DECLASSIFIED

Eng. 70-C [redacted]

REPORT NO. R-1559

DATE 12 October 1939

Classification changed from CONFIDENTIAL
To UNCLASSIFIED
By authority of 1550-156/49
File No. ________ Dated 3/31/49

SUBJECT

Development and Test of Gas-Tight Transmission Line Terminals

FR-1559

BY

DECLASSIFIED by NRL Contract
Declassification Team
Date: 11 MAY 2016
Reviewer's name(s): A. THOMPSON, P. HANNA
Declassification authority: NAVY DECLASS MANUAL, 11 DEC 2012, 03 SERIES

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

DISTRIBUTION STATEMENT A APPLIES
Further distribution authorized by UNLIMITED only.

U. S. GOVERNMENT PRINTING OFFICE 4—7450

NRL Report No. R-1559
Development and Test of Gas-Tight Transmission Line Terminals

DECLASSIFIED

12 October 1939

NRL Report No. R-1559
BuEng Problem No. B-1R

[redacted]

NAVY DEPARTMENT

Report of

Development and Test of Gas-Tight Transmission Line Terminals

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Number of Pages: Text - 4 Tables - 1 Plates - 3

Authorization: BuEng let.C-S67/62(1-26-R6) of 20 Feb.1939.

Date of Test: 1 March to 15 September 1939.

Prepared by:

Harold Granger, Contract Employee

Reviewed by:

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

A. Hoyt Taylor, Head Physicist
Superintendent, Radio Division

Approved by:

H. G. Bowen, Rear Admiral, U.S.N.
Director

Distribution: BuEng (10)

LP

TABLE OF CONTENTS

APPENDICES

[redacted]

AUTHORIZATION

1. The development and test reported herein were undertaken by authority of Bureau of Engineering letter, reference (a). Other relevant correspondence is indicated under references (b) and (c).

Reference: (a) BuEng conf.let.C-S67/62(1-26-R6) of 20 Feb.1939.
(b) NRL conf.let.C-S67/62 of 26 January 1939.
(c) BuEng let.C-NP14/N8(12-16-R8) of 19 Dec.1938.

OBJECT OF TEST

2. This problem was undertaken to develop and test a suitable design of gas-tight transmission line terminals first described in reference (b).

ABSTRACT OF TEST

3. Transmission line seals in three sizes (1/4", 3/8", and 3/4") were constructed at the Naval Research Laboratory and subjected to tests to determine their suitability for use in the Naval Service. Reference (a) requested information and data on seals for 7/8" line. Glass sealing alloy tubing suitable for construction of 7/8" transmission line seals was not obtainable except by special order and payment of tool costs. Therefore no seals of this size were tested. A pair of 1/4" and 3/8" seals were attached to 20-foot lengths of 1/4 and 3/8" line respectively, the lines filled with dry nitrogen and sealed. At the end of the test period, these lines were subjected to several temperature cycles. Seals were tested for leaks over a period of approximately eight weeks. Further, they were subjected to standard vibration and shock tests after which they were again examined for gas leakage.

[redacted]

<u>Conclusions</u>

(a) It is believed practicable to manufacture and use seals of this type on 1/4 and 3/8 inch transmission lines.

(b) In view of experience gained in the manufacture of these items, there is no reason to believe that seals of this type can not be used on 7/8 inch transmission line.

(c) It is believed that transmission lines fitted with these seals could be placed in service for an indefinite period of time without requiring attention.

[redacted]

Recommendations

(a) In view of difficulties encountered at the Naval Research Laboratory in the use of screw-thread fittings of any kind, it is believed that their use should be discouraged wherever it is important that gas leakage be reduced to a minimum.

(b) It is suggested that the Bureau take steps to obtain a quantity of the subject seals commercially and place them in service on Naval ships and stations in order to prove their value in actual service.

[redacted]

DESCRIPTION OF MATERIAL UNDER TEST

4. Several 1/4-inch, 3/8-inch, and 3/4-inch glass to metal seals were constructed for use in this investigation. Since no 3/4-inch transmission line was available, 3/4-inch seals were not subjected to the same tests as the 1/4 and 3/8-inch variety, but were constructed primarily to determine the feasibility of glass to metal seals in the larger diameters. In Plate 1, (a) and (b) show 1/4 and 3/8-inch seals respectively. The inner and outer conductors of the seals were manufactured of a nickel-iron-cobalt alloy, known commercially as "Kovar," furnished by Stupekoff Laboratories, Inc., a subsidiary of the Westinghouse Electric and Manufacturing Company. The glass seal proper was manufactured of Corning Glass Works No. 705-AJ glass. The coefficient of linear expansion with temperature of both glass and metal is approximately 4.7×10^{-6} centimeters per centimeter per degree Centigrade between 25° and 450° C.

