Electric Auto Association

CURRENT EVENTS

March '96 Promoting the use of electric vehicles since 1967 Vol 28 No. 3

GM'S EV-1

It's the Little Juice Coupe

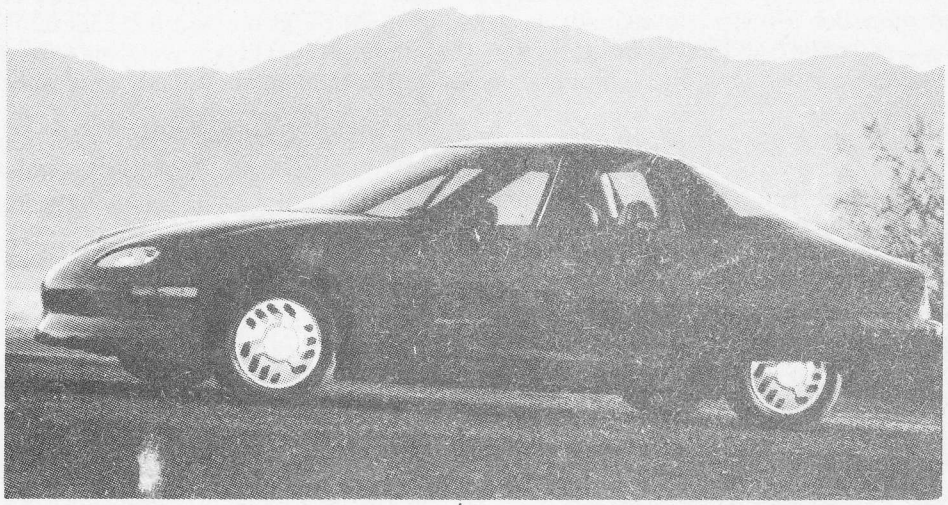
Transformed from Impact-3 into EV-1, GM's two-seater Aero-Vironment-designed electric sport coupe goes on sale in Southern California and Arizona this fall. Saturn dealerships in Los Angeles, San Diego, Phoenix, and Tucson will be handling the new EV, the first ever to wear a General Motors' badge. Test drivers in GM's PrEView Drive program praised the car's quick acceleration, responsive handling and space-age silence. (See page 4 for details.) Its teardrop shape, allowed by a track that is narrower in the rear makes it one of the most efficient and aerodynamic EV platforms. Electronics limit top speed to 80 mph, otherwise owners might try to emulate the test track performance of "SunnySide Up", the modified Impact-3 that set an EV speed record of 187 mph.

The EV1, which carries 23 new patents, is already in prototype production at GM's Michigan Lansing Crafts Center. GM Chair Jack Smith said the EV fits a special market, as do the Corvette and Suburban. GM intends to fill that "emerging market."

Initially the EV-1 will draw power from 26 Delphi sealed lead-acids. However later versions will have Ovonics NIMH nickel-metal-hydride batteries. Charging is via the inductive Hughes Magnecharge paddle, inserted into a recess in the front of the car.

Impacting the Mandate

GM's "little juice coupe" (as the car was dubbed by Maryland EAA member Hugh Gribben in an Internet post) is



sending shockwaves through the EV community and the general public. The former Impact is certainly making one, not only because of the car itself, but the politics surrounding it. It is fairly clear now that the price of the 3,000-5,000 cars GM is expected to produce in 1996 was the California Air Resources Board retreat from the 1998 2% ZEV mandate.(CE foresaw this, see the Jan. 1996 issue.) GM's announcement, coming almost immediately after the heated battle in which ZEV was outspent and then overwhelmed by orders from the governor's office (unproven as of yet, but almost certainly true), lends credence to this interpretation.

Only Game In Town?

Is the EV-1's introduction a power play by GM? Many industry and envi-

continued on page 4

EDITOR'S CORNER

Impacting EAA

by Clare Bell

The Saturn dealerships who will be handling GM's new plug-in pony were caught a bit flat by their parent company's announcement. According to Eco-Electric's Mary Ann Chapman, they were barely out of the "uh...duh.." stage when the TV cameras arrived on their doorsteps, although they recovered fairly quickly. GM and Saturn insist that they can solve the problem of supporting infrastructure for the EV-1.

Even so, it will be a major scramble. There will undoubtedly be gaps which EAA members and chapters can help fill. The network of "friendly plugs" and technical help that EAA is known for could supply critical assistance for early EV-1 buyers. In a pinch, even a 110 outlet can supply the EV-1 by means of its on-board convenience charger. It could make the difference between a delighted or discouraged new EV owner.

GM says that people can buy cars in the test-market cities and bring them home, but initially there will be no service support outside the four designated areas. EAA member Bob Mueller commented, "I... asked the (GM EV Info Line 1-800-25ELECT) lady when we could have one in San Jose, California. She said I was welcome to buy it and ship it here, but there would be no one locally to maintain it if anything went wrong."

EAA membership expertise and experience with EVs may help get EV-1 buyers from outlying areas through this interim period. Although its motor and drivetrain are different than EAA's conversion cars, some of the simpler problems are likely to be similar to those in our conversions (battery interconnects, interlocks, charging etc.). Other problems will probably be handled by field replacement units that can be installed by an experienced EV mechanic.

Those EV-1 owners who commute to work will get their first convenience charges at designated EV parking places which owe their existence to EAA members who asked companies to install them. They may be carrying maps in their glovebox of convenience charging sites; maps put together by EVAA and EAA members and chapters in cities such as Sacramento, Boston, Las Vegas, Seattle, Atlanta, and Washington, D.C. EAA Board Chair Stan Skokan suggests that EAA may well find its role changing — we may take on a character similar to the various state and national automobile associations (AAA), with on-road service vehicles, insurance and discounts. Hmm. Is that where we want to go? From hobbyist club to EV advocacy organization to AAA? We may want to give it from thought. —CB

(Thanks to Mary Ann Chapman and Stan Skokan.)

APS Phoenix Electrics - World's Premier EV Race

At the 6th Annual APS Electrics, slated for March 1-3, 1996 the largest-ever field of most advanced electric cars will compete at Firebird International Raceway in Phoenix, AZ. Drawing over 15,000 spectators and EV enthusiasts, the race challenges EV technology and infrastructure under real-world conditions on Firebird's 1.1 mile road course.

Started in 1991, the race has been continuously sponsored by the Arizona Public Service Company, one of the most visionary and progressive utilities in the US. Presently organized by Electric Vehicle Competitions Limited (EVTC), the event heighten public awareness and enthusiasm for electric transportation. The APS High School Competition, and Feature Race, the central focus of the event, continues to educate hundred of students through a one-of-a-kind learning experience in EV technology that can lead to careers in the field.

Access: Mike Shaw or Don Karner at EVTC, tel. 602-256-2599, fax 602-256-2606

Ooops

News in Brief

In "Physicians testify at CARB hearings" in the January News in Brief, we incorrectly reported that half of all Los Angeles county youths have "severe lung disease because of environmental pollution." The correct statement is that they have a form of lung disease called "centryacinar region lung disease" because of environmental pollution. CE regrets the error. Perhaps some of our physician members can tell us what this means!

Thanks to Ruth Shipley.

SunRayce Report (Jan '96 issue)?

To Richard R. Rahders,

I just read your Sunrayce 95 report, and found what the University of Minnesota team always considers a major mistake when referring to Aurora-II. Aurora-II ran with a Unique Mobility motor and NOT a Solectria BRLS-8 motor and controller as you say in the document.

If you check out the team's WWW HomePage at: http://www. umn.edu /nlhome/g259 /umnsvp and look at Aurora-II information, and the technical specifications for the car, you will see we did use a Unique Mobility motor. If you have questions, please let me know, and I will be more than willing to explain this in detail.

Scott Grabow, PRODIGY: (MechE)

Dear Mr. Grabow:

The Sunrayce '95 Program data for your car said it had a Solectria drive system. I relied on this, since I had no photographic or video data on it. Goro Tamai also sent a correction. I sent your message to the editor of "Current EVents", since I assume that's where you saw the article. If you saw it somewhere else, please feel free to send your note to your source. Sorry for the error.

Very truly yours, Richard R. Rahders
PRODIGY: (FMJG65C)

Both items received from Internet, Friday, 26-Jan-96 07:41 PM.

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PHOTO CREDIT - PAGE 1

GM Publicity Photo.

CURRENT EVENTS STAFF

Managing Editor
Clare Bell
271 Molina Drive
Santa Cruz, CA 95060
Tele: (408) 469-9185
Fax: (408) 469-3714

Contributing Authors
Scott Cornell
Melissa Kasnitz
Kathy Watson
Sparkz
Richard Lane

News In Brief
Ruth Shipley

Calendar of Events
Anna Cornell

Photography Credits
Clare Bell
Jeff Simpson

Advertising & Production
Susan A. Hollis (PCTEK)
(408) 374-8605
Fax: (408) 374-8750
18297 Baylor Avenue
Saratoga, CA 95070

Article Submissions
The deadline for articles is the 25th of each month for the next issue of CE. Articles received after this date will be retained for future issues of CE.

Contact Clare Bell, Managing Editor for further information. If you would like to submit an article for CE, the preferred format is on a floppy disk, along with a printed copy of the article. Include camera-ready photos or graphics in TIFF or EPS.Please specify PC or MAC and identify software and version number.

