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Evaluation Tests
of a
Developmental Model
of a
Modified AN/AVQ-2A Searchlight

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Test 21N-6/56

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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

1. MATERIAL

This report describes tests of a modified AN/AVQ-2A searchlight manufactured by the Strong Electric Corporation, Toledo, Ohio, to comply with the requirements of Bureau of Aeronautics Experimental and Developmental Specification, XEL-228, dated Sept. 1, 1951, Modification Version of Searchlight Set AN/AVQ-2A. The searchlight was procured under Bureau of Aeronautics Contract NOas 53-250-F. The purpose of the contract was to modify an AN/AVQ-2A Searchlight Set to permit operation of the arc mechanism for periods as long as 15 minutes or as short as 5 seconds in a stable and useful manner. The contract also called for the development of a power supply for the arc for operation from a 120/208-volt, 400-cycle power source. One modified searchlight was submitted for test.

The arc lamp in this searchlight operates at 120 amperes with an 11-mm cored high-intensity positive carbon and an 11-mm cored copper-coated negative carbon. The operation of the arc lamp is automatic. The position of the tip of the positive carbon is maintained at the focal point of the reflector by a control utilizing an optical system which projects an image of the positive crater on a heat sensing element that in turn operates a relay controlling the positive drive motor. The distance between the negative and positive carbons is automatically regulated to maintain the arc current to within plus or minus 4 amperes of the nominal value of 120. This is accomplished by current sensitive relays that control the operation of the negative carbon feed motor.

The power supply for the arc lamp is contained within the searchlight housing. It consists of a transformer-rectifier assembly which converts 120/208-volt, 3-phase, 400-cycle power to 62.5-70.5-volt direct current. A blower is located in the power supply assembly to cool the transformers and rectifiers, the arc lamp mechanism, and the mirror, and to shorten the tail flame by "clipping".

2. TESTS

The contractor prepared Design Approval Test Sheets which covered the tests to be conducted on this searchlight. These test sheets were approved by the Department of the Navy and were used in conducting the tests at the National Bureau of Standards. These tests covered individual inspection, weight, rectifier performance at rated frequency, rectifier performance under frequency variation, stability

of operation, arc lamp and rectifier operating life, operation with frequency variation (as limited by power sources available at NBS) and position control life.

Power for the arc lamp was obtained from a 45-kw, 400-cycle, 120/208 three-phase engine-generator set. A 50-kw motor-generator set furnished 28-volt direct current power. Photometric measurements were made on the National Bureau of Standards 900-foot outdoor range.

In addition to the above mentioned tests the performance of the unit was tested in a wind tunnel and the effective area of the mirror was determined.

The wind tunnel tests were made at a wind velocity of approximately 140 knots. The searchlight was completely assembled with its plastic dome and tail section in place during the test. The arc lamp was operated continuously for 15 minutes under these conditions and then allowed to cool 15 minutes. This cycle was repeated three times.

The shadowed areas of the mirror were determined by photographing the light pattern projected by the searchlight on a nearby translucent screen. A small incandescent lamp was used in place of the carbon arc. The size of the shadowed areas in the beam was computed from this photograph.

3. RESULTS

The results of the tests conducted in accordance with the Design Approval Test sheets are as follows:

- A. General Examination of Searchlight and Rectifier: Satisfactory.
- B. Panel Illumination: Satisfactory.
- C. Burner Mechanism Test. Satisfactory.
- D. General Operation of Servos: The servos operated satisfactorily. The searchlight elevated 6 degrees and depressed 46 degrees, trained left 26.5 degrees and trained right 31 degrees.
- E. Positioning Control Tests: The positioning control operated satisfactorily. The speed of rotation was 20 degrees per second in azimuth and 30 degrees per second in elevation.

