



# CURRENT EVENTS

June/July 1992

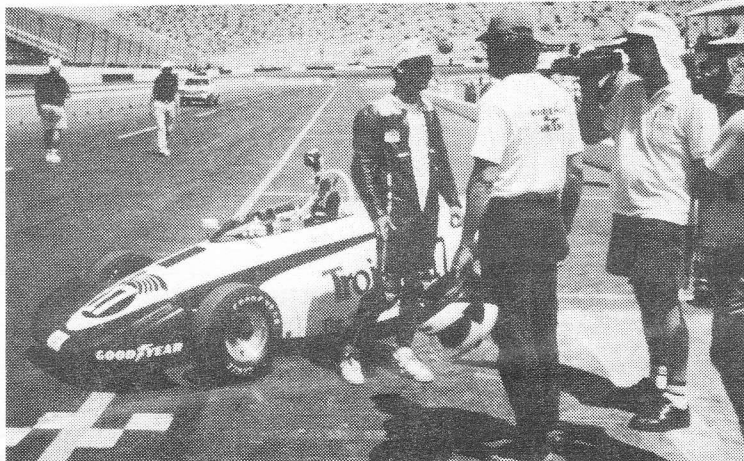
Promoting the Use of Electric Vehicles Since 1967

Vol. XXIV No. 4

## The Greatest Spectacle in EV Racing

# PHOENIX 500 - The Second Time Around

By Paul Brasch



*Ely Schless, in winners circle, talks to Press, while Michael Hackleman looks on.*

The second time around proved to be much more wonderful than the first at the Solar and Electric 500 Race at Phoenix this year. Although the solar race car field was smaller, the total racing field more than doubled from 22 to 46 entries for all classes. The peak speeds went from about 69 MPH last year to the mid 90's in the open class on the backstraight. The numbers of media types in the press room greatly increased this year. Last year I counted only eleven people at the best, but this year by Sunday's main stock car race I counted thirty-five including a National Geographic reporter.

In addition to the Solar and Electric Stock Car Races, as in last years event, there were new classes. An Open Competition race in which battery changing was allowed and a Hybrid race with a point scoring system were new this year. This time all of the sponsors and dealers as well as the Ride and Drive were located on the infield instead of

being split up as before. This drew the race fans into the infield to check out the technology that the vendors/sponsors had on display. This made the stands look more empty than last year even though the box receipts were

up. With all of the garage area filled this year and all of the vendors in the infield, this was the place to be.

One thing that did not change was the ungodly heat. Last year and again this year Phoenix gave us a warm welcome with 20 degree above normal temperatures. 104 last with 110 in the shade this year, and there was NO shade except in the vendors tents (some of which had swamp coolers) or the air conditioned press room. By the end of the day on Sunday the track surface temperature was 133 degrees F. No wonder the stands looked bare. But the show must go on. And it did.

One review that I read said that no major new developments were apparent. Nothing could be further from the truth. The new techniques, technology and showmanship displayed at this event far out weighed who won or came in second, third or whatever to my way of thinking. Sure it is great to win, but

what was Really happening here was REAL electric vehicle RACING of a professional nature. Never mind that Larry Burton has not gotten an EV to Indianapolis yet. He will. I am confident of it. But REAL Electric Car Racing already exists and will only grow — here and around the world.

When it comes to showmanship, scenes like Ed Rannberg doing a burn out on his electric motorcycle, the fellow with the electric dragster and the Phoenix challenge, demonstrated EV power now! The Phoenix challenge was a daily head to head sprint race between a stock gasoline powered Saturn and an identical but electric powered Saturn prepared by DEMI. This used Zinc-Air main batteries with NiCds for acceleration. In the first 1 to 2 laps the EV could slightly out run the gas

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## Editor's Corner

### Public Acceptance

*Recently I gave a talk before the American Society of Mechanical Engineers (ASME) in combination with the Society of Automotive Engineers (SAE) at Santa Clara University. To start off the talk I asked the audience to give me their impressions of how the public perceives electric vehicles.*

*"Golf cart, slow and sluggish, little old lady, can't use in a motorcycle and not exciting to drive or ride" were their comments. Although "range limited" was mentioned, as well as, several positive attributes, such as, non-polluting, quiet, and very efficient—as you can see, the main perception was one of poor performance.*

*The chairman of California's Unocal Corporation said at a conference for oil industry executives "who wants to be cruising around our roads in an oversized golf cart?". (see page 12) Some of us in the EV field know this perception to be wrong, but the poor performance (as in much less than equivalent to even econo-car acceleration) does apply to many of our conversions, unfortunately.*

*Although some of our EVs can "burn rubber" (some can even do it in second gear) these are the exceptions. Why is this? We are not limited by the technology but by its application. The exceptions prove that it can be done. The numbers of poor performing EVs show that it is not being done.*

*Why all this talk about performance? Well, think of it this way, would you be willing to drive a vehicle that almost needed a push to start it even if it got a 1,000 miles on a charge? There is a new ad from Chevron that shows a Corvette in front of a Kenworth or Mack truck. They then talk about other companies' gas with less performance and the Corvette shrinks to a child's kiddy car. This is the public's perception of EVs and they for the most part will not tolerate being embarrassed or frightened by a truck or bus behind them that honks and can out accelerate them. This defines the present pure solar cars, but does not exemplify what can be done in a battery powered car.*

*It is well past time that the EV be made competitive with the gas car in performance. Think of this. If batteries are improved, your range may be improved, but if you cannot get the power needed from your motor, your acceleration won't change much. Since 95% of vehicle travel is less than 50 miles round trip, 25 miles one way, perhaps we have been promoting range to the public, to the detriment of the very thing that they want—Equal performance.*

*The American public almost exclusively **WILL NOT TOLERATE** a wimp-mobile. Our EVs do not have to be such and must not be if we are to over come misperceptions about their practicality. It is time that we design or redesign our EVs for better performance. I believe that if you can demonstrate equal "practical" performance, then people will consider just what range they really do need. In most cases a smaller amp-hour but higher voltage system will serve them well. Providing the needed range at the desired performance.*

*Back to the talk. After showing a picture of Ed Rannberg's well over 100 mph motorcycle doing a burn out, I showed pictures of the Solar and Electric 500 sprint races, as well as, all of the other races. Many misperceptions about EVs were corrected that evening to the delight of many in the audience. Now it is up to us to make these the norm and not exceptions.*

- Pb editor

### Articles

If you would like to submit an article for the Current EVents—the preferred form is on a floppy disk, formatted for DOS (Ascii Format) along with a printed copy of the article. Any form is acceptable. Also include camera-ready photos or graphics or include TIF formatted files with your copy. Please send to Paul Brasch, Editor (see address below.)

### Advertisements

If you would like to submit an ad, please contact Susan Hollis/PCTEK at (408) 374-8605 or Paul Brasch at (408) 371-5969 between 10-5pm PT for additional information and rate sheet.

### New Members

If you know someone interested in becoming a new EAA member, they may call EAA @ 800-537-2882 for a brochure and membership application. As a non-profit organization, the membership fee of \$25 is tax deductible.

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# EAA XA-100 Hybrid Electric Vehicle Project - Chapter 3

By Bill Palmer, EAA

This is the third and final of several articles about the project. The first, in the December '91/January '92 issue, described the role of EAA, as contractor to the California Energy Commission, and gave an overview of the work the team of EAA members and Stanford students and faculty did in converting and testing the car. The second, in the April/May issue, described why we built a hybrid car, performance objectives and how the car was selected. This time we will go more into the details of what we did, how and why. We hope our process and experiences will be helpful to any of you who plan to convert or build an electric car.

One of the key objectives and considerations as we designed the project was to use only today's technology which had been proven and for which hardware was commercially available.

## MOTOR SELECTION

With the vehicle selected, its weight, air drag and rolling resistance were known. Transmission ratios were taken from the car manual and the drive wheel diameter was measured. We were ready to calculate the motor torques and speeds required to achieve the performance objectives established earlier. Several people did parallel calculations using computer spreadsheet programs such as Lotus 1-2-3 and Supercalc. The results gave us the required motor torques and speeds under several operating conditions such as cruising, accelerating and hill climbing. By assuming the durations of each operating mode we arrived at the continuous and short-time torques and corresponding speeds which translate directly to motor horsepower requirements.

With the motor rating determined, we needed to decide what kind of motor to use. Table 2\* shows relative characteristics of three of the several types of motors suitable for electric vehicle traction duty. Actually, while the relative characteristics of motors are interest-

ing, the selection was governed more by what was available at a price the project could afford. Also, an affordable controller must be available that is suitable for the available motor. We would like to have used a high-speed ac induction motor with an inverter-controller which would accept constant voltage dc power and produce variable frequency, variable voltage ac to the motor. Unfortunately, neither a suitable induction motor nor inverter-controller was available.

We found a GE 25 hp, 100 Volt, series, dc motor which met the torque and speed requirements. It was heavy but available and affordable. It had face-flange mounting and, with an adapter, fit the transmission flange and just cleared the opposite wheel well.