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For information on new membership or change of address, please send your requests to:

EAA Membership
2710 St. Giles Lane
Mountain View, CA 94040

Little Juice Coupe

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EV-1 Essentials at a glance

Type — 2-seat, 2-door electric sport coupe
Size- — (approx) 14.1 ft x 5.8 ft x 4.2 ft or 4.3 m x 1.8 m x 4.2 m
Curb weight — 2970 lb/1350 kg
Airbags — 2, driver and passenger
Body — Auuminum alloy with replaceable composite panels
Performance Acceleration — 0-60 mph in less than 9 sec (fully Top speed - 80 mph (governed)
Driving range — 70 mi city, 90 mi highway
Rated motor power —137 hp/ 102 kW
Motor type — 137 hp three-phase AC induction
Controller — IGBT Three-Phase Power Inverter - 102 kW
Driveline — Direct drive to front wheels with traction control
Rated battery capacity— 16.2 kwhr
Battery Mass — 1175 lbs/ 533 kg
Charging — Inductive coupling (Hughes Magnecharge paddle) 220v, 30 A Onboard convenience charger, 110 V, 12 A
Recharge time — (from 15-95% state of charge) 3 hrs at 220 V, 15 hr at 100 V
Tires —175/65R14 low rolling resistance type
Steering — Power assist
Brakes — Regenerative plus electric-assisted hydraulic antilock ABS disk

More EV-1 Tech details

Exact dimensions — Length 169.7 in / 4309 mm
Width — 69.5 in/ 1766 mm
Height — 50.5 in 1281 mm
Wheelbase—98.9 in/ 2512 mm
Track—(Front) 57.9 in /1470 mm (Rear) 49.0 in. /1244 mm
Frontal Area —1.89 sq. meters
Drag coefficient — 0.19
Front airdam, skirted rear wheels, flush headlights,wraparound windshield
Drivetrain — Single 137 hp motor on front axle
Wheels — Lightweight aluminum
Tire size — 175/65R14
Low inflation tire pressure monitor
Low rolling resistance tires
Suspension type — Double wishbone
Body — Rigid welded and bonded aluminum alloy frame with snap-on composite plastic panels (similar to construction of present Saturn). Corrosion-free and dent resistant.
Performance characteristics—Instantaneous throttle response shift-free acceleration
Safety — Design complies with all applicable -vehicle standards
Traction control
High-voltage isolation
Climate control and passenger comfort:
Electric motor-driven heat pump
AM/FM Cassette/CD player
Solar glass
Electriclear windshield (defroster)
Cruise control
Power door and window locks
Power outside mirrors
Batteries Manufacturer — Delphi
Config — 26 modules / 312 volts total

EV-1 Availability

Price: $35,000

When: Aug-Sept 1996

At: Saturn dealerships in Los Angeles, San Diego, Phoenix and Tucson.

Produced in: Lansing Crafts Center, MI

Information line: 1-800 25-ELECT

What's changed? 1993-1996

The original Impact specifications (1993) from brochure - The Car That Plugs In

Dimensions Wheelbase — 95.0in
Length — 163.0 in
Width — 68.2 in
Height — 47.5 in
Curb weight — 2200 lbs.
Aero drag — 0.19
Drivetrain — Front-wheel drive, one motor per wheel
Type - AC Induction
Horsepower — 57 bhp @ zero to 6600 rpm (per motor)
Torque — 47 lb-ft @ zero to 6600 rpm
Motor revs at 60 mph — 9500
Top speed — Electronically governed to 75 mph 0-60 mph in 8 sec, 30-60 mph in 4.6 sec
Electronics — Dual MOSFET inverters
Max current 159 amps.RMS to ea. motor.
Max system voltage — 400 V
Frequency range — 0-500 Hz
Battery charger — computer-controlled integral with dual inverter package.
Batteries — Delco/Remy recombinant lead-acid batteries, 10 volts
Number — 32 in series
Capacity — 42.5 Ahr, 13.6 kwhr
Tires — Low rolling resistance P165/65R14
Wheels — 14X 4 in forged aluminum.
Steering — Rack and pinion
Suspension — Two control arms per wheel, coil springs, gas shock absorbers.

Little Juice Coupe

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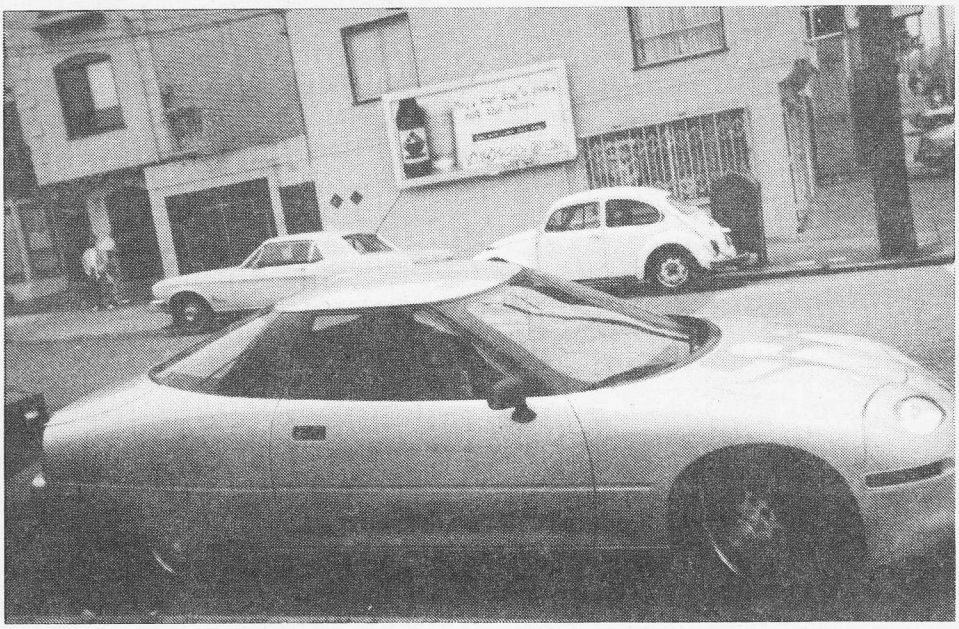
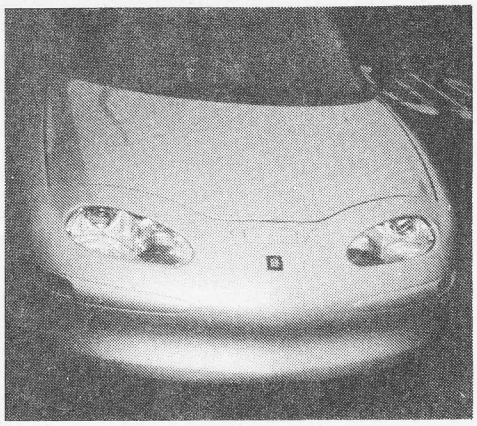


The EV-1 may look good on the track, but she's meant for running around for the city.



Eyeball to headlight with the EV-1.

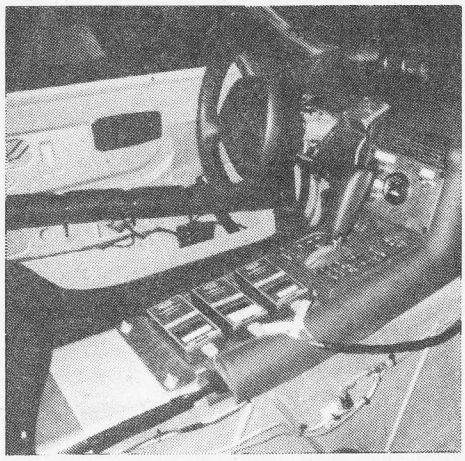
ronmental observers think so. The mandate, they feel, would have forced auto to compete in what they saw as a tiny and uncertain market. GM didn't want any competition. In the Impact, they had an EV "bulldozer" strong enough to push the ZEV mandate aside. In a San Jose Mercury News article by Matt Nauman, Patricia Patano, marketing director at J. D. Power and Associates, aptly described GM's mass-market EV position.

"If there's no mandate, then... they're the only game in town," she said.

But Mike Gage, head of CalStart, a statewide consortium of private and public companies and agencies working to develop the electric vehicle industry in California, had a different view. "I am sure that people made that argument about computers, when Apple was launched," he said. "Why would anybody go with anybody besides IBM?" Purchasers of vehicles from Solectria, AC Propulsion, Eco-Electric and other small but quality EV builders (the "Apples" of

continued on page 6

Sunny-Side Up. — The 187 mph Impact.



Sunny's stripped-down cockpit.

Little Juice Coupe

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the EV world) would agree with Gage that the biggest isn't necessarily the best.

EAA member Hugh Gribben pointed out another GM advantage in a recent Internet post. "I don't think that the conversion of existing Chrysler minivans and Ford pickups have the same mass market appeal as a purpose-built sexy EV."

Bruce Parmenter, the Internet EV Discussion List Editor, suggested that GM may have given its plug-in pony an earlier push out the gate because of competition from sources other than its Detroit compatriots, Tokyo or Europe. Fiery little Solectria of Boston, MA was breathing hard down GM's neck with their new four-seater Sunrise, the 238-mile (on one charge in its nickel-metal hydride batteries) Tour de Sol winner. (See "Sunrise!" CE, Sept '95).

The Detroit giant might have also been eyeing ex-GM exec Robert Stempel, who has made rumbles about starting up his own company to build EVs (Wall Street Journal, 1/25/94, P-B10). Now working closely with Ovonic Battery Co. in Michigan, Stempel guided the development of the Impact and the contract of its design to AeroVironment while he was still at GM.

EV1 Launch Contradicts CARB Testimony

The Santa Monica-based Coalition for Clean Air was delighted by GM's action. Executive director Linda Waade noted that GM's EV-1 announcement contradicted the car companies' summer-long nay-saying about the viability of EVs. She expressed the attitude of many in the EV community when she stated, "(GM's) announcement today flies in the face of what they've been testifying to in these (CARB) workshops."

Testimony in the workshops revealed that the automakers, despite their negative stance, are much further along toward producing EVs that they would have the public believe. They were playing a two-pronged game, blustering and bluffing against EVs to the tune of $2.1M (budgeted for the AAMA's ant-EV campaign) while at the same time, scrambling to develop them. This was especially true with GM, who probably could have launched their prototype as early as 1994, but chose instead to use it as a battering ram against the Air Board's ZEV mandate.

Rollout Honors Father of CA ZEV

Los Angeles City Council member Marvin Braude, instigator of LA's clean car program and a long-time EV proponent, looked on as GM rolled out a red EV-1 during the Jan 6th LA Auto Show. The councilman and the car are both veteran campaigners in the fight for Zero Emission Vehicles (ZEVs) in California and other states. GM's announcement in 1990 that they would produce the AeroVironment-designed EV lent credence to Braude's vision. It led to a surge of popular and political support that resulted in CARB's ZEV mandate. Ironically, the EV-1 has become GM's bargaining chip in a deal to undercut ZEV.

Braude, whom many consider the father of the present California ZEV effort, said "I'm going to buy it. I'm ready today to give them a check to buy or lease it." He believes many others will join him despite the EV-1's $35,000 price tag.

