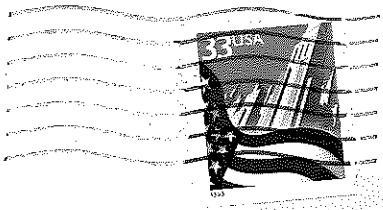
Fox Valley Electric Auto Association
1522 Clinton Place
River Forest, IL 60305-1208



Address Correction Requested

David B Aarvold
915 Oak Street
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60115+3470

NEXT MEETING: FRIDAY December 17 at 7:30 PM at Triton, INDUSTRIAL ARTS Building, Room 139. Note the new meeting room at Triton. The building is on the EAST campus.

DISCUSSION TOPICS: 1. Recap of the November meting. 2. Consideration of letter to Triton regarding Student SAE Chapter conversion of vehicle for Triton. 3 Conversion discussion

MEMBERSHIP INFORMATION
Any person interested in electric cars is welcome to join the FVEAA. The cost for a full year's dues is $ 20 which will entitle the members to receive our monthly Newsletter that contains useful information about electric car components, construction, policies, and events. Membership is not required to attend our monthly meetings

To obtain information about the FVEAA, you may contact either Past President Ken Woods or President Shafer

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December **PRESSEZ**

Our future meetings have been approved by Triton[illegible]d. I have arranged for a change in meeting room assignment. Future meetings will be in Room 139 of the Industrial Arts building, located on the EAST side of Fifth Avenue, south of the Collins Center (The building with the lighted "T") . I believe this will better serve our requirements. I appreciate the help of the Triton Facilities Manager, Kathy Kaspar.

I believe the November meeting was of value to those who attended. Everyone also appreciated the work of Member Larry Claypool in moving his collection of unique automobiles outside where they could be viewed and especially Larry's detailed description of the each car.

A draft letter to Triton proposing that a conversion project be initiated will be presented at the meeting for member's consideration.

December is the last chance to renew your membership.

BILL

NOVEMBER 20, 1999 MINUTES

The meeting began in Frankfort at 10:20 AM. Twenty- two members and four guests attended. Warfield Electric Co. Owner, Jerry Warfield, gave us a tour of his electric motor plant..

Jerry explained the process of repairing electric motors. The first step after disassembly is to remove the existing windings from the armature by cutting all connections to the commutator on a lathe and removal of conductors from their armature slots. He demonstrated how replacement coils are wound from coated copper flat stock of the proper size. The individual coils are then formed in an arc.

Each slot is insulated with NOMEX before the coils are inserted. Each coil is carefully positioned and spot-welded to the proper commutator segment.

The stator is disassembled and rewound in a process similar to the armature.

The entire armature and stator are then dipped in a plastic "varnish" compound and oven baked. The adhesive in the cured compound holds coils rigidly in their slots. Any coil movement under the magnetic and rotational forces in the motor could lead to failure.

The final step before re-assembly is dynamic balancing of the armature.

The Frankfort plant has a staff of 85 persons. Warfield also operates other plants in various locations in the U.S.

The tour was concluded with a Q&A session

After the Q&A, President Woods called the meeting to order. Minutes of the October meeting were approved with some comments about the accuracy of map directions. Treasurer Corel reported no change from the previous financial report.

Members approved the recommended slate of officers and directors. Members were reminded to renew their membership before the end of the year.

New President, Bill Shafer, stated that member's data from the returned application forms will be used in a new database. Previous errors would not be repeated - and this caused some laughter.

The meeting was adjourned at 11:30 AM and the group moved to Member Larry Claypool's "VAIR garage, about four miles from Warfield's. Larry has assembled a personal collection of over twenty unusual cars. He moved them out of their garage space for display in the driveway. Larry gave a comment on each vehicle, exhibiting a detailed knowledge about the history and construction of each.

At 12:30, the group moved to the Bierstube Restaurant in downtown Frankfort for lunch. The town has been historically restored to a 1900's appearance.

The Editor has received several phone calls from those attended saying they found the meeting informative and enjoyable.

Submitted by Secretary Aarvold and from Bill Shafer's notes.

