

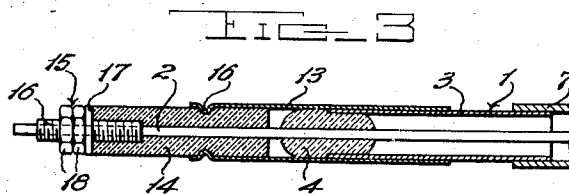
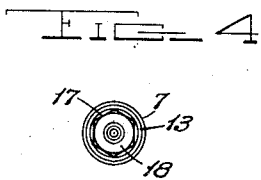
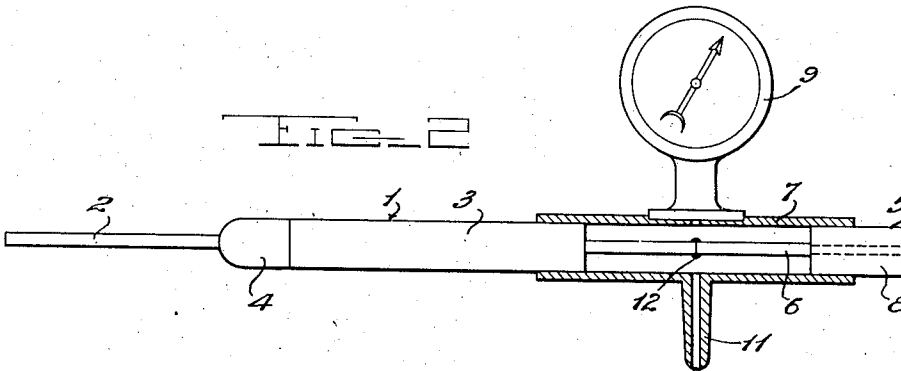
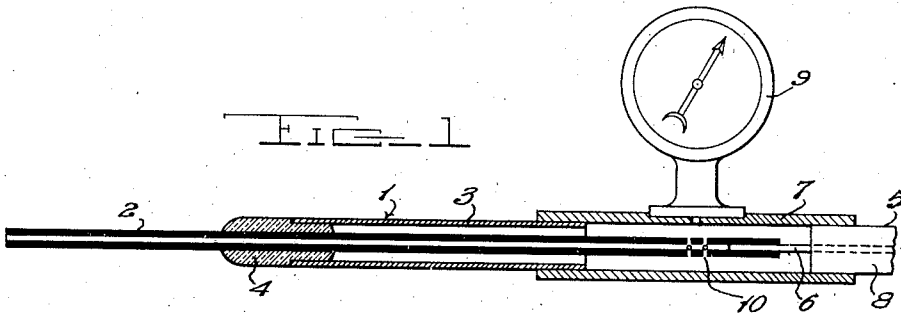
June 22, 1943.

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2,322,233

COAXIAL TRANSMISSION LINE TERMINAL

Filed May 2, 1941



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2,322,233

COAXIAL TRANSMISSION LINE TERMINAL

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Application May 2, 1941, Serial No. 391,455

2 Claims. (Cl. 174-19)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 376 O. G. 757)

My invention relates to a coaxial transmission line terminal and, more particularly, to a terminal of the stated character that maintains its fluid-tight integrity unimpaired in use and provides a convenient means for connecting electrical conductors thereto.

As is well known, coaxial transmission lines are employed for the transmission or reception of radio frequency energy because of the many structural and electrical advantages inherent therein. Among the advantages possessed by coaxial transmission lines are the maintenance by the same of substantially uniform electrical characteristics under all service conditions and the ability to increase the power transmission thereof either by the partial evacuation of or by the introduction of gas under pressure into the space between the outer and inner concentric conductors.

In order to insure the retention of the above enumerated advantages, it is essential that the coaxial transmission line be provided with a terminal that maintains its fluid-tight integrity unimpaired in use. This is achieved in accordance with the present invention by the provision of a terminal comprised of a pair of insulatingly spaced concentric metallic conductors and a layer of glass for sealing one conductor to the other. The glass has a low dielectric loss at radio frequencies and a temperature coefficient of expansion substantially equal to that of the metallic conductors to thus insure a vacuum-tight seal.

