### 5 October 1939

NRL Report No. R-1560 Eng.Problem No. M12-7

-R-1560

Report of Test

NAVY DEPARTMENT

BUREAU OF ENGINEERING

of

Dogardite as a Mater-Proofing Compound for Radio Frequency Coils.

FR-1560

## NAVAL RESEARCH LABORATORY ANACOSTIA STATION WASHINGTON, D. C.

Number of Pages:	Text - 4	Tables - 1	Plates - 7
Authorization:	BuEng.ltr.	S67/61(12-9-R8	) of 13 December 1938.
Date of Test:	23 March to	o 26 May and 14	to 19 August 1939.

Prepared by:

R.B. Owens, Associate Radio Engineer, Chief of Section.

Reviewed by:

A.Hoyt Taylor, Principal Physicist, Superintendent, Radio Division.

Approved by:

H.M. Cooley, Captain, USN, Director.

Distribution: BuEng. (10)

in.

APPROVED FOR PUBLIC RELEASE - DISTRIBUTION UNLIMITED

vhw

# TABLE OF CONTENTS

AUTHORIZATION	1
OBJECT OF TEST	1
ABSTRACT OF TEST Conclusions Recommendations	l la lb
MATERIAL UNDER TEST	2
METHOD OF TEST	2
DATA RECORDED DURING TEST	2
PROBABLE ERRORS IN RESULTS	3
RESULTS OF TEST	3
CONCLUSIONS	4

## APPENDICES

Q OF TEST COILS AT CERTAIN FREQUENCIES AND FOR THREE TEST	
CONDITIONS	TABLE 1
Q OF 6.9 MILLIHENRY UNIVERSAL WOUND COIL DOPED WITH DOGARDITE	PLATE 1
Q OF 6.9 MILLIHENRY UNIVERSAL WOUND COIL DOPED WITH A WAX	PLATE 2
Q OF 10 MILLIHENRY UNIVERSAL WOUND COIL DOPED WITH DOGARDITE	PLATE 3
Q OF 10 MILLIHENRY UNIVERSAL WOUND COIL DOPED WITH A WAX	PLATE 4
Q OF SINGLE LAYER COIL DOPED WITH DOGARDITE	PLATE 5
Q OF SINGLE LAYER COIL DOPED WITH A WAX	PLATE 6
VIEW OF COILS USED IN TESTS	PLATE 7

Page

#### AUTHORIZATION

1. The tests reported herein were authorized by Bureau of Engineering letter, reference (a).

Reference: (a) BuEng.ltr. S67/61(12-9-R8) of 13 December 1938. (b) NRL Report R-1345 "Test of Insulating Varnishes for Radio Frequency Uses!"

#### OBJECT OF TEST

2. The object of the test was to determine the effectiveness of Dogardite as a water-proofing compound for protecting radio frequency inductance coils against the effects of high humidities.

#### ABSTRACT OF TEST

1.1.1

3. Tests were conducted to determine the effectiveness of Dogardite as a humidity protector for both single layer and Universal wound coils by making measurements of the Q of coils in three conditions, namely: (1) untreated; (2) impregnated and allowed to dry for several days; (3) after immersion for 24 hours in distilled water and air dried for one hour. Identical coils were impregnated with a wax which had been previously determined to be a satisfactory water-proofer and measurements were made on both sets of coils to determine comparative results.

-1-

## Conclusions

(a) As a water-proofing compound for protecting radio frequency inductances from atmospheric moisture, Dogardite is inferior to a number of previously tested materials, and is therefore not considered suitable for Naval use for this purpose.

# Recommendations

(a) Dogardite is not recommended as a radio frequency coil dope for Naval use.

#### MATERIAL UNDER TEST

4. The material submitted for test consisted of a can of Dogardite which as stated in reference (a) is basically a water-proofing material for stone. This material is a thin colorless liquid.

#### METHOD OF TEST

5. The coils which were impregnated are described below:

- (a) A single layer coil of approximately 28 microhenries of inductance, wound with #20 double cotton covered wire on a form of phenolic insulation having a diameter of 1-1/2 inches.
- (b) A Universal wound coil with an inside diameter of 1 inch, a width of 1/2 inch and a depth of winding of approximately 5/8 inch with an inductance of 6.9 millihenries. This self-supporting coil, wound with #20X38 D.S.C. Litz wire, was used without a coil form.
- (c) A Universal wound coil similar to the above but with sufficient added turns to raise the inductance to 10 millihenries.

A second set of identical coils were treated with a wax and measurements were made of the Q of the coils on a Boonton Q meter with the coils in the three following conditions:

- (a) Coils untreated and subjected to ambient atmospheric humidity. (This is the "undoped" condition referred to on Plates 1 to 6.)
- (b) The same coils heated in an oven to about 120 degrees C. for 24 hours, transferred to a desiccator containing a drying agent and allowed to cool to room temperature; one coil of each set was impregnated with Dogardite and the other with the wax mentioned on Plate 2 and allowed to stand for three days after which measurements were made in the "doped" condition.
- (c) Coils were totally immersed in distilled water at room temperature for 24 hours, removed and the surface moisture wiped off and measurements of Q were made ten minutes and one hour after removal from the water.

The Dogardite was applied by dipping the coils into the liquid as recommended in Enclosure (B) of reference (a) except that the vacuum treatment was not employed. The work reported in reference (b) indicated no appreciable difference in the effectiveness of coil impregnating compounds whether applied to dry coils in vacuum or at atmospheric pressure. In the case of the Universal wound coils, the Dogardite was applied four times, with a period of one to two days between applications. The Q of the Universal wound coils was measured between 80 and 220 kilocycles while that of the single layer coils was measured between 1500 and 4500 kilocycles.

