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C. B. GREEN ET AL
RESISTOR HAVING DISTORTION
PROTECTED CONNECTING MEANS
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FIG. 1

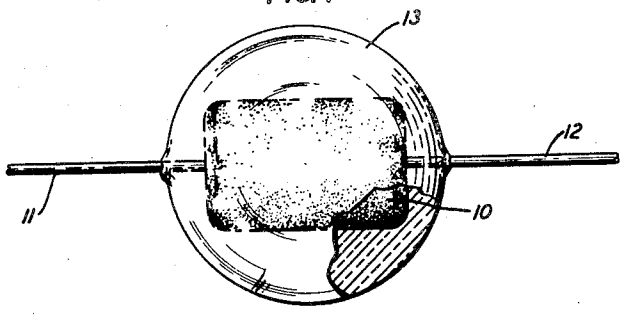
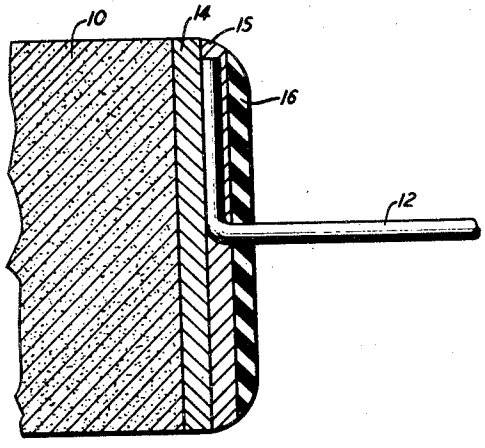


FIG. 2



INVENTORS: C. B. GREEN
R. L. RULISON
BY
ATTORNEY

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RESISTOR HAVING DISTORTION PROTECTED CONNECTING MEANS

Charles B. Green, West Orange, and Raymond L. Rulison, Scotch Plains, N. J., assignors to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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5 Claims. (Cl. 201—63)

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This invention relates to circuit elements and more particularly to resistors having connecting leads affixed thereto. The invention is particularly applicable to insulation encased resistors made from semiconductive material comprising metal oxides, in which a lead wire or conductor is secured to the resistor body by a heat-cured metallic paste.

Certain types of resistors, the resistance of which changes greatly with changes in temperature, have been called "thermistors," and such a device is intended wherever the term may be used in this specification or the appended claims.

For some circuit applications, thermistors comprising small pellets of semiconductive material having an insulating coating of glass or like material have been used. Lead wires are attached to such pellets by a heat-cured metallic paste before the coating is applied. The glass or other coating material is usually selected for a substantial thermal expansion coefficient match with the semiconductive material. For some applications, a near match may not be possible because of requirements not consistent with matching. Also even in cases of relatively close expansion coefficient matching of materials, distortion and consequent impairment of the connections may be caused by application of the coating.

An object of this invention is to inhibit impairment of connections of the type discussed.

A feature of this invention resides in providing resistor connections with a cushioning means to absorb distortions that might otherwise impair these connections.

The foregoing and other objects and features of this invention will be more fully and clearly understood from the following description of an exemplary embodiment thereof taken in connection with the appended drawings in which:

Fig. 1 is an elevational view, with parts broken away to show internal structure, of a glass-covered, pellet type thermistor made in accordance with this invention; and

Fig. 2 is a sectional view of a portion of a thermistor pellet showing structural details of the embodiment illustrated in Fig. 1.

In the construction shown in Fig. 1, 10 is a thermistor pellet having connecting leads 11 and 12 secured to its opposite faces. The pellet and a portion of each lead are enclosed in a glass covering 13 fused around the assembly.

Details of the connection are shown in Fig. 2 and include a metallic layer 14 adhering to a face of the pellet 10. A similar metallic layer 15 secures a portion of lead 12 to layer 14 and thus to

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the body 10. Covering the securing layer 15 is a layer 16 of insulating material which acts as a cushioning means after the glass covering 13 is applied.

