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AUTO ELECTRIC CORNER
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IT WORKED FOR ME
Verifying the Linkage Between the Starter Drive and the Solenoid

110V AC GENERATOR
JLG 600AJ Articulating Lift Boom

A WORD FROM THE PRESIDENT
2022 Trade Show Planning To Begin



The older I get, the faster the yearly seasons seem to fly by. This summer, although a warm one, has come and gone, as it's September already. As a rule for my shop, the month of August tends to be somewhat slow as many of our customers tend to take their vacation during the month of August. I shut down my operation the first week of August for some much-needed R&R time.

Other than the week that we shut down, our operation has been exceptionally busy for the entire summer season, as it has been many of my friends in the trade work industries. They, as have I, had to turn work away as we cannot get qualified and or even non-qualified individuals to apply for employment. I don't know how the membership is doing with this issue, but for my fellow tradesmen friends and myself it's time to end the free ride. It's time to get able individuals back to providing for themselves.

OK, back to the ERA. Now that the summer months are behind us, the ERA trade show committee will begin to convene with meetings to start the progress of putting together the 2022 ERA Trade Show to be held next spring in Seattle, Washington. As always, the trade show committee is looking for input from our membership. The trade show committee welcomes your input and participation with the planning of this annual event.

If you have any interest in participating with the trade show committee, please email or telephone any board of director member and or myself with suggestions of technical training seminar topics. If you yourself has a topic that you would like to present in a seminar format that would benefit your fellow peers we would like to hear about that too. We would also like to hear from any member who might want to become a hands-on committee member for our next show. The ERA trade show committee is in need of new blood with new concepts & ideas to bring to the table. As always, all ERA committee doors are open to the complete ERA membership. For those that would like to express their ideas or concerns anonymously, you may do so on our website homepage's suggestion box that is read aloud at our monthly board of directors meetings.

It's your association. Be a part of it.

Ken Plourde

ABOUT THE COVER

GDZ-4108A Generator for 1939 Plymouth
(Photo courtesy of Sammy's Auto Electric)

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AUTO ELECTRIC CORNER —
Parasitic Drains, Antique Units, Denso Rectifier Swap



BY MOHAMMAD SAMII

As part of electrical/electronic repair and diagnostic work, we get a good number of vehicles—either from customers or referrals from the other shops—that have a starting problem due to excessive parasitic drain that depletes their battery overnight or over a weekend. I understand many of our readers do not perform any on-vehicle service, but the changes in the electrical/electronic service does require electrical rebuilders to at least have a fair amount of familiarity with the new systems and their layout.

In the old days finding such drains was a matter of disconnecting the battery, installing an ammeter inline, and then pulling fuses out one at a time to narrow down the culprit circuit. This is not so in new or newer vehicles as it has become a very complicated procedure that takes a lot time, patience, and access to the appropriate system information (SI), as well as advanced scan tools to narrow it down. It has practically become a sort of specialty of its own and nearly an art form...!

Disconnecting the battery is no longer an option. A lot of diagnostic work is done LIVE…meaning without disconnecting the battery. Thus, use of some sensitive (and expensive) milli-ammeter and micro-ammeter with magnetic pick-up has become necessary. Disconnecting the battery can cause a slew of problems which may require resetting a number of modules to turn off the warning lights that may come on, and complicate the problem.

A typical car built within the last 10-15 years has nearly 10 to 20 electronic modules. Many of them (if not all) are on the communication bus, and talk to each other. When the ignition switch is turned off, not all the modules shut down immediately. In some vehicles it might take 30 to 45 minutes for the entire system go into what is called a *sleep-mode* and draw minimal current. If for any reason one or more modules do not time-out and would not go into the sleep-mode, then the excessive parasitic draw exceeds what the battery can handle in an overnight or weekend, and a no-start will ensue.

Figures for allowable parasitic draw given in milli-amps differ widely from car to car and the variety of options that the vehicle has, and the size of battery or batteries it is equipped with. In our experience a fully shut-down newer vehicle may have a parasitic draw from 30-55 mA. When this figure gets closer to 60 or 70 mA, occasional no-start can be expected. Our experience shows any draw of 80 mA and higher, does indeed constitute an overnight battery run down.

The add-on stereos, power amps, burglar alarms and remote starts all contribute to the parasitic draw. What we are seeing more and more is the addition of a hidden GPS locater that is required by some auto finance companies and is installed by the used car dealers. The electronics of these devices can deteriorate and after a while they do cause additional drains that can run a battery down overnight.

For the sake of full disclosure, I admit that we do install these GPS locaters for some used car dealers. They provide us the device, and we ensure their added drain does not exceed the figure that we are comfortable with. We have no control over what happens to them after our work is done, and we are not liable for its operation. (*Figure-1*)

Finding parasitic drains could become a challenging process that I will not go into here in this column, but

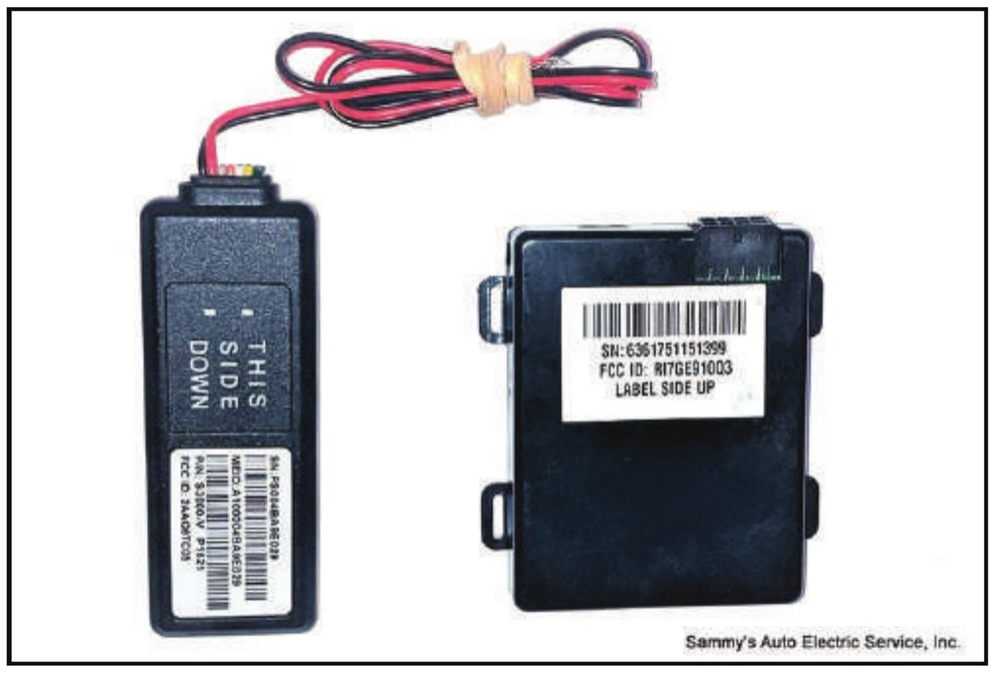
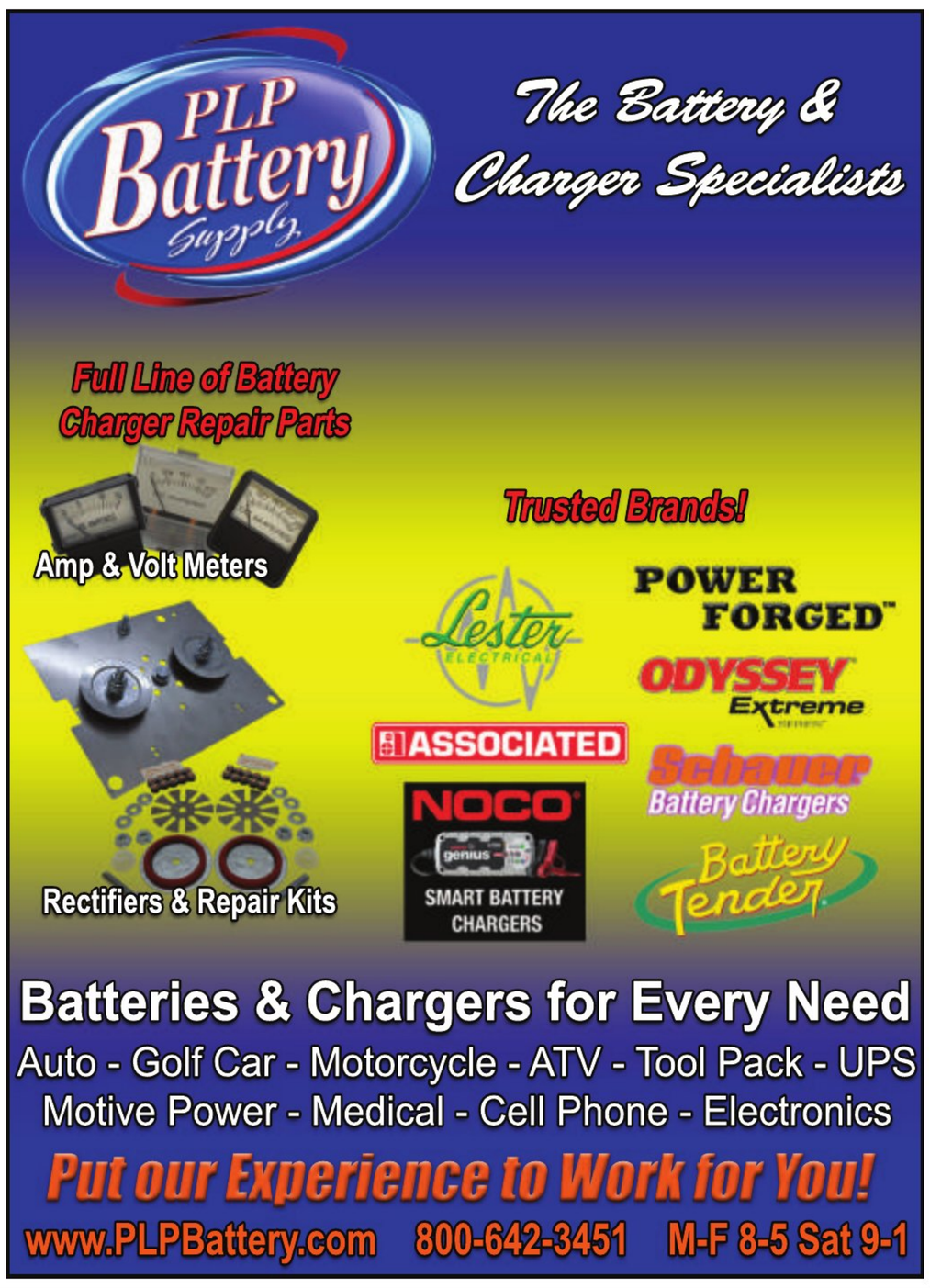


