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BOLOMETER FOR COAXIAL TRANSMISSION LINES

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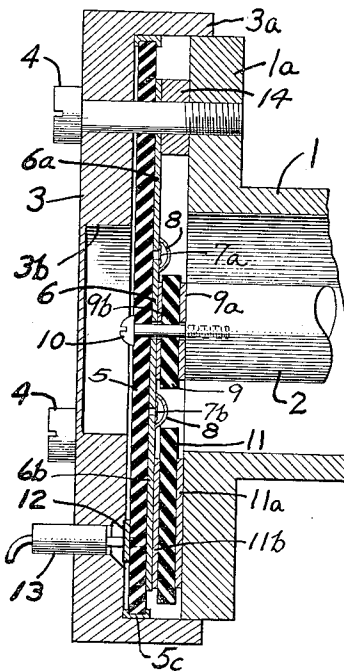


Fig. 1.

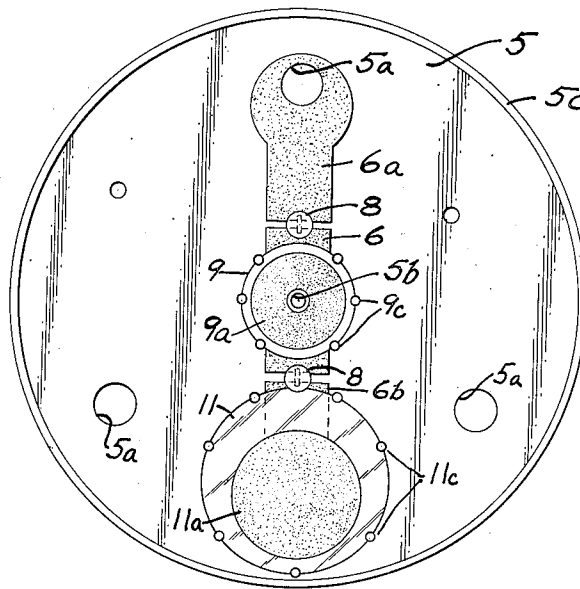


Fig. 2.

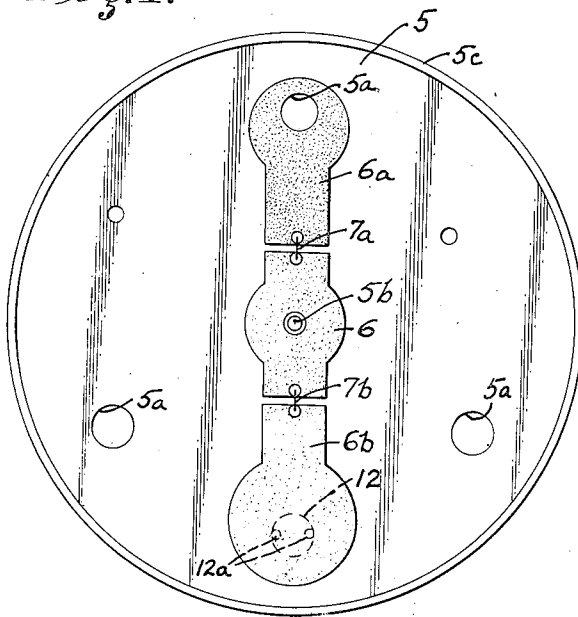


Fig. 3.

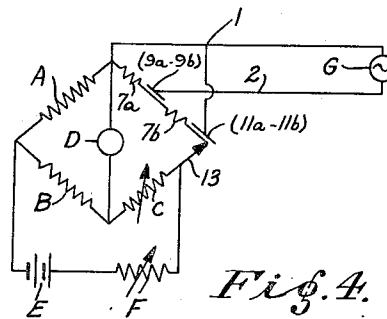


Fig. 4.

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BOLOMETER FOR COAXIAL TRANSMISSION LINES

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6 Claims. (Cl. 324-95)

1 This invention relates to bolometers for the measurement of high frequency power in coaxial transmission lines.

An object of the invention is to devise an improved arrangement for the mounting of the bolometer resistance units.

Another object is to devise a bolometer structure which is rugged and is easily assembled.

The bolometer of our invention is of the type in which two bolometer resistors are effectively connected in parallel with respect to the high frequency currents to be measured and are connected in series with respect to the direct-current biasing current.

Other features of our invention include novel structure providing by-passing and blocking condensers, and the provision of protective coverings for the bolometer resistors.

The preferred form of our invention is illustrated in the accompanying drawing in which:

Fig. 1 is a longitudinal sectional view of the assembled bolometer structure shown on a greatly enlarged scale;

Fig. 2 is a view of Fig. 1 taken along the line 2-2 but omitting the casing; and

Fig. 3 is a view like Fig. 2 with certain parts removed.

