FR-1168

REPORT NO. B-1168

DATE 17 June 1935

SUBJECT

Report of

Test on Electric Solenoid Valves and Air Horn

Manufactured and Submitted

by

Clark Cooper Company
For Submarines SS-176 to SS-178

Naval Research Laboratory
Office of Naval Research
Navy Department
Washington 25, D. C.

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NAVY DEPARTMENT

BUREAU OF ENGINEERING

Report of

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NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D.C.

Number of Pages: Text - 5 Plates - 2

Date of Test: May 1935.

Authorization: Bu.Eng. ltr. S65-4/L5(4-12-Ds) of 16 April 1935.

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TABLE OF CONTENTS

	SUBJECT	PAGE
1.	AUTHORIZATION FOR TEST	1
2.	OBJECT OF TEST	1
3.	ABSTRACT OF TEST	1
	(a) Conclusions	1a
	(b) Recommendations	1a
4.	DESCRIPTION OF MATERIAL UNDER TEST	2
5.	METHOD OF TEST	2
6.	RESULTS OF TEST	3
7.	COMMENTS ON RESULTS OF TEST	4
8.	CONCLUSIONS	5

Appendices

Photograph of single horn and electrically operated valve submitted under reference (b), by Inspector of Machinery, Groton, Conn. ..... Plate 1

Photograph of modified electrically operated valve, Type N, submitted under reference (c), by Clark Cooper Company, manufacturer. ..... Plate 2

AUTHORIZATION FOR TEST

1. This test was authorized by reference (a), and other additional references pertinent to this problem are listed as references (b) to (d) inclusive.

Reference: (a) Bu.Eng.ltr. S65-4/L5(4-12-Ds) of 16 April 1935.
(b) IM,Groton,Conn., ltr. SS176/S65(C) of 2 April 1935, to Bu.Eng.
(c) Clark Cooper Co.'s ltr. of 7 May 1935 to Bu.Eng.Bureau File SS174/S65/5-7.
(d) Interior Communication Laboratory Report No. 482 of 4 Nov. 1932, to Navy Yard, Wash.,D.C.

OBJECT OF TEST

2. The object of this test was to determine whether the electrically operated valve and air horn, submitted under reference (b), had been modified in accordance with recommendations, outlined in ref. (d). Type approval tests were also conducted on an electrically operated valve, Type N, embodying later modifications and submitted under ref. (c).

ABSTRACT OF TEST

3. Each of the valves was connected to a horn, as shown on Plate 1, and tested for operation at various air pressures while being supplied with voltages ranging from 10% above to 10% below its rating (115 volts D.C.). Part of the test was conducted at ambient temperature of 40°C and the remainder at approximately 26°C. Under these conditions the valves were also tested for operation when inclined 30° from normal in every direction.

CONCLUSIONS

(a) The valve submitted under reference (c), embodying the latest modifications, was superior to the one submitted under reference (b) throughout the test and is considered more suitable for the Naval Service.

(b) The horn operated satisfactorily under both tests, total 96 hours of operation at intervals of one minute every alternate minute.

RECOMMENDATIONS

(a) It is recommended that the valve submitted under reference (b) be approved for the Naval Service, subject to correction of defect causing leak and correction of the adhering of the armature to the stationary armature.

(b) It is also recommended that the valve submitted under reference (c) be approved in view of the satisfactory results obtained under test. This valve is considered far more satisfactory in view of its better performance throughout the test.

(c) It is further recommended that the air horn, as submitted, be approved.

DESCRIPTION OF MATERIAL UNDER TEST

4. The valves as submitted are identical mechanically, with the exception of the valve seats. The valve submitted under reference (b) is equipped with a cone-shaped steel spindle, while that submitted under reference (c) is equipped with a plunger containing a semi-hard molded rubber composition insert.

5. Each unit is enclosed in a watertight cast iron case, the lower half of which contains a terminal box equipped with a removable cover and is mounted on a brass plunger type valve.

6. The solenoid armature is enclosed in a watertight brass cylinder, the upper part of which contains an iron stationary armature. The movable armature is provided with a brass insert to prevent its adhering to the stationary armature.

