ALMD58071901109

Copy No. 16

MLM-CF-58-7-19

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

B. C. Blanke

RECORD COPY
Do Not Remove From Library

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.

Mound Laboratory
Miamisburg, Ohio
Operated By
Monsanto Chemical Company
Research and Engineering Division

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

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

Released through the
MOUND LSDR PROJECT
(funded through DOE's OPENNESS INITIATIVE)
Record Copy held at Mound Facility

July 29, 1958

Contracting Officer
Laboratory Procurement Office
U. S. Army Signal Supply Agency
Fort Monmouth, New Jersey
ATTN: R and D Branch, Contract Adm. Div.

Gentlemen:

Reference: MIPR No. R-65-8-99811-SC-01-91

In accordance with MIPR No. R-65-8-99811-SC-01-91, page 3, Note G, paragraphs (a) and (c), three (3) copies of MLM-CF-58-7-19, "Nuclear Battery-Thermocouple Type. Sixth Quarterly Progress Report, April 1, 1958 to June 30, 1958," by B. C. Blanke, are enclosed for review.

The remaining forty-seven (47) copies of the report will be held pending receipt of instructions for their distribution.

Very truly yours
Original
Signed by
T. G. Linxweiler
T. G. Linxweiler
Research Division

TGL/js
Enclosure: cited above

blcc: Dr. J. H. Roberson
Mr. E. C. McCarthy
Dr. J. F. Eichelberger
Mr. B. C. Blanke
Dora Colwell
Mr. T. G. Linxweiler

Document #58-7-19
sent copies 16, 17 & 18
on 7/29/58
M. M. Haney

AD _____ Accession No. _____
Mound Laboratory, Monsanto Chemical Company, Miamisburg, Ohio
NUCLEAR BATTERY - THERMOCOUPLE TYPE
6th QUARTERLY REPORT - B. C. Blanke
MLM-CF-58-7-19, 30 June 1958, 11p., 3 illus.
Signal Corps Contract No. R-65-8-99811-SC-01-91
U.S.D.A. Project No. 3-99-15-102
Unclassified Report

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.

UNCLASSIFIED

Nuclear Batteries
- Design
- Construction
Batteries

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

B. C. Blanke

AD _____ Accession No. _____
Mound Laboratory, Monsanto Chemical Company, Miamisburg, Ohio
NUCLEAR BATTERY - THERMOCOUPLE TYPE
6th QUARTERLY REPORT - B. C. Blanke
MLM-CF-58-7-19, 30 June 1958, 11p., 3 illus.
Signal Corps Contract No. R-65-8-99811-SC-01-91
U.S.D.A. Project No. 3-99-15-102
Unclassified Report

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.

UNCLASSIFIED

Nuclear Batteries
- Design
- Construction
Batteries

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

B. C. Blanke

AD _____ Accession No. _____
Mound Laboratory, Monsanto Chemical Company, Miamisburg, Ohio
NUCLEAR BATTERY - THERMOCOUPLE TYPE
6th QUARTERLY REPORT - B. C. Blanke
MLM-CF-58-7-19, 30 June 1958, 11p., 3 illus.
Signal Corps Contract No. R-65-8-99811-SC-01-91
U.S.D.A. Project No. 3-99-15-102
Unclassified Report

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.

UNCLASSIFIED

Nuclear Batteries
- Design
- Construction
Batteries

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

B. C. Blanke

AD _____ Accession No. _____
Mound Laboratory, Monsanto Chemical Company, Miamisburg, Ohio
NUCLEAR BATTERY - THERMOCOUPLE TYPE
6th QUARTERLY REPORT - B. C. Blanke
MLM-CF-58-7-19, 30 June 1958, 11p., 3 illus.
Signal Corps Contract No. R-65-8-99811-SC-01-91
U.S.D.A. Project No. 3-99-15-102
Unclassified Report

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.