Figure 1 – A Couple of GPS Locator Transmitters



the main point is to be aware of new systems, as disconnecting the battery and putting an ammeter in line would no longer be an appropriate approach.

Antiques Units

It is not often we see units that are older than I am (!), but these two were exceptions. A gentleman who was restoring this 1939 Chrysler P6 Sedan brought in the starter and generator of this vehicle to be rebuilt and the regulator to be tested and adjusted. The surprising thing was he was from Edwardsville, Illinois, which is only 25 miles from downtown of the greater metropolis of St. Louis, Missouri, but 160 miles from me…! I did not ask why…!

Both the generator (GDZ-4108A, *Figure-2*) and the starter (MZ-4062, *Figure-3*) needed armatures that are nearly impossible to find and had to be rewound. A call to CC Battery that is the closest option to me was made and our good friend Kenny Turner accepted the challenge to rebuild them on an R&R basis. The armatures were meticulously rewound and performed well. Using an extra turn of wire in the generator armature (GDZ-2006, or #4), it made it charge almost immediately after start-up, unusual for an old 6V generator. It turned off our make-shift warning light attached to the regulator almost immediately after spinning. The starter armature (MZ-2108, or #2012) looked great and ran flawlessly in a free-run on the test bench.

The voltage regulator (VRR-4003A) was checked and it was very stable given all the years it has been in service, either working or sitting idle. Its terminals were not marked but they are in the arrangement shown in Figure-4, if you ever run into one of these.

Servicing these antique starter and generator brought up a couple of issues I would like to discuss here. Rebuilding such units is considered specialized work and requires a skilled rebuilder to do that work. Sourcing parts also adds another degree of complexity, raises the price and the value of these types of units. Finding such units on eBay is a risky business which may also need rebuilding as well.

When you add all of these factors and considering there are no other alternatives, then it is safe to say these types of units command much higher prices than an average units. Thus, the price should reflect the value of it to the customer and not the price of parts or labor that goes into it. Our price of $650 for both the starter and generator was met with no objection as our customer had looked around extensively, finding no suitable replacement.

Another issue I would like to highlight is our supply chain, especially where it relates to R&R of odd or rare armatures. The number of existing armature rewinders such as C.C. Battery, Romaine, Zorko, International Winding and others are very limited and support of these businesses is of utmost importance. We as rebuilders would have a hard time meeting our customers' demand if such businesses ceased to exist due to economic and financial reasons or lack of industry support.

