ERA EXCHANGE

YOUR GUIDE TO ELECTRICAL REBUILDING

August 2020 $12.95

AUTO ELECTRIC CORNER
Test Fixture, eBay Alternator and Old Prestolite

A TALE OF TWO ARMATURES
What Does High Torque Really Mean?

COMMON SENSE | A Rebuilder's Nightmare

A WORD FROM THE PRESIDENT

Thank You All



With the cancellation of the 2020 ERA Trade Show, which would have included the Sunday morning ERA Annual Meeting, the executive board made the decision to hold that annual meeting as part of our June Board Of Directors Meeting. As many of you are aware, the agenda of our annual meeting includes the election of officers to fill all of the expired terms on the Board of Directors and the Board of Advisors.

Fortunately, enough members were present at the meeting to form a quorum and the elections were performed within the rules of our bylaws. I want to thank our nominating committee for their work at providing and presenting our slate of candidates. I also want to thank all of the members who volunteered to become an officer and those that volunteered to continue to serve another term.

Our association would not be able to function or be as successful as it has been without the dedication of all of those that committed to giving up their own time and efforts to help us fulfill our association's Mission Statement: "The purpose of the Electrical Rebuilder's Association is to further the electrical rebuilding industry by providing information and training to the members of the association and promote the professionalism and public awareness of the industry as a whole." As the saying goes, as a group we can move mountains. Again thank you all.

Our office has informed me that all of the 2020 ERA Trade Show registrants have been contacted and all requested refunds have been either mailed out or credited to their respective credit card accounts. Many of our supplier member vendors have requested that their registration fees be applied to their ERA Exchange advertising accounts. I encourage all rebuilder members to remember to patronize our monthly magazine advertisers. They make it possible for you to receive this publication. Without their support we could not produce and publish it. As for the rebuilder members who registered, the office has informed me that approximately $18,500.00 of trade show registration fees have been donated to the association in lieu of a refund.

I am completely blown away and overwhelmed by this news. I am at a loss for words to describe just how grateful I am for your support and thoughtfulness. In today's world, with so many negative things going on, all of you are true heroes. Thank you all so much. I am looking forward to the 2021 ERA Trade Show and am looking forward to personally thanking every one of you for your support when I see you there.

Ken Plourde

NEW ERA MEMBERS

Sanford Hydraulic, LLC
Sanford, North Carolina

Carpenters Auto Electric
Wadesboro, North Carolina

ABOUT THE COVER

High Torque 25MT Armature, Lester 1998

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EDITORIAL ASSISTANT / Bob Thomas

DESIGN & PRODUCTION / Stephanie Schroeder

CONTRIBUTING WRITERS / Mohammad Samii, Ken Plourde, Dan Bell, Bob Thomas

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& ANNOUNCEMENTS

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AUTO ELECTRIC CORNER —
Test Fixture, eBay Alternator and Old Prestolite



BY MOHAMMAD SAMII

Test Fixture

Testing popular PM (Permanent Magnet) alternators made by Kokusan-Denki (acquired by Mahle in 2015) are the subject of occasional calls and questions on the ERA Help-Line. I wrote about my method of testing these in the January 2018 issue of the *ERA Exchange* in the Auto Electric Corner column. In that article I showed how I used the coil of a Chrysler alternator rotor as a load, with a 194 bulb across the coil to function as a visual indicator. I also showed the scope capture of the resulting AC wave form.

Some rebuilders use only a test-light across the two AC wires but I believe that might be insufficient to emulate the actual load. Additionally, if the alternator is good, the light gets very bright and with a slight increase in the RPM, it can blow out the bulb…which is a common occurrence.

Due to their small size and shape, securing these alternators on the test bench is tricky. So to find a better and more secure way to run them, I modified a broken Ford IAR DE housing by removing the center portion of it (*see Figure 1*) and drilling extra holes to mount the alternator (*see Figure 2*). This allowed a more secure way of installing and running them on the test bench. Of course, many alternator housings could be adapted for this purpose but the 3-inch (76mm) long mounting spool of the Ford DE housing makes for a sturdy platform of sort to run these on a test bench (*see Figure 3*).