UNCLASSIFIED

Nuclear Batteries
- Design
- Construction
Batteries

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

B. C. Blanke

AD _____ Accession No. _____
Mound Laboratory, Monsanto Chemical Company, Miamisburg, Ohio
NUCLEAR BATTERY - THERMOCOUPLE TYPE
6th QUARTERLY REPORT - B. C. Blanke
MLM-CF-58-7-19, 30 June 1958, 11p., 3 illus.
Signal Corps Contract No. R-65-8-99811-SC-01-91
U.S.D.A. Project No. 3-99-15-102
Unclassified Report

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.

UNCLASSIFIED

Nuclear Batteries
- Design
- Construction

Batteries

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

B. C. Blanke

AD _____ Accession No. _____
Mound Laboratory, Monsanto Chemical Company, Miamisburg, Ohio
NUCLEAR BATTERY - THERMOCOUPLE TYPE
6th QUARTERLY REPORT - B. C. Blanke
MLM-CF-58-7-19, 30 June 1958, 11p., 3 illus.
Signal Corps Contract No. R-65-8-99811-SC-01-91
U.S.D.A. Project No. 3-99-15-102
Unclassified Report

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.

UNCLASSIFIED

Nuclear Batteries
- Design
- Construction

Batteries

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

B. C. Blanke

AD _____ Accession No. _____
Mound Laboratory, Monsanto Chemical Company, Miamisburg, Ohio
NUCLEAR BATTERY - THERMOCOUPLE TYPE
6th QUARTERLY REPORT - B. C. Blanke
MLM-CF-58-7-19, 30 June 1958, 11p., 3 illus.
Signal Corps Contract No. R-65-8-99811-SC-01-91
U.S.D.A. Project No. 3-99-15-102
Unclassified Report

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.

UNCLASSIFIED

Nuclear Batteries
- Design
- Construction

Batteries

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

B. C. Blanke

AD _____ Accession No. _____
Mound Laboratory, Monsanto Chemical Company, Miamisburg, Ohio
NUCLEAR BATTERY - THERMOCOUPLE TYPE
6th QUARTERLY REPORT - B. C. Blanke
MLM-CF-58-7-19, 30 June 1958, 11p., 3 illus.
Signal Corps Contract No. R-65-8-99811-SC-01-91
U.S.D.A. Project No. 3-99-15-102
Unclassified Report

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.

UNCLASSIFIED

Nuclear Batteries
- Design
- Construction

Batteries

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

B. C. Blanke

MLM-CF-58-7-19

NUCLEAR BATTERY-THERMOCOUPLE TYPE
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

U. S. Army Signal Research and Development Laboratories Technical Requirement Nos. P. R. and C. 58-ELS/R-3705, 58-ELS/0-3861 (S)

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

MOUND LABORATORY
Miamisburg, Ohio
Operated By
MONSANTO CHEMICAL COMPANY
Research and Engineering Division