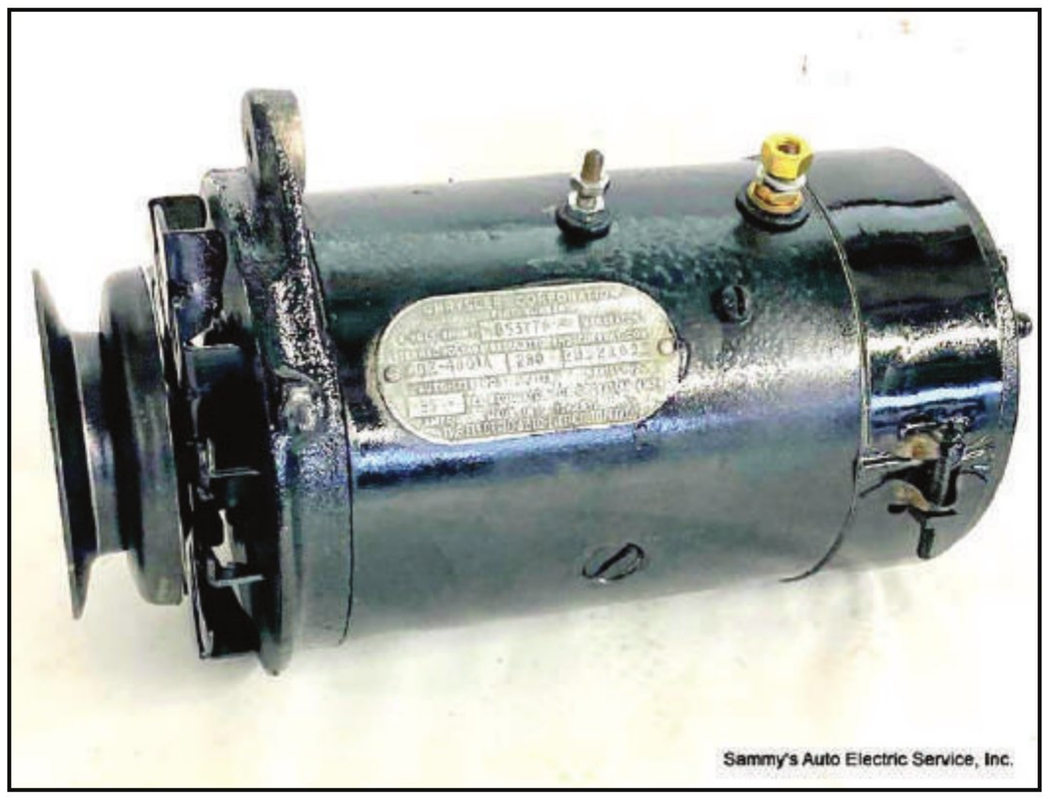


Figure 2 – GDZ-4108A Generator for 1939 Plymouth

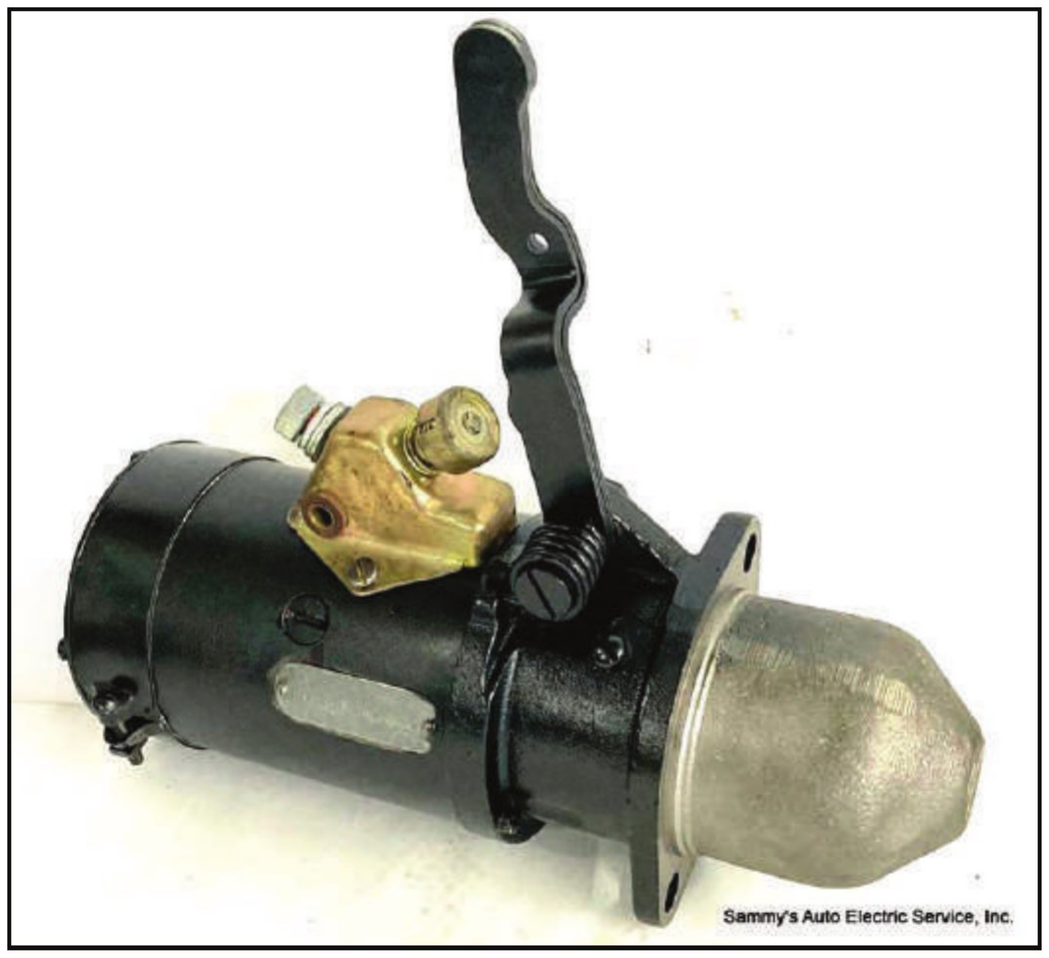


Figure 3 – MZ-4062 Starter for 1939 Plymouth

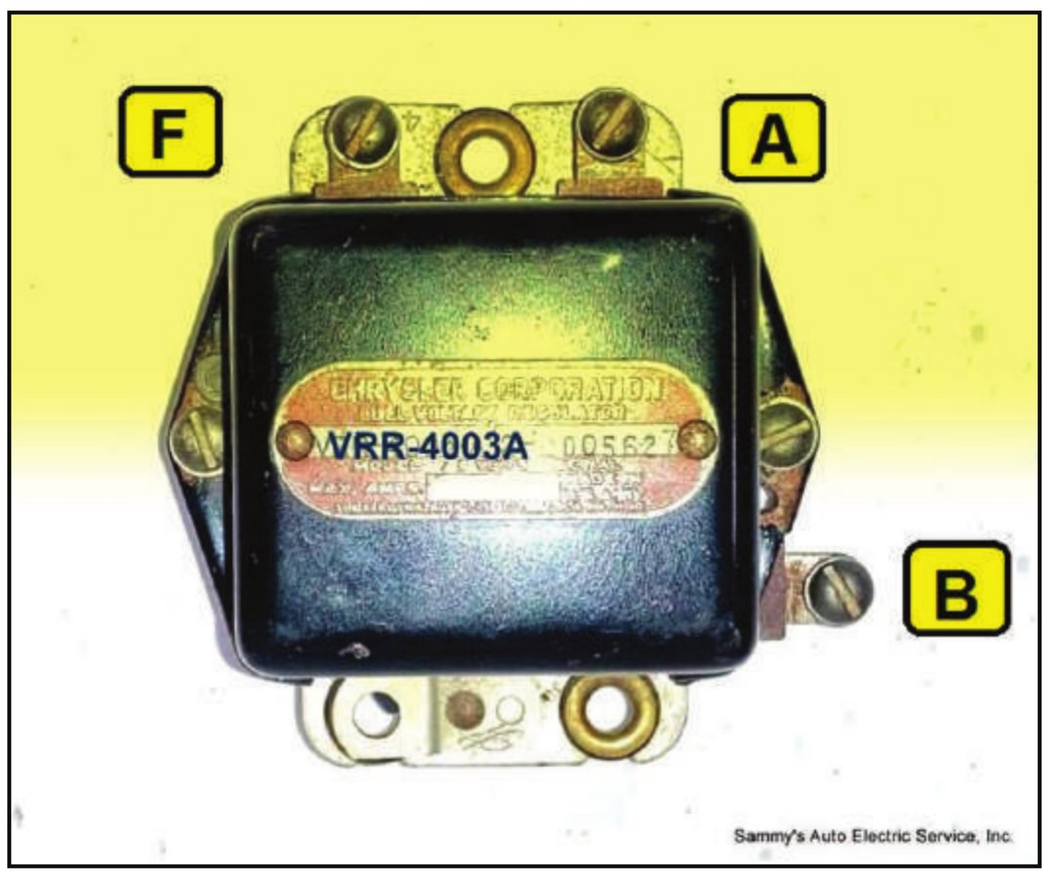


Figure 4 – VRR-4003 Voltage Regulator



Denso Rectifier Swap

Denso hairpin (or more correctly *SC-type*) alternators, particularly their stators and rectifiers have been the subject of many calls on the ERA Help-Line and many discussions on our website's Forums.

Generally speaking, the 100-150-amp versions of these alternators are used in passenger cars and light truck applications. In this category, their stators are either in the more common double-wye configuration (for 130 to 150 Amp) or a single or double-delta configuration (for 100-115 Amp) applications. (*Figure-5*)

The most common rectifier used for the first group is a 12-diode rectifier that may or may not have Avalanche diodes. The second group usually uses a 6-diode rectifier that also may or not have Avalanche diodes. Due to the variety of part numbers for these rectifiers and varied location and size of their output posts, it requires a large stock of rectifiers to be able to rebuild these alternators for a quick turn-around. Service shop customers as well as some individuals are not willing to wait a day or so if you have to order the required rectifier. They can easily go to any parts store, pick up an alternator, or if one is not on their shelves, they can have it overnight.

So to simplify the stock, we buy the most reasonably priced 12-diode rectifier that has 50A avalanche diodes, and by removing the post from the original rectifier and installing it on our new one, we make the ones we need. A few minutes of labor and a little bit of finagling makes swapping the posts quite worthwhile. (*Figure-6*)

The other question that arises is what if you use a 12-diode rectifier for a double wound wye stator in the place of a 6-diode rectifier made for a delta wound stator? After having done this numerous times, I can say with a great degree of certainty that we never had any problem with doing this swap, and we have literally done tens and tens of them.

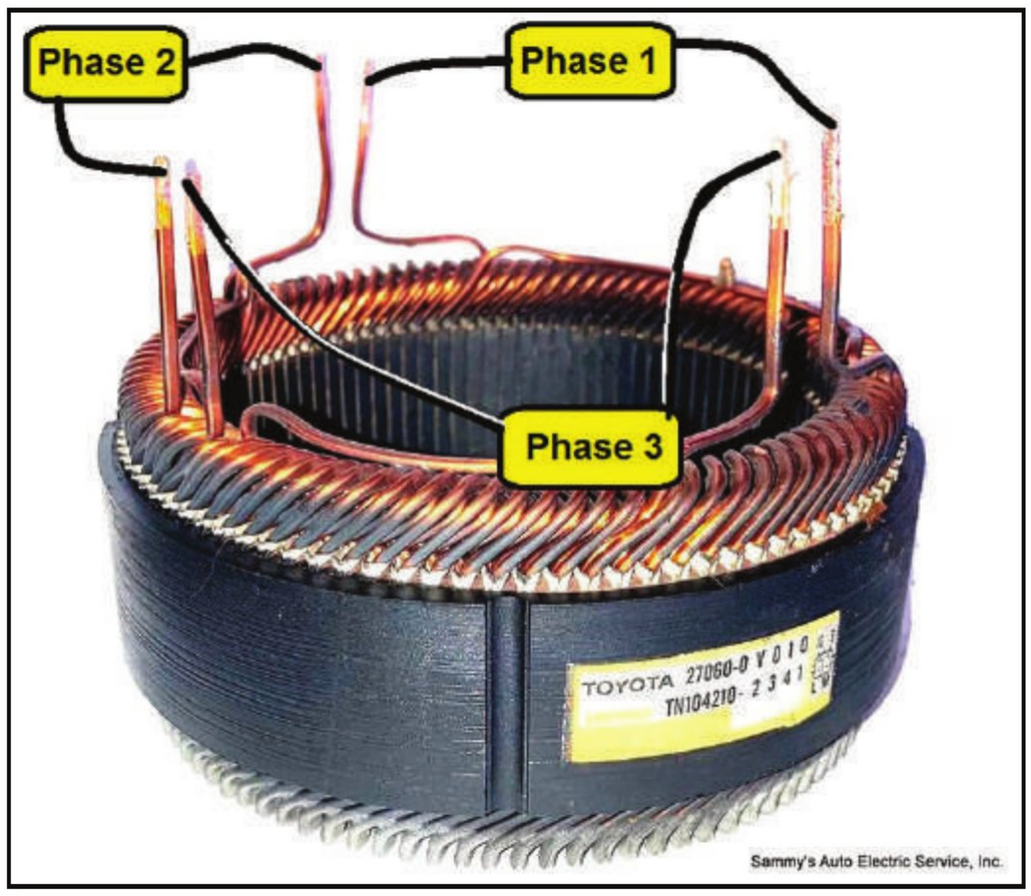


Figure 5 – A 100 Amp Denso Stator in Delta Configuration

If you look at my hand-drawn schematic (*Figure-7*) you will see by doubling the diodes, you are routing the current for each phase of the Delta stator between 2 diodes. This will reduce the current in each diode by half, which in turn makes them run cooler.