I am hoping our ERA machinist guru Mike Dietrich forgives me for my sophomoric attempt at machining, milling, and grinding…! I also would like to solicit opinions from the readers to know what they use (if any) for testing these alternators. Please send me your ideas with pictures to be promoted here or on the ERA website, which may qualify you for a prize of some sort…!

eBay Ford Mod alternator

There are plenty of starters and alternators (as well as practically anything else under the sun) sold on the internet by eBay, Amazon and assorted online stores. There seems to be no slowing down in that regards. These online purchased units may or may not work for the application claimed. But at times we get to fix them as a last resort because the replacement would not function either. By then the customer has given up on the internet supplier and is desperate to have it done locally, even though he or she has spent a significant amount of money already.

Case in point was this self-exciting alternator that was a mixture of a 10-SI with a Ford type DE housing, made to fit a race car of sort with a Ford engine. The label "Tuff

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Figure 1 – Ford IAR housing modified to hold a Kokusan-Denki PM alternator



Figure 2 – Running a PM alternator using our MOD fixture

Stuff" that implied a robust solid construction was obviously a misnomer as it was dead-on-arrival and not very "tuff" at all…!

A teardown to inspect the internal parts quickly showed the problem. As you can see in the photo (*see Figure 4*) of the rotor. In addition to being open, it had loose claw poles that had shifted, perhaps causing the coll to become open. A replacement rotor from a 10-SI worked well but we noticed the turn-on speed was around 4000 RPM with his regulator. A new Regitar regulator



