ERA EXCHANGE

YOUR GUIDE TO ELECTRICAL REBUILDING

October 2016 $12.95

LIGHT EMITTING DIODES
Understanding the Light of the Future

BATTERIES — JUST THE FACTS
Wet Cell, Gel Cell, and AGM

GENERATOR PROBLEM
Electronic Solution

PLAIN TALK | PROVE ALL THINGS

Electrical Rebuilder's ERA ASSOCIATION FOUNDED 2001

A WORD FROM THE PRESIDENT
Content Draws Attention

Hopefully I have you at least thinking about improving the web presence of your own rebuilding business. The internet has already replaced the Yellow Pages. Today, a good presence on the web is required to attract customers.

Assuming that you have a website, or are in the process of planning one, I have something else to share. Before I do that, you should know some things about search engines - those browser tools that help people find "things" on the rapidly expanding world-wide web.

• Google is used in 70% of all web searches today. It services an estimated 1.6 billion unique monthly visitors. Unique means different. If you used Google at least once over the last 30 days, you are one of the 1.6 billion.

• Bing is Microsoft's Windows default search engine. As such, it has the second most unique monthly visitors - 400 million. However Bing's share of all web searches is less than 7% percent. That is because many of those using Bing are occasional users, searching far less often. Some others may not know how to change their preferred search engine setting.

• Yahoo was once the king of all search engines but that was 20 years ago. It is now the third most used search engine with less than 6% of all web searches and 300 million unique monthly visitors.

• There are dozens of other search engines out there, a few old and nearly forgotten like AOL, and many newer options like DDG (DuckDuckGo), which may eventually give Google some competition. But for now, the others are all competing for less than 20% of the web search pie.

So what does this mean? Google dominates, for now at least. It is the most used search engine by a wide margin because it is the best at customizing each search for the individual user. Every time you use Google it learns more about you by keeping track of the pages that you visited during that search. The more you use Google the better it gets at finding exactly what you are looking for.

But I'm not promoting Google. If you don't like being tracked, DDG does pretty well without tracking its users. But for now, today, 70% of your potential customers are using Google. Your website must be optimized for Google to reach those using it.

Bottom line – your goal is to come up on the first page of a Google search, just below the paid listings. This is something that you can easily check yourself or ask your friends to check for you. Why the first page? Research indicates that over 90% of all searches never look beyond that first page.

How do you get there? That is really not complicated. Google's web crawlers will look at every word on every page on your website. So first of all, make the most of that. Web developers know that and they can help you get there.

However, remember this. Nobody knows more about what you can do for a customer or what you offer for sale, than you do. Like it or not, you must supply the content.

That involves more than just including the "key words" in the text. One thing that a web developer cannot do for you is provide helpful technical content. Google gives weighted preference to sites that provide helpful information. Content that contains helpful hints or descriptions of testing procedures will move you up the search results listing.

If you want more information, this web address explains it in more detail. http://answers.google.com/answers/threadview/id/158026.html

Mike Dietrich

NEW ERA MEMBERS

Southwest Core
Las Vegas, Nevada

ABOUT THE COVER

This LED replacement lamp for a common 1157 emits light that is already red.

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Rebuilding is Recycling!

PLAIN TALK — PROVE ALL THINGS

BY ROB BUKSAR

There is always talk about corporate America leaving the country and taking their means of production, capital and jobs with them. Of course, they're painted the "bad guy" and maybe to a certain extent, they are. However, if you are anywhere around my age, between 60-70, you've lived through times when everyone on the planet was lined-up to either relocate or at the very least, invest in the good "ole" USA.

Traditionally, we have always been a good solid bet with great returns on investment. Well, things have really changed! We're still a pretty good market to sell to, for the time being. Yet, to function and produce is nowhere as near user-friendly as it used to be.

Other industrial nations have business-friendly governments, it makes sense. Many would suggest ours "is not", I would too! Furthermore, our work force continues to race in the wrong direction! Have you ever heard of someone running for a high office, claim that given a level-playing field, the American worker can compete with anyone. I'm not going to agree with that. You, as a small businessman, should know why but I think I'll gab on anyway.

Our country has the world's greatest drug problem and it's become epidemic! In light of this, state governments are legalizing recreational "pot" knowing "damn well" that most high-paying industries are zero tolerant for the substance in a blood test. Have our political leaders gone brain dead? Are they so out of touch with the economic aspect of our country that they would support and pass such a self-defeating idea? They must be because it's happening! Trucking, petrochemical, utilities, oil, natural gas, airlines, and airline maintenance and law enforcement just to name a few are starving for clean drug-free applicants. These are steady high-paying jobs with a future and they come with all the bells and whistles. Some entry-levels start in the 6 figure annual income level. Yet, smoking a few "joints" sounds like a good trade-off?

Now, you have a small handful that has passed the drug test. The next hiring hurdle to get over is the academic and or competence level. This is what I want to focus on today.

