

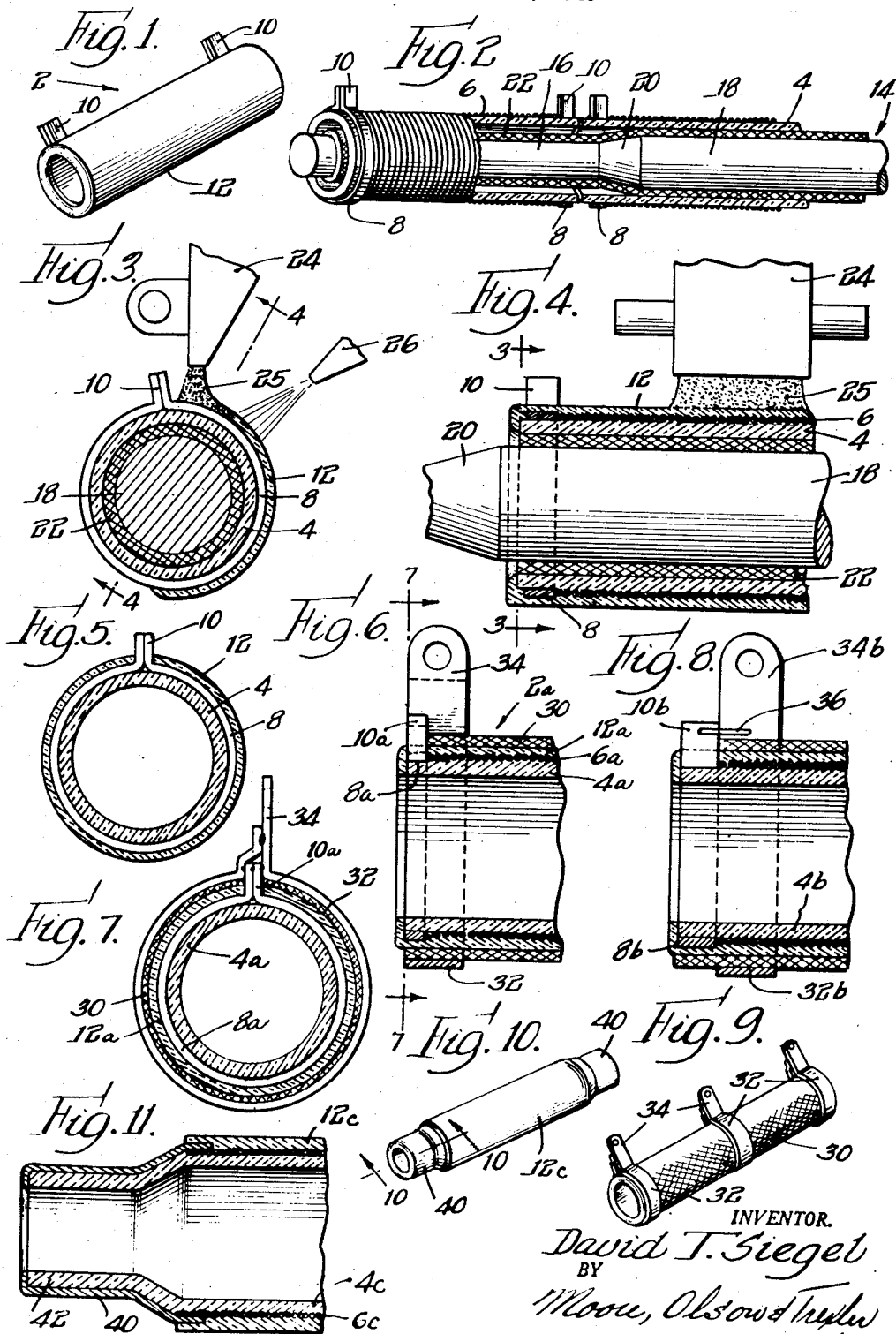
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RESISTOR STRUCTURE AND METHOD OF MANUFACTURE

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RESISTOR STRUCTURE AND METHOD OF MANUFACTURE

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This invention relates to an electrical unit and more particularly to an improved resistor having a body of selected vitreous material in which a resistance element is embedded in an improved manner and which is capable of withstanding high thermal shocks.