5. A 20-foot length of 1/4-inch transmission line manufactured by Communications Products Company was obtained and two seals attached thereto. This line is constructed of soft drawn copper tubing 1/4-inch outside diameter. The insulation consists of spun glass cord spirally wrapped about the inner conductor at a pitch of approximately two turns per inch. The inside diameter of the outer conductor is 0.177 inch and the outside diameter of the inner conductor is 0.051 inch. This line, with seals attached, was filled with dry nitrogen to a pressure of approximately 14.5 pounds per square inch.

6. One 20-foot length of 3/8-inch transmission line manufactured by Isolantite, Inc., was fitted with a pair of seals, filled with dry nitrogen to a pressure of approximately 27 pounds per square inch and sealed. The outer conductor of this line consists of 3/8-inch outside diameter soft drawn copper tubing, the inside diameter of which is 0.311 inch. The outer diameter of the inner conductor is 0.080 inch. The insulation of the line consists of isolantite washers spaced approximately one inch apart.

7. In order to provide suitable protection to the glass seal, a secondary terminal arrangement was designed and constructed as indicated in Plate 1. With reference to Plate 1, (c) shows the complete 1/4-inch terminal. (a), (d), (e), and (f) are the component parts of same. (g) portrays the 3/8-inch terminal and (b), (h), (i) and (j), the component parts. One terminal, such as is shown in Plate 1 (c) and one terminal in Plate 1 (g) were fitted to short lengths of transmission line and subjected to vibration and shock.

8. Plate 2 portrays a 3/4-inch seal without the protective terminal. Several seals of this size were constructed in order to determine the feasibility of their manufacture. They were not subjected to the same tests as the 1/4-inch and 3/8-inch seals.

METHOD OF TEST

9. The 1/4-inch and 3/8-inch lines shown in Plate 3 (a) and (b) respectively, after having been filled with dry nitrogen, were checked periodically for gas pressure by means of the pressure gauge attached

[redacted]

and insulation resistance by means of a General Radio Type 487-A megohmmeter. At the conclusion of a period of approximately eight weeks, both of these lines were subjected to two temperature cycles, after which the gas pressure and insulation resistance were again noted. Table 1 is a record of gas pressures, ambient temperatures and insulation resistances for test period.

10. The completed terminals (one of each size) attached to short lengths of a transmission line were tested for leaks by submerging in water and applying approximately 150 pounds per square inch air pressure. These terminals were then mounted on a vibration table and subjected to vibration ranging from 1200 vibrations per minute to 3,000 vibrations per minute over a period of five hours. The terminals were mounted on the vibration table in such a manner that the last clamp on the transmission line was approximately 5 inches from the end of the terminal.

11. These two terminals were then mounted in the same manner on the shock testing equipment and subjected to 20 shocks of 250 foot pounds. The terminals were tested for leaks after the vibration test and again after the shock test by submerging in water and applying 150 pounds per square inch air pressure. They were also checked for insulation resistance before and after each test.

DATA RECORDED DURING TEST

12. Data recorded during test are furnished in Table 1.

RESULTS OF TEST

13. In a problem of this type a considerable portion of the information obtained cannot be readily tabulated and, therefore, a discussion of various problems encountered and their solution is in order. In the manufacture of glass metal seals of the type reported herein, it was found that a process of annealing was necessary in order to normalize strains set up in glass during the process of manufacture of the seal. The annealing was carried out in an electric furnace and the procedure was as follows: The seals were brought up to the annealing temperature of "Kovar" or approximately 450° C in about 4 hours and then allowed to cool to ambient temperature in approximately 12 hours. This method prevented fracture of the glass in the seal after any period of time and as long as the annealing process was used, no casualties were suffered. In the 3/4-inch diameter seals, the glass invariably cracked within a period of 48 hours unless the annealing process was used. As for 1/4 and 3/8-inch diameter seals, about 50% of those manufactured without annealing would fracture in the course of 48 hours.