A PC on Wheels

Auto analyst Kenneth Blaschke at Dean Witter Reynolds in San Francisco, feels that the EV-1 will appeal to style- and image- oriented upscale buyers who want to make an environmental statement. "This is a unique car, so people who buy these will be instantly recognized as electric car enthusiasts." EAA member Bruce Parmenter, in a post to the Internet EV Discussion List, added, "It will become a "status car", such as the Cadillac....This is the jump-start that will get the cost of EVs and batteries down."

GM's president of R & D, Ken Baker confirmed the image-marketing approach. GM chose Saturn, he said, not only because they have an outstanding dealership system, but their customer profile matches that of potential EV buyers. Curiosity may prompt these "early entry" consumers, who are involved in high technology, are car buffs, and/or environmentalists. They bought the first personal computers, VCRs and CD players. To them, the EV-1 will appeal, not just as another high-status high-performance car, but as a sophisticated "PC on wheels".

Despite the hoopla, there does seem to be some confusion about how enthusiastic GM really is. In its December 25 issue, the auto trade publication Automotive News predicted that that "General Motors will introduce the Impact electric car and will grossly underestimate demand."

Would-be EV-1 buyers include actors and other public figures. Dan Akroyd announced on TV that he intended to get one. Judge Lance Ito had already said that he wanted one. Actor/race driver Paul Newman got a kick out of one of the test cars. And rumor says that even the big-O-name has budgeted $35,000 to meet GM's asking price. Car collectors are also waiting to pounce, expecting the short-production run EV-1 to be a long-term investment. They may, however, be disappointed. If the reaction of GM's PrEView Drive program participants is any indication (GM's biggest problem was getting the test cars back!) the EV-1 won't be any rarer than the Mazda Miata.

Now EAA members, if they have the cash, can join the high-rollers in a stroll down to the nearest Saturn dealer in four western cities; Los Angeles, San Diego, Phoenix and Tucson. Those who don't

continued on next page

Little Juice Coupe

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can avail themselves of GM's credit, financing and leasing programs. These will cover the EV-1, just as any other new GM car. Walk in and roll out on non-polluting electric wheels.

According to Ken Baker, GM's vice-president for research and development, EV-1 buyers can expect the same quality and service as any new-car customer. "A real car. This is a real car," Baker said. GM is already moving to train dealer mechanics, salesmen and buy new equipment to service the cars. They are also co-operating with utilities so that EV-1 owners can place chargers in their homes and perhaps at workplaces.

Although the EV-1's racy performance positions it as a muscle-car, GM Chairman Jack Smith points out its primary purpose. "(The EV-1 is) a car designed for people — to commute, to shop, to run around town. And it's a car for people who never want to go to the gas station again." —CB

Alex Barnum, "GM to Sell Electric Cars In California This Year", PAGE ONE section, San Francisco Chronicle, 01/05/96

Matt Nauman and Pam Kramer, "GM to market electric cars for $35,000" 1/05/96, San Jose Mercury News

E. Scott Reckard - "GM to Offer Electric Sports Car at about $35K this Fall" Associated Press 01/05/96

GM Newsline - 1/08/96 - "Trade Mag Says GM Will Grossly Underestimate EV Sales"

Thanks to Bruce Parmenter, Steve Lough, Hugh Gribben and all members of the Internet EV Discussion List.

EV TERMS AND ACRONYMS

By Clare Bell

AAMA *- American Automobile Manufacturers Association*

APU *- Auxilary Power Unit. A small internal combustion engine that combines with the electric drivetrain to deliver power to the wheels. APU's are run at constant RPM for greater efficiency. They can be mounted onboard or on towable "power trailers" that can be attched to a pure EV to make it into a temporary hybrid EV or HEV*

Battery or traction pack *- Individual batteries cabled together to form a larger energy-storage system.*

EV *- Electric Vehicle. Any vehicle powered by an electric motor. Power is usually stored onboard by means of batteries, although an EV can be powered totally or in part by fuel cells, flywheels or solar cells.*

Battery *- An electricity storage device composed of individual electrochemical cells that are interconnected to increase their energy storage capability. A grouping or "battery" of such cells form the device.*

California Air Resources Board (CARB or ARB) *This 11-member panel is part of the California Environmental Protection Agency. It is supposed to be an independent scientific advisory board to the governor and the legislature. As part of a state agency, it can make mandates and enforce them. See "California Air Resources Board", pg 8, this issue.*

Conversion *- A production car modified into an electric vehicle. This is done by removing the engine, exhaust system, tailpipe, fuel tank and fuel lines. They are replaced with an electric motor, controller and batteries. In most coversions, the electric motor drives the wheels through the original transmission or gearbox*

ICE *- Internal combustion engine. This includes gasoline, ethanol, methanol methane and natural gas-burning engines.*

Hybrid, Hybrid EV or HEV *- A vehicle that uses two power sources, one internal combusion, one electric. In a series hybrid, the IC engine runs at constant RPM to charge the batteries, which power the electric driveline. In a parallel hybrid, both powertrains drive the wheels directly. Some hybrids have one axle driven electricially, the other by the ICE and the driver can choose which one is operating. Others combine power in different ways, such as "on-demand" ICE plus continuously running electric.*

LEV *- Low Emission Vehicle - usually a gasoline car with pollution control devices (catalytic converters).*

Parallel connection *- components, usually batteries, linked one beside the other.*

Regen *- Regenerative braking. Running the electric motor as a generator to recover motion energy and put it back into the batteries. It combines with regular friction brakes to slow the vehicle and helps conserve battery power.*

Series connection *- components, usually batteries, linked one after the other.*

ZEV *- Zero Emission Vehicle - A vehicle that produces no tailpipe emissions during operation. At this time only electrics qualify as ZEVs*

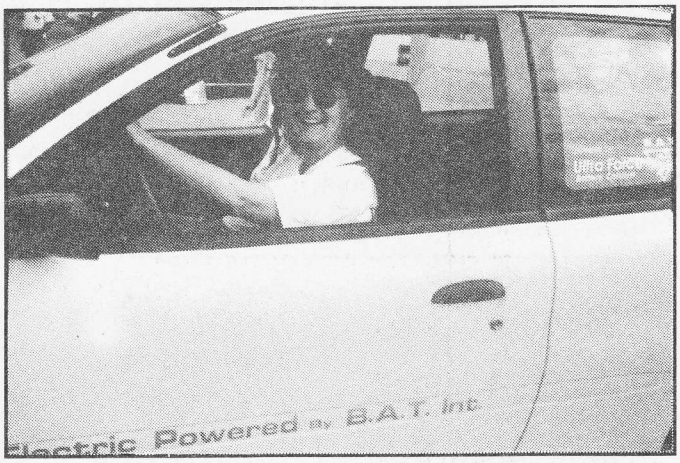
ZEV Mandate *- This California law was enacted in 1990 by the Air Resources Board as an air pollution control measure. It requires all carmakers who sell more than 30,000 vehicles per year to make 2% of those ZEVs by 1998, or pay fines of $5K per EV not supplied. That law has been under siege by auto and oil companies and its fate is uncertain.*

Thanks to Dan Mollecker, who pointed out the need for this reference . — CB

Phoenix Clean Air Expo '95

By Kathy Watson, Phoenix Chapter

Clean Air Expo '95 was a tremendous success, October 21 as Phoenix residents enjoyed the last hot day of the season. Thanks to the quick thinking of Phil Terry, Tom Huettle and Kent Johnson. With only a few weeks of preparation, they managed to provide an EVent that was enjoyed by all. The EV scavenger hunt race has become a popular theme for EV events and understandably so, as it is a challenging adventure and always proves to be FUN.



Kathy Watson takes a spin in an electric Geo.

The participants in "Midday Madness" were given staggered departure times which provided a wide variety of display vehicles the entire day. Twenty-four electric vehicles in all graced Chris Town Mall. The public was asked to vote for their favorite EV in three categories; private, high school and corporate. Picking just one proved difficult for most people.

George Drum's beautiful 1966 Ford Mustang was voted best of the show in the private division. And Sandra Terry gave George some hot competition with her sharp white 1965 Corvair. The high school division had a great number of EV conversions for the public to examine. And winning the popular vote was Marcos de Niza High School with their 1987 Suzuki. The corporate crowd pleaser was no surprise; the Salt River Project Ford Probe took best in its class. It seems that racecars, even when sitting still, have mass appeal.

Contestants in the "Midday Madness" scavenger hunt were given the most bizarre riddles to decipher in order to find their next destination. Tom and Diana Convey blazed the course in record time in their sweet efficient 1985 Chevy Sprint. Tom and Diana plan to do a second EV conversions soon to take to the races. No doubt Tom has been practicing the race car driver mentality.

First place Central High School had tough competition as they narrowly beat out second place Cortez High School and third place Camelback High. And Jesse James was on hand to provide comic relief as always. With his son as navigator and Jesse firmly behind the wheel, the #84 Karmann Ghia set the course's new record for the longest trip time. And don't forget, Jesse, as Gene Cosmano always says, "If all the losers stayed home, there wouldn't be any winners!

Thanks to all the participants. Let's do it again next year!

Kathy Watson, EAA, 1131 E. Flint St. Chandler, AZ 85225 (602) 821-0646

California Air Resources Board

California began reducing its air pollution in 1955, long before the rest of the the nation. The Bureau of Air Sanitation set the state's original air quality standards by first identifying health-threatening pollution levels. Upon recognizing cars and trucks as a major smog source, the state formed the Motor Vehicle Control Board in 1960 to regulate tailpipe emissions. By 1967, a year before the rest of the US adopted it, over one and one-half million California cars had pollution control technology.

In 1968 the State Legislature combined the above two agencies to create the Air Resources Board (ARB or CARB). The task of establishing air pollution's health threat and regulating its causes were united in a single organization. Since then, in partnership with county and regional air pollution control agencies, the ARB's program has evolved into one of the world's most comprehensive. To enforce its own more stringent air quality rules, California adopted its own Clean Air Act in 1988. The Air Resources Board continues to set and enforce the Act's air quality standards.

The ARB also:

- monitors air quality
- provides technical expertise to local air pollution districts
- operates a broad air pollution research program
- provides compliance assistance for small businesses
- produces educational and outreach programs and materials.

The Air Resources Board's 11 members are appointed by the Governor. Five are experts in fields such as medicine, chemistry, physics, engineering, business, and law. Five others are elected officials who represent county and regional air pollution control districts. Of these five, four represent the state's

continued on page 15

More EcoElectric News ! !

