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AUTO ELECTRIC CORNER
Stop-Start System: Types, Units, Case Study

WHEN AN 'N' DIODE IS BEING USED AS A 'P' DIODE

How to Fix a Broken "Boss"

2023 TRADE SHOW INFO ENCLOSED

A WORD FROM THE PRESIDENT

Overhead, Overhead, Overhead



Well the national midterm elections have come and gone. As usual, the bombardment of media ads and rhetoric have subsided and I'm glad that it's over. It doesn't look like there will be much change other than the other side getting back at the other side.

Inflation appears that it will not be slowing down any time soon. The prediction here in the northeast is that home heating oil will reach $7.00/gallon by January. The local utility company just announced that a request for a 50% electric rate increase was submitted to the Public Utility Commission.

In my opinion, the future looks bleak and tightening for the majority. What does this mean for you and me? Overhead, overhead, overhead.

We all have seen the increase in prices for complete units and component parts along with increases in freight charges. We have made adjustments to our pricing of our rebuilt and new replacement units. This inflation problem is not immune to our employees as we are all feeling the burden at home.

We as employers need to be aware of this and remember that we need our employees to provide the labor and expertise for us to provide the goods and services that we sell. You must be thinking where am I going with this. (Hint) Overhead, overhead, overhead.

I, like you, am reluctant to raise prices, but in my opinion we have no choice. I am not willing to destroy our business reputation of providing quality rebuilt and new replacement rotating electrical parts and the professional service that goes along with maintaining good relationships with my suppliers.

Twenty years ago, if you said that our hourly shop labor rate would be what a law firm was charging then, I would have asked what you were smoking. But today my hourly shop rate is $110.00, and with the current trend it will be increasing again in the very near future. My point here is we need to take off our work bench cap and put on our Fedora business hat at times to maintain the image of a professional and successful business operation to our current and new potential customers.

OK Ken, time to get off your high horse. Reminder to all that the 2023 Trade Show Committee is looking for training seminar topics and possible seminar presenters. If you have a training topic or would like to participate by presenting a seminar yourself, please contact any one of the Trade Show Committee members with your suggestions or requests. This is your association. Be a part of it!

On behalf of the complete Board of Directors including the Advisory Board and the Editors of the ERA Exchange, we wish you and your family and employees a Happy & Joyous Holiday Season. HO HO HO and Merry Christmas.

Ken Plourde

NEW ERA MEMBERS

John's Auto Electric
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ABOUT THE COVER

Happy Holidays from the Electrical Rebuilders Association!

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Topics, times and presenters will be available in the January issue. Stay tuned, and we hope to see you there!





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AUTO ELECTRIC CORNER —
Stop-Start System: Types, Units, Case-Study



BY MOHAMMAD SAMII

The changes in rotating electrical components for automotive, light truck, and Heavy-Duty application is not as often and as prominent as changes that we see in other systems. If you compare it to evolution in ignition, fuel delivery, injection, E-steering, communication and computer control of all of the above systems, you will see the development and changes in rotating electrical, however a lot more recently but generally speaking, they are not happening at a fast pace and as repeatedly compared to other systems mentioned.

This may not be the newest technology but our *New-Kid-On-The-Block* is the introduction of the Stop-Start system that has been partly a source of misinformation and confusion. Explaining the details of the whole operating system of Stop-Start could probably be done best in a long seminar in a classroom setting, but in this column, I will briefly share my take on the system and hopefully clear some misconceptions.

The Stop-Start system as we know it falls into 3 different classes and categories. Each one differs drastically from one another, to a point that there is absolutely no resemblance between the types. Here is a brief description of each type:

Type-1 Hybrid Electric Vehicles

Hybrid Electric vehicles such as well-known brands like Toyota Prius, Honda, Ford, Hyundai and others use a combination of electric motor drive in addition to their Internal Combustion Engine (ICE). They obviously have HV battery that powers the Motor-Generators (MG's) that can work as an electric motor to assist the ICE or be driven to function as a generator to charge the HV battery via a very sophisticated inverter assembly. The inverter shapes and modifies the HV battery power to drive the motor-generators or conditions the generated power to charge the HV battery. The inverter also has provisions to charge the 12V battery, as well as generate HV to operate the air-conditioning compressor which is belt-less.

In such system (particularly Toyota Prius) the combination of power of ICE, MG-1 and MG-2, and their mode of operation as being OFF or ON (for ICE) or being a Motor or a Generator (MG-1 or MG-2) is managed through a device called Power Split Device which is a marvel of mechanical engineering. (*Figure-1*)Without going into the details of the system operation that takes hours or pages, let's suffice to say the MG-1 (the smaller one) acts as the starter, spins a planetary gear system inside the PSD that's its star-gear carrier is bolted to the engine, and spins the ICE to get it started.

During deceleration, very light load, and/or going downhill, the ICE shuts off (fuel saving) and the car runs on electric via MG-2 (the larger one) but as soon as the vehicle accelerates and the load demand increases, MG-1 spins and starts the engine. The power of ICE in addition to the MG-2 is what drives the wheels and accelerate the vehicle. This stop-start operation that repeatedly happens during heavy traffic driving is so seamless and so smooth, it can be totally imperceptible to the driver.

The Stop-Start feature of full hybrid vehicles such a Toyota Prius, and Highlander Hybrid are an integral function of the vehicle, its engine management and its many computers. The driver has no control over its Stop-Start operation.

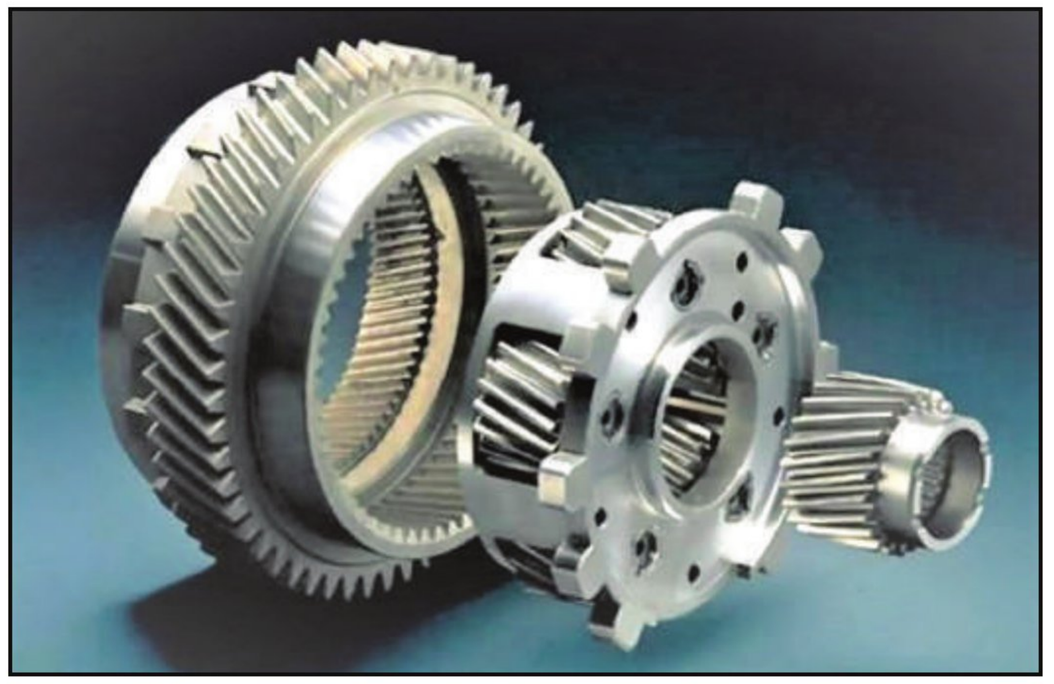

Figure 1 – Power Split Device (PSD) for Toyota Prius (Toyota Motor Corporation)

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Type-2 Mild Hybrid

This class of Hybrid vehicles which are also called Mild Hybrids do not have a starter but have a combination alternator-starter unit that functions as both. Since these units are belt driven, they are also called BAS for Belt-Starter-Alternator system. The power of a 36V battery (42v nominal) is turned into a 3-Phase PDC which is applied to the unit to make it spin the engine for starting. Once the engine starts, the unit turns into a 3-Phase AC alternator that its output is rectified to charge the both 36V hybrid and the 12V normal vehicle battery. (*Figure-2*)

The blue wires are the high voltage AC wires (*Figure-3*) that are fed to the Starter Generator Control Module (SGCM) where it is conditioned to feed the 36V and 12V battery. The contribution of the BAS for driving the vehicle is very minimal as the main fuel savings are accomplished by engine shut-down at stop-start traffic. This system was used on Saturn Vue Green Line and Saturn Aura, as well as their sister vehicle Chevrolet Malibu from a period 2007 to 2009.