Figure 3 – The 3-inch spool making for a stable fixture

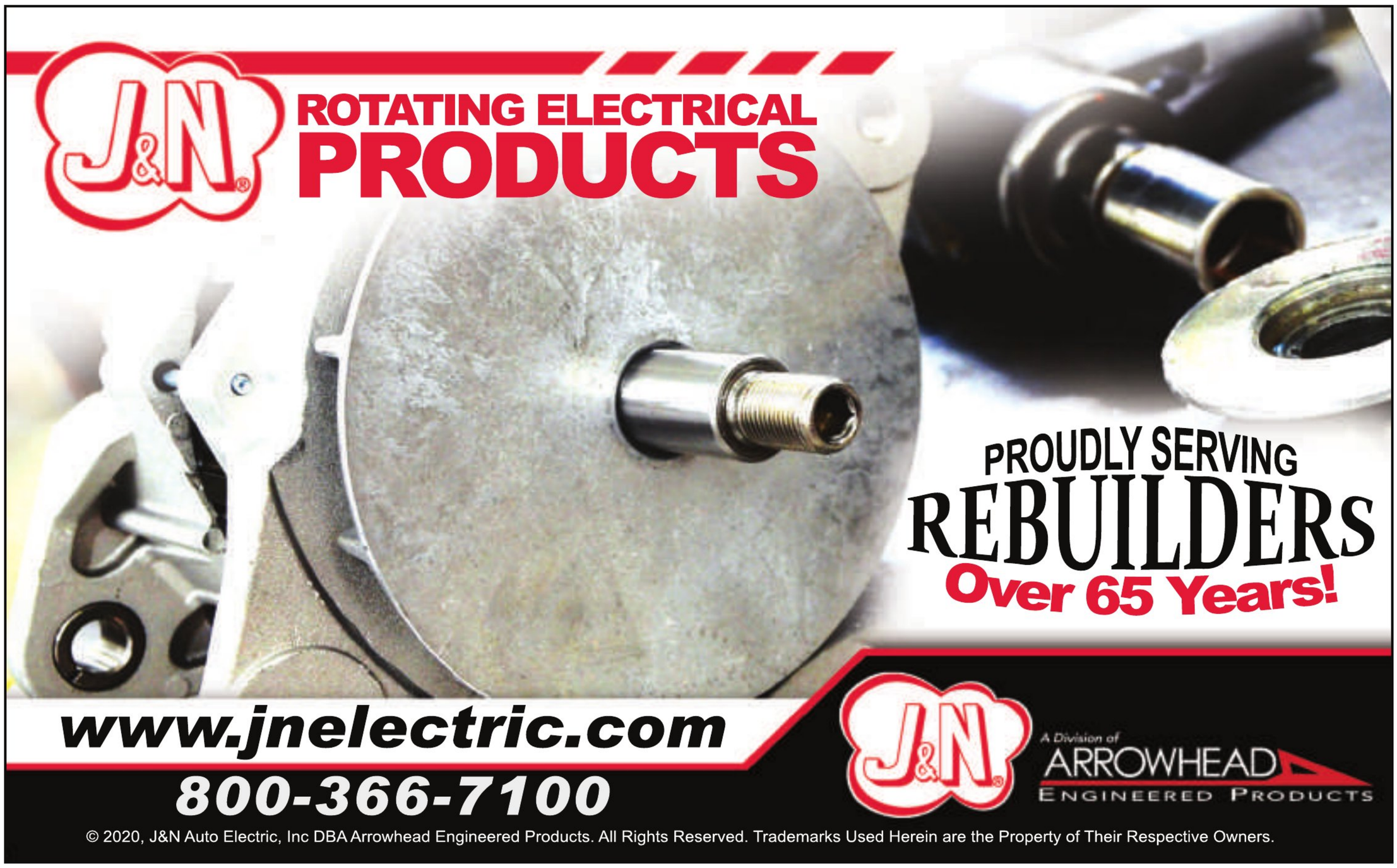




Figure 4 – Tuff Stuff Mod alternator for Ford application



Figure 5 – Prestolite ALK-6221 for an old Eaton (Yale) forklift

was installed which brought the turn-on RPM down to a very acceptable 2000 RPM. As usual, I gave the customer a little lecture, emphasizing the benefits of getting things done locally with the people who live, pay taxes, and support the infrastructure in their own backyard, something that cannot be expected from an unknown eBay seller.

An Old Prestolite Alternator

When possible and feasible, I try to stick to rebuilding an original alternator that came with the machine rather replacing it with a 10-SI or and any other modified units. My reasoning is twofold: first, rebuilding the original unit, particularly if it is a rare hard-to-find one commands a much better price, and second, with these days of internet accessibility, almost everyone can find a self-exciting alternator, thus my services may not be needed as much. Whatever the reason; I prefer rebuilding the originals.

Case in point was this older ALK-6221 Prestolite alternator (*see Figure 5*) from an old Eaton (Yale) forklift that could not be found anywhere. The customer who depended on his machine was desperate as his effort to find one at various auto part stores did not pan out, and he was directed by one of them to us.

Rebuilding the alternator was a straightforward process as far as rebuilding an old Prestolite alternator was concerned. The teardown went as planned without breaking anything, the stator, regardless of its age, was in a very good shape, the slip-ring was good enough to be polished, and the regulator checked fine. The blown diodes were easily replaced and after cleanup and blasting, it turned out to be a satisfactory rebuilt, delivered in a clean and service-ready shape to a happy customer who did not think twice about our $275.00 invoice.



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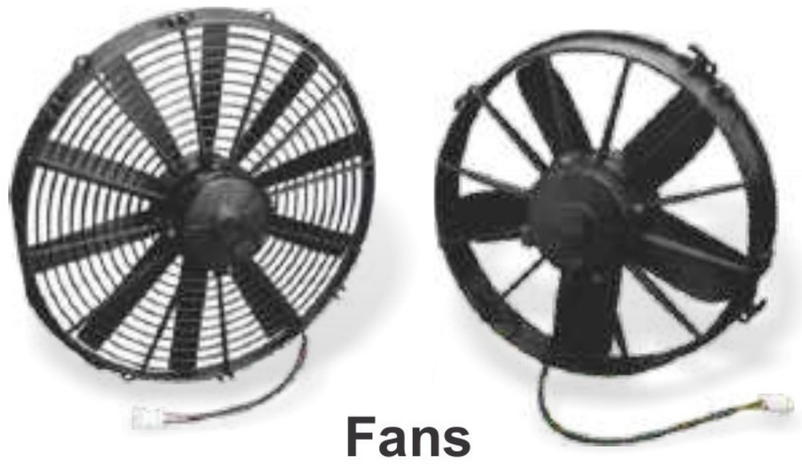
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While rebuilding this alternator and changing the blown rectifier diodes, I noticed this was one of those old style units that has 4 diodes on the positive heatsink. Three diodes are the typical positive diodes that are attached to any positive rectifier heatsink but the fourth diode that acts as an isolation diode is Negative, even if it is pressed into the positive heatsink. A point that must be observed, otherwise the alternator would not work.