The 6-diode rectifier has an internal connector which is a junction point between each phase. Since the 12-diode rectifier does not have this connection, some may think this connection has to be made. That is not necessary. Once all the wires are soldered, the stator will still be in Delta connection. Each phase will pull from the common ground through each respective diode and will push it through its respective positive diode toward the output post while the total vector sum of the current remains the same whether the phase straps are there or not.

To prove the point, I connected our Fluke 88 in a milli-ammeter mode to act as a connecting strap on a 12-diode rectifier, running an 11402 Toyota alternator. As you can see (*Figure-8*) the amount of amperage going through that point is a mere 44 mA (either DC or AC) which would not have any effect on the output of the alternator.

Having talked about the rectifier change, I have omitted the higher output Denso alternators (200-250 Amp) out of this discussion due to peculiarity of their robust rectifier design, where changing the output post to make it into another part number is not quite feasible and at times nearly impossible.

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

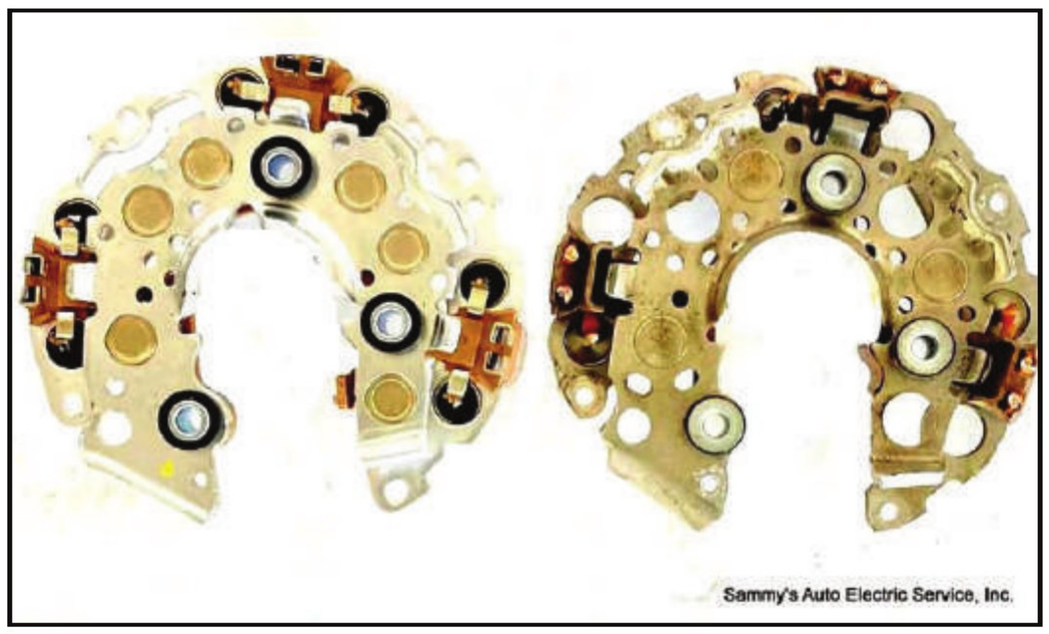


Figure 6 – 6 & 12-Diode Rectifiers with Output Posts Removed

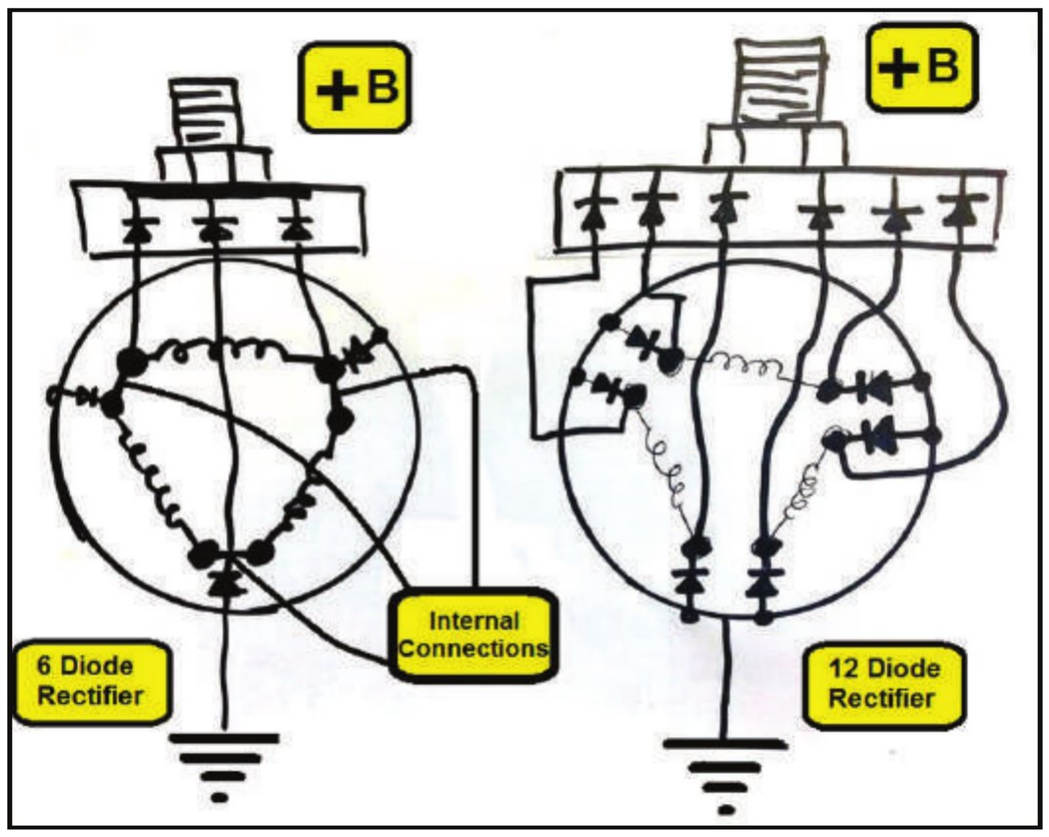


Figure 7 – Schematic Showing 6 vs 12-Diode Configuration

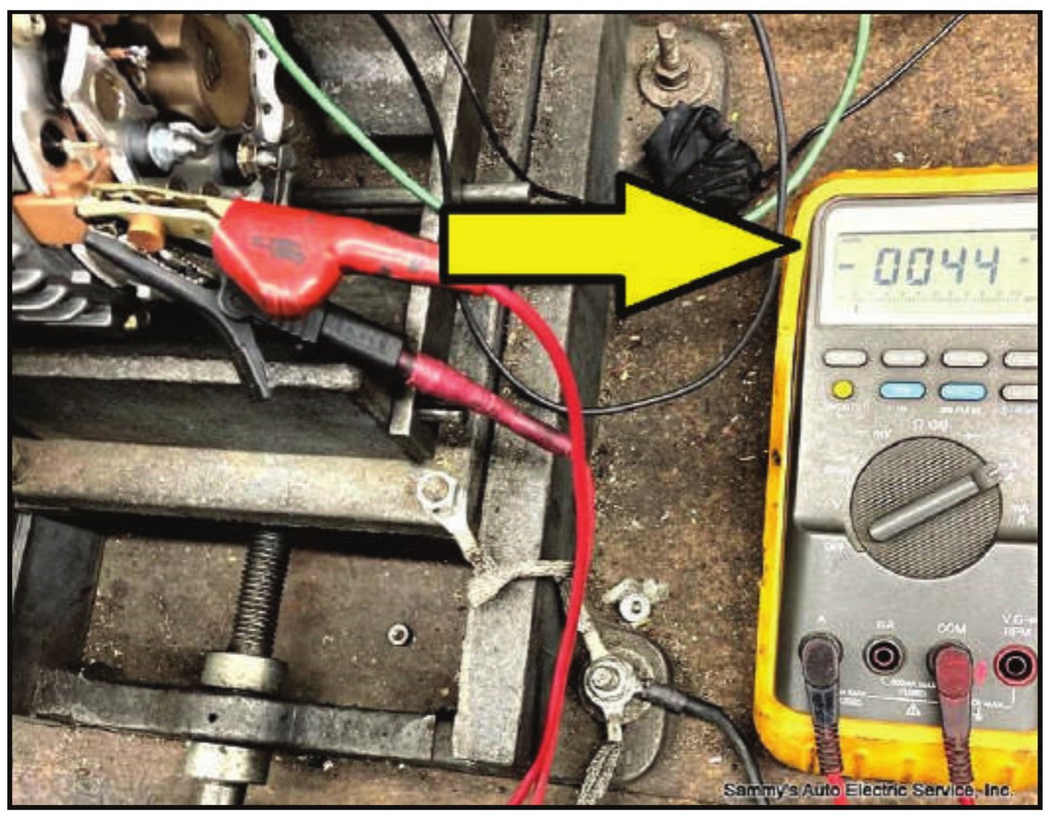


Figure 8 – Measuring Current Flow in Rectifier Straps

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IT WORKED FOR ME

Verifying the Linkage Between the Starter Drive and the Solenoid



BY NATHAN UNGER

A tractor dealer customer sent me a John Deere diesel starter. Denso 028000-3970, Lester 16644 (*Figure 1*). Because he was in such a hurry, I got him a rebuilt one from a big nation-wide supplier instead of rebuilding it myself. What I did not know is that it was faulty from the factory and was waiting for just the right conditions to cause a problem. The pinion clearance had probably been checked at the factory, but there was a little bit of end-play with the armature – either there weren't enough shim washers behind the armature commutator, or maybe not enough behind the center support plate. This means that if the armature happened to be forward as far as the endplay would allow, then the pinion clearance was greater than it should be. Because the armature had spiral splines, and as long as the starter was cranking the engine, the drive would stay forward against the stop collar. This in turn kept the bottom half of the shift lever pulled forward, which means the top half of the shift lever (above the shift lever pin) would push back on the plunger, which would keep the contacts closed. (*See Figure 2*)



Figure 1 – A typical Denso F-series Starter (Photo courtesy ERA Tech Archives)

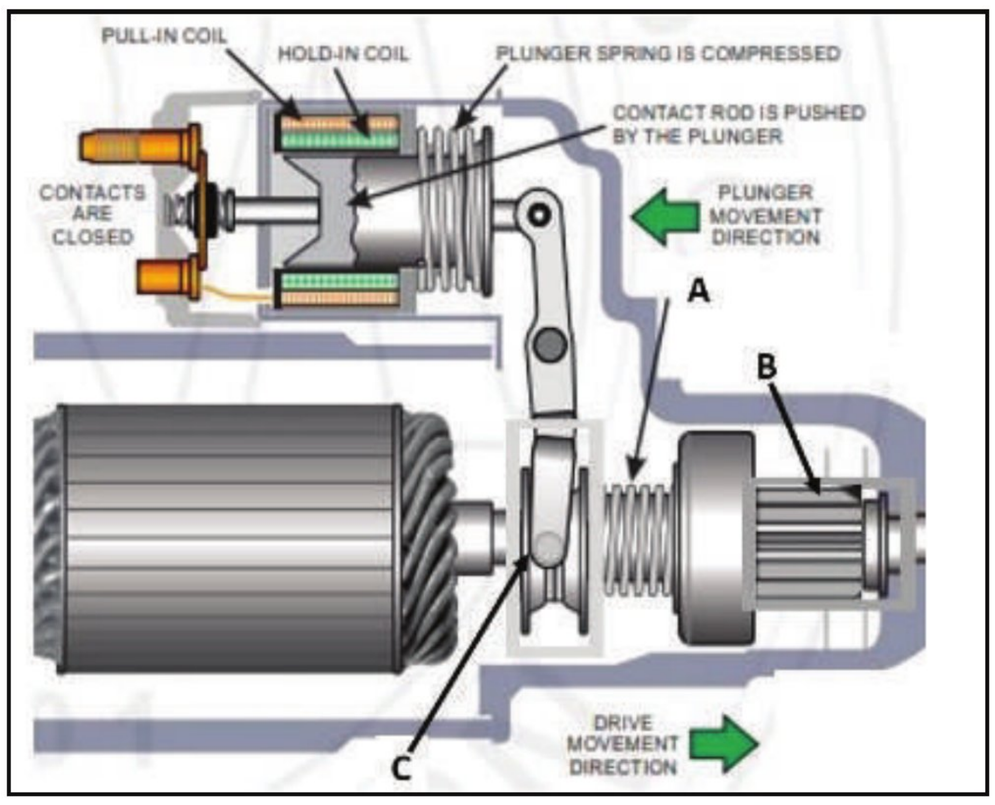

Figure 2 – drawing courtesy ERA Tech Archives, adapted

