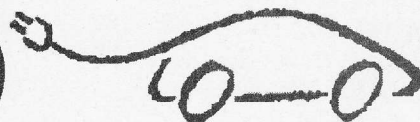


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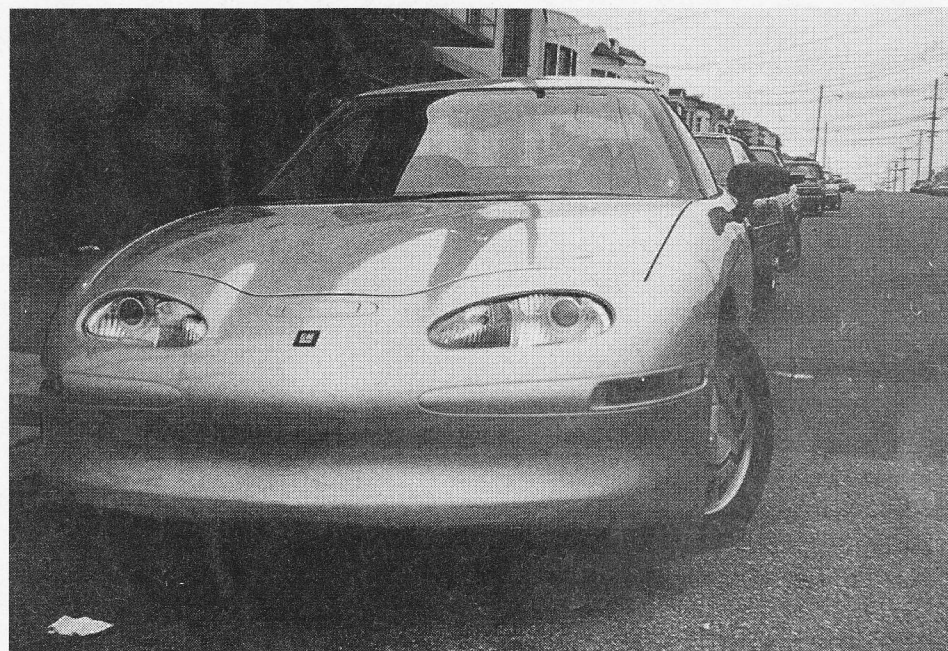
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97
January 96 Vol. 29 No. 1

1ST TECH FOCUS ISSUE

Regenerative Braking!

This issue of CE begins something I've wanted to do for a long time, namely some Tech Focus issues centering around some aspect of EV technology. A Tech Focus issue won't be entirely devoted to that area, but it will have an expanded technical section and three or more contributions on the subject. This is the first, and, as appropriate for the (soon to be renewed) year of 1997, the focus is regenerative braking, or "regen" for short.



More Than Hardware

A discussion about regen includes more than just principles or techniques. It also gets into emotions and philosophy; for instance, how should an EV feel? Should it have the same sort of pseudo-compression braking effect as in a gas car, and be driven like a gas car? Or should it coast and freewheel, very much un-like a gas car.

Distinctive EV-ness

The characteristic of electric motors that allows that choice, (namely their ability to freewheel without power and without dragging the drivetrain to a halt) gives EVs much of their distinction. Letting the batteries rest while gliding serenely up to the next stop is something I enjoy most about driving an EV. Rolling free down a grade with only the wind and the ocean-wave sound of the tires against the pavement is something

I've often done, since I live in the Santa Cruz Mountains. It is then that an EV shows how different a creature it is from an internal combustion car.

However freewheeling is a classic two-edged sword. Gravity-sailing down a two, three or five percent grade can be exhilarating; trying to hold back an EV that wants to hurtle down a ten or fifteen percent winding mountain road with mechanical brakes can instantly go from exciting to terrifying.

Or Not

So, should an EV be allowed to revel in its "EV-ness", or should it be yanked back on the straight and narrow and made to drive like a gas car? There are strong emotions and valid arguments on both sides.

Depends on the Individual

To some extent it depends on the vehicle and its mechanical/hydraulic brakes. Pickup trucks have brakes that can take a lot of abuse. Some sportscars, including my favorite, the 914 Porsche, with its all-wheel 10-inch disks, boast that they never have brake fade. Well, I have faded a 914's brakes going down Alba Road (about 2000 feet in 4.5. miles, in fact I've boiled the brake fluid.

From experience I know that if you keep pumping, you can restore partial function, and if you anticipate braking, you can make it down without running off the road, into a car, or a tree. If you don't ride the brakes, you may not experience severe fade. I've done Alba Road repeatedly in an EV and gotten away with it. Many people tell me that this is really pushing the envelope for EVs. I also know that if you try to get away

continued on page 4

We promised and now we've delivered. Here is the first Tech Focus Issue. Appropriately enough, it's on regenerative braking, one of the most promising yet confounding developments in EV technology. Since one issue can't begin to cover it adequately, we hope to cover it adequately in two. February 1997 will be also be Tech Focus, Regen Issue #2.

3

Nepal, Mexico Ban Smokers. Are the automotive pollution problem and the drastic measures being taken to combat them a foretaste of the future in US cities such as LA? A report and an editorial commentary.

6

Clean Air Vehicles... Now! Canadian EVs Ltd. in British Columbia has teamed up with other Canadian companies and folks to supply EVs for a two-week get-acquainted program. Neat story from VEVA member, Randy Holmquist.

8

The Clueless Crew- "In Search of an Outlet". This is a story that should be told — it's funny, courageous and wry. Two high-school girls raced an Easy Racer Zap EV1 in the Sun Sprint of the Rockies—and managed to beat Myhee, their coach. Can a bike make a 15 ft roostertail in the rain? Find out from Cherie Carroll, Earth Options in Alameda, CA.

10

Regenerative Braking for Series DC Motors in EV Conversions. Gary Jackson tells how an extra 6V battery, an additional contactor and some other odds and ends can be whipped up into a race-tested regen system.

12

ZAPI H2 Regen in '59 MGA Roadster. How a ZAPI made Bob Wing's '59 MG Happy (going down hills). How-to, who-to (contact) and the scoop on brush-ring adjustment for our old friend the Prestolite 4001.

14

Regenerative Braking in On-Road Electric Vehicles. The view from across the Atlantic. Shunts and separate excitation? An excellent technical paper by Paul (Society for the Release of Smoke from Semiconductors) Compton of EAA UK, the newest EAA affiliate/chapter. He also drives a Kitten with bubbly NiCads.

PHOTO CREDIT - PAGE 1

Part of the EV1's appeal is seamless regen braking provided by its 3-phase AC drive-line. The former Impact goes on sale Dec. 5th in Southern California and Arizona. Photo: Clare Bell

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Nepal, Mexico Ban Smoggers

BY CLARE BELL

Nepal and Mexico are cracking down on smog-emitting vehicles. Both nations are experiencing air pollution from uncontrolled diesel and gasoline exhausts.

Mexico has been experiencing dangerous ozone levels 2.5X in excess of International World Health Organization standards. According to WHO, a one-hour exposure to ozone levels over 100 is hazardous. During the week of 10/18, levels hit 256.

The culprit? Cars and trucks. 3.5 million motor vehicles, half still operating on leaded gasoline, generate 70 % of Mexico City's smog.

In Kathmandu, Nepal, diesel-fueled, three-wheeled mini-taxis and runabouts called "tempos" and "tuk-tuks" are a major contributor to the city's smog. Nepalese cars and trucks also emit their share. Six months ago the Kathmandu Municipality began emissions testing 100,000 locally registered vehicles. Of the 20,000 tested so far, almost half failed. Both nations have been forced to take severe measures.

During the week of 10/18/96, Mexico City smog officials took the drastic step of banning 40% of the city's vehicles from the streets. They also had to sacrifice industrial production in hopes of salvaging air quality; heavy industry had to cut back by 40%. High-polluting factories and a number of gas stations were closed. Auto users were restricted to driving only 3 days out of the 5-day work week.

Roving squads of Nepalese police in Kathmandu have begun red-tagging high-polluting cars and banning them from the downtown area and government offices. Kathmandu Municipality has instituted an outright banishment of tempos and tuk-tuks from its streets.

—CB

Commentary: A Vision of the Future?

Are the steps being taken by these third-world nations a reflection in microcosm of what may be in store for US cities such as Los Angeles? Possibly. We may have catalytic converters and oxygenated gasoline, but we also have a much more massive vehicle population. And we are also dealing with the powerful psychological imperatives that frustrate efforts to deal with the problem by voluntary methods. The "driving passion" that binds Americans to their cars may be so strong that the only effective measures will be coercive. The fuss surrounding California's Smog Check 2 may be a foretaste of the future.

Both Mexico and Nepal are turning to alternatives, including electrics. Mexico has announced that it will begin seeking EVs from US and European manufacturers. Programs have begun in Nepal and Thailand with prototype versions of electric tempos and tuk-tuks.

Much more must be done in these countries. The solutions may not be high-tech, high-cost vehicles such as the EV1 (though those will have their place), but lower-cost conversions, such as the ones EAA members build from kits. Lightweight EVs, such as Neighborhood Electric Vehicles (NEVs), motorcycles, scooters and E-bikes could play an even larger role, since they cost less.

One might envision a sort of "mercy mission" to Mexico City, where EAA members or small companies would take parts and vehicles down, convert them locally and put them on the road. 50 96V EV Rabbits, converted pickups, Jet Escorts and other older conversions might not put a real dent in the problem, but they would be a visible start.

If Mexico City put in bike lanes to make E-bike commuting more viable, a couple of thousand E-bike motors applied to two, three and lightweight four-wheelers could make a BIG difference.

The same is true for Nepal. The three-wheel diesel taxis are ubiquitous because they are cheap, tough and simple. So are the recently developed cycle-assist motors (Zap and others).

If cycle-based vehicles are viable for these countries (which I imagine they should be, here's a great opportunity to do some good needed work and to gain some welcome publicity —CB.

