UNCLASSIFIED

AD NUMBER
AD047677
CLASSIFICATION CHANGES
TO: **unclassified**
FROM: **confidential**
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; SEP 1954. Other requests shall be referred to Navy Bureau of Ships, Washington, DC.**
AUTHORITY
30 sep 1966, DoDD 5200.10; navy 1 apr 1968

THIS PAGE IS UNCLASSIFIED

AD No. 47677
ASTIA FILE COPY

CONFIDENTIAL

FARNSWORTH ELECTRONICS COMPANY

A DIVISION OF INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
FORT WAYNE, INDIANA

FARNSWORTH ELECTRONICS TELEPHONE EASTBROOK 7571

Serial No. 713 Copy No. 4

RESEARCH DEPARTMENT

STATEMENT OF PROGRESS ON RESEARCH AND DEVELOPMENT OF INFRARED ELECTRON IMAGING DEVICES

NAVY DEPARTMENT BUREAU OF SHIPS ELECTRONICS DIVISION

NObsr-64520 Work Order No. 853-56018 September 29, 1954

Period Covered: July 15, 1954 to September 15, 1954

Prepared by

E. H. Eberhardt
Project Engineer

Approved by:

R. K. Orthuber
Project Supervisor

C. C. Larson
Director of Research

IMPORTANT: This report is for the information of the addressee only. It is not to be circulated or duplicated without express permission of the Bureau of Ships.

NOV 4 1954

CONFIDENTIAL 54A A 66648

1.0 PURPOSE

The purpose of the work being done under this contract (NObsr-64520) is to investigate and develop a heat image tube capable of presenting a continuous view of objects near ambient temperature by the utilization of the infra-red radiation beyond 2 microns emitted by such objects.

2.0 WORK PROGRESS

During the first month of this report period work on the project was kept to an absolute minimum, sufficient only to maintain project personnel, since the monetary appropriations had not yet been completed. A number of thin (0.1μ to 0.2μ) Al_2O_3 films were constructed in preparation for more extensive target investigations. Experimental tests were made of Harris' method for making Al_2O_3 films, and found to have some advantages over Strohmaier's method. However, the latter method is still being used as the standard technique and is considered to be the best at present.

During the period from August 15th to September 15th, a more intensive work program was started although, of course, the limited appropriations for this year limit the personnel to a maximum of two full-time engineers. Emphasis has been placed on the construction of composite films, with evaporated thermo-resistive layers. The primary reason for this decision, was that, so far, no material has been found which satisfies the requirements for both the mechanical film support and the sensitive layer. Also it is felt that an evaporated layer can be made much more uniform in thickness, less subject to surface imperfections, and more adaptable to special treatments to improve the thermo-resistive properties.

In addition an effort is being made to find a method of measuring the resolving power of present films, which are so thin that the optical system is probably limiting the resolution obtained during test.

3.0 FILM TESTS

A. Al_2O_3 + Cr

A simple film of this construction was built and tested chiefly to confirm earlier results and to serve as a comparison reference to other films. As expected, Al_2O_3 as a thermo-resistive element, is unsatisfactory due to polarization, burn-in effects, and general instability.

B. $Al_2O_3 + Cr + Sb_2S_3$

A composite film of this type was tested and found to hold considerable promise. A certain amount of pattern burn-in was noted, but polarization and raster burn was negligible. Sensitivity was fair-to-good, about 100-150° threshold (see definition below).

C. $Al_2O_3 + Cr + Sb_2S_3$ (multiple)

Two special films were constructed using variable thicknesses of both Cr and Sb_2S_3 in an effort to find, if possible, optimum conditions. The results show that the Cr must be heavier than about 500 ohms/square and the Sb_2S_3 at least 3 interference orders thick in order to get satisfactory electron scan operation. Thinner layers of Cr show a very much increased number of spots under scan, probably due to a break up in the Cr layer. No measurements of any loss in thermal resolution for the thicker films was observed, apparently due to the lack of optical system resolution. At least 30 line pairs per raster resolution can be obtained even with the heavier films.

D. $Al_2O_3 + Cr + As_2S_3$

This As_2S_3 film showed improved (higher) resistivity over Sb_2S_3 and probably higher sensitivity. However, very severe pattern burn-in occurred - preventing the use of such a composite target film, at least without further treatment. Exposure to air between target evaporation and test is known to be detrimental in some cases, which may explain the burn-in. This exposure can be eliminated if necessary.

E. Glass-backed Film

A composite film of $Al_2O_3 + Cr + Sb_2S_3$ was built in which part of the thin film was self-supporting and part backed by a glass plate. Using a slide projector and 2540 filter as an image source, and thus utilizing 1-3μ heat radiation, it was found that Sb_2S_3 was sensitive only to thermal changes in this region, and did not have any observable photoconductive effect.

4.0 OPTICAL SYSTEM

Due to the lack of resolution in the far infra-red optics now available (tilted spherical mirror) this was replaced by an earlier system using a projector and glass refractive optics with a 2540 filter, confining the input radiation to the sensitive targets to the near infra-red region (1-3μ). The thermal output of this system was calibrated with a non-selective calibrated thermopile. The absorption by the target film is then measured or approximated (about 20% for present films) giving the image radiation density input to the thin film. Thus, threshold radiation densities can be readily determined. If it is assumed that a far infra-red optical system were available, whose optical efficiency was 5%, then this radiation density can be converted to an equivalent black body temperature. This process will be used to specify temperature thresholds for targets (see 3-B above) until a far infra-red system is obtained.

The present optical system is limited in resolution due to chromatic aberration in the lens used which is corrected only for the visible region. Experimental measurements of the optical system resolving power will be made immediately.

Investigation of the problem of a far infra-red optical system with satisfactory efficiency and resolving power will continue. Lack of adequate funds requires that careful consideration be given to this problem.

5.0 DEMOUNTABLE VACUUM SYSTEM

Tests are being confined largely to the demountable vacuum system, although one sealed-off tube has been pumped and another built during this period. Thermionic cathodes stand up fairly well but must be replaced every 3-4 pumpings. It has been found that the defining beam aperture in the electron gun must be reduced from .010" to .003" in order to get satisfactory scan operation.

6.0 PROGRAM FOR NEXT PERIOD

A. Measure resolving power of present near infra-red optical system and improve if necessary.

B. Try more Sb_2S_3 composite films. Try to improve shading and spot (noise) problems.

C. Try porous (gas evaporated) Sb_2S_3 to obtain higher resistivity.

D. Find and test other suitable thermo-resistive materials which can be evaporated.

E. Investigate thermal radiation from gun to target. Minimize if desirable.

F. Continue search for suitable far infra-red system.

7.0 PROJECT PERSONNEL

H. Lott - Full time
E. H. Eberhardt - Part time