Desert Lightning™

EcoElectric's electric pickup is now in series production. It features COLD, efficient air-conditioning, power steering, optional automatic transmission, and tested, reliable DC technology.

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Blue Sky Motors

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INTERNET

World Wide Web Home Page: *http://www.primenet.com/~ecoelec*
Desert Lightning Information: *http://www.primenet.com/~ecoparts/desert.html*
On-line Components Catalog: *http://www.primenet.com/~ecoparts*

ECOELECTRIC COMPONENTS SALES are now handled by email and the World Wide Web.
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Charger GFI Tripping in Jet Escorts

By Dorothy Bradley and Clare Bell

In the early eighties, a company called Jet did commercial conversions of Ford Escorts. Jet built about three thousand of these cars. Ford supplied gliders (engineless cars) while Jet installed the 96 V electric drivetrain. It consisted of a Prestolite motor and an early version of the Curtis controller. These cars were sold mostly to government motor pools, whose personnel didn't want to understand or bother with them, so they sat around and the batteries sulfated. As a result, they were sold off cheaply, many to EAA members.

Good Learner Cars

The Jets are sturdy, well-performing little cars, ideal for short or mid-distance commuting. The shocks and springs have been properly modified to take the extra battery weight. Tough and forgiving, they are an excellent "learner" car for beginning EV-ers. Many come with fairly complete documentation, or a number of EV businesses have the original manuals and can copy them.

Jet Upgrades

The original charger and controller seem to perform fairly well, although the early Curtis does make a 4KHz whine. A common upgrade among Jet owners is to replace the old heavy 220/110V onboard charger with a more modern type, commonly the K and W Engineering BC-20.

The BC-20 incorporates a GFI or ground fault interrupt device. The GFI looks at amperage on both sides of the AC input lines and if it sees a difference of as little as 5 ma, it shuts off (interrupts) the charger. The GFI trips when it sees a low resistance path to ground, thus not allowing the charger to operate if there is a possible short from the traction pack to the body. Intended as a lifesaving safety feature, the K and W's GFI can be a royal pain if it trips repeatedly and you can't charge your car.

In wet weather, repeated GFI tripping can often be caused by moisture plus an accumulation of acid on battery tops. A careful inspection followed by a bicarbonate wash, dry and airing out can resolve the problem in some Jets. In others the problem is more deep-seated and stubborn, as was the case with a brown Escort belonging to Dorothy Bradley of Palo Alto, CA

A Snappy Ginger

"Gingersnap" or "Ginger" for short, had recently undergone an upgrade consisting of battery replacement, DC/DC converter installation, battery box repair and charger replacement. She was running fine after that, except for a tendency to give a mild zap to whoever was working on her front batteries. This happened when the mechanic's elbow touched the body or battery box while the fingers were on the battery terminals. The result was a strong "buzz" along the forearm; not strong enough to burn, but a good tingle. For some reason Ginger didn't zap Dorothy, but seemed to take mischievous pleasure in getting Clare.

Ginger's GFI often shut off in mid-charge, requiring two or three resets before the car was fully charged. This was bearable in warm dry weather, but as soon as the fall rains started, Ginger refused to charge. Battery-top descuzzing failed to resolve the problem, as did checking the wiring, the controller and other electrical parts. The mechanic-zap problem continued, though the car never got Dorothy. Maybe she was less conductive. (Or more careful.)

After nearly two weeks of chasing this bug (with Ginger sitting in the driveway, and Dorothy driving Ginger's gasoline-powered twin, a Mercury Lynx), we were about to give up and reinstall the original charger. Then Dorothy found out what was going on.

Diagnosis

Ginger's problem lay in the EPO, the Emergency Power Off. This is a cable-pull device used to kill the electrical system should anything happen. It interrupts the high-voltage traction circuit, cutting off the batteries and shutting down the motor. In Ginger, the EPO interrupt was simple and low-cost; a knife-switch type consisting of a mechanic's clamp mounted on a non-conductive phenolic base. A yank on the cable opened the switch.

The switch itself was live, which was normal, because it had to be. However, the pull cable itself was also carrying current, although it wasn't supposed to. What had happened?

Actually two things. The mechanic's clamp switch should have been isolated from the actuating cable by a plastic bushing. This bushing was worn and had developed cracks and holes. The EPO cable itself passes through the front firewall of the body and through another plastic bushing. This one guides the cable and isolates it from the body metal. It had also worn out.

Ginger had developed a conductive path from the mechanical cutoff switch, through the first failed bushing to the pull-cable, and through the second failed bushing to the body. Not quite a direct short, but a path with low enough resistance to cause problems. The EPO plastic pull-handle protected Dorothy from the live cable, so she couldn't tell directly that anything was wrong.

Repair and replacement of both isolating bushings resolved both the GFI tripping and the zap problem. Ginger was promptly charged up without further fuss and went back into service the next day.

Check the Bushings

If you have a Jet Escort, Omni or similar Jet conversion, we recommend that you inspect your EPO linkage carefully and replace or repair any worn or cracked plastic insulators or bushings. Even if you don't have a GFI built into your charger, bushing inspection and

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Q: Should I Solder Lugs To Cables?

Contrary to popular opinion, no. If you could use industrial soldering equipment, you could get a connection that would be a little bit better at conducting electricity. The equipment heats both lug and cable uniformly to achieve a good joint. However, with equipment available in your home shop, you can't get this level of quality. If the lug and cable aren't evenly heated, a "cold joint" can result. This can cause resistance and heat, leading to damaged insulation, and–possibly–melted battery terminals.

In addition, solder can wick up the copper strands, making them stiff and brittle. Finally, the solder drain hole in the lug can let in moisture to cause corrosion. I have seen these things happen, even in professionally soldered lugs.

The better alternative is a properly crimped connection. This includes: an an anti-corrosion compound inside the lug; the stripped copper cable end inserted deep inside the lug; a deep crimp made by a proper crimping tool; and a section of heatshrink tube over the joint. I have never had a failure from this type of crimp, and they show no corrosion, even years later.

One type of crimper looks like a big set of bolt cutters, but it is awkward to use. I prefer a small tool with a cradle for the lug and a spring-loaded punch in a guide sleeve. It works.

Send your questions to Mike Brown's EV Q&A, POB 1113, Felton, CA 95018 or fax (408) 429-1907. Include address for reply. Mike Brown has 28 years of professional automotive experience, & 16 years of professional conversion experience. His book, "Convert It", is available for $30.00 postpaid in the U.S. & Canada.

Battery Comparison Comparison

by Scott Cornell, CE Tech Editor

Why test batteries when battery capacity data is readily available from battery manufacturers? Battery capacity as specified by most manufacturers is usually in ambiguous automotive terms such as Cold Cranking Amps (CCA) and Reserve Capacity (Min @ 25 A). For true deep cycle batteries, capacity is most often specified in Minutes At 25 Amps at 80 Deg. F, Minutes At 75 Amps at 80 Deg. F, or Amp-Hours at the C/20 rate at 80 Deg. F (how many amp-hours you can get out of it if you discharge it continuously so that it is just becoming dead at 25 hours at 80 Deg. F). None of these ratings can accurately predict how a battery will perform in an EV, since we rarely discharge batteries at the C/20, 25 amp, or 75 amp rates, and we rarely keep the batteries at 80 Deg. F (except, of course, in sunny California in the summer). What was needed was a level playing field upon which to compare batteries in conditions in which we are likely to use them. Besides, I was tired of hearing people argue about which battery was better when they were often comparing apples and potatoes.

Conditions used in testing batteries and why these conditions were chosen:

- All batteries were of Lead /Sulphuric Acid type (since most of us can't afford other types at this point)
- Batteries were fully charged to manufacturers' specifications before each test (reasonable)
- Batteries were discharged at 70 Deg. F. (more reasonable than 80 Deg. but not cold enough for northern folks in the winter, I know)
- Batteries were discharged at 100 Amps, resistive load, continuously (I've been driving EVs for 15 years, and when I am a little bit concerned with range, I can usually keep the current drawn from the batteries around 100 Amps (90 and 96V vehicles))

TABLE 1

Battery	Weight(ea)	Size (L-W-H) in.	Cost(mine,incl. tax)
Eveready 27-EV	53 lbs	30.30 x 5.05 x 5.22	$ 46.00
Gates G12V190W15SP	34 lbs	7.75 x 6.5 x 6.5	$135.00 (est)
Horizon 12N85	49 lbs	30.30 x 5.05 x 5.22	$ high and var.$
Optima 800S	42 lbs	10.0 x 6.75 x 7.75	$ 92.10
Trojan T-125	64 lbs	10.25 x 7.0 x 11.0	$ 69.26
Trojan 5-SHP	87 lbs	13.5 x 6.75 x 11.75	$165.25
US Energy 1450	86 lbs	13.5 x 6.75 x 11.75	$135.64
US Energy 2300	64 lbs	10.25 x 7.0 x 11.0	$46.00

- Test was terminated when the battery terminal voltage reached 10 Volts (usually, the voltage is dropping very rapidly at that point, and a vehicle using the batteries would soon have to stop and "grow a few kilowatts")