## AUXILIARY POWER UNIT (Engine/Generator) Selection

Table 3\* shows some characteristics of several types of engines against several performance criteria. Of course, we wanted the auxiliary power unit to be as small and as light as possible. A design objective was that the car be able to cruise at 65 mph on a level highway with no wind using only power from the auxiliary power unit. Calculations for motor sizing indicated that cruise power of 25 hp. would be adequate. This translates to a generator rating of 20 kW and an engine rating of about 40 hp.

There are several "off-the-shelf" engine/generator units available such as some built by Honda. One, rated 4.5 kW, weighs 66 kg. (146 lb.). Its power-to-weight ratio is .068 kW/kg. A 6 kW. unit weighs 129 kg (284 lb.). Its ratio is .047 kW/kg. These units are designed for stationary use where weight is not very important. They are too heavy and their power output is much too low.

We found a rotary engine being developed by Norton Motors, in England for small remotely piloted air-

craft, "drones", which produces 40 hp. and weighs only 11.8 kg (29 pounds). After we added cooling and lubricating systems, a 23 kg (50 lb.), 20 kW. alternator and controller, a mounting bracket, drive pulleys and belt the weight was still only 61 kg (135 lb.) and the power-to-weight ratio was .33. This is nearly five times the power-to-weight ratio of the packaged units.

The alternator is a permanent-magnet, brushless dc motor made by Unique Mobility. When powered electrically it produces torque. When it is driven by an engine it operates as a three phase alternator. Its controller will regulate its power output both as a motor for starting the engine and as an alternator for powering the car. The controller also rectifies the ac output to dc for charging the batteries and supplying the traction motor. The only problem with this power unit was that, both engine and alternator were developmental models. Even though they were commercially available, they were not being mass produced and therefore were very expensive. We used them because they showed technical feasibility which could become economically feasible with volume production.

## SELECTING CONTROLLERS

Controllers were needed for the traction motor, the alternator and the auxiliary power unit. For the motor, we chose the PMC controller because it was suitable for the application, it was being commercially manufactured and Curtis-PMC worked with the project. It has proven to be reliable and it was reasonably priced. The alternator controller was part of the Unique Mobility package with the alternator.

The auxiliary power unit controller needed to sense the voltage of the main dc bus and, when auxiliary power is needed, tell the alternator controller to energize the alternator as a motor to

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# Phoenix

(Continued from Page 1)

car. By the 4th to 5th lap the electric would fall 10 to 100 yards behind at the finish line. They were hitting some 87 MPH speeds in the EV. Darn fine for something that many "experts" used to tell us could never be done in a stock car.

In the realm of new techniques there were two. First of all Michael Hackleman perfected the battery charge dumping technique he introduced with problems last year. This year all went well with four minute recharges accomplished from higher voltage battery packs in the pits. The most startling new technique was battery exchanges—for the first time at Phoenix. These ranged from the crude (using block and tackle) to slide in styles that sometimes stuck, and even raise up the vehicle and bolt and unbolt the battery pack techniques (slow and dangerous). The highlights were demonstrated on the top two finishers in the Open Competitions.

Car #17 driven by Ely Schless of the Hackleman/Schless racing team and car #10 driven by Billy Roe of the Roe/Brawner team both came up with quick exchange techniques wherein the car would stop at its pit and battery packs on each side would simply be lifted out as a unit by hand. The car would then be rolled forward 10 feet where fresh packs were positioned. These were then lifted into place. Here is where the variations won the race or not. The #17 car used an automatic connection scheme, whereas the #10 team had to tighten fasteners. This meant that they took 25 to 35 seconds to pit and the Schless car could do it in 17 seconds typically. So although Billy Roe could pull 95 MPH peak speeds vs about 87 MPH for Schless, he (Schless) spent much less time in the pits. He also was able to run about twice as far per charge requiring many fewer, as well as, shorter pits than Billy. Schless used an Advanced DC motor and PMC controller with Trojan batteries. Roe used

a GE. motor and GE. controller with EXIDE batteries.

New technology was in abundance at this years race. The MOST important for us all, and of immediate use, were Goodyear's new low rolling resistance tires. Presently they have an Invectra line of tires that are claimed to be some 20% better than the now out of production Wards Grapplers. Also, most teams were testing new super tires that are better than those used on the Impact. These are the tires that have been fitted on GM's ultralight that has gotten a lot of press recently. No they are not for sale yet as they have not completed DOT testing and approval.

Other new technologies of interest were a new lubricant and a new battery catalyst that claims to reduce battery impedance while increasing energy delivered and cycle life. Motorola was testing brand new motor controllers on the DEMI/APS Saturn. And a prototype of a new battery of the Nickel-Metal Hydride type was displayed by Ovonic Inc. This battery costs about twice the present NiCd cost/whr in "c" cell size and stores about twice the energy per unit weight. Incidentally, Ovonic just got one of the first USABC contracts. Also on display was the LA301 hybrid car in the LADWP booth.

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## TOP RACE FINISHERS

**Solar and Lightweight race.** (Final for all 3 legs 1 hour each)

### Electric Lightweight Open competition

1st Andy Heafitz 151 miles

### Solar Division Competition

1st Alan Redmond 127 miles

### Electric Hybrid Student Competition

1st Louis Meyer for Paradise Valley H.S. #7 49.5 points

### Electric Stock Car Sprint Race - 25 Laps

1st Tim Considine #11 Hackleman Honda Vx

2nd Chris Smith #2 APS DEMI powered Saturn

### GNB Open Competition Electric Race (90 min.)

1st Ely Schless #17 Hackleman/Schless F440 formula racer

2nd Billy Roe #10 Brawner Midget racer

### Chrysler-Plymouth Electric Stock Car Race

1st James Worden #99 Solectria (GEO Metro)

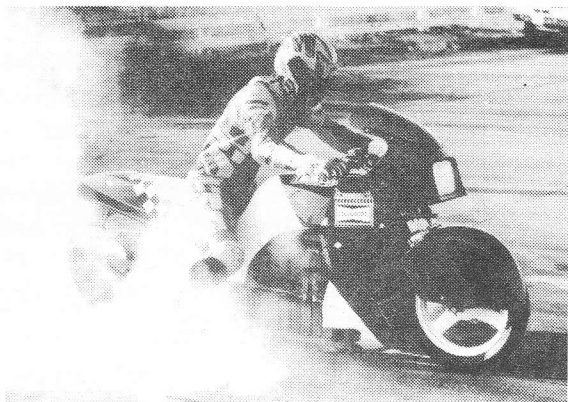
2nd Tim Considine #11 Hackleman Honda Vx

**For full official results contact, SERA at (602) 953-6672**



# Phoenix

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Ed Rannberg is pictured here doing a "burnout". Ed has made record runs of 0-110 mph in 11 sec.

Photo credit: Jeannine Adams for GNB Inc.

By the way, Louis Meyer who co-drove for the student/hybrid team, is an 87 year old 3 time Indy winner.

A final comment on technology and the Stock Car Race which was Red flagged due to a new technology incident. Several new battery designs were shown at phoenix. Chrysler had their Nickel-Iron powered minivan there and ABB showed but did not run a sodium-sulfur battery. There were many NiCad and Lead-Acid packs in use and Dreisbach Electro Motive Inc. (DEMI) had Zinc-Air packs again in one of their three cars (gas and NiCd in the others). But strangest of all were the Zinc-Bromine battery systems, from different manufactures, in the Texas A&M University car and in James Worden's #99 Solectria (Geo Metro) car. He also had NiCd and Lead-Acid powered cars, but #99 had the super power Zinc-Bromine in it and was driven by James himself.

Right from the beginning Jim pulled out in front and proceeded to lead the race. The only car that (seemingly) could pace him was Hackleman's Honda Vx driven by Tim Considine. But Tim had to stop to "refuel" his lead-acid batteries with 4 minute pit stops. Jim knew that he did not need to stop for the duration of the two hour event.

About lap 90, some 89 minutes into the race with Jim leading the pack by 4 to 5 laps, (which looked like a train

or convoy as 5 to 8 cars drafted each other bidding time till the end), car #99 started trailing an orange-brown mist as he headed for the start-finish line. Immediately after crossing the line his car filled with a dark cloud as he frantically tried to stop the car and bail out at the same time. This led to a spin out at turn one followed by his climbing out the drivers side window and collapsing face down on the ground outside.

Within minutes he was airlifted to a Phoenix hospital and spectators were asked to leave the grandstands. About a dozen other people were treated and released at a nearby hospital. Worden himself was released 3 days later. Meanwhile the race had been Red flagged and declared over with Worden the winner in spite of the fact that his car forced the end of the race. This was reportedly the first time in racing history for this to occur. Worden still thinks that "Zinc-Bromine is the battery of the future", but he acknowledges that they'll "have to encase it in

some kind of shell to contain the liquids."

The sad part of all this, (aside from the injuries) is that all of the other racers who had been holding back waiting for the last 15 minutes of the race to sprint for the finish never got to show their stuff. Also some of the media coverage only talked about the incident as a toxic gas attack and said nothing about the fabulous demonstrations all weekend long of new and real technology to help save the earth. Fortunately CNN and others only told of the great successes and not the failures.

