Feb. 21, 1950 E. W. HUNT 2,498,335

TERMINATION FOR COAXIAL LINES

Filed May 3, 1945

Fig. 1.

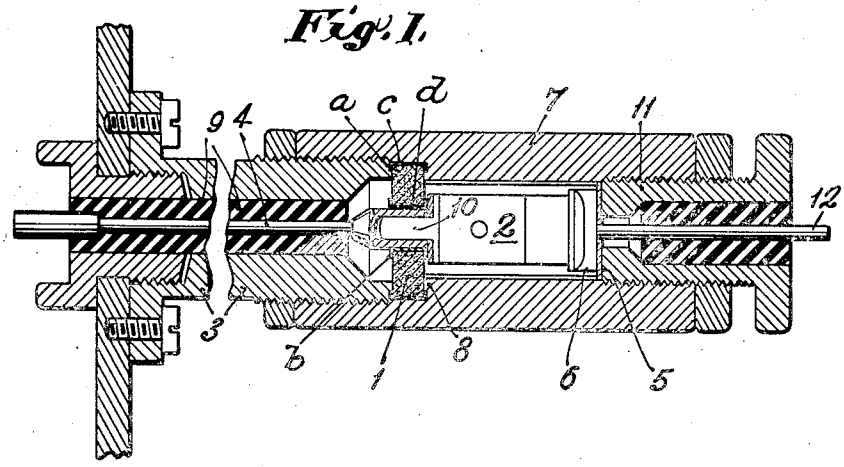


Fig. 2.

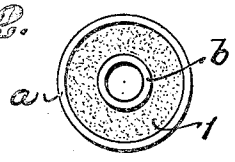


Fig. 3.

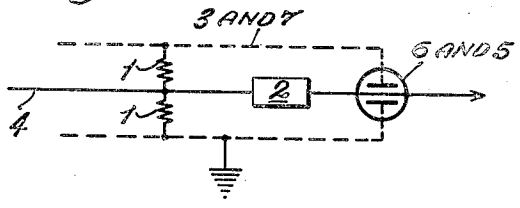
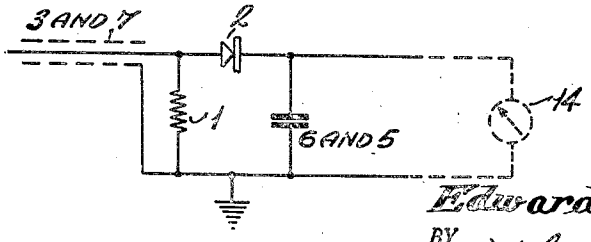


Fig. 4.



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TERMINATION FOR COAXIAL LINES

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10 Claims. (Cl. 250—31)

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This invention relates to improvements in coaxial transmission lines, particularly in the termination thereof. It is more especially concerned with a termination device for a coaxial transmission line which is required to operate in the very high frequency range extending from 1 to 1000 mc./s. The invention, however, resides in the principle involved in the device itself and not in any particular range of frequencies in connection with which the device may be required to be used.

The principal object of the invention is to provide an essentially resistive termination for a coaxial transmission line having a characteristic impedance lying between 30 to 120 ohms.

Another object of the invention is to provide a device for the detection or measurement of the voltage across the termination.

According to the invention in its broadest aspect, a substantially exclusively resistive termination for a coaxial transmission line includes a centrally apertured carbon disc having at least the peripheral surface and the internal surface of the aperture metallised to constitute terminals with which, in use, the interior surface of the outer conductor of the transmission line (or of an extension thereof constituting part of the terminating device) and the exterior surface of the inner conductor of the transmission line (or of an extension thereof constituting part of the terminating device) make continuous circumferential and width electrical connection, and wherein the resistance between the edges of the two metallised surfaces through the disc has the desired value.

In addition to the peripheral surface, an outer annular surface on one or both sides of the disc may be metallised, the metallising of the peripheral surface and of the annulus or annuli being continuous, and the resistance between the edge of the annulus or edges of the annuli and the edges of the metallised surface of the aperture through the carbon disc having the desired value.

Again, in addition to the said peripheral surface or peripheral and outer annular surfaces, an inner annular surface on one or both sides of the disc may be metallised, the metallising of the inner surface of the aperture and of the last named annulus or annuli being continuous, and the resistance between the edges of inner and outer annuli having the desired value.

According to the invention in a more restricted aspect, a terminating device for a coaxial transmission line includes an outer tubular conductor, a coaxially disposed inner conductor, a carbon

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disc having a concentric aperture, the said outer conductor being electrically connected to the said disc continuously around the outer cylindrical surface, or continuously around an outer annular surface adjacent thereto on one or both faces of the disc, or around both, and the said inner conductor being electrically connected to the said disc continuously around the inner cylindrical surface of said aperture, or continuously around an inner annular surface adjacent thereto on either or both faces of the disc, or around both, the resistive termination being constituted by the carbon disc between the surfaces of connection and being disposed symmetrically about the centre line of the transmission line.