Since this single diode carries the entire alternator's output, it is preferable to use one with 35 or 50-Amp capability (*see Figure 6*). It should also be noted that there is a post on this alternator that the battery positive connects to. It is totally insulated and does not have any connection to anything inside the alternator. The isolation diode is connected to the output post which is connected externally through a short fusible link called a Reverse Polarity Protection or RPP link to the battery post. The RPP is there to protect the alternator from a reverse polarity connection, such as hooking up the battery backward (*see Figure 7*).

In our case the RPP link was missing, probably discarded during the long years of service. So we instructed the customer to use the output post for the B+ wire. For more details on this alternator you can check out "Look-Up Diagrams" heading of the Jimco on-line catalog on the ERA website, select Prestolite and click on PRES24 on the bottom row of the first page for all of the details.

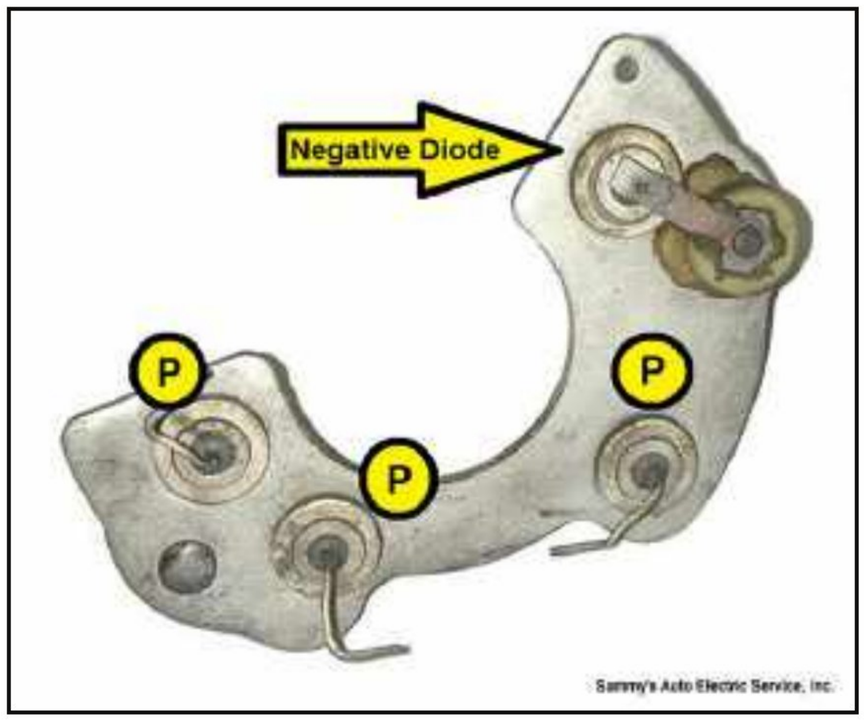


Figure 6 – Positive heatsink of the Prestolite ALK alternator

Denso Drive Gear

Our shot blaster was running when we heard a loud noise followed by a repeated banging sound of a loose item in the blaster. We rushed to it and shut it down as quickly as we could to prevent any further damages. What caused the problem…? It was a drive gear for a Denso 228000-6320 starter. To clean and polish these gears, we usually tie them to a larger piece like the starter housing, and use a few twisted strands of discarded field coil or solenoid coil wires to prevent them from getting loose in the blaster. But this time the wire somehow broke and the gear got loose and fell through the basket.

The damage to the blaster was manageable and the broken paddle plate was replaced with a good used one that we had saved. It all worked fine while it could have been a lot worse. But now finding a new gear to replace the broken one became a challenge and almost impossible as every supplier with the exception of one did not show any stock (*see Figure 8*).

The unit belonged to an implement dealer. It was an original Denso for Kubota application, and as a dealer, they did not want a much cheaper and easily available aftermarket replacement.

At the last moment, Romaine came to rescue. They were the only vendor who showed any stock, with just three in their Kent warehouse. So an order was put in for two, the parts arrived a few days later and the Kubota starter was delivered to the dealer. Now I have one extra gear for this starter, waiting for a day that it could be needed. Many thanks to Romaine for saving the day for us.

