

UNCLASSIFIED

AD 402 639

*Reproduced
by the*

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

63 3 3

THE DEVELOPMENT OF A LOW-WORK-FUNCTION COLLECTOR
FOR THERMIONIC ENERGY CONVERTERS

Authors:

W. B. Hall
R. J. Hill
J. J. O'Grady

Approved by:

F. G. Block
J. L. Straub, II

402 639

RADIO CORPORATION OF AMERICA
Electron Tube Division
Lancaster, Pennsylvania

Second Bi-Monthly Status Report

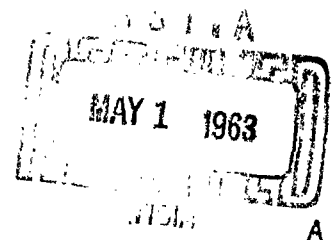
Period Covered:

15 February 1963 through 15 April 1963

Contract NONR 4012(00)-FBM

Prepared For:

DEPARTMENT OF THE NAVY
Office of Naval Research
Washington 25, D. C.



CATALOGED BY ASTIA
AS AD NO. 402639

SECOND BI-MONTHLY STATUS REPORT
CONTRACT NONR 4012(00)-FBM

THE DEVELOPMENT OF A
LOW-WORK-FUNCTION COLLECTOR
FOR THERMIONIC ENERGY CONVERTERS

SECTION I
PURPOSE

The effort under the subject program will be directed to the achievement of a "low-work-function collector" for converters operating in the "Ball-of-Fire" mode of the low-voltage arc. Changes in work function will be determined by comparative measurement in actual operation of converters under identically controlled conditions. Three approaches will be investigated: (1) the development of a material or surface which, when partially coated with cesium, gives a low-work-function, (2) the development of a low-work-function surface which is kept free of cesium, and (3) the addition of gas additives which, in conjunction with cesium on the base material, produces a low-work-function.

26 April 1963

SECTION II
DETAILED FACTUAL DATA

A. General

The effort under the subject contract has progressed in accordance with the program outlined in the first report.

B. Detailed Program

The design of all the components has been completed and all parts ordered. Most of the items have been received and fabrication has started.

The feasibility of using a long bellows for a flexible coupling was demonstrated using a mock-up assembly.

The main design problems include the development of an emitter capable of working in the 1200-1400° Centigrade range with stability and reliability and having a low temperature variation across its diameter. It is also important to be able to outgas and "age" the emitter at temperatures higher than 1200-1400° Centigrade operating range, preferably up to 1800° Centigrade. In order to process an emitter for these properties electron bombardment heating and conduction heating are being evaluated. The electron bombardment method is capable of reaching the high outgassing temperature, but may present problems of poor radial temperature distribution. In conjunction with the electron bombardment design, a conduction-heated emitter has been designed and a test model constructed. This conduction-heated emitter consisted of a heater of photoetched 0.002-inch thick, rhenium sheet, sandwiched between two thin sheets of high temperature ceramic. The sandwich was pressed into a recess in the back of the emitter and held in place by a molybdenum disc. Preliminary tests of this design show that at 1450° Centigrade

there is very little variation in temperature across the emitter surface. The top working temperature of this device is limited by the melting point of the ceramic; which is in excess of the 1800° Centigrade level desired.

The first approach, as outlined in Section I of this report, will be the investigation of the physical nature of a collector material and its relation to minimum work function. Collectors will be constructed of single crystal, ultra-pure polycrystalline, and matrix materials. Tungsten has been chosen for the initial test because of its availability in the three desired forms.

In conjunction with this investigation, additional collectors are being fabricated employing the following materials:

- (a) Nickel, in pure and commercial grades
- (b) Niobium
- (c) Tantalum
- (d) Molybdenum
- (e) Stainless Steel - Type 304
- (f) Rhenium
- (g) Iridium as matrix on a molybdenum base

The first test will indicate the optimum material form to be used for best performance. Subsequent tests will determine the best material for use in a collector.

The cesium distillation system has been modified to incorporate a liquid nitrogen cold finger. This modification will achieve an increased purification of the cesium following the method of Herold,¹ by the removal of hydrogen. It will also facilitate electron bombardment outgassing of collectors, and evaporation of material onto collectors, without the complete removal of cesium from the system.

¹Herold, Annales de Chemie, Ser. 12, 6, 33 (1951).

SECTION III
PROGRAM FOR NEXT REPORT PERIOD

The effort during the next report period will include the following items:

- (a) Assembly of parts and completion of the test vehicle.
- (b) Evaluation of electron bombardment and directly-heated emitters.
- (c) Test of circuit for monitoring characteristic curves as compared with prior experience.
- (d) Assembly and check-out of RCA-owned vacuum system.
- (e) Development of methods of fabrication of matrix collectors employing rhenium and iridium on a molybdenum base.

