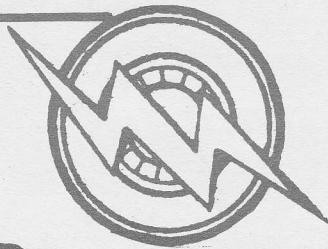


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NEWS

JULY 1984

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VOL. XVI

NO. 7

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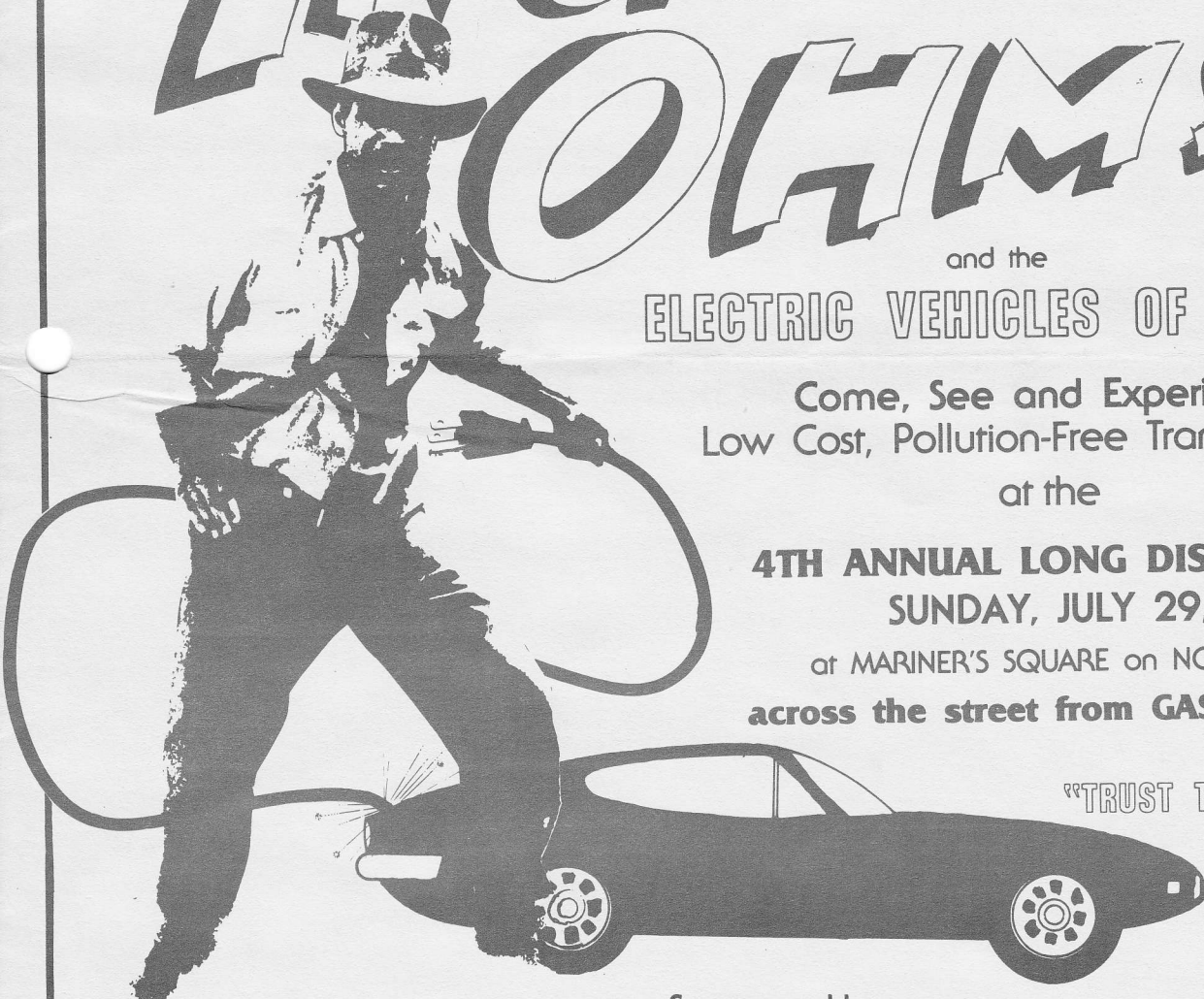
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BATTERY DETERIORATION by Hans Koski

Battery deterioration has been ignored generally but now we have Don Gillis's interim report on the Battery Usage/Life Survey which indicates very poor life mileage obtained by EAA EVs. Other sources have reported poor life in some fleet EV tests so we are not alone.