I am sure that safety will be paid more attention to at the next race. And perhaps the philosophy of allowing experimental battery systems (toxic or not) in a stock car race of so called "street registerable" vehicles is out of line. It seems that these should belong in the Open Competition class.

All in all, thanks to Ernie Holden, the Second Annual Solar and Electric 500 Race in Phoenix proved to be **without a doubt** the *Greatest Event in History* and the *Greatest Spectacle in (EV) Racing*.

The world's EV race has begun. ♦



Hackleman's Honda Vx, driven by Tim Considine, won the 25-lap stock car heat sprint race.

# EAA XA-100 Hybrid

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start the engine. Then, when the engine is up to speed, switch to the alternator mode and to regulate both engine speed and alternator power until the auxiliary power unit is shut down manually or by high bus voltage. A team of Stanford students developed a microprocessor-based controller which performs these functions. It is one of the most significant developments of the project.

## SELECTING BATTERIES

The battery, as we all know, is the weakest part of an electric vehicle. Batteries have not yet been developed which have all of the needed characteristics: high specific energy for long range, high specific power for good acceleration, will survive many deep discharge cycles and reasonable cost. The best commercially available technology approaching these characteristics is nickel-cadmium. However, finding Ni-Cads in suitable shapes and ratings is difficult and they cost at least five times as much as lead-acid batteries.

The project was fortunate to have several sets of 12 Volt RV/Marine batteries in two ratings donated by Delco. Naturally, that solved the problem of battery selection for immediate vehicle testing. However, RV/Marine batteries are designed for many deep discharge cycles when used at low currents, such as a 20 hour rate. They do not last long when battery currents of up to about 450 amperes are drawn during accelerations even for short times. The first

set of ten we put in the car survived only a few cycles. Then we installed 20 of a new, higher-rated type in two series strings of ten and connected the strings in parallel. That cut the current each battery carried in half and increased battery life. But energy storage is still much too low for desirable range on battery power alone. Also, that change increased battery weight from 361 lb. to 656 lb.

## CONNECTING IT ALL TOGETHER

Figure 1 is a block diagram showing how the several components and functions are connected together. The auxiliary power unit controller is shown as "Manual Control Unit" because some automatic functions of the students' controller were not operational when the diagram was made.

## INSTALLING COMPONENTS

Several team members built full-scale models of the main components, such as the motor, controllers, engine/alternator and batteries. The models were made from plywood, sheet metal, cardboard, duct tape etc. and made it much easier to fit those components into the limited spaces available. That fitting would have been much more difficult if we had selected a smaller car.

Other team members made accurately scaled engineering drawings from which brackets, adapters and couplings were machined or fabricated.

An adapter was made of aluminum plate to fasten the main motor frame to the automatic transmission housing where the engine had been. A shaft coupling was designed and machined to connect the motor shaft to the

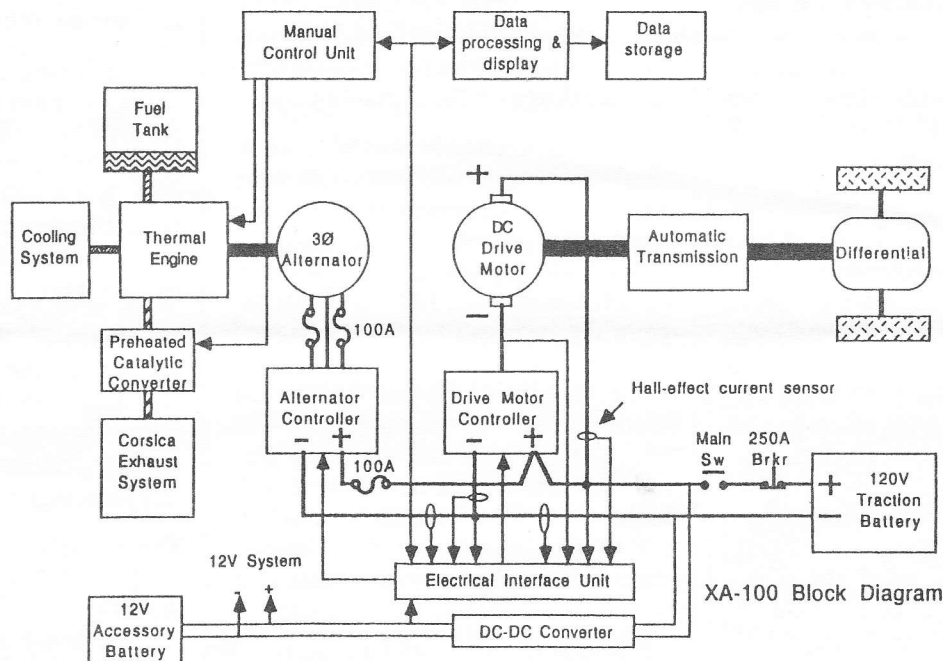


Figure 1 XA-100 Block Diagram

## SELECTING OTHER COMPONENTS

Miscellaneous components, such as a smaller radiator for engine cooling, a transmission cooler, blowers for motor and alternator cooling, vacuum pump for the power brakes, main electrical switch and fault protection circuit breaker were obtained from local sources, usually only after much searching.

(Continued on next page)

## EAA XA-100 Hybrid

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transmission's torque converter. Brackets were made to support the motor to the original engine mounts. Additional brackets were made to support the blowers, engine/alternator, controllers, vacuum pump, coolers, etc.

### OPERATING AND TESTING

The car drives just like it did before it was converted, except that, during testing, the inside is somewhat cluttered with data collecting wires, several multi-meters, a video camera on a tripod and platform and the test data storage laptop computer. During test runs signals from hall-effect current transducers, voltage taps and speed sensors are displayed on the multi-meters and on the master controller display and are recorded in the laptop computer. The video camera records some of the displays and a clock. After test runs the computer data are analyzed on a larger computer and graphs of the test results are plotted.

### CONCLUSION

Conversion, but very little testing, was completed just in time for the car to be shipped to Florida to be a support vehicle for the Stanford students' solar car in the solar car race from Florida to Michigan sponsored by General Motors. During that shakedown cruise many bugs were discovered and corrected and a few fires had to be extinguished. A lot was learned about designing, building and testing for reliability! Since then the car has performed quite well during dynamometer and on-the-road testing. The following table shows how actual performance compares with design goals:

Table 1 PERFORMANCE RESULTS

| Performance          | Design Goal | XA-100 Actual |
|----------------------|-------------|---------------|
| <b>Acceleration</b>  |             |               |
| 0-30 mph             | 10 sec      | 8 sec         |
| 0-50 mph             | 20 sec      | 20 sec        |
| <b>Hill climbing</b> |             |               |
| From rest            | 20% grade   | est. <25%     |
| 3% grade             | 55 mph      | <55 mph       |
| <b>Top speed</b>     | 60 mph      | <65 mph       |

We are still testing and tuning to determine values for three variables: range on batteries, engine emissions and fuel economy. Range, of course, is a function of the number of batteries on board. A heavy load of batteries will extend range but the car will be less agile. A compromise is necessary. Emissions can be minimized and fuel economy improved by engine tuning, operating at the most efficient and cleanest speed and load and by injecting air into the exhaust line ahead of the first catalytic converter. We are still experimenting, adjusting and testing for lower emissions and higher fuel economy.

The project has been extremely educational and a satisfying activity for all of us who have worked on it. It is attracting considerable interest from car manufacturers and component suppliers. With a lot of luck we may see hybrid electric vehicles become available and popular as "bridge technology" while we continue the long wait for better batteries. ♦

The author thanks Dr. John Reuyl, Project Director, for permission to use the tables and figures in this article.

\*Editor's Note: Table 2 & 3, referenced on page 3, is available as a reprint.

## Energy Conservation A WISE Alternative

The following excerpts are from an editorial titled "Conservation Makes a Case" which appeared in the April 2 New York Times:

**"What we found is that the cheapest source of new power is conservation."** Those words from a senior New York State official explain Gov. Mario Cuomo's laudable decision to cancel a \$12 billion contract to buy power from a mammoth hydroelectric complex planned for Quebec.

"[The project] would have turned a huge, unspoiled area of Quebec into a managed system of waterways and reservoirs, threatening the hunting grounds and livelihood of native Indians."

"Alarmed American environmentalists...moved to block the deal. Mr. Cuomo based his reversal largely on economic grounds. He did not address the difficult question of whether New Yorkers should try to dictate environmental policy to Quebecers. Nor did he dispute the fact that the deal makes environmental sense for smog-ridden New Yorkers."

"But the protests forced a fundamental question: Does New York really need the energy? The answer turned out to be NO. The surprising finding was that New York's utilities had done a remarkably good job conserving energy. Instead of building new plants to meet demand, utilities have tried to satisfy that demand by getting everyone to use existing energy more efficiently."