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Under those conditions, when you let go of the start switch (removing the voltage from the 'S' terminal), if the engine has not started, the starter might keep on cranking. With the armature forward against the front endplay, the pinion clearance was excessive and needed to be reduced.

Please note – this kind of trouble is not revealed with a simple free-run test!

Arrow A - Indexing spring is not compressed

Arrow B - Drive is against stop collar during cranking

Arrow C - While the starter is cranking, the spiral splines hold the drive forward. If the pinion clearance has been adjusted too loose, then the bottom half of the shift lever is pressured forward by the drive spool. This forces the top half of the shift lever to push the plunger, contact rod, and contact disc backward so that the contacts stay closed.

What I think kept the problem from being revealed sooner was that the engine would always start right away, and that would release the pressure on the drive. Because of the spiral splines, as the now running engine tried to speed up the drive, it would help throw the drive back. Until one time when the engine wouldn't start because the farmer ran it out of fuel...

The farmer mistakenly thought he could get that diesel engine started anyway by cranking it for an extended time. Then he thought he should let the starter cool for a bit. Imagine his surprise when he released the start switch, but the starter kept right on cranking. He hastily removed a battery clamp to put a stop to that, and then sent the starter back to the tractor dealer who sent it back to me to figure it out. (That's the short version!!)

There are different ways to deal with this, but I tightened the castle nut inside the solenoid to move the contact disc back a bit. (*Figure 3*)

This of course, reduced the reserve burn-off too, but it was still within range – about 2mm.

To adjust the castle nut, I had to remove the roll pin that keeps it. That takes such a thin and long punch that the punch might get bent. So I took a larger size punch, and flatted two opposing sides on the grinder. Now I have a stronger punch that is still thin enough. Once the pin is sticking out on the back side, I can pinch/grab it with side cutters to pull it out, a little at a time.

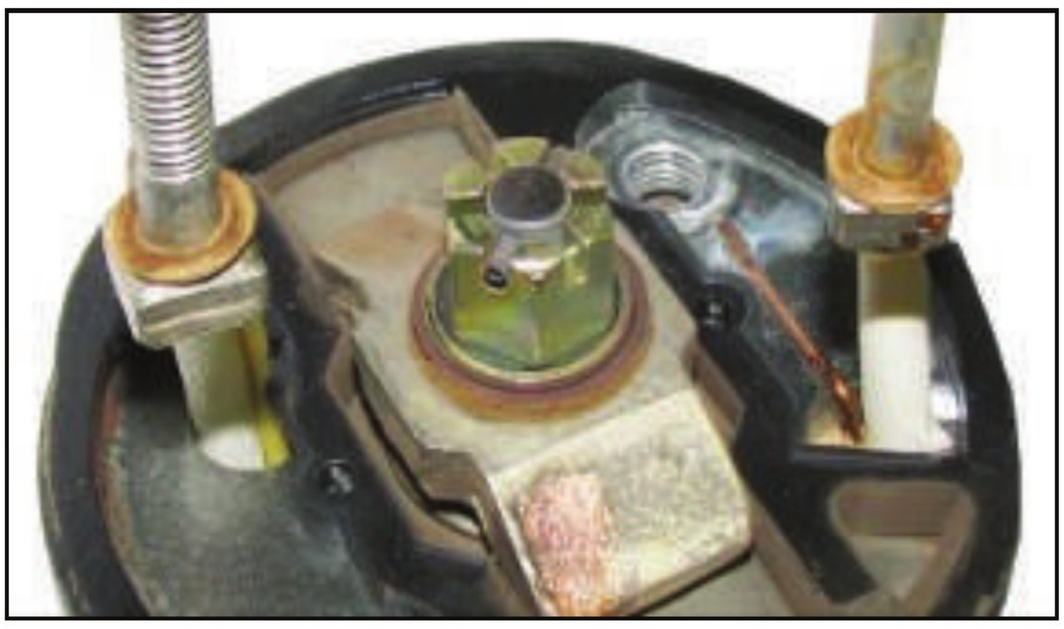

Figure 3 – Courtesy ERA Tech Archives



To pre-empt this run-on problem, every time before I free-run test a starter, I pry a screwdriver or hook between the drive and the housing to put forward pressure on the drive to make sure it is forced as far as it can go against the stop collar, and also to eliminate forward end-play of armature. (*See Figure 4*)

At the same time I have my continuity beeper connected (between the B+ and the motor stud) so I can make sure the contacts stay open. (*See Figure 5*)

I do NOT connect or apply battery power to B+ at this point, only the 'S' terminal.

