# NATIONAL BUREAU OF STANDARDS REPORT

**NBS PROJECT**
0201-20-2300

March 26, 1954

**NBS REPORT**
3176

REPORT
ON
AN INVESTIGATION OF THE OPERATING CHARACTERISTICS
OF
AN NBS OBTURATOR-PROBE FOCUS CONTROL
IN
AN AN/AVQ-2A AIRCRAFT SEARCHLIGHT

by
J. A. LeReche
and
J. W. Lane, Sr.

Naval Aircraft Lighting Group
Photometry and Colorimetry Section
National Bureau of Standards
Washington 25, D. C.

Test 21N-179/53

Sponsored by
Lighting Section
EL-521
Bureau of Aeronautics
Department of the Navy

NBS

**U. S. DEPARTMENT OF COMMERCE**
**NATIONAL BUREAU OF STANDARDS**

An Investigation of the Operating Characteristics of an NBS Obturator-Probe Focus Control in an AN/AVQ-2A Aircraft Searchlight

## 1. INTRODUCTION

In 1951, the Naval Aircraft Lighting Group at the National Bureau of Standards developed a modification kit for the AN/AVQ-2A aircraft searchlight. This modification was intended to improve the reliability of operation of the searchlight. The principal component of the kit was the obturator-probe, a disc of copper which replaced the obturator of the searchlight and at the same time acted as a probe control to maintain the positive carbon in focal position automatically. The probe method of focus control replaced the thermostat-optical system that is standard on the AN/AVQ-2A searchlight. Ten modification kits were fabricated at the National Bureau of Standards and furnished to the Navy for field evaluation. Two evaluations were made, one at the Key West Naval Air Station and one at the San Diego Naval Air Station. The reports of both evaluations were favorable and it was recommended that the modification be incorporated into the searchlights.

Recently, it was found at NBS and at the Strong Electric Corp. that under certain operating conditions, a deposit forms on the controlling edge of the obturator-probe, leading occasionally to reduction in the accuracy of focus control, and, in the most extreme cases, to loss of control altogether. Accordingly, the investigation herein reported was undertaken to ascertain the conditions under which these deposits form, and, if possible, to redesign the obturator-probe so as to minimize or eliminate the difficulty, and generally improve its operation.

## 2. MATERIALS TESTED

The AVQ-2A arc lamp mechanism was tested with several obturator-probes modified by various changes from their original shapes.

Tests were made with obturator-probes modified as follows:

1) Two one-quarter inch holes were drilled from the bottom of the obturator-probe to the recess in the center. Two more holes of the same diameter were drilled from the top of the obturator-probe to the recess. This was done to determine whether ventilating the recess would affect the formation of the deposit.

2) The controlling edge of the obturator-probe was raised 1/16 of an inch above its original design. This was done to remove the edge from the intense heat of the arc and the products of combustion.

3) The controlling edge was rounded to present a smooth curve to the positive tail flame. The screw mounting holes were later elongated vertically in order to permit vertical adjustments of the obturator-probe over a range of about 7/32 of an inch.

## 3. TEST PROCEDURE

The modified obturator-probes were mounted on a standard NBS-modified AVQ-2A arc lamp mechanism and their performance compared with an obturator-probe of the original design. The values of resistive ballast in series with the arc current were varied in order to determine the relation between the value of ballast and the tendency for the deposits to form on the obturator-probe. It was found that the deposits formed most readily with smaller amounts of ballast (stiffer power supply). Accordingly, the bulk of the work was done with the minimum ballast practicable in the laboratory, amounting to a voltage drop at rated current of about 12 volts. This effectively limited the peak current on striking to about 350 amperes.

Two methods were used to evaluate the results and compare the effectiveness of the modified obturator-probes. By one method, the extension of the positive carbon from the obturator was measured after each run. This method was used in evaluating the first two modifications of the obturator-probe.