"The Power Authority has spent millions of dollars encouraging high schools, police departments and municipal hospitals to use more efficient lighting, heating and air-conditioning systems. Investor-owned companies, which would have bought 80 percent of Quebec's power, had done the same with their customers. By 1991, these efforts had begun to pay off." ♦

(NEW YORK TIMES: 4/2)



# Lead Acid Battery Care Tutorial

By Gordon Schaeffer, East Bay Chapt. EAA

**B**e kind to your batteries! They are your major maintenance expense with an electric vehicle. In reality your batteries cost you 3 to 5 cents a mile. You want to make them last as long as possible.

The first thing to do is to get the correct battery. For the longest life most EV owners agree that a 6 volt golf cart battery is the best. Since more of these are in use, the price is also much better. Often they come 36 to a pallet. If you can team up with someone and split the pallet, you can often get a better deal from the supplier. There are four standard golf cart batteries. Trojan lists them in Table 1 below.

Do check each battery on arrival: physical damage, voltage, acid level covering the plates.

Do not add water up to the cap ring until the batteries have been fully charged. The acid level rises with charge so if you do fill up an under-charged battery and then charge it you will have quite a mess on your hands.

Use lead clamp around or tinned copper/brass terminals on the battery posts. Beware of cheap zinc clamp around terminals, they have a high resistance and tend to loosen. To keep down corrosion be sure that all terminals and nuts, bolts, washers be lead coated. Covering the terminals with petroleum jelly or a commercial terminal coat makes for a neat, long lasting installation.

Water the batteries only with distilled water. The \$2.00 you spend every three months is cheap insurance. Do not let the cell plates become uncovered when fully discharged. If you do notice a low cell, add just enough water to cover the plates and then you can safely charge. At the end of charge top off the cells to the indicator split ring.

## Using (Discharging) the Batteries

Take out as little energy as necessary. Draw as few amps as you can for as brief a time as you can. That means easy acceleration, coasting as much as you can, anticipating traffic signals; in other words not driving like the typical lead footed gas hog driver. The batteries give back much more of the energy that you put into them when you draw it out at 70 amps than you get when using 400 amps. All batteries have internal resistance. By Ohm's law one can see that high current creates a voltage drop and heats the battery. The internal resistance of a fully charged battery is very low, but rises as the battery discharges. The reason is that as the battery discharges there is less and less sulfuric acid in the electrolyte and more and more water (the specific gravity gets closer to 1.000). Water doesn't conduct electricity very well and that is what is between the positive and negative plates in each cell of the batteries. Therefore the voltage drops and you need more pedal to give you more amps

to keep the motor at the same speed. The increased current means more voltage sag and the vicious circle goes on and on until you pull over and get an ice cream and let the batteries cool and let the electrolyte mix. If you are patient enough, in half an hour or so you'll have enough energy at a modest current draw to get back home.

The best advice is to watch your battery pack voltmeter. It is really the only meter that you must have. By watching it you can determine the state of charge and discharge. Lead acid electric vehicle batteries have a very constant voltage over a wide discharge range of current until the battery is down to about one third of its remaining capacity. The pack voltage starts to drop more and more when the same current is used as the internal resistance gets higher and higher. Learn the characteristics of your vehicle's voltage versus driveable range and you will not be left stranded. Remember the only useful voltage reading is one that is made under load. The batteries could be severely discharged and still show within five volts of the nominal pack voltage if no current is drawn.

## Charging

There are several styles of chargers, but all of them have a means of limiting the beginning charge current. The best have a way of reducing the charge current when the batteries are fully charged. Continuing to charge a battery that cannot accept any more chemical changes to the plates creates heat and the production of hydrogen and oxygen gas. Heat shortens the life of the battery and excessive gassing lowers the acid level, requiring frequent addition of water and it sprays acid all over the top of the battery. This coating of acid is electrically conductive and can slowly discharge the battery or more annoying, make a ground fault interrupter equipped charger shut off.

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Table 1 - Golf Cart Batteries

| Model | Weight | Amp hours<br>(20 hr rate) | Min. @75A | Height  |
|-------|--------|---------------------------|-----------|---------|
| T-90  | 58     | 185                       | 90        | 11 1/4" |
| T-105 | 61     | 217                       | 105       | 11 1/4" |
| T-125 | 66     | 235                       | 125       | 11 1/4" |
| T-145 | 71     | 244                       | 145       | 11 1/2" |

each is 10 3/8" long and 7 1/8" wide

## CASH for Clunkers Deal, Hidden Ills

The following are excerpts from an editorial titled "A Kind, Clean Word for the Clunker," which appeared in the March 15 Chicago Tribune:

"The White House, against the deadline of a primary in the auto-producing state of Michigan, has formulated a plan whereby companies that buy old cars and then junk them could get 'pollution credits.'

"The scheme claims a double benefit. Consumers would turn in their polluting clunkers, getting anywhere from \$700 to \$1,000 from companies needing the credits. New car sales would be given a boost.

"The central fact is that the abused clunker may well be generating less pollution in today's urban environment than the late-model automobile equipped with a catalytic converter.

"The story begins more than 20 years ago, in the policy battles preceding the passage of the Clean Air Act. Environmental policy-makers and their scientific advisers were looking at two principal classes of compounds fueling the smog process: oxides of nitrogen and hydrocarbons.

"One consequence of that faulty model was the modern car equipped with its catalytic converter. The converter further oxidizes the incompletely burned fuel, that is, hydrocarbons, in the raw exhaust. These hydrocarbons are burned with the help of the platinum catalyst.

"But the converter also acts as a catalyst on sulfur, a component of all gasoline. In the combustion process this sulfur is rendered into sulfur dioxide, which, as it crosses the platinum in the catalytic converter, becomes sulfur trioxide, which, with the addition of water,—becomes sulfuric acid. All cars equipped with catalytic converters are miniature sulfuric acid factories.

"Though there is no doubt that 20 years of environmental regulation has reduced hydrocarbons, no one has yet demonstrated that in consequence the air is less toxic. Indeed, the catalytic converters may have engendered greater toxicity, as early tests on rats untiringly ignored—suggested. Bureaucratized science bred bad air, which clunker-napping and pollution credits promise to render even fouler." ♦

(LA TIMES 3/15)

*Ed Note: We have been trying to play down the effect of some slight acid vapors from our EVs, while present day catalytic converters may be making more. Whom should be pointing the finger at whom?*

## Energy Future Lies with Alternatives

The following are excerpts from an editorial titled "Edging Toward the Energy Future," which appeared in the March 6 Boston Globe:

"The energy bill passed recently by the Senate is a step forward, but only a modest one. As Sen. James Jeffords of Vermont said: 'The bill falls short because we still will become increasingly dependent on oil from the Middle East. We still don't have a national energy strategy.'

"The central problem is attitudinal. President Bush is married to fossil fuels - oil, coal and gas - and nuclear power. His national energy strategy focuses on increased production. His ersatz brand of conservatism includes no commitment to conserving, to using less energy more efficiently.

"If, during the Reagan-Bush decade, the U.S had spurred energy-use efficiency and invested in renewable energy instead of cheering on the use of conventional fuels, the energy future might be promising. But Bush's steep tilt of the playing field in the other direction has made fossil fuels and nuclear power artificially cheap, accelerating foolish waste ranging from muscle cars to inefficient buildings.

"The bill is marginally stronger on spurring efficiency than the bill that was filibustered to death last fall. The task for the House is to increase the incentives for efficiency and provide funding to subsidize development of renewable energy; photo-voltaics (technology that converts the sun's rays directly into electricity); solar-thermal (the use of focused heat from the sun to heat fluid and run turbines); wind-driven generators; geothermal heat from deep in the Earth; and biomass.

"The long-run energy future of the United States, and of the world, will not be found in fossil fuels, which in time will run out - and in the meantime may catastrophically alter the climate. Rather the future lies in increasing fuel-use efficiency and in developing alternatives to coal, oil and gas." ♦

(BOSTON GLOBE 3/6)

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## Connecticut Ready to Join California Rules

**C**onnecticut now seems ready to join other Northeastern states in adopting strict California automobile emission standards. The state, which had originally opted not to go along with 11 states and the District of Columbia in implementing the air pollution rules, now says it is willing to incorporate them into its smog abatement efforts.

The state had earlier claimed that adopting the California rules was not the most cost-efficient way to cut air pollution. But, a Department of Environmental Protection (DEP) spokesman said further study revealed "a growing understanding of how (the California standards) fit in with an overall emission reduction strategy."

The other states agreed to adopt the California rules as part of their Clean Air Act compliance strategy. The regulations require states to take measures to reduce emissions of smog-forming pollutants, but don't specify exactly how.

The DEP said Connecticut would implement the low-emissions rules beginning with the 1998 model car year. It will also require the sale of reformulated gasoline and the use of special gas pump nozzles that keep gasoline vapors from escaping during refueling. ♦

(REUTER 3/10)

## \$100 Million for LEVs?

**T**he fledgling electric car industry and other clean-fuel technologies are getting a boost from California legislators. *The state Senate recently approved a bill that would authorize a \$100 million bond measure on November's ballot.* If voters approve, the money would fund the research, design, and manufacture of low-emission vehicles powered by fuels such as methanol, natural gas and electricity.