In order to provide a device for the detection or measurement of the voltage developed across the terminating resistance, a crystal element is situated, within the outer tubular conductor, on the side of the disc remote from that on which the coaxially disposed inner conductor is situated and has one of its terminals connected to the said inner conductor, or continuously around an inner annular surface on the face of the disc adjacent to the said crystal.

The end of the outer tubular conductor may be provided with a conductive plug having a coaxial bore through which extends a conductive shank insulated from but in capacitative relationship with the said plug, the inner end of the shank being provided with a terminal to which the other terminal of the crystal is connected, the capacitance between the shank or terminal and plug constituting a by-pass condenser for high-frequency energy.

An indicating instrument, for example, a micro-ammeter, may be connected to said shank and to said outer tubular conductor or to the said plug, or to any other conductive member which is in conductive relationship to the outer conductor of the transmission line.

In order to ensure good electrical connection with the carbon disc, those parts (outer cylindrical, inner cylindrical, and outer or inner annular surfaces) to which connection is to be made should be metallised.

The invention is illustrated in the accompanying drawings in which Figure 1 is a sectional view of an embodiment of the invention; Figure 2 is an end view of a metallised disc; Figure 3 is a schematic diagram of the circuit, and Figure 4 is a simplified circuit diagram.

In Figure 1, an outer conductive tubular member 7, internally threaded at both ends is provided with an abutment at 8. Into one end of

tubular member 7 is screwed a tubular member 3 having an internal diameter equal to the internal diameter of the transmission line in use (in an experimental model $\frac{7}{32}$''). Coaxially supported, by insulating material 9 is an inner conductor 4 having an external diameter equal to that of the inner conductor of the transmission line. The members 3 and 4 serve as means whereby the terminating device may be connected to the conductors of the transmission line.

A terminating resistor, consisting of a carbon disc, a method of producing which will be described, is indicated at 1. This disc is metallised as at *a* and *b*, Figure 2, on both faces and on its outer and inner cylindrical surfaces *c* and *d*, Figure 1. The disc 1 is threaded upon conductor 4 so that its metallised surface *d* makes connection with that conductor. The member 3, conductor 4 and disc 1 are then screwed into tubular member 7 so that connection is made at *a* (on both faces) and *c*, continuously around the disc, with members 3 and 7. Thus the terminating resistor 1 is symmetrical about the centre line of the device and consequently of the transmission line.

A crystal element 2, is inserted in the tubular member 7 so as to make connection, by means of a shank 10 which enters a recess in conductor 4, with the said conductor 4, and thus with the inner terminal of the disc resistor 1.

Into the right-hand end of tubular member 7 is screwed a conductive plug 11, having a coaxial bore. Through the bore in plug 11 extends a shank 12 having on its inner end a terminal 6 for connection to the other end of the crystal element, shank 12 being coaxially supported within metal plug 11 by a plug of keramot or other suitable insulating material. The outer face of terminal 6 and the inner end of plug 11 are insulated from each other by means of a disc 5 of, for example, mica and together constitute the electrodes of a by-pass condenser. Shank 12 serves for the external connection to a microammeter 14, Figure 4, which serves as a voltage indicating device, being connected between the shank and the earthy outer member of the device.

In Figures 3 and 4, the parts corresponding to those of Figure 1 are, so far as may be, indicated by the same reference numerals as are used in Figure 1. It is thought unnecessary to describe the circuit.

The production of resistor 1 may be effected as follows: A carbon resistor of the 2 watt rating (e. g. Erie R. M. A. 1) nominal value 400–1,000 ohms, is drilled through the centre and a section about ⅛'' wide parted off. The entire surface of this section is then rendered conductive by copper-electro-plating in an electrolyte of copper sulphate solution. A plating current of 100 ma. should not be exceeded, otherwise the layer of copper deposited on the carbon will be too soft and will peel off too readily in the subsequent operation. An annular ring of the deposited copper is now removed from each end surface of the section until the resistance from centre to outer edge is of the required value (in the case of the experimental model, 75 ohms). The completed section is then wax impregnated.

It is found that the resistance is fairly stable in operation, the total drift being of the order of 1% over a period of a week. The circular nature of the resistor makes it possible to preserve absolutely symmetrical construction of the unit.

The fact that the internal diameter of member 3 is the same as that of the outer conductor of the transmission line, and that the external diameter of member 4 is the same as that of the inner conductor of the line preserves the physical properties of the coaxial cable in use, and therefore since the terminating resistor 1 is placed directly across the end of this composite line, no rise in voltage occurs between the source of voltage and the termination. The arrangement of the experimental model was to provide a load of nominal value, 75 ohms, for a crystal voltmeter and enabled the crystal 2 to be mounted directly on the terminating resistor, thus eliminating another source of error due to rise in voltage.

What I claim is:

1. A coaxial transmission line comprising a metallic housing, inner and outer conductors terminated within said housing by means of a centrally apertured solid carbon disc, said disc being electrically connected to the outer cylindrical surface of the inner conductor adjacent one face of the carbon disc and retained to the housing by a bushing threaded in said metallic housing, the outer conductor of said line and said metallic housing forming part of the terminating device, the resistive termination being constituted by said solid carbon disc between the surfaces of connection to said housing and being disposed symmetrically about the inner conductor of the transmission line.