RECENT ARTICLES ABOUT ELECTRIC VEHICLES

Bar stools on wheels. Naperville **SUN, 10/31/99, P A3.** This article is about the concept cars exhibited at the Tokyo Auto Show this fall. Among the many unusual concept cars at this event was the Nissan AYX, a stubby four-seater with headlights just below the windshield. The Fuja-jo that has driver and passengers perched on bar stool seats in front and a back door with a rack for skateboards. Suzuki had an EV 2-seat sports vehicle using the GM electric drive system. Detroit wonders where Japanese design is headed. *Car & Driver* says it was ,"Fun in the *rising* sun."

Several magazines in November, including Business Week, Forbes, and probably other publications that your editor doesn't regularly read, had a special advertising section describing future cars. The Section on Environment covered electric and hybrid vehicles. Most efforts are focused on cleaner engines. GM future EV-1's will be equipped with NiMH batteries that boost driving range about 30%. Ford has acquired the Norwegian company that makes the THINK. Nissan will begin building a hybrid, called the TINO this year. DANA Corporation is exploring drivetrain modules that automakers can "plug into" their current production processes.

Electryfying Times, Vol. 7 # 1 & 2,, has a new tabloid-sized publication that starts off with USA TOMORROW. The lead story is about urban gridlock, air pollution and urban sprawl. The 2nd annual Labor Day Weekend Ford L.A Street Race had the usual lineup of Ferraris, Porsches, Vipers, BMWs, and Corvettes. Environmentally friendly alternative-fueled vehicles were featured, including (of course) the electrified Ranger.

They also had side-by-side articles about the Prius and Insight. They noted that 250,000 e-bikes would be sold in Japan this year; 50,000 in Europe, and 15,000 in the U.S. These new-category vehicles are the subject of special legislation in many states. Max speed is limited to 20 mph, pedal assist is standard, power ranges from 180-600 watts. Several $ 350 kits are sold for attachment to existing machines. Most use sealed lead-acid batteries, typically in a 12-36-volt system. Chargers plug into a 120-volt outlet.

Anyone wishing his own copy of this publication can send $ 15 to Electrifying Times, 63600 Deschutes Market Road in Bend, OR 97701 for a one-year subscription.

The Chicago Sun-Times 10/17 issue, Page 92B notes the new Ford **ECHO**, the successor to the Escort, weighs only 2080 pounds. Keep this in mind when the engines begin to fail – they may be good candidates for conversions to electric power. The January 2000 issue of **Car & Driver** lists the weight of the Ford **FOCUS** as 2600 pounds.

FROM OTHER EV NEWSLETTERS

EEVC, the Valley Forge group in their November Newsletter reported on their October 23 King of Prussia event. Featured was a hybrid car from Swathmore College. It is a converted 1996 Chevy Beretta with a 620 cc Kawasacki tractor engine running on CNG. The engine drives a 15 kW generator. There are 20 6-volt batteries and a Curtis controller. Drive power is from a 36HP Advanced DC motor. The car weighs 3700 pounds. Construction is still in progress.

President Oliver Perry reported his impressions after attending the NESEA workshop on car conversions for schools. He states the EV movement is not going to fade away. A paticipant from North Carolina spoke about a planed network of charging stations down a route parallel to I-95 that will allow an EV to drive across the state.

VEVA, the Vancouver group in their September Newsletter had a thoughtful editorial from Editor Rob Cameron about the history of that organization. He noted several points: 1. The organization developed from Electrathon competitions. 2. Those members who have completed a conversion can develop a '"Been there and done that" attitude. 2. Meetings don't deliver what people want. Suggestions were solicited.
3. The Internet now provides a virtual EV club. 4. The meeting time is inconvenient for some members. 5. There is not much in the way of new technology. 6. Commercial EVs are coming anyway. 7. The political climate just doesn't support EVs. 8. Most club activities fall on a few members and this can lead to burn-out. His points are relevant.

COMMENT: Rob Cameron's observations can be applied to almost any volunteer organization that has been in existence for a while. In my opinion, EV groups can render a vital service by regular use of their conversion to demonstrate it is a useful vehicle. RANGE does not have to be a limiting factor. When an electric car is used for short-range trips instead of using an IC engine car there is an environmental benefit, an opportunity to use renewable energy, a national benefit, and the individual's interest is served.

The United States will eventually have to deal with petroleum supply. Most of our oil is now imported and this influences foreign policy. We had a taste of what may be coming from the oil crises of the 1970's. Energy for an electric car can be derived from domestic sources. Our bumper sticker reads, **BEYOND OIL GO ELECTRIC,**

By using an electric, the life of an IC engine "first" car is extended. The owner does not have to buy a new IC engine car as frequently. Detroit probably doesn't favorably view extending vehicle life but it is beneficial to the owner. Keep a journal of car use and expenses and demonstrate to yourself and others the car has saved money.