United States Atomic Energy Commission
Contract Number AT-33-1-GEN-53

CONFIRMED TO BE UNCLASSIFIED
MOUND DECLASSIFICATION OFFICE
RAYMOND RATAY A.D.D. DATE: 4/28/98

	No. of Copies
Dr. Carroll A. Hochwalt, Vice President, Monsanto Chemical Company	1
Mr. H. K. Nason, Project Director, Vice President, Monsanto Chemical Company	1
Dr. John H. Roberson, Area Manager, Dayton Area Office, USAEC	1
Mr. E. C. McCarthy, Plant Manager, Mound Laboratory	1
Mr. D. L. Scott, Director of Production, Mound Laboratory	1
Dr. J. F. Eichelberger, Director of Research, Mound Laboratory	1
Mr. J. W. Wiesler, Director of Engineering, Mound Laboratory	1
Mr. J. H. Birden	1
Mr. B. C. Blanke	1
Dr. J. W. Heyd	1
Mr. K. C. Jordan	1
Mr. D. W. King, Patent Attorney, ALO, USAEC	1
Jet Propulsion Laboratory, Attn. I. E. Newlan	1
TISE, Oak Ridge	2
Library and Records Center	15
Dr. Emil Kittl, U. S. Army Signal Research and Development Laboratories	1
Contracting Officer, U.S. Army Signal Supply Agency	3
Tech Library, OASD (R and E), Rm 3E1065, The Pentagon, Wash 25, D. C.	1
Ch of R and D, OCS, Dept of the Army, Wash 25, D. C.	1
CG, USASRDL, Ft Monmouth, N. J. ATTN: Dir of Research	1
CG, USASRDL, Ft Monmouth, N. J. ATTN: Tecn Doc Ctr	13
CG, USASRDL, Ft Monmouth, N. J. ATTN: Adjutant Br, Mail, File and Records	1
CG, USASRDL, Ft Monmouth, N. J. ATTN: Ch, Tech Info Div (FOR RETRANS TO ACCREDITED BRITISH AND CANADIAN GOVMT REPRESENTATIVES)	3
Continental Army Command Liaison Office, USASRDL, Ft Monmouth, N. J.	3
CO, U. S. Army Signal Equipment Support Agency, Ft Monmouth, N. J. ATTN: SIGFM/ES-ASA	1
Chief Signal Officer, Dept of the Army, Wash 25, D. C. ATTN: SIGRD-7	1
Director, U.S. Naval Res Lab, Code 2027, Wash 25, D. C.	1
Commanding Officer and Director, U.S. Navy Electronics Lab, San Diego 52, California	1
Commander, Wright Air Development Ctr, Wright-Patterson Air Force Base, Ohio ATTN: WCOSI-3	2
Commander, Air Force Cambridge Res Ctr, CROTR, L. G. Hanscom Field, Bedford, Massachusetts	1
Commander, Rome Air Development Ctr, Griffiss Air Force Base, Rome, New York ATTN: RCSST-3	1
Commander, Armed Services Tech Information Agency, Arlington Hall Station, Arlington 12, Virginia	10
CG, USASRDL, Ft Monmouth, N. J. ATTN: SIGFM/EL-P	1
CG, U.S. Army Electronic Proving Ground, Fort Huachuca, Arizona	1
Commander, Wright Air Development Center, Wright-Patterson AFB, Ohio ATTN: WCLEE-1	1
Chief, Bureau of Ships, Dept of the Navy, Wash 25, D. C. ATTN: Code 560 S	1
Naval Ord Lab, Rm A-022, White Oak, Silver Springs 19, Md ATTN: Mr. Hellfritsch	1
National Bureau of Standards, Electrochemistry Sec (Div 1.9, Wash 25, D. C.	1
	81

TABLE OF CONTENTS

	Page
ABSTRACT	4
LECTURES, REPORTS, AND CONFERENCES	5
FACTUAL DATA	6
CONCLUSIONS	11
PROGRAM FOR NEXT INTERVAL	11
KEY TECHNICAL PERSONNEL	11
ILLUSTRATIONS	
Fig. 1 Heat Sources	7
Fig. 2 Thermoelectric Generator No. 6	8
Fig. 3 Thermoelectric Generator No. 6 Cross Sectional View	10

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.

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.

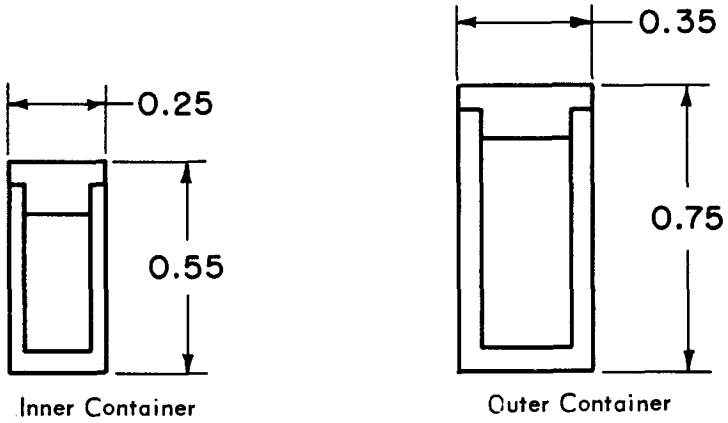
A conference was held between Dr. Emil Kittl, Dr. Wm. Shorr, and Mound Laboratory personnel at Mound Laboratory on 8 May 1958. It was concluded that three weeks advance notification would be given for preparation of the heat source for the 50-milliwatt battery. Time tables were arranged for completion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

