Return of the Electric Auto

Or rather Son of Electric Auto: A new kind of battery promises a sleeker, faster, longer-range vehicle

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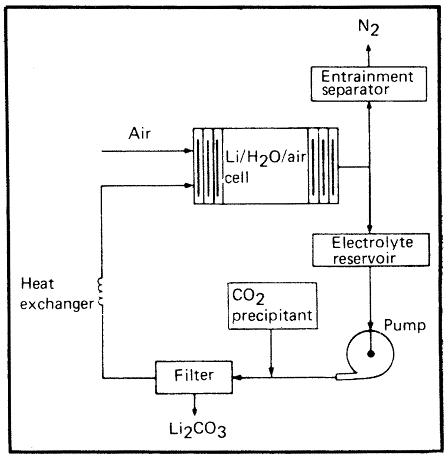
Remember when grandma sat high over the tiller of her old Reo electric and tooled off down the road to town to do her shopping? If grandma had any vinegar in her soul, on her way she might have raced the electric interurban car, whose tracks probably ran alongside the road. If she raced, she probably lost. The interurban car could go twice as fast as the Reo.

In a few years there may be no longer any farms on which people live or any farmer's towns for them to drive to if they did live on farms, but both the trolleycar and the electric automobile seem poised for a comeback. In the trolley's case that's not surprising. It remains the efficient and flexible mode of transport it always was. The trolley died in the United States (not in the rest of the world) as the purely psychological victim of the auto industry, and now that what's good for General Motors looks even better for Saudi Arabia, public authorities are giving the trolley a new look.

But the electric automobile is an entirely different proposition. It faded out long ago because it was too slow and genteel to keep up with traffic on improved highways—really, it had a little-old-lady-in-high-button-shoes image—its range was so limited that it probably couldn't have gotten grandma to Dubuque or Mason City if the store in Petticoat Junction didn't have the dress she wanted, and finally the task of recharging its battery, a frequent necessity, was about as convenient as elective surgery.

If the electric auto comes back, and a number of scientists and technologists are betting that it will, it will not be in that form. It will be in a fast, cheap, long-range form, powered by an entirely new kind of battery. A group at the Lawrence Livermore Laboratory, which includes L. G. O'Connell, B. Rubin, E. Behrin, I. Y. Borg, J. F. Cooper and H. J. Wiesner, are confident that the powering element is likely to be a lithium-water, or lithium-water-air cell they are developing. They see promise of a battery weighing 220 kilograms delivering an energy density of 225 watt-hours per kilogram at a power density of 200 watts per kilogram, that could run a 900-kilogram automobile for 330 kilometers.

That's considering just one battery. There are a number of more complicated arrangements. One of them cited by O'Connell and colleagues in an LLL publication describing their work combines a lithium-water-air primary battery with a small secondary battery. The secondary would be a power buffer and supply juice for starting, lighting and instrument functions. In this case your 900-kilogram basic option with a battery system weighing 227 kilograms would have a range of 330 kilometers, an acceleration from zero to better than 64 kilometers (40 miles) per hour in 10 seconds and a maximum sustained speed of 97 kilometers (60 miles) per hour. If you are not a jumper like Evel Knievel, and you do respect speed limits, that should be sufficient.



LLL

Basic lithium-water-air battery system.

Recharging, the chief drawback of the oldfashioned electric, will be a good deal simpler. The largest part of it will be replacing the lithium anode. Grandma will be able to leave her Neoreo at the service station for a recharge while she goes to the hairdresser. Furthermore, if the system carries 29 kilograms of lithium beyond the 7.3 kilograms necessary for the 330-kilometer range, the anode need only be changed every 1,600 kilometers.