Changes in both federal and state air quality laws mandate changes in auto technology. One million clean-fuel autos are projected to be on the California roads by the turn of the century. Beginning in 1996, the federal Clean Air Act will require the sale of 150,000 low-emission vehicles annually in California. The California Air Resources Board will require that 2 percent of all autos sold in the state be emission-free by 1998.

The bill's sponsor, Sen. Herschel Rosenthal (D-Los Angeles) says that the proposed bond measure will "help commercialize the California clean-fuel industry," and added that it could help put displaced workers from the area's declining defense and aerospace industries back to work. Supporting the measure, Senate energy consultant Michael Shapiro said, "We have created a government-mandated market for these cars, and we want to make sure the economic benefits remain in the state."

With both industry and environmental interest group support, the measure is expected to win state Assembly approval and, say political experts, could win voter's approval if they see it as beneficial to both environment and the economy.

Harry King, general manager of Hughes Power Control Electronics sees economic benefits accruing "any time you infuse money into a new and sound technology." Hughes will provide the drive system for General Motor's electric cars in California. GM's vehicle is scheduled to be on the market by 1995. Its prototype can achieve speeds of 110 mph, and requires recharging every 100 miles. ♦

(LA TIMES: 4/5)

## California Auto Emissions Rules Defeated

**A** bill to adopt tough automobile emissions standards was defeated in the Maryland state Senate on Thursday. The Senate Judicial Proceedings Committee defeated a proposal to adopt California-style regulations by a vote of 6 to 5, leaving supporters to hope that the House of Delegates will pass a similar, if not weaker bill.

One factor in the vote was the defeat of a similar bill in Virginia's legislature earlier this year, and the failure of the District of Columbia to commit to the same emissions rules. Auto industry lobbyists have argued that, should a state adopt such measures while its neighbors fail to do so, car dealers will lose business.

"This is the way opponents of the bill have been picking it off, state by state," said state Senator Howard Denis.

The bill was seen as one way for Maryland to comply with the Clean Air Act, which essentially leaves it up to individual states to draw up their own air pollution plans. Maryland's environment chief said the state would have to look at other ways to reduce emissions.

"If it's not going to be cleaner cars, it's going to be cleaner something else," said environment secretary Robert Perciasepe. ♦

(WASHINGTON POST, WASHINGTON TIMES 3/13)



## New Battery Catalyst for Improved Lead Acid Battery Performance

**B**attery Automated Transportation announces a new battery catalyst for improved lead acid battery performance

### Ultra Force Battery Specifications

The "Ultra Force" battery catalyst is the result of years of research to develop a deep cycle battery adequate to power electric cars. The "Ultra Force" electrolyte retards sulfation of battery plates and has a much lower impedance (which reduces resistance to the flow of power) resulting in several advantages over regular lead-acid batteries.

With lower impedance, recharging energy requirements are reduced by approximately 20%, resulting in a 20% reduction in energy costs.

With lower impedance, power output is sustained at higher voltages, extending operational time between fully-charged and fully-discharged batteries. Normal batteries are considered depleted when battery-load voltages decline to 5.25 volts (for 6 volt battery). The Ultra Force Catalyst allows the battery to continue to discharge under substantial load conditions down to 5.00 volts.

With lower impedance, heat buildup is reduced, substantially reducing water consumption and lowering maintenance costs.

The Ultra Force Catalyst retards the sulfation process, increasing the number of cycles from as few as 400 to as many as 1,500 to 2,000 cycles, thus considerably extending battery life.

"Ultra Force" batteries are safer to operate because they significantly reduce the amounts of hydrogen gas which are normally produced by lead-acid batteries. Normal lead-acid batteries boil profusely (emitting hydrogen gas) when the charging voltage exceeds 14.2 volts (12 volt battery). "Ultra Force" batteries will exhibit minimal gassing, even at higher voltages.

For more information contact Bob Martino, B.A.T. Technologies, 2471 S. 2570, West Valley City, UT 84119 or call 800-255-0906. ♦

*Editor's Note: After talking to Joe LaStella, President of B.A.T., I felt that this could be a breakthrough even at the cost of about \$16 per battery. If This proves out to last 50K-100K miles, conventional lead acid will still have a future.*

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## Solar Power Utility Company Lack of Subsidies

**T**he following are excerpts from an editorial titled "Unbind Solar Energy from Washington's Red Tape," which appeared in the March 12 Christian Science Monitor:

"From 1984 to 1991, Luz International Ltd. and its subsidiaries built nine solar thermal generating plants in the Mojave Desert. Together, they produce 354 megawatts of electricity - 90 percent of the world's solar energy.

"The next generation of plants, planned for construction in 1994-95, would have brought costs down to 6 or 6.5 cents per kilowatt hour — less than the cost of natural gas electric generation."

"Unfortunately, they may never be built. Luz International filed for bankruptcy in November.

"Nuclear plants are the beneficiaries of massive federal subsidies, and gas and oil companies benefit from an array of tax benefits."

"In contrast, federal and state support for solar power, briefly substantial in the wake of the 70s oil crisis, became more and more uncertain after 1986." Beginning then, renewal of federal tax credits for solar and geothermal energy was made part of a package of orphan laws known as 'extenders.' And it was this governmental red tape that tripped Luz International.

"Extenders" had to be approved by Congress every year, so starting in 1987 Luz had to lobby Congress for an extension of its tax credit at the beginning of the year, then frantically raise capital and, finally, build the plant before the end of the year when the tax credit ran out.

"These uncertainties increased the cost of financing — new money had to be raised every year — and led to cost overruns as Luz rushed to finish new construction every year. And last year, when Congress extended the tax credit for only nine months, the burden became too great and the company failed." ♦

(CHRISTIANSCIENCEMONITOR 3/12)

## U.S. Not Tapping \$200 BILLION MARKET

American businesses have tapped only 10 percent of the potential \$200 billion international market for environmentally sustainable products and services, says Michael Deland, chairman of the U.S. Council on Environmental Quality.

The latest government figures show that the U.S. spent approximately \$115 billion or 2 percent of the GNP, to control pollution in 1990. Deland estimates that by the year 2010, more efficient pollution control technology will save the US economy \$32 billion per annum.

Deland feels the U.S. has done a "remarkable job" in the past two decades of controlling air and water pollution. **"In the same time period, the economy grew by 50 percent-breaking the myth that we can't have a burgeoning economy and a clean environment,"** he said. "We can have both, they are mutually dependent."

Deland recommends a wide range of avenues for the U.S. to exploit this relatively unexplored region of the economy. Such steps include: market-based approaches to pollution control such as air pollution trading, and investment in environmental technologies that will lead to an increase in job creation. According to Deland, the key lies in "building bridges between the environment and corporate communities". ♦

(CHICAGO TRIBUNE: 4/3)

## Fuel Cell ADVANCE

The monolithic solid oxide fuel cell (MSOFC) concept under study at Allied-Signal Aerospace's AiResearch Division in Torrance, California, may be the wave of the future. Data suggest that such systems could cost less and provide higher performance than any other present fuel cell technique. Allied-Signal's Gorick Hossepian says the project has demonstrated dramatic performance gains as well as manufacturing methods that provide sample elements with "good repeatable production of defect-free cells."

Of the three fuel cell technologies currently under scrutiny, phosphoric acid (PAFC) and carbonate (MCFC) cells are nearing commercial status while SOFC is probably furthest from commercialization. In Pittsburgh, Westinghouse expects tubular SOFC startup in the mid-1990s and has plans for a 250 megawatt demonstration plant in Japan.

The Electric Power Research Institute (EPRI) in Palo Alto, California lauds SOFCs for their compact and lightweight properties that will allow flexibility of size and siting. EPRI also notes that, thanks to the ceramics used, they avoid corrosiveness problems caused by PAFC and MCFC electrolytes, but warns that tubular and planar-type SOFCs will have lower efficiency.

Hossepian rebuts that Allied-Signal's MSOFC competes in efficiency with any fuel cell. He cites 60 percent efficiency, which increases to 80 percent when exhaust energy is recovered. He also says the flat plate/corrugated MSOFC design can achieve power densities of 600 watts/kilogram, compared to 250 for planar types and less for Westinghouse's tubular model.

Initial MSOFC units will be small enough for use in aircraft power control systems. The Department of Energy is funding production of scaled-up cells for use in coal-fired cogeneration plants. ♦

(R&D MAGAZINE: MARCH 1992)

## Oil Executive Criticizes EVs

Electric cars were the subject of derision at a New Orleans conference for oil industry executives last week. Richard Stegemeier, chairman of California's Unocal Corp., slammed the alternative vehicles as expensive and not very convenient.

Stegemeier also criticized California state laws slated to go into effect later in the decade that will virtually mandate the sale of electric, or "zero emissions", vehicles. It is this legislation and not more practical reasons, he contended, that is the driving force behind the development of electric vehicle technology.