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

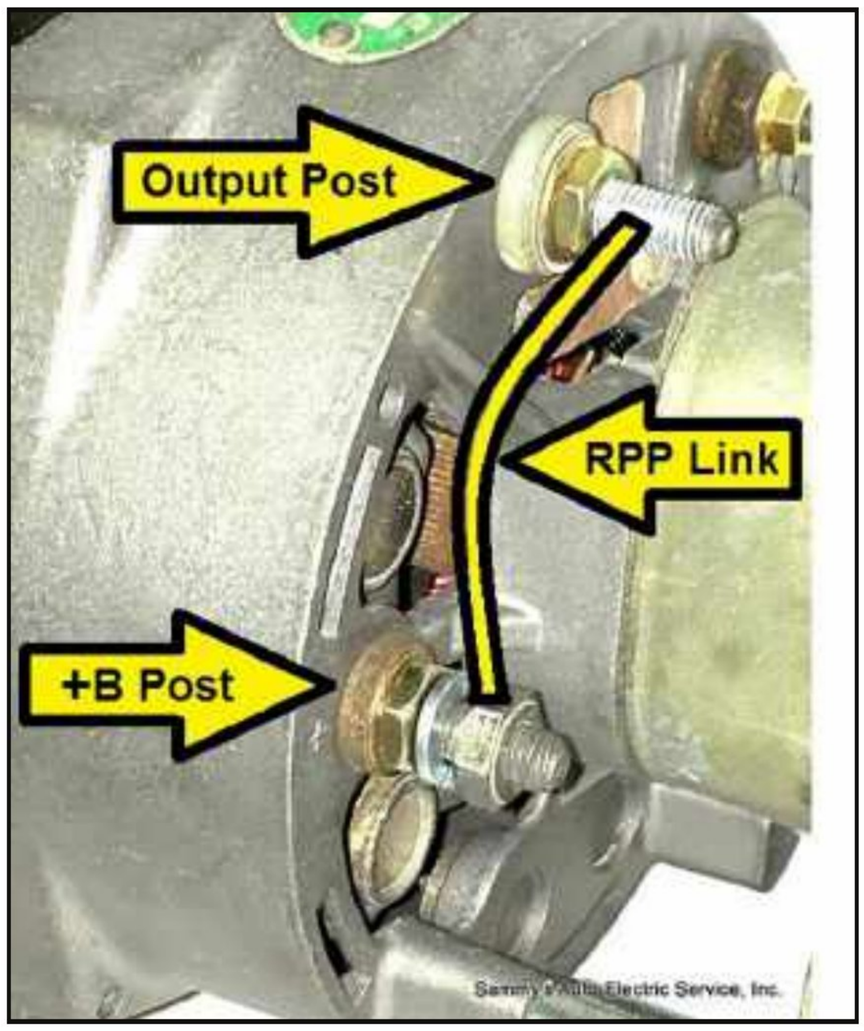


Figure 7 – RPP Link connecting +B and output post



Figure 8 – Denso 228000-6320 starter and broken gear

COMMON SENSE —
A Rebuilder's Nightmare



BY BOB THOMAS

I was cruising down I-95 looking forward to spending a long weekend with my dad when it happened. He's 94-years-old and still lives in the same south Florida home where I lived as a teenager. It was a beautiful day, the sky was clear and the traffic was light because I was already well past the I-4 exit in Daytona. I was just 50 miles north of my halfway point.

Through this part of the state, there is still a lot of undeveloped land with only a few sparsely populated small towns – if you can believe that after visiting Orlando or Miami. In the 1960's much of the Florida peninsula looked like that. This section of I-95 did not even exist then and US 1 was the main highway along the east coast, heavily traveled then by tourists and truckers alike. Mom and pop businesses provided food, comforts and rooms by the night.

About 20 minutes past New Smyrna Beach, something on the instrument panel caught my attention. It was a red light - the one with a battery icon. My first thought was oh no, this could not be happening in a worse place. Instinctively I switched off the AC, cracked the window open about six inches, turned the radio off and even unplugged the cell phone charger to save energy in the battery. I was aware that the biggest drain was the fuel pump and it would probably be the first to quit working when power ran out.

Forced to drive on to the next exit, I was unsure of how far away that was and what I would find once I got there. As it turned out, the next exit was Scottsmore, which is not really a town at all but more like a rural undeveloped area. What I found there was one self-service gas station and lots of cows in pastures on both sides of the road.