Still, you say you never go to a hairdresser and you prefer to drive up to a pump and fill your tank with a draft of Old Knocketyknock? O'Connell and collaborators have some numbers for you to consider. "At present gasoline prices (which are expected to rise) and 20 miles per gallon [this is the 1980 goal, but when did you ever get anything like it in city traffic?] the cost of fuel is 3¢ per mile." Assuming that there are a number of lithium-battery vehicles on the road and that the lithium from spent anodes is reprocessed, "it is expected that the cost of reprocessed lithium in large quantities will be $1.50 per kilogram. If the battery system is primary, then the cost of operation will be 7.4¢ per mile; if it is hybrid with the secondary battery sized for 20-mile range, the cost will be about 3¢ per mile. Other combinations will give different operating costs."

So it looks as if the day will come, if it is not yet, when a lithium-battery electric will be competitive with a gasoline burner on an individual basis. Meanwhile the general statistics on energy use and petroleum fuels look just a bit scary.

Transportation uses about a quarter of the energy consumed in the United States, and 73 percent of that is consumed by highway vehicles. Other energy users have the option of alternative fuels to switch to when petroleum products become scarce or prohibitively expensive. At present highway vehicles have no other option. Considering the political games that have been played with petroleum in recent years and that are likely to be played more intensely in the future, that is not a happy situation to be in.

Lithium-battery electric vehicles could provide a viable alternative, those who are working on the scheme believe. There are a number of uncertainties: Lithium has so few uses that little of it is refined. Neither the United States' nor the world's lithium resources have been thoroughly prospected, but they are believed to be copious. So little lithium is refined that known prices are based on small orders, and there are difficulties in predicting the effect mass production would have.

On the other hand, a good deal of lithium can be recovered from the spent anode elements (in the chemical reaction envisioned it would turn to lithium carbonate) and recycled, cutting down the amount of fresh lithium that would have to be mined. Nothing is recoverable from the burning of petroleum products.

Another bit of conservationism possible with electric vehicles is the use of flywheels for energy storage. In the process of braking, energy is lost as heat of friction. Much of this could be stored in a flywheel and returned to the propulsion system when the vehicle starts again. The flywheel is not merely a bright engineer's idea: Cars equipped with them are now operating on the New York subway system, as efficiently as conventional cars and drawing less power.

The great environmental advantage of electrical propulsion systems is that they do not pollute the air (this is also an important reason for the current reconsideration of trolleycars). On the other hand, mining lithium would involve certain unavoidable environmental detriments, and the handling and chemical processing involved in the lithium-fuel economy will present certain hazards of spillage. A detailed environmental-impact study needs to be made, but proponents believe the lithium-fueled electrics will be less of an ecological insult than gasoline burners.

The battery that holds this promise began as a lithium-water cell designed by the Lockheed Missiles and Space Co. for marine use. The electricity is generated by chemical reaction between the lithium anode and the water, which is effectively the cathode. (For energy-collecting purposes an iron-wire-mesh cathode is introduced.) The chemical reactions go like this: At the anode lithium is ionized. In the cathode reaction the water picks up the released electron and separates into a hydroxyl radical and hydrogen. The hydroxyl then combines with the lithium to give lithium hydroxide so that the net reaction is lithium plus water yields lithium hydroxide (mixed in the remaining water) plus hydrogen. The total energy generated is a positive 2.22 volts. This kind of cell has the added advantage that the iron cathode and lithium anode can be pressed tightly together because the chemistry involved forms a protective coating on the lithium that prevents its corrosion by the iron. The arrangement avoids the energy loss involved in transporting the charged electrons and ions through the electrolyte in cells where the electrodes must be separated.

To run this kind of battery efficiently requires controlling the concentration of lithium hydroxide mixed in the water. The Lockheed version does this by continually introducing new water. Such a procedure is not difficult in a marine environment, but on the highway it would require automobiles to carry heavy water tanks that had to be continually refilled.

A better way to control the lithium hydroxide, the Livermore group believes, is to introduce carbon dioxide and precipitate lithium carbonate. One then gets the overall reaction: Two lithiums plus carbon dioxide plus water give lithium carbonate plus a hydrogen molecule. One could stop here and just let the hydrogen go, but O'Connell and collaborators think that's an unwarrented discarding of energy. Introducing oxygen in the form of an air cathode can suppress the electrolysis of water that makes the free hydrogen so that the overall reaction is lithium plus oxygen plus carbon dioxide yields lithium carbonate, and water is no longer consumed.