Articles on converting the Asian three-wheeled taxis to electric have appeared in recent issues of Home Power Magazine. Mention of EAA member involvement in those projects ran in Current Events in '95. Steve Van Ronk, of Global Light and Power has been doing work with lightweight EVs in Mexican high schools and universities. Burton Gabriel, of the Northern Olympic Electric Car Club, was involved with an Asian EV conversion project.

Sources: "Mexico City Smog Reaches Danger Levels" - CALSTART News Notes. (News Notes 1/25). CALSTART (feedback@calstart.org) <http://www.calstart.org>/Tel 818-565-5655, Fax 818-565-5610. 3601 Empire Ave., Burbank, CA 91505 USA. "Nepal Moves to Ban Smoggy Vehicles from City", based on a report by Xinhua News Agency. POSTed on the Internet Electric Vehicle List News for public AE & EV informational purposes by Bruce Parmenter, (BruceDP@aol.com)



The fun of freewheeling. Electro Automotive's VoltsRabbit sails along during EAA Rally. Photo: Jim Sharman

with too much, reality will sneak up behind you and sink its fangs in your rear.

The Real Place for Regen

The experience of other EV drivers and the authors of these articles suggests that regen braking is most effective and efficient in hilly terrain. That is handy, since that is where it is most needed for safety as well as range.

If I stay in the mountains, I probably will put some form of regen on my car, although at a weight of 2500 lb., it doesn't have as severe tendency to plunge downhill as EVs in the 3000 or 4000 lb. class.

So, is regen necessary or even desirable on a given EV? It depends on the vehicle and its surroundings. For a big heavy vehicle in the mountains, it is essential. For a lighter weight EV with strong mechanical brakes, it may be a desirable option. For a commuter car that lives pretty much on the flat, it's debatable. For a lightweight EV that freewheels easily and doesn't live in hilly country, it may be an unnecessary complication that doesn't return enough energy to make it worthwhile.

Different motor types and drive systems also influence the choice whether to have regen. In three-phase AC systems, such as AC Propulsion's Honda CRX and the GM EV1, regen just falls out — it is so much an intrinsic fea-

Regenerative Braking

continued from page 1

ture of these systems that it would seem silly not to use it. Brushless DC or synchronous AC also makes it fairly easy to implement regen. The Solectria Force is an example, as Michael Bianchi will show.

The Toyota RAV-4 uses a permanent magnet motor, which is unusual for a vehicle its size. Permanent magnet motors tend to show up in smaller EVs such as bikes. Because the field is supplied by magnetized segments of metal, "permag" motors require only control of the armature, and when driven, will automatically source regen current. That is why very simple EV bikes can have something as sophisticated as regen. Easy regen is probably another reason why Toyota chose a permag for their RAV-4. However, permags can have disadvantages, such as possible de-magnetization due to overheating.

Our Favorite Motor and Regen

Regen seems to be straightforward and simple for most systems...except for the one most of us are using, namely the series-wound (armature and field in series) DC motor. Getting regen out of series-wound DC motors seems to be fraught with pitfalls, at least at this stage. That is too bad and an example of Bell's Law of Perversity (things always behave in precisely the manner you don't want them to). Perversity, like entropy, always remains the same or decreases. Never does it decrease; such is the cross-grained nature of the universe.

However the advantages of series-wound DC motors (high efficiency, fairly easy control and a whacking great amount of starting torque) are valued so much that controller developers have tackled the problem. The solutions at this point are clumsy (involving excessive aggregations of clacking contactors), are somewhat complex to install, and have a tendency to fry both con-



A Big EV for a Big Guy could definitely benefit from regen. Bruce Parmenter's Solar Electric S-10 conversion.

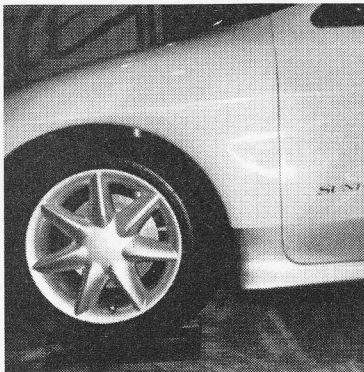
Photo: Lee Hemstreet



Regen or not? There are as many answers as there are EVs. Photo: Lee Hemstreet



Regen is straightforward for Evs using permanent magnet motors, such as this Zap Power Systems E-bike. Photo: Zap Power Systems



Solectria's Sunrise uses a brushless DC motor system that delivers regenerative capability. Photo: Lee Hemstreet

troller components and commutators if not correctly installed, (not to mention the nerves of customer engineers at companies such as Curtis and Zapi).

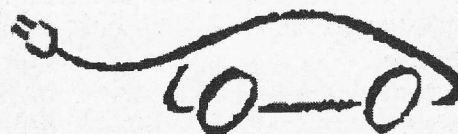
On the other hand, regen with a series motor can and has been made to work. Bob Wing's Zapi H2 in his '59 MG classic is a successful example. So is Gary Jackson's nifty APS-race-tested regen system. (And series motors can be fried without resorting to regen, as I regretfully found) Ongoing developments in controllers and packaging may lessen and eventually eliminate the present difficulties.

So...to regen or not to regen, that is the question. ("Whether 'tis nobler in the mind to freewheel or suffer the slings and arrows of series-motor regen....")

Well, Shakespeare misquotes aside, read on, enjoy, ponder and decide for yourself and your EV. —CB

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ELECTRIC AUTO ASSOCIATION

Clean Air Vehicles...Now!

BY CLARE BELL AND RANDY HOLMQUIST

A member of the Vancouver Electric Vehicle Association is working to give potential government and company EV users a free two-week EV test drive. Clean Air Vehicles...Now!, begun in June 1996, is a two-year program that supplies EV pickups and vans for two-week trials with private firms and government agencies. Canadian Electric Vehicles of Lantzville, B.C., run by VEVA member Randy Holmquist, supplied a truck and van conversion for the program. Co-ordinated by the Vancouver Island Technical Centre and a group of private companies with funding from Environment Canada, the B. C. Environmental Ministry and B. C. Hydro, the program has already placed vehicles with two Canadian municipalities, Saanitch and Esquimalt.

Saanitch got the Grumman van to shuttle its public works staff from office to construction sites while Esquimalt received the EV pickup. Canada Post, BC Buildings Corp. and CFB Esquimalt have also tested vehicles. Terminal Systems, which runs a shipping container storage yard in the Port of Vancouver, is also trying out an EV pickup.

Pickups - Best Range

Holmquist feels that older small pickup trucks make the best conversions, with ranges on the order of 90 km. Cars such as VW Rabbits can be converted too, but the trucks have more battery-carrying capacity and better range. He has converted eight vehicles during the past four years for customers on Vancouver Island and the Lower Mainland. The \$4-\$5K donor vehicle cost and \$15-19K conversion costs are offset by lifetime operation with almost no maintenance.

"The body will fall off before the engine gives out, said Chris Gower-

Power system

- 9" Advanced DC motor producing 85 peak hp.
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- Albright Contactor
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- Emergency disconnect, cable operated from dash
- 144V Trojan main battery pack supplied by MAGNACHARGE
- Automatic transmission

Charging system

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- 30 Amp twistlock charging port
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- CEV 2250 watt ceramic heater
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- AM-FM cassette stereo
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- WATERMASTER Battery watering system
- Battery Master Low Electrolyte Warning System

Performance

- Top Speed. - 140 kph
- Range - 70-100 km

Reese, spokesperson for the electric program. He added that electric conversions will appeal to those who want to save on fuel, maintenance, and tune-ups. So far 30 firms are taking part and 15 have now tested vehicles.

Vancouver Island Technology Centre Consultant Gordon English pointed out that the intent isn't to develop new technology. The problem is that not enough people are using the existing technology. People don't have to wait for a vehicle with a Ballard fuel cell. they can get the benefits of electric power today. —CB & RH

Access: Clean Air Vehicles...Now! - Chris Gower-Reese, (604)744-3200. The program is looking for applicants to take the vehicles in 1997

Canadian Electric Vehicles Ltd., Randy Holmquist, 7647 Superior Road, Lantzville, B. C. Canada, V0R 2T1. Tel. (604) 390-3364, fax (604) 390-1166. Email ul6@freenet.victoria.bc.ca. or canev@islandnet.com. Web address, www.islandnet.com/~canev. "The I.C.E Age is over"

Sources: "Getting a charge out of two-year program", Malcolm Curtis, B. C. Times Colonist, 7/20/96, p. B2 "Electric-powered truck just purrs", Glen Bohn, Vancouver Sun.

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The Clueless Crew- "In Search of an Outlet"

BY CHERIE CARROLL, EARTH OPTIONS

Two vans filled with six people, two recumbent motorized race bikes, the Varna recumbent race bike, the Chariot, two Zap-Demo bikes, Josh's mountain bike, tools, parts, an army of chargers, camping equipment, food, and too much other stuff headed off from Alameda, Calif. to race in The Sun Sprint of the Rockies in Aspen, Colorado

I don't think any one of us could have been completely prepared. And after experiencing the difficulties of just getting the bicycles together and getting there, we were completely and literally "The Clueless Crew". Yes, that's us, "The Clueless Crew - in Search of an Outlet".

Getting There

We grabbed sleep on our on our 27 hour roadtrip by sitting up in the passenger seat, between taking turns driving. Our 2 teams consisted of Mhyee, who rode alone the Zap-Powered Sacks Supersonic Transport, and Rhonda Kirkpatrick and Shannon Carroll, our High School Team, who shared the riding duties of the Easy Racer Zap EV I. Crew Chief Jim Kirkpatrick, plus members Cherie Carroll and Josh McDonald made up our support team.

What a Way to Start

We found ourselves in the parking lot of the ski lodge in Aspen exactly 1.5 days later than we planned, needing sleep badly. The guys threw their sleeping bags on the ground next to the van, and gave the girls the comfort of being inside. 7:00 AM found us all walking around like zombies, unloading the race bikes, working to get our situation together, and get our pre-race technical inspection finished. Zak and Curt, the race promoters, were great and they

Mhyee found that his coaching had more of an impression then he anticipated when the girls applied his teachings and came in ahead of him 2 of the 9 days.

pushed the start back an hour to give us extra time, or so we thought.