Do you remember when Lee Iacocca saved Chrysler from going under? During those heady days, he was a highly-sought after speaker. At a National Association of Governors meeting, the floor was opened for questions. One governor asked Mr. Iacocca, "As state governors, how can we assist American businesses to be successful?" Mr. Iacocca gave an answer that has stuck with me to this very day. He said that his Chrysler plants had warning signs with written words removed and replaced with signs using "stick men". This was necessary because far too many workers "can not read!" You guys want to help American business? I and others like me will take care of the business end. As governors, focus your attention on our public schools and insist the graduates are competent and capable to enter the work force. They must be able to read, write and have a good comprehension level. Without that, they are no good to themselves and certainly not useful to business and industry.

I would hope that you are aware of this but if not, here it is. Just because a young person brings home a good report card or indicates high school completion on a job application does not mean what it used to. The meaning of a diploma has changed big time! We were graded and moved forward based on demonstrated performance. If we didn't test 70% or above on grade requirements, we were held back until we did. Now, I don't think anyone is held back in fear of hurting their little feelings and ticking the parents off. I think it's called "social passing". God forbid little Bebop should be able to read, write and comprehend instructions before being given a cap and gown.

I go through the drive-thru and ask for minimal lettuce and the manager sticks his head out and says they only have Romaine. I asked the girl working at the donut shop if she uses warm soapy water or kerosene to clean the empty coffee pots. She said that she wasn't sure and would have to ask! I frequently ask a sales clerk to count back my change to me rather than dropping it in my hand. Most just stare at me and ask what I'm talking about. By the way, if a person can't count change back then they cannot read a micrometer. It's the same concept, think about it.

McDonalds is the most systemized business on the planet. Their thinking is if you put an extraordinary system in the hands of average people, you can achieve extraordinary results! That's been true for a lot of years and McDonalds' success proves it. However, even McDonalds' system does not work when many of their employees do not qualify as average.

"High school completion on a job application does not mean what it used to."

For decades, we all have done this work and hired folks and watched them move on for one reason or another. We pretty much had to train all the "newbies" because there has never been a labor source for starter & alternator technicians. Nevertheless, we successfully trained someone and in a relatively short period of time, we had a rebuilder. *That sure ain't the case these days!*

Assuming that they understand that they are required to be on time and dressed for work, we now have additional problems. I have learned the hard way that I have mistakenly hired folks who couldn't: count change, read a ruler or a micrometer, look for something in a catalog, check-in parts on a packing slip, count anything accurately, fill out a bill of lading or postal form, answer a phone pleasantly, look at someone when they're addressing them, simple problem solving, taking notes on keeping records and remembering where they left off the day before without being told. There's much more but this should give you the drift.

All of the above and more was a given when we were starting out. Today, someone on top of the basics as we were is considered a super star! We wonder why we're racing backwards as a country while we fall for any sweet-talking politician who promises everything without work, responsibility or the ability to pay for it!

For the sake of ourselves, we have to quit assuming and begin testing and proving. When your child comes home with a good report card, test it. Have him or her show you how to balance a check book or determine what is or isn't a bargain in the grocery store.

PLAIN TALK

For the sake of small and big business alike, "test your employees". If you're going to survive and move forward, it is imperative that you know what your crew can and cannot do and who in fact, can perform. There's a lot of ways to do this without anyone knowing what you're up to or embarrassing anyone.

Also, knowing what I know now, I would have an applicant take a short, qualifying quiz before I gave them an application. No quiz, no application. If they refuse or fail, you just saved a ton of money and a lot of time. The schools used to do this for us, but not anymore. We're on our own folks. If you need some ideas and methods on how to do this in-house testing or qualifying quiz, contact me at hoosierelectric@comcast.net. If you don't have the knowledge or ability to email, maybe a good place to start is with yourself.

It's 2016 folks and could-a, would-a, should-a will not net any of us a plug nickel. The here and now is all we have. The good or bad has to be dealt with. Remember, no coach, commander, manager or leader worth his salt goes into battle or competition without first knowing the strengths and weaknesses of those he commands. Test and prove it all. There's no way to win without it!

God bless America and please sustain our little industry.

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LIGHT EMITTING DIODES
Understanding the Light of the Future

BY BOB THOMAS

You have probably noticed the strange looking lights that have been appearing on new vehicles in greater numbers with each model year. Most of them are LED lamps. They are not a fad. Auto manufacturers are using them to save themselves and their customers money over the life of those cars and trucks. If you service any vehicles in your business, they can make you money too (*see Figure 1*).

The light emitting diode, or LED for short, is not new. The effect on which it operates was actually discovered over 100 years ago in 1907. But it took until the 1960's for the technology to advance to the point that the device could be manufactured commercially. The initial cost was around $200 each – high tech but very expensive for a little light. Within a decade, production cost per diode was reduced to five cents.