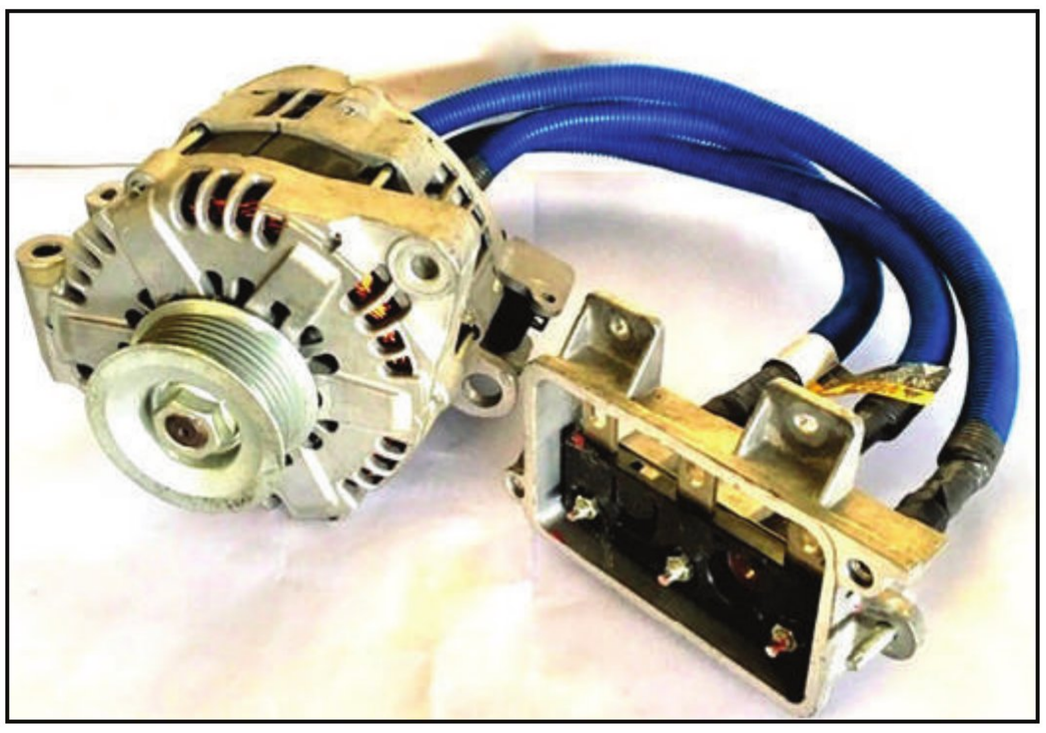

Figure 2 – Hitachi 11469 BAS Unit (GM 24242950)



Figure 3 – BAS Output Connecter to SGCM

The Hitachi BAS unit (Lester 11469) is a subject of many calls on ERA Help-Line to which I try dissuade the members not to do anything with the unit as there is no testing, testers, service parts and service information available to us at this time. Once you work on it, even for a simple bearing change (which actually are not that simple) then you expose yourself to any future malfunction of the unit or the car as the only thing the customer remembers is: *"YOU are the only person who worked on it…!"*

Type-3 System with Starter and Alternator

This is one of the most common systems used for Start-Stop operation where the vehicle has a typical starter and an alternator. The engine shuts off when vehicle comes to a complete stop if all the enabling criteria is met, and then restarts as soon as the driver removes his foot off the brake and pushes the gas pedal.

The type of starters used are a little more robust to withstand repeated starts in much greater number than a typical vehicle. The ones used on later GM applications have a dual post solenoid that will be discussed later. The vehicle may have one main battery or be equipped with an additional auxiliary battery which are normally a small AGM type.

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As an example, the 10700 starter (438000-2410, *Figure-4*) is the starter used is some late model GM applications such as Buick and Chevrolet cars and trucks, starting around 2015. Upon teardown, you will notice that the armature and brushes are completely different from what we have been used to seeing. (*Figure-5*)

The commutator and the matching brush contact surfaces are grooved to ensure increased surfaces, allowing a much heavier and more positive contact area between the brush and the commutator.

Another different item is the solenoid that its design is completely a departure from a normal starter solenoid. It has 2 "S" posts, S1 and S2. (*Figure-6*)

This solenoid has 2 different stages that serve 2 different functions. S-1 only powers up the motor and makes the armature to spin, no drive engagement at this point. S-2 only moves the pinion forward allowing the drive gear to engage with the flywheel, but no spinning. In normal operation from a cold start the two parts obviously get energized at the same time to make the starter to spin the engine for a normal start.

In Stop-Start mode, especially in stop-and-go traffic their function is not simultaneous. Right before the

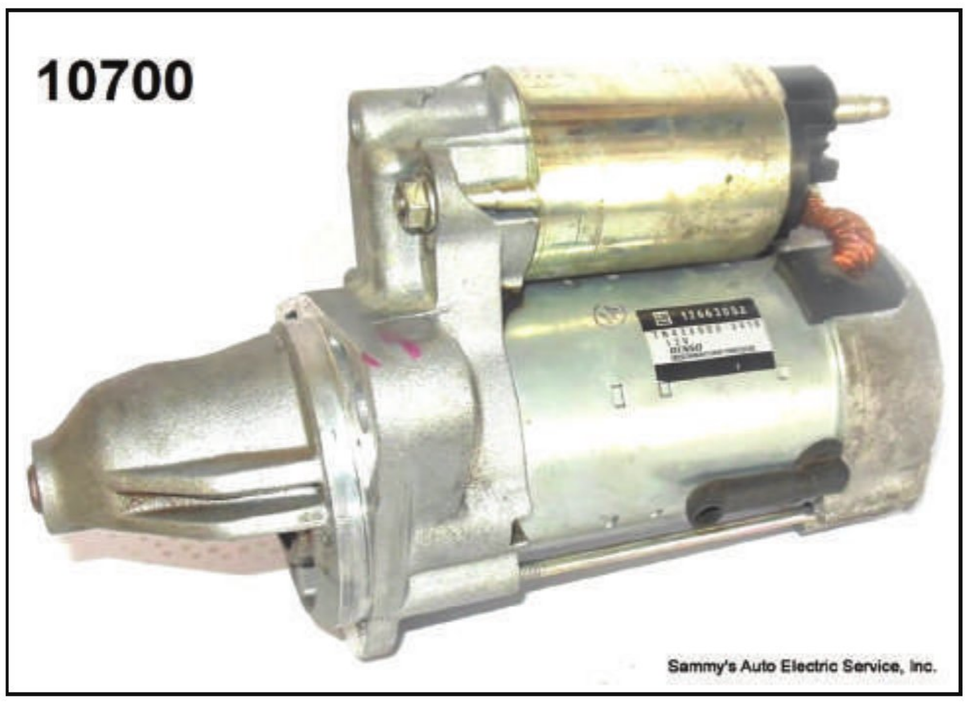

Figure 4 – 10700 Starter (Denso 438000-2410)