Later we found we weren't the only ones with discomfort to deal with. All the other participants, who had been there since the day before, had their own problems. While they were all comfortably sleeping on the lawn that morning, the sprinklers had turned on and drenched the entire group. So although the trip was fraught with difficulties, we weren't alone. What a way to start a challenging and difficult 564 mile race!

Preparations

We had been working day and night for almost two weeks just to get there. Jim and his crew, including Rick Quinn, who had to miss the race because of family illness, started building the two race bikes immediately after we finished the Open House Project. It seemed like they worked on those bikes non-stop. Many hours had been spent in meetings during the previous months, in our "hanger" office (Calstart Incubator, Hangar 20). We thought we should have a reasonable grip on working this race. I don't think any of us had any concept of what it would entail. I know I could not have EVER imagined in a million years what it would be like. It was one of the most incredible, stunning, beautiful, grueling, intense, difficult, demanding, and wonderfully gratifying experiences of a lifetime. It would take every one of us to our own personal limitations, and test them severely. I don't know if the trial came from the nature of a race rally, or if this one is special in regards to the degree of total personal challenge it demanded.

Totally Extreme

It was completely high-energy in everything. From the difficulty of the course, which went through the awesome Rocky Mountains and hot desert mesas, to the actual hourly job of going

down the road racing on those high tech-unprecedented fantastic bicycles. Not to mention dealing with environmental shows, radio interviews, showers in local schools, sleeping on the lawns in community parks, getting ice and feeding ourselves. Did I mention recharging daily, usually in the middle of nowhere for three hours: Everything was just totally Extreme. It Was Great!

We can look back now and say it would have been a lot easier if the batteries we had planned to use had arrived before we had to leave or if we had been better prepared financially or had better camping equipment. Easier perhaps, but the experience wouldn't have been what it was. We survived and learned how to deal with the various difficulties we faced.

"Lugging Lead"

For 9 days we were all "on" - 24 hrs. a day - life was a total non-stop, hands-on Solar Electric Bicycle Race and Show. The people around us considered us professional racers and we participated as such. We lived and breathed bike race. Our riders were totally dedicated, putting their hearts and spirits alongside 100% physical effort. Many times during the race our high-school girls' racing spirit proved remarkable. Burning out their motors 10 miles before the end of the race, they "lugged lead" of almost 100 lb. in 120 degree heat keeping their 20-25 mph. pace. Rhonda's competitive drive was evident when she had to be persuaded to pull over after experiencing a nosebleed but didn't want to interrupt a 40 mph mountain descent.

A Personal Victory

Or Shannon's fantastic 40 mph downhill mountain run in a thunderstorm with a 15 ft. rooster-tail, as cars and trucks passed her in the rain. Shannon came away exhilarated after dealing with that. One of the reasons

Shannon had participated in the race was to conquer her fear of bike riding after being hit by a car 3 years. ago, totaling her bike.

The first 30 miles of the race took place on what is considered to be the most dangerous road in Colorado. Shannon got to face and conquer her fear early on and found other challenges ahead. She enjoyed the race so much that she is planning on building her own Solar Electric Recumbent Race Bike, and racing next season as her Senior Class Project. She wants to again use a Tour Easy Recumbent Bike and put the ideas she was inspired with while riding into action. Jim will serve as her mentor on the project.

A Teacher Ouidone

Mhyee found himself challenged by racing a bike team with an excellent coach — himself. He was not just riding in the race but also coaching our high-school team. He had started training them the week before the race at the Alameda Naval Air Station Earth Options Office, and finished when the 2 bikes left the last charging station. Mhyee was gone like a flash, not to be seen again until the finish line.

Mhyee found that his coaching had more of an impression than he anticipated when the girls applied his teachings and came in ahead of him 2 of the 9 days. They worked hard those days to do it and they were thrilled. Mhyee's first place trophy was well deserved, plus he was a great coach. A lot of work went into The Zap Powered Sacks Supersonic Transport and The Easy Racer Zap EV I and a lot was learned. The girls can be proud of their second place trophy and their time of an hour under a world champion on a nine day race. Everyone who participated worked incredibly hard, did an excellent job and had an experience of a lifetime.

Kudos

We would like to thank everyone who made this possible, starting with our sponsors: Zap Power Systems for providing us with offices, literature,

hats, T-shirts and a plethora of mechanical/electrical paraphernalia and specifically Jim McGreen, who designed 2 uniquely different drive systems for the 2 excellent race machines.

Thanks to Gardner Martin of Easy Racers for providing what we believed to be the ideal bicycle for what we did. Its flawless performance, comfort, safety, and speed spoke for itself and left the repair crew feeling like the Maytag Repairman.

Thanks to Michelle Murphy at Hawker Gates for their Genesis Batteries, an absolute essential contribution to our effort. The 12 batteries did an excellent job of accelerating and carrying themselves as well as the machine and rider.

Thanks to Saks for their derailleurs, hubs, chain and brakes, with 105 speeds. From 3 to 63mph and back to 0 was no problem. We expected and realized flawless performance.

Thanks to Robinson's Wheel works for building our wheels. We did break a few spokes due to a 300 lb. load on the rear wheel rear wheel. Replacement and truing was easy due to Chris Robinson's as expertly made custom wheels, which were built and rushed to us during the birth of his child. Congratulations and thank you.

Thanks to Be Bop for the pedals of choice by our riders and Zipper for the fairings that added comfort and speed to our ride.

Special thanks to Ted for his ingenious assistance during the last all-nighter before we left, oh, and the van too... Thanks.

Also, thanks to Chuck of Centerline Metals who always helps us with something and Jackie Dunne who supplied the race uniforms and taxi service for the high school teams' last-minute errands.

Thanks to Zak Teele for promoting, Nathan Jakubiak for helping and Curt Grinell for everything else. They did a great job of creating and overseeing a very difficult and successful challenge. We learned much. Thanks! —CC

Rolling-Resistance Tires

Here's a little info to fill in that gap. Low-rolling resistance tires are made by Goodyear (Invicta GLR, GFE, Momentum, also Corsa) Michelin makes the MXV4, advertised as their "Green Tire". I have used both the Goodyear Corsas and the Michelins for racing and have gotten good performance out of both. The MXV4s are about \$100/per tire in the 165/R15 size. They are designed to run at 45-50 psi.

If you can't get tires that are specifically designed for low rolling resistance (none fit your car) you can get pretty close by looking for radial tires with these characteristics:

- High tread wear rating. A tread wear rating of 250 or 300 indicates a harder compound.
- Tall and skinny (high aspect ratio)
- High load capacity (you can get away with running them at a higher tire pressure, say 40 or 50 psi.)
- Broken-in tires have lower rolling resistance than new ones.

I've used tires such as Wards Roadtamer 900s on my EV bug.

One caution. Higher tire pressures do lessen rolling resistance, but don't make the fronts too high or the car won't steer properly. VW Bugs used to have a problem when people overfilled the front tires — they were already nose-light and with no front tire grip, they would run right off the road.

Reference - Bill Egan at Goodyear.

Regenerative Braking for Series DC Motors in EV Conversions

BY GARY L. JACKSON, LITTLE GUY RACING,
SAN DIEGO, CA

Have you ever been driving your EV down a long hill and started smelling the brakes? How about hearing the sound of metal-on-metal and realizing that you prematurely need a new a brake job? These are some of the problems that can occur with Electric Vehicle (EV) conversions because the electric counterpart of an old internal combustion car is heavier and puts more strain on the braking system. Is there a solution? Actually there are several solutions, but one of most environmentally friendly is to put the energy back into your batteries, which is referred to as regenerative braking, or REGEN. In addition to being easier on your brakes, REGEN can also extend your driving range a few miles between charges.

No Free Lunches, But..

Unfortunately, there are no free lunches and REGEN is no exception. It adds some complexity and expense to your EV. For example, if you have a \$10,000 to \$50,000 ac drive system (or happen to lease an EV1) then REGEN is one of the bells and whistles that you'll get. However, most present EV conversions use a pulse modulated electronic controller like the Curtis PMC series or Auburn controller and a series DC motor like the Advanced DC Motor Company's products. This combination is reliable and cost effective (which explains its popularity) and is great for providing power to the wheels, but it is not easy to reverse the process and put power back into the batteries when you're slowing down or going down a long hill.

A book on REGEN is available "Regenerative Braking for Series DC Motors — A Practical Guide". You can get more information on this from the Web: <http://www.primenet.com/~ecoparts>.

APS-Electrics Race-Tested Regen

However, all is not hopeless if you want REGEN in your present EV. Several solutions exist, but the one we have developed and tested at the APS Electrics race is simple in that it doesn't require modifications to the controller and only involves off-the-shelf components. Additional high-current external components needed to install the REGEN are a SPST contactor, a resistor, a fuse, a 6V battery, and diodes (there are some smaller components, particularly for safety, but these are not expensive). Before describing how our REGEN works, you need to understand a little about series motors and the problems in making them into a 'generator'. Many people have assumed that REGEN with a series DC motor is easy to do, but due to the inherent characteristics of a series-wound motor, it requires some thought and planning. Series motors operate on the principle that the same current flows in the stator windings as the armature. Thus, under conditions where you're using very little power, you don't waste power in the stator winding as you might in a shunt DC motor. Series motors, or "traction motors", have been used for many decades, especially in locomotives or other applications that require a large speed range. One way to make a series motor temporarily operate as a generator is to have unequal currents of opposite sign in the stator and armature. The current in the stator windings still flows in the normal direction but in the armature windings it reverses direction (to charge the batteries) windings. Fortunately, Advanced DC motors allow access to the connection between armature and stator so that an addition-

al connection to the REGEN circuit can easily be made and enabled by a SPST contactor. There are some pitfalls in implementing this. The most important is that the motor brushes must be set to 'neutral' or else you're simply trading off brake wear (without REGEN) for brush wear (with REGEN). In addition, a circuit to temporarily cut back the motor current while you are selecting REGEN is also desirable.