7. Surrounding the cylinder, but enclosed in a cast iron case, is a solenoid winding equipped with flexible leads which connect to the line terminals. The case forms part of the magnetic path.

8. For preventing incorrect installation, the pressure side of the valve connection is stamped "IN".

9. No adjustable features are incorporated in either of the valves.

10. A photograph of the horn and valve, submitted under reference (b), is shown as Plate 1. The valve, embodying later modifications, is shown as Plate 2.

11. The air horn is essentially the same as that tested under reference (d).

METHOD OF TEST

12. Each of the sample valves was connected to a horn, as shown on Plate 1, and first tested at a pressure of 100 pounds per square inch at rated voltage by operating the solenoid one minute, every alternate minute, for a period of 40 hours.

13. Next, each unit was placed in a compartment having an ambient temperature of 40°C and tested at a pressure of 100 pounds per square inch for its operating characteristics by energizing the solenoid one minute, every alternate minute, for a period of 8 hours. During this test, the temperatures of the solenoid windings were obtained by the resistance method.

14. At intervals during the endurance test, voltages from 10% above to 10% below normal were supplied to the solenoid winding when the valve was inclined 30° in all planes from normal to determine whether it would operate satisfactorily under these conditions.

15. Following this, each of the valves was placed on a Bureau of Engineering shock stand and given 20-250 ft.lb. blows while energized and when deenergized to test its shock integrity.

16. Finally, each valve was tested for current consumption, insulation resistance, dielectric strength and watertight integrity, after which inspection of the design and material was made.

RESULTS OF TEST

17.

Specifications	Requirements	Test Values
Voltages	115 Volts	115 Volts
Current	Direct	Direct
Amperes	Not specified	Valve, ref.(b) 0.162 amps Valve, ref.(c) 0.148 "
Endurance	Solenoid shall be operated at rated voltage, one minute, every alternate minute, for a period of 48 hours while valve is supplied with an air pressure of 100 lbs. per sq.in.	Both valves operated satisfactorily under these conditions.
Temperature rise of solenoid windings.	Shall not exceed 30°C at ambient temperature of 40°C. when operated one minute, every alternate minute, for a period of 8 hours.	Valve, ref.(b) 29.64°C " ref.(c) 20.58°C (Ambient 40°C)
Insulation Resistance	Not less than 5 megohms when measured by 1000 volt megger.	200 megohms each by 1000 V. megger.
Dielectric	1230 V. A.C., 60 cycle, applied between winding and case for a period of 1 minute.	Both windings withstood the required test.
Shock Test	20-250 ft.lb. blows applied while energized and when deenergized.	*Valve, ref.(b) - short blast of horn occurred. Valve, ref.(c) - Satisfactory.
Inclination	Valves shall operate satisfactorily when inclined 30° in all planes from normal, at voltages from 10% above to 10% below normal.	Both valves satisfactory when operated at an air pressure of 100 lbs.per sq.in.
Watertight Integrity.	Shall not leak when submerged 3 feet in salt water for a period of 12 hours.	*Valve, ref.(b) - Leaked 10 cc. Valve, ref.(c) - no leaks.

Specifications	Requirements	Test Values
Case material	Not specified	Cast iron
Valve material	Not specified	Cast brass
Assembly screws and nuts.	Steel, cadmium plated.	Steel, cadmium plated
Resistance of solenoid windings	Not specified	Valve, ref.(b) - 748.6 ohms. Value, ref.(c) - 796.0 ohms. (Ambient 40°C)
Protection of windings against absorption of moisture	Impreganted with insulating varnish and baked.	Impregnated with insulating varnish and baked.
Weight	Not specified.	Average 8 lbs.5 oz.
Pitch of note of horn	Not specified	500 CPS at 100 lbs.per sq.in.
Audibility range at air pressure of 100 lbs per sq.in.	Not specified	2900 Yards Wind slightly unfavorable
Air consumption of horn at pressure of 100 lbs.per sq.in.	Not specified.	Approximately 25.8 cu. ft. of free air per min.
Diaphragm	Not specified.	0".015 - thickness 3".0 - diameter (Phos. bronze)

COMMENTS ON RESULTS OF TEST

18. The valve submitted under reference (b) complied with all of the requirements for Interior Communication equipment except as noted below:

19. Under test for watertight integrity, it leaked around the case cover gasket and allowed 10 cc. of water to enter.

20. It was also noted during the endurance test that the armature occasionally failed to return to its normal position when deenergized due to insufficient residual gap. A larger diameter brass insert would correct this defect.

