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June 8, 1956

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Dear Sir:

In accordance with agreements reached at a meeting with [redacted] 25X1
[redacted] of your office, the following 25X1
information is submitted:

1. In connection with the thermocouple generator discussed, information appears on this item in the magazine, "Electronic Design," dated May 1, 1956, page 83. We are attempting to obtain the reference mentioned in this article (Radio Amateur Handbook, 1955 edition, published in Moscow).

2. In "Chemical and Engineering News," dated May 28, 1956, the following item appeared: "The U.S. Army has established a research and development liaison group in West Germany. Headquartered in Frankfurt, the group will engage scientists and technicians for research work of interest to the Army. Hoping to promote research that is further advanced or not available in the U.S., the liaison group will finance and coordinate basic research in unclassified subjects in universities, research institutes, and industry." This is being organized by the Research and Development Division of the U.S. Department of the Army under the direction of Lt. Gen. Gavin. We would be very interested to know whether this group is sponsoring any work of interest to our Power Sources Study, and would be interested in obtaining an interview with this group. Please advise us as to when you can make the necessary arrangements.

3. In connection with the German thermocouple developed by Dr. Justi for Siemens and Halske AG, additional information has been received. While the demonstration of the Justi thermocouple to [redacted] was not made in strict 25X1
confidence, the demonstration and [redacted] name and affiliation should 25X1
not be mentioned in any future contacts to be made by the U.S. government.

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Beyond this precaution, however, government requests for information on the device would not be detrimental to [redacted] interests. 25X1

Dr. Justi's work was done for the Siemens and Halske AG, and it is recommended that information requests be made to the company rather than to Dr. Justi. Dr. Justi has reported that he has been approached by several U.S. government agencies, each of whom was not aware of the interest of the others. It is, therefore, possible that substantial information is already contained in U.S. government files. We are not aware of any U.S. government requests for information on the Siemens and Halske AG.

The addresses you requested are as follows:

1. Dr. Edward Justi, Director
   Physikalisches Institut
   Technische Hochschule
   Braunschweig, Germany

2. Siemens and Halske AG
   Erlangen, Germany

A self-explanatory enclosure is submitted which gives information on the electrical energy available from a fuel cell operating from portable hydrogen supply.

Your commentary on all of the above submitted information would be appreciated.

Very truly yours,

[redacted] 25X1

Contract Administration

[redacted] 25X1

Encls.

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[redacted]

June 4, 1956

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Dear [redacted]

This letter is intended as a memorandum report for transmittal to the Government Agency supporting the requisition mentioned above.

When [redacted] returned from a visit to the Customer on May 31, 195625X1 he requested that I calculate the electrical energy theoretically available from consumption of the hydrogen contained in a standard "lecture bottle". Data from one of the suppliers of the gas in this form indicate that two cubic feet* are contained in a metal cylinder 15 inches long and 2 inches in diameter at a pressure of 1600 pounds per square inch. The cost of such a cylinder is seven dollars, with a one-dollar charge for refilling with hydrogen.

Assuming that the conversion of chemical into electrical energy is 100 per cent efficient, the contents of this cylinder would produce 135 ampere-hours of current at a potential approximating one volt. The energy output would therefore be about 135 watt-hours, at a cost of $0.052 per watt-hour, assuming that the tank will not be refilled. Although this is far more costly than a lead-acid storage battery of similar capacity, it has the advantage of infinite shelf-life and increased portability. In addition, a fuel cell might be activated by opening the valve from the gas bottle, and de-activated (with a return to long shelf-life) by closing the valve. The combination of extended shelf-life, light weight (of the order of five pounds), and the absence of necessity for maintenance during storage between uses may combine to offset the high cost per watt-hour of the fuel and the additional expense of the fuel cell itself.

Although the Customer did not specifically request it, I also investigated other portable, easily-activated sources of hydrogen. Lithium hydride and lithium aluminum hydride have the disadvantage of being far more costly than the tank hydrogen, as well as posing problems of storage in air- and moisture-free containers. An alloy consisting of 35% sodium, 65% lead, and sold under the trade-name of "Hydrone" by the Fisher Scientific Company is less expensive than the tank hydrogen and may be stored and handled more readily than the lithium compounds. "Hydrone" produces hydrogen by chemical reaction between the sodium in the alloy and water. The material may be fabricated in the form of pellets which could be sealed individually in plastic containers and which could be made to supply a predetermined amount of electrical energy upon immersion in water.

The advantages of "Hydrone" as a source of supply for a fuel cell over a small tank such as is described above may be summarized:

*atmospheric pressure

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1. Lower cost: The same amount of hydrogen as is contained in a bottle may be generated from "Hydrone" at a cost of $4.85. This corresponds to a fuel cost of $0.036 per watt-hour.

2. Lighter weight: About 0.8 lb. of "Hydrone" (exclusive of packaging material and a light-weight generating chamber) will generate as much hydrogen as is contained in a five-pound tank. The volume would be one-fourth to one-half that of the tank.

3. Metered gas-delivery: As explained above, a pelleted product could be used to produce predetermined amounts of power. Valve leakage between uses of the fuel cell would not be a hazard, as the only loss would be the gas evolved from the pellets actually in the gas generator.

4. Safety in storage: Since no gas is present during the storage period, no hazard from the high pressures obtaining in the tank exists for the "Hydrone".

The chief disadvantage of "Hydrone", when compared to a tank of gas, lies in the complexity of the equipment and handling needed to use it. A gas-generating chamber must be developed, a supply of water must be found, and disposal of the sodium hydroxide solution and lead sponge resulting from the reaction of "Hydrone" with water may pose difficulties. It is, nevertheless, my opinion that these difficulties may be diminished by careful design of equipment.

I would conclude, on the basis of this brief study, that substantial amounts of electrical energy may be produced from a fuel cell drawing its supply from a portable source of gas. The choice between a tank of gas and a water-activated gas generator would have to be made on the basis of other considerations than were included here.

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[redacted] 25X1

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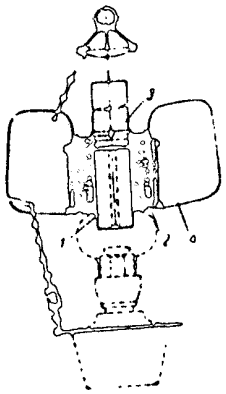
Thermocouple Generator

BATTERY-OPERATED radio receivers up to six tubes are fed with a unique thermocouple battery described in the 1955 edition of "Radio Amateur Handbook" published in Moscow. The thermocouple generator (Type TGK-3) consists of two piles containing many series-connected thermocouples made of "metal-ceramics." One of these generators 2v at 2amp and is used to supply the plate circuits of the receiver through a vibrator converter, while the other, delivering 2v at 0.5amp, is used for the filaments. The battery has still another tap at 1.2v (with a current rating of 0.36amp).

The thermocouple generator is heated with a kerosene lamp which is used at the same time for illumination. It has a long service life and is not harmed by short circuits.



1. Heater
2. Thermocouple Pile Blocks
3. Draft Chimney
4. Cooling

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