NUCLEAR BATTERY-THERMOCOUPLE TYPE
SIXTH QUARTERLY PROGRESS REPORT
APRIL 1, 1958 TO JUNE 30, 1958

MASTER

B. C. Blanke

U. S. Army Signal Corps Contract No. R-65-8-99811-SC-01-91

U. S. Department of the Army Project No. 3-99-15-102

U. S. Army Signal Research and Development Laboratories, Ft. Monmouth, N.J.

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Operated By

Monsanto Chemical Company

Research and Engineering Division

UNITED STATES ATOMIC ENERGY COMMISSION
CONTRACT NUMBER AT-33-1-GEN-53

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SIXTH QUARTERLY PROGRESS REPORT
APRIL 1, 1958 TO JUNE 30, 1958

B. C. Blanke

Date: 30 June 1958

Issued: AUG 29 1958

The object of this contract is to conduct research on radioactive materials and thermocouples suitable for the direct conversion of heat to electrical energy.

U. S. Army Signal Corps Contract No. R-65-8-99811-SC-01-91

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U. S. Department of the Army Project No. 3-99-15-102

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PURPOSE

Radioactive materials and thermocouples suitable for use in a system for the direct conversion of heat to electrical energy will be investigated. Isotopes having suitable characteristics will be determined, heat sources will be designed, and prototype batteries will be constructed.

ABSTRACT

A thermoelectric generator having independent outputs of 1.2 and 4.8 volts at more than 50 milliwatts after six month's service has been constructed and tested using a mock Po-210 heat source with an initial thermal power of 37 watts.

LECTURES, REPORTS AND CONFERENCES

A lecture on, "Future Trends of Nuclear Thermoelectric Power Generation", was given by B. C. Blanke at the 12th Annual Battery Conference at Asbury Park, N. J., 22 May 1958.

A conference was held between Dr. Emil Kittl, Dr. Wm. Shorr, and Mound Laboratory personnel at Mound Laboratory on 8 May 1958. It was concluded that three weeks advance notification would be given for preparation of the heat source for the 50-milliwatt battery. Time tables were arranged for completion of the battery. The program for the next and succeeding intervals was discussed.

A telephone discussion was held on 3 June with Francis T. Miles, assistant head of Nuclear Engineering, Brookhaven National Laboratory to determine the possibility of obtaining polonium-210 from the bismuth coolant of the Liquid Metal Fuel Reactor Experiment (LMFRE). Brookhaven estimates that 0.05 gram of polonium can be obtained per thermal megawatt day, or a total of about 25 grams per day. If they are notified of a demand before the final design is complete, this amount could be increased four or five times. A five megawatt experimental reactor of this type should be in operation by 1961.

A 440-curie polonium-210 heat source was prepared to check the activity transfer and welding techniques to be used in battery construction. A sketch of the capsule used is shown in Figure 1. This type of capsule, containing about 1000 curies, will be used as a sub-assembly unit in the construction of larger battery heat sources. It is believed no undue difficulty will be encountered in preparing either the sub-assembly units, or the composite heat sources from them.

Design and construction was completed on a battery with 3 volt-50 milliwatt output after six months service. The design was similar to that of thermoelectric Generator No. 3.

This generator, shown in Figure 2, consisted of 20 mica-cards each containing 37 chromel P-constantan thermocouples in series. The hot junctions were on one edge of the card and the cold junctions on the opposite edge. The cold junctions were mounted between anodized aluminum bars and were electrically insulated by insertion of 0.003-inch Teflon sheet. The aluminum bars were mounted between the edges of two anodized aluminum rings so that the thermocouples were aligned radially with the hot junctions toward the center. There the hot junctions were seated in grooves on an oxidized nickel sleeve. A thin mica strip was placed in the bottom of each groove for electrical insulation, and a thread of Pyrex glass insulated each wall of the grooves and acted as a spacer. A small amount of Sauereisen No. 7 cement was forced into the groove to hold the assembly in place and to insure good thermal contact. The aluminum support bars were turned to a uniform diameter on a lathe after

Cylindrical Capsule for 1000-curie Po-210 Heat Source

Cylindrical Outer Container to Hold 21 Sub-Units for 20,000-curie Heat Source

8684

Figure 1. Heat Sources

580126

Side View

580125

Top View

Figure 2. Thermoelectric Generator No. 6

assembly, and the unit was slid into a close-fitting aluminum can. Spring steel supports were fitted at each end of the assembly to hold a small ceramic rod which aligned the heat source. A cross-sectional view of the assembly is shown in Figure 3.

The size and weight of this battery were slightly greater than those predicted in the previous quarterly report, MLM-CF-58-4-49. The larger size was necessary because the heavier thermocouple wires used required a longer thermal path. Also, this generator is a test unit, and components might have to be removed and checked.

The battery is 2.955 inches in diameter and 2.911 inches long. It weighs 200 grams, including the dummy heat source.

Tests have been run to determine battery output characteristics in a water bath and in air. No vacuum testing was done on this generator. At a temperature differential of 249°C induced by a thermal input of 15.612 watts, an efficiency of 0.32 per cent was obtained. This is the calculated thermal input after six months of the polonium-210 source for this battery.

8083

Figure 3. Thermoelectric Generator No. 6 (Cross Section)

CONCLUSIONS

The generator for the 50 milliwatt battery has been completed and its electrical characteristics determined. The characteristics fell within the specified 1.2 and 4.8 volt independent output at 50-milliwatts. A polonium-210 heat source was constructed and tested for this type of battery.

PROGRAM FOR THE NEXT INTERVAL

Studies will be made to estimate maximum heat source temperatures available as a function of volume of isotope with the various isotopes discussed in the first quarterly report, MLM-CF-57-4-34.

IDENTIFICATION OF KEY PERSONNEL

Bertram C. Blanke	(260 hours)
Kenneth C. Jordan	(260 hours)
John H. Birden	(520 hours)
Elton L. Murphy	(384 hours)
John McKinney	(520 hours)