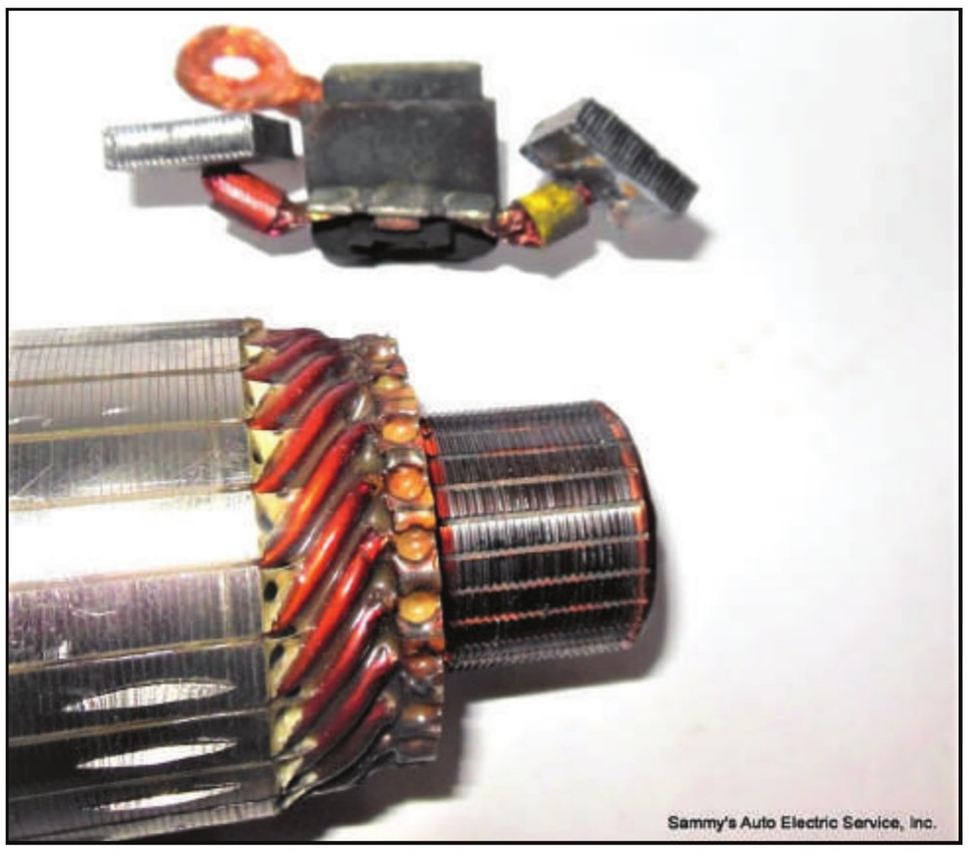

Figure 5 – 10700 Brushes and Armature



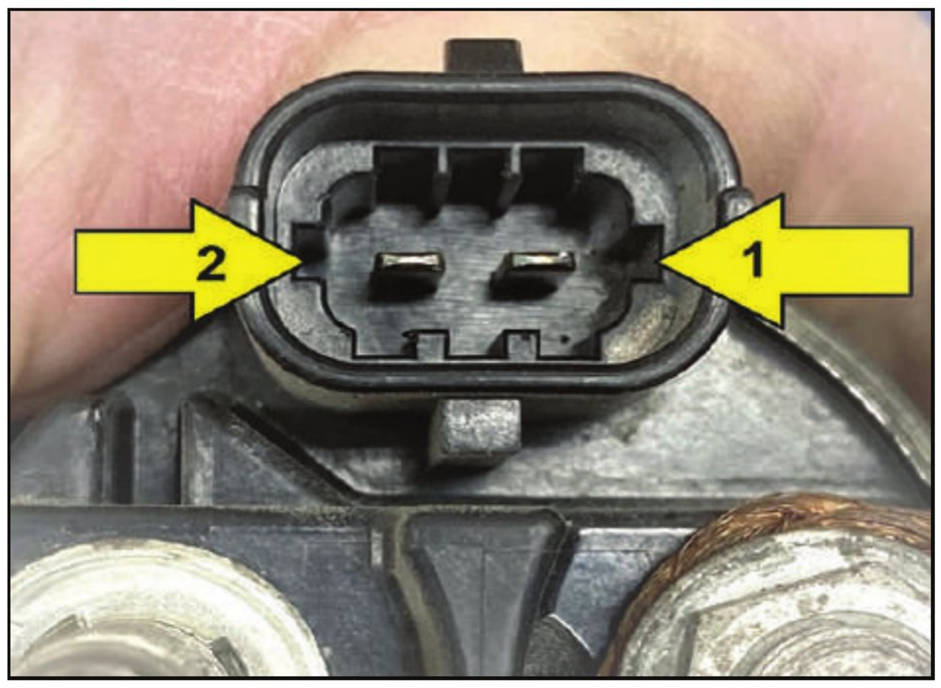

Figure 6 – 10700 Dual Solenoid Post

engine comes to a full stop (about 50 RPM) the pinion actuation relay powers up the S-2, allowing it to go forward and engage with the nearly stopping flywheel. An algorithm built into the operating system (the PCM) allows for predictive actuation without any clashing of the gears. Now the gear is engaged with the flywheel while the engine is stopped.

At this moment as soon as the driver moves his/her foot away from the brake pedal and pushes the gas pedal, the S-1 get energized by the respective relay and the armature along with the drive gear start spinning with pre-engaged gear, and the engine will start easily without any clashing of the gears.

The dual starter relays along with a sophisticated communication to and from PCM constitutes the heart of Stop-Start system (*Figure-7*)

As you can imagine, diagnosis of the system for a no-start or no auto-start problem is very involved. It needs the detail knowledge of the system along with OE level scan tool and OE level information to determine the problem area which maybe hardware or software related, with an emphasis on the software and the operating system issues.

At times the Stop-Start system failure exasperated by over-zealous or negligent drivers can have catastrophic results on the unit. We had this 2016 Chevrolet Malibu (1.5L engine) towed in for a no start condition which the

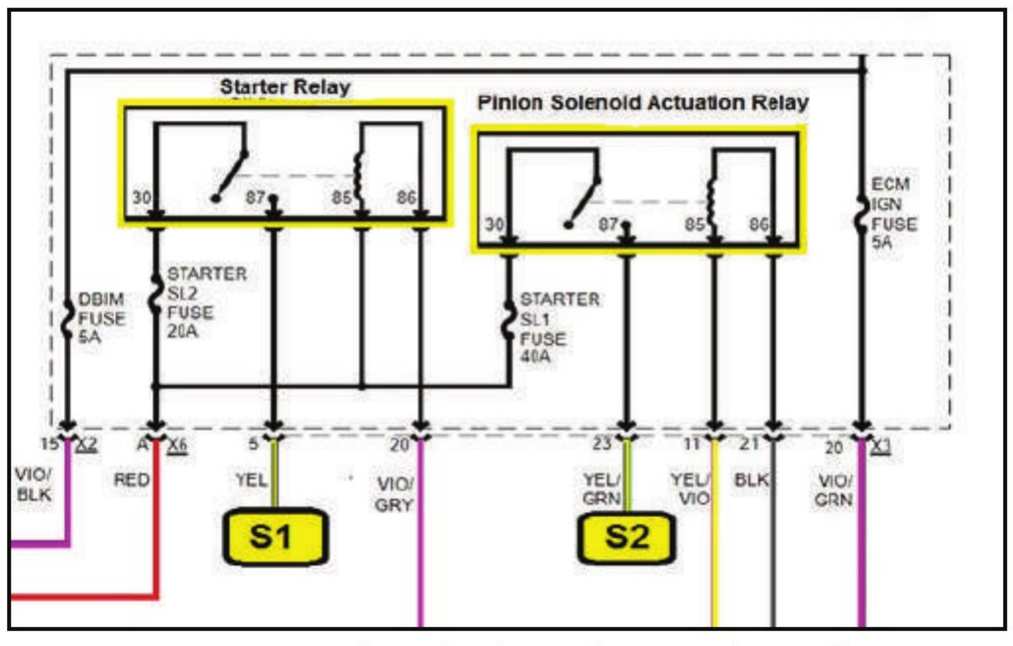

Figure 7 – Solenoid Relays Schematic (Partial)

owner was adamant not to take it to the dealer due to past experience.

After charging the battery, our diagnosis showed the necessary power was there but the starter was not responding. Upon removal of the starter and disassembly it was noticed that the armature was nearly exploded (*Figure-8*) and the brushes and brush holder of this



Figure 8 – Ruined Armature and Brushes



Mitsubishi 31035 (*Figure-9*) were completely ruined. This starter just like the Denso 10700 discussed above was probably the size of a 1.8 or a 2.0 KW starter (large for the engine size) had a dual post "S" terminal solenoid which seems to be common on GM stop-Start applications. (*Figure-10*)

After the starter was replaced with a very low mileage and clean used unit (no replacement or any repair parts are available), all was needed was a new battery which I believe was the cause of the failure due to repeated jump starting. This vehicle was a single battery type. We thought we were done but more surprises were waiting!