How Does It Work?

A simple switch which can be mounted on the dash, floor, or gearshift handle enables the REGEN function. For safety reasons, this is a push-button switch that has to be held in as long as the REGEN is enabled. A contactor closes the auxiliary 6v battery which supplies current to the series winding (through a current-limiting feedback resistor). This system works reliably for battery voltages 72-96v (i.e. 12 to 16 6V batteries in series) and some regenerative action is obtained for voltages up to 108V. For battery voltages of 108-144v, the same principle applies, but the battery pack must be divided in half using a DPDT contactor when selecting the REGEN action. In both of these circuits, switching to REGEN requires phasing back the current while enabling the large contactors and this can be done with a simple passive RC network in parallel with the accelerator rheostat. In practice, using the REGEN is quite simple. You select the REGEN mode with the push button switch. Once in REGEN, the accelerator acts as a brake: the farther down you push, the more current recharges your batteries. In order to get the most REGEN action, you will generally downshift before enabling REGEN. This is a rather brief

continued on page 20

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ZAPI H2 Regen in '59 MGA Roadster

BY BOB WING, EAA EAST BAY CHAPTER

ZAPI regen is now installed in my '59 MGA Roadster. I have been running my Italian ZAPI H2 400 amp 96 VDC controller in the standard traction mode since June 1996. The ZAPI 400 amp was considerably less expensive than other standard traction controllers, even with shipping added. My 11 year old controller had given up, so I was in the market for a new one. I wanted one that did not squeal and also had regenerative braking. My only choice was the ZAPI H2, a well-proven controller for pumps, lift trucks and EVs in Europe.

Extra Contactors

Plan for the cost of extra contactors as well as the controller. For regen you need a changeover contactor (single pole-double throw) and reversing contactor (double pole-double throw) at \$190 and \$329 respectively. This certainly adds to the cost of regen, but I required it as the MGA has drum brakes all around. On the paved roads in my neighborhood, hills rise 400-1000 ft above sea level and grades reach 18%. In mid-October the Albright contactors arrived from the UK and re-wiring for regen could proceed.

Driving with Regen

In driving with the ZAPI, the car is in free-wheeling mode as long as the throttle is just barely depressed. With the release of the throttle microswitch, the mode simulates the compression supplied by an ICE engine. Hitting the brake causes a further speed reduction by putting a larger regen current into the pack. This is done by connecting the brake pedal stop-light switch to a relay.

Brush Ring Adjustment

For regen to work without damage to the motor, it is necessary to move the

When comparing the H2 to my four previous controllers, the first thing I notice is that you can creep when starting.

brush ring to the neutral position midway between the clockwise (CW) and counter-clockwise (CCW) settings. This is not difficult to do although it took me several months to find the information for my Prestolite 4001.

How-to for the Prestolite 4001

Remove the four motor cap screws leaving the aluminum-finned motor end cap in place. By hand, rotate this end cap in place and move the brush ring from CCW to CW (used with some Hondas). Where the screws were removed, there is a boss that looks like you can drill at 6 or 12 degrees from the CCW advanced brush setting. The 6 degree midpoint position is neutral setting. As it turned out we did not have to remove the batteries and the motor. We drilled the new holes at the mid point thru the grill and reinserted the screws in the new holes. The forward, reverse and regen have worked fine with this setting.

Electric Conversions, Inc.

Two different hand-held programming consoles are available at extra charge but Greg McCrea, Electric Conversions, Sacramento CA programmed mine for straight traction before he shipped it to me so I did not need to buy one. The initial installation took several days as the instruction manual is for the factory installers. After you've done

the procedure once, it will become easier. Greg plans to assemble ZAPIs in metal box, complete with heat-sinks and wiring. You will only need to feed in motor and battery cables. He will also supply a terminal block for the micro-itch-to-controller connections, making installation much easier.

Greg came over in October to show me how to cable the new Albright contactors and reprogram the H2 for regen. I now feel much safer and under control going down the hills. There has never been any trouble going up-hill.

Running Characteristics

When comparing the H2 to my four previous controllers, the first thing I notice is that you can creep when starting. Although the 5k ohm linear pot is the same one I used with other controllers, the ZAPI start program provides different speed curves so the forward start can be very slow; half the speed of walking. However, it moves up quickly to full current.



Bob Wing and his Zapied '59 MG.

Although I have a reverse gear, I find the electronic reverse is much easier since it can work with any forward gear. With a high starting-torque motor, the reverse gear has such a high gear ratio that more than once I have broken the welded motor clamp while in reverse. A dash-mounted locking toggle switch with forward, neutral and reverse is very convenient and prevents the passenger from accidentally changing it.

It is important to have motor governor speed control. With the motor under no load (even at 72 VDC and now at 96 VDC) it runs too fast with the clutch disengaged. Certainly you want the loaded motor to go much faster than an ICE, since the electric has good torque at low speed but is much more efficient near its upper end. You do not want to lose battery power to resistive heat through inefficiency. I now have 16 - 12 volt Optima prototype deep cycle batteries in two strings.

The Future

My next project is to install Rich Rudman's battery regulators at \$20 each to limit charging to 14.7 VDC on each sealed battery. John Wayland of E-Car in Portland, OR sells these regulators <Datsun1200@AOL.COM>.

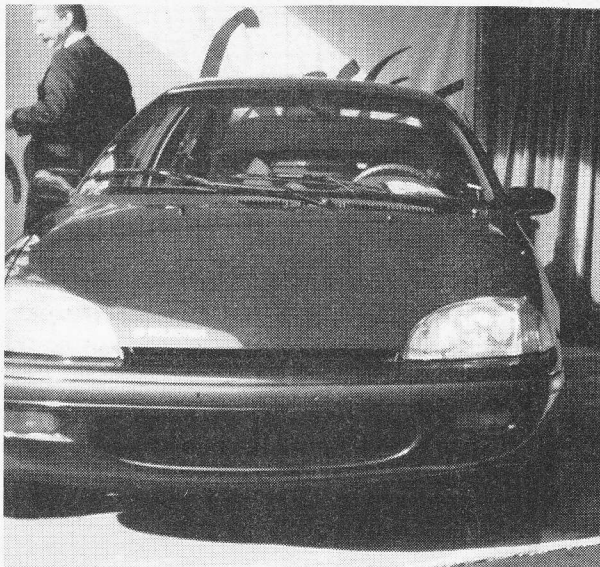
To complete my 24-year-old project I want a 7kW, 120/240 Vac onboard charger to use at home or on the road. —BW

Access: Greg McCrea, Electric Conversions. 214 14th Street, Sacramento CA 95814. Phone 916/441-4161. Fax 916/444-8190. <greg_mccrea@macnexus.org>

Bob Wing, EV Consultant, West Coast Editor GLEAN/EV News, POB 277, Inverness CA 94937-0277. Phone 415/669-7402. Fax -7407. bobwing@nbn.com

Solectria Force Regen

BY MICHAEL BIANCHI



Michael Bianchi's Solectria Force (similar to this one) has an excellent driver interface for regen braking.

A key factor in my decision to buy a Solectria Force was the presence of a seamless regenerative braking system, which I see as a safety factor. It is integral to their AC induction motor and controller.

On the Force, the regenerative braking is on the accelerator pedal and operates somewhat like compression braking on a manual transmission internal combustion engine. Since my other car has a diesel engine, the idea of a car that aggressively slows down as you take your foot off the accelerator pedal seems totally natural.

The operational details of the Force's regen system are these:

- The accelerator pedal provides electric acceleration and deceleration.
- The brake pedal provides mechanical deceleration.
- When the car is not moving, pressing the accelerator pedal half-way to the floor causes no motion. Only once you press past the mid-point does the car start to accelerate.
- Returning the accelerator pedal to the mid-point puts the car in a coasting mode.
- By releasing the accelerator so it is "above" the mid-point, the car goes smoothly into regenerative braking. The amount of braking is determined by the distance above the mid-point. With your foot completely off the accelerator pedal, the regen braking is pretty aggressive.
- As you would expect, the energy recovered by regen braking is returned to the traction battery. However, if the car has not traveled far since it finished recharging, there is little room in the batteries for the extra energy. As a result, if you attempt aggressive regen braking before you've taken about 10 amp-hours out of the battery, the controller "chops" the regen braking current which limits the braking effect. It also causes a buzzing sound that I see as a warning that I'm not getting all the braking effect I might expect.

When I drove electric cars without regen braking, I found that relying on the mechanical brakes for stopping or just maintaining speed going down a hill was disconcerting. I've experienced fading from hot brakes and it is not pleasant. At the time I bought my Force, Solectria's regenerative braking system was the most thoroughly tested one available. I still believe it to be among the best. —MB

Regenerative Braking in On-Road Electric Vehicles

BY PAUL COMPTON, EAA UK

Regenerative braking or 'regen' is a common topic of discussion between EV enthusiasts.

Using the drive motor for braking purposes is an attractive proposition. Vehicle weight has usually increased significantly and there is no longer any compressive braking effect from an engine. This imposes a much greater strain on the original brakes.

E-brakes

There are two types of electrical braking: dynamic and regenerative. Dynamic braking dissipates kinetic energy from the forward motion of the vehicle into heat in some kind of resistive load. In this respect dynamic braking is like conventional friction braking in that the energy is wasted as heat. Regenerative braking, on the other hand, returns energy to the battery, and, if reasonably efficient, does not produce large quantities of heat that need to be disposed of.

Advantages and Limitations

Regenerative braking is thought of by some as a magical range-extender. Figures of up to 25% range increase are sometimes mentioned. On fairly flat terrain, thinking ahead and coasting to conserve as much precious momentum as possible is likely to result in less energy consumption. Regen, however, is not a 100% efficient process. The motor and controller are pretty efficient but the batteries are the weak link. Flooded lead-acid batteries in particular are pretty inefficient at accepting high charge rates and some can sustain damage. However, some of the valve-regulated batteries now on the market, such as the Optima yellow-tops, Hawker Genesis and the Electrosorce Horizon are far more efficient at high charge and discharge rates. If you are rich enough to

A correctly designed separately-excited motor can generate the same starting torque as a series-wound motor.

have a set of NiCads or nickel-metal hydride batteries, these too will accept high charge rates.