14. It was found that standard gauge fittings or any transmission line fittings that depend upon a screw-thread for attachment and a sealing compound, such as white lead or litharge can not be depended upon as being gas-tight or remaining so. Therefore, fittings and terminals were attached to lines by a sweating process only.

[redacted]

15. As indicated in Table 1, over the period 25 July to 19 September 1939, there was no detectable leakage of gas from either the 1/4 or 3/8-inch line and no measurable change in insulation resistance. Table 1 also indicates gas pressures and temperatures for each line during the temperature cycle test. This test was conducted primarily to discover whether or not the seals would withstand wide variations in ambient temperatures without the development of leaks or fractures resulting in loss of gas. Indications were that no leaks developed and at this date gas pressures are still comparable to those indicated at the beginning of the test.

16. The terminals subjected to vibration and shock were tested for leaks at an air pressure of 150 pounds per square inch. No leaks were indicated. This test was repeated after a period of vibration and again after the shock test. There were still no indications of leakage. In addition, terminals were tested for insulation resistance before and after the vibration and shock tests and no change was noted, the insulation resistance at all times being in excess of 50,000 megohms.

CONCLUSIONS

17. It is believed practicable to manufacture and use seals of this type on 1/4 and 3/8 inch transmission lines.

18. In view of experience gained in the manufacture of these items, there is no reason to believe that seals of this type can not be used on 7/8-inch transmission line.

19. It is believed that transmission lines fitted with these seals and protective terminals could be placed in service for an indefinite period of time without requiring attention.

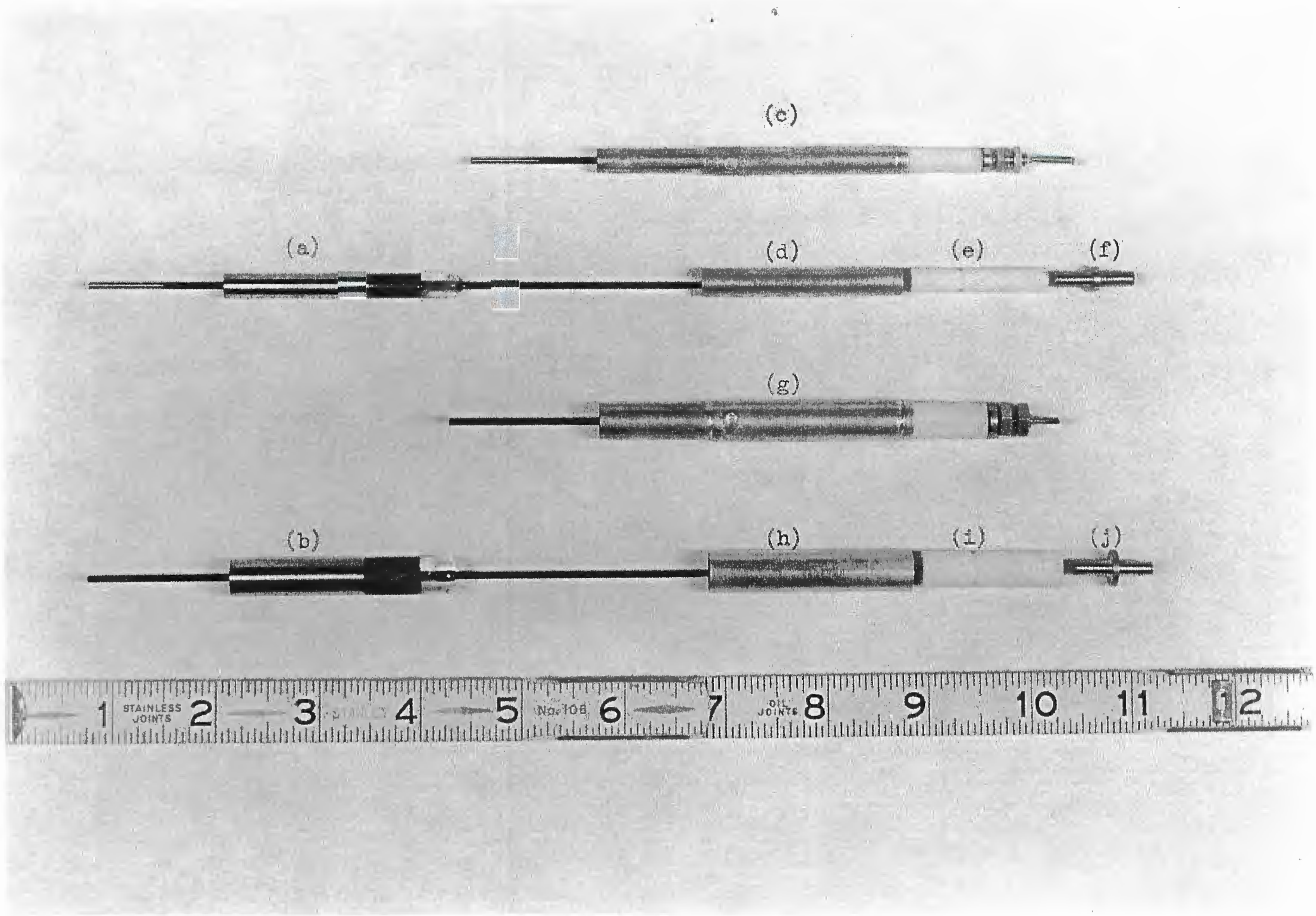
[redacted]