A lithium-water-air cell of this type has been tested and gives a voltage of 3.4 volts. Its energy density is calculated to be 330 watt-hours per kilogram at a power density of 200 watts per kilogram. Much research on the functioning of the battery, looking to improving its performance, and the best means of integrating it into an engineering design are necessary before use is feasible. At the moment the researchers envision an optimum system that is a battery/battery (that is, primary/secondary) hybrid. If the battery is made to carry 36.3 kilograms of lithium, the vehicle could travel 1,600 kilometers between lithium changes. "Assuming an average of 16,000 kilometers travel per year," the researchers calculate, "the lithium need only be refueled every 1.2 months. Lithium replacement would not take place at the 'gas' island, but as part of a more lengthy servicing of the vehicle, similar to the 1,600-kilometer oil change. Routine refueling would then consist of adding carbon dioxide and removing lithium carbonate."

Of course after feasibility is demonstrated, there remains an important task of industrial convincing. The American automobile industry is so monolithically organized that a routine style change involves the risk of a fortune. Asking skittish industry executives to adopt an entirely new mode of propulsion might cause dangerous rises in blood pressure. Proponents of electric propulsion might have to finance new companies.

From the individual point of view, lithium electrics would be attractive only if enough service stations stocked the lithium anodes and other parts and maintenance equipment necessary. And that would be attractive to service-station owners only if there were enough electrics on the road to pay them for the investment. It makes a kind of chicken-and-egg problem that might require some economic pump priming. Nevertheless as petroleum gets scarcer, more expensive and more and more involved in volatile international politics, an automobile economy based on a fuel that is abundant and has few competing uses could look extremely attractive. ☐

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toward the surface, each carried an instrument that measured ion and electron concentrations in the upper atmosphere. An analysis of the electron flux reported by lander 1, according to William B. Hanson of the University of Texas, shows a transition boundary about 2,000 kilometers from the planet that just may be the bow shock formed where the solar wind and a planetary magnetic field interact. It will take several weeks to be sure, he says, but unless the plasma pressure in the upper atmosphere turns out to be sufficient to balance the pressure of the solar wind by itself, it looks as though a magnetic field—and an intrinsic rather than induced one at that—is the answer. (Such a conclusion had already been reached by Soviet researchers using data from direct-measuring magnetometers aboard their own Mars orbiters, but, says one U.S. scientist, that conclusion "sorely wanted confirmation.")

Meanwhile, Viking's biologists continued their tantalizing quest. Lander 2's pyrolytic-release experiment reported only the most limited reaction from a soil sample incubated in darkness (a 21.5-count-per-minute "second peak" compared to a 7,133-count first peak), which is a boost for photosynthesis—but also for inanimate photochemistry. It also looks bad for microorganisms that might have been living in darkness below the surface to hide from the almost unfiltered solar ultraviolet radiation. For the metabolism-seeking labeled-release experiment, which produced appropriately positive and negative results from normal and heat-sterilized soils in lander 1, Gilbert V. Levin of Biospherics, Inc., was preparing this week to run a "cold-sterilized" control cycle aboard lander 2. His plan called for subjecting a soil sample to about 50°C instead of 160° in hopes of separating easily cooked biology from inanimate chemistry that might produce the same reaction.

The biologists were also anxiously awaiting results, due to start coming in this week from lander 2's organic chemistry instrument. On Sept. 25, after exhaustive planning, the craft's scoop-equipped arm presented the instrument with a soil sample from an area topped with what was apparently an evaporite-cemented crust (SN: 9/25/76, p. 196), offering the highest hopes yet of revealing the organic molecules that could swing the balance of opinion substantially closer to the finding of life on Mars. ☐