Figure 4 shows one example of a bridge circuit in which the bolometer may be used.

Referring to the drawing, the bolometer is formed of a tubular outer casing 1 which is coupled to a coaxial transmission line (not shown) by any suitable coupling means. A conductor 2 is mounted centrally within casing 1 and is connected to the center conductor of the coaxial line by suitable means. Preferably the inner diameter of casing 1 is the same as the inner diameter of the tubular conductor of the coaxial cable, and conductor 2 has the same outside diameter as the inner conductor of the coaxial cable.

The casing 1 is provided with a radial flange 1a at its outer end having a flat outer face arranged normal to the axis of the casing. A cover plate 3 is secured to the flange 1a by means of a number of screws 4 passing through the plate and having threaded engagement with the flange 1a. The cover plate 3 is provided with a cylindrical flange 3a which extends over the outer edge of flange 1a. A cylindrical counter-bore 3b is formed at the center of the inner face of plate 3 and constitutes a waveguide beyond cut-off at the end of conductor 2.

Mounted within the space between the flange 1a and the cover plate 3 is a disc 5 of suitable

2 insulating material, such as mica, for supporting the temperature sensitive resistor elements. The disc 5 when formed of mica, may be of a thickness of about 0.002 inch and is provided with suitable holes 5a for receiving the clamping screws 4; and it is also provided with a central hole 5b for receiving another clamping screw referred to later. Preferably disc 5 is provided with a conducting rim 5c formed around its periphery by any suitable process such as by applying conducting silver paint, either by spraying or by brushing. This rim adds strength to the disc and prevents splitting of the disc.

On the front face of disc 5 are formed three electrodes 6, 6a and 6b, as shown in Figure 2 and more clearly in Figure 3. These electrodes may also be formed by applying conducting paint to the front face of the disc 5 over the stippled areas marked 6, 6a and 6b. It will be noted that a narrow gap is provided between the central electrode 6 and each of the outer electrodes 6a and 6b. Suitable temperature-sensitive resistors 7a and 7b are connected across these gaps, as shown in Figures 2 and 3. The size and shape of the electrodes, and the dimensions of the gaps, may be used as electrical matching parameters to match the resistors with the characteristic impedance of the connected transmission line.

Protective caps 8 are arranged over resistors 7a and 7b and these caps are formed of thin domed pieces of insulating material such as polystyrene. The caps are sealed to the face of disc 5 by lacquer applied at the rim of the caps.

The resistors 7a and 7b may be formed of Wollaston wire (silver jacketed wire) attached across the gaps with conducting paint. Lacquer is then applied to the wire and the adjacent electrode area, leaving the proper length of wire exposed in the center. The silver jacket is then removed by deplating. The desired resistance value is obtained by alternately deplating and measuring until the desired value is reached.

The resistor elements 7a and 7b may also be formed of extremely thin metallic films deposited on the disc 5 across the electrode gaps, the film having a thickness less than the depth of penetration of current at the operating frequency and for the particular metal employed in the film. Such films may be formed according to the process disclosed in Weber et al. Patent No. 2,529,436, or they may be deposited by thermal evaporation according to the process disclosed in the application of Weber et al. Serial No. 699,546, now Patent #2,586,752.

For measurement purposes, the bolometer is connected in the usual Wheatstone bridge circuit, the two resistors 1a and 1b being connected in parallel with respect to the radio frequency currents to be measured and are connected in series with respect to the direct current for biasing the bridge.

One suitable bridge circuit is shown in Figure 4 where arms A, B and C of the bridge correspond to arms 11, 12 and 13 of the bridge in Hansell Patent 2,481,589, and the indicator D corresponds to 16 in Hansell. The bolometer unit shown in Figures 1 to 3 of the application forms the fourth arm of the bridge, and the two bolometer elements 1a and 1b are shown connected in series with respect to the direct current source E. These elements, however, are connected in parallel with respect to the source of high frequency energy represented at G and supplied to the elements 1a and 1b in parallel through the center conductor 2 of the coaxial cable and through the condenser 9a-9b. The end of unit 1b connected to the plug 13 is connected to the outer conductor 1 of the coaxial cable through the condenser element 11a-11b.