One object of the present invention is to provide an electrical unit, specifically a resistor, wherein the electrical element or resistance wire is embedded into its support body in an improved and more positive manner; and wherein the physical characteristics of the material of the support body exteriorly and interiorly of the resistance wire coil may be more properly correlated and controlled. In a preferred embodiment the support body exteriorly and interiorly of the coil may be of the same vitreous material whereby to provide a homogeneous body, equalize thermal expansion, and provide an improved bond between the wire coil and the body material.

A further object of this invention is to provide an improved resistor structure wherein a preformed inner body tube is provided with a resistance element disposed thereon, and wherein an outer tube is formed by the simultaneous spraying and firing of powdered vitreous material to form a coating integrally fused with the inner body tube and bonded to the resistance element.

Another object of this invention is to provide an improved resistor structure wherein relatively narrow terminal bands are connected to a resistance element at selected points on the resistor and are hermetically sealed between an inner body tube and an encompassing outer body tube, said bands having relatively small upstanding lugs projecting through the outer tube to afford electrical connection with larger lugs applied externally of the outer body tube.

Still another object of this invention is to provide a modification of the resistor structure described above wherein a sleeve of fiber glass or like cushioning material is positioned on the outer body tube or coating, and the relatively broad terminal bands are mounted on said sleeve at selected points on the resistor structure, said bands being afforded electrical connection with the relatively narrow terminal lugs which project through the outer coating of the resistor.

A form of resistor structure which has heretofore been used is provided with an inner core made of porcelain and an outer core made of vitreous enamel. The degree of moisture absorption in the porcelain core is frequently an unknown and troublesome factor in this type of structure. The present invention contemplates

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using both inner and outer body sleeves of controlled vitreous material for which the degree of moisture absorption may be readily controlled and predetermined.

A further object of this invention is to provide novel methods of making an improved resistor of the type mentioned above.

A still further object of the invention is to provide a terminal lug connection, of the sleeve type, in a resistor structure of the character defined.

Further objects of this invention will be apparent from the following description and claims taken in connection with the accompanying drawings forming a part of this application.

In the drawings:

Figure 1 is a perspective view of an electrical unit, specifically a resistor structure, constructed in accordance with and embodying the principles of the invention;

Figure 2 is a perspective view, partly in longitudinal section, illustrating means and methods for fabricating the resistor, in accordance with the principles of the invention;

Figure 3 is an enlarged transverse sectional view illustrating further steps in the manufacture of the resistor, said view being taken as indicated by the line 3-3 of Figure 4;

Figure 4 is a longitudinal sectional view of the structure of Figure 3 taken as indicated by the line 4-4 thereof;

Figure 5 is a view similar to Figure 3, but showing the completed resistor;

Figure 6 is an enlarged fragmentary view of a modification of a resistor structure embodying this invention, the section being taken in a vertical longitudinal plane passing through the axis of the resistor;

Figure 7 is a sectional view of the modification shown in Figure 6, the section being taken in a transverse plane indicated by the line 7-7 of Figure 6;

Figure 8 is an enlarged fragmentary sectional view of another modification of a resistor embodying this invention, the section being taken substantially in a vertical longitudinal plane passing through the axis of the resistor;

Figure 9 is a perspective view of a completed resistor structure, constructed in accordance with the principles of Figures 6 and 7;

Figure 10 is a perspective view of still another modification of a resistor embodying this invention; and

Figure 11 is an enlarged end sectional view of the resistor shown in Figure 10, the section be-

ing taken substantially in a longitudinal axial plane indicated by the line 11—11 of Figure 10.

Referring more particularly to the drawings, and first to the structural embodiment illustrated in Figures 1-5, it will be seen that the resistor, generally indicated at 2, is of cylindrical form and comprises a preformed inner body tube 4 formed of a selected vitreous material, such as boron-silicate glass, which has characteristics of high heat resistance, of low thermal expansion, and of electrical insulation. Around the inner tube 4 there is wound a resistance coil or element 6 having each coil winding spaced from the adjacent coil winding in uniform relationship. The resistance element is wound for substantially the full length of the inner body tube, in the structure shown.