Why do EVs fall so far short of laboratory tests such as those on the EV106 showing full capacity and voltage maintained for 500 cycles at 75 amperes? Don's survey and the rallies may give some clues.

A recent listing of the 1982 rally provides new data on the EVs that might help in putting this picture in focus. The chart below presents this information with the cars divided into four groups of varying efficiency based on the assumption that all cars have new batteries with available stored energy based on the manufacturer's rating. By dividing the stored energy by the rally mileage a watt-hour per mile value is obtained for each car.

The watt-hours per mile value is calculated as follows:

$$\text{wh/mi.} = \frac{(75)(\text{minutes @ 75a.})(\text{nr. of batts})(\text{v./batt.})}{(60)(\text{miles in rally})}$$

When these values were calculated for the cars in the 1982 rally they seemed to be naturally divided into four groups with the range of wh/mi. shown at the head of the columns. The cars in Group I probably have new or nearly new batteries. The cars in the other columns then have older batteries and/or mechanical problems or they have higher running losses. The wh/mi. then consists of a basic loss figure for the car and an increased or decreased amount for any loss changes and an unknown amount that is actually the amount lost due to battery deterioration and is not available from the original battery capacity.

The chart shows several items that affect the efficiency of the EVs. The cars are grouped by battery manufacturer and each car is represented by motor manufacturer or type / number of batteries / make or model of car. The other symbols are: "H" for parallelled batteries and "R" for relay type control.

The lines with arrow points show where that car was in the 1981 rally (to the left), or the 1983 rally (to the right). Gillis's Bradley (Gr. IV Globe) would have been in Gr. I in 1981 but his batteries had deteriorated 60% by the 1982 rally. John Newell's Fiat (Gr. IV Globe) would have been in Gr. I in 1981 but he had a dragging brake in 1982. Some of the others probably are combinations of battery deterioration and mechanical or electrical problems. There are six EVs with relatively small amounts of change between rallies that show a change of 10 to 30 percent. These may be representative of battery deterioration in EVs and Gillis's 60% may be unusual. More likely the other drivers did not drive as much as Gillis but they may or may not obtain greater battery life ultimately.

Santa Clara Rally - 1982

	Group I	Group II	Group III	Group IV
	100-200 wh/mi.	200-260 wh/mi.	260-320 wh/mi.	320-700 wh/mi.
	70-124 mi.±	55-75 mi.±	25-60 mi.±	20-40 mi.±
Globe	Presto 20 Fiat Presto 20 Saab G.E. 16 R Honda Baldor 16 Honda Baldor#16 VWdb Presto 14 VWdb	Aircr.# 16 R Aztec Presto 12 Aquila	Aircr.# 12 R VW sed.	G.E. 16 R Brádjcy Aircr.# 16 R Aztec Aircr. 12 Fiat
Trojan	Aircr.# 20 VWdb Baldor 13 Vega Aircr. 10 VWdb	Presto 16 VWdb Presto 16 Ford Aircr. 12 R Bradley Aircr. 8 R Renault	Baldor 16 Ford Baldor 12 Vega Aircr. 12 R Datsun Tr. Aircr.# 10 R VW sed.	Aircr.# 18 R Metropolitan Aircr.# 14 R Datsun Tručk Aircr.# 14 R VW sedan Aircr. 8 R Audi
Alco	Presto 20 Honda Baldor 16 Honda Presto 16 Aztec	G.E. 16 Bradley China 12 Datsun Tr.	Comm.# 12 R Nordskog	
Sears	Presto 12 Honda Baldor 12 Fiat		Aircr. 12 Karman	Honeywell # 16 H&MV Aircr. 12 Fiat
Clyde	Aircr. 14 R Le Car			
Presto	Aircr. 12 Honda			
Exide		Baldor 19 Vega Presto 12 Fiat		
Wards				Baldor 6 Midget
Total Cars	16	10	7	10

The distribution of the cars with different manufacturer's batteries is interesting and might show some pattern of deterioration. The Alco battery is a new brand and its price has attracted a number of EV owners. The distribution of the Alcos in Groups I thru III then represents almost new batteries with the more efficient cars in Gr. I and some with battery deterioration and lower efficiency in Gr. II and III. The Trojans apparently have been in steady use with regular replacements with batteries in varying states of deterioration. Globe is unusual with half of the users in Gr. I. This may be partially due to recent changeouts to larger battery packs.