As shown in drawing, electrode 6a extends outwardly and surrounds one of the holes 5a so that the outer end portion of the electrode will be connected to the flange 1a either directly or through an intervening washer. The central electrode 6 is connected to the end of center conductor 2 by means of a blocking condenser formed of a disc of insulating material 9, such as a disc of mica of a thickness of about 0.0005 inch, and having conductive coatings 9a and 9b applied to opposite faces thereof. The disc 9 is provided with a central opening aligned with the opening 5b in the disc 5 and the blocking condenser is mounted on the disc 5 by means of spots of lacquer 9c applied around the outer edge of the disc 9. The blocking condenser is clamped against the end of conductor 2 by means of a clamping screw 10 passing through discs 5 and 9 and having threaded engagement with the conductor. The blocking condenser is provided to prevent shunting of the direct current from the bolometer elements by the conductor 2.

The electrode 6b is effectively connected to the flange 1a for high frequency currents by a by-pass condenser formed in the same way as the blocking condenser and involving a thin disc of insulating material 11 having conductive coatings 11a and 11b applied on opposite faces and being secured to the front face of disc 5 by means of drops or spots of lacquer 11c applied around the edge of disc 11. It will be noted that coating 11a has contact with the face of flange 1a while coating 11b is in direct contact with the circular end portion of electrode 6b. It will be understood that the thickness of parts 5 to 11b has been greatly exaggerated in the drawing.

In using the bolometer in a Wheatstone bridge, direct current for biasing the bridge is supplied to the two resistor elements in series by means of a contact 12 applied on the rear face of the disc 5 immediately behind the circular part of electrode 6b and being connected to electrode 6b by means of a pair of connections 12a passing through holes formed in the disc 5. The bolometer is connected in the bridge circuit by means of a plug 13 having engagement with the contact piece 12.

The part of electrode 6a which surrounds the clamping screw 4 should be of increased thickness corresponding to the thickness of the blocking

and by-pass condensers, or a conducting washer 14 may be interposed between the electrode 6a and the flange 1a.

While it is preferred to form discs 5, 9 and 11 of mica, other insulating material may be used such as glass. Also, while it is convenient to form the metallic coatings of the metallic paint applied in the manner indicated, these coatings may be applied in other ways, such as by the process disclosed in the Weber et al., Patent No. 2,529,436.

We claim:

1. A bolometer for coaxial transmission lines comprising, a tubular casing having a radial flange at one end and being adapted for connection to a coaxial line at the other end, a conductor mounted at the center of said casing, a cover plate mounted in spaced relation with said flange, a disc of insulated material interposed between said cover plate and said flange, a central electrode and two outer electrodes formed on one face of said disc and providing a narrow gap between each outer electrode and the central electrode, a temperature-sensitive resistor connected across each gap, a blocking condenser connecting said central electrode with the end of said conductor, means providing a conductive connection between one outer electrode and said flange, means for connecting the other outer electrode to an external source of current, and a by-pass condenser connecting said other electrode to said flange.

2. A bolometer for coaxial transmission lines comprising, a tubular casing having a radial flange at one end and being adapted for connection to a coaxial line at the other end, a conductor mounted at the center of said casing, a disc of insulated material secured to the outer face of said flange, a central electrode and two outer electrodes formed on the inner face of said disc and providing a narrow gap between each outer electrode and the central electrode, a temperature-sensitive resistor connected across each gap, means connecting said central electrode with the end of said conductor through a capacitive reactance of low value at the frequency of operation, means providing a conductive connection between one outer electrode and said flange, means for connecting the other outer electrode to an external source of current, and a by-pass condenser connecting said other electrode to said flange.

3. A bolometer according to claim 2 and including a protective cap of insulating material sealed over each resistor on the front face of said disc and extending into the space between said conductor and said casing.

4. A bolometer for coaxial transmission lines comprising, a tubular casing having a radial flange at one end and being adapted for connection to a coaxial line at the other end, a conductor mounted at the center of said casing, a disc of insulated material secured to the outer face of said flange, a central electrode and two outer electrodes formed on the inner face of said disc and providing a narrow gap between each outer electrode and the central electrode, a temperature-sensitive resistor connected across each gap, means providing a conductive connection between one outer electrode and said flange, means for connecting the other outer electrode to an external source of current, a thin sheet of dielectric material interposed between the central electrode and the end of said conductor, and a thin

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sheet of dielectric material interposed between said flange and the other outer electrode.

5. A bolometer resistor assembly comprising a disc of insulating material, a thin metallic coating applied to one face of said disc over a central area and two outer areas spaced from said central area by small gaps, a temperature-sensitive resistor bridging each gap, a pair of condensers each formed of a thin sheet of dielectric material having conductive coatings applied to opposite faces thereof, means securing one of said condensers in contact with the coating on said central area, and means securing said other condenser in contact with the coating on one of said outer areas.

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6. A bolometer mount according to claim 5 and including a protective cap of insulating material sealed over each resistor.

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