2. A terminating device for a coaxial transmission line, comprising an outer tubular conductor, a metallic housing having a shoulder portion and threaded means to join said outer tubular conductor thereto, a coaxially disposed inner conductor insulatingly arranged to extend within said housing, a solid carbon disc having a concentric aperture, the said outer conductor being continuously electrically connected by a threaded bushing and retained in position at the shoulder portion of said housing to said disc around the outer annular surface of said disc adjacent to said outer conductor on both faces of the disc, and the said inner conductor being continuously electrically connected to the said disc around an inner annular surface of said disc adjacent to said outer conductor on both faces of the disc, the resistive termination of said device being constituted by connections between the disc surfaces which are disposed symmetrically about the center line of the transmission line.

3. A device as claimed in claim 2, wherein in order to insure good electrical connection with said metallic housing and said inner conductor the carbon disc has its outer cylindrical, inner cylindrical and outer and inner annular surfaces metallized with copper.

4. A device as claimed in claim 2, wherein in order to insure good electrical connection with said housing and said inner conductor the carbon disc has its outer cylindrical, inner cylindrical and outer and inner annular surfaces metallized with copper, and the carbon disc is wax impregnated.

5. A coaxial transmission line terminating device comprising a metallic housing member having a threaded portion and a shoulder portion, an outer conductor, an inner conductor, means to electrically connect said metallic housing member to said outer conductor, a centrally apertured carbon disc having at least the peripheral surface and the internal surface of the aperture metallized to constitute terminals for said disc, means including a threaded bushing to retain

said disc within said housing at the shoulder portion thereof and to make contact with the peripheral surface of said disc, and insulating means within said bushing to support said inner conductor within said housing.

6. A coaxial transmission line terminating device comprising a metallic housing member having a threaded portion and an internal abutment portion, an outer conductor and an inner conductor, means to electrically connect said metallic housing member to said outer conductor, a centrally apertured carbon disc having at least the peripheral surface and the internal surface of the aperture metallized to constitute electrical terminals for said disc, means including a threaded bushing to retain said disc within said housing and to make contact with the peripheral metallized surface of said disc against said abutment portion, and insulating means within said bushing to support said inner conductor within said housing.

7. A coaxial transmission line terminating device comprising a metallic housing member, an outer conductor, an inner conductor, means to electrically connect said metallic housing member to said outer conductor, a centrally apertured carbon disc serving as a terminating resistance for said transmission line, a crystal detector element centrally located within said housing and connected in series with said inner conductor for detection of the voltage developed across said terminating resistance, means to retain said disc within said housing and to make contact with the peripheral surface of said disc, and insulating means to support said inner conductor and said crystal element within said housing.

8. A coaxial transmission line terminating device comprising a metallic housing member, an outer conductor, an inner conductor, means to electrically connect said metallic housing member to said outer conductor, a centrally apertured carbon disc serving as a terminating resistance for said transmission line, a metallic shank connected to one end of said inner conductor and arranged to pass through the centrally apertured portion of said carbon disc, a crystal element connected to said shank so as to be in series with said inner conductor for the detection of voltage developed across said terminating resistance, means to retain said disc within said housing and to make contact with the peripheral surface of said disc, and insulating means to support said shank and said crystal element within said housing.

9. A coaxial transmission line terminating device comprising a metallic housing member, an outer conductor, an inner conductor, means to electrically connect said metallic housing member to said outer conductor, a centrally apertured carbon disc serving as a terminating resistance for said transmission line, a metallic shank connected to said inner conductor and arranged to pass through the centrally apertured portion of said carbon disc, a crystal detector element connected to said shank so as to be in series with said inner conductor for the detection of voltage developed across said terminating resistance, an insulating washer interposed between said crystal element at the end opposite said shank and a portion of said housing to serve as a by-pass condenser for said transmission line, means to retain said disc within said housing and to make contact with the peripheral surface of said disc, and insulating means to support said shank and said crystal element within said housing.

10. A transmission line device comprising inner and outer conductors, a metallic housing member having a shoulder portion at one end thereof and threaded at both ends, a threaded tubular metallic member, an apertured solid carbon disc having its outer periphery connected to said metallic housing member at the shoulder portion thereof and retained in position by said threaded tubular metallic member, a threaded metallic plug retained in said housing at an end opposite said shoulder portion, a crystal detector located centrally within said housing member, said crystal detector having a metallic shank extending within the aperture of said solid carbon disc and electrically connecting said carbon disc to a portion of the inner conductor, an insulation member retaining said portion of the inner conductor within said threaded tubular metallic member, a mica disc having a central aperture therein, said mica disc being interposed between the crystal detector and said threaded metallic plug at the end opposite said shank to serve as a bypass condenser between the inner and outer conductors, and insulating means to permit another portion of the inner conductor to pass through said metallic plug and through the aperture in said mica disc to connect the crystal detector in series with said other portion of the inner conductor the latter connection being made at an end opposite said shank.

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