#### DATA RECORDED DURING TEST

6. The data recorded during the test are shown in graphical form on Plates 1 to 6. The coils are numbered from 1 to 6 and the graphs for each coil appear on the similarly numbered Plate. The odd numbered coils were treated with Dogardite and the even numbered coils with the selected wax.

#### PROBABLE ERRORS IN RESULTS

7. The error in the measurement of the Q of the coils is believed to be less than 5% except that it may be slightly greater in the measurement on the coils in the "wet" condition where the Q is appreciably less than for the dry condition.

#### RESULTS OF TEST

8. The effect of impregnating coils with the water-proofing compounds and of immersing the impregnated coils in water is conveniently expressed by noting the change in the Q of the coils. The Q of a coil is equivalent to the inductive reactance divided by the radio frequency resistance at the frequency in question. Obviously the higher the Q the better the coil, since the Q is inversely proportional to the radio frequency resistance.

9. The effectiveness of a material as a protection against the penetration of moisture into the coil when the coil is exposed to extremely high atmospheric humidity over extended periods of time can be determined relative to other materials by subjecting the impregnated coils to actual immersion in water and after removing them noting the change in Q under the same condition of length of immersion and length of drying after immersion.

10. The results of the application of Dogardite, and the wax used on similar coils, are shown on Plates 1 to 6. The relative water-proofing qualities of Dogardite and the wax may be observed by comparing the curves of Plate 1 with those of Plate 2 for the 6.9 millihenry Universal wound coils. Similarly, Plates 3 and 4 may be compared for the 10 millihenry Universal wound coils, and Plates 5 and 6 for the 28 microhenry single layer coils.

11. The results of the tests may be summarized as follows:

- (a) Applying Dogardite, or the wax used, to single layer or Universal wound coils when the coils are thoroughly dried out does not reduce the Q of the coil appreciably in any case, and may cause a slight increase in the Q if the undoped coil was measured in a condition of high atmospheric humidity.
- (b) The reduction of the Q of the Dogardite impregnated coils after 24 hours soaking in water and one hour of air drying was many times that of the similar wax treated coils as indicated on Plates 1 to 6 and Table 1.
- (c) The Q of the Dogardite Universal wound coils when only ten minutes out of the water bath was too small to be measured, while that of the similar waxed coils was only slightly less than when one hour out of the water, (although not plotted in this report).
- (d) The Q of the single layer Dogardite coils when only ten minutes out

-3-

of the water was less than half the value after drying one hour, while in the case of the waxed coil the difference was only a few percent, as shown on Plates 5 and 6.

- (e) Dogardite does not bind the turns of a coil together or seal them to the form.
- (f) After a piece of copper gauze had been left standing partly immersed in a test tube of Dogardite for a period of two hours, the liquid had a blue color indicating some chemical action. No exhaustive tests were made in this respect.
- (g) Dogardite may be used on coil forms other than ceramic -- for example, on forms of phenolic insulation.

12. The water-proofing qualities of Dogardite relative to all the substances covered in reference (b) may be noted by comparing the values in Table 2 of reference (b) with those in Table 1, columns 6 and 7 of this report.

13. It is evident that the Dogardite is definitely inferior to the wax used in these comparative tests in its humidity protecting properties and is not to be recommended for impregnating radio frequency inductances. Therefore, no measurements were made to determine the effect of Dogardite as a coil impregnating compound on the temperature coefficient of inductances, or to measure the dielectric constant and power factor of the material in the solidified condition. A photograph of coils used in these tests is appended as Plate 7.

#### CONCLUSIONS

14. As a water-proofing compound for protecting radio frequency inductances from atmospheric moisture, Dogardite is inferior to a number of previously tested materials, and is therefore not considered suitable for Naval use for this purpose.

-4-

# TABLE 1

Coil	Coil		Q at Freqs.Below		Ratio of Q (Undoped Value = 100)	
Dope	No.	Condition	80 KC	200 KC	80 KC	200 KC
Degendite	٦	Indeped	202	100	100	100
Dogararce	1	Deped	102	100	100	100
	1	Doped	19%	90	95	90
II	T	Wet	68	24	34	24
Wax*	2	Undoped	210	107	100	100
11	2	Doped	200	95	95	89
11	2	Wet	200	92	95	86
Dogardite	3	Undoped	200	80x	100	100
11	3	Doped	202	80	101	100
11	3	Wet	21	5x	11	6
Wax	4	Undoped	217	92	100	100
11	4	Doped	205	80	94	87
12	4	Wet	195	72	90	78
			2000 KC	4000 KC	2000 KC	4000 KC
Dogardite	5	Undoped	145	149	100	100
11	5	Doped	147	155	101	104
**	5	Wet	125	103	86	69
<b>2</b> 2	5	Viet	68	36	47	24
Vev	6	Undoped	142	142	100	100
11	6	Doned	148	150	104	106
11	6	Wot	146	138	102	97
98	6	Wet*	144	135	101	95

## Q OF TEST COILS AT CERTAIN FREQUENCIES AND FOR THREE TEST CONDITIONS

x = approximate extrapolated values.

\* = 10 minutes out of water.

Other "wet" values are for 1 hour out of water. Values in columns 4 and 5 taken from Plates 1 - 6.