The very first LEDs emitted infrared light, a narrow band that is outside the spectrum visible to the human eye. Within a short time, a visible red light LED was produced. These were used mostly on lab equipment but soon found their way into home electronics. Most wireless remote controls signal with a flashing infrared LED. Tube shaped red LEDs soon found their way into digital clock, watch and meter displays (*see Figure 2*). Interestingly, most LEDs look clear with no indication of color until they are turned on by voltage.

Semiconductor researchers learned quickly that by varying the composition of the crystalline wafers and the doping characteristics, virtually any color of light was possible. The blue LED was the last color to be unlocked. Today, LEDs can be manufactured to produce light of almost any wavelength from infrared to ultraviolet, including all of the visible spectrum. While a single LED is bright for its size, it is also very small.

An LED is a single diode. An LED lamp on the other hand is an array of LEDs assembled and packaged on a board with resistors (*see Figure 3*). LED lamps are designed to operate with a specific voltage source, be it 12 volts or 120 volts, AC or DC (*see Figure 4*).

White light, needed for general illumination, took a different approach. There are several methods that can be used to produce a white light LED. One of them combines red, green and blue LEDs within a single lens. Another uses a UV LED to excite a red-blue-green phosphor coating on the LED. The phosphor coating shifts the UV light to different wavelengths to simulate what we see as white light.

But today, most white LED lamps use a blue LED to excite a yellow phosphor – referred to as phosphor conversion because the yellow shifts the blue wavelength. The balance of white can be adjusted by the depth of the yellow phosphor coating. This is the most common method for making white LEDs because the manufacturing process is simple and less expensive than the other options. The majority of high-intensity white LED lamps on the market are manufactured using phosphor light conversion.

The light from an LED is emitted from the P-N junction at the center of the diode as a cone shaped beam. This beam is only visible from within the area of the cone. For that reason,

Figure 1 – Conventional tungsten 3157 tail/brake lamp (left) next to an 3157 LED replacement bulb (right).

Figure 2 – LED lights have been used in digital displays since the late 1960's.

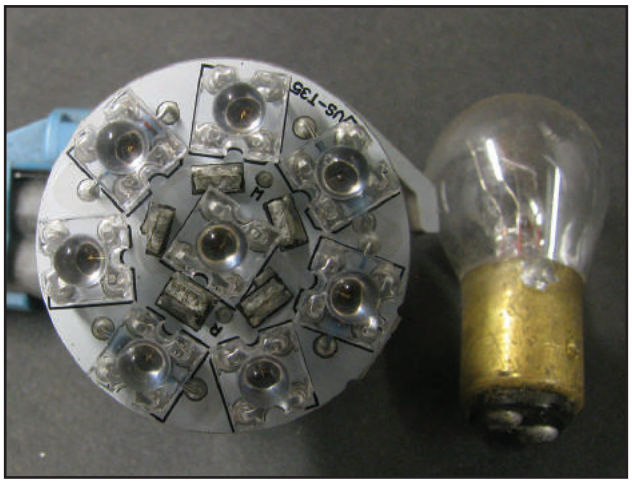

Figure 3 – 1157 LED tail/brake lamp (left) can be used to replace the original 1157 bulb (right). Note the resistors on the array's circuit board.

LED's are usually encased in a plastic lens to diffuse the light. Multiple LED's can be mounted together on a small circuit board to duplicate the intensity of just about any type of incandescent light. While some car makers are using LED lamps in their headlight displays, most are doing so in conjunction with Halogen lamps with conventional reflectors to control the beam. The reason has more to due with intensity vs cost than lack of technology. I'll explain that later.

Today, most new vehicles utilize some LED lighting. Replacement LED light bulbs are available to upgrade lighting on most older vehicles (*see Figure 5*). Advantages far exceed the extra cost, making LED conversion lamps an easy sell to customers.

Selling Points

Advantages of LED lamps over incandescent bulbs.

- LED lamps are much more efficient – producing equivalent light with far less energy (*see Figure 6*).
- Life expectancy of LED lamps far exceeds incandescent bulbs. While a typical incandescent bulb is expected to last 1,000 hours, LED lamps may last 10,000 to 50,000 hours depending upon their designs.
- They run significantly cooler than an incandescent bulb (*see Figures 7 and 8*).
- LED's are more durable and can withstand vibrations much better than an incandescent bulb's filament.
- Colors can be achieved without the need of colored lenses (*see Figures 9 and 10*).
- An LED can reach full brightness within a microsecond. There is no warm-up lag.
- LEDs can be cycled repeatedly without affecting life expectancy, even at very high frequencies.
- LED lamps are safer. They fail by dimming over time, unlike incandescent bulbs that can fail at any time without warning.

The primary downside is their higher cost, which today can be easily recovered from the many benefits. Savings on wire size, switches and relays outweighs the costs on new cars and trucks. Chances are high that those LED lamps will outlast the vehicle's themselves. The energy savings on older cars means that less of an electrical load is being placed on the old switches, wiring and harness connections. Lower operating temperatures do not overheat the bulb sockets. Plus, they are much brighter!