With the second method, a 50 mm photographic lens was employed to project the image of the arc on a screen placed at a suitable distance to obtain a magnification of about ten to one. A scale was drawn on the screen to represent 1/32-inch movements of the positive carbon. The image of the arc was observed during the entire run during which the limits of control and the general behavior of the arc were noted. This method of observation was used in the measurements made to determine the proper mounting height of the third modification of the obturator-probe. The amount of deposit on the controlling edge of the obturator-probe was observed and noted during and after each run. The duration of the strikes was varied in order to simulate the range of actual operating conditions and to ascertain the conditions under which the deposits are most likely to occur. Observations on about 400 runs were compiled for the results of the test. In each case the magnetic field surrounding the arc was adjusted by bending or aligning the positive bus beneath the arc to obtain a good tail flame and a smoothly operating arc. The arc was operated at rated current and voltage.

## 4. TEST RESULTS

The rate of formation of a deposit on the controlling edge of the obturator-probe did not appear to be affected by the addition of vent holes nor was it affected by raising the controlling edge.

It was observed that deposits on the controlling edge of the obturator-probe could be placed in two categories, soft and hard deposits. The soft deposits resembled a very small feather protruding from the controlling edge of the obturator-probe, and parallel to the positive tail flame. Its formation was rapid and took place when the arc misbehaved because of an improperly placed magnetic field or eccentricity in the negative and positive carbon axes.

This deposit is apparently conductive, since it affected the controlled position of the positive carbon as if it were an extension of the obturator-probe. However, it is easily dislodged by heat, convection currents, and probably by vibrations such as would occur in an aircraft. This type of deposit is not of much concern since its formation can be controlled to a certain extent and, in every case, it disappeared within about one half minute of operation. The hard deposits of the second category resembled a small bulbous growth of carbon on the controlling edge of the obturator-probe. This deposit, like the soft deposit, was found to be electrically conductive and therefore affected the position of control of the positive carbon. Its formation was rare when the arc was operating normally; however, it was almost certain to occur when the positive carbon burned back into the recess of the obturator-probe because of malfunction of the mechanism or because of an abnormally large number of strikes (of the order of six or more) of very short duration (about five seconds). Violent strikes such as occur when the arc power supply does not have the proper droop characteristics (see NBS Report No. 1872, "Droop Characteristics of Power Supplies for the AVQ-2A Searchlight"), or with carbons still hot from a previous strike, also increase the possibility of deposits of the hard variety. These deposits formed comparatively slowly over a period of about one or two minutes of actual operation, intermittent or continuous. They disappeared in about the same length of time apparently due to the intense heat. The situation became grave when the positive carbon burned back into the recess of the obturator-probe and the deposits formed on the controlling edge extended downward sufficiently to block the advance of the positive carbon. Continued operation under this condition may result in the formation of additional deposits and possible arcing between the obturator-probe and the negative carbon.

Increasing the vertical distance between the controlling edge of the obturator-probe and the positive carbon did not appear to have an effect on the formation of deposits on the obturator's controlling edge. When deposits did occur, it took a longer time for them to extend down to the positive carbon and cause serious

malformation of the arc. However the location of the tip of the positive carbon was not controlled as accurately with the controlling edge further from the carbon.