Best in Hilly Terrain

In tests that give high figures for improvement in range, you can usually find that the improvement is due to the difference between someone using the wrong technique for driving an electric vehicle and that same person using regen. Where regen is particularly effective is in hilly terrain. Here the conventional brakes of the vehicle are going to struggle with the task, and, if you are going to the trouble of an electric braking system, then it might as well be regenerative in order to recoup some energy.

Regen Motors

Current will only flow into a battery when the voltage applied is higher than the voltage present on the battery. All brush-type DC motors are capable of acting as generators, but some are much easier to implement regen with. A permanent-magnet motor automatically generates an output voltage which is directly related to RPM. Regen current can be achieved by raising the rpm of the motor when braking is required, (i.e. shifting down a gear), but this risks over-revving and bursting the armature. Alternatively, the battery voltage could be lowered, but this is only possible in series/parallel switching arrangements, and so limits its use to applications such as scooters or small motorcycles, etc.

Shunt and Separately-Excited

A shunt motor is a much easier proposition, as the separate field can be used to control the output voltage of the generator. Even better is a separately-excited motor. A shunt motor is designed to have its field connected directly in parallel with the armature, whereas the separately-excited motor

has its field fed from an externally-controlled source. Although a shunt motor's field can be fed separately in this way, it does not give the same range of control as the separately-excited motor.

The thickness and number of turns of wire in the field coils are very different in each case. A correctly designed separately-excited motor can generate the same starting torque as a series-wound motor, and will provide regen down to fairly low rpm. However, attempting to obtain large amounts of regen to low rpm by this method can result in excessive field currents and possible overheating.

Series — Not Simple

The series-wound motor is not a simple proposition for regen. Unlike the PM and shunt-wound motors, which exhibit a more-or-less linear relationship between current and torque, the series-wound motor has a current-squared relationship. This characteristic makes an electronic control system necessary for smooth braking torque. The series motor's field only drops a few volts at the same current as the armature, making field control difficult. Also, most of the popular series motors available at the moment do not have interpoles.

Brush Angles

In any brush DC motor there exists what is known as "the neutral position"; the brush angle at which minimum arcing occurs. Without interpoles, this position varies with the current through the armature. If the current is reversed, as in regen, then the brush angle must also be reversed. Advanced DC motors are supplied with the brushes set for the required direction of rotation. If regen is desired, then the brush angle must be set to zero as a compromise between drive and regen. Obviously this brush angle is not ideal for either mode, and current and/or voltage may have to be

limited in order to prevent arcing and subsequent damage to the commutator.

Controllers

The controller in most on-road electric vehicles today is 'solid-state' (no moving parts) and is based on either MOSFET or IGBT power devices. The controller acts as a variable 'buck' converter, reducing battery voltage according to throttle input. With a simple reorganization of the motor and controller power circuit layout, a 'boost' circuit can be created that will raise the output voltage of the motor above that of the battery. The controller logic must be modified to control current into the battery instead of voltage into the motor.

Problem - Overcharging

Some protection is needed to prevent overcharging. This is one of the problems with regen, namely, if the battery is fully charged, then no regen braking is available. You may start down a hill with full regen only to have it cut out half-way due to a fully charged battery. Ideally, a combination of regen and

dynamic braking should be used, with a smooth transition between the two. The above situation is only likely to occur if you live at the top of a substantial hill.

Driver Interface

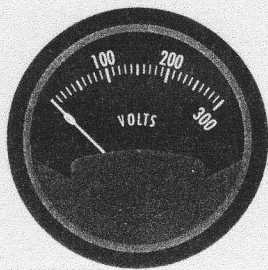
Another problem is how to control regen. Should there be a fixed amount of braking when the pedal is pressed, or variable braking controlled by pressure on the brake pedal. If your vehicle uses a gearbox, then regen will give different amounts of braking depending on which gear you are in.

There are very few controllers on the market with regenerative capability. Members of the EV Internet Discussion List have heard about the trials and tribulations in of using a Zapi H3 controller. Curtis will not sell the 1221R in the US, and (I believe) no longer recommends its use for road EVs in the UK. Various people and organizations are working on regen controllers, but probably the simplest and most common methods of achieving regen is to use a modified alternator or dynamo (generator). These can be run off the tailshaft of

the motor with other field control or a clutch of some kind to eliminate drag when not in use. Mike Slominski has an alternator on his Rabbit which keeps his 12V auxiliary battery charged while saving the cost of a DC-DC converter. One or two EV component suppliers can provide a parts kit for regen using an alternator.

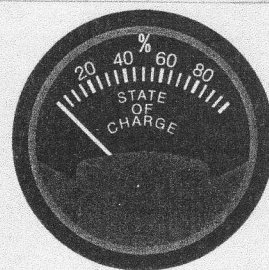
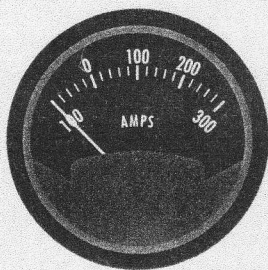
The question you have to ask yourself is "Can I really justify the added cost and complexity of regen for my application? On the other hand, everyone I have talked to who has regen would like it on their next vehicle as well.—PC

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EV1 at SAE Dinner Meeting, Sept. 96

BY KATHY WATSON, EAA PHOENIX

At the Sept. 21st meeting, the SAE Arizona section featured the GM EV1, now being marketed by the Saturn Corporation. Guest Speakers were Bruce Zemke of General Motors Advanced Technology Vehicles Division and Steve Haas, Marketing Analysts for the GM-EV1 program. Approximately 118 people attended the dinner meeting at the Holiday Inn - Airport.

Two beautiful EV1s were on display inside the conference room, one green and one red. John "EV" Rietter and Brad Reeder brought the cars down from the GM proving grounds. After the meeting, they took the EV1s to the APS building for the beginning of training sessions for the Saturn employees.

(Mr. Zemke went into great detail about the EV1 and I regret not asking if I could record the presentation.)

Charging

Bruce Zemke stated that the EV1s have smart charging, which is a module on the battery pack that informs the charger of its' state of discharge. It even tells it what kind of batteries it has (either Lead Acid or NiMH). GM has added many features and fine-tuned many parts of the EV during and since the PreView Drive Program. The PreView Program is currently in Canada and then will be finishing up in Houston.

Mr. Zemke commented that the EV program really got serious for them (GM) in 1987 at the World Solar Challenge when the GM SunRacer went 40 MPH and only used a total of 1,500 Watts of power. Then in 1990, the GM Impact prototype was introduced in LA. The prototype had 2 motors, front-wheel drive, lead acid batteries, and the rear track was narrower than the front.

Bruce put a plug in for a new book just out in publication, "The Car that Could" by Michael Shnayerson, which he said was a very-well-done history of

The utilities are installing an Inductive charging station at Eva's Mexican Restaurant (off I-10 near Casa Grande, AZ) between Phoenix and Tucson. Lets go cruz'n!

the GM Impact-EV1's development and the people involved.

Bruce listed the large amount of research that went into the EV1 product development. It was not only a matter of building the EV1. General Motors did a great deal of research into commercial viability and market analysis on consumer perceptions and needs. The first car they experimented with was a Geo Storm that they converted as test-bed for their ideas. Then in 1991, after choosing a single-motor design and front-wheel drive, it took GM 99 days to build the first prototype. This was the beginning of an extensive engineering and marketing study, testing the EV1 in the cold and snow and in the heat of Phoenix. Mr. Zemke was very proud of the fact that they did extensive EMF interference testing, which proved very difficult but successful.

Record-Holder

He reminded some of us, and notified others for the first time, that the GM Impact-EV1 currently "holds" four records. One being the Electric Vehicle land-speed record of 183 MPH. I don't know what the other three records are, but probably one of the them is a first modern ground-up EV design in production.

After the meeting, privately referring to Clare Bell's article about the Friday Night drag race at the APS Electrics when Sunny Side-Up (16.95) was beaten by Wilde Evolutions electric Mazda RX-7 (14.70) in the quarter-mile drag. Mr. Zemke stated, "Yes, they beat the pants off of us, but look at how the GM 'record' was performed. The EV1 is still the land-speed record holder."

Although the EV1 will be introduced in Arizona with lead-acid batteries, Mr. Zemke feels that NiMH will be the EV battery in the very near future. Long-term expectations focus on Lithium Polymer. For the present, Mr. Zemke feels that the infrastructure

development will be the most important part of EV1 commercial introduction. He drew the similarity between EVs of today and combustion cars in their early stages. He told a story about the first family vacation with a combustion car. A women wanted to take her children on 100 mile trip, the only problem was where to get gasoline. In order to make the journey, she obtained the fuel from a chemist. The PreView Drive Program started over two years ago.

The second stop was Phoenix and it is finishing up currently in Houston. There were 50 GM Impacts built of the 4th generation prototype and 30 of those were used in the PreView drive program. On average, the cars were driven 300 miles a week by the PreView Drivers, and GM was told that the EV1 met 85% of the PreView Drivers commuting needs. Personally, as one of the lucky PreView Drivers, I honestly feel the EV1 would meet very close to 100% of all my "commuting" needs!

By the way, the utilities are installing an Inductive charging station at Eva's Mexican Restaurant (off I-10 near Casa Grande, AZ) between Phoenix and Tucson. Lets go cruz'n!

The EV1 was designed for maximum efficiency; wind drag as well as cross-winds were considered in designing the body. With a drag coefficient of 0.19, the EV1 achieved a coefficient 25% lower than any other production car.