Motor losses have been brought to the forefront by Russ Kaufman's recent report on motors. His graph of the motor input at 30 mph in test car runs showed the Prestolite MTC4001 required 140 wh/mi., 2CM76 170, 2CM88/77 190, EA40/G29 190. These values are all within Group I and the 1982 graph does show several aircraft motors in Group I. The Baldor and Prestolite predominate in Group I but the aircraft are distributed with a concentration in Group IV. Are these breakdowns, deteriorated batteries, or motor problems? Most of the aircraft motors are used with parallel batteries and with relay control. The relay control systems are efficient but may have breakdown problems. The parallel battery cars increase from Group I to IV indicating a problem there. If parallel banks of batteries are used a monitoring system is essential to verify that the banks are equally loaded and to spot bad batteries. If the batteries are wired in a permanent series-parallel system then it is almost impossible to monitor the system and to isolate trouble. Unbalanced battery banks could cause rapid battery deterioration.

The number of batteries and the weight of the car are important factors. The average number of batteries in Groups I thru IV are 15, 14, 12, 13. the average curb weights of cars in Groups I thru IV are 2571, 2643, 2694, 2390. The better cars have more batteries and are lighter weight. More batteries (higher voltage) less current. Less weight lower rolling losses, less current. Less weight lower peak current during acceleration or hill climbing.

The outstanding characteristic of the 1982 graph is that out of 11 Hondas and VW dunebugs 10 are in Gr. I. The other 32 are distributed in Gr. I thru IV. Do these Hondas and dunebugs have uniformly low running losses or is it driving technique. Do they have new or slowly deteriorating batteries?

The running losses - tire, aerodynamic, chassis - come with the car when we acquire it but the manufacturer doesn't give the figure. Formulas give a rough figure. There is a test to determine the running losses which would give us a more accurate and consistent figure for each car.

If we had an accurate figure for each car, then we would have the true basic wh/mi. and all the variations noted above would be deviations from this basic figure.

The test for losses is made by coasting the car to terminal speed. This test would verify what the Hondas and dune bugs have and would show the other 32 if their car is the problem or the conversion. In 1981 and 1982 I made some coasting tests and presented the results at SEVA meetings. If anyone is interested I will send copies of these tests.

If all the above factors don't explain everything then driving technique has to be considered. This is so personal that it can't be factored -- easy on the amperes and brakes, easy on acceleration and hills.

Possibly the most important factor affecting battery life is the way we charge. It has been stated by someone in the battery industry that no battery has

been ruined by discharging, only by charging. There might be some truth to that statement. There is some question of whether to charge every night or when the battery has been discharged to the maximum limit. Discharging to the limit means that the battery is deteriorating each night at partial discharge, but this may not be serious. An empirical battery formula indicates best battery mileage life by charging at 40 to 80% discharge with maximum life at 60%. Charging at 60 to 80% may be the safest way to avoid charging trouble. The chargers are basically designed to charge a fully discharged battery in 6 or 8 hours, but when they charge a partially discharged battery they may overcharge. A charger that depends on fixed time periods could ruin the batteries unless the owner resets it for the particular condition. Voltage sensing chargers should be able to charge at the best rate for any discharge condition. The proper charging rate can be verified by visual inspection to see that gassing is at a minimum.

Some cars in the rally may have used regeneration. This is another method of charging the battery and should be controlled just as closely. The argument against this is that when you use regeneration it follows discharge greater than the amount of regeneration. That may not always be true and when you regenerate it may be at a rate of several hundred amperes. If you are looking for longer battery life, use regeneration but control it.