The pellet 10 may be made of one or more of the oxides of manganese, nickel, cobalt, and copper. For example, the mixture may be of manganese and nickel oxides in proportion to provide nine atoms of manganese for each atom of nickel. The oxides in powdered form may, after thorough mixing with a temporary binder, be extruded into rods and heat treated to drive out the binder and to sinter the material. The rods may then be divided into small pellets such as 10. This may be done, for example, by breaking the rods into short sections and then grinding their ends flat and smooth.

The metallic layer 14 may be made from a silver paste applied to a face of the pellet 10, dried, and cured by heating. The silver paste may comprise finely divided silver, a small amount of glass, a temporary binder, and a solvent for the binder. Such a paste can be spread over the face of the pellet, heated to drive out the temporary binder and then at a higher temperature to fuse the glass. After cooling this layer is substantially of metallic silver.

A portion of the lead 12 may then be applied to layer 14 and secured in place by another layer 15 made of the same silver paste material and similarly cured.

The layer 16 may be made of a powdered insulating material, such as fused aluminum oxide mixed with a suitable glassy binder. This layer may be applied and cured in a manner similar to that used for the metallic layers.

The glass or like coating 13 may be applied in any suitable manner to the assembled pellet and leads. One way of doing this is to slip a piece of glass tubing over the pellet and then to heat the assembly to fuse the glass over the pellet, the connections, and the inner ends of the leads. Advantageously, the coating material should have a thermal expansion coefficient close to that of the pellet material.

In devices where a cushioning layer was not used, it was found that cooling distortion of the connections was sufficient to impair them for proper circuit operation. Such distortion would cause undesirable, non-linear voltage-current variations with resulting modulation difficulties. The use of the layer 16 however, avoids this difficulty since the distortion forces will break the bonds in this layer converting it to a powdery

cushion that absorbs these forces and inhibits damage to the connections.

Since the foregoing description is directed to an exemplary embodiment of the invention, it will be understood that it is not intended to limit the scope of the invention as defined by the appended claims.

What is claimed is:

1. A circuit element comprising a body of resistance material, leads for making circuit connections, connecting means for securing each lead to a portion of the body comprising an electrically conductive adhesive, a heat applied insulating covering that shrinks upon cooling on said body and connecting means, and cushioning means for inhibiting shrinkage distortions of the connecting means, comprising finely divided insulating material between the connecting means and the insulating covering.

2. Means for making a substantially distortion-free connection to a resistor body that is enclosed in a fused insulating cover that comprises a connection secured to said body, said fused insulating cover, and a cushion of insulating powder between the connection and the cover.

3. The method of making a circuit element that comprises securing leads to portions of a resistor body with an electrically conductive adhesive, covering the connection so made with a bonded insulating powder, and fusing upon the body and connection an insulating cover of material that shrinks upon cooling, thereby breaking the bond securing the powder particles together to form a cushion between the connection and the cover.

4. In a circuit element comprising a body of resistance material, leads for making circuit connections, connecting means for securing each lead to said body, and a fused insulating cover on the body and connecting means, said cover being of a material that shrinks upon cooling, the method of inhibiting distortion of the connecting means that comprises covering the connecting means with a layer of powdered insulation mixed with bonding material prior to application of the cover, heating to bond said layer, and fusing the cover to the body, connecting means and layer, whereby the bonding of the insulating layer is sufficiently broken by the cooling shrinkage of the cover to provide a cushion of powdered insulation between the connection and the cover.

5. The method of making a substantially distortion-free connection to a resistor body that is enclosed in a fused-on insulating cover that shrinks upon cooling, that comprises applying a layer of bonded insulating particles over the connection, and shrinking on the cover, thereby breaking the bonds among the insulating particles to provide a distortion-absorbing cushion between the connection and the cover.

CHARLES B. GREEN.
RAYMOND L. RULISON.

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