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NAVY DEPARTMENT
BUREAU OF ENGINEERING

REPORT ON
WATER REPELLENT COATINGS
Tests of Water Repellent Materials
For Coating the Interior of
Submarine Main Battery
Ventilation Ducts.

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TABLE OF CONTENTS

<u>SUBJECT</u>	<u>PAGE</u>
ABSTRACT.....	1
1. AUTHORIZATION.....	2
2. STATEMENT OF PROBLEM.....	2
3. KNOWN FACTS BEARING ON PROBLEM AND NARRATIVE OF WORK DONE AT NRL.....	2
4. METHODS.....	3
5. DESCRIPTION.....	3
6. DATA OBTAINED.....	3
7. FACTS ESTABLISHED.....	3
8. CONCLUSION.....	3

APPENDICES

RESISTANCE OF TEST SPECIMENS, TEST I.....	TABLE I
RESISTANCE OF TEST SPECIMENS, TEST II.....	TABLE II
SPRAY TEST APPARATUS.....	PLATE 1

ABSTRACT

This report describes test to determine the relative suitability of several materials for coating the interiors of submarine main battery hard-rubber ventilation ducts to render them water-repellent. The materials tested were -

Plain hard-rubber (control)
Smooth-finish hard-rubber
Paraffin
Beeswax
S.D.O.

These were tested by subjecting them to the action of sulfuric acid electrolyte spray blown onto the surfaces. The tests show that paraffin is the best of these materials.

AUTHORIZATION

1. This problem was authorized by the Bureau of Engineering letter SS/S62 (9-7-De) of 30 Sept. 1933.

STATEMENT OF PROBLEM

2. It has been shown by experimental work at this Laboratory that the electrolyte film which normally forms on the inside of the hard-rubber ventilation ducts of submarine main storage batteries constitutes a current-carrying ground which, under certain conditions, may generate arcs or sparks which would ignite any explosive hydrogen mixture present and thereby cause a serious explosion. Safety therefore demands that the formation of this continuous moisture film be somehow prevented. Two methods have been suggested for doing this:

- (a) Preventing electrolyte droplets from getting into the ducts either by preventing their formation inside the individual cells or preventing them ever from leaving the cells by suitable moisture traps, and
- (b) Preventing such electrolyte droplets as do enter these ventilation ducts from forming continuous films.

The first of these methods has been attacked and reported on elsewhere. The second has been done by coating the interior of the ventilation ducts with some water repellent material such as paraffin, which coating has the property of preventing the formation of a continuous moisture film by any aqueous liquid deposited on it. The present problem is to test the suitability of several water-repellent coatings to determine their suitability.

KNOWN FACTS BEARING ON PROBLEM AND NARRATIVE OF WORK DONE AT NRL

3. The use of paraffin to reduce the explosion hazard in submarine batteries was first noted by Comdr. Holbrook Gibson, USN., in the German U-boats taken over by the U.S. Navy after the World War. The entire engineering of the German batteries showed that the German Navy appreciated the explosion hazards of electrolyte grounds inside the ducts and had made suitable provision for reducing the danger from them.

At Comdr. Gibson's suggestion, some experimental work on paraffin coatings was undertaken at this Laboratory, and service tests were made at the Laboratory on the USS S-21 and the USS R-3. As a result of these service tests, the Bureau of Engineering authorized the paraffin coating of all submarine ventilation ducts. The paraffining of hard rubber ducts had several disadvantages, among them being the fact that subjecting the hard rubber composition to the high temperature necessary to insure a proper uniform coating impaired the characteristics of the hard rubber. Realizing this, Lieut. Rickover of the office of the Inspector of Naval Material, Philadelphia, sought other water repellent coatings for this purpose and also suggested the possibility of

fabricating ventilation ducts with an interior surface so smooth that this surface would be water repellent. He provided this Laboratory with suitable smooth ducts for test and these were tested in conjunction with several water repellent coatings in the work reported here.

METHODS

4. The present tests consisted essentially in blowing droplets of storage battery electrolyte through a duct simulating on a small scale the hard rubber ventilation ducts of submarine main storage batteries. The apparatus is sketched in Plate 1. In this, the blower caused a stream of air to pass through the spray-chamber which was filled with electrolyte spray droplets by the gassing of the storage cell shown. The spray filled air then passed through the coated ducts shown and finally through a spray trap and out into the air. The coatings used were as follows:

1. Plain hard rubber (control)
2. DuPont synthetic drying oil (SDO)
3. Paraffin
4. Beeswax
5. Plain hard rubber (control)
6. Smooth surface hard rubber

DESCRIPTION OF EXPERIMENTS

5. In each test the blower and storage cell were started up and permitted to run for several hours. At intervals after the start of the test the resistance of the interior coating was measured by a "megger" or, when the resistance had fallen low enough, by a Leeds and Northrup Wheatstone bridge. The apparatus was next washed out completely with fresh water, dried, and the first test repeated (Test II).

DATA OBTAINED

6. The data obtained are tabulated in Tables I and II.

FACTS ESTABLISHED

7. The above data show

(a) That the smooth interior hard rubber duct supplied by the Inspector of Naval Material, Philadelphia, Pa., is but little better than the plain hard-rubber duct.

(b) That neither beeswax nor SDO is suitable as a water repellent coating.

(c) That paraffin is superior to any other coating tested.

CONCLUSION

8. It is therefore concluded that the present standard practice of coating submarines main battery ventilation ducts with high melting paraffin is the best method so far tested of making the ducts water-repellent.

TABLE I

Resistance of Test Specimens, Test I.
Spray from 1280 sp.gr. electrolyte
Resistance in megohms.