How Do They Work?

The silicon diodes that are used to rectify alternating current in an alternator accomplish that by only allowing current flow in one direction. A drop of about 7/10ths of a volt occurs to the forward voltage. That energy loss takes place at the P-N junction, where two differently doped crystalline wafers meet. As electrons cross that threshold, they dissipate energy in the form of heat, which is why those diodes must be mounted in some type of heat sink for cooling.

Light emitting diodes are made of crystalline gallium phosphide or gallium arsenide phosphide, both translucent materials. Instead of producing heat at the threshold, the electrons dissipate energy by emitting photons, the subatomic particles that we know as light. This light emitting effect is called electroluminescence. While some energy is still lost as heat, it is insignificant unless the LED is over driven by

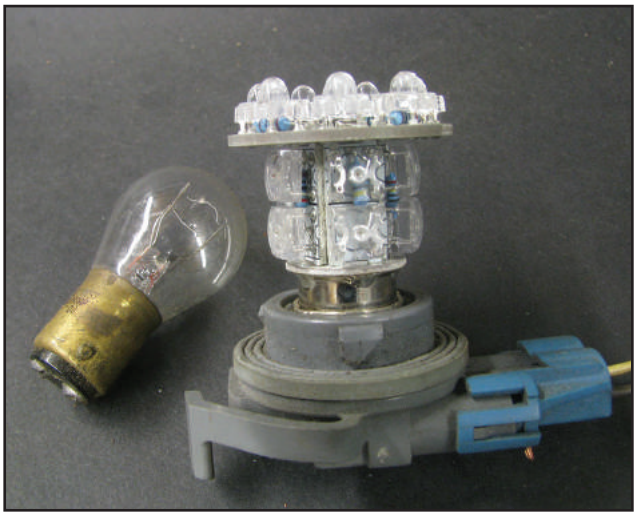

Figure 4 – Side view of an 1157 LED lamp installed in a 1980's automotive lamp socket. This LED bulb, shown illuminated on the front cover, emits red light.

Figure 5 – A sample of some of the available LED replacements next to their incandescent counterparts.

Figure 6 – Here you can see the brightness and the current draw between a standard 194 incandescent bulb (left) and its LED replacement (right) when powered with 14.5 volts. The LED is brighter on 80% less current.

excessive voltage. When voltage is tightly controlled, most of the threshold energy is converted directly into light.

An LED is markedly different from any other type of diode, but it is still a diode. As such, it is polarity sensitive and current can only flow in one direction. Like any other diode, it cannot simply be connected to any voltage source. LED lamps use resistors in series with the diodes to limit the amount of current flowing through each LED. You can see those resistors in some of the earlier photos.

The amount of light that is emitted from an LED is directly proportional to the amount of current passing through it. The current flowing through an LED is an exponential function of the voltage across the LED. But like any other diode, every LED has its limits. A small change in voltage can result in a huge change in current. To get light without excessively over-driving the LED, the applied voltage must exceed the LED's threshold voltage while preventing current from exceeding the diode's rating.

Therein lies the problem with pure LED headlamps. They must be over driven to provide sufficient light for headlamps. That requires cooling, which mandates heat sinking and even fans. Kits are available for some older vehicles, but require a significant amount of labor and experience to install. Over-driving an LED also shortens its life expectancy. In addition, the cone shaped beam must be perfectly positioned to work with a halogen reflector.

When you buy an LED replacement lamp to replace an incandescent bulb, the manufacturer has done all the math, no matter the application. All you have to do is swap bulbs. Whether you are rewiring a trailer, installing lights on a tractor or just replacing a tail light bulb, LED lighting is an easy sell that both you and your customer can benefit from.

Figure 7 – Here you can see the current draw of the brake element of an 1157 bulb along with the its temperature after two minutes of "on" time, common in heavy traffic areas.

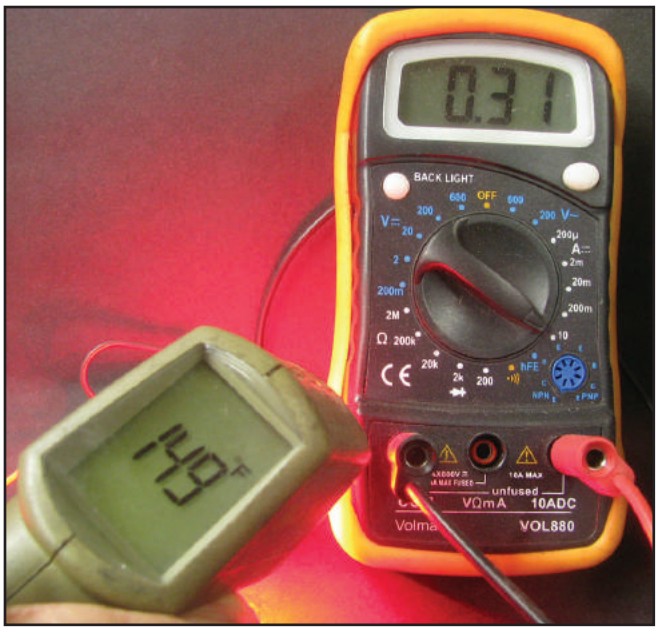

Figure 8 – Here you can see the amperage used by the LED in brake lamp mode. It appears dimmer in the photo because the LED's projected beam is being completely blocked by the temp sensor.