At each end of the inner tube 4 is secured an electrical conducting metal band 8 which is electrically connected to an end coil winding of the resistance element 6. The connection may be made in any suitable manner, but preferably is made by welding as set forth in the copending application of Harry A. Chanowitz, Serial No. 601,902, filed June 27, 1945, now Patent No. 2,479,556 issued August 23, 1949. Each band 8 is terminated in upstanding lugs 10 suitably welded together and arranged for connection with the electrical apparatus with which the structure is to be used.

Formed over the inner tube 4 and the resistance element 6 in a manner presently to be described, is an outer coating 12 of selected vitreous material forming an outer body tube. The vitreous material of the outer coating 12 is preferably of the same constituency as that of the inner tube, for reasons presently to be explained, but of course may be of different constituency than the inner tube to afford a resistor unit of different physical and selected characteristics as required in any particular case. The outer coating 12 extends over the metal bands 8 to seal the resistance element 6 and the bands 8 in the resistor unit. The upstanding lugs 10 project through the outer coating 12, in the completed structure, as shown in Figure 1.

The resistor structure, as above described, may be fabricated, for example, in accordance with the preferred method of fabrication illustrated in Figures 2, 3 and 4.

A horizontally arranged mandrel 14 is provided with an end or lead portion 16 of a diameter smaller than its main body portion 18, said lead portion 16 being joined with the main portion 18 by a tapered section 20. In fabricating the resistors, after the coils 6 and lugs 8 have been mounted on the inner sleeve bodies 4, one or more of the bodies are positioned onto an expandable braided fiber glass sleeve 22, as shown in Figure 2. The mandrel 14 is then moved endwise into the fiber glass sleeve 22, the tapered section 20 expanding the fiber glass sleeve 22 so that the glass resistor bodies are firmly supported when positioned on the main mandrel portion 18. The fiber glass sleeve 22 is adapted to prevent deformation of the glass cylinder resistor bodies when subjected to heat in the application of the outer glass coating, and also affords a simple means for protecting the glass cylinders from breakage as they are moved on and off the mandrel.

When the cylinders have been positioned onto the mandrel 14, the mandrel is moved into juxtaposition to a hopper 24, Figure 4, containing a selected powdered vitreous material 25, so as to

position the hopper above the mandrel. The hopper 24 is provided with an elongated opening in its bottom for discharge of the powdered vitreous material in a uniform spray onto the top surface of the glass cylinder. A torch 26, or other suitable heating means, is positioned in juxtaposition so as to effect the fusion of the powder onto the resistor in the form of an outer sleeve encompassing the resistance coil 6 and inner glass body.

More particularly, as shown in Figures 3 and 4, as the mandrel is rotated in a clockwise direction, and the powdered material sprayed onto the cylinders, and the heat of the torch applied, the powdered glass material will be fused onto the inner cylinders 4 and the resistance coils 6 in the form of an encompassing glass sleeve 12 or outer body firmly bonded to the inner bodies and the resistance coils. By moving the mandrel longitudinally as it is rotated, the hopper 24 and the torch 26 will be in effect moved along the mandrel axis, while keeping their related positions, whereby to form the outer body coatings progressively along the length of the inner resistor bodies.

The outer coatings 12 will also be fused onto the bands 8 and over the ends of the resistor bodies, with the terminal lugs 10 projecting through the coatings, as shown.

After the outer bodies or coatings 12 have been applied, as above described, the completed resistor structures may be readily removed from the mandrel, by withdrawing the mandrel from the fiber glass sleeve 22, as previously indicated.

It will be seen that by reason of the structure and methods thus provided, the spaced coils of the resistance element 6 will be firmly embedded into the resistor body and held in position between the inner glass sleeve or body 4 and the outer glass sleeve or body 12, as perhaps best shown in Figure 4. The vitreous material of the outer sleeve fuses integrally with the vitreous material of the inner sleeve, thereby forming an integral support body into which the resistance coil is embedded. The outer coating or sleeve 12, when formed over the end of the resistor structure, as shown in Figure 4, produces an end seal for the resistance coil, and also provides a complete seal for the terminal bands 8 whereby to provide, as stated, an integral one piece body structure for the resistor. The fused coating or sleeve 12 forms itself tightly around the projecting lugs 10 whereby to effect a seal for the lugs and their associated bands.