Table 1

Test Data on Glass Sealed Concentric Lines

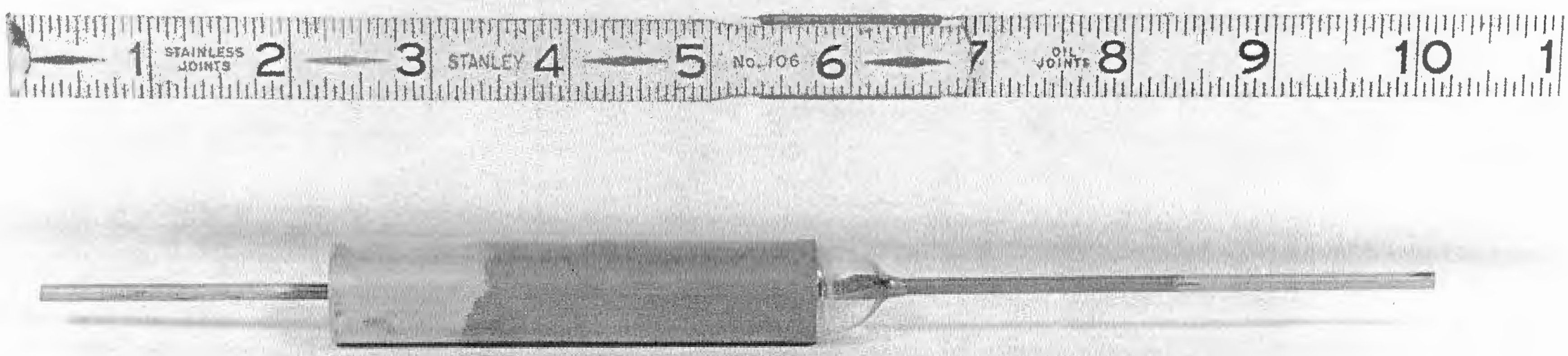
Pressure lb./sq.in. 1/4" line	Pressure lb./sq.in. 3/8" line	Insulation Resistance 1/4" line	Insulation Resistance 3/8" line	Ambient Temp. °C	Date	
14.4	26.2	50,000+ meg	50,000+ meg	26	7-25-39	
14.5	27.0	"	"	26.6	7-26-39	
14.5	26.5	"	"	27.0	7-27-39	
14.7	27.0	"	"	29.0	7-28-39	
14.5	26.6	"	"	28.0	7-31-39	
14.8	27.2	"	"	31.0	8-1-39	
14.6	27.0	"	"	30	8-2-39	
14.7	27.3	"	"	32	8-3-39	
14.5	27.0	"	"	29	8-7-39	
14.6	27.2	"	"	31	8-8-39	
14.6	27.1	"	"	30	8-9-39	
14.7	27.3	"	"	32	8-11-39	
14.7	27.3	"	"	32	8-15-39	
14.6	27.0	"	"	29	8-18-39	
14.7	27.3	"	"	31	8-20-39	
14.5	27.0	"	"	29	8-24-39	
14.3	26.4	"	"	26	8-28-39	
14.2	26.0	"	"	23.5	9-19-39)	Temp.
12.8	20	"	"	-14	9-19-39)	cycle #1
14.2	25.8	"	"	21.0	9-20-39)	Temp.
12.5	18.4	"	"	-25	9-20-39)	cycle
14.9	30	"	"	50	9-20-39)	#2
14.1	25.8			22	9-25-39	