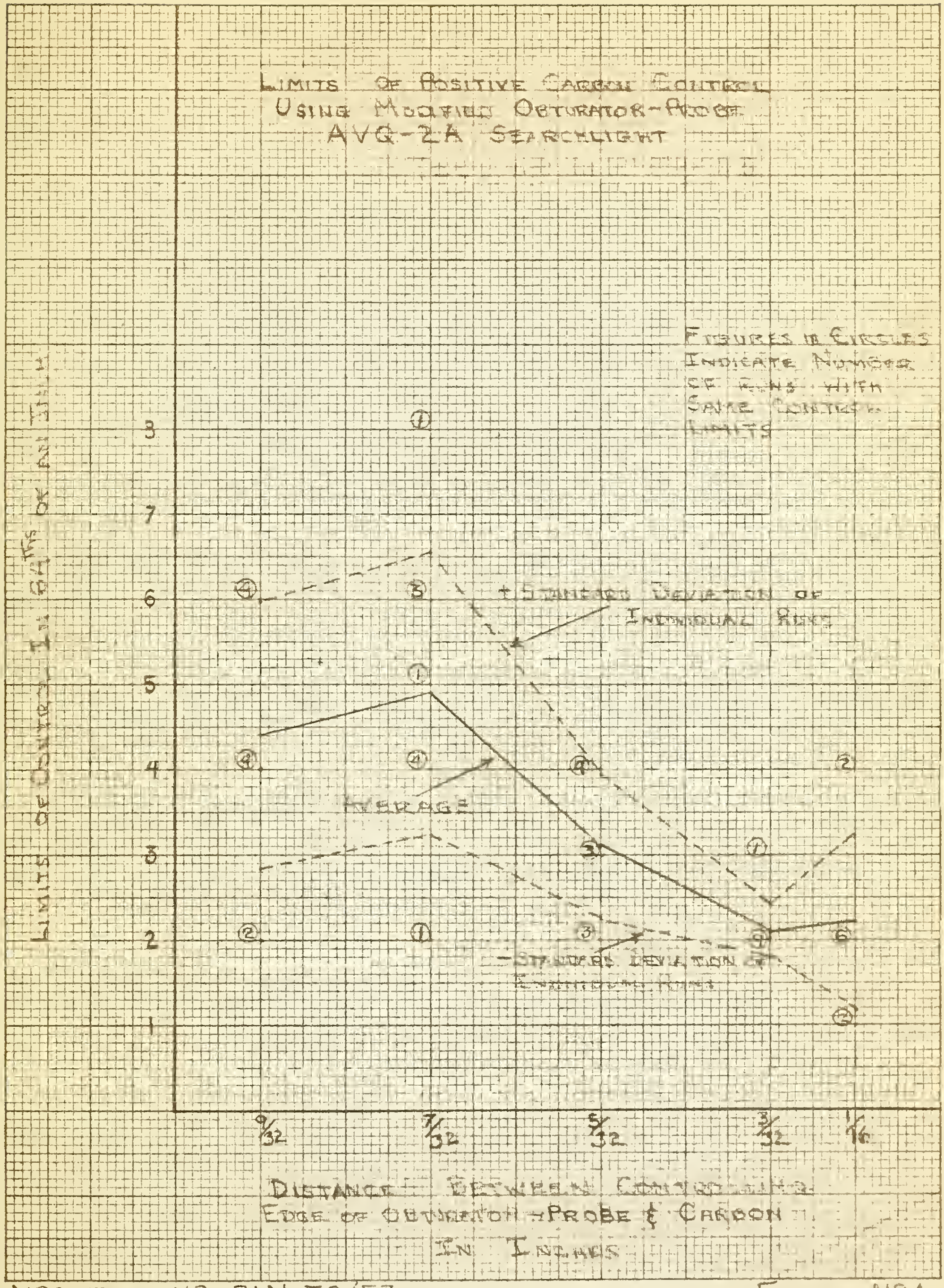
Rounding the controlling edge of the obturator-probe did not prevent the formation of deposits. However the deposit was more widely distributed and took longer to build up in sufficient quantity to affect the control position of the positive carbon.

The effect on focus control of varying the distance between the controlling edge of the obturator-probe and the positive carbon is shown in Fig. 1. The average variation of the limits of control for groups of ten runs for various vertical separations is shown. The standard deviation for individual runs is also indicated on the graph.