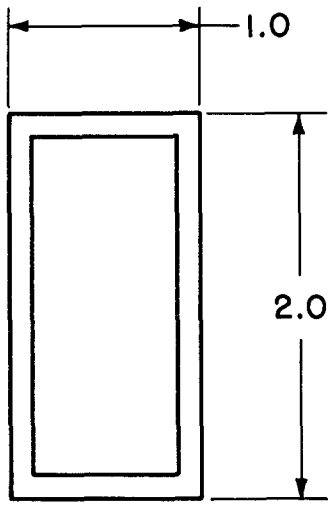
A 440-curie polonium-210 heat source was prepared to check the activity transfer and welding techniques to be used in battery construction. A sketch of the capsule used is shown in Figure 1. This type of capsule, containing about 1000 curies, will be used as a sub-assembly unit in the construction of 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 6 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

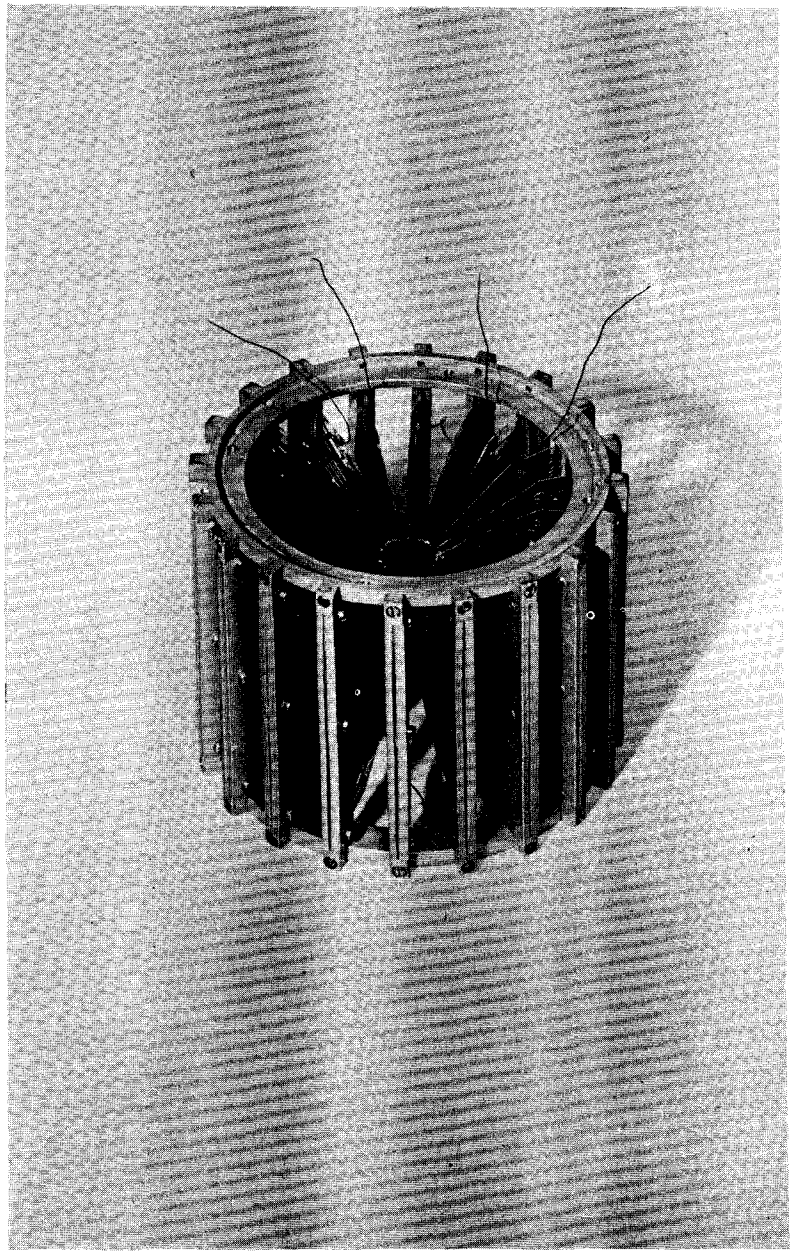


Cylindrical Outer Container to Hold 21
Sub-Units for 20,000-curie Heat Source

8684

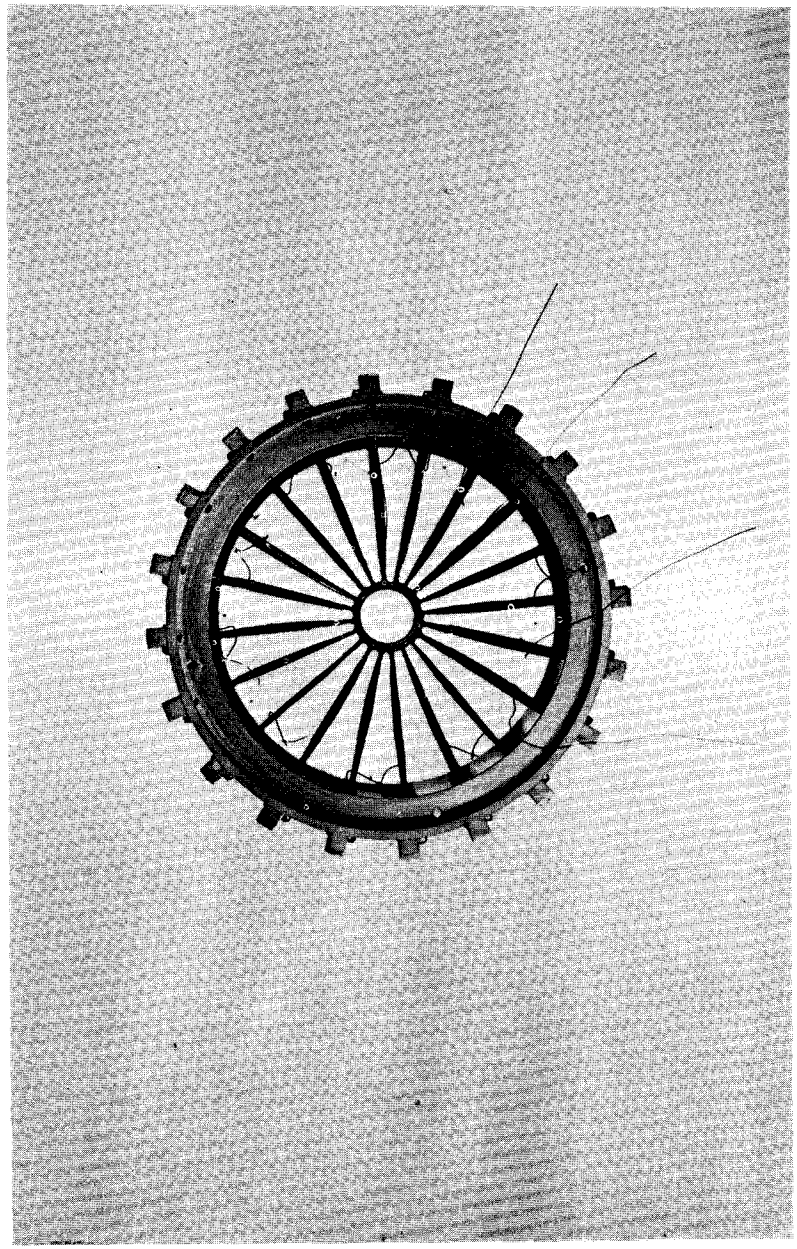
Figure 1. Heat Sources

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.