About the only good thing about the Scottsmore exit was its close proximity to US 1, which was less than a mile away. In some places the two north-south highways are over 10 miles apart. That was the only thing going in my favor at that point. I thought that Tituseville to the south was too far away to risk running out of battery, so my plan was to head north on US 1, back toward New Smyrna Beach, hoping I could make it that far, or find something in between. There were two small towns along the way and at least I was off the Interstate at that point, making a tow a little easier to get and cheaper if it eventually came down to that.

As I made my way along US 1, toward civilization,



there was very little traffic. I passed by more deserted businesses left over from pre-Interstate days than open businesses or even homes for that matter. As I drove, my mind kept wandering back to the alternator. On early Santa Fe's with a V-6 engine it is located between the engine and the firewall. To get to it, you have to remove the wheel, drop the suspension and pull the axle out of the transmission, not an easy R&R and certainly not a job you could do in a NAPA parking lot. I needed to find a business, any business, who could do that for me.

The first town was Oak Hill. There was a quarter mile strip of small local businesses and what looked like a one or two room police station. Except for a small used car lot (in the yard of a home), none of the businesses were automotive related.

When I got to Edgewater, it was obviously more populated and developed. There were many more businesses including auto parts stores which offered some relief to my worries. I noticed an auto repair shop on the right side of the road near the center of town with a very crowded parking lot. I could tell by their sign and location that this place had been there for a long time. I felt like I might have found the right place, but would Myron's Auto Service have time to take care of my problem on what looked like a busy day for them? To make matters a little more difficult in the small packed parking lot, I was pulling a trailer.

As I walked into the office I was immediately impressed. The waiting room was small, but neat, organized and clean. I explained my situation to Myron and asked if they could check my charging system, to at least verify that that the alternator had quit charging. Myron rolled out his VAT60 and checked it himself. We both saw the answer to the charging question at the same time -12.5 volts. Then he returned to the phone to find an alternator and work up an estimate for me. I did not expect them to get me in and out without leaving the car overnight. It was already well past noon and the bays were full with others waiting. But Myron suggested that they might be able to get me back on the road that day. My plan B was to spend the night in a motel about ¼ mile down the road.

While waiting, I listened to Myron take dozens of phone calls and talk to almost as many walk in customers – some of whom obviously had become friends. I listened to how he explained technical things in a language that each one could understand at their own level. He was courteous and caring to every one of them, even the few who tested his patience by challenging a diagnosis or recommendation. I listened to some of his customers as they praised Myron's service to each other. There was no doubt in my mind that I was in the right place.

It was about two hours before they were able to get the Santa Fe into an open service bay, but 75 minutes later it was parked back outside, charging again. Myron walked out to help me get the trailer re-connected. We talked for a couple of minutes so I was able to not only thank him again but to express my happiness to have found him when I did. As I was driving back south again on US 1 to Scottsmore, I thought about just how lucky I was to have ended up at Myron's business. I have sold alternators and starters to hundreds of different automotive service businesses over the years, and I cannot remember any that matched the understanding and professionalism of the one that I had just left.

You can contact Bob Thomas by email at ere.bobt@gmail.com or by phone or text at 904-673-7301



A TALE OF TWO ARMATURES
What Does High Torque Really Mean?



BY BOB THOMAS & DAN BELL



While our subject components, two similar but different armatures used in Delco 22, 25 and 27 MT starters, may seem like old news, they exemplify a confusion that still exists today between torque and power in relation to starter motors. That topic is as relevant today as it was when these starters and armatures were brand new.

Power, once measured in horsepower (HP) and today measured in mechanical kilowatts (kW) is the ability to do work, like cranking an internal combustion engine. Hence, it is a fairly good way to rate starters. While you can find conversion formulas to change HP into kW and vice versa, it should be noted that kW is a standardized unit, while horsepower is a little more complicated because there are several different standards for measuring it.

In addition, be aware that while mechanical kW and electrical kW both equal the same amount of energy, when you convert from one form into the other there is always some loss in the process. So the mechanical kW rating of a starter is never going to be equal to the electrical power it consumed. The loss will depend upon the efficiency of the starter, but there will always be some energy loss which appears in the form of heat inside the starter. That loss is often quite substantial which is why they get burned up from extended use. The ratio of output power (mechanical kW) divided by input power (electrical kW) is called the efficiency of the motor.