The inner conductor of the concentric terminal pair may be tubular, if desired, to thus provide a ready means for partially evacuating the space between the outer and inner conductors of the transmission line or for introducing gas under pressure into the space therebetween. A suitable connector electrically continuous with the inner conductor of the concentric terminal pair may be supported in an insulating manner from a metallic sleeve secured to the outer conductor of the concentric terminal pair and extending beyond the seal therebetween. This is a feature of importance in the present invention since the sleeve not only provides a protective covering for the seal but also takes the mechanical stresses that would otherwise be imposed upon the seal through the securement of conductors to the connector or otherwise.

In the light of the foregoing, it is among the several objects of my invention to provide a coaxial transmission line terminal in which fluid-tight integrity is achieved through the utiliza-

tion of a glass-to-metal seal; to provide a terminal of the stated character through which gas may be conveniently introduced into or withdrawn from the transmission line; and to provide a terminal of the character noted above which incorporates a novel arrangement of parts for protecting the glass-to-metal seal and for facilitating the connection of conductors to the transmission line.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying sheet of drawing, wherein:

Fig. 1 is a view in partial sectional elevation of one embodiment of the terminal of the present invention shown connected to the transmission line and as incorporating an inner gas conveying conductor;

Fig. 2 is a view in partial sectional elevation of another embodiment of the terminal of the present invention shown connected to the transmission line and as incorporating a solid inner conductor;

Fig. 3 is a view in partial sectional elevation of the novel arrangement of parts that may be employed in conjunction with either of the embodiments depicted in Figs. 1 and 2 for protecting the glass-to-metal seal and for facilitating the connection of conductors to the transmission line; and

Fig. 4 is a view in end elevation of the structure delineated in Fig. 3.

Turning now to Fig. 1 of the drawing, there is shown depicted therein a coaxial transmission line terminal identified in general by the reference character 1 and comprised of the pair of insulatingly spaced concentric metallic conductors 2 and 3 sealed together by the layer of glass 4. The glass 4 has a low dielectric loss at radio frequencies and a temperature coefficient of expansion substantially equal to that of the metallic conductors 2 and 3, as will be pointed out more in detail hereinafter.

The coaxial transmission line 5 is shown with its inner conductor 6 in telescoping and electrically continuous engagement with the inner tubular gas conveying conductor 2 of the concentric terminal pair, electrical continuity being achieved by soldering or otherwise securing the telescoping conductors 2 and 6 at their junction point. A metallic sleeve 7 is secured in fluid-tight relation to the open end of the outer conductor 3 of the transmission line and to the outer

concentric conductor 3 of the terminal pair in any suitable manner, as by sweating or welding the sleeve 7 and the outer concentric conductors 3 and 8 at their junction points. A pressure gauge 9 of any conventional prior art construction may be optionally employed to indicate the pressure of the gas between the inner and outer concentric conductors 6 and 8 of the transmission line 5.

The inner gas conveying conductor 2 of the concentric terminal pair is suitably apertured at 10 by providing a number of diametrical perforations through the conductor so that gas may be easily introduced within or withdrawn from the transmission line. By virtue of this construction it is possible to provide the transmission line with dry air or a dry inert gas at or above atmospheric pressure or to evacuate the transmission line to any desired degree of pressure. After the desired gas pressure is established within the transmission line, the inner tubular conductor 2 of the terminal pair is hermetically sealed in any suitable manner as by crimping the same and soldering the conductor at the crimped portion.