DISTRIBUTION LIST

	<u>Number of Copies</u>
Commander J. J. Connelly, Jr. Bureau of Ships Department of the Navy Washington 25, D. C.	3
Office of Naval Research Power Branch (Code 429) Department of the Navy Washington 25, D. C.	4
Cognizant ONR Area Branch Office	1
U. S. Naval Research Laboratory Technical Information Division Washington 25, D. C.	6
Commanding Officer Office of Naval Research Branch Office Box 39 Navy #100 Fleet Post Office New York, New York	2
Office of Technical Services Department of Commerce Washington 25, D. C.	1
Armed Services Technical Information Agency Arlington Hall Station Arlington 12, Virginia	10
National Aeronautics & Space Administration 1520 H. Street, N. W. Washington 25, D. C. Attn: James J. Lynch	1
National Aeronautics & Space Administration Lewis Research Center 2100 Brookpark Road Cleveland 35, Ohio Attn: H. Schwartz R. Breitwieser B. Lubarsky Wm. LeGray R. P. Migra	1 1 1 1 1

DISTRIBUTION LIST
(Continued)

	<u>Number of Copies</u>
Chief of Naval Operations (OP-O7G) Department of the Navy Washington 25, D. C.	1
Commandant, U. S. Marine Corps Code CSY-3 Headquarters, Marine Corps Washington 25, D. C.	1
Chief, Bureau of Ships Department of the Navy Washington 25, D. C. Attn: Code 342B	
Code 1500, Mr. Wm. Hewitt	1
Code 456B, Mr. V. Gardner	1
Code 210L	1
U. S. Atomic Energy Commission Division of Reactor Development Washington 25, D. C. Attn: SNAP Reactor Branch	1
Direct Conversion Branch	1
Army Reactor, Water Systems Branch	1
Isotopic Power Branch	1
U. S. Atomic Energy Commission San Francisco Operation Office 2111 Bancroft Way Berkeley 4, California Attn: Reactor Division	1
Aeronautical Systems Division ASRMFP-2 Wright-Patterson Air Force Base Ohio	1
Air Force Cambridge Research Center (CRZAP) L. G. Hanscom Field Bedford, Massachusetts	1

DISTRIBUTION LIST
(Continued)

	<u>Number of Copies</u>
Power Information Center University of Pennsylvania Moore School Building 200 South 33rd Street Philadelphia 4, Pennsylvania	1
Director of Special Projects (SP-001) Department of the Navy Washington 25, D. C.	10
Los Alamos Scientific Laboratory P. O. Box 1663 Los Alamos, New Mexico Attn: Dr. George M. Grover	1
Argonne National Laboratory 9700 South Cass Avenue Argonne, Illinois Attn: Aaron J. Ulrich	1
Director, Advanced Research Projects Agency The Pentagon Washington 25, D. C. Attn: Dr. John Huth	1
U. S. Army Signal R&D Laboratory Fort Monmouth, New Jersey Attn: Emil Kittl	1
Research Laboratories Library General Motors Corporation General Motors Technical Center P. O. Box 388 Warren, Michigan Attn: Dr. F. Jamerson	1
Atomics International P. O. Box 309 Canoga Park, California Attn: Dr. R. C. Allen	1

DISTRIBUTION LIST
(Continued)

	<u>Number of Copies</u>
General Atomic P. O. Box 608 San Diego 12, California Attn: Dr. W. Pidd	1
ARACON Laboratories Virginia Road Concord, Massachusetts Attn: Dr. S. Ruby	1
Ford Instrument Company 3110 Thomson Avenue Long Island City, New York Attn: T. Jarvis	1
Armour Research Foundation 10 W. 35th Street Chicago 16, Illinois Attn: Dr. D. W. Levinson	1
Jet Propulsion Laboratory California Institute of Technology 4800 Oak Grove Drive Pasadena, California Attn: P. Rouklove	1
RCA Laboratories David Sarnoff Research Center Princeton, New Jersey Attn: Dr. Paul Rappaport	1
Thermo Electron Engineering Corporation 85 First Avenue Waltham 54, Massachusetts Attn: Dr. George Hatsopoulos	1
Hughes Research Laboratories 3011 Malibu Canyon Road Malibu, California Attn: Dr. R. C. Knechtli	1

DISTRIBUTION LIST
(Continued)

	<u>Number of Copies</u>
Thomson Ramo Wooldridge, Inc. 7209 Platt Avenue Cleveland 4, Ohio Attn: Wm. J. Leovic	1
General Electric Research Laboratory Schenectady, New York Attn: Dr. V. C. Wilson	1
The Marquardt Corporation ASTRO Division 16555 Satacoy Street Van Nuys, California Attn: Dr. R. Laubenstein	1
Texas Instruments, Inc. P. O. Box 5474 Dallas 22, Texas Attn: Dr. R. A. Chapman	1
University of Denver Colorado Seminary Denver Research Institute Denver 10, Colorado Attn: Dr. Charles B. Magee	1
Radio Corporation of America Electron Tube Division Lancaster, Pennsylvania Attn: F. G. Block	1
Electro Optical Systems, Inc. 300 N. Halstead Avenue Pasadena, California Attn: Dr. A. O. Jensen	1
General Electric Company P. O. Box 846 Atomic Product Division Vallecitos Laboratory Pleasanton, California Attn: Robert Scott	1

DISTRIBUTION LIST
(Continued)

	<u>Number of Copies</u>
General Electric Company Power Tube Division 1 River Road Schenectady 5, New York Attn: Mr. D. L. Schaefer	1
Knolls Atomic Power Laboratory Schenectady, New York Attn: Dr. R. Ehrlick	1
Consolidated Controls Corporation Bethel, Connecticut Attn: Mr. David Mends	1
Institute for Defense Analysis 1666 Connecticut Avenue, N. W. Washington, D. C. Attn: Mr. Robert Hamilton	1
RCA	25

"Information furnished by RCA is believed to be accurate and reliable. However, no responsibility is assumed by RCA for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent rights of RCA."