The use of regenerative braking adds 20% to the city driving range. The automotive heat pump for the air-conditioning is Ozone-safe and the EV1 has a preconditioning feature to pre-cool or pre-heat the car to desired temperature with a programmable setting. This saves on range by using the energy from the charger instead of the traction batteries. The EV1 has an aluminum body structure that is 40% lighter than steel. And GM uses a very durable epoxy instead of welding. The frame of the EV1 is only 132kg. Magnesium seat

frames are 60% lighter than standardized materials and the seat covers are a 3D knit material. The rolling resistance is 30% lower than most combustion vehicles, using Proxima low-rolling resistance tires by Michelin with 50 PSI tire pressure. The EV1 has a tire-pressure detection system that warns the driver if the tire pressure falls. Lanette and I found that out, because it also detects when your tires lose contact with the road. Because of the inflation detection system, GM eliminated the spare tire, saving on weight. The batteries are arranged in a "T" shape for the best weight distribution and cargo design considerations.

He reminded the SAE group that the Induction Charging System is the only SAE-approved charging system. (On a personal side-note, if the conduction advocates could just agree on a universal conduction plug then we could also have an SAE approved conduction charging connection standard.)

A long list of features have been added to the EV1 since the Impact prototype; keyless entry, remote trunk release, etc. Electrically-driven motors are used for all the pumps on the EV1, no belts to wear out or break.

EV1 Regen

The braking system is made up of three components; regenerative braking, hydraulic front brakes, and electronically-actuated rear brakes. The hydraulic front brakes are solid rotors with a computer power-boost. Solid rotors are used because venting is not necessary due to the regenerative braking. The electronically-actuated rear drum brakes are powered by electric motors to insure that the shoe does not drag on the drum and cause an efficiency loss. All three parts of the braking system communicate with the computer to orchestrate the braking system in unison.

Driveline

The 137 HP, 12KW motor has an 11:1 fixed drive ratio. The controller is capable of handling 600 volts and is water-cooled. Each battery in the 1,175 lb. battery pack is individually moni-

tored, not only telling the charger its state of charge, temperature and voltage, but also communicating battery type. The traction battery network has two relays in case of accident or loss of isolation, and a daisy-chain on each battery so that if one opens, they all do. The lead-acid batteries are valve-regulated and there is less than a teaspoon of acid that could leak out in case of an accident.

Licking in the Rain....

GM is very proud of the fact that the inductive charger is extremely safe; a person can hold the paddle in the pouring rain standing knee deep in water, in their stocking feet, and lick the paddle. GM engineers do this for demonstrations, and they have actually tested the inductive charging under water. The EV1 uses two main chargers, 1.2 KW convenience charger at 110V, and the 6.5 KW charger at 220V. And some of the Utility companies in California are using a 50 KW 480V induction charger that can charge the EV1 80% in 15 minutes.

Bruce hinted that the EV1 is just the beginning of what is to come from GM's Advanced Technology Vehicle Projects. The EV1 is the first in 90 years to carry the GM label. Which, I feel, is a sign of the level of pride and resolve that GM has about the EV1 program.

Mr. Steve Haas, Saturn/GM Marketing Analyst, stated that, based on their research, the EV1 target customer is 35-54 years of age, owns their own home, has a family income of \$125,000+ and typically owns two or more family cars. The EV1 would be used as one of the families' commuter vehicles.

Saturn will use their existing advertising agency, which Mr. Haas stated has done so well with giving the fairly young Saturn Division a fresh image. They will start with spot TV ads and will target specific publications that target their intended consumer.

Dealership Training

The EV1 will be leased from 26 dealerships in LA, San Diego, Phoenix and Tucson. It will be featured in a standalone display and the Saturn sales

personnel are going through extensive training so that they can explain this very unique vehicle to the public. It takes approximately forty-five minutes to one hour to explain the features on a combustion vehicles, since most consumers are very familiar with those. With the EV1, Saturn expects it will take a great deal of time to explain the EV1 to consumers. The EV1 team consist of fourteen people; they will visit the consumers' home or office and evaluate their commuting needs. As Steve emphasized, the EV1 Specialist must be able to tell the customer if the EV1 will not meet their needs. As a side note, there was a gentleman that did not attend the dinner, but who stood very anxiously listening to the guest speakers as he admired the EV1s in the back of the room. He wanted to know, could someone take the EV1 out of the Phoenix area? Mr. Haas replied that in a case like that, the EV Specialist would have to say, "I am sorry but the EV1 will not meet your needs."

Lease Restrictions

From conversations with EV Specialist, Joe Ricciardi, I found that this is a very frequent problem for the Saturn EV1 team. The lease contract states that if the EV1 is taken out of the 75-mile service range, the consumer will be the responsible for returning the vehicle, in case of warranty service needs. Saturn can repossess the EV1 if they feel it is necessary. I felt very sorry for the gentleman, because having had a taste of this wonderful car, I must say, I would almost sell my soul to the devil to have one.

I know Saturn wants very much to make sure all their customers are happy, so the EV1 will be leased only, at least for the first few years of its' introduction. The lease will be a typical \$35,000, three-year-lease program with no money down, but a lot easier to get out of. And a separate lease for the 220V Hughes charger will be provided by EV Power in Arizona.

continued to page 20

News in Brief is compiled by Ruth M. Shipley from information supplied by the Environmental Information Network. If reprinted, please credit CE and Ruth Shipley.

EVs Come to the Middle East

New York, NY-based Electric Fuel Corporation recently signed an agreement with Israel Electric Corporation (IEC) to market its zinc-air energy system for EVs in Israel, Egypt, Jordan, Lebanon, Syria and the Palestinian Authority.

Government-owned IEC will invest \$1 million to start the program in which it will receive the exclusive license for zinc-air battery refueling and regeneration in the Middle East. Under the agreement, the electric utility will also build and operate the infrastructure for the Electric Fuel battery system. The companies plan to collaborate in a demonstration field test to operate several zinc-air EVs using the current Electric Fuel infrastructure in Bet Shemesh, a suburb of Jerusalem.

(ELECTRIC FUEL RELEASE: 11/14)

GM Delivers First Shipment of EV1s

General Motors Corporation saw the fruit of many years of work this week when the first shipment of EV1 electric cars was unloaded at the Southern California Automotive Distribution Center in San Bernardino, CA. "Watching the EV1 roll off these rail cars today illustrates that the electric car is charged up and ready for sale in California," said John Dunlap, chairman of the California Air Resources Board (CARB). "With the EV1s, General Motors is showing the world what can be done when industry and government act as partners instead of adversaries." The EV1 will be leased from 26 Saturn retailers in Los Angeles, San Diego, Phoenix and Tucson beginning December 5. For details, contact Sharon L. Sarris, phone 805-373-9572.

(PRNEWswire: 11/18)

Toyota To Invest in AFV R&D

Tokyo-based Toyota Motor Corporation has decided to invest \$800 million annually on alternative fuel vehicle (AFV)

research, putting AFVs on an equal footing with conventional powerplants. "We haven't been able to determine which is better: trying to improve the current internal-combustion engine or developing alternative engines," said Toyota president Hiroshi Okuda. "So, we're devoting efforts equally on both sides." Toyota's hybrid vehicle powered by a hydrogen fuel cell was showcased at the recent Electric Vehicle Symposium. Meanwhile, the company's electric RAV4 powered by NiMH batteries is already being sold in Japan and will go on sale in California next September.

(AUTOMOTIVE NEWS: 11/18)

EV Day Declared in Hawaii

Hawaii's Governor Ben Cayetano declared Thursday, November 14, as Electric Vehicle Day in the state, and started a 3-month trial program in which he himself will drive an EV. As part of the trial program, Cayetano was presented with the keys to an electric GEO Prism, part of the Hawaiian Electric Company's (HECO) electric fleet. At present, the Hawaii Electric Vehicles Demonstration Project has brought 35 electric and hybrid EVs to the state, with another 20 expected soon. HECO and the Maui Electric Company have a combined EV fleet of over a dozen, including one electric bus. For details, contact Tim Quinn, phone 808-594-0100.

(STATE OF HAWAII RELEASE: 11/14)

Honda Gears Up for EV Sales

Honda is examining which dealerships should market its EVs in California and to what degree the dealers will need to be subsidized. The trial markets will include fleets in Sacramento and southern California where dealers will be provided extensive training for their sales staff, service advisors and technicians, as well as mechanical support for the EV program. Specialized service equipment will also be necessary for the two-door, four-seat EV equipped with a 1,000 pound NiMH battery. The EV will go on sale in the Spring of 1997 along with the company's 1998 Civic GX, a natural gas-powered vehicle. Honda

hopes to sell approximately 300 EVs in the next several years. The car will initially be available only by lease and will include an extensive service package with roadside service.

(AUTOMOTIVE NEWS: 11/18)

Toyota First to Mass Produce Hybrids

Toyota Motors recently announced that it will begin mass manufacturing the world's first production-line hybrid EV within a year. With its plans to produce tens of thousands of the new hybrid EVs before the end of 1997, the company is ahead of its competition in the hybrid market. According to company sources, the new vehicle will have twice the gas economy of the current Toyota Corolla. Other features of the hybrid EV include its capability of rerouting dead power to the car's battery for later use by the electric motor and a range of 70 to 84 mpg. The company plans to encourage consumer awareness for hybrid vehicles by maintaining low costs. Toyota will first target the American market due to its growing interest in low-emission cars.

(REUTER: 11/17)

Humboldt U. Delivers Fuel Cell EV

The Schatz Energy Research Center at Humboldt State University is working on two hydrogen-powered small urban fuel cell vehicles for delivery to the City of Palm Desert, CA as part of an EV fleet. The center has already converted a golf cart to hydrogen power with a 5kW 64-cell PEM fuel cell for Palm Desert. The two new EVs will most likely serve as utility vehicles for city maintenance operations.

A total of 8 vehicles — 5 utility and 3 large neighborhood EVs — will be developed for the city as part of a 3-year, \$3.9 million contract. "We're working our way from golf carts to neighborhood electric vehicles to regular highway cars. Our ultimate goal is to see clean and reliable fuel cell cars on all our nation's highways," said Peter Lehman, director of the center.