Therefore, when I release the solenoid 'S' voltage with the drive pried forward as far as it can go (also eliminating shaft forward play), the contacts should open and the beeper should turn off.

In Figure 5, notice the little 'sound wave' icon at the top of the display. I have selected the continuity beeper mode on that meter. I highly recommend that meter (Extech MN16A) because of its versatility. I refer to it in other articles also.

On many starter designs there is also slack designed into the linkage, but this design didn't have that, so the linkage had almost no play. It also did not have the cam-style shift lever pin, which on some starter designs is used to adjust the pinion clearance. That's why I resorted to adjusting the castle nut and setting the moveable contact further back. It was brought to my attention by my venerable colleague and mentor Mohammed Samii, that the shift lever being installed backwards could also cause this problem. In Figure 2, the shift lever is bent, another problem to watch out for.

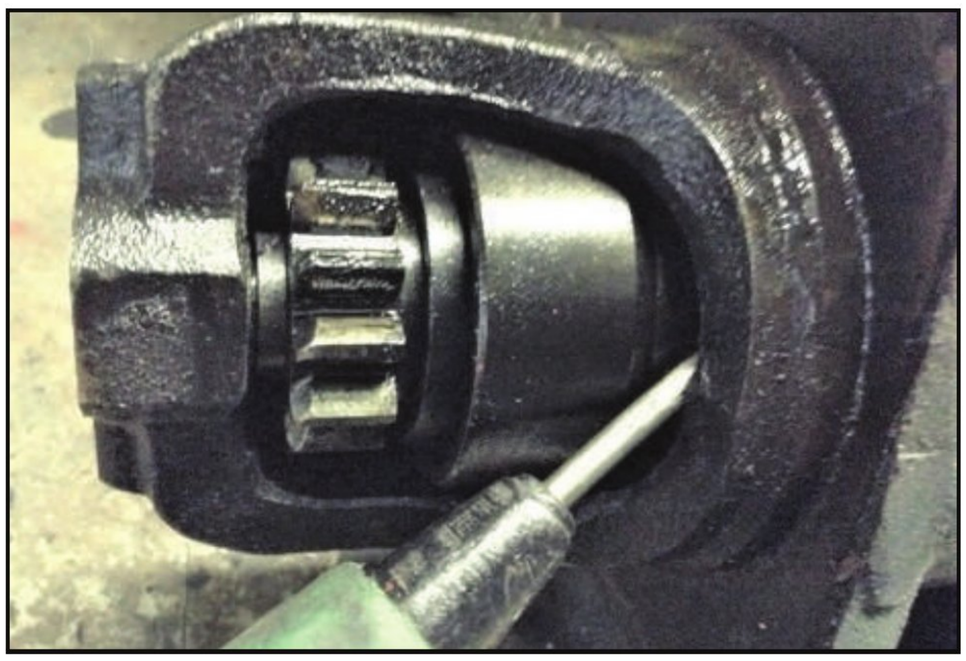

Figure 4 - a screwdriver between the drive and the housing to put forward pressure on the drive

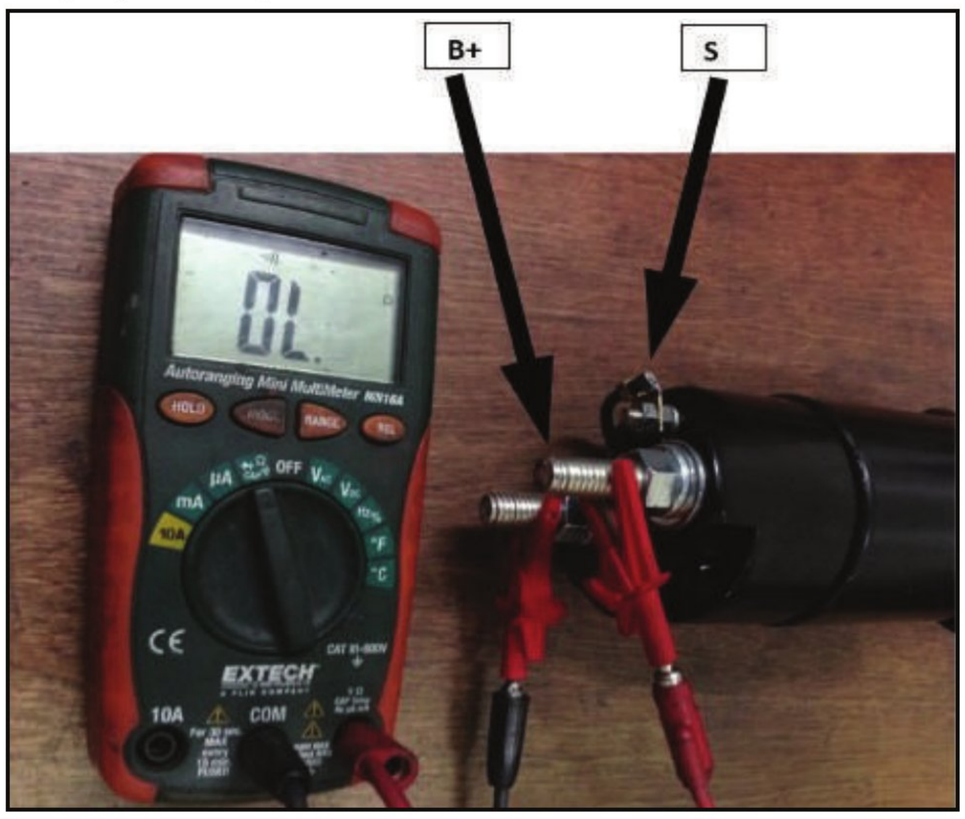

Figure 5 – Testing contact closure on a solenoid

— FIVE IMPORTANT SOLENOID TESTS —

Test #1 Drive At Rest

At the rest position of the drive, there should not be play in it. There is usually a brake washer behind the drive if the starter has a CS (center support) plate, or a brake washer at the commutator end of the armature, if the starter does not have a CS plate. This brake washer is to slow the armature down more quickly after cranking to avoid unnecessary brush wear, and to avoid having parts rattling around while the engine is running.

Make sure the power is off, then check for play in the at-rest drive by simply tugging/twisting it.

Test #2 Pinion Clearance

Verify the pinion clearance between the drive teeth and the stop collar, while gently pushing back on drive. Apply 'S', but power should NOT be connected or applied to B+. You don't want the starter to spin while you are working with the gear.

The drive gear should not clamp tightly against the stop collar. If it does, that means that the linkage is too tight, and may cause a click-no-start problem in the case of abutment (except in certain soft start designs). The contacts must be able to close even if the teeth are not meshed yet, so that the starter can start turning. This will then clear the abutment problem. (Alternately, if the pinion clearance is too loose, then you may see a run-on problem as described above.) See Figure 6 for the spec and the technique.