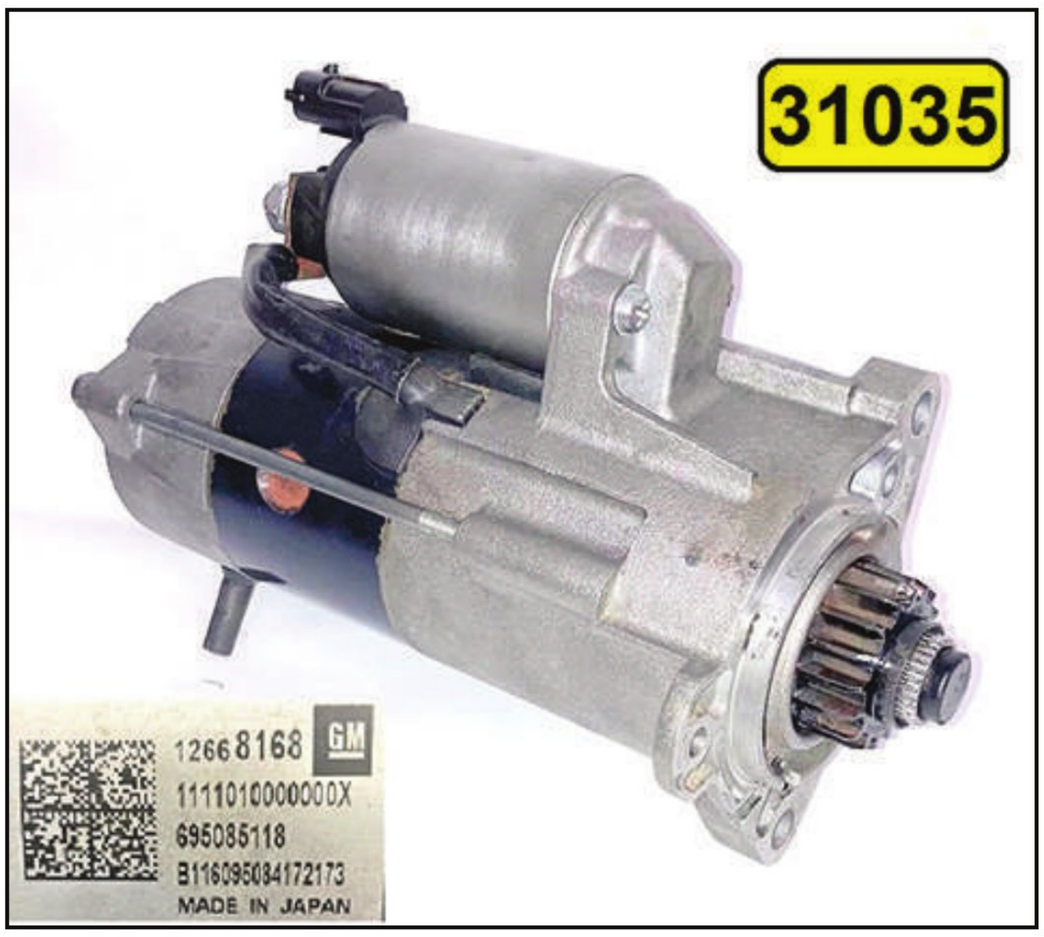

Figure 9 – 31035 Starter Made by Mitsubishi

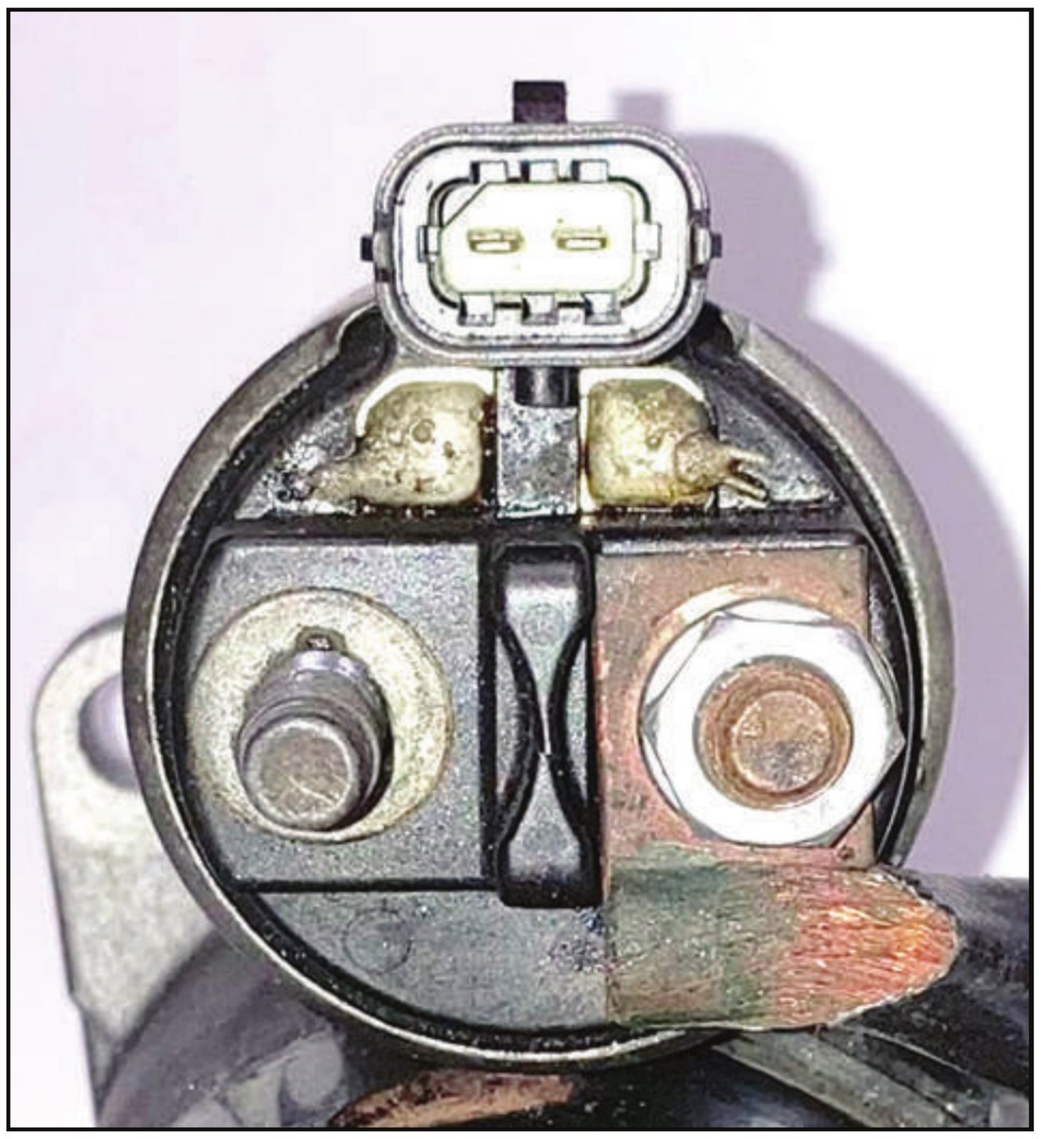

Figure 10 – Dual Post "S" Terminals of 31035 Starter



Further inspection revealed that repeated jump starting has blown a 400-Amp fuse on the fuse box located right on the top of the battery called Battery Distribution Block. The blown fuse was bypassed with a thick piece of cable (*Figure-11*). A new junction block was ordered via the dealer and we noticed the 400-Amp and a 250-Amp fuses on the old junction block were replaced with two 350-Amp fuse, for the reasons that is not clear to me. Finally, the car was done and delivered to the customer. (*Figure-12*)