Figure 9 – This is an amber 1156 bulb next to a yellow LED lamp. Note that the LED lamp appears to be clear.

Figure 10 – Here you can see that once illuminated it is the correct color.

BATTERIES – JUST THE FACTS
Wet Cell, Gel Cell and AGM

BY BOB THOMAS

At the 2016 ERA show, there was some conversation about batteries during an open forum. Specifically, it was suggested that AGM (absorbed glass mat) batteries were to blame for a large number of stator failures on 200 amp Denso hairpin alternators on a fleet of Ford diesel pickups. After talking to a production rebuilder who was present at the discussion, he stated that stator failures are extremely common on these trucks using conventional flooded batteries too. The debate seemed to peak interest. But the basis for the original claim was never fully explained.

Here, we will simply attempt to outline the differences between conventional lead-acid wet cell batteries and the alternatives, including AGM's. Hopefully this will help to help you better serve your customers in choosing the battery best suited to fit their needs.

The lead-acid battery was invented over 150 years ago, but it did not gain wide spread use until the 1900's when the mass production of automobiles created a rapidly growing demand for it. While many other battery chemistries have been developed since then, none so far have been able surpass the lead-acid in terms of cost and performance when it comes to cranking engines of all types.

Any battery, no matter what type, is simply a storage device to provide electrical energy when needed. All batteries store chemical energy that can be quickly converted into electrical energy. All batteries share three parts in common: an anode (negative), a cathode (positive) and an electrolyte. The electrolyte stores the energy. The anode and cathode are the electrical connections used to access the energy in the electrolyte. Storage batteries like the lead-acid can be recharged.

In the case of lead-acid batteries, the anode and cathode are grid-structured plates made primarily of lead. Depending upon intended use of the battery, metals such as antimony, calcium, tin, nickel or selenium may be used to add strength and improve characteristics. The electrolyte is sulfuric acid diluted with purified water to a density of about 1.25 kg/L (kilogram per liter) or a little over 30% acid in a lead-acid wet cell.

As the battery discharges, the sulfuric acid is converted to sulfur which deposits on the plates and water that dilutes the electrolyte. Recharging will recombine the deposited sulfur with hydrogen and oxygen in the water to increase the acid concentration back to the 30% level. The charging process creates extra hydrogen as a byproduct that must be vented off. The gassing also causes the gradual loss of water.

Every cell in a lead-acid battery contains a group of plates, half being anodes and half being cathodes. The negative anodes are all connected together in parallel and the positive cathodes are connected in the same way. Each cell is actually a stand alone battery, with one anode connection and one cathode connection. It is capable of providing approximately 2.1 volts when fully charged (30% acid). When connected in series with five other cells, the whole 12 volt battery can supply about 12.6 volts.

Today, there are three designs based on the original lead-acid wet cell principle. They are the wet cell, the gel cell and the absorbed glass mat (AGM). While they all function basically the same way, each has its own advantages and disadvantages.

Wet Cell

Flooded lead-acid batteries have improved tremendously since their humble beginnings (*see Figure 1*). The batteries used in automobiles in the early part of the 20th century were constructed in tar-coated wood containers that slowly seeped acid. Thin lead sheets were used as plates, separated by wood strips to prevent shorting. Charging systems of the day were not kind to them either, with little or no voltage control. As such they were often overcharged. Used daily on unpaved roads, it was rare for them to last over a year.

Today, battery cases are much more durable, manufactured with polyethylene, polypropylene and carbonized plastics. The plates are grid-shaped lead alloy to increase strength and efficiency. Polyethylene separators, unaffected by the acid, prevent the plates from shorting.

All of this has improved the wet cell's durability and performance. Conventional wet cells are still the least expensive automotive battery to manufacture and the most common in use today. But other options have entered the market and they are gaining acceptance by manufacturers. The major downside of the wet-cell is in the liquid electrolyte itself, which gasses explosive hydrogen, requires the periodic addition of distilled water and is highly corrosive if it leaks or spills over. The caps used today are designed to trap the gases to minimize water loss.

Figure 1 – This is a Delco cranking battery from the 1950's (left) compared to an East Penn made flooded wet cell cranking battery of today (right).

Figure 2 – These gel cell batteries were made for emergency backup service.