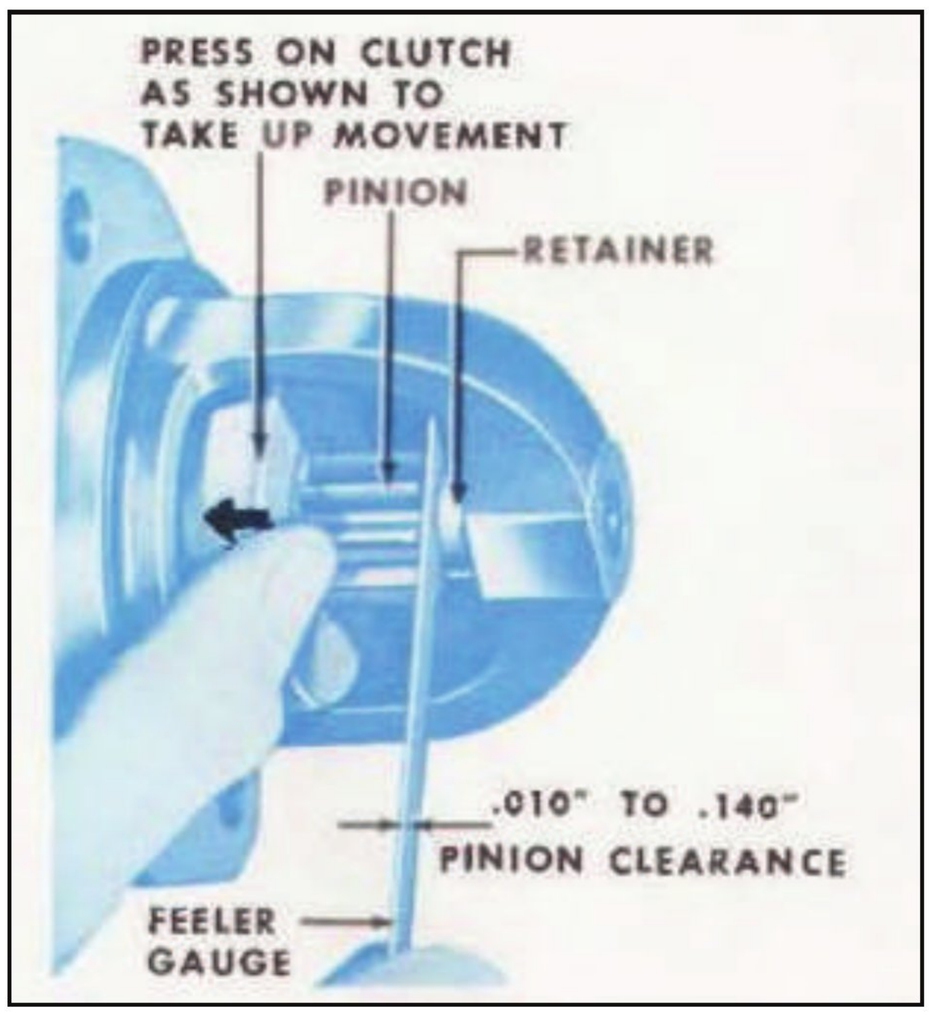

Figure 6 – Courtesy ERA Tech Archives

Test #3) Blocked engagement voltage

Arrow A - Long wear pattern from leading edge as drive gear is cranking the ring gear.

Arrow B - Bevel to insure engagement with ring gear.

Arrow C - Shorter wear pattern from trailing edge on the back side of each tooth. It is a shorter pattern because the ring gear has the bevel on the tooth facing the trailing edge of the drive tooth.

When the drive bevel hits the ring gear, it will slide off and move into mesh. The direction it slides will be the same as the rotation of the starter. This is called indexing. (*See Figure 7*)

Skill testing question:

What direction will gear in Figure 7 turn? CW or CCW? Notice the bevel on the teeth. The correct answer will be viewed from the gear end, not the cam end. I will give the answer at the end of this article.

The wider pattern (*arrow A*) on the leading edge of each tooth is our clue as to how far back the drive will be if it abuts without meshing. I made a stepped gauge out of 14ga sheet metal. I find the step that is closest in width to the wear pattern (*arrow A, Figure 7*) on the leading edge of the drive tooth. I put that step in between the drive gear and the stop collar. This simulates the situation where the tips of the drive abut the tips of the ring gear teeth instead of meshing properly. The contacts of the solenoid cannot close until abutment is cleared. But current flowing through the solenoid's pull-in coil passes through the motor circuit to get its ground. That causes the armature to rotate slowly until the pinion clears an abutment.

I gradually increase the voltage to the 'S' terminal (with the B+ NOT applied nor connected) with my feeler inserted as shown (*Figure 8*) until the continuity beeper sounds. This voltage should be no more than 9.5-10 volts max for a 12v system.

For a description of a way to vary (and measure) the voltage to the 'S' terminal, see Figure 1 in my article (Hold On Solenoid) in the July issue of the ERE.