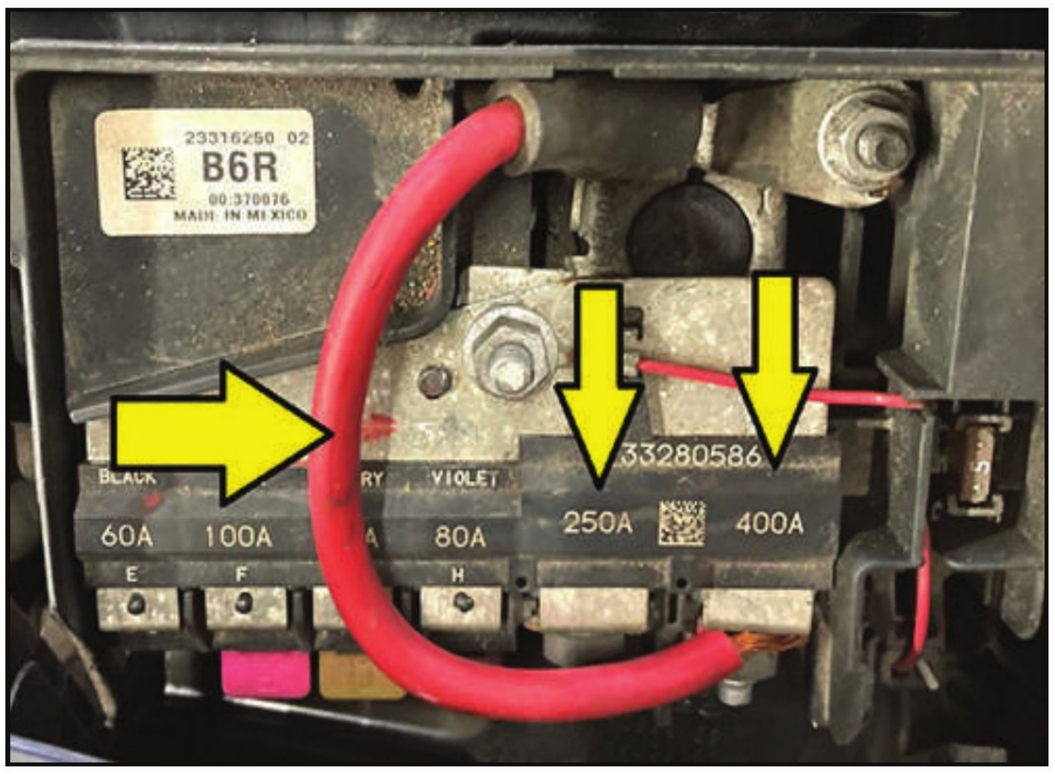

Figure 11 – Old Battery Distribution Block with Blown 400-Amp Fuse

Well, this being the last issue of 2022 and you probably will get it around the holidays, it allows me a chance to wish you all a very Happy New Year and a great Holiday Season, full of happiness, prosperity and good health. My sincere wishes are that for the New Year, we hopefully see the end of the COVID-19 and its variants which has changed and affected all of us, one way or the other. Happy New Year.

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

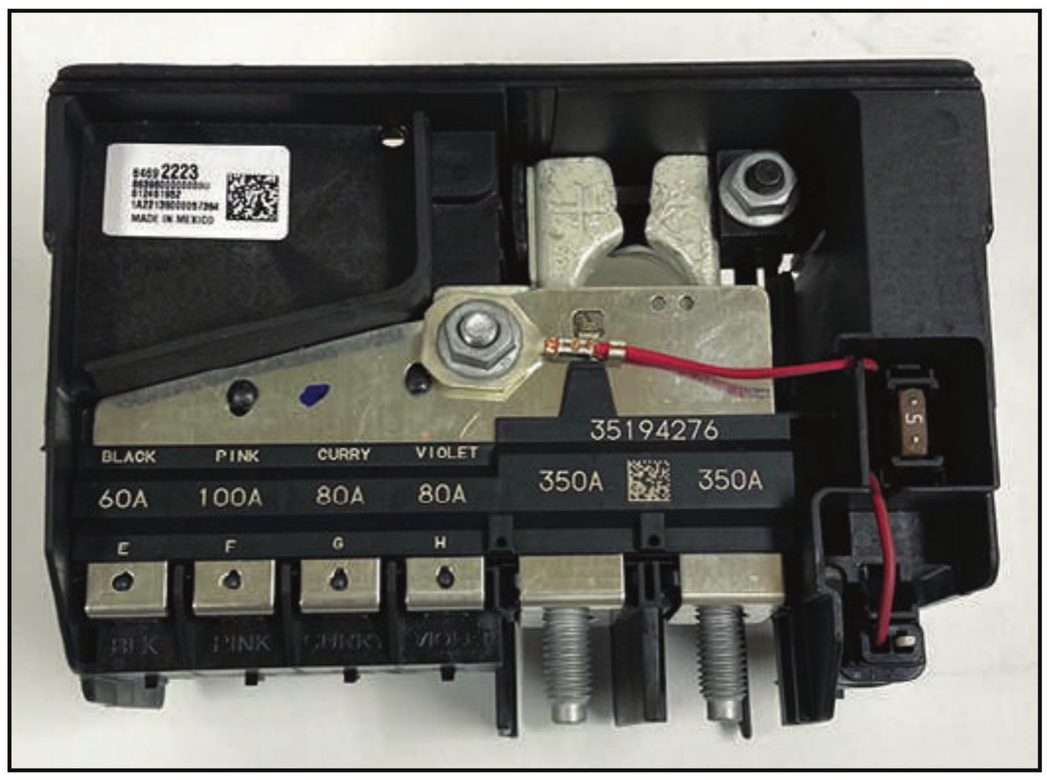

Figure 12 – New Distribution Block from Chevy Dealer



WHEN AN 'N' DIODE IS BEING USED AS A 'P' DIODE

How to Fix a Broken "Boss"



BY NATHAN UNGER

A customer brought in a couple of alternators from a late 70's Landrover 101, forward control, one-ton 4wd used (among other things) for towing a dual Rapier-missile launcher. (*See Figure 1*) Apparently the British made only about 2700 of these. My customer found one in a field in Alberta, Canada and wanted to fix it up. They are good for off-roading, and great for wading too.

One alternator (*See Figure 2*) worked fine, but the other would not turn out the light on the dash. They both had all sealed bearings and brush compartment. These things weigh a 'ton'- about the same length as a 25SI Delco, but bigger in diameter than the old 'triple nickel' 555 Motorola.

It had a diaphragm on the back for preventing negative pressure inside the brush box from drawing in moisture. Usually the alternators we see have a slidable bearing race at the slip ring end, but this one had it at the front. This bearing and race combo is very pricey if you



Figure 1

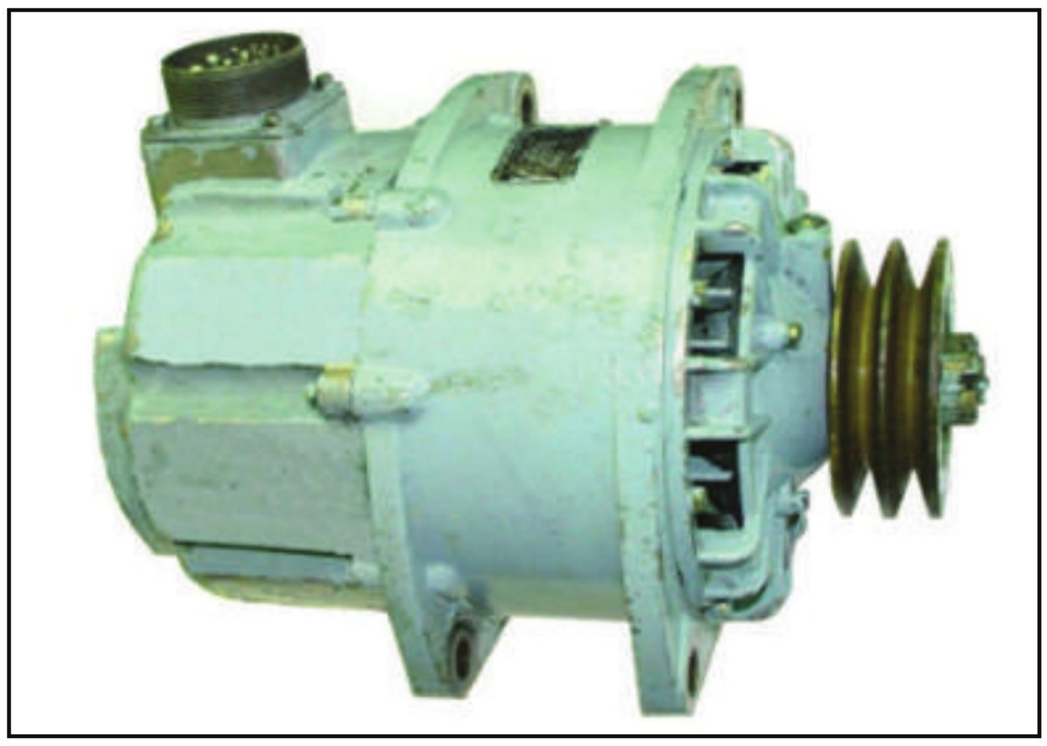

Figure 2



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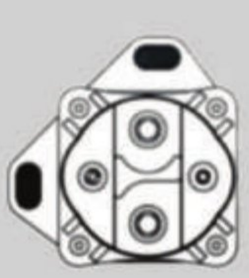

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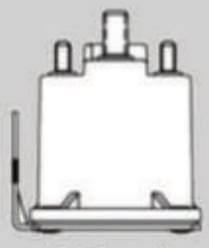

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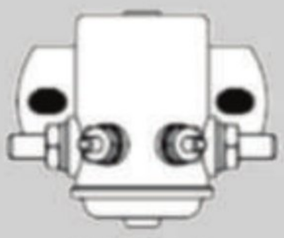

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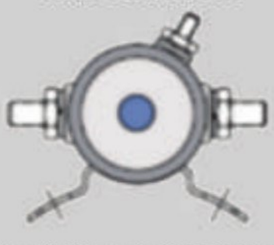

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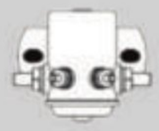

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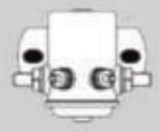

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can even find one 'new, old stock' NOS. A 6205LL bearing was captured inside a carefully sealed pocket at the back, to prevent endplay.