"Who wants to be cruising around our roads in an oversized golf cart?," said Stegemeier. "This is a powerful invention in our free market system. It's also a high-risk experiment in government forcing technology." ♦

(HOUSTON CHRONICLE 3/26)

## CANADIAN Smog Reduction

**"T**o fight smog, California is concentrating on the automobile, and phasing in the toughest auto emissions standards in the world. America's largest state is pulling the rest of the continent, including Canada, along with it. **Last month, Ottawa and the car manufacturers signed an agreement to harmonize Canada's emissions standards with those of California."** ♦

(GLOBE AND MAIL 3/16)

## Fuel Cell Demonstration Plant Nearly in Final Stages

**T**he Santa Clara Development Group (SCDG), a consortium made up of a number of utilities, is set to begin final engineering on a \$45 million plant that will use carbonate fuel cells to generate a capacity of 2 megawatts of electricity. The plant, intended as a demonstration project, is expected to promote the commercial viability of fuel cells.

Although almost prohibitively expensive at the moment, carbonate fuel cells are being looked to as a nearly pollution-free and highly reliable energy source. The plant is expected to be nearly 60 percent energy efficient by 1998, when the first commercially available fuel cells are expected to be available. They are expected to cost about \$1,000 per kilowatt. The plant marks a significant step in the process to first develop fuel cell technology, and then create demand for the technology by making it affordable.

"The SCDG feels that it has solved the fuel cell commercialization dilemma by getting the manufacturer to agree to pay royalties on our investment in the demonstration, and to link the project to a logical progression of steps that will result in commercial power plants," said SCGD chairman Paul Eichenberger. ♦

(COAL AND SYNFUELS TECHNOLOGY 3/16)

*Editor's Note: This compares with \$1,000/kw for wind power in 1990 real dollars. Is this worth it?*

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## BREAKTHROUGH for Thin-Film Solar Cells

**N**ewly developed technology may further lower the costs of generating electricity using photovoltaic cells. A new, thin-film cell has been developed by University of South Florida professor Ting Chu, in collaboration with Colorado State University and the National Renewable Energy Laboratory (NREL).

Chu's cell is constructed of cadmium telluride, a common photovoltaic material, and can achieve an efficiency rating of 14.6 percent. Chu coated the cell with a special non-reflective material, which cut down on the amount of light lost by reflection. NREL verified the 14.6 percent rating as a record for a thin-film solar cell.

Although other photovoltaic cells have been rated with efficiencies as high as 34 percent, they are quite expensive to produce. The industry is trying to find a happy medium between cost and efficiency, with the hope of reducing the price of photovoltaic cell-generated electricity to around 6 cents per kilowatt-hour within this decade. ♦

(INDEPENDENT ENERGY, FEB 1992)

## CHINA Commits 1% to Air Pollution

**C**hina has announced its intention to halt emissions of sulfur dioxide (SO<sub>2</sub>) and soot as part of a nationwide effort to combat air pollution. A planned, five-year program will devote \$14.7 million to combatting the problem, largely due to the fact that most Chinese industry is powered by coal.

The investment represents almost 1 percent of China's gross national product, believed to be the largest amount to date committed by a developing nation to battle environmental problems. ♦

(COAL AND SYNFUELS TECHNOLOGY 3/9)

*Ed: It has been stated that if China does nothing to clear the air that all of the rest of the world's efforts would be nullified.*



## "Red" Sparks Offers some Helpful Hints for First-Time Electric Car Converters

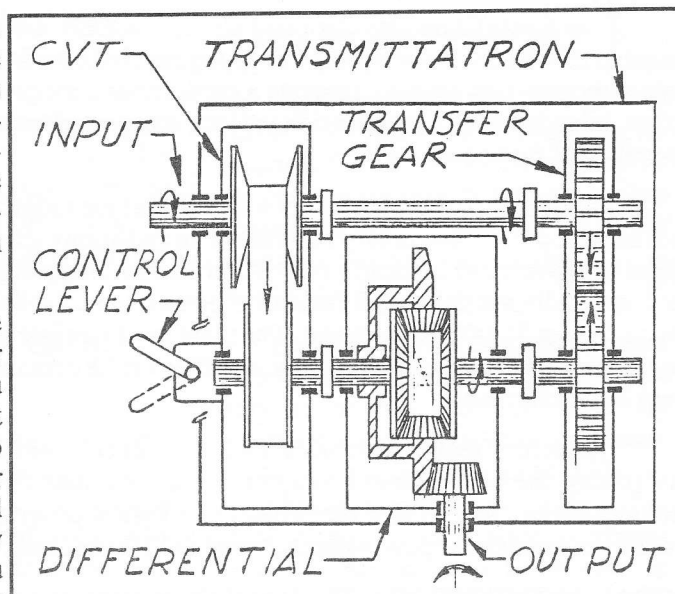
John Burke, Guest Author

First you take your car; we'll say its one of the old-fashioned kind that the engine points backward and there is a differential rear axle. you pull out you engine and transmission and radiator, but leave the drive shaft. Then you get yourself some batteries and a D.C. motor, a shunt wound job. Notice that you have to kind of juggle how you hook up the batteries so you get enough volts to run your particular motor at its rated power. Now you put in the batteries and a keyed switch, and hook your motor to the batteries directly through the switch. Connect the motor shaft to the input shaft of a TRANSMITTATRON and hook the output of the TRANSMITTATRON to the differential shaft. That's all there is to it! A diagram is shown below to clear things up in case I lost you back there.

When you get into the car the first thing you notice is a control lever sticking out the side of the TRANSMITTATRON. Move it to "Zero". Turn on the switch and the motor buzzes up to its natural on load rpm and stays there. Now you're all set to go. Take a hold on the steering wheel and gently ease the control lever in the "Forward" direction. Easy now; she starts to move, and wherever you stop the lever the car will just keep on running at the same speed. Lever in some more forward; she goes to a higher

speed and holds there. Pull back some on the lever and the car slows down. There is a steady-running speed for every one of the infinite number of lever positions, and for those in between!

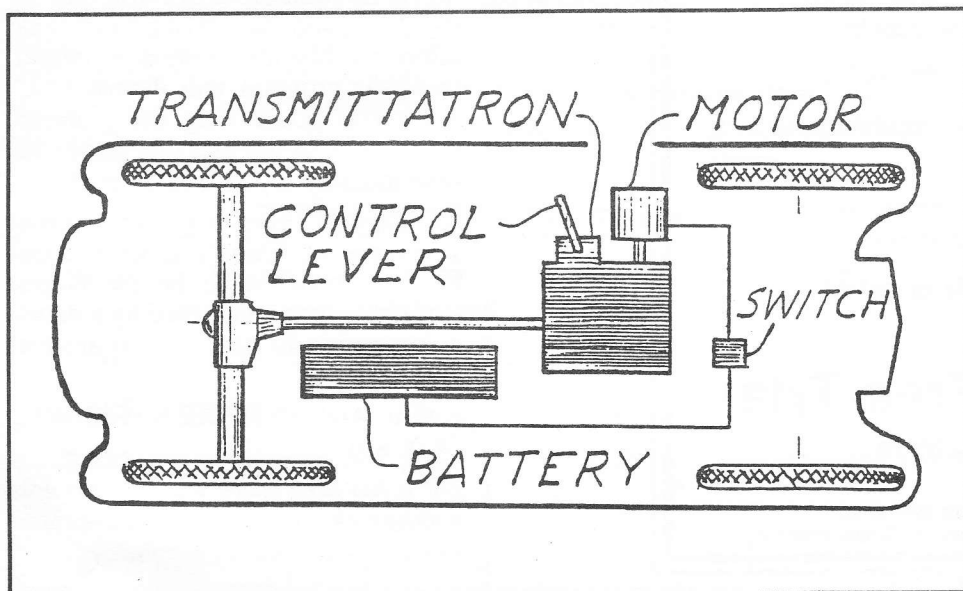
Well, when you've been driving this rig for a while you realize you can put the blocks to it as fast as you want to move that lever, either forwards or back, and this baby will really cook! But watch it! You could cook your motor and make soup out of the batteries. Maybe an ammeter would not be out of place here. But any reasonable handling and you've got full speed motor torque working for you right from the word go, and you can keep crowding full speed volts and amps into battery regeneration right down to a couple of miles an hour if you want to. You shouldn't hardly have to use the hydraulic brakes at all. When you get to zero and the car stops, try hauling back easy on the lever. You will back up according to how heavy you are on the lever. Makes it easy to back uphill real slow into a parking space. No messing



with forward and reverse gear; just pull on the parking brake when you get through.

These TRANSMITTATRONS are kind of hard to find, so I'll show you how to make your own using regular industrial parts which are called out in the second diagram. This shows a variable-pulley continuously variable transmission (CVT). That's the part that has the control lever on it.

You can buy a new one (see Power Transmission in the Yellow pages) or try some of the surplus stores. Sandy Ames can tell you where there is one that came out of a Subaru Justy. There are also other types of CVT that would do just as well. And there is a parallel-shaft gear set, like a truck power-take-off. You will also need another differential and some bearings and shafts and couplings, mostly junkyard arts unless you want to get fancy. If your car happens to be one of those front-drive outfits you will also need to use a belt or chain drive to differential. And if you've got the moxie to tackle a conversion like this you won't have any trouble dopping out a foot pedal instead of a control handle.