- F. General Operation of Power Supply and Burner. Satisfactory. The alternating current to each of the three phases was 30.5 amperes when the arc was operating at 117 amperes and 65 volts.
- G. Peak Candlepower Measurement. The average peak candlepower was approximately 79 megacandles. Horizontal candlepower distribution curves taken at times when the arc current was 120 amperes are shown in figure 1. The beam spread at 10 percent of the peak candlepower was approximately $3\frac{3}{4}$ degrees. This meets the requirements of Specification XEL-228 which calls for a peak beam candlepower of at least 70 megacandles and a beam spread of at least $3\frac{1}{2}$ degrees at 10 percent of the peak candlepower. However, the Design Approval Test sheets call for a beam spread of not more than $3\frac{1}{2}$ degrees instead of not less than $3\frac{1}{2}$ degrees as does the specification, and are in error in this respect.
- H. Bomb Release Switch: Satisfactory.
- I. General Operation of the Servos at Low Voltage. Satisfactory.
- J. General Operation of Arc Controls at Low Voltage: Satisfactory.
- K. Pitch Signal Operation: Satisfactory.
- L. Supply Current Measurement: The maximum value of the current was within the limits specified. The current readings at 28 volts in #4 wire with the system in standby and operating conditions were 14.75 amperes and 16.5 amperes respectively. The current readings at 28 volts in #5 wire were 0 amperes at standby and 3.1 amperes operating. The 115-volt, 400-cycle current in #25 wire was 1.33 amperes at standby and 1.32 amperes while operating.
- M. Weight Requirement Test.

	Max. Specified pounds	Actual pounds
1. Complete Search-light	176	*189
2. Electronic Control Amplifiers	14	13.8
3. Mount	1	0.75

M. Weight Requirement Test (Continued)

	Max. Specified pounds	Actual pounds
4. Searchlight Control	6.7	1.8
6. Wiring Harness	3.3	3.0
Total	<u>201.0</u>	<u>208.35</u>

* Includes

Center Section w/o Wiring Harness	157 lbs.
Wiring Harness	3
Tail Section	14
Nose	15
	<u>189 lbs.</u>

- N. Rectifier Frequency Variation Test. The frequency of the alternating current power supply available to the test group could only be varied between 350 and 420 cycles per second. Tests were therefore made only at 350, 400 and 420 cycles. The performance of the searchlight was satisfactory at these frequencies.
- O. Stability of Operation Test. This test was made in conjunction with the arc operating test. The stability of the searchlight was satisfactory during this test.
- P. Arc Lamp and Rectifier Operating Life Test. The arc lamp was operated for a total of 50 hours. During this time several failures of the doublers occurred. The insulating block in the douser operating rod broke twice. The douser operating solenoid failed to open the douser far enough to actuate the safety interlock switch several times. Mr. J. A. Bartelt of the Electronics Division, Bureau of Aeronautics, Department of the Navy, has indicated that doublers will no longer be required on this type of searchlight and that accordingly the failures of the douser mechanism are to be disregarded in evaluating the searchlight.

The negative feed mechanism/jammed in the retracted position several times during the life test. This was caused by failure of the negative carbon carriage limit switch to function.

Q. Amplifier Frequency Variation Test. Satisfactory.

R. Position Control Life Test. Satisfactory.

The searchlight performed normally throughout the wind tunnel test with no noticeable accumulation of foreign matter on the searchlight dome and no abnormal heating of the mechanism.

The results of the measurement of the effective area of the mirror were as follows, expressed in percentage of the frontal projected area of the mirror exclusive of the five inch hole in the center:

Mirror clamps	2.0%
Hole and shadow of negative feed mechanism	2.7%
Cutouts on edge of mirror for lamp supports	0.8%
Other shadowed areas	<u>5.9%</u>
Total	11.4%
Douser	*4.3%

* See comment on douser in section 3, P, page 4.

3. DISCUSSION

The performance of this searchlight throughout these tests was very good and trouble-free except for the minor difficulties experienced with the negative carbon feed mechanism and douser assembly. The binding of the negative carbon feed mechanism was caused by the failure of the negative feed limit switch to operate. A minor redesign of the mechanism will remedy this.

The method of placing the negative carbon in the arc lamp should be simplified and the mechanism made more accessible. The installation of a negative carbon is time consuming. It requires the searchlight to have electric power; the clamping screw is not readily accessible, and the reference mark used in prepositioning the negative carriage is difficult to see.

