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Report
on an

Investigation of the Feasibility

of

Forced-Air Cooling

of an
NBS-Modified
AVQ-2A Aircraft Searchlight

by

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Test No. 2.1N-19/53

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NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Investigation of the Feasibility of an NBS-Modified Forced Air-Cooled AVQ-2A Aircraft Searchlight

I. INTRODUCTION

The AVQ-2A Searchlight, modified with an NBS modification kit (see NBS Report No. 1354, Instruction book for modification of the AVQ-2A Aircraft Searchlight), is equipped with a copper obturator-probe weighing about four pounds. This mass acts as a heat reservoir for energy emitted from the carbon arc during the 30-second "On" period of the five-minute duty cycle. The purpose of this test was to determine the feasibility of using forced air to cool the obturator-probe in an effort to permit continuous operation of the AVQ-2A searchlight. Water-cooling of the obturator-probe has been tried and found to be successful. However because of the added weight of the coolant as well as of the necessary auxiliary equipment, and because of the difficulty of maintaining a liquid-tight system subjected to the vibrations and wide temperature gradients encountered, an effort was made to use air alone as the cooling medium.

II. MATERIALS TESTED

Fig. 1 is a copy of the shop drawing originally prepared for fabrication of an air-cooled obturator-probe. As finally worked out the design was slightly modified to call for fewer holes of larger diameter than shown. This was made necessary by the difficulty encountered in drilling the long, small-diameter holes called for. A further refinement incorporated later was an end plate with a large nozzle to permit the attachment of a large air hose.

III. TEST PROCEDURE

The obturator-probe to be tested was mounted on an AVQ-2A searchlight lamp mechanism, and was operated at the rated current of 120 amperes at 70 volts. The temperature rise of the obturator-probe was measured with a calibrated iron-constantan thermocouple located in contact with the back of the upper half of the obturator-probe. The thermocouple was connected to a recording potentiometer and the temperature rise of the obturator-probe thereby recorded during each run.

Air for the purpose of cooling the obturator-probe was obtained from three alternate sources: a) the laboratory air supply of about 8 lbs/square inch through a 3/16 inch pipe, b) a 1 1/2 HP high-pressure compressor, and c) a 1 1/3 HP portable blower. An air current shield was provided to minimize the effects of air currents in the neighborhood of the arc. This shield consisted of a brass baffle plate attached to the obturator-probe at the side opposite to that from which the air entered.

IV. TEST RESULTS

The amount of air provided by the laboratory supply or the 1 1/2 HP compressor was not sufficient to cool the obturator-probe by an appreciable amount. The 1 1/3 or portable blower provided a supply of air at a sufficiently high speed to accomplish a certain amount of cooling. The air-cooled obturator-probe reached a temperature of about 700°C after a period of about four minutes as shown in Fig. 2. After that time the temperature remained fairly constant as long as the searchlight was operating normally.

V. DISCUSSION

Although the cooling of the obturator-probe was partially successful, the test indicated that more extensive experimentation and development of air cooling of the AVQ-2A searchlight in its present design would not be practical. It is felt that a satisfactory air cooling system should limit the maximum temperature of the obturator-probe to about 400°C. This would require a blower of considerable size in addition to adequate air ducts to the obturator-probe. The cooling system would have to be sufficiently well constructed and rigid to prevent stray air currents from disturbing or extinguishing the arc. In addition to the obturator-probe, other parts of the arc mechanism would have to be cooled in order to insure continuous operation without injury to the arc lamp.

In other experimental work directed toward improving arc performance, it has been found that increasing the angle of the negative carbon from 16° to 45° improves the stability of operation. In addition, it reduces the amount of heating of searchlight parts and therefore lowers the demand on a cooling system.