Time	Coating					
	Plain	S.D.O.	Paraffin	Beeswax	Plain	Smooth
0	Inf.	Inf.	Inf.	Inf.	inf.	Inf.
5 min	Shorted	"	"	"	"	175
10	"	"	"	"	"	Shorted
30	"	"	"	"	"	"
1 Hour	"	"	"	"	60	"
1-1/2	"	"	"	"	800	"
2	"	"	"	35	50	"
2-1/2	"	"	"	Inf.	90	"
3	"	"	"	"	250	"
3-1/2	"	"	"	250	150	"
4	"	"	"	250	50	"
*4-1/2	.003	"	"	1500	150	.009
5	"	.009	"	Inf.	60	.009
5-1/2	"	"	"	"	75	.009
**) Secured.					
26	.006	20	"	"	.01	.01
26-1/2	"	0.8	"	25	"	"
27	"	"	"	20	"	"
27-1/2	"	0.6	"	"	"	"
28	.002	"	"	15	.005	.005
28-1/2	"	0.3	25	12	"	"
29	"	"	"	"	"	"
30	"	"	"	8	"	"
31	"	.01	"	1	.004	"
**) Secured					
46	.005	.03	30	1.5	.007	.02
46-1/2	.003	.03	20	1.2	.006	"
47	"	.02	"	1.1	.005	.01
48	"	"	"	1	"	.008
49	"	"	"	1.2	"	.007
50	"	"	"	1.1	"	.007
51	"	"	"	1.2	"	.009
52	"	"	"	"	"	.01
53	.005	"	"	"	"	"
54	.006	"	"	1.3	"	"
**) Secured.					
70	.004	.03	6	1.3	.006	.02

*Started using Wheatstone Bridge for low resistances.

**Blower and spray secured overnight.

TABLE II

Resistance of Test Specimens, Test II.
 Spray from 1280 sp.gr. electrolyte.
 Resistance in Megohms

Time	<u>Coating</u>					
	<u>Plain</u>	<u>S.D.O.</u>	<u>Paraffin</u>	<u>Beeswax</u>	<u>Plain</u>	<u>Smooth</u>
0	Inf.	Inf.	Inf.	Inf.	Inf.	Inf.
15 min.	.009	20	"	"	3	"
1 hour	.004	1.5	"	"	2.5	250
1-3/4	.005	.3	"	700	.7	4
2	"	"	"	"	"	"
3	.007	.1	"	150	"	1.5
3-1/2	"	.1	"	"	"	"
4	"	.08	"	100	"	"
5	"	"	"	50	.6	1
6	.003	.05	600	30	"	.5
7	.006	.04	60	15	.08	.05
8	"	.05	20	10	.08	.08
) Secured.						
24	.01	.04	125	4	.6	.3
24-1/2	.006	.04	80	2.5	"	.3
25	.004	.03	50	2.2	.4	.2
26	.007	.04	20	2.	.2	.1

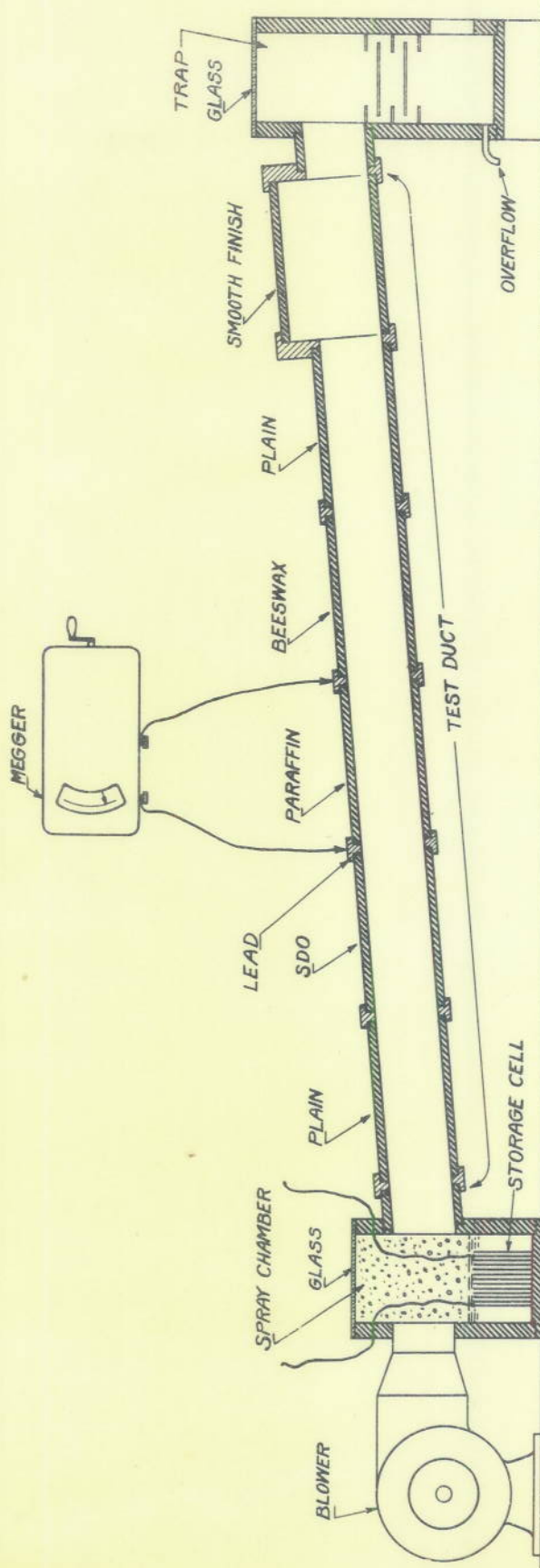


PLATE I SPRAY TEST APPARATUS