## 5. CONCLUSIONS AND RECOMMENDATIONS

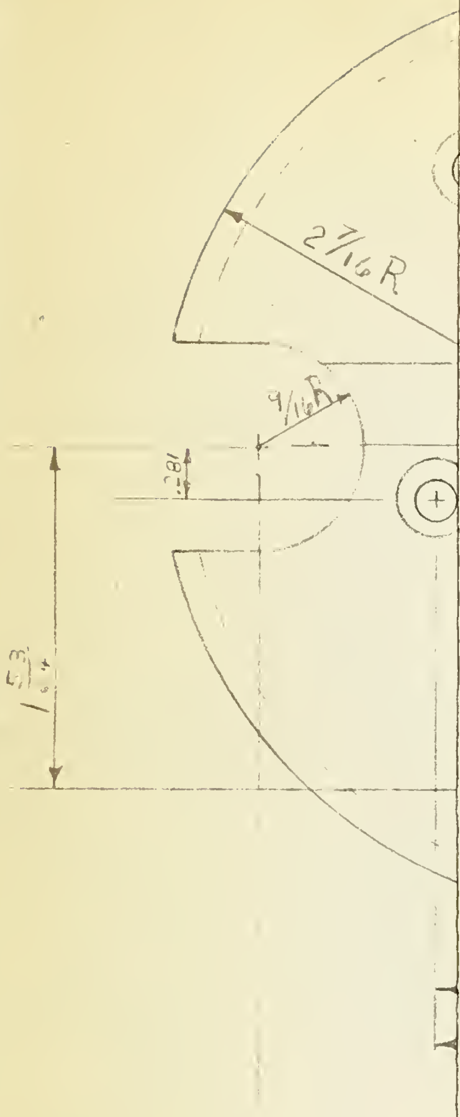
The modification of the obturator-probe controlling edge is recommended as shown in Fig. 2 (Drawing 1354-1A), "Obturator-probe for AVQ-2A Searchlight". The rounded controlling edge will not prevent the formation of a deposit, but will tend to minimize its deleterious effects and will result in improved operation. The one-eighth inch spacing between the controlling edge of the obturator-probe and the positive carbon was determined to be optimum design for good control, reliability of operation, and reasonable safeguard against the formation of deposits in sufficient amounts to cause actual contact with the positive carbon.

Deposit build-up on the controlling edge of the obturator-probe can be minimized by careful adjustment for proper arc operation. This adjustment should include, if necessary, bending or alignment of the positive contact bus located under the arc in order to obtain a smoothly operating arc with a tail flame that is not split and produces little or no soot. Attention should also be given to the arc current and voltage as well as to the power supply characteristics with respect to ballast of proper droop regulation. (See NBS Report No. 1872).




NBS Test No 21N-79/53

Figure No 1

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REF: NBS REPORT 1354

| PIECE NO. | NOMENCLATURE | NO. REQ'D |
|---|---|---|

**NATIONAL BUREAU OF STANDARDS**
WASHINGTON 25, D. C.

OBTURATOR – PROBE

FOR— AVQ-2A SEARCHLIGHT

| MODEL | TYPE | SCALE 1:1 |
|---|---|---|
| DIMENSIONS IN INCHES (*Unless otherwise specified*) | DRAFTSMAN J.A.L. | CHECKER |
| TOLERANCES (*Unless otherwise specified*) | PROJECT ENGR. | PROJECT ENGR. |
| DECIMALS ±.005<br>FRACTIONS ±.015<br>ANGLES ±½° | SUBMITTED BY<br>CHIEF. SEC. ........ | |
| | EXAMINED BY<br>CHIEF ENGINEER | |
| DO NOT SCALE THIS PRINT | APPROVED BY<br>CHIEF. DIV. ........ | |
| DIV. SEC. 2.1 / THIS PRINT ISSUED | 1354-1A | |