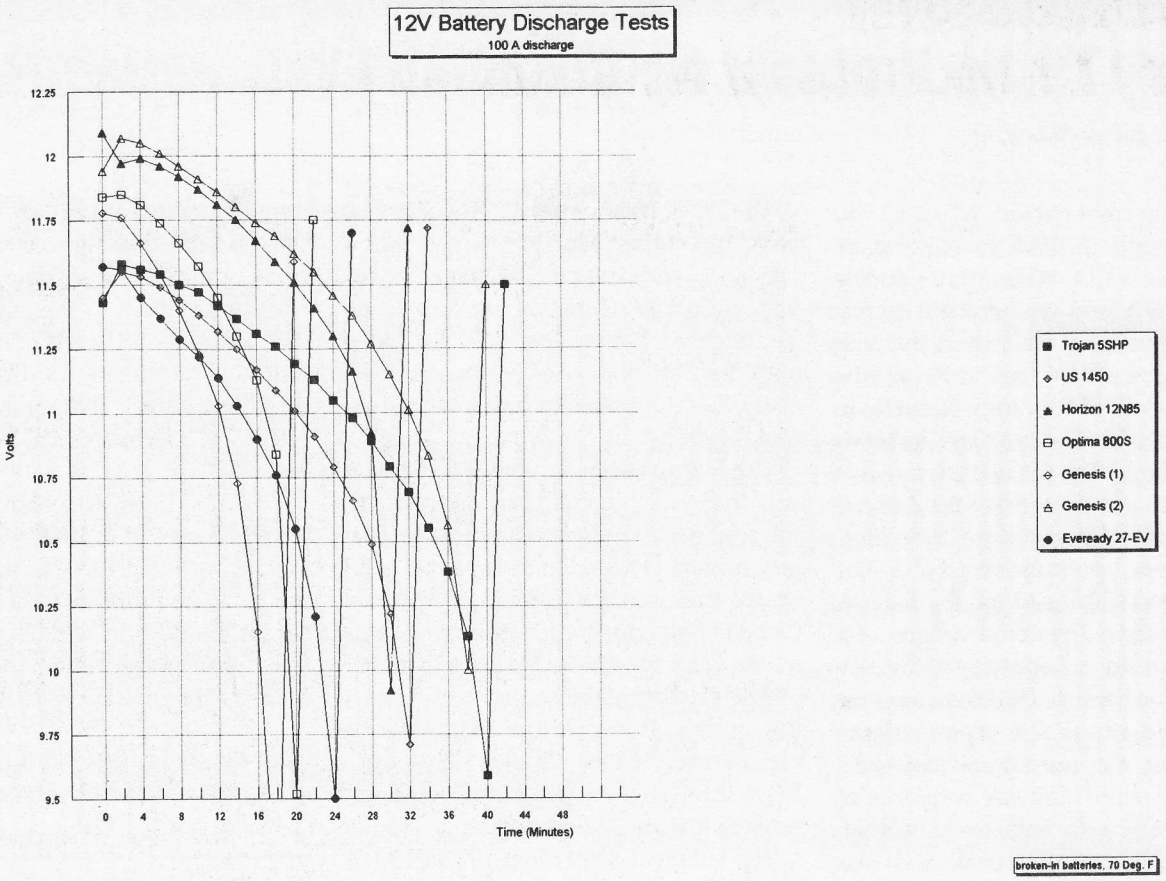
The final data point shown is the non-loaded voltage to which the battery recovered after having the load removed for 2 minutes (can be used to judge how dead the battery really is, and if it would have the capacity to take you a little farther if you waited 20-30 minutes for the charge to equalize through the plates)

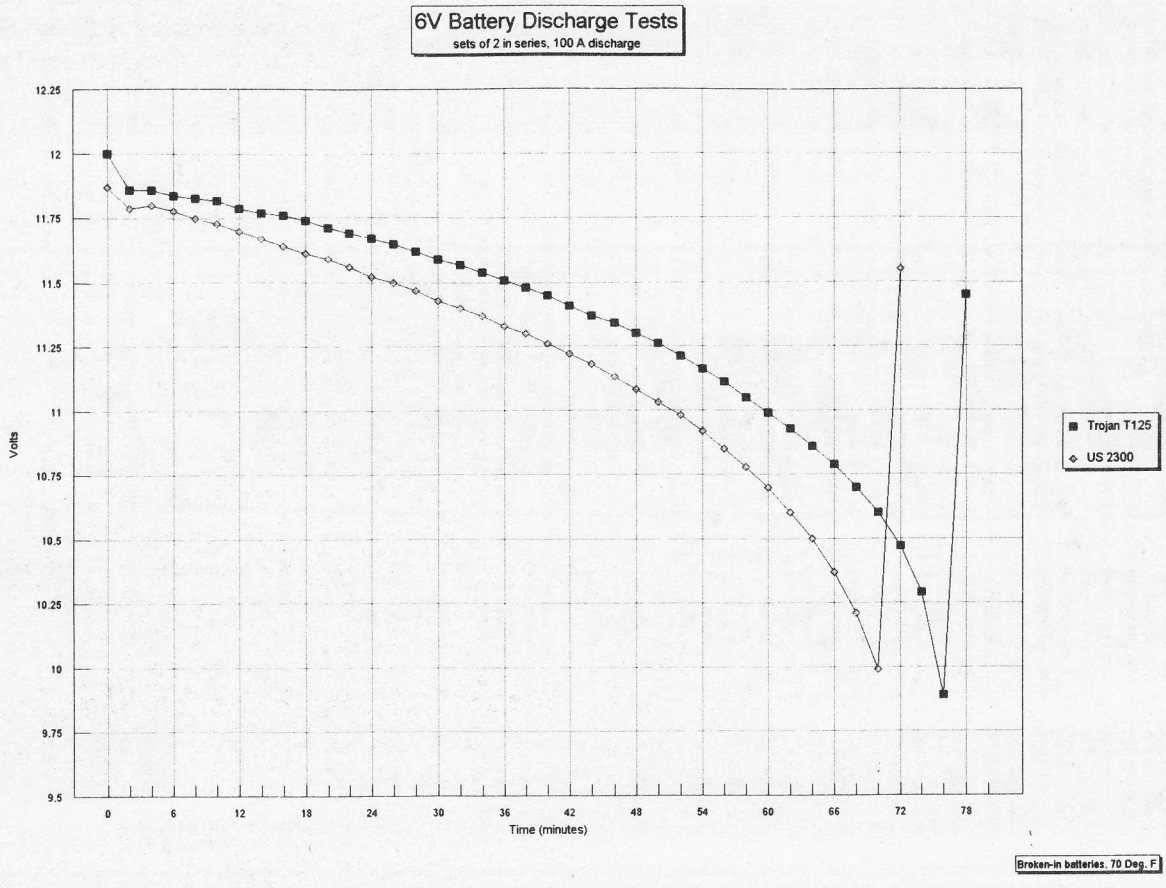
- Data points were taken every 2 minutes (I don't have an automatic data acquisition system, but I do have a stopwatch and a voltmeter) o 12 Volt batteries were tested alone (except for the Hawker Genesis (Gates), since it is often used in parallel strings, single and parallel data were both collected)
- 6 Volt batteries were tested with 2 in series to make a 12 Volt set (so I could use the same test loads at the 12 Volt batteries)
- Results shown are for batteries that were broken-in (around 50 cycles for the 6 Volt and big 12 Volt batteries, and around 10 cycles for the rest of the 12 Volt batteries. I considered them broken in when the batteries stopped showing a marked increase in capacity within a few cycles)
- The batteries that were tested were either purchased ($ouch$) or borrowed from someone with no vested interest in the outcome (usually other nice EV people, no manufacturers or distributors)
- No data is given for the number of cycles expected from each battery (I didn't have the time, patience, or funds to destroy that many batteries, and some of them weren't mine anyway. Manufacturer's data for cycle life was good enough for me).

Refer to Table 1for aome other data that graphs don't show well:

Special Thanks

I would like to give special thanks to the folks who loaned me a few of the batteries, and especially to my wife, Anna, who didn't complain too much when I spent hours and hours with the batteries (taking up space on our fireplace hearth) instead of with her.


12V Battery Discharge Tests
100 A discharge
Volts
Time (Minutes)
Trojan 5SHP
US 1450
Horizon 12N85
Optima 800S
Genesis (1)
Genesis (2)
Eveready 27-EV
broken-in batteries, 70 Deg. F


6V Battery Discharge Tests
sets of 2 in series, 100 A discharge
Volts
Time (minutes)
Trojan T125
US 2300
Broken-in batteries, 70 Deg. F

Minus 17°? No Problem for Canadian EVs!

by Author by Richard Lane, Electriv Vehicles Council of Ottowa

During the period of Oct. 10 through 13, 1995, two members of EVCO (Electric Vehicle Council of Ottowa) were invited to test the effectiveness of the battery heating systems installed in their EVs at the Environmental Technology Centre in Ottowa, Ontario, Canada. The test was designed to establish the normal range at 20 degrees C and then freeze the cars to -17 degrees C and compare the range obtained using the same test cycle. The test cycle used was the EPA FTP-75 LA-4. This is the electric powered version of a standard hybrid vehicle test program. This cycle consists of a 12 km urban trip which would simulate a typical trip to work. There are numerous start and stops and a short highway sequence at speeds up to 90 kph. Each cycle was followed by a 10 minute break and was repeated until the batteries showed an 80% discharge. The equipment used was the same dynamometer that are used to establish fuel mileage ratings and emission standards for all new vehicles sold in Canada.

The EVs used were a 1986 Pontiac Fiero owned by Mr. Fred Green and a 1987 VW Jetta owned by Mr. Richard Lance. Both conversions were done by Mr. Richard Lane using 96V DC deep cycle lead-acid batteries enclosed in specially-designed battery boxes with thermal heating.

The Fiero had a hot range of 57.5 km. It was then fully charged and moved into the cold room, parked with only the battery heaters plugged in for a period of 18 hours, then run for a range of 52.9 km. Only an 8% reduction! Performance was a little sluggish during the first cycle but improved during the second and following cycles. This confirms Mr. Green's experiences, having driven his electric Fiero through two winters at temperatures as low as -27 degrees C.

The Jetta had a hot range of 76.8 kM. It was moved into the cold room and then charged with the battery heaters turned on. After 18 hours at -17 degrees C, a range of 77.0 km was achieved. It was then recharged without the battery heaters being activated in order to test the temperature drop of the batteries. This simulated being parked when away from home. After 20 hours at -17 C, a total of 42 hours in the cold, a range of 76.7 km was achieved. This represents only a 0.4% variation in range over the three test runs. Temperature had little effect on performance and none on range.

The test was conclusive. With the proper design of the battery boxes, selection of an efficient drivetrain and cold temperature lubricants, the electric vehicle can be used in winter climates without major range reductions claimed by many of the opponents to EVs.

With thanks to EV Circuit, the newsletter of the Electric Vehicle Council of Ottowa (EVCO)

For more information, please contact: Richard Lane, Electric Vehicle Specialist (conversions and fabricating) 249 Anna Avenue, Ottowa, Ontario, K1Z7V4 (613) 722-9939

CA Air Resources Board

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largest metropolitan areas: Los Angeles, San Francisco, San Diego County and the San Joaquin Valley. The other member may represent any other air pollution control district. The only full-time member is the Chair. All members are appointed by the Governor and serve at his pleasure.

Controlling air pollution in California is shared between the state Air Resources Board and 34 county and regional air quality agencies which are primarily responsible for controlling emissions from industrial facilities. These agencies look to the ARB for technical expertise or special testing equipment when needed.