21. The valve, when mounted in its normal position and subjected to a shock of 250 foot pounds, opened and allowed a short blast of the horn to occur. This did not happen when shocks of 100 foot pounds were applied.

22. Although the pressure rating of the value is 200 lbs. per sq.in., under test the maximum pressure at which it would function when supplied with normal voltage was 150 lbs. per sq.in.

23. The valve submitted under reference (c) proved to be satisfactory except that it would not operate with a pressure of 200 lbs. per sq.in., when supplied with a voltage lower than normal. However, it is understood that the maximum working pressure for this installation will be 100 lbs. per sq.in.

24. This valve did not permit a blast of the horn when subjected to shocks of 250 foot pounds.

25. The horn operated satisfactorily under both tests, total 96 hours of operation at intervals of one minute, every alternate minute.

CONCLUSIONS

26. The valve submitted under reference (c), embodying the latest modifications, was superior to the one submitted under reference (b) throughout the test and is considered more suitable for the Naval Service.

27. The horn operated satisfactorily under both tests, total 96 hours of operation at intervals of one minute every alternate minute.

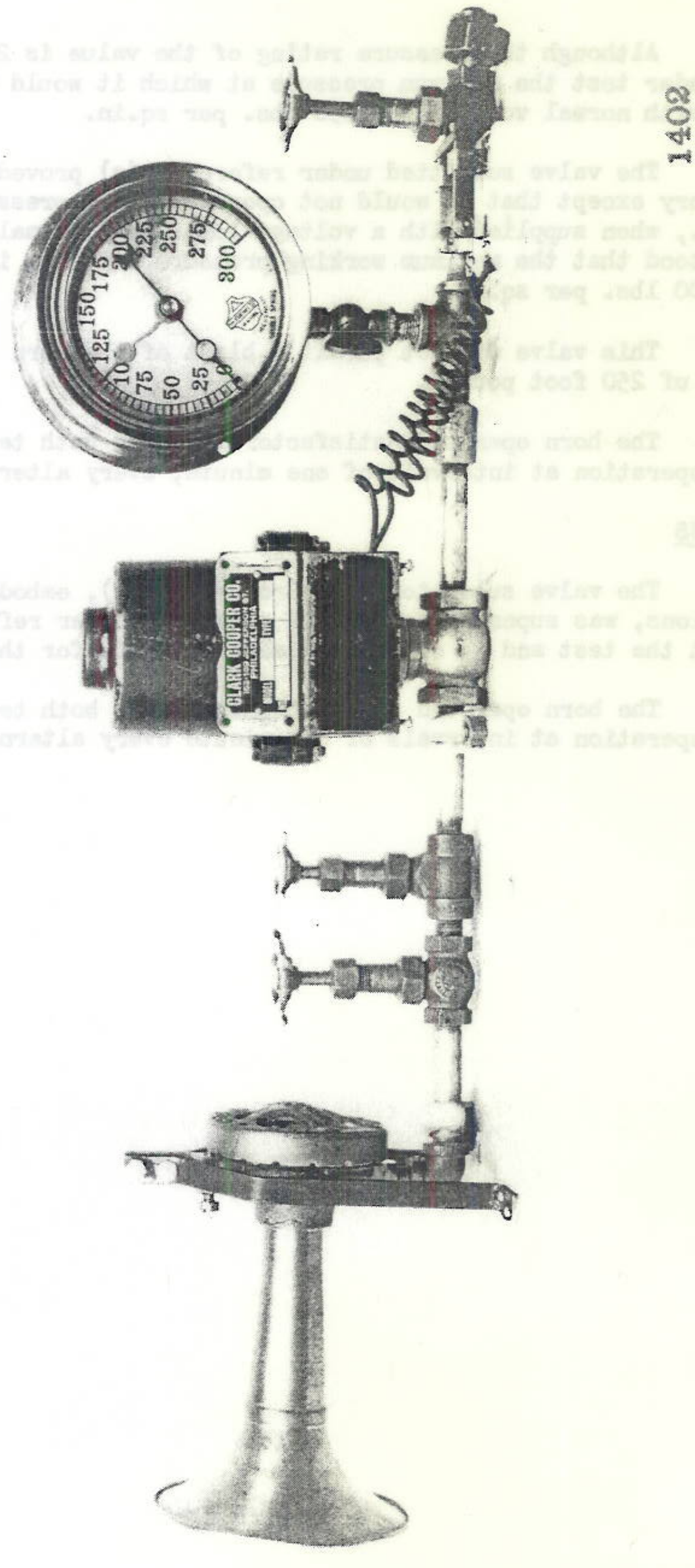

PLATE I

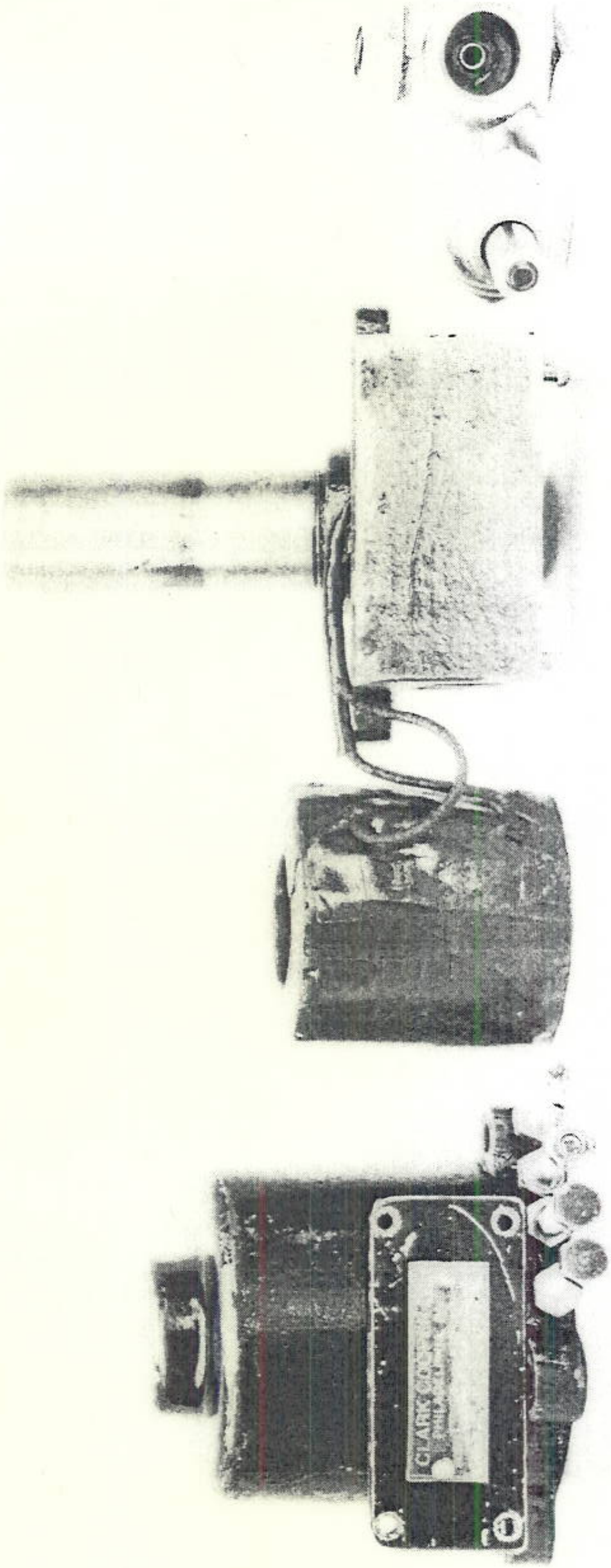

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PLATE 2