Another experimental change tried out in the AVQ-2A searchlight was a redesigned positive head. The obturator-probe was replaced in its obturation function by a hollow air-cooled cylindrical copper contact sleeve, about an inch in overall diameter, which encased the positive carbon and delivered

current to it. Since the area of the material exposed to the arc was much smaller, less heat was absorbed. A separate air-cooled copper probe was provided to assume the electrical sensing function formerly accomplished by the obturator-probe. This new positive head and probe arrangement when operated in conjunction with the 45° negative carbon trim operated satisfactorily with only the laboratory air supply (8 lbs/sq. in. through a 3/16 in. pipe).

VI. CONCLUSIONS

1) Air cooling of an AVQ-2A searchlight for continuous duty operation is not practicable without extensive modifications of both the positive and the negative heads of the arc mechanism.

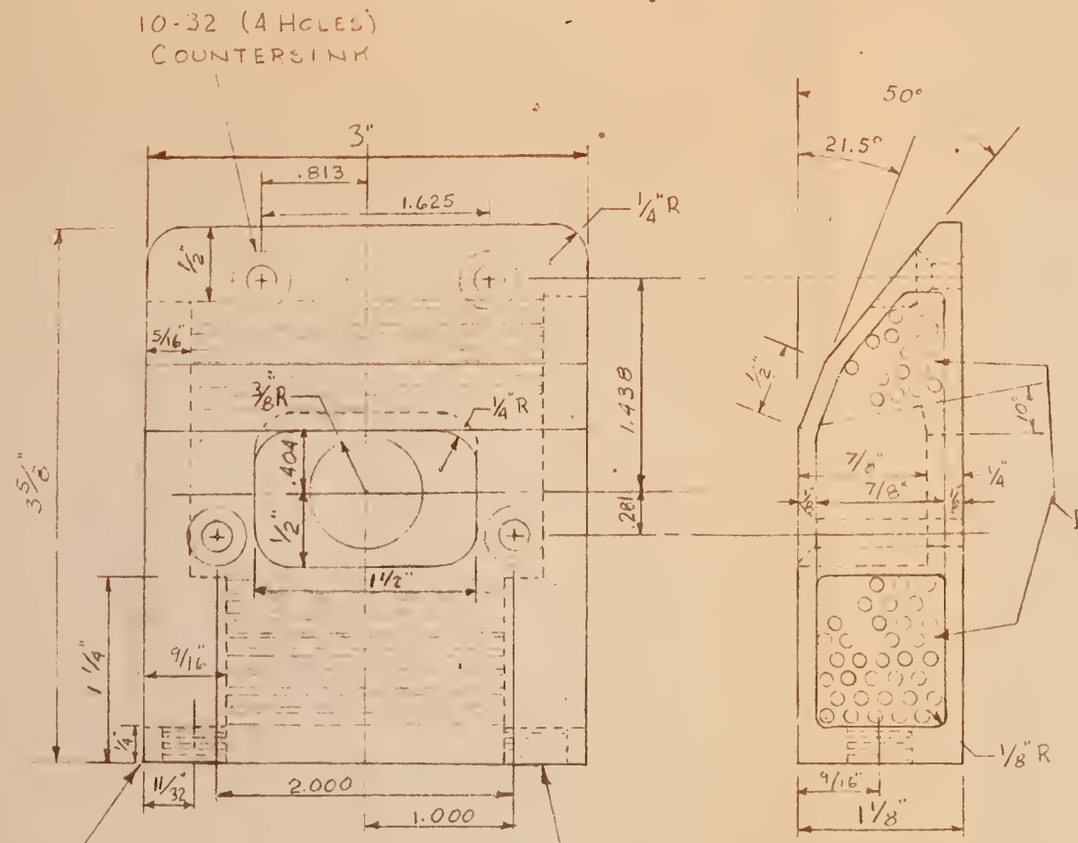
2) The combination of a liquid coolant heat transfer medium and air would be a more practicable modification of the AVQ-2A searchlight for continuous duty operation.

3) Redesign of the arc mechanism to improve operation and minimize overheating of the components should precede any effort to incorporate a cooling system.