(Continued on next page)

## Helpful Hints

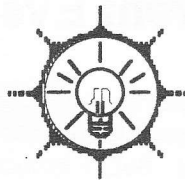
(Continued from previous page)

Of course you have to get these things all lined up and connected to the motor and the drive shaft, but when you do you've got a sturdy job that will go uphill and down. And if you're ever feeling sporty you will get a big kick out of slapping that stick forward, pulling everything the batteries will give for maybe four or five seconds, and astounding the onlookers by laying scratch. But avoid overdoing this; you might do a wheele.

Most of the time you will just be tooling around town at forty or less. The motor will draw no-load amps at standstill, but this will not be much of a loss and you can chop the motor at any time, like waiting for a train to pass. Going uphill she will slow down some and the back emf, as the engineers say, drops down, so more juice can come from the battery and boost up the motor torque until it is just enough for the kind of hill you have. Then you go along without losing any more speed. If climbing takes the motor too far down you better ease off on the TRANSMITTATRON lever setting. Downhill the motor turns into a generator and squirts amps back into the battery and you have to keep an eye on this, using the brakes as a mentioned before.

An interesting idea is you could belt two or even three motors to the TRANSMITTATRON, each one running off a separate battery bank. Like you could run two sets of three 12-volt batteries into 36-volt motors or three sets of four 6-volters into 24-volt motors. I'm sure other combinations will suggest themselves. This way you can cut down quite a lot on resistance losses in the batteries, as Gene Fowler keeps telling us. Besides, smaller motors with lower volts might be easier to find and could fit you space better. No reason the motors on your car all need to be the same voltage either, as long as you have them hooked up and switched correctly.

Well, hey, I hope these tips are helpful, and I'm looking forward to taking a ride with you at next year's rally! ♦



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Western New Mexico University, Silver City, NM, and New Mexico State University, Las Cruces, NM, (Community College Branch), through their *NON-TRADITIONAL EDUCATION* offices, have offered two courses in practical planet-saving for several years. Conceived and written by Jack Hedger Ph.D. Physics, these courses are titled "**POWER WITHOUT POLLUTION**" and "**POWER WITHOUT POLLUTION II, Electric Automobiles**".

Now, to better reach the public, Dr. Hedger has re-structured these courses for the home mechanic, in book, or manual, form. The book entitled "**POWER WITHOUT POLLUTION**", author Jack Hedger, is scheduled to be published August 6, 1992. Pre-publication copies are now available in limited quantities, at a greatly reduced price of \$19.95. The book gives direction for converting the gas guzzler to electric and uses the engine as a cross-head to build your solar powered battery charger to charge the batteries in quick-time.

To order or for more information, send self-addressed, stamped envelope to Akela West Publishers, PO Drawer 1077, Deming, NM 88031 or call (505) 546-0288.

## Letters to Current Events

Dear Paul:

Who knows what happened to the *Horizon Battery*, to be marketed by Electrosources, Inc. of Austin, Texas?

Their 1991 spec. sheet claimed 52 watt hours per kilogram (39.1 @ 2 hour rate), about twice that of current lead acid batteries. The reason for the improved performance was stated to be a new production technology for lead acid batteries.

Last August, I wrote Benny Jay, their executive VP, asking about obtaining some horizons for the 1992 Solar Electric 500, but received no reply.

If the *Horizon Battery* is for real. I hope they will put that battery into production so us poor peons can buy some?

- Robert E. May, Phoenix, AZ

*Ed: See Page 17. They now have funding and are moving forward again.*

Dear Mr. Brasch:

First of all, let me congratulate you on the superb job you're doing on the *Current Events*. Too bad it can't arrive every month!

In the April/May issue, Mr. Gasquet asked about the Voltek. I've never seen one, but it's reportedly a 3-wheel electric designed by James Amick of Amich Enterprises, Ann Arbor, MI.

Now, I have a few questions I hope you, or someone you know, can answer.

I'm using 96 volts of US battery 2200s, charged by a Lestronic I charger. This charger normally operates at a finishing rate (8 amps) for some time after it has sensed full charge, to apply an "equalizing charge" to the pack.

My typical maximum range to about 90% discharged is 45 miles. But often I drive 2 to 5 miles. I may not drive the car again that day.

Of course I want to get the maximum life out of my batteries. I under-

stand that lead-acid batteries should be recharged as soon as possible after use, to minimize sulfation. But, I would think that frequent charging from 10% or 20% depth of discharge would also depreciate the batteries, in part because of that equalizing charge.

Questions:

1. Should I recharge immediately after each short trip? If not, when?

At some fixed depth of discharge, say 50%?

At the end of each day when I make one or more short trips?

Every second or third day?

Should I recharge after each trip, but shut off the charger when the charge current drops to the finishing rate?

Is the answer different during cold weather or hot weather?

2. I'm interested in using one of the PTFE additives (Slick 50) in the transmission of '74 Honda Civic conversion. Will it mix with the Amsoil 70/80/90 synthetic gear lube I'm using now? If not, what's the thinnest lubricant I can use? (I'd like to drive the car more in the winter.) Do you have a recommendation?

3. Does anyone know of 12" tires with especially low rolling resistance? Several EAA members have mentioned Wards Grappler II tires, which I understand are General Tire Aramid-belted radials. They are not made in 12" sizes. Any suggestions?

I appreciate your help with these questions.

David Roden - Kent, OH

Dear David:

*I wish that CE were monthly again myself, but with only the two of us publishing this newsletter we are already doing the work of 4 or 5 people.*

*If we had more help we could get back to monthly.*

*In reference to the Voltek, Mark at Magnetic Power called and said that Gordon Stone is president of Voltek and can be reached at (618) 277-5130, 140 Iowa Avenue, Bellville, ILL 62220.*

*The answer to question #1 is yes (all of the above). Not to be funny though, all of these are good ideas but sulfation is related to the time and depth of the discharge. Sitting a few days at 10-20 percent down (80-90 percent full) is not so bad. A month like this is bad. A week at 90 percent discharge (10 percent full) is very bad. However too many 8 amp equalizing charges are also not good. Try to keep these long equalizing charges to every 1-3 weeks. They must be done to ensure full charging.*

*I suggest that you work up an about 2 ampere trickle charger and use this on a timer and set it for 1 hour for each mile you drove that day if you only went less than 1/2 your range. Do this at night to help the utility. If you drove a major distance, then of course use the Lester in its normal mode to get a good equalizing charge; again at night. So much of this is black magic that I am sure that many will disagree with me but this is my best feel for the subject after 21 years input from all over.*

*For question #2 - you may have caused yourself some damage using the 70/80/90 gear lube. The shop manual calls for 10-40 weight engine oil and I think that Mobil 1 at 5-15 would do just fine, but certainly nothing heavier than the shop recommendation, especially for winter use. Remember the only need for the higher number on an oil is due to the heat caused thinning by the gasoline engine which of course you don't have with an electric.*

*For question #3 - if you are talking about the '74 Honda—if it does not now have 13" tires on it you should be*

*(Continued on next page)*



## More Letters . . .

(Continued from previous page)

able to find 13" wheels with the correct bolt pattern. The larger diameter tires tend to roll easier and you can buy a set of the new low rolling resistance Goodyear Invectas in size 175-70R13 invecta GLR product #772-904-465.

-Ed.

Dear Editor:

I like the idea of starting a technical advise column in Current EVents. In fact, I like it so much that I will ask for some technical advise.

How feasible and safe is it to install an electric heater into the passenger compartment of the 007 Jet Omni?

My plan is to take a 1500 watt heating element out of an old 120 volt (AC) electric oven and run 120 volt (DC) through it. The heating element will be partially enclosed for safety reasons and will be controlled by a one-hour mechanical timer rated at 120 volt (AC) 20A.

Bob Buchwald - No Arlington, NJ

Dear Bob:

A better heater is an old hair blow-dryer. We have found that only a few hundred watts of heat is needed in the small space of a car. Call Ken Koch at KTA Services (see ad on back page) and talk to him. He has a circuit or you could try Instant Auto Heater Co. at (718) 476-2497. They mostly have low voltage heaters, but may now have some high ones.

-Ed.

Dear Paul:

I wonder if you could help me with the information. I have purchased a 1980 Fiat X-19, 5 Speed, which I intend to convert to electric. I've got two problems ...

I don't know what I'm doing, and I have limited funds. What I would like is the name and number of someone

who has converted an X-19 and is willing to share their knowledge. I live 15 miles from work with minor hills between. I need to travel at 45 mph for 5 miles and 55 for 10 miles. Is there anyone in the EAA that can help in or around Birmingham, Alabama?

P.S. I enjoy the newsletter.

Michael Chappel - Leeds, AL

Dear Michael:

Your Fiat X-19 should be a great conversion. Space is tight for your batteries and it is an older lower production model, but parts should still be available. Consider 12 volt deep cycle as well as traditional 6 volt golf batteries in your planning. See Editor's corner and XA-100 article. Anyone who can help in the Birmingham area?

-Ed

Dear Current EVents:

Hi there folks. My name is Burton Gabriel and I am the elected Secretary-Treasurer of our club of 22 members. I am sending along a check for \$25 as a donation for EAA members from North Olympic Peninsula Electric Cars, N.O.pec.