The embodiment depicted in Fig. 2 of the drawing is in all respects identical with that of Fig. 1 except that the inner concentric conductor 2 of the terminal 1 is solid instead of tubular and that the sleeve 7 is provided with a connection 11 for introducing or withdrawing gas from the transmission line 5. After the desired pressure is established within the transmission line, the terminal portion 11 integral with the sleeve 7 may be sealed in any suitable manner. As shown in Fig. 2 of the drawing, the inner conductor 2 of the terminal and the inner conductor 6 of the transmission line are butt welded at 12 or otherwise suitably secured at this point to establish electrical continuity therebetween. With the exceptions noted above the construction in Fig. 2 is identical with that of Fig. 1. Hence, similar reference characters have been employed in both figures to designate corresponding parts.

It is known that the electrical losses in solid dielectrics increase with frequency and that these losses are principally due to dielectric hysteresis. The electrical energy lost as a result of dielectric hysteresis appears in the form of heat generated within the dielectric, the heat so generated being cumulative in part and resulting in higher temperatures within the dielectric with increase in the electrical losses.

In order, therefore, to insure a vacuum-tight seal in the terminal of the present invention, it is essential that the dielectric material 4 have a low loss at radio frequencies, a high melting point, high resistance to thermal shock and a coefficient of expansion substantially equal to that of the metallic conductors 2 and 3 sealed thereto. In accordance with the present invention I employ as the dielectric sealing material 4 glasses having the above cited characteristics and in particular the hard glasses because of their lower dielectric loss at radio frequencies.

Among the hard glasses I have found it advantageous to use the boro-silicate glasses which have an expansivity or coefficient of expansion varying in general between 3.0 and 7.0×10^{-6} cm. per cm. per degree C. The dielectric losses of these glasses at radio frequencies is not only exceedingly low but these glasses by virtue of their low coefficient of expansion exhibit a high resistance to thermal shock. Thus, they will with-

stand sudden changes of temperature without fracture.

By way of illustration there are tabulated below a number of boro-silicate glasses that may be advantageously used in the fabrication of the seal:

TABLE I
Compositions and properties of some hard glasses

No.	Expansivity, 25 to 325° C.	Annealing point ¹	Compositions				
			Per cent SiO ₂	Per cent Na ₂ O	Per cent B ₂ O ₃	Per cent Al ₂ O ₃	Per cent PbO
1	$6.1 \times 10^{-6}/^{\circ}\text{C.}^{\circ}$	566	72.4	9.8	10.2	5.1	1.8
2	$4.6 \times 10^{-6}/^{\circ}\text{C.}^{\circ}$	496	67.0	6.5	22.0	2.0	-----
3	$3.2 \times 10^{-6}/^{\circ}\text{C.}^{\circ}$	550	80.0	4.0	13.0	2.0	-----

¹ Lowest temperature at which strains will decay to an inappreciable value after exposure for fifteen hours.

While tungsten and molybdenum have coefficients of expansion of the right order of magnitude for sealing to the boro-silicate glasses and hence may be employed in the fabrication of the concentric terminal conductors 2 and 3 to form an efficient vacuum-tight seal, they possess the disadvantage of being rather expensive and difficult to machine. In the fabrication of the conductors 2 and 3, I prefer, therefore, to use instead an nickel-cobalt-iron alloy that forms an efficient vacuum-tight seal with the boro-silicate glasses. In general, the ranges of the principal ingredients of the alloy are from 15% to 32% nickel, 12% to 45% cobalt, less than 1% manganese, and the remainder iron.

By way of example, there are tabulated below a number of nickel-cobalt-iron alloys that may be employed in making a vacuum-tight seal with the boro-silicate glasses:

TABLE II
Compositions and properties of some alloys

No.	Expansivity, 25 to 325° C.	Compositions				
		Per cent Ni	Per cent Co	Per cent Fe	Per cent Mn	Per cent C
1	$6.2 \times 10^{-6}/^{\circ}\text{C.}^{\circ}$	32	16	51.1	0.80	0.10
2	$4 \times 10^{-6}/^{\circ}\text{C.}^{\circ}$	29	17	53.6	0.20	0.20
3	$3.6 \times 10^{-6}/^{\circ}\text{C.}^{\circ}$	29.8	15.5	54.18	0.22	0.30

