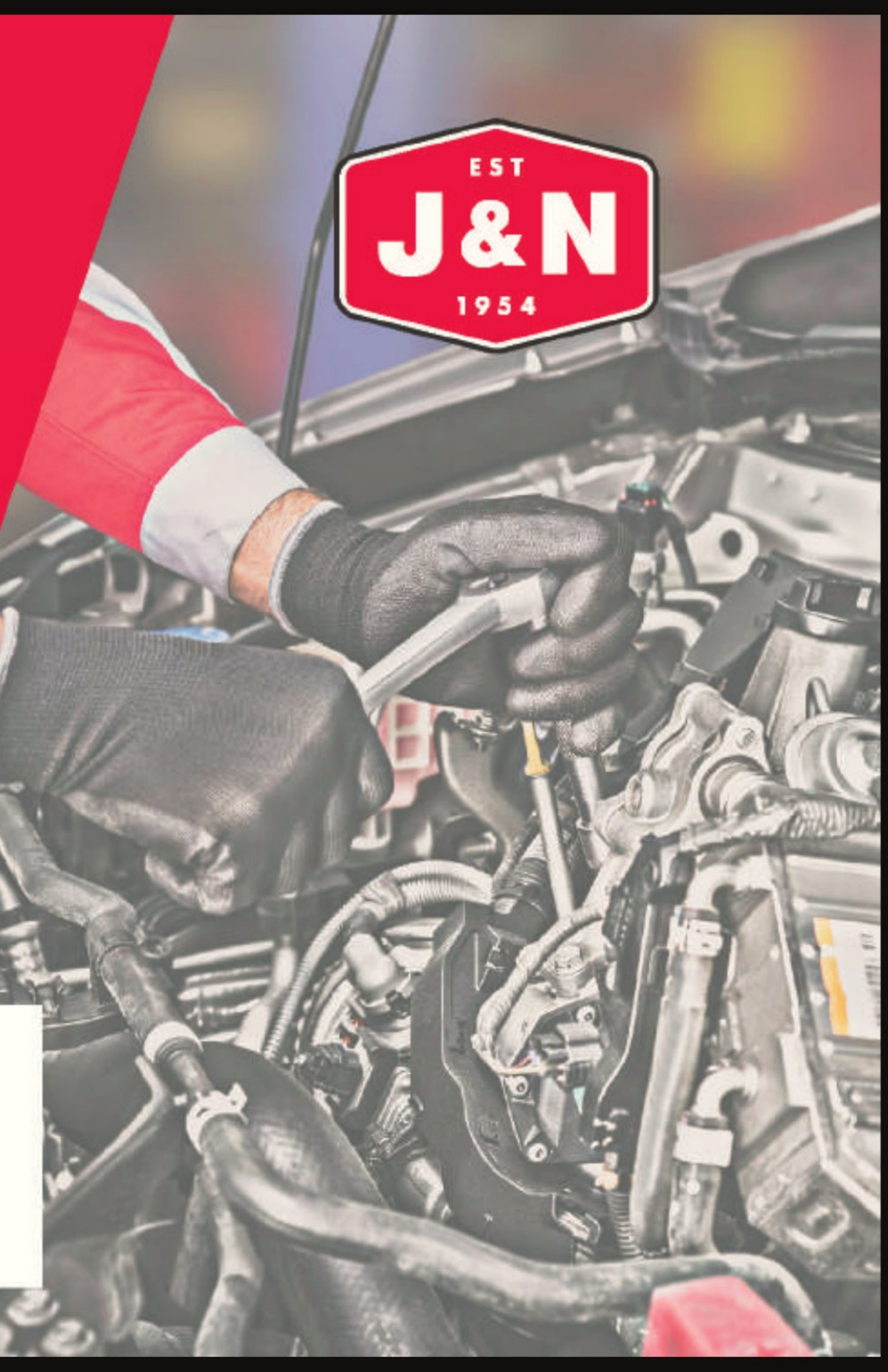
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