(HYDROGEN & FUEL CELL LETTER: NOV. 1996)

Lithium Ion Battery Receives Award

The editors of Popular Science have selected the Nissan/Sony lithium-ion battery as one of 100 new products to receive a 1996 "Best of What's New" Award. Nissan's new EV — a 4-passenger compact van powered by the lithium-ion batteries — will be introduced to the California fleet market in early 1998.

The lithium-ion battery contains about 3 times the energy density of conventional lead-acid batteries and almost twice that of NiMH batteries. The batteries also feature a newly developed electrolyte to handle both hot and cold climates. The EV will have a driving range of more than 120 miles and acceleration performance similar to that of gasoline-powered vehicles. For more information, contact Kurt von Zumwalt at 310-771-5238 or Gina Pasco at 310-771-3416.

(PRNEWswire: 11/13)

Bombardier Introduces Neighborhood EV

Montreal, Canada-based Bombardier recently unveiled its low-speed Neighborhood Electric Vehicle (NEV) in Phoenix, AZ. The Bombardier NEV will allow people to travel short distances to the supermarket and bank within their community at a top speed of 25 mph and a range of 30 miles. The company is also offering a Golf Option Package that provides power train settings for fairways and roadways while meeting most national golfcart standards. The NEV is powered by recyclable batteries that can be recharged overnight in a standard household AC outlet. The vehicle is equipped with 4-wheel independent suspension, automotive-like braking and steering systems, retractable seat belts, a large lockable trunk and an accessories package. The suggested retail price is \$6,699.

(BUSINESS WIRE: 11/12)

Trabant Factory to Produce Hybrids

A plant in the former East Germany that had been used to churn out Trabants, the ubiquitous and high-polluting Soviet Bloc compact car, is now being used to produce advanced diesel-electric hybrids. The UNI 1, a 7-passenger van, features a 90hp diesel-fueled internal combustion engine and a 30hp electric motor for short trips. The plant, located in Zwickau, Germany, and the company Sachsenring Automobiltechnik GmbH, were purchased by businessman Ernst-Wilhelm Rittinghaus in 1993. He and brother Ulf turned the company around from the brink of bankruptcy to a profitable parts supplier to European and U.S. auto manufacturers in less than three years.

(BLOOMBERG BUSINESS NEWS: 11/8)

Californians Test City Bee

The City Bee, an electric commuter car made by the Norwegian consortium PIVCO, is making inroads in California. Reminiscent of the Austin Minis built in the 1960s, the EVs are made of thermoplastic and aluminum. CALSTART introduced them in California last fall, and so far, 40 have become part of the Bay Area Station Car Project. The company hopes to begin production of the cars in California by 1998 and has raised \$10 million through a private stock offering. PIVCO is looking for partners to help manufacture the vehicles in California. PIVCO is currently manufacturing 150 of the cars for different European demonstration programs and may open a facility near Glasgow, Scotland, close to the site of a natural gas fueled power plant. Statoil Norge AS is also planning to rent the City Bees for traveling at the Oslo airport.

(CALSTART CONNECTION: AUGUST/SEPTEMBER 1996)

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Daihatsu to Develop Rental Stations

Japanese auto manufacturer Daihatsu Motor Company is developing an EV rental network mechanism through which users can pick up and leave their cars at different urban locations with the swipe of a magnetic card through a card reader. The company will locate the rental stations about one-quarter-mile apart in urban areas throughout Japan. A central computer that monitors distribution of the cars between stations will also have billing functions. The project, which is similar to Tulip's and Praxiteles' in France, will be profitable if Daihatsu can attract at least 1,100 subscribers per car. A main benefit urban users can reap from the system is not searching for a parking space. Drivers simply leave their cars at the rental-recharging stations. Daihatsu is currently developing one-, two-, and four-passenger EVs.

(CALSTART NEWSNOTES: 11/1)

Welcome to the Electric Auto Association calendar of events. Listed are events of direct or related interest to Electric Vehicle Enthusiasts and Alternative Transportation Technology Businesses. If you know of an event that should be listed, please email event information to [kawatson \(evchdler@primenet.com\)](mailto:kawatson@evchdler@primenet.com)

1997

January 24-28

Great Southern Sunrace, Australia. First annual solar car race from Adelaide to Melbourne via Elizabeth, Peterborough, Broken Hill, Mildura and Bendigo. Contact: Sustainable Energy Enterprise Developments, tel. (03)9820 9032, fax (03)9820 2027

January 22-27

Convert It: The Workshop: Hands-on Training, Santa Cruz, CA. Electro Automotive (Mike Brown and Shari Prange) is doing their classic four-day hands-on electric vehicle conversion workshop. Location, Electro Automotive, Felton, CA (Santa Cruz area). Emphasis on safety and reliability. Geared for the amateur mechanic and EV hobbyist. The primary focus is actually putting together an electric Rabbit and getting it running. Cost \$400 per person, pre-registration required, space limited. Contact: (408) 429-1989

February 24-27

SAE International Congress and Exhibition, Detroit, Michigan. Annual conference and exhibition sponsored by the Society of Automotive Engineers, held at Cobo Center, Detroit. Contact: SAE, 400 Commonwealth Dr., Warrendale, PA. 15096-0001 tel. 412-772-7131, fax 412-776-0002, email meeting@sae.org or visit SAE Web site at: <http://www.sae.org>

March 7-9

APS Electrics, Phoenix, Arizona. EVTC conducts electric vehicle competitions as a means to increase public awareness of electric vehicles, develop an electric vehicle educational infrastructure and advance EV technology, all in

an effort to support commercialization of electric vehicles in accordance with Energy Policy Act mandates. EVTC competitions provide laboratories for High School and University students to work out real life solutions to textbook problems. Location of Event: Firebird International Raceway Classes (additional classes maybe added however): ABB University Spec Series, Formula E Class, Prototype Demonstrations, High School Challenge Series, Street Stock Class, Super Stock Class. Contact: EVTC, tel. (602) 256-2599, fax (602) 256-2606

April 7-10

EnV'97, Detroit, Michigan. Fifth annual Environmental Vehicles Conference and Exposition is held concurrently with the 12th Annual Advanced Composites and 6th Annual Advanced Coatings Technology Conferences and Expositions at the Westin Hotel. Sponsored by The Engineering Society of Detroit and SAE. For more information on the 5th Annual Environmental Vehicles Conferences, contact Kristin Karschnia, ESD, 29355 Northwestern Hwy., Suite 200, Southfield, Michigan, 48034, tel. 810-355-2910, fax. 810-355-1492.

Apr. 20

Contra Costa Earth Day at the Concord Pavillion, Concord, CA. Hours, 10 AM-6PM. They are looking for Evs to show. In previous years attendance has exceeded 30,000. Contact Anna Cornell, EAA Events Co-ordinator, (510) 585-7580.

April 21-22

First Annual National Storage Battery Conference, Boca-Raton, Florida. Hosted by Albercorp, 990 South Roger Circle Suite 11, Boca Raton, Florida 33487. Tel. 407.997.2299.

The intent of this Calendar is to provide a comprehensive list of Events that will help to increase awareness and participation in the ever growing interest and use of Electric Vehicles. Your support and input is greatly appreciated. Thank you.
Produced by [kawatson \(evchdler@primenet.com\)](mailto:kawatson (evchdler@primenet.com)).
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EV1 At SAE Dinner

continued from page 17

Roadside Assistance

Saturn will offer a Roadside Assistance Service within a 75-mile range from any of the 26 dealerships leasing the EV1. The warranty on the EV1 is very extensive and will cover the batteries and even the tires.

EV1 production numbers are still a matter of speculation, but that their assembly facility is ready for a large demand. Mr. Haas stated that, "with a new product like this one, we are going to stay flexible and see what happens." Mr. Zemke said "One thing is for sure. Arizona is hotbed of electric vehicle enthusiasm!"

For more EV1 information: Check out their Web site at <http://www.gmev.com>

Regenerative Braking

continued from page 10

description of the REGEN circuit, but the point is that it works with present day EV conversions. If you want more detailed information on actually implementing a REGEN circuit for a series motor, a book on REGEN is available "Regenerative Braking for Series DC Motors — A Practical Guide". You can get more information on this from the Web: <http://www.primenet.com/~ecoparts/> or by Email: ecoparts@primenet.com.

In this discussion, we have shown that REGEN doesn't have to wait for sophisticated new AC drive systems (or even permanent or shunt motors). It can be used on nearly all present day EV conversions using DC series motors to add additional driving miles between charges and save on brake wear, which can be a real problem with EVs which are generally heavier than their original gas configurations and, without REGEN, can provide no braking action (like a gas engine) on long downhills.

96-12-06 15:40:43 from JACKSON@GAV.GAT.COM

Aug 31, 1996

The Board meeting started at 10:45 am at Stan Skokan's residence, with Stan, Anna, Clare and Harold present. 3 proxies were received from Tony Cygan, Michael Slominski and George Gless. Stan read a fax asking for an updated list of the members and he thought the EAA should lobby the automakers to co-operate in making Evs. He passed out an updated phone list and showed us a letter from Calstart and his response.

The June meeting minutes were approved by Harold Bell and seconded by Clare Bell. Today's agenda was approved with additions by Clare, with Anna seconding.

Committee Reports

Mike Slominski (read by Stan). Mike sent letters to the chapters asking for nominations to the upcoming election this year. Anna indicated that she had no response at the time she spoke to me. He is working on a chapter list and hopes to have it finished by the next board meeting. Clare had a proposed deal from Phillip Terpstra of Spirit regarding the EV Buyers' Guide, but has not yet reviewed it. CE ad income was low due to different time schedules/reports. Some funds were deposited in 4th quarter this year. We are under budget and should be able to spend it safely. The Association has picked up approximately 55 new members between June and July.

TONY's report was given over the phone due to his (gas) car being out of commission. Tony said that Tim Loree of Sacramento Chapter was nominated to the board at the their chapter's last meeting. He'll try to get a bio from Tim to Clare for CE. Tony's automated voice system doesn't work well — it has problems with Windows 3. Ziff-Davis has been re-doing EAA National's Web site. CalStart has a site and shows charging stations and maps.