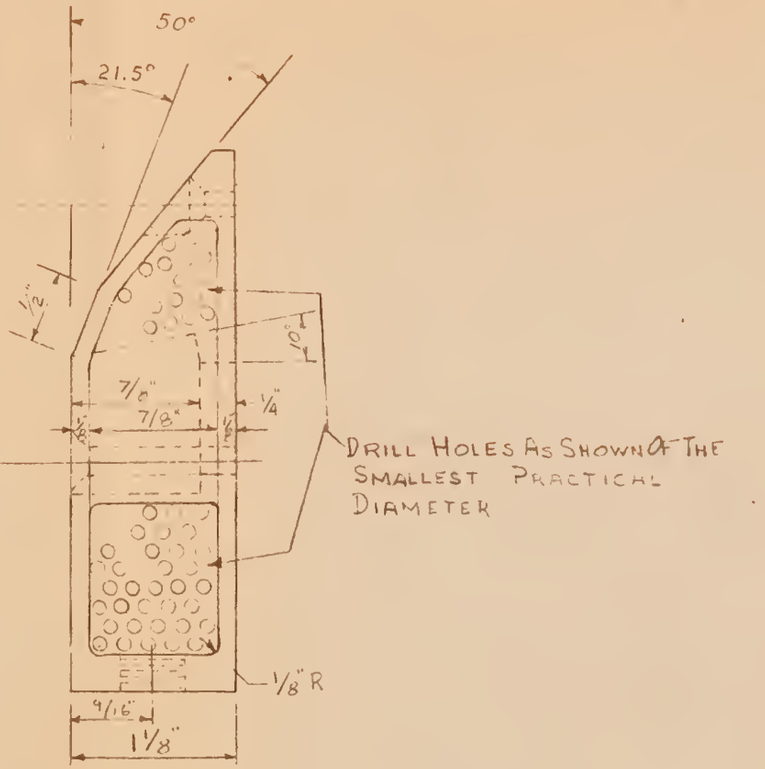
ORIGINAL DATE OF DRAWING	DEC. 11 1952

REVISIONS

NO	E. C. N.	CHANGE	DATE
1			
2			
3			
4			



FRONT VIEW

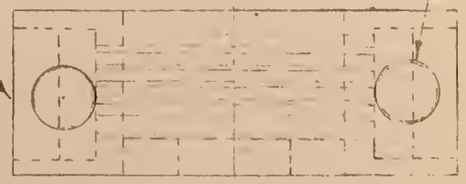


SIDE VIEW

DRILL HOLES AS SHOWN OF THE SMALLEST PRACTICAL DIAMETER

PROVIDE COVERS (NOT SHOWN) FOR BOTH SIDES MADE OF COPPER SHEETS 1/32" THICK; FASTEN TO OBTURATOR WITH FLAT HEAD SCREWS.

DRILL & TAP TO FIT FITTINGS FURNISHED



BOTTOM VIEW

NBS TEST No 21N-19/53

PIECE NO.	NOMENCLATURE	NO. REQ'D

NATIONAL BUREAU OF STANDARDS
WASHINGTON 25, D. C.