Access: P.O. Box 2815, Sacramento, CA 95812. (916) 322-2990

Charger GFI

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replacement is a good safety precaution and should probably be a standard part of Jet upgrades.

The phenolic base of the knife-switch can also get crudded up with conductive gunk, and behave just like a dirty battery-top. Clean it up too. Any low resistance path can develop into a short, giving you a real wakeup call when you touch your car. (FYI: battery-to-body shorts can happen in gas cars too; CB remembers backing up to a '64 Opel Kadett with a live body and getting a love-tap on the rear that made her jump six feet.)

For a more permanent fix, one could replace the mechanic's clamp knife switch with a hefty DC circuit breaker, as used in many conversion kits. An equally effective, and perhaps cheaper solution would be to install a nonconductive short plastic bar or rod as a isolating linkage between the knife switch handle and the actuating cable, as shown.

By doing that simple little task, you can tame your gingery Escort. It will charge willingly and won't joybuzz anyone.

Both authors are curious about the incidence of GFI tripping problems in refurbished Jets. Does your car behave like this? Did you fix it and if so, how? Send replies to "Ginger", c/o Current EVents at the editorial address. Happy Escort-ing! —CB and DB

ACTION NEEDED!

CARB Again...Crisis

By Melissa W. Kasnitz, California Public Interest Research Group (CALPIRG)

Hi, EV supporters. Once again we need some action from you. Word leaked out of the negotiating sessions between the automakers and CARB indicate that the car companies are writing their own ticket. The latest drafts of the proposed agreement contain no ramp-up toward the 10% in 2003 goal, no premium for reduced emissions, minimal penalties if carmakers do not comply — in short, everything that the automakers want, with NOTHING in return.

Please express your concern about this giveaway. CALL, WRITE, or FAX Governor Pete Wilson andAir Resources Board Chairman John Dunlap. You can reach them as follows:

Wilson

State capitol; Sacramento, CA 95814; phone 916-445-2843; fax 916-445-4633; 24 hour voice mail 916-658-2793

Dunlap

Air Resources Board; PO Box 2815; Sacramento, CA 95812; phone 916-322-5840; fax 916-327-5748; email: webmaster@www.arb.ca.gov

Even if the mandate itself cannot be preserved (or even if you were not much of a mandate fan), this proposal destroys all support for electric cars while contributing to environmental and economic harm in California.

Please let them know you oppose this measure. —MK

Received from Internet, Wed, 24 Jan 1996 14:53:45 -0800 from <mkasnitz@WESTMX.WESTMONT.EDU>

THE ANTI-ZEV CAMPAIGN

Money Talks; Is California's Clean Air For Sale? Fact sheet from CALPIRG

Lobbying/Campaign Contributions - 1994-1995

$9.2 M for oil industry lobbying in California
$1.9 M for auto industry lobbying in California
$1.1 M for campaign contributions to state legislatures by oil industry
$276,000 for campaign contributions to state legislators by auto industry
$325,000 in contributions to Pete Wilson by oil industry
$74,000 in contributions to Pete Wilson by oil industry
Total: Almost $13 M ($12.89 M)

Studies:

$250,000 for RAND report
$50,000 each for Sierra Research Studies (2) and DRI/McGraw-Hill study
$140,000 minimum industry contribution for Carnegie-Mellon study.
Total: $540,000

The PR Campaigns

$1 M from WSPA to Woodward and McDowell
$416,000 by WSPA for PUC Working Group
$2.5 M budgeted from AAMA to Cerell and Associates ($750,000 spent)
$590,00 by Chevron on direct mail to Chevron credit card holders
$26,000 by ARCO for lobbying newspaper
$2,000 by Unocal on direct mail
$35,000 by California Manufacturers Association (CMA) for polling and direct mail
Total: $4.5 M

The Advertisements

$3.5 M by Mobil Oil (TIME, Newsweek, New York Times)
$46,000 by "Ratepayer Revolt" funded by WSPA (SF Chronicle)
$280,000 by AAMA (Boston Globe, Boston Herald, NY Times, Wall Street Journal)
$450,000 by AAMA on radio (LA, SF, Sacto, Boston, Albany, NY)
Total: $4.3 M

Lobbying outside of California

$372,000 in New York by oil interests in 1994
$355,00 in Massachussetts by oil interests in 1994
$326,000 in Massachussetts by oil interests in 1994-95
$67,000 in Massachussetts by auto interests in 1994-95
$430, by AAMA for PR program in the Northeast
Total: Over $1.5 M ($1.55 M)

GRAND TOTAL: APPROXIMATELY $24 MILLION

Summarized from "No Clean Air for Christmas", a complete report on the selling of California's ZEV program. Includes contributions by Union of Concerned Scientists, CALSTART, Natural Resources Defense Council, Environmental Advocates of New York and others. For copies of the study, write to CALPIRG, 1129 State St., Santa Barbara, CA 93101.

CALPIRG Legislative Office - (916) 448-4516, fax (916) 448-4560

The action that CALPIRG is documenting are massive examples of what used to be called "Corruption". Aren't there laws against this sort of thing? If you don't like it, use the numbers above. WRITE letters and FAX them to Wilson and CARB. —CB

An EV in the Hand

By Sparkz

(This is Part 2 of the article that ran in the previous (Jan '96) issue

Motor-to-Transmission Adapters

Most EV conversions utilize the clutch and tranny, because they happen to be conveniently there. The most common conversions use an adapter plate that bolts the electric motor to the transmission case. The clutch in a gas car is located inside the flared end of the transmission case ("the bell housing"). The adapter plate connects the transmission to the electric motor plate and also allows the clutch to operate.

The adapter must ensure that the shaft from the motor and the shaft from the gearbox stay in-line (concentric). If not, one shaft will wobble with respect to the other, creating vibrations that become destructive at high RPMs and create rapid self-disassembly (read as "the whole thing comes apart"). Adapter plates, therefore, have bushings or bearings that hold the two shafts in line while allowing the clutch to couple and decouple them.

Motor-to-transmission adapter plates are the trickiest part of doing an EV conversion. It is much easier to buy one, since they are available for nearly all types of cars. Most EV conversion kits include adapters.

Batteries and Wires

How does the mini-to-maxi EV scale-up affect batteries and connections? Look at your mini-EV again. The cells in your countertop pocket rocket each have have 1.5 volts worth of push; all lined up, they deliver anywhere from 6 to 9 volts. That's plenty to spin the tiny motor, and it only needs a one-fourth to half an amp of electrical current. The little wires can carry this easily.

For a full-size Chevy Blazer or Ford Escort, you are into the 96-120 volt range. That means a lineup of more and bigger batteries. The larger batteries come in standard voltages, including 6, 8 and 12 volts. They have to be rechargeable, since they are too big and expensive to chuck in the trash (not a good idea, even with the small ones). The sixes are most common, although there is a growing shift to 12s. Like batteries in a mini-EV, big batteries get run flat, so they have to be able to take it repeatedly. Batteries designed to recover from deep discharge are called traction batteries. They are made for industrial trucks and golf carts and adapt very well to use in EVs. Both mini and maxi EV batteries are mostly the lead-acid type. Other types are also in use, but we'll talk about them in a later column.

Car starting batteries are a different animal, called an SLI or Starting, Lighting and Ignition battery. They are designed to deliver a short, high-power burst ("cold cranking amps") and then be recharged by the alternator. Repeated deep-drawing kills SLIs quickly. Since they are light and high-powered, SLI's often show up in EV race cars, but after a few rounds they are dead lead.

Wiring also scales up in size. From slender hookup wire in the mini-EV, we go to heavy welding cable with crimped on lugs. These lugs usually bolt to battery terminals. Now the maxi-EV's circuit can handle the 96-144 volt "push" and the 100-400 amp current flow.

OK, now we've got the power source and wiring scoped out for both mini and maxi-EVs. Next comes control, which means how much power gets to the motor and when.

Early EV Control: Switches and Resistors

You can run a big EV the same way as little one: simply by closing a switch. A number of electric boat racers just a big hefty knife-switch — slam 'er down and hang on! My friend, "Thousand-Amp Fred", swears by it. The big knife-switch way works. And it's certainly one way to spin your tires in the parking lot. In the low-speed, low-powered electric buggies of 1905, it worked quite well. But as the greed for speed lead to more powerful systems, the ol' all or nothing switch approach got dicy. At higher voltages, switches arced and burned. And the jerk at takeoff could whiplash the strongest of necks.

EV designers tried to solve the problem by adding a device that controlled the amount of current going through the wire by making the current work harder to get through. This device is called a resistor, because it resists the flow of current. (For you A-trackers: Think of your bunch of racehorses hurtling down on the track, getting squeezed down into a single lane or a tunnel. They'll jump around and bounce off each other and things will start getting pretty wild and hot. They'll also have to slow down. That is what a resistor does — slows down current by turning it into heat.)

Resistors can be made so that they can vary how much they impede current flow (just like narrowing or widening our tunnel so the racehorses speed up or slow down) Some Early EVs used huge variable resistors called rheostats while others used networks of large resistors interconnected by switches. Still others tapped the battery pack at different points to get different amounts of "push" (voltage) to the motor. One of my first EV rides was in a Morgan replica kitcar that used resistor switching and battery tapping. It was a lively, if rough-riding little beast.

Enter the Chopper Controller

Spoiled by their exposure to gas cars, which gave continuous power output as the accelerator was depressed, EV drivers and designers turned to alternatives. Dissipating current through a huge rheostat or a resistor network ate up a lot of energy and generated heat (though a

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News in Brief

Compiled by Ruth Shipley

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

Solectria Doing a Brisk Business

Solectria Corp. attributes a marked increase in sales activity in the fourth quarter of 1995 to the sterling performance of two of its vehicles. A 1996 Solectria Force equipped with Ovonic nickel metal hydride batteries was the only sedan that passed a month-long test by the EV America program, a nationwide effort coordinated by the federal government and the utility industry. The Force traveled more than 105 miles on a single charge at 45 mph and traveled 85 miles on a single-charge in mixed highway/city driving. The Solectria E-10 pickup truck, now entering its third production year, also passed tests of acceleration, range, handling, stopping ability, charging ability and more. For more information, contact Karl Thidemann at 508-658-2231.