In order to make a successful seal, the coefficients of expansion of the metal and the glass must be substantially the same over the temperature ranges within which the metal and glass are both elastic. A large difference in the coefficients of expansion produces stresses which may cause the glass to crack when cooled to room temperature and thus destroy the vacuum-tight seal. Some degree of differential expansion, however, between the metal and glass may be tolerated and is even desirable. Thus, it has been found that the alloys designated by the numbers 1, 2 and 3 in Table II above may be sealed respectively to the glasses designated by the numbers 1, 2 and 3 in Table I to form therewith a vacuum-tight joint under the conditions encountered in use.

For protecting the glass-to-metal seal and for facilitating the connection of conductors to the transmission line, the construction depicted in Figs. 3 and 4 may be employed with either of the embodiments heretofore described. As shown more particularly in Fig. 3, a metallic sleeve 13

is firmly secured in any suitable manner as by welding or sweating to the outer conductor 3 of the terminal pair and extends well beyond the seal 4 therebetween to thus form a protective housing for the same. An electrical insulator 14 of any suitable material, such as a ceramic material, is longitudinally apertured and terminally recessed to receive respectively the conductor 2 and the connector 15 electrically continuous therewith. The insulator 14 as shown is securely affixed to the sleeve 13 in any convenient manner as by crimping the sleeve firmly at 16 into an annular groove of the insulator 14.

While any convenient type of connector may be employed I have shown the connector 15 supported from the ceramic insulator 14 as including a metallic sleeve 16 threaded at both ends and terminating centrally in a metallic disc 17 integral with or otherwise secured to the threaded sleeve. The sleeve 16 is sweated or soldered to the inner conductor 2 of the concentric terminal pair to establish electrical continuity therebetween. One or more nuts 18 are in threaded engagement with the sleeve 16 so that a good electrical connection may be made to a conductor by interposing and clamping the same between the disc 17 and the nut 18 next adjacent thereto. Since the connector 15 is soldered or sweated to the conductor 2 and has a portion thereof embedded in the terminal recess of the insulator 14, a rigid and secure mounting is provided for the same.

By virtue of the foregoing construction, the glass-to-metal seal is protected against mechanical shocks and hazards. For not only does the sleeve 13 provide a protective covering for the seal 4 but it also takes the mechanical stresses that would otherwise be imposed upon the seal through the securement of the conductors to the connector 15 or otherwise. Finally, the construction delineated in Fig. 3 provides a very convenient means for connecting a conductor to the transmission line.

According to the provisions of the patent statutes, I have set forth the principle and mode of

operation of my invention and have illustrated and described what I now consider to represent its best embodiments. However, I desire to have it understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically illustrated and described.

The invention herein described and claimed may be used and manufactured by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. A coaxial transmission line terminal comprising in combination a pair of insulatingly spaced concentric metallic conductors and a layer of glass for sealing one conductor to the other, the said glass having a low high frequency dielectric loss and a temperature coefficient of expansion substantially equal to that of the metallic conductors, a tubular metallic conductor secured to the outer conductor of the concentric conductor pair and extending beyond the seal therebetween, an insulator affixed to the tubular metallic conductor and a connector supported from said insulator, the said connector being electrically continuous with the inner conductor of the concentric conductor pair.

2. A coaxial transmission line terminal comprising in combination an inner tubular gas conveying metallic conductor concentric with and insulatingly spaced from an outer tubular metallic conductor and a layer of glass for sealing one conductor to the other, the said glass having a low high frequency dielectric loss and a temperature coefficient of expansion substantially equal to that of the metallic conductors, a metallic sleeve secured to the outer tubular conductor of the concentric conductor pair and extending beyond the seal therebetween, an insulator affixed to the sleeve and a connector supported from said insulator, the said connector being electrically continuous with the inner tubular conductor of the concentric conductor pair.

HAROLD GRANGER.