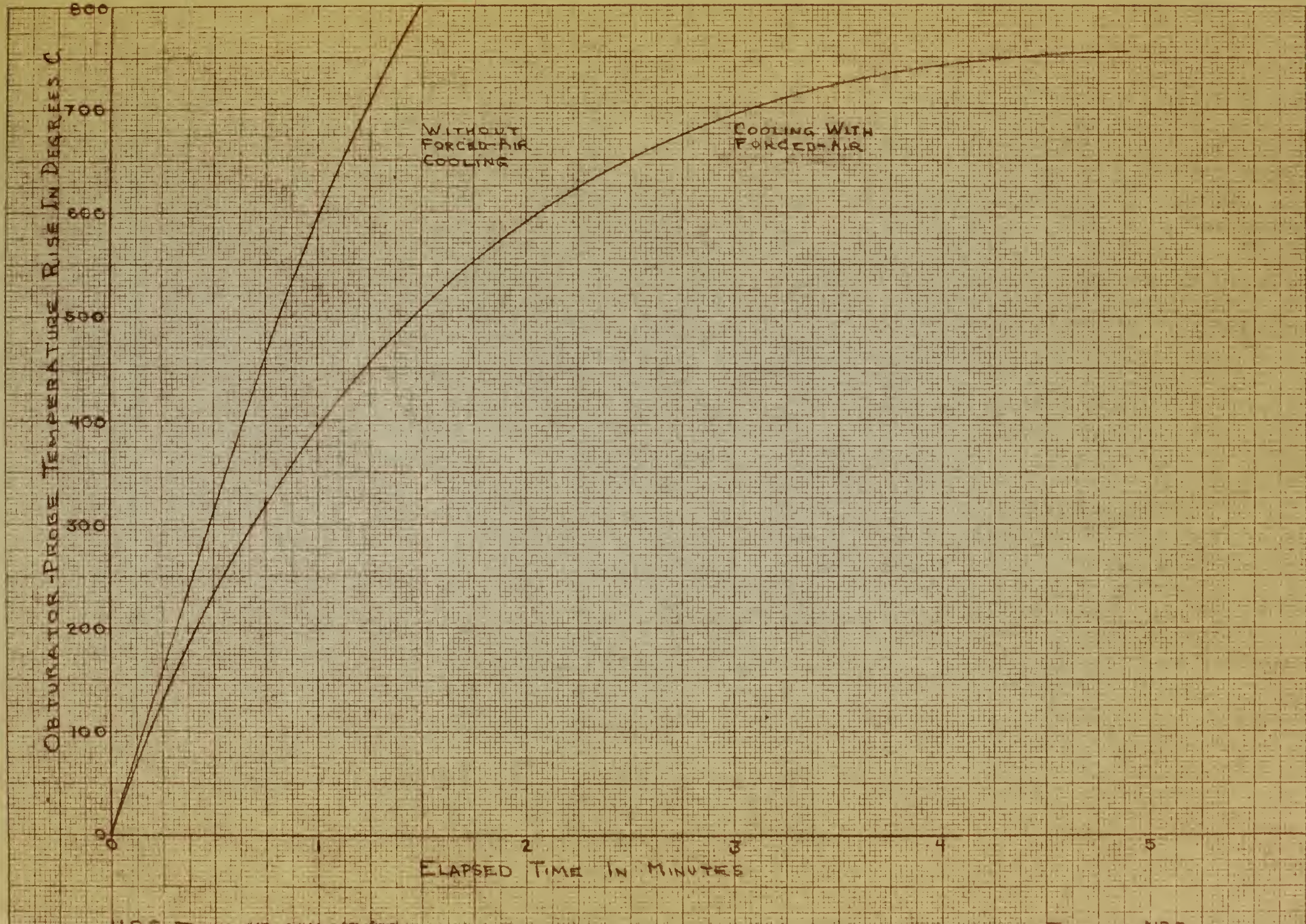
AIR-COOLED OBTURATOR

FOR AVQ-2A SEARCHLIGHT

MODEL	TYPE	SCALE 1" = 1"
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN JAL	CHECKER
TOLERANCES (Unless otherwise specified)	PROJECT ENGR JAL	PROJECT ENGR.
DECIMALS .005	SUBMITTED BY	CHIEF, SEC.
FRACTIONS 1/16		
ANGLES 1/2°	EXAMINED BY	
DO NOT SCALE THIS PRINT		CHIEF ENGINEER
DIV. SEC. 2.1 THIS PRINT ISSUED	APPROVED BY	CHIEF, DIV .....

FIG. No: 1

TEMPERATURE RISE OF AN OBTURATOR-PROBE FOR THE AVQ-2A AIRCRAFT SEARCHLIGHT WITH AND WITHOUT FORCED-AIR COOLING



NBS TEST Nº 21N-19/53

FIGURE Nº 2.