(Solectria Release: 12/04)

GM Ovonic Wants to Cut Cost of Battery

In an effort to make EV batteries less expensive, former GM Chairman Robert Stempel will become a full-time consultant for Troy, MI-based GM-Ovonic, a joint venture that is developing nickel-metal hydride (NiMH) batteries. EVs equipped with NiMH batteries have achieved significantly greater ranges than vehicles with conventional lead-acid batteries, but NiMH batteries are much more expensive. The USABC goal is to produce a battery pack that costs about $2,500 for a car like the GM Impact. Currently, a NiMH battery pack would cost about ten times as much. Stempel hopes to get the cost of NiMH battery packs down to about $5,000 in a year.

(Automotive News: 12/18)

Cold Won't Stop Solectria Force

After a night during which temperatures dipped to -10 degrees F, a Solectria Force sedan traveled 42 miles on a single charge in mixed city/highway driving in single digit temperatures, according to CEO and Director of research and development, James Worden. Solectria is participating in the Vermont Electric Vehicle Program, EVermont. Worden said the vehicle's performance can be attributed to an automatic battery thermal management system that keeps the batteries warm and a new fuel-fired cabin heater that reduces battery drain. It took only 10 minutes for the cabin temperature to heat up from six degrees F to 70 degrees. For more information, contact Solectria at 508-658-2231.

(Solectria Release: 12/15)

U.S. Charging Sites Identified

There are 888 non-residential charging outlets at 219 sites in 23 states, according to a survey recently completed by the Electric Vehicle Association of the Americas (EVAA). Forty-three are public stations and 169 are private charging facilities. Seventy-two percent are in California. Ninety percent of the facilities use conductive charging through a typical electric outlet and 10% feature inductive chargers that transfer power to batteries through a magnetic connection. "The presence of sites other than home garages where drivers can recharge their electric vehicles is one measure of a city becoming EV-ready," said EVAA Executive Director Robert Hayden.

(EVAA Release: 12/12)

Massachusetts EV Program Could Fail

Massachusetts Governor William Weld is scrambling to save the state's EV program following the decision by the California Air Resources Board to drop a law requiring all major automakers to provide EVs to the state's residents by 1998. Weld has pledged to fight for the mandate despite the action in California, but observers say his hands may be tied. In the absence of the California mandate, automakers could simply refuse to comply with the Massachusetts quota, and Weld would likely have to sue them in federal court. Meanwhile, Boston Edison and two small car companies say despite the uncertainty of the mandate, they will continue with plans to build two EV manufacturing plants in Boston, and electric utilities are constructing recharging stations throughout the state.

(Boston Globe: 1/1)

GM to Begin Selling EVs This Fall

General Motors will become the first of the big U.S. auto manufacturers to put an EV on the mass market. At the Los Angeles Auto Show in December, GM announced that it plans to start selling the two-seater EV1 model at 25 Saturn dealers in Los Angeles, San Diego, Phoenix and Tucson. The EV1 will cost around $35,000, a price which does not include buying or leasing a charger for the vehicle's battery. In an effort to alleviate some of the recharging costs, Southern California Edison has said it plans to have 18 recharging stations in operation by this summer. The car has a reported top speed of about 80 miles-per-hour, and a range of between

60 and 90 miles on a single charge, depending on driving and weather conditions.

(AP: 1/4)

CA Bill Would Let EVs in Carpool Lanes

Despite the continuing debate in California over whether EV mandates should be modified, BAT International and California Assemblywoman Sheila Kuehl plan to propose a bill that would allow EVs to use carpool lanes. The bill is patterned after a federal law that allows HOV (high occupancy vehicle) access to extra-clean fleet vehicles if lanes are underutilized and located in high air pollution districts. By 2010, California will have more than 1,000 miles of carpool lanes that could provide EV access while also reducing congestion and improving air quality. BAT believes carpool access would encourage drivers to consider buying EVs. For more information, contact Robin Podoisky with Kuehl's office at 818/501-8991.

(BAT Release: 1/5)

CALSTART Launches New Advanced Projects

A new $5.5 million partnership between CALSTART, the Advanced Research Projects Agency of the U.S. Department of Defense and nine California companies will give a boost to seven new CALSTART demonstration projects designed to enhance advanced technologies for a new generation of commercial and combat vehicles. The funds will help Monrovia, CA-based AeroVironment Inc. develop and test critical high-risk components, such as hybrid drivetrains, needed on next-generation military hybrid electric reconnaissance vehicles. Other projects involve developing and testing flywheels, developing and demonstrating efficient rotary engines to power electrical generators on hybrid EVs and developing low-cost power relays for EV systems, including simple-to-manufacture, high-power battery pack safety switches.

(Business Wire: 01/10)

Utilities Commit to Electric Pickups

Just eight days after General Motors unveiled its Chevrolet S-Series electric pickup truck at the Los Angeles Auto Show, ten of the nation's largest electric utilities announced they would purchase more than 900 of the trucks over the next three years. The vehicles will be available for purchase by fleet buyers during the first quarter of 1997 for a suggested retail price of $32,795. The truck is powered by a Delco Propulsion System 85 kW, 115 hp, AC Induction Motor and a Delco Valve Regulated Acid battery pack, which is located under the trunk. The truck utilizes the Delco Electronics Magne-Charge inductive charging system. It has a range of 40 to 60 miles with a top speed of 70 miles per hour.

(PRNewswire: 1/12)

EVs Effective in Pollution Control

Not only are EVs a bargain when compared to many other pollution reduction methods, but their life-cycle cost is less than other vehicles, according to an Electric Power Research Institute (EPRI) technical brief that reviews findings of a U.S. Department of Energy study. DOE's report, "Encouraging the Purchase and Use of Electric Motor Vehicles", maintains that EVs will become more cost effective over time. Furthermore, EVs are eight to 12 times less expensive per ton of pollution removed than many existing or proposed programs imposed on small business. Using a sales weighted average cost of removing emissions in California from 1998 to 2005, the cost of pollution removal is projected at $200 per ton. Many small businesses, however, now pay more than $20,000 per ton of pollution removed.

(Green Car Media: 1/96)

New Company to Sell Recharging Systems

The nation's second largest utility company, SCEcorp, has announced the opening of a new subsidiary, Edison EV, to sell, lease, install and service recharging systems for EVs. Edison EV is already in partnership with General Motors to provide recharging systems for the EV1, GM's new electric car. Edison EV, based in Los Angeles, will also offer recharging systems to companies and public agencies with electric fleets throughout California. The company plans to install between 8,000 and 10,000 public and private recharging systems in home garages, shopping centers, sports stadiums, movie theaters, grocery stores and workplace parking lots throughout Southern California within the next three years.

(UPI: 1/17)

An EV in the Hand. . .

continued from page 17

variation of this, called "plug braking" is still used in electric bus and tram systems.)

Due to a characteristic called inductance, electric motors don't mind if you switch the current on and off while running, if you do it fairly fast. The motor sees this string of on/offs, or pulses of current and voltage as a constant level, though lower than full-on. With long off times and small on times, the perceived voltage is low. As on times become longer and off times shorter, the perceived voltage rises. So, accordingly does the power output of the motor. Because it varies or "modulates" motor power using the duration, or width in time, of the power pulses, this method is called Pulse-Width Modulation (PWM). Since it "chops" the power into pulses, it is also called chopper control.

Shockley's Baby

You can implement chopper-type motor control mechanically (by just clicking a switch on and off manually — try it with a mini-EV! You can also do it with tubes (remember them?) however it is easier with an electronic device called a transistor. William Schockly came up with the transistor in 1957. Shockley's baby literally made today's world. Everything from computers to utility power delivery systems depends on transistors or devices derived from transistors. Simply, a transistor is an electronic switch, opened and closed by a very small current that acts like the lever or pushbutton of a mechanical switch. It is made from materials called "semiconductors", which means that they only conduct current under specific conditions (I'll be going more into transistors in a future column). Power transistors can switch high levels of current and voltage without arcing or overheating.

EAA Member Designed First Commercial Controller

Motor control using transistors was soon common in industry, but it wasn't until the late 60's that EAA Member Frank Willey applied it to EVs in his "Willey 9", the first transistorized PWM motor controller available to individual EV builders. This homebuilt box set the pattern of today's EV controllers, such as the Curtis 1221-B and others. To run an EV with the Willey 9, you rigged the accelerator pedal with a small variable resistor called a potbox. Electronics in the controller continuously read the potbox resistance as the driver depressed the pedal. Big power transistors switched the high DC voltages and currents. Electronic cleverness translated the potbox resistance reading into signals that told the power transistors how fast to switch and how long to stay on.

The use of power transistors in pulse-width modulated control made an EV's pedal response much more like a gas car's. It brought brought mid 20th century EVs from backyard projects to serious contenders in the fight for pollution-free transport.

Don't be intimidated by that brown box with channels or fins on the outside and big impressive-looking lugs. It's only a smartened-up, fancily packaged version of a simple knife-switch.

Now you should be able to look that EV right in the headlights without a qualm, since you now understand more about it than it does about you. Well, maybe.—Sparkz

Inviting the EV-1 to Town

GM chose Southern California and Arizona cities as pilot markets due to their temperate climate, flatter terrain —-and because the cities actively solicited EVs. That happened, in part because of active and vocal EV organizations. These include L.A, San Diego and Phoenix EAA Chapters, the Electric Vehicle Association of Southern California (EVAOSC) and Tucson Electric Vehicle Association (TEVA). These areas have also staged many rallies, races and EV displays.

Where the EV-1 may be offered next may depend more on GM's impression on the level of interest than on climate, since tests have shown that EVs equipped with battery heating can survive and perform well in cold and snow. (See page 14, in this issue.) States or cities with high interest (and active EAA chapters or other groups) are Seattle, WA, Northern CA, Washington DC, Boston MA, Atlanta, GA, Texas, Hawaii, North and South Carolina, Florida, Michigan, Virginia and Ohio. Expansion will come when GM is convinced that these markets are ready. More EV activity in those areas, in terms of driving/building conversions and having EVents, could help convince them. Also a large volume of info-line inquiries from those areas. —CB

EVents Calendar

by Clare Bell

1996

Mar. 1-3

APS Electrics at Phoenix—Firebird Raceway. The biggie, and it's nearly here. Call EVTC 602-256-2599

Mar. 3

EAA (SF) Peninsula Chapter Meeting—The Station Car Concept, using EV's Marty Bernard, National Station Car Association.