BILL

PUTTING PERFORMANCE IN YOUR ELECTRIC CAR - PART IV

REVIEW

In Part III, data was presented on the steady-state efficiency and the SAE standard driving cycle used for comparing electric vehicle efficiency was introduced. The subject of batteries will be covered in this Part,

INTRODUCTION

The battery is the most-important element in electric vehicle performance. All batteries depend on an electrochemical reaction to produce electricity. There are two types of batteries, primary and secondary. The typical primary battery has a zinc negative, immersed in a solution of ammonium chloride, with a carbon positive. Discharging the battery converts the zinc to zinc chloride. The battery must be replaced after the zinc is depleted. The familiar D-sized dry cell is an example.

A secondary battery employs a similar electrochemical process, except it is reversible. The most common secondary battery is the lead-acid, used in conventional cars for Starting, Lighting, and Ignition (**SLI**). The positive terminal is made of lead oxide, a granular solid contained in a lead matrix called the grid. Between the positive and negative plate is a porous separator for the electrolyte. The negative is composed of sponge (porous) lead, also pasted into a grid. The plate and separator assembly is immersed in a sulfuric acid electrolyte. Each cell contains a parallel-connected groups of these plate assemblies. During discharge lead and lead oxide is converted into lead sulfate and sulfuric acid is diluted by water generated during the process. Charging the battery reverses the process. Calcium or antimony is added to the lead in each grid for rigidity.

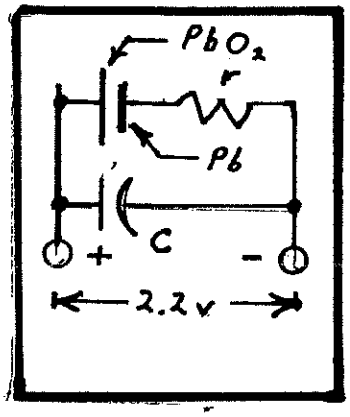
There are other possible combinations of materials that can be used to construct a secondary battery. They range from potassium (-2.92 volts) to silver (+0.80 volts) relative to hydrogen that is 0. A great deal of research has been conducted on possible combinations in the search for the *BETTER BATTERY*. Some combinations require high temperatures (Lithium-Sulfur), involve expensive materials (Nickel), some have high toxicity (Bromine). Combinations, such as Nickel Metal Hydride (NiMH) only give marginal improvements (30%) over lead-acid energy storage capability. Hobbyists are not in a position to use these exotic systems in a conversion projects.

In all lead-acid batteries, the amount of **power** (watts) the battery can deliver is an important factor. This is dependent on the amount of plate active surface available for electrochemical reaction. The SLI battery is made up of a stack of thin plates and separators to maximize the surface area. The battery is only required to deliver high current for a short time until the engine starts and the alternator begins taking over and recharging the battery.

The amount of **energy** (watt-hours) a lead-acid battery can deliver depends on the amount of lead oxide converted into lead sulfate with each discharge-charge cycle. Energy translates into **range.** The EV battery is designed with thick plates to maximize the energy it can deliver. An EV the battery can be deep-discharged. A SLI battery that is repeatedly deep-discharged will fail after a dozen or so cycles. One early converter of an IC engine car to electric power bought SLI batteries at a Sears store for his vehicle. A short while later he bought them back to the store for warranty replacement because of early failure. The store replaced them a couple times before they caught on to the misapplication. SLI batteries require the vehicle have an on-board charging means for the warranty to be valid.

During every cycle there is an accumulation of lead sulfate on plate surfaces during discharge. Lead sulfate is an insulator. If allowed to stand discharged large lead sulfate crystals "clog" plate porosity and inhibit further electrochemical activity. If lead sulfate remains on the surface it becomes almost impossible to transform it back into lead oxide by recharging. The battery becomes useless. It is desirable to recharge a battery as soon as possible after use.

About 2.2 volts is generated by the electrochemical reaction in each battery cell. This means that each 3-cell, 6-volt (nominal) battery will have a terminal open-circuit voltage of 6.7 volts. Sixteen 6-volt batteries connected in series will produce a 96-volt system. The open-circuit voltage of this connection is 101.7 volts. Twelve 8-volt batteries have the same terminal voltage.