Torque, on the other hand, is actually something completely different. Torque is a twisting force, measured in foot pounds or newton meters. You use torque every time you tighten a bolt – whether you measure it or not. The shaft of a starter must generate a lot of torque, which is especially critical when turning an engine against a compression stroke from a dead stop. The greater the mass of the parts being moved (crankshaft, connecting rods and pistons) and the higher the compression in the cylinders and the number of cylinders, the more torque that is required. As such, the word torque has often been used to compare different versions of similar starters, or in the case of our subject components, similar armatures that have sometimes been interchanged in our industry.

The high torque 10MT armature gained most of its advantage over its low torque relative by simply being greater in diameter. That extra quarter of an inch of outside diameter gave it more leverage on the shaft. It gained a higher torque rating by its size. But its hairpins were larger too, giving it a lower circuit resistance (between positive and negative brush positions) which allowed more current to flow. There was a significant difference between Delco's high and low torque 10 MT's.

But our subject armatures, Lester numbers 2204 and 1998, appear nearly identical in every dimension (*see Figure 1*), including outside diameter. The only visible difference between them is the direction in the pitch of the hairpins. While a right hand pitch is more common with CW armatures, the 1998 uses a left pitch, which in this case does not affect direction of rotation because the pitch and span are both greater than the pitch and span of the 2204 (*see Figure 2*). A greater pitch and span requires a longer hairpin, which also lengthens each turn and increases circuit resistance. Coincidentally, Delco used the 1998 in both 12 and 24 volt starters.



Figure 1 – 25MT armatures, Lester 1998 on the left and Lester 2204 on the right.



Figure 2 – Lester 1998 pitches to the left and 2204 pitches to the right. Both are CW armatures

It is worth mentioning here, that the field coils have a more significant impact on the torque and power of a finished starter than the armature could ever have. Yet, somewhere along the line someone decided that armatures should have some impact too. The 1998 has been referred to as the high torque version of a 25 MT armature, but when you look at tests conducted with each armature in the same starter (field coils and brushes), the results point out clear differences beyond simple torque values (see Figures 3 and 4).

Comparing Performance

These tests were conducted by Whatcom Electric in Bellingham, WA using their D&V Electronics starter load tester. Each test measures the starter's ability to crank under load, taking a sequence of measurements fractions of a second apart based on shaft speed, in this case the parameter of their choosing. Each line represents a picture of exactly what the starter was consuming electrically and producing mechanically at each given shaft speed. We need to note here that the same starter was used to test each armature. Field coils, brushes, brush springs and solenoids were the same.

RPM is shaft speed. Amps and Volts represents exactly what the starter was consuming electrically. The tester has its own DC power supply, so these numbers do not represent what you would see on a vehicle using a battery. However they do represent the amount of electrical power being consumed by the starter at that point in the test. Newton meters is torque. Watts is the mechanical power being produced. The % sign is the starter's efficiency at that point in the test and Nm/A is an efficiency measurement of torque divided by the amperage being consumed at that instant (keep in mind that voltage is changing too). Voltage Drop is measured across the solenoid's contacts.

While D&V did not include electrical Watts (power consumed) on its print out, Electrical Watts can be calculated by multiplying Amps times Volts. We did that for you and added Watts consumed in red because that number best represents what the starter was consuming power-wise at that point in the test. The efficiency column clearly shows the percentage of electrical kW that makes it through the conversion process to become mechanical power. As you can see, only about half of it at best, and only at the higher shaft speeds.