On the 1982 rally chart we have identified trends that seem to indicate battery deterioration and factors that appear to improve efficiency of the EV. Now if we keep track of what our EV is doing and what we are doing we should be able to improve battery life mileage.

In Russ Kaufman's tests at 30 mph the Prestolite motor required 140 wh/mi. In the 1983 rally with the same installation his calculated wh/mi. was 158. This verifies the battery capacity and gives a good base - you know what the car requires; you know what the new battery can produce. Farther down the line you can repeat the tests, make 30mph road tests and your own rally run. Modify your car or charging procedure, and keep track of what is happening to the battery. This will help you and if you report the results to Don then everybody benefits.

ADD BATTERIES?

by Hans Koski

Russ Kaufman's recommendation to add batteries appears to be confirmed in a number of cases but at the same time there appear to be some disappointing results. Some EVs may be good candidates for added batteries while others may not. The following table shows how EVs perform in general:

# of batteries	Rally Miles		
	Better	Good	Average
8	50	38	32
10	58	46	38
12	70	56	47
14	82	66	55
16	96	77	66
18	112	90	74
20	128	103	85

The better cars are generally light, 35 to 40% battery weight. They probably are not candidates for increasing batteries - they probably have the maximum already installed.

The good cars could benefit from added batteries.

The average car should have three changes - add batteries, go to the better batteries and reduce weight. The average EV is overweight and would still be overweight with added batteries and may produce disappointing results unless lightened.

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These engines drive generators which produce electricity. The electricity generated is a clean source of power. Now this clean source of power is used in our clean electric cars.

All this time our air has become more polluted as our number of gasoline and diesel cars have increased. Now we have an alternative for these faithful old gasoline cars. It is the electric. As their numbers increase the pollution will decrease for the electric can use many clean sources of energy such as hydro, natural gas, geothermal, solar, winds and photovoltaic.

Most recently, rubbish and garbage can be added to the list of clean sources by using the methane recovery method described.

So you see, both the garbage and the automobile stench and smoke can be eliminated. Now we environmentalists can look forward to living happily ever after.

BY JOHN NEWELL

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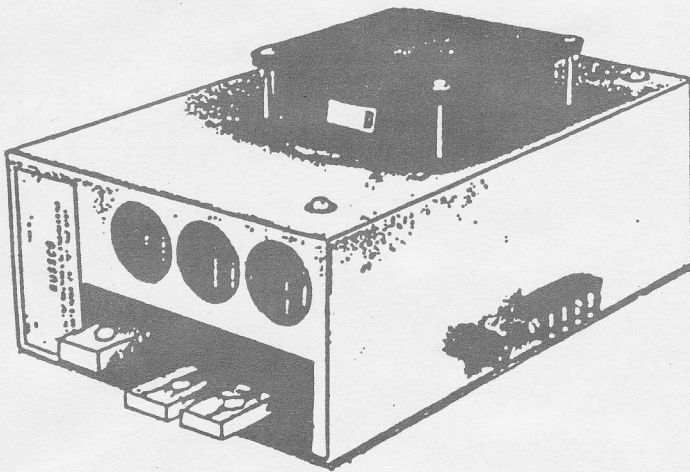
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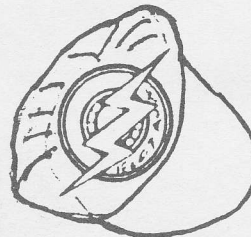
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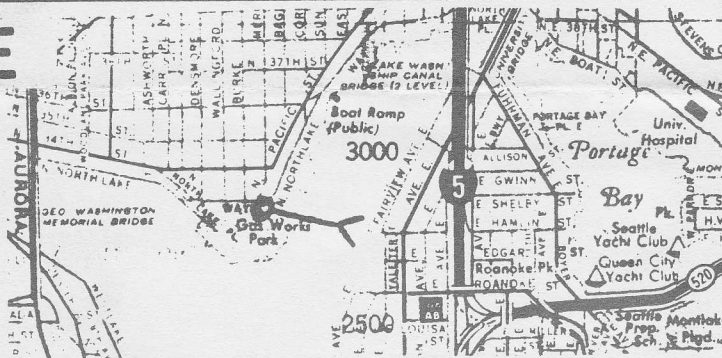
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