Contact Peter Barnes, Tel#:415-592-2099 (pbarnes@octopus.wr.usgs.gov)

No date

EAA Los Angeles Chapter Meeting 11AM-1PM (1st Sat. of mo.) Cal Tech Institute, Winnett Lounge, at Hill Ave & Calif Ave., Pasadena. Go north on Harbor Fwy to Pasadena Fwy, take Calif. exit, right turn east, left turn to Hill, north 2 blks to Pasquel. Street parking OK. Contact Irv L. Wiess Tel#:818-841-5994 2034 N. Brighton, Apt. C, Burbank, CA 91504 USA Leni Goldberg (len@wcc.wnsnews.com)

Mar. 16

EAA North Bay Chapter Meeting * New meeting frequency! 10AM-12Noon (3rd Sat, odd numbered months), North Bay Savings Bank, 20 Petaluma Blvd South, Petaluma. Take Hwy 101 towards Petaluma, Washington Ave. exit, turn left onto Petaluma Blvd South. At Petaluma Blvd & C St., use C St. side entrance. Parking at rear.

Contact Andy & Jeannine Clary Tel#:707-526-7692 {Santa Rosa} Chuck Hursch (gandhi!chuck@uunet.uu.net)

No date

EAA Riverside (S. CA) NEW Chapter 4-6pm (last Sat. of mo.) University CA Riverside, call for rm location. Dr Jea Park (Pres.) Tel# 909-796-6557 Pager: 909-309-3060 (key in your#) 25998 Reynolds St., Loma Linda, CA 92354 USA

No date

Oregon Electric Vehicle Association Meeting 7:30-9PM (2nd Thurs. of mo.), Two World Trade Center, Plaza Conference Room 26 SW Salmon Street, Portland. From the center of Portland, go 1/2 block west of Front Ave., at Salmon Street Springs (the big fountain). Contact: Lon Gillas, Tel#:503-434-4332, Fax#:503-434-1519, PO 556, McMinnville, OR 97128 USA Lou Tauber, Tel#:503-297-6767 (ecar@europa.com)

Mar. 30

Palm Springs International Gran Prix. Contact Chris Martin (71270.1565@compuserve.com) Tel. 213-465-4488

Apr. 6

EAA (SF) Peninsula Chapter, ZEVs and promotion of Electric Vehicles. Clare Bell, Current EVents editor, EAA Board, Santa Cruz. Contact: Peter Barnes,Tel#:415-592-2099 (pbarnes@octopus.wr.usgs.gov)

Apr. 24

Earth Day! Get ready to show your EV.

Apr. 25-27

Virginia Power EV Grand Prix, Richmond International Raceway, Richmond, VA. Tel. EVTC 602-256-2599

May 10-17

8th Annual Tour de Sol '96, solar electric race and rally, NESEA, 23 Ames St. Greenfield, MA 01301, tel. 413-774-6051, Fax 413-774-6053

May 25-Jun. 9

Ener*Run IV, Hardy, AR, Santa Fe, Colorado Springs, Cheyenne, Fargo, and St. Louis. Sports Pro, 510-856-3877

Jun. 1

CALSTART electric vehicle program (tentative) CALSTART - Alameda Plant. Contact Peter Barnes, Tel#:415-592-2099 (pbarnes@octopus.wr.usgs.gov)

Jun. 4

SF BEAR - San Francisco Bay Electric Auto Rally and Clean Air Fair, San Francisco, CA Supporting Clean Air Month and the American Lung Association. A rally delivering clean air to cities arround San Francisco Bay. Contact: Peter Barnes,Tel#:415-592-2099 (pbarnes@octopus.wr.usgs.gov)

Jun. 10-16

1996 Future Car Challenge, contact Argonne National Lab, 9700 S. Cass. Ave. Bldg 362, Argonne, IL 60439. Tel. 708-252-8677, fax. 708-252-3443

Jun. 20-23

Solar Splash (Electric Boat Regatta), Milwaukee, WA. Advanced Energy Competitions, 602-773-0230

Jun. 27-29

Cleveland Electric Formula Classic '96. Formula Lightning Races) Burk Lakefront Airport Raceway, Cleveland, 216-447-3200

July 4

Chevrolet Pikes Peak Auto Hill Climb, Manitou Springs, CO 719-685-4400

Aug 5-13

Sun Sprint of the Rockies, Aspen, CO to Moab Utah, 907-872-3882

Sept. 20-26

Beijing International EV Exhibition, Beijing, China 86-10-5013764

Thanks to Bruce Parmenter, Editor of the Internet EV Discussion List.

Please fax Calendar items to Anna Cornell at (510)685-7580.

FOR EAA MEMBERS ONLY

EV Want Ads

For Sale

For Sale: '79 Honda Civic Station Wagon. Electric powered by a 15 HP Prestolite motor. 96 volt DC system w/8 x 12 volt Trojan batteries, Curtis PMC-21 controller, radio & heater, aluminum wheels., 4 spd. transmission, 110 vac charger. Excellent condition, green exterior, tan interior, top speed 65 mph, range 40/charge. $3750. Call Bob (310) 532-4536.

For Sale: '72 914 Electric. 108 v, Advanced DC 8" motor, on-board charger, DC-DC converter, US 2300 batteries, Curtis 1221B controller, Polypropylene battery boxes, suspension and brake upgrades. Buy a completed car for less than the car, conversion kit and batteries. $9800. Call Phil Durbin (510) 455-1183.

For Sale: '85 Pontiac Fiero GT. 63K miles, converted last year at 61K, 96 volt system, Curtis 1221B controller, Trojan batteries, on-board 120VAC charger, sunroof, rear-window defogger, heater, delay wipers. Super nice sporty EV! $10,000. Call Mark Gilbert, Colwich, KS (316) 796-1514.

For Sale: Collectors item!! One of the few Urba Electrics ever completed from the article in the Feburary '77 issue of MECHANIX ILLUSTRATED. 72 VOLT SYSTEM, 50+ MILE RANGE, 65+ MPH. 2400 miles on Exide batteries. $3900 to proper individual. Call Glenn Vandiver, (602) 967-6901 after 4 pm MST weekdays.

For Sale: 'Used deep-cycled batteries for EV's. Trojan T125, US2200, 6-volt and 12-volt DC. Los Angeles area. $10 each. Call Bob (310) 532-4536.

For Sale: 5 HP GE Motor. $400. 48 volt charger $150. Also misc parts — all un-used. Call John (408) 624-4563. Carmel, CA.

For Sale: 2 Permanent Magnet Motors. 5 HP - 84 to 108 V 7/8" shaft, 3/16" key, 2" long. 6" diameter, 18" long, 70 pounds. Call Ervin (612) 235-2461.

For Sale or Trade: Comuta Car. All original, show-room condition, red, new batteries. $2000. '82 EVA Ford Fairmont Wagon. New paint, tires, interior. Runs good with original controller and 120V series motor, new batteries. $3500. FOB Albuquerque, NM. Call Dale at (505) 260.0070.

WANTED: 24 Volt DC Electric Motors. 7" long x 4 1/2" with 5/8" shaft, by American Bosch or others. Need 5 to 25 or more. Call Carlo @ (702) 361-1933. (Nevada)

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.

$7 for the first 25 words. Each additional word, 25 cents. Want Ads are available to EAA members for the sale of electric vehicles, equipment and parts only.

Please see advertising rates for commercial products or information below on the NEW! Commercial Want Ads listed below. .

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.

NEW! Commercial Want Ads

For small businesses, CE would like to offer a new commercial ad rate. For just $25 you may submit an ad up to 25 words for your small business. Each additional word, 50 cents.

Please submit a disk with a text file or hard copy that is typed to ensure accuracy . If you would like more information on this, please contact Susan Hollis at (408) 374-8605.

ADVERTISING RATES

Full page	7.25" x 9.25"
1 ad	$400 ea
3 ads	$300 ea
12 ads	$250 ea

1/2 page	7.25" x 4.50"
1 ad	$200 ea
3 ads	$150 ea
12 ads	$100 ea

1/4 page	3.50" x 4.50"
1 ad	$150 ea
3 ads	$100 ea
12 ads	$ 75 ea

1/8 page	2.0" x 3.5"
1 ad	$100 ea
3 ads	$75 ea
12 ads	$50 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 need to be prepaid per quarter.

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.

Advertising Manager

Susan Hollis, AdvertisingManager
Office: (408) 374-8605
FAX (408) 374-8750

Address

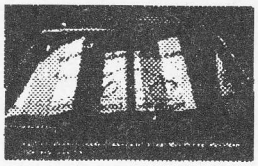
Make check payable to EAA. Camera-ready copy and payment for the ad should be sent to:

Electric Auto Association
18297 Baylor Avenue
Saratoga, CA 95070

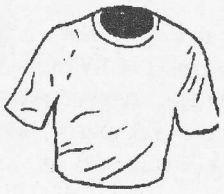
CE ADVERTISERS

EAA Reprints Order Form

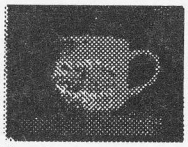
100% Cotton Cap Forest Green "Charging into the Future" EAA Logo
CAP001.....$6.50



Auto SunShade
SS001.....$8.00



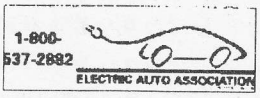
T-Shirt with EAA Logo
TS001 .....$14.50



Porcelain Mug with "The Swtch is on" and EAA Logo
MUG001 .....$5.00

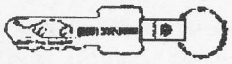
Thermal Auto Mug
MUG002 .....$6.00

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 ***(specify specific issue)***	$3.00 each issue
CEFY	Current EVents - Full year ***(specify specific year)***	$20.00 each year
PB001	Discovered:The Perfect EV Battery	$ 2.00
FW001	Flywheel Energy Storage	$ 5.00
BG1995	1995 Buyer's Guide to Electric Vehicles (Feb 95 issue CE)	$ 2.95
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

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

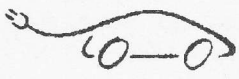
Name _____
Address _____
City,St,Zip _____

Item#	Size	Quantity	Item Description	Unit Cost	Amount

Subtotal	
Postage +10% for USA*	
Handling	$2.00
Total	

Make check payable to: **EAA** (US dollars)

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



ELECTRIC AUTO ASSOCIATION
2710 St. Giles Lane, Mountain View, CA 94040

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