Our club has two 96-volt D.C. cars on the road daily and two 120-volt Jet Ind. pickups in a high school project. We are building an Electrothon racer, also. There is lots of interest up here in EVs and my shop, Gabriel Marine, is turning out its fourth electric car. Thanks for the great work you guys do.

Burton Gabriel - Port Ludlow, WA ♦

### CAR TRANSPORTER TO SEER

Electro Automotive is arranging a transporter from the Bay Area to SEER '92 in Willits and back. Room for up to nine cars total. Approx. \$500/car round trip. Call Electro Automotive at (408) 429-1989.

## Battery Breakthrough

Austin, Texas, May 27, 1992—A significant breakthrough in rapid charging of an advanced lead acid battery was announced today in Austin.

A research and development effort, funded by EPRI and conducted by Electrosorce, Inc. (ELSI) announced a battery performance level of over 52 watt-hours per kilogram specific energy. Additionally, this highly advanced lead acid battery has the rapid-charge capability of 50 percent recharge in eight minutes and 99 percent in 30 minutes.

*"This advanced lead acid technology holds great potential for meeting electric vehicle battery requirements in the near term, and, in particular, its rapid rechargeability makes it competitive with gasoline pump delivery,"* Jack Guy, EPRI's manager for technology commercialization, said. "EPRI has spent \$80 million in the last ten years on various programs. To date, our development, our \$80 million, has not produced anything as exciting as the battery that we see at Electrosorce."

Electrosorce President, Benny Jay, describes the technology as first-of-its-kind, adding, "It allows for all three energy, power and cycle life—met simultaneously at an affordable cost."

The battery developed by ELSI uses the same raw materials—lead and sulfuric acid—as the lead-acid batteries used to start internal-combustion-engine vehicles. The ELSI battery features several patented materials, processes and designs invented by former Aerospace, defense and electronic industry scientists and engineers, and is radically different from the conventional designs. These features increase the

(Continued on Page 18)

## ELSI

(Continued from Page 17)

energy and power per pound that can be stored in and retrieved from the battery in a single cycle and greatly increase the number of useful cycles.

While the best conventional secondary batteries provide energy per pound (measured over a three hour discharge cycle) of 9 to 14.5 Watt-hours per pound (or 20 -32 Whrs/kg), the ELSI battery design currently provides >22.7 Whrs/lb (or >50 Whrs/kg). The ELSI designs also promise to more than double the cycle life available from conventional technology, providing more than 600 charge/discharge cycles with an average range between charges up to 145 miles at 55 mph. This improvement should result in a cumulative range of more than 80,000 miles over the battery's life.

Electrosource believes there is a lot of life left in the venerable lead acid battery.

For further information contact Electrosource, Inc, 3800B Drossett Drive, Austin Texas 78744-1131 or call 512-445-6606, FAX 445-6819. ♦

*Editors Note: WOW! New developments are breaking fast thanks to the C.A.R.B mandate. The future is here.*

### ELECTRIC CARS ON VIDEO

TECHNOLOGY TRENDS is a program shown throughout the San Francisco Bay Area on cable television and is now available on video.

#### FACTS AND FABLES ABOUT ELECTRIC CARS

Paul Brasch talks about what electric cars can do and their everyday practical uses.

#### AWAY WE GO IN MY ELECTRIC CAR

Chuck Olsen drives his electric car everyday and no other, find out just how economical and practical an electric car can be!

#### A CLEAN, LEAN, ELECTRIC MACHINE

Dudley Lewis converted his Volkswagen Rabbit into an electric vehicle, find out how he did it in this practical "how to" video.

#### SILICON VALLEY ELECTRIC CAR RALLY

Paul Brasch tells how the Electric Auto Association of Silicon Valley held their Electric car rally and the resulting community response.

#### ELECTRIC VEHICLES CAN COMPETE

Paul Brasch tells how electric cars can compete against conventional vehicles, plus additional footage of the Annual Electric Auto Association car rally.

Also available on video, Electronic Auto Association of Silicon Valley meeting lecture tapes.

For more information send a SASE to:



GAVEGIN Video Productions  
23392 Connecticut Street #5  
Hayward, CA 94545

## Calendar

**June 28** 9th Annual Automotive Literature Swap Meet at Pasadena City College parking lot on Hill Avenue, corner of Colorado Boulevard in Pasadena on Sunday between 6am to 3pm. For more information, call Jeff Minard (310) 545-1070

**June 28** Palo Alto Concours D'Elegance For more information, call (415) 948-1027 or (415) 948-1004

**August 7-9** SEER, Solar Electric Expo & Rally, Willits CA

**August 9-22** ENER-RUN Transcontinental Rally. Washington DC to Los Angeles in alternative powered vehicles. Call Les Adam (501) 856-3877 for details.

**September 19-20** World's Oldest EAA Rally, Electrathon and Symposium.

**September 23-27** Al Tran Ex'92, International Alternative Transportation Exposition. Santa Monica Civic Auditorium. (310) 285-0093

**September 27-30th** The 11th International Electric Vehicle Symposium.

**October 3-4** New Energy Technology Expo at Laguna Seca. For more info, call Billy Hinds (408) 646-1490

**October 8** The Inaugural Pikes Peak Solar/Electric Challenge, Colorado Springs, Colorado. For more info, call (719) 635-8803

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## Battery Care

(Continued from Page 8)

Golf cart batteries give the best life if the starting charge is 25 to 35 amps. This can be safely maintained until the onset of gassing (about 2.4 volts per cell) when 5 amps or so can be maintained until 2.6 volts per cell are reached (125 volts for a 96 volt system). There will always be some gassing but by ending at a low current—this is minimized. Gassing mixes the electrolyte and it is important to mix for an hour when adding water. If the vehicle is used every day, once a week the batteries should be given an equalizing charge at the lowest charge rate for one or two, or until the battery pack voltage will increase no more. This will overcharge most cells but it is necessary to bring up to full charge those cells that may have slightly less capacity. Failure to do this over an extended length of time means that the weaker cells never do get a full charge and therefore they deteriorate at a faster rate than the others that have been fully charged.

The number of total miles that you can get out of a set of batteries is very dependent on the number of times that they have been deeply discharged. This is why opportunity charging is so important for long battery life. This means that if you charge the batteries every chance you get during the day, they never get deeply discharged. This extends your driveable range during the day as well. Realize that your vehicle's range will decrease as the batteries get older so plan your battery capacity to account for this a couple of years down the road or you will be replacing the pack much too often just to keep up the maximum range.

Remember, batteries work by chemical reactions and heat speeds the process. Warm batteries give out more energy than cold ones. Charging warms the batteries. A heated garage is nice. Park in the sun. Insulate the battery box.

Be nice to your batteries and they will give you many non-polluting miles of driving. ♦

## Want Ads

**Silver Volksrabbit**, newly converted/Electro Automotive kit. Only 800 miles. 9" motor. Competed at Phoenix Solar & Electric 500. Only \$12,000. Optional 160 w. new solar roof rack; \$3000. Call (415) 508-1489

**For Sale**, 2 generators, 400 amp and 200 amp; both 30 volts D.C. Make offer. Call Harvey (408) 238-4657

**1981 Electric Ford Escort Prestolite**, 21 HP motor, Curtis PMC Mosfet controller (1221-B), 96-volt pack, 12V -SLI. Onboard charger (110V, 15-amp). Excellent condition. (Electric conversion by Jet.) \$10,000/OBO. Call Samuel (310) 452-0067

**1982 Datsun Lektrikar II**, looks sharp, new paint, batteries good, 2.5K on batteries, 5K on car, 108V, Prestolite motor, DC-DC converter, \$5,200 Call Rick (408) 945-7992

**1981 Datsun 200SX Lectra Hatchback**, 20 HP Prestolite, 108V system, gas heater, air conditioner, PMC controller. \$6,500 Call Dan (415) 388-0838

**1981 Jet Ford Escort Hatchback**, with batteries, 20 HP Prestolite, Mosfet PMC Controller, Aux. 700 watt generator, like new, 4K miles. \$6,500 Call Dan (415) 388-0838

**1971 Pinto Elec. car**, 96 and 12 Volt. New Controller. Automatic Charger for 12 & 96 volt; Tires and Brakes excellent; drive it away for \$3,000. (408) 738-1310

**1978 Volkswagen Dasher**, hatchback, 4 spd. trans., converted to electric, SCR control 66 VDC, int. & ext. reconditioned, new tires and brakes, top speed 80 mph plus, \$9,000. Call (408) 578-5280, (work) (408) 441-0378 (FAX)

**4 Electric Cars**, VW Rabbit, Datsun, 2 Ford Fairmonts, professional conversions with only 1-3,000 miles on odometers. Need new batteries and other work. Will consider all reasonable offers. Call Tom (408) 475-0423

### Rates for Want Ads

\$5 for the first 30 words. For each additional word, 25 cents per word.

Please use abbreviations whenever possible.

The EAA is not responsible for the accuracy of ads.

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# KTA SERVICES

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June/July 1992

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