Gel Cell

The gel cell battery was developed primarily to limit water loss during charging by sealing it to prevent gas from escaping. The battery's case is manufactured to withstand some pressure (2 to 3 psi). A gas diffuser is built into the cover to trap vented hydrogen for safer dispersal. A relief valve prevents pressure from exceeding a safe limit. The technology of venting through a pressure valve is referred to as a valve-regulated lead acid (VRLA).

Calcium is added to the grid plates of a gel cell to increase tensile strength and reduce gassing. The electrolyte in gel batteries is mixed with silica to form a jelly-like mass that does not give up gas as easily as the flooded wet cell. This also makes the battery nearly spill proof. While it is often referred to as being "sealed and maintenance free", it is vented and not actually sealed. However, it is designed to never need water and the gel virtually eliminates any leaking.

For those reasons, Gel batteries are used more in emergency back-up systems, lighting and telephone stand-by systems. They usually have a better amp hour (ah) rating than the same size flooded battery (*see Figure 3*).

While the basic chemistry of the gel cell is lead-acid, the addition of calcium and silica change more than the battery's ability to prevent water loss. It also limits charging voltage. Charging will be explained in more detail later. Suffice to say at this point that gel cell batteries can be quickly damaged by what you might consider a safe charging voltage. Also worth mentioning is that VRLA technology is being used in many flooded wet cell batteries today, so a sealed top with a vent does not necessarily mean that the battery is a gel cell.

AGM

The absorbed glass mat battery appeared in the 1980's as a sealed, valve regulated battery that was first used in military aircraft. Reinforced cases permit higher internal pressures than other VRLA batteries – as high as 40 psi in some applications. Unlike a gel cell, the electrolyte is a liquid, suspended in a very fine glass fiber mat. The glass, being non-porous, cannot absorb the electrolyte, but the mat does absorb and hold the liquid between the tiny glass fibers.

The electrolyte can move freely within the mat and maintain uninhibited contact with the plates. The mat holds the electrolyte and serves as the perfect separator between the plates because glass is a very good insulator. Electrons can flow easily through the electrolyte, around the glass fibers.

The plates and saturated mat are compacted prior to case insertion. This is possible because the insulation property of the glass allows much closer plate spacing than other batteries while still preventing the plates from shorting. AGM batteries have been tested by shaking in a commercial paint shaker. No other wet cell design has ever passed this test. AGMs are both very efficient and extremely rugged. They make an excellent choice for off road equipment – small or large (*see Figure 4*).

The leading advantage of an AGM is its very low resistance, which allows it to supply more amperage at a higher voltage than any other lead acid design of the same size and weight. This ability to maintain higher voltage under heavy load makes it excellent for cranking an engine. It also offers a much greater depth-of-discharge than any other cranking battery. That means it can handle deep cycling and the parasitic drains of modern vehicles for longer periods of time. Unlike the flooded wet cell and gel cell, the AGM can accept higher amounts of amperage during recharging because of its low resistance. That allows it to be recharged up to five times faster.

The downsides are high cost, a sensitivity to overcharging and susceptibility to damage by high temperatures. In spite of that, some high end automotive applications are being delivered to customers today with AGM batteries as standard equipment. Most if not all are located away from the engine compartment. Those vehicles' charging systems are also programmed specifically for the characteristics of the AGM battery.

Charging Lead-Acid Batteries

Prior to charging, always test the battery for state of charge to know where you stand. When you are reading voltage of a battery that has recently been on a charger, your reading will be skewed by a "surface" charge. That is a temporarily higher voltage than the battery's actual state would indicate. A surface charge can be "knocked off" by applying a brief heavy load for a second or two. Do not be fooled into thinking that a battery is fully charged as soon as you see 12.7 volts. Surface charges will eventually dissipate on their own once the charging stops.

State of Charge	Specific Gravity	12V	6V
100%	1.265	12.7	6.3
75%	1.225	12.4	6.2
50%	1.190	12.2	6.1
25%	1.155	12.0	6.0
Discharged	1.120	11.9	6.0
Shorted Cell	1.265	10	4

Each type of lead-acid battery has a different absorption rate. This refers to the maximum rate at which it can be charged, affected by the charge voltage. For that reason, absorption rate must be considered when swapping battery type on a vehicle or whenever recharging a battery.

Whenever you are recharging a deeply discharged battery, no matter whether it is a cranking or deep cycle battery, the charging process must go through three stages. They are **bulk** or constant current, **absorption** or topping and **float**. Recommended voltages for each stage vary by battery type and manufacture. The numbers provided here are intended as a general guide.

Bulk may also be called the constant current or boost stage. During this stage of charging the battery is brought up to a level of 70% to 80% of full charge.

- Wet Cell 14.6v to 15.2v
- AGM 14.6v to 15.0v
- Gel Cell 14.1v to 14.5v

Batteries that are only partially discharged, may not need bulk charging. Internal resistance is high, so higher voltage is needed. Monitor voltage and battery temperature when charging. Reduce the rate of charge if the temperature exceeds 120°F.