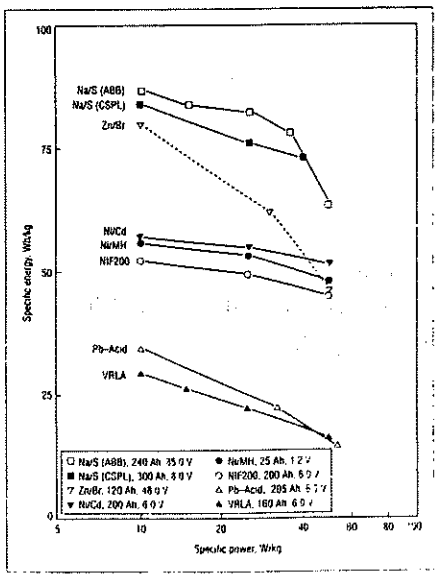
A cell can be represented by an *equivalent circuit,* illustrated by this diagram. The battery current encounters an internal resistance. The internal resistance depends not only on the material used but also the number of plates in each cell. The greater number of plates, the lower the internal resistance. With thin plates, SLI batteries have a much lower resistance that an EV battery with fewer thick plates. The parallel plates also act as a capacitor.

Internal resistance is an important factor. There will be a voltage drop during acceleration when there is high current. The motor terminal voltage in a 96-volt system will drop 8 volts with a current of 400 amps. The motor will produce less accelerating torque with reduced motor terminal voltages. This will be less with a current-limiting controller such as the Curtis than a T-Rex controller that does not automatically limit current.

There also is a voltage drop caused by the interconnecting battery cables and the resistance of the connection at each battery terminal. This is the reason for using 4/0 cable for interconnections, using post-style terminals and tightening bolts securely. If the terminals feel warm to the touch after driving, tightening is indicated. If the cables are warm they are too small.

The following table compares two Trojan EV Batteries. The T-124 is a 6-volt unit and the T-874 is an 8-volt unit. Note the magnitude and significant difference in power loss at 400 amps. A small difference in cell resistance changes performance.

ITEM	T-125	T-874
Battery Ohms	0.00124	0.00138
# Batteries (96 volts)	16	12
Pack Weight – Lbs.	990	756
Pack Ohms	0.0198	0.0167
Open Circuit Volts	101.7	101.7
IR Drop @ 100 A	1.98 v	1.67 v
- 200	3.96	3.34
- 400	7.92	6.68
Motor Volt @ 100A	100	100
- 200	99	98
- 400	96	95
Power Loss – Watts		
@ 100 A	198	167
- 200	792	668
- 400	3168	2672
Mins. @ 75 Amps	132	75
Energy @ 75 Amps	15 kWh	9 kWh



The **RATE** of discharge has an effect on battery performance. When a battery delivers high currents its available energy is diminished. This effect is shown here. It plots the specific energy available and the specific power level. The data is from a paper prepared by Argonne Lab and shows the effect for seven battery types. Just as a "lead foot" on the accelerator pedal of an IC engine car reduces gas mileage, range is reduced for an electric vehicle when acceleration is increased or driven at speeds where aerodynamic resistance becomes significant..

Battery life is another factor. It doesn't affect the car's performance but does apply to the performance of your wallet. Contributing to battery life is battery recharging and maintenance. Series-connected batteries in a pack develop voltage inequalities among cells. Different battery temperatures in a pack also cause inequalities. Correction of unequal cells is accomplished by a periodic **equalizing charge**. An equalizing charge may be required every month or so. In this process, a charger voltage exceeding the open-circuit voltage rating for each cell is applied to the pack terminals. For a 96-volt system, the equalizing voltage is 111 volts. The normal charging voltage is 107. For long-term maintenance a charger voltage of 105, a value that will keep about ¼-amp flowing through the system and compensate for self-discharge that averages about 10%/month.

Undercharged cells are brought to proper terminal voltage while those cells that have reached the proper level will start to ***gas.*** The water in a gassing cell is electrolyzed into hydrogen and oxygen during equalization. This is an explosive mixture of gas that accumulates at the top of each cell. A match or spark at the filler cap at this time will produce an explosion, as some of our members have experienced.

It is necessary to add distilled water to those cells having a lowered electrolyte level. Each cell has a slightly different characteristic. In no case should the electrolyte level be permitted to fall below the top of a cell. Overfilling is also undesirable. Water should be added until the level just touches the bottom of the filler tube.