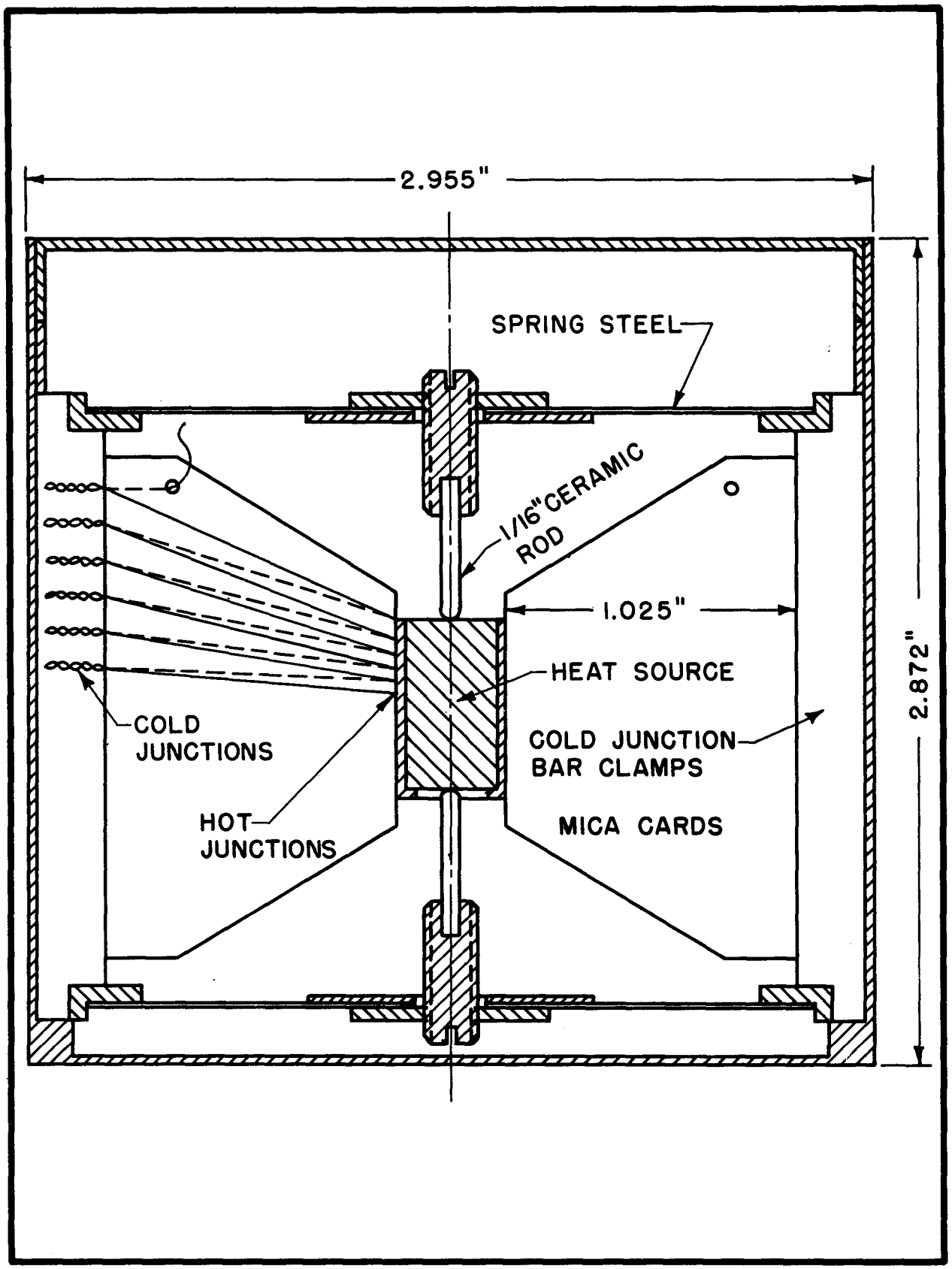


Figure 3. Thermoelectric Generator No. 6 (Cross Section)

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)