Figure 3 – Note that this flooded wet cell battery has the vent on the side of the cover.

Figure 4 – These deep cycle AGM deep batteries were made by East Penn.

Absorption may also be called the topping off stage. During absorption the battery is brought up to 95% to 98% charge.

- Wet Cell 14.2v to 14.7v
- AGM 14.2v to 14.5v
- Gel Cell 14.0v to 14.2v

As internal resistance decreases, charging voltage must be decreased. However, a battery's own voltage capacity increases with the state of charge, and that causes the battery to become increasingly resistant to accepting a charge. For that reason, the absorption stage normally takes longer than the bulk stage. Reduce charge rate if temperature exceeds 120°F.

Float stage will bring the battery up to 100% charge with a further reduction of charge rate.

- Wet Cell 13.1v to 13.4v
- AGM 13.2v to 13.4v
- Gel Cell 13.1v to 13.3v

Batteries should not be left in float for extended periods. Most serviceable automotive batteries require one to two hours at most.

Be aware that much of the above charging information pertains to recharging a discharged battery. Under normal circumstances, that should never happen to a cranking battery unless the vehicle has been driven with an non-working alternator or has had it's lights left on overnight. Normally, if all is well, a cranking battery should be in a high state of charge when the a vehicle is shut down. Even after a week of sitting unused, a good battery should remain in a high state of charge. When it is called upon to crank the engine again, it will give up some of that energy. But the amount of that energy is only a small percentage of what the battery actually holds, perhaps 5% at most. The alternator should ideally be capable of replacing that quickly.

Lithium-Ion

I am mentioning lithium-ion batteries here only because some are beginning to be marketed in automotive group sizes by at least one manufacturer. Lithium batteries have been around for a long time in many applications ranging from cell phones and lap top computers to power tools and lighting. They excel in those applications. They are light weight, charge quickly, long-lasting and environmentally friendly. But will they work in vehicles?

Lithium batteries are already being used in electric and hybrid battery packs. Someday, we may see them in automotive applications in place of the 100-year-old lead-acid cranking battery. However, there are a number of obstacles to overcome that include high cost and charge voltage requirements that do not match today's vehicle's charging system.

BATTERIES – JUST THE FACTS

To retro-fit the lithium-ion battery into a current vehicle requires an electronic circuit (built into the lithium-ion battery pack) that reduces the vehicle's charge voltage to match the lithium-ion battery pack's requirements. If the battery is used as intended – to crank the engine, it should do that very well. Once the alternator takes over, all accessories should perform normally on charging system voltage. The unanswered question is: Is it really worth the cost?

Conclusion

Consumers have many options when it comes to buying a battery today. When a customer comes to you to purchase a battery for their vehicle, that person is seeking your advice. To aid him or her in making the best decision, you need to know and understand exactly how the battery will be used. Will it be used daily? Are the trips short or long? Will it sit unused for weeks or months at a time?

What was in the vehicle originally is becoming increasingly important as modern charging systems are often designed to recharge and maintain one battery chemistry better than the others. It is true that just about any 12 volt replacement battery that will fit in the battery box will probably crank the engine. But it may not last as long as your customer expects it to.

Special thanks to Tom Barrett, Dakota Battery & Electric in Rapid City, SD for his generous help in producing this article.

GENERATOR PROBLEM
Electronic Solution

BY LARRY HAGEMEISTER

We recently had a customer that had asked us to change an old CAT engine over to electric start by replacing the pony motor with a 12 volt starter. The starter conversion was relatively easy as we have done those before. But the charging system presented a real challenge.

This engine came out of a 1948 military vehicle that originally had a 4 coil 6 volt gear driven American Bosch generator which was charging just fine. If you have ever had any experience working with gear driven American Bosch generators, you know that the regulators were hard to find and even harder to adjust properly. On top of that we also had to make it 12 volts! There was no accessory drive on this engine so a belt driven 10-SI alternator was out of the question.

Upon testing the generator we found that it had 6 amps of field current on 12 volts and the generator was B circuit. Knowing that this was a stationary engine with no electrical loads other than cranking, we knew it would only have to recharge the battery after each start.

We used a Transpo F540XHD voltage regulator to control the voltage and a D100 electronic cutout to isolate the armature from battery B+ (*see Figure 1*). It all worked just fine. Just one more thing that you can do with an old generator.