[redacted]



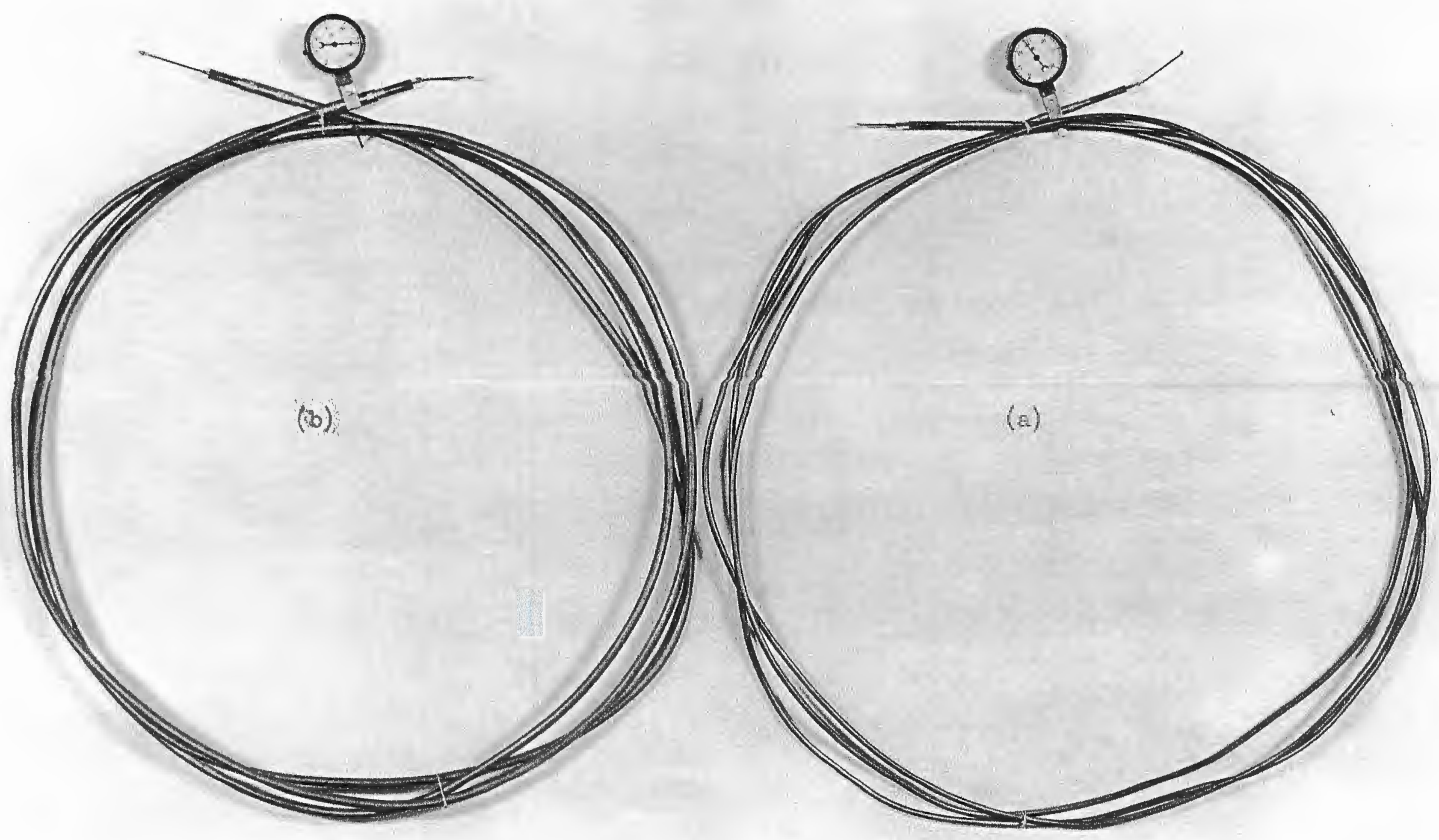
1/4" and 3/8" terminals

Plate 1



3/4" seal

Plate 2



1/4" and 3/8" Sealed Lines

Plate 3