Battery life is shortened by repeatedly deep-discharging. A partially discharged battery each driving cycle will have a longer life than one that is deep discharged. Immediate recharging after use is also beneficial.

Battery life tests have been performed. Typically, a deep-discharge battery will have cycle life of 400-700. This would seem to indicate battery replacements could be expected to be required every two years. Some of our members have experienced a replacement interval of 5 years. This is indicative of the way they drive their cars, how far they travel before recharging, how soon after use do they recharge, and the battery charger for their vehicle.

Ambient temperature also affects battery performance. Battery tests are conducted at 70 degrees F. During the winter when the temperature can be in the zero range the electrochemical reaction is slowed and the battery can deliver much less energy. Members of the Ottawa, Canada Electric Vehicle Group have solved this problem by enclosing their battery packs in insulated boxes with supplementary heat. Another possible solution, which has yet to be tried, is use of battery warmers. Chicago's J. C. Whitney Co. Catalog lists a rubber battery warmer for use under a single battery for $ 30. It is rated at 50 watts and comes with a 4-foot long ac plug. Twelve of these total 600 watts and would cost $ 360.

There is another lead-acid battery type not yet discussed. It is the **sealed** lead acid. rolyte. The basic electrochemistry is unchanged but the electrolyte is handled differently. In a **gel-cell** the electrolyte is a dilute gelled solution of sulfuric acid. When a gel cell is discharged, both positive and negative plates are mostly converted to lead sulfate and the electrolyte is mostly water. Recharging reverses the process.

A **starved electrolyte** sealed battery uses an absorbent material to keep the electrolyte bound. A discharged starved electrolyte battery has a very low specific gravity when discharged that increases internal resistance. This type of battery has problems with recharging after a deep-discharge. They can also dry out and fail prematurely.

If a sealed battery is overcharged using an applied voltage that is too high the water in the gelled electrolyte is disassociated and the battery will fail prematurely. Undercharging allows some of the lead sulfate to remain on the plates and this reduces battery capacity.

Another type of sealed battery employs a spiral construction of the plates and separator. **OPTIMA** batteries has patented this concept and recently licensed it to Johnson Controls. The spiral construction has about 4 square feet of active surface. This produces a high power rating. The OPTIMA *Yellow Top* battery is for uses where a SLI type battery is employed. Their *Red Top* battery is meant for deep-discharge applications. A 12-volt unit has an internal resistance of 0.0028 ohm, an expected cycle life of 350, and weighs 43.8 pounds. Their cost is about twice that of an EV flooded battery. The batteries require a charging system that individually regulates the charge to each battery. When they are series-connected in an electric car, a *regulating system* is required.

Don't let the complexity of the topic of this paper intimidate you. You don't have to be a chemist or engineer to successfully build and drive your own electric car. It helps to have a basic understanding of the elements making up an electric car. The important things to remember are:

1. Use proper components when you build your car.
2. Drive reasonably.
3. Give your battery some *tender loving care*
4. Recharge your battery at every opportunity. I have an AC cord hanging from the ceiling of my garage at a point that when the back bumper touches the cord, the front clears the garage door. I back into the garage until in the rear-view mirror I see the cord touch the rear bumper. It is a 10-second task after I get out of car to plug the female socket into the receptacle located by the rear license plate and flip the switch on the battery charger circuit for recharging.

BILL SHAFER
11/6/99

CLUB STUFF

FVEAA Officers elected at the November Meeting for the coming year are:

President and Newsletter Editor, Bill Shafer
Vice President, Bob Munroe
Secretary, Dick Ness
Treasurer, Dale Corel
Director and Registered Agent, John Emde
Director, Ed Meyer
Director and Past President, Ken Woods

Early next year the FVEAA should develop a proposal to work with TRITON on a project. Initially, I recommend that members offer to work with Triton personnel to have the Student Society of Automotive Engineers Chapter at Triton do a car conversion project. I believe that the school has resources to obtain a suitable vehicle for the project and we can assist them in getting a corporate sponsor willing to grant the $ 7000 out-of pocket expenses for a project. This will be discussed at the December meeting.

The PRESSEZ noted we have a new meeting location at Triton, beginning with the December meeting. It is in the Industrial Careers Building, Room # 139, located in the East Campus. The location is identified on the map below.