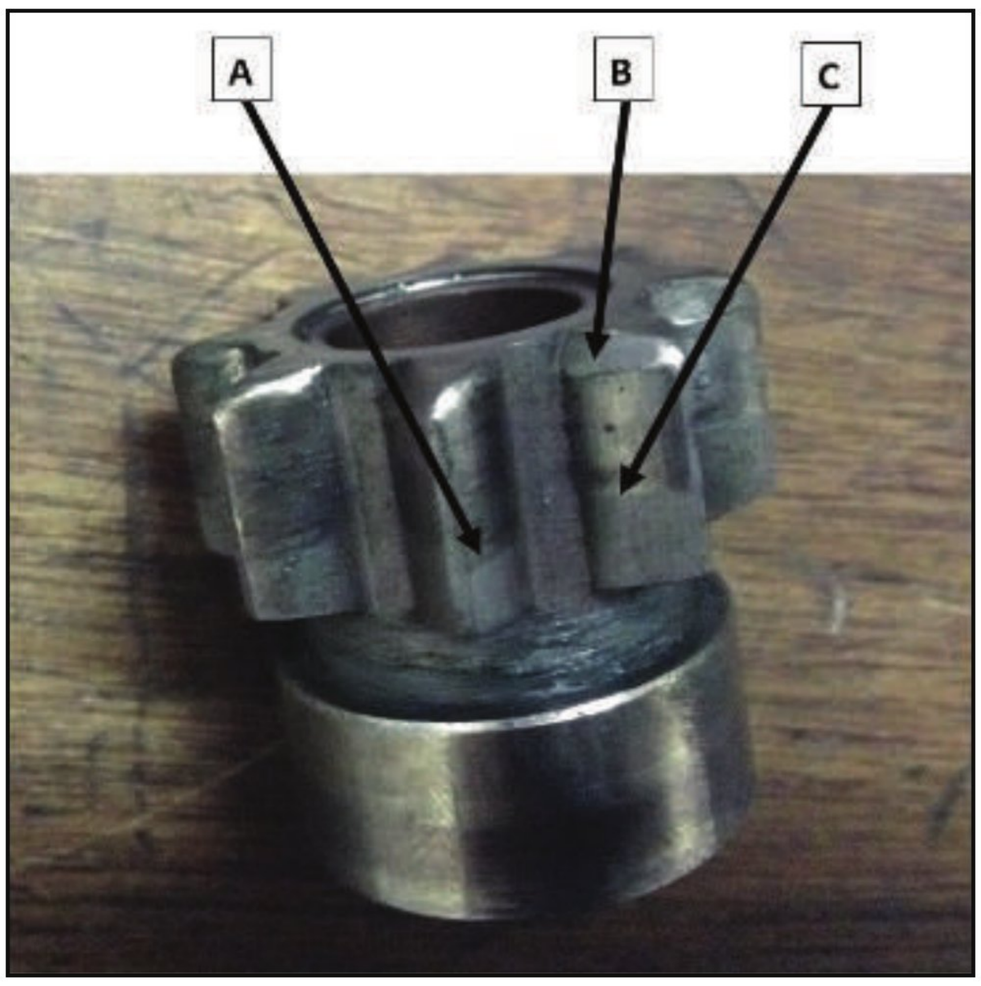

Figure 7 – bevel and wear patterns on the teeth

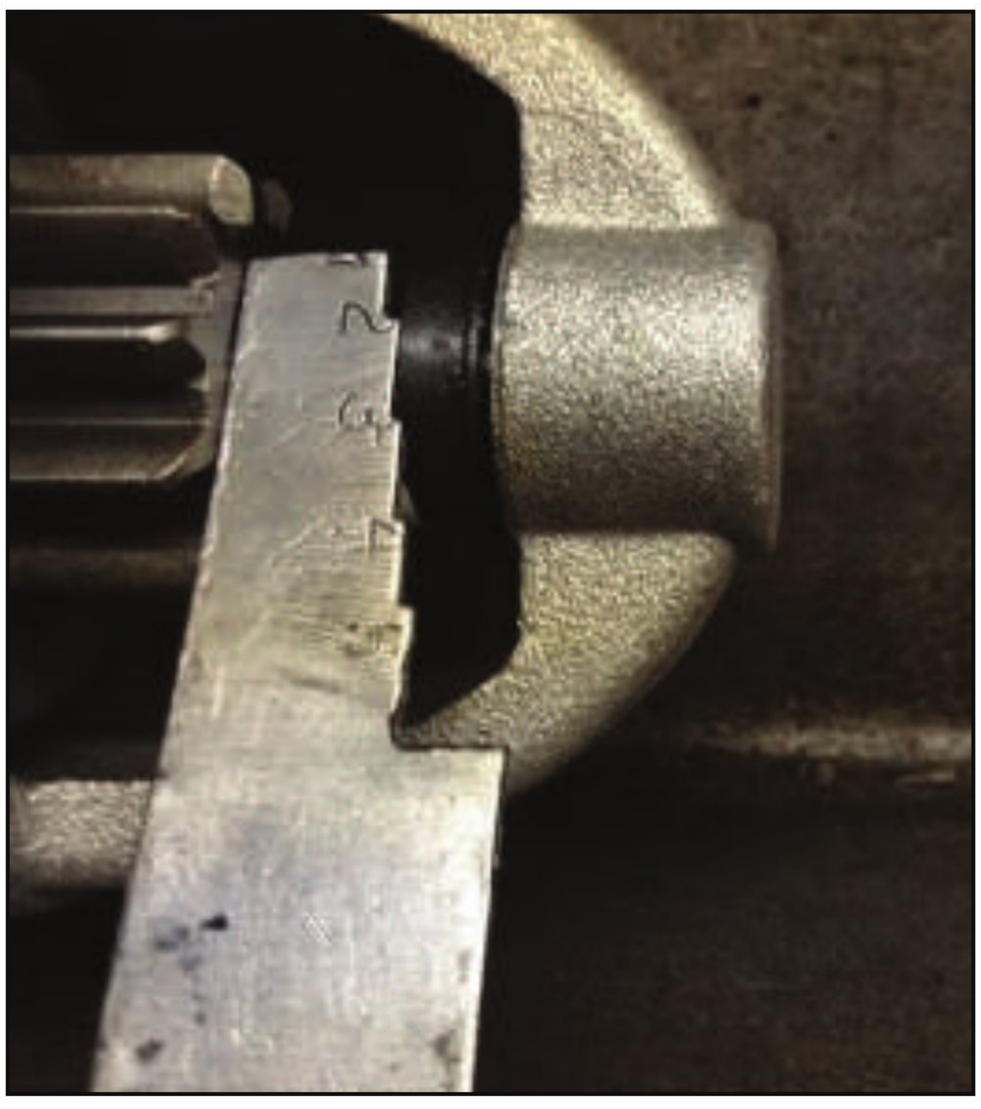

Figure 8 – Blocking the gear to simulate abutment

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Test #4 Drive Blocked Forward

As described above, this will ensure the starter will not run-on. (*See Figure 4*)

Make sure the drive body (not only the gear) is forced as far as it can go against the stop collar, and also to eliminate forward end-play of armature. This test is done by engaging the 'S' electrically, inserting your screw driver or hook, then releasing the 'S' voltage. Again, do NOT apply or connect B+ for this test. The continuity beeper should be silent with drive gear forced forward, but no voltage at 'S', indicating that the contacts can open under those conditions.

Test #5 Contact voltage

To do this test, connect it like in Figure 5, but now use the DC voltage scale instead of the continuity beeper.

Do your free run test like normal, and note this voltage while the starter is spinning.

I like to see 50mv (0.05V) or less at free-run current, but definitely under 100mV (0.1V).

In a Toyota starter servicing guide published in the ERE: (keyword search "exploring" and it is article #3 in the list, called *Exploring Toyota Battery/starter Circuits Starter Circuit Inspection And Testing Procedures Part II*) **www.electricalrebuilders.org/eren/archive/ere_2009/ere_2009_05_exploring_toyota_part_2.pdf** (*see step 6b on the last page*)

- it said to try it at least 6 times, because the burn-off will change character every time you open and close the contacts.

They are getting a maximum of 0.5 volts drop across the contacts because the starter is cranking the engine and drawing more current than at free-run, so if you have a starter load tester, you should get a similar result each of the 6 tries when under load.

Also please note: It is very important when free-run testing any starter, that you activate the solenoid independently of power to the B+. If your test bench connects 'S' and B+ together first and then applies power, it will mask some potential problems. The correct way is to first apply power to B+, then apply power to 'S'. When releasing 'S', leave B+ on until after.

Solution to skill-testing question:

The drive gear in Fig 7 is from a CCW drive. Imagine if that bevel hit a sharp solid object, which way would it force the pinion? Viewed from the gear end, it would be forced CCW.

Another way to verify an assembled drive's rotation is to twist the pinion manually. In the direction it clutches or ratchets, that is the direction the drive is designed to operate. It seems almost counter-intuitive, but it's all about your frame of reference. If you hold the gear still, and then twist the drive body, it will 'grab' in the same direction it clutches when you hold the *drive body* still, and twist the gear. (as viewed from the gear end in both cases).

Many thanks to Mohammed Samii for proofing this article.

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BY JERRY ZELAZNY

A while back, a customer brought in a generator that I had never seen before. It came off a JLG 600AJ articulating lift boom and looked somewhat similar to an older automotive generator. It was belt driven with a single and had a steel field case with aluminum housings at each end. Both end housings were completely destroyed with the mounting ears broken off (*see Figures 1 and 2*). In addition, the bearing cavities were hollowed out too. Oh, and this generator puts out 110v AC at 60 Hz to run power tools from an outlet in the bucket.

After several phone calls I discovered that no service parts were being offered anywhere for this unit that was manufactured specifically for JLG's lift booms. The price of a new replacement generator was about $1,300, which leaves a lot of room to make money if only I could find new housings.

At the suggestion of a friend, I took them to a local machine shop that had the capability to weld aluminum. Not only did they repair the broken mounting tabs, they made them stronger in the process. They also bored out the bearing cavities to oversize and installed steel sleeves to hold the new bearings more secure (*see Figure 3*).

As you can see in the third photo, the repaired CE housing looked good as new. In fact, both of them were better that they were when they were new. The customer was elated and the sale was profitable for me. Sometimes we have to look beyond our normal supply chains in order to make the sale.

Jerry Zelazny is the owner of Jerry's Sales & Service in Northbend, Nebraska. You can reach him by phone or text at 402-919-9379, or by email at: jpzelazny@outlook.com.



Figure 1 – Damaged drive end housing

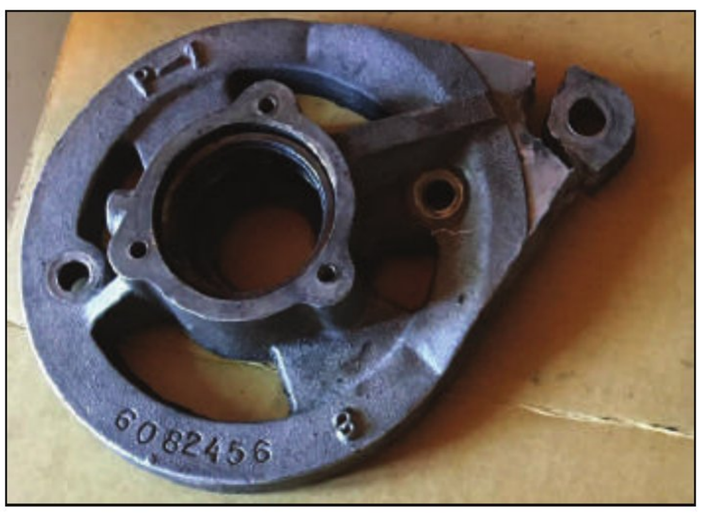

Figure 2 – Damaged rear end housing

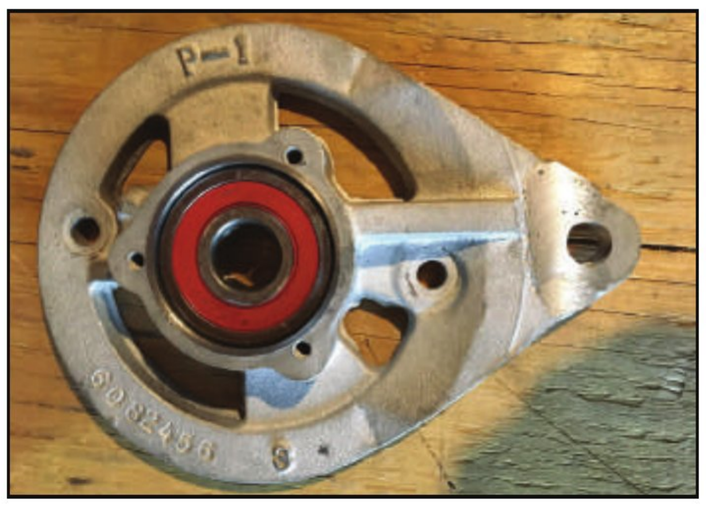

Figure 3 – Rear housing after the machine shop repair



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