One thing that sticks out is the difference in torque at the 600 RPM mark. When a starter is initially supplied power, the armature is stationary and the circuit is a dead short until the armature begins to rotate. When the pinion gear moves enough to mate with a ring gear and meets resistance from the engine, torque and amperage draw will be at their highest points (not shown). As the armature picks up speed, RPM will quickly rise building momentum while the torque value begins to drop. The

Test **1998**	Speed [RPM]	Current [Amps]		Voltage [Volts]	Torque [Nm]	Power [Watts]	Efficiency [%]	Trq. Const. [Nm/A]	Voltage Drop [Volts]
1	2501	454	**2482**	8.38	7.62	1994	52.3	0.0167	0.01
2	2001	523	**2870**	7.81	9.83	2058	50.3	0.0187	0.01
3	1499	611	**3361**	7.11	12.68	1990	45.7	0.0207	0.02
4	999	707	**3929**	6.35	15.83	1655	36.8	0.0223	0.02
5	749	759	**4162**	5.94	17.70	1387	30.7	0.0233	0.02
6	599	787	**4292**	5.70	18.65	1169	26.0	0.0236	0.02

Figure 3 – D&V test results using the 1998 armature

Test **2204**	Speed [RPM]	Current [Amps]		Voltage [Volts]	Torque [Nm]	Power [Watts]	Efficiency [%]	Trq. Const. [Nm/A]	Voltage Drop [Volts]
1	2501	454	**3804**	8.38	7.62	1994	52.3	0.0167	0.01
2	2001	523	**4084**	7.81	9.83	2058	50.3	0.0187	0.01
3	1499	611	**4344**	7.11	12.68	1990	45.7	0.0207	0.02
4	999	707	**4445**	6.35	15.83	1655	36.8	0.0223	0.02
5	749	759	**4508**	5.94	17.70	1387	30.7	0.0233	0.02
6	599	787	**4485**	5.70	18.65	1169	26.0	0.0236	0.02

Figure 4 – D&V test results using the 2204 armature

starter with the 1998 armature is producing considerably more torque, 23.04 Nm compared to 18.65 for the 2204. You would expect that the starter producing the highest torque would require more power. But if you look at the Watts consumed (in red), you can see that the 1998 actually required less electrical power, 4.3 kW compared to 4.5 kW for the 2204. This also shows up in the efficiency column, 33% compared to 26% for the 2204.

The D&V test also measures the voltage drop across the solenoid contacts. You will notice that the drop was significantly higher with the starter using the 1998 (0.05 V) compared to the 2204 (0.02 V). While both figures are acceptable, they represent a direct correlation with the heat produced where the contact surfaces meet. The higher drop creates more heat which will wear contacts faster and destroy them more quickly during extended cranking.

What is shown here are some dramatic differences between these two armatures in the way that they perform under simulated loads. While they can obviously be interchanged mechanically because they "fit", electrically they perform differently. We have to assume that Delco had a reason for those differences. Perhaps different engine sizes, different cranking speed requirements, different batteries and possibly even different size cables for their applications. The battery and cables play a huge part in any starter's performance.

Our point here is that you cannot go wrong when you use the armature that matches the original starter number for a specific application. You might get away with substituting a different part number, but you might also end up introducing a variable less obvious that could cause your customer problems that he didn't have before. And that is never good for your business.

Dan Bell is the owner of Whatcom Electric in Bellingham, WA, an electrical rebuilder, battery distributor and the provider of Apptrak, their in-house online information database. They also created and provide the Plug Code information on the ERA website. You can contact Dan Bell by email at dan.bell@whatcomelectric.com. You can contact Bob Thomas by email at: ere.bobt@gmail.com or by phone or text at 904-673-7301.

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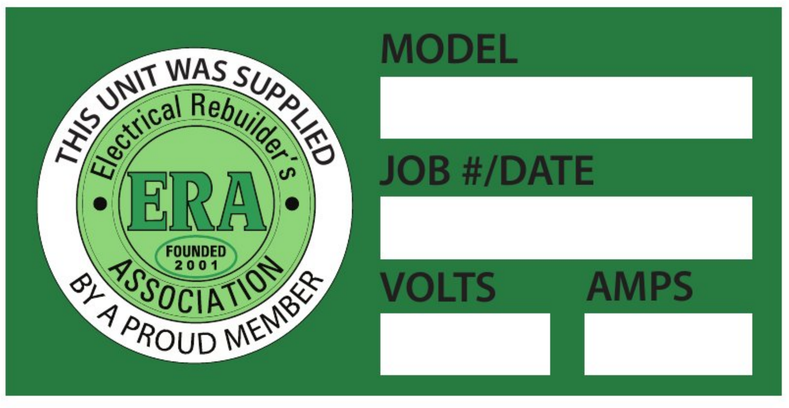
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