| ORIGINAL DATE OF DRAWING | FEB [illegible] | | |
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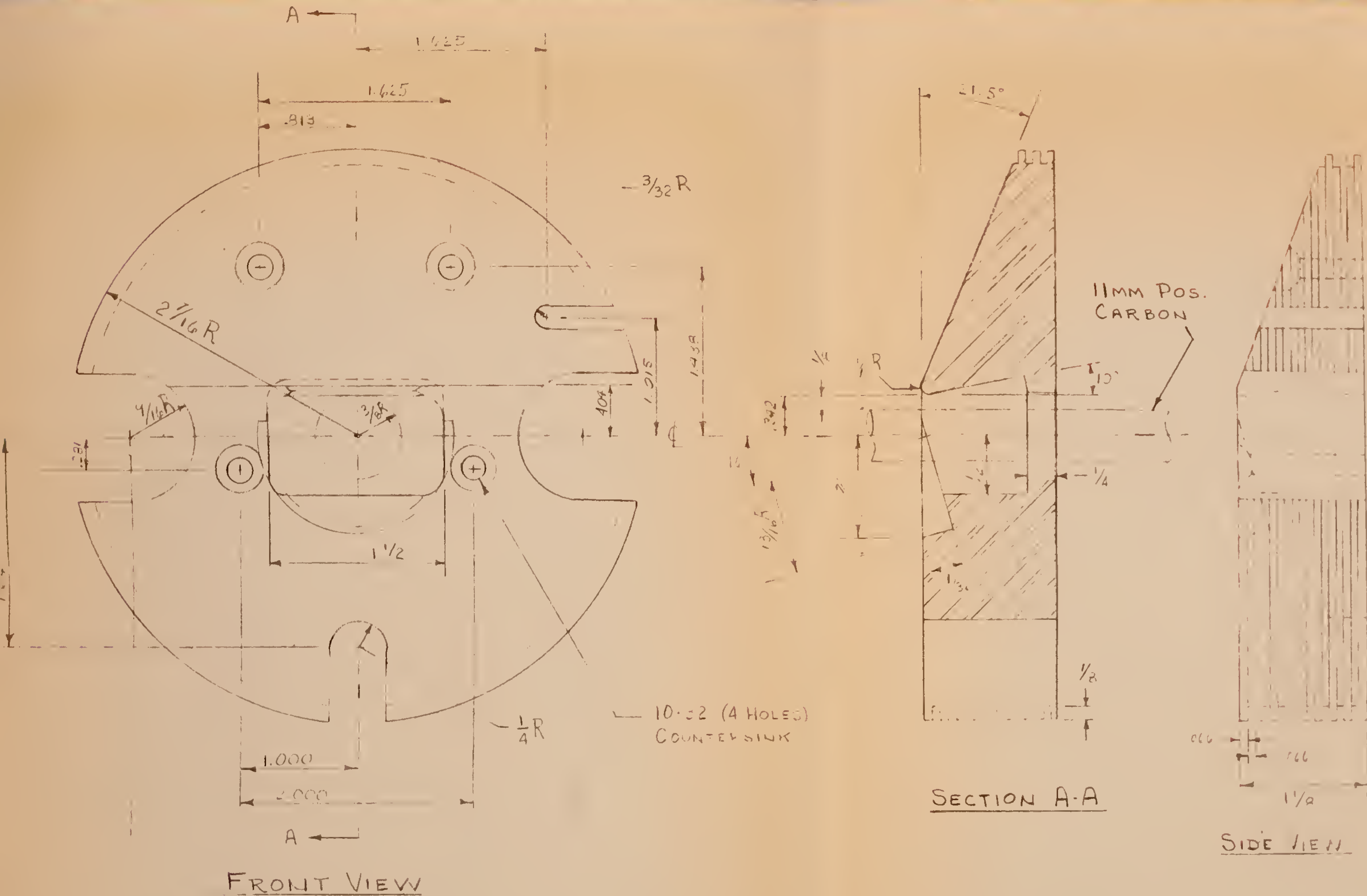


REF: NBS REPORT 1354

MATERIAL: CAVITY-FREE, ELECTROLYTIC TOUGH PITCH COPPER - THERMAL CONDUCTIVITY AT LEAST 3.8 WATT-CM/CM²/C° (220 BTU-FT/FT²/HR/°F)

| PIECE NO. | NOMENCLATURE | NO. REQ'D |
|---|---|---|

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WASHINGTON 25, D. C.

OBTURATOR - PROBE

FOR AVQ-2A SEARCHLIGHT

| MODEL | TYPE | SCALE 1:1 |
|---|---|---|
| DIMENSIONS IN INCHES (Unless otherwise specified) | DRAFTSMAN J.A.L. | CHECKER |
| TOLERANCES (Unless otherwise specified) | PROJECT ENGR | PROJECT ENGR |
| DECIMALS ± .005 | SUBMITTED BY | |
| FRACTIONS ± .015 | | CHIEF, SEC. |
| ANGLES ± 1/2° | EXAMINED BY | |
| DO NOT SCALE THIS PRINT | | CHIEF ENGINEER |
| DIV. SEC. 2 1 | THIS PRINT ISSUED | APPROVED BY / CHIEF, DIV. |
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