Of course it has the big sealed connector on it with lots of pins that are not used. (*See Figure 3*) It even has provision for a 3-phase output to run power tools in the field. (Notice the 3 medium sized pins near the middle of the connector.)

Inside the alternator, there are tiny 6-32 and 4-40 screws so be careful with that impact gun!! If you break one, you can always drill and tap it out to an 8-32 instead. It had a 3-phase wye-wound hairpin stator (and here I thought the 'hairpin' was a recent Denso design). (*See Figure 4*)

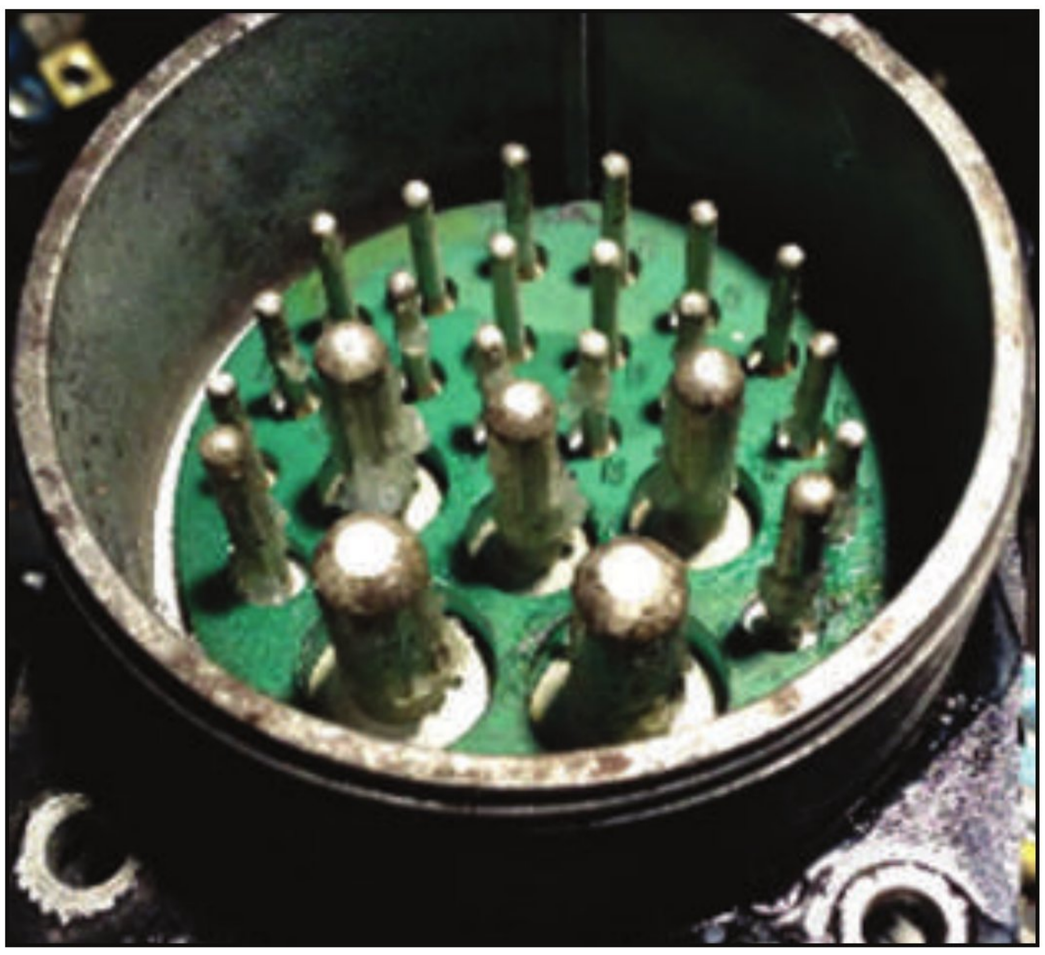

Figure 3

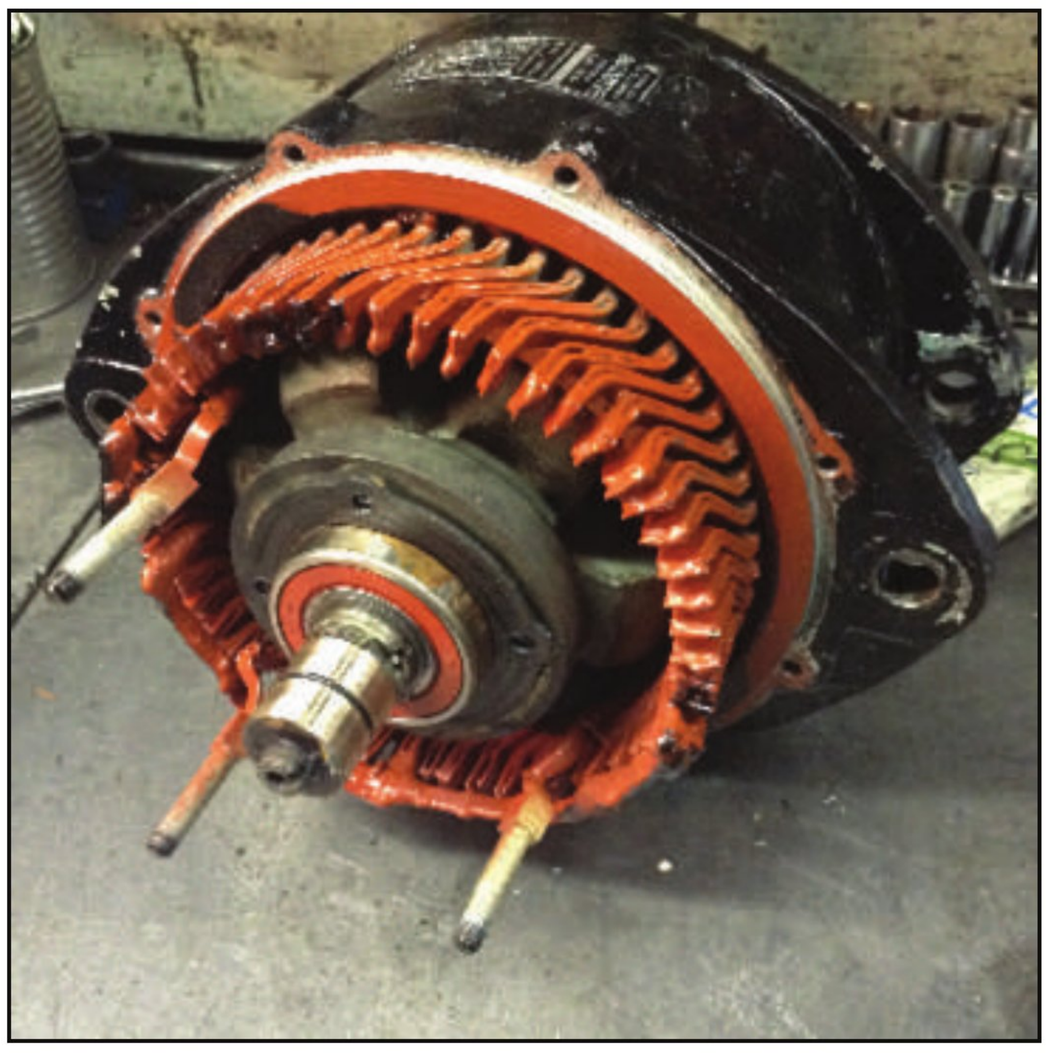

Figure 4

The stator is capable of more than the rated 90 amps at 24v in my opinion, but I assume that's to give it more output at idle. Some of those little trucks had serious radio equipment.