Clare's report involved resolving some of the difficulties experienced in meeting production deadlines. She also mentioned that she is still receiving responses from Scott Cornell's battery test article. She is proposing that CE could run a color cover if CE gets a good enough color photo.

EV Buyer's Guide

All of us talked about this year's issue of the EV Buyers' Guide. Clare spoke to Phil Terpstra and found that Spirit is not that interested in doing it this year, so EAA could take it on and give it a slightly different name. Stan said that he did the BG advertising last year and prefer that someone else do it. Clare said she would negotiate with Sue for PCTEK to handle the advertising. She said she would also contact Home Power and Bruce Meland (Electrifying Times) to ask for help in advertising and distribution. Clare is to make cost estimates for the project and send them to Board members. Clare motioned that EAA do the EV Buyers' Guide and Harold Bell seconded. All voted in favor.

Anna reported she received 30 calls to her home for info and 12 miscellaneous ones in the period of 6/29 - 8/30, 1996. There were 88 calls to the 800# for the same period with two incomplete addresses. The phone bill for June 20 showed 47 calls in the US and 45 in California alone. July 20 had 67 calls in the US and 49 in CA. the newest chapters are picking up members and becoming official. She also said that EV events are slowing down.

Harold reported that Phoenix Chapter is considering putting the 800 # number in their phone directory and wanted Anna's opinions on it first. She said it was OK, after talking some more about it. She also wanted letters directed to her. Phoenix chapter also nominated Bill Wedmore to the Board.

Elections

Headed by Anna Cornell. She was nervous about the elections because no one had called or wrote in any names. All she had were the members who were finishing their terms. Anna couldn't reach Steve Lough to find out if he wanted to run again. His name will be put on the ballot unless he says no. Ballot will be designed by Anna and sent to Clare for the October issue of CE. Members are asked to mail their ballots in by December 15, 1996. The election will then be closed. Results will be published in the next issue of CE after the Christmas holidays.

WWW

The EAA National Website has the best of CE and a lot of links to other chapter sites. No one is doing stats on the EV Discussion list. Things are discussed on the list from the practical to the political with a little negativity. Senior members of the List "police" it. Clare said we need more presence on the Web and the EV Discussion List.

EAA Radio Spot

Clare wrote a script and sent it to Mike Slominski. She hasn't seen his revisions yet. Stan added some ideas that seemed short enough for the spot.

The meeting was adjourned at 4:09 PM. The location for the 26th meeting will be at Anna Cornell's residence in Pleasant Hill, CA at 10:30 AM.

CORRECTION

Steven S. Lough
6021 32nd Ave. N.E.
Seattle, WA. 98115-7230
Tel. (206) 524-1351
Fax. (206) 526-5348
E-Mail: slough@halcyon.copm

For Sale: 9-inch Advanced DC Motor \$1,000 (like-new condition), Curtis 96-144 volt Controller (new in box) \$925, Albright Main Contactor (new) \$90, Volt/Amp gauges with shunt (new) \$65, Main Contactor "Panic" button \$25. All prices are negotiable. Contact Michael at (503) 585-0639. (Salem, OR).

For Sale: Datsun 310 Hatchback. 4-door, 4-seat, original 1981 "Lektrikar II" EV, professional rebuild with new electronics and wiring 1995, new paint, new seats, new tires, new batteries, new Curtis 1221C controller in 1996. Under 5,000 original miles, all as 108-volt EV. Daily driver. \$10,500 (delivered West Coast/SW.) Contact Richard Rahders, Santa Cruz, CA. Tel: (408) 426-3783, Fax: 2526, E-mail: fmjg65c@prodigy.com.

For Sale: '82 Lectra 2-Dr. Hatchback. Professional Lectra Factory conversion from a new 1982 Datsun 2+2 SL, Mesa tan color. Only 242 miles on car. Tires like new. Never driven or registered as a gasoline car. Comes complete with with spare Prestolite 96V motor and Lester charger. Car needs electrical disassembly, total cleaning of all parts electrical and cosmetic. Needs all new batteries, cables and 2 matching front bucket seats (missing). Good project car and good deal at \$2600. Includes detailed factory manual. Call Ted @ (619) 365-6146. (Yucca Valley, California)

Member Want Ads

Print clearly or submit typed copy of your ad with your name, address, and phone number. The EAA is not responsible for the accuracy of ads. Want ads must be received before the 1st of each month and must include payment to run in the next issue of CE.

\$10 for the first 35 words. Each additional word, 25 cents. Want Ads are available to EAA members for the sale of electric vehicles, equipment and parts only. If you want to run your ad in more than one issue, please specify and include payment for each issue requested.

For corrections or updates, please send a written note or fax to EAA Want Ads @ 408.374.8750. Photographs of your vehicles may be submitted with your ad. If room is available, we run one photo each issue. These photos will not be returned.

Send your Member Want Ad request and check made payable to: EAA Want Ads, 18297 Baylor Avenue, Saratoga, CA 95070



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12 ads	\$125 ea

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1 ad	\$200 ea
3 ads	\$150 ea
12 ads	\$100 ea

1/8 page 2.0" x 3.5"

1 ad	\$150 ea
3 ads	\$100 ea
12 ads	\$75 ea

Ads may be placed for 1, 3 or 12 months. Camera-ready copy for each ad must be submitted along with payment. Ads may be submitted on diskette in TIF or EPS format on the PC or MAC. For 12 ads, an invoice will be billed quarterly. A minimum of 3 ads is required to be pre-paid.

Ad Deadline

The Deadline for camera-ready copy is the **1st of the month**. Copy received after the 1st will be run in the next issue. Ads will be placed in the priority received. Prepaid ads will receive 1st priority. Make check payable to EAA. Camera-ready copy and payment for the ad should be sent to: EAA AUTO ASSOCIATION, 18297 Baylor Avenue, Saratoga, CA 95070

Advertising Manager

Susan Hollis, PCtek
Advertising Manager
OFFICE: (408) 374-8605
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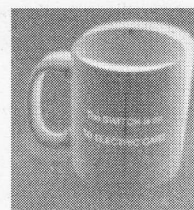
Auto SunShade
SS001.....\$8.00



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(adult small only)
TS001.....\$14.50



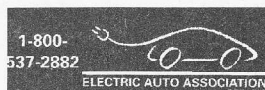
Thermal Auto
Mug
MUG02...\$6.00



Porcelain Mug with
'Charging into the Future'
MUG003.....\$5.00



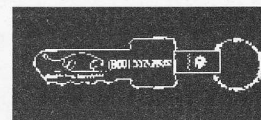
Window decal 'The Switch is on
to Electric Cars' Black and Red
printing. 3 x 9 inches
DC001.....\$3.00



Bumper sticker 3.75 x 15 inches
BS800.....\$2.50



Bumper sticker 3.75 x 15 inches
BS002.....\$2.50



EAA Key Chain, actual shape
may vary
KC001.....\$1.50

Printed materials

CE	Selected Current Events (<i>specify specific issue</i>)	\$ 3.00 each issue
CEFY	Current Events - Full year (<i>specify specific year</i>)	\$20.00 each year
PB001	Discovered: The Perfect EV Battery	\$ 2.00
FW001	Flywheel Energy Storage	\$ 5.00
BG1996	1996 Buyer's Guide to Electric Vehicles (Feb 96 issue CE)	\$ 5.00
BG1995	1995 Buyer's Guide to Electric Vehicles (Feb 95 issue CE)	\$ 5.00
TT001	Team Tucson Land Speed Record Plans	\$ 5.00
IDX001	EAA Current Events Index - 10 Years!	\$ 4.00
XA100	EAA XA-100 Hybrid	\$ 5.00

Other EV Items

PN001	Ball point pen with "EAA, 800 phone # & Charging....Future"	\$ 1.00
CS001	Current Solutions/Motor Show Video Tape (14 minute runtime)	\$14.00
WL001	Window Literature Holder (fits pages 8.5 x 11 inch)	\$22.00
PARK01	"EV Parking Only" Sign (18"x12") green icon on white background	\$22.00

Electric Auto Association **Reprint** Order Form
Send order to: EAA Reprints
5820 Herma St., San Jose, CA 95123-3410

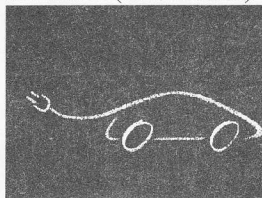
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CATALOGAERS

Subtotal	
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Total	

* for Canada add 15% or for other foreign destination add 25%

1996 04 04

KTA SERVICES INC.

944 West 21st Street - Upland, CA 91784
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Established in 1984, KTA SERVICES caters to electric vehicle hobbyists and manufacturers by supplying EV components, kits, publications, and design/consulting services. We are a complete supplier of EV components and certified kits....everything you need except for the batteries. All components we sell have been selected with safety and reliability foremost in mind. All components are new, competitively-priced, and come with full manufacturer's warranties. We STOCK and sell the largest variety of the very best.

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- ◆ SEVCON & CURTIS DC-DC Converters from 48 to 160 V input/14 V/25 A out
- ◆ BYCAN Battery Chargers for 48, 120-144 V battery systems
- ◆ K & W ENG. AH-100 Amp-Hr. Meter & TD-100 Tachometer Drive/Rev Limiter
- ◆ The latest in EV publications with a growing lineup of videos
- ◆ EVCC Adapter Plates, Couplings, Clamps, & Brackets
- ◆ PRESTOFLEX Welding Cable in 3 sizes from #6 to #2/0
- ◆ MAGNA Welding Cable Lugs in 3 sizes from #6 to #2/0
- ◆ Battery Cable Assembly Tools
- ◆ KTA SERVICES Expanded-Scale & Dual-Scale Meters
- ◆ WESTBERG Automotive Style Gauges in 10 configurations
- ◆ DELTEC Meter Shunts in 4 models from 50 to 1000 A
- ◆ CRUISING Equipment E-Meters, Prescalers, & DC-DC's
- ◆ Electric Vehicle Heating & Air Conditioning Components
- ◆ 5 Conversions Kits for vehicles from 500 - 500 lbs. total wgt.
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