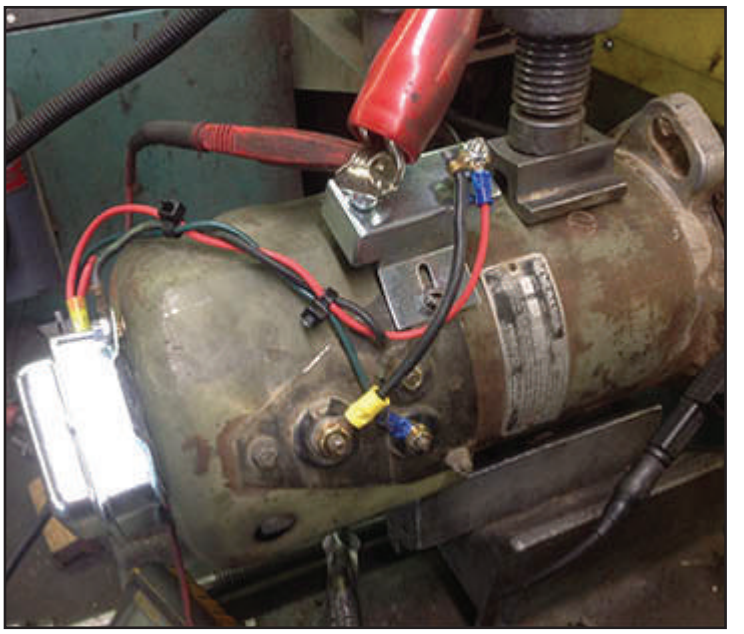

Figure 1 – This is a 6 volt gear-driven American Bosch generator on a stationary CAT engine converted to 12 volts.

Larry Hagemeister is the owner of Hagemeister Enterprises, Inc with locations in Lebanon and Redmon, OR.

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3 – Only current Rebuilder and Honorary ERA members are eligible.
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The 2017 ERA Expo will be held in Dearborn, MI over the weekend of April 7-9. Plans for the annual event are well under way. It will be held under one roof at the DoubleTree by Hilton Hotel, 5801 Southfield Rd, Detriot, MI 48228.

The schedule includes:
- Seminars by Mohammad Samii and Dan Marinucci with more to be announced soon.
- A tour of Ford's Rouge River plant on Friday morning.
- A vendor sponsored reception prior to the show's floor opening on Friday afternoon.
- A luncheon buffet on Saturday between the morning seminars and the afternoon exposition.
- Sunday morning breakfast and ERA annual meeting.

The hotel is a short 15 minute ride from Detriot Metro Airport. The DoubleTree offers free shuttles to and from the airport as well as Greenfield Village which is only a few miles away.

The famed Henry Ford Museum is but one part of the 12-acre Greenfield Village complex. To learn more about it, you should visit their website: www.thehenryford.org

You may want to arrive a day early to take in this historic village and museum.

More details and a complete schedule will be announced on the ERA's website as well as the next issue. Mark your calendar now.

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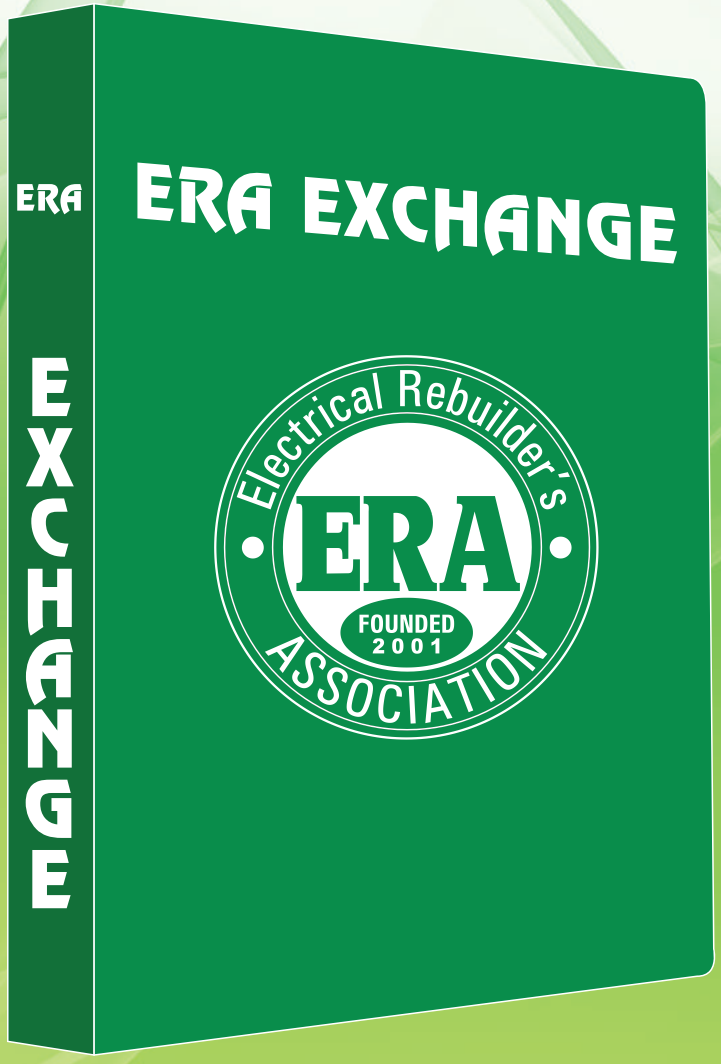

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