The rectifier was kind of interesting. It had 3 heatsinks instead of the usual two. (*See Figure 5*) It's kind of the same design as the rectifiers in those 'ancient' 7069 Motorcraft alternators on the old Ford trucks. Remember them? (*See Figure 6*)

What this means is that each heatsink itself was the stator-to-diodes connection, and the positive B+ was taken from three diode stems. The ground cable was taken from the three other diode stems. The D+ of the diode trio connection went through a 100 micro-Henry choke for high frequency suppression.

Typical rectifier from most alternators. (*See Figure 7*) Contrast the Land Rover 101 Rectifier, like Motorcraft 7069 rectifier. (*See Figure 8*)

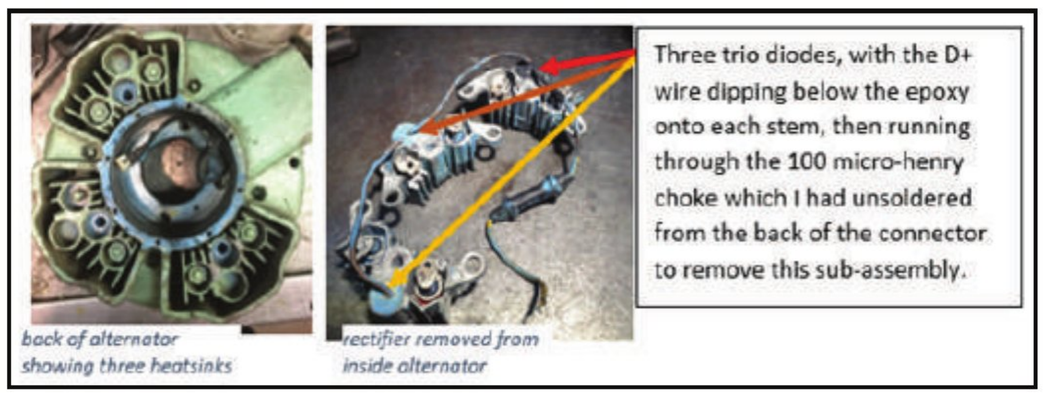

Figure 5

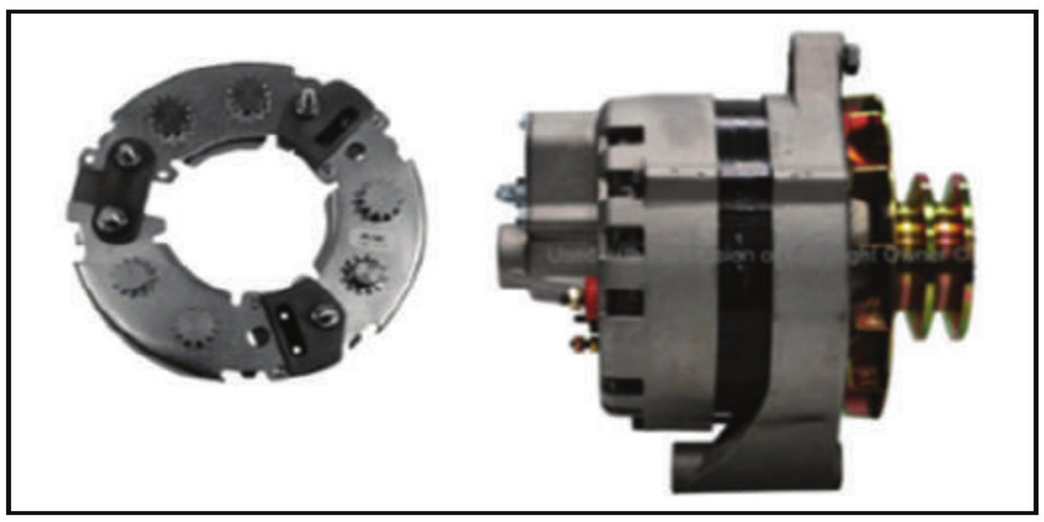

Figure 6

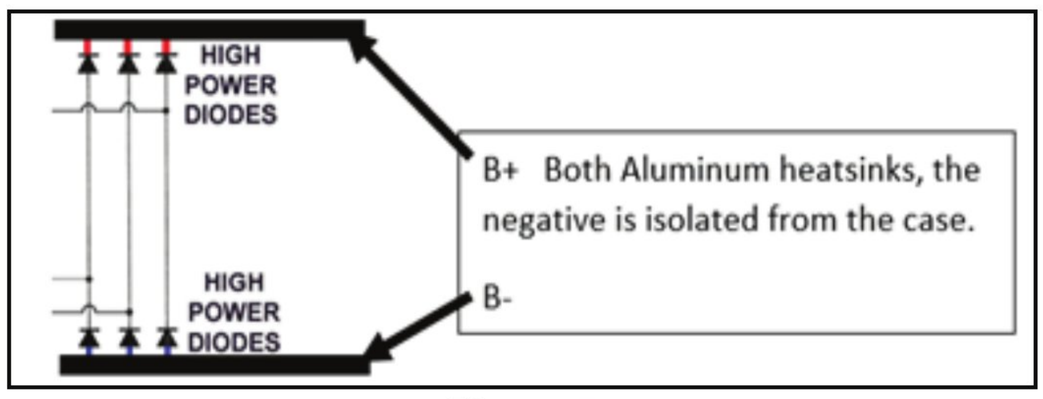

Figure 7

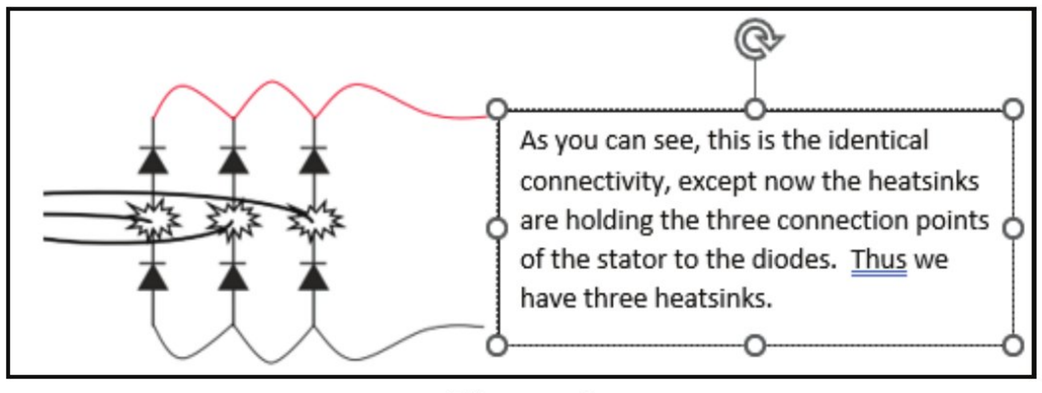

Figure 8

WHEN AN 'N' DIODE IS BEING USED AS A 'P' DIODE

To press the diode cans into the heatsinks and still have the same polarity, you must use the opposite diode! The positive side uses an 'N' diode, and the negative side uses a 'P' diode.

Referring back to *Figure 5,* the trio diodes are also pressed into the same heatsinks, so they have to be negative diodes also. Understand what you are doing when testing these diodes. The polarity and the connection points are not like usual. For example, if you connect from a corresponding diode stem to the B+ terminal pin, you will find 0.0 ohms, as if the diode is shorted!

Finally, everything is connected and assembled with tiny screws, nuts, insulating washers, and insulating tubes inside. (*See Figure 9*) Fun!

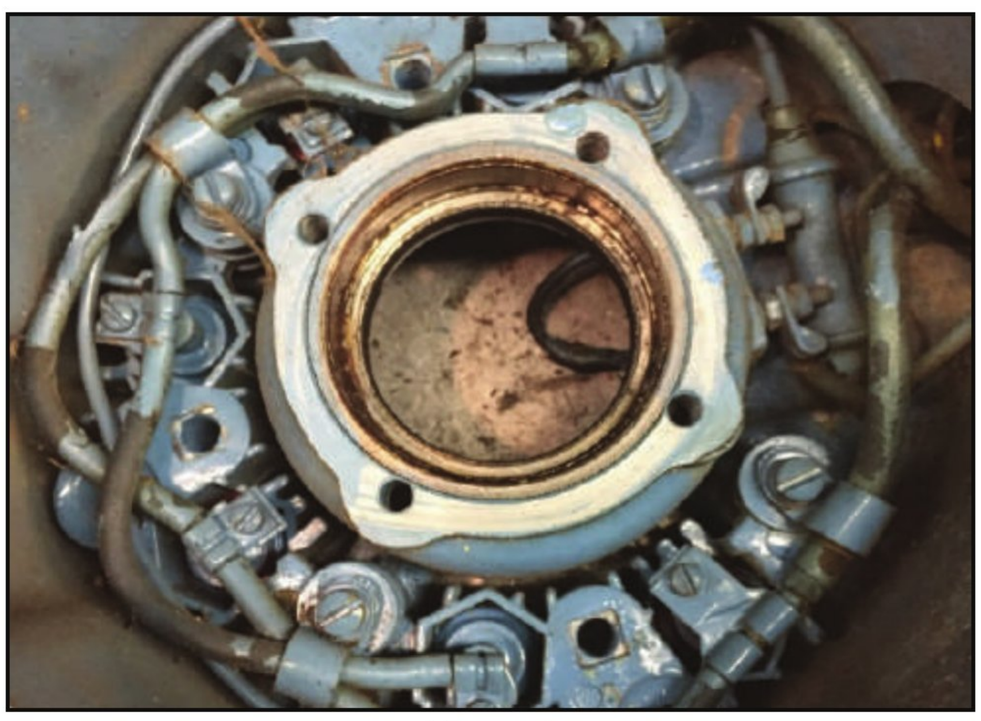

Figure 9

So that all was fine, but now why was this alternator not turning out the light on the dash?

We now turn our attention to the connector. Putting a 1 amp current and testing voltage drop from each pin to the opposite end of a wire soldered to it, is the easiest way to reveal the problem that was on one of the wires going to the light circuit.

The customer had kindly provided me with a pinout and circuit diagram of the alternator and regulator, so it really helped in the diagnosis.

After I had dug out the silicone sealant, and clipped away the heat-shrinking, I discovered a wire that was not soldered! As near as I can tell, the original factory worker had pushed the wire into the then-molten solder, but the solder had not adequately warmed up the wire to bond to it. Over time and with vibration, most of the solder that immediately surrounded that wire had been arc'd/corroded away. (*See Figure 10*)

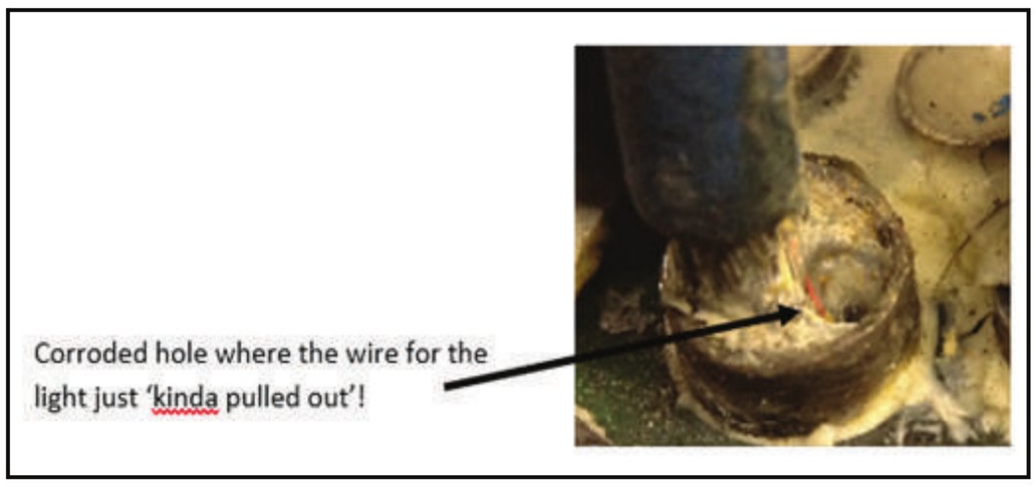

Figure 10

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WHEN AN 'N' DIODE IS BEING USED AS A 'P' DIODE

(I'd like to thank Bob Thomas for suggesting the HB100MM clip-on macro lens for my old iphone to be able to capture a reasonable image of this.)

Emergency Repair Of A Broken 'Boss'

A Mitsubishi M2T56271 starter for an old excavator was not readily available at the time, so I had to deal with the broken boss.

After so many times of rebuilding and maybe steel-shot blasting each time too, the threads wear out. That little piece is not big enough to allow a thread insert. So, it just got tired and broke. (*See Figure 11*)

I drilled a 25/64ths (slightly undersize of 10mm to account for lack of precision drilling) hole where the boss had broken off. (*See Figure 12*)



Figure 11



Figure 12

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WHEN AN 'N' DIODE IS BEING USED AS A 'P' DIODE



Figure 13



Figure 14

Using an ordinary 10mm bolt, I cut the head thinner, then drilled and tapped a hole for a 6x1.0 mm through-bolt thread and cut it short. (*See Figure 13*) Finished repair (*See Figure 14*)

Lonnie at Alltemp Auto Electric did a similar repair on a Harley Trike reverse motor. (*See Figure 15*) https://www.electricalrebuilders.org/forums/showthread.php?t=10938&highlight=trike

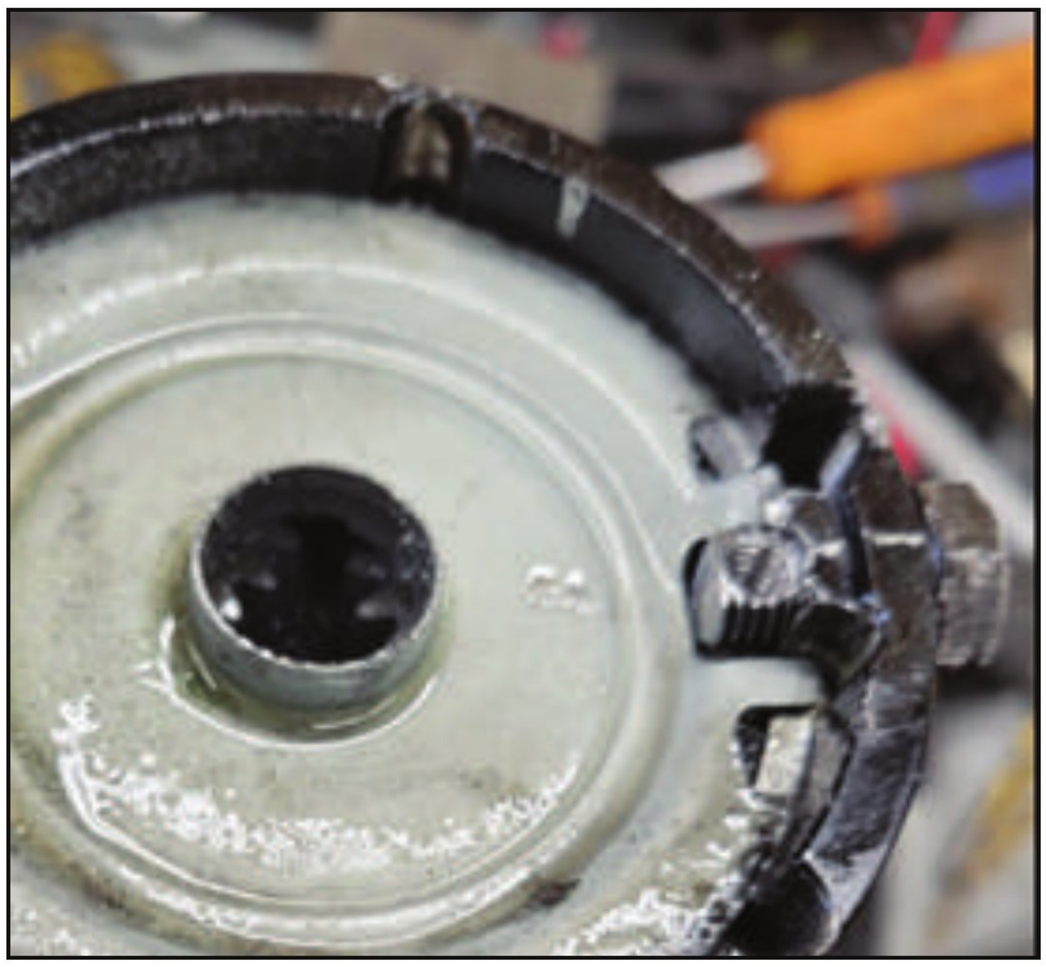

Figure 15



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