As will be understood, the convolutions of the wire coil 6 may either be spaced, as heretofore described, or substantially in contact in instances wherein the convolutions are wound very closely together. In any event, and whether or not spaces are provided between the convolutions, the inner and outer glass sleeves 4 and 12 are fused together in that both are fused to the coil 6 and thus are fused to each other through the intermediary of the coil, forming an integral fused structure. Preferably the resistance wire is provided with an insulating oxidized coating, this coating serving to insulate the convolutions from each other and also promoting the fusion between the glass and the wire in that the oxide of the wire fuses into the vitreous oxide material, and a strong and integral fused bond is obtained.

By employing the same material for forming the inner sleeve 4 and the outer sleeve 12, as above described, a homogeneous as well as integral body structure is provided, producing a

structure highly resistant to thermal shock and possessed of other desirable operating characteristics. By providing the inner and outer sleeves of different selected materials, predetermined and desired different physical properties may be imparted thereto.

In Figures 6 and 7 an arrangement is shown for reducing the size of the lug projecting through the fused body coating, while still providing a terminal of adequate size for ready connection to electrical apparatus with which the resistor is to be associated. As shown, the resistor, generally indicated by the numeral 2a, in this instance comprises an inner preformed body or sleeve 4a, a resistance coil 6a, and an outer fused sleeve or body 12a, all arranged in the manner and for the purpose previously described in reference to the structure of Figures 1-5.

A terminal band 8a, functionally similar to the bands 8, previously described but considerably narrower in width, has its upstanding lugs 10a projecting through the fused sleeve 12a and also through a fiber glass sleeve 30 which is provided externally of the sleeve 12a and in encompassing relation therewith. This fiber glass sleeve may be of preformed construction, and may be slipped over the lugs 10a by compressing the sleeve which increases its diameter due to its braided construction, as will be understood. After the braided sleeve has been brought into position upon the fused sleeve 12a, it may be longitudinally expanded whereby to decrease its diameter and bring it into firm engagement with the fused sleeve.

After the braided sleeve 30 has been applied, as above, the relatively large terminal band 32 may be formed therearound, said larger band having upstanding lugs 34 welded together and to the lugs 10a as best shown in Figure 7.

By this arrangement relatively large terminals 34 are provided for connection with the associated electrical apparatus, while at the same time only the smaller projections 10a extend through the fused sleeve, thereby promoting the insulating characteristics of the resistor body. Also, it will be seen that a relatively longer resistance coil 6a may be provided, in respect to the length of the resistor, inasmuch as a smaller portion of the resistor length is taken up by the contact terminals, viz., the relatively larger terminal bands 32 overlie the resistance coil 6a, as shown. If desired, the terminal band 32 may be applied directly to the fused sleeve 12a, but the use of the interposed fiber glass sleeve 30 is preferred as it provides a firm and smooth base for attachment of the bands 32 to the resistor body. As will be understood, the combination of the bands 8a and 32 may be provided at opposite ends of the resistor as well as intermediate the length thereof, as may be desired. A three-terminal resistor, so arranged, is illustrated in Figure 9.

In Figure 8 a terminal structure is illustrated substantially similar to that described in reference to Figures 6 and 7 except that in this instance the smaller terminal band as indicated at 8b is somewhat wider, and the smaller and larger bands are positioned in longitudinal juxtaposition rather than in radial superposed relation. The bands are electrically interconnected by means of a welded or soldered wire 36, as shown.

In Figures 10 and 11 an embodiment is illustrated showing the manner in which the principles of the present invention may be applied to a cylindrical type terminal contact.

In this instance the inner preformed vitreous

body 4c has the resistance wire coil 6c applied thereto, as in the embodiments previously described. However, in place of the band terminals, a metallic coating 40 is plated or otherwise metalized onto the reduced end 42 of the body 4c and extending up to and onto the end of the coil 6c for electrical connection therewith. The fused glass outer body 12c is then applied to the resistor as previously described, forming a hermetical seal for the resistor coil 6c and for the end of the metalized cylindrical contact 40, and for the point of connection between the metalized contact and the resistance coil. An integral and moisture-proof structure is thereby provided.

It is obvious that various changes may be made in the specific embodiments set forth without departing from the spirit of the invention. The invention is accordingly not to be limited to the specific embodiments shown and described, but only as indicated in the following claims.

The invention is hereby claimed as follows:

1. In an electrical unit, a cylindrical base member of insulating material, a sleeve covering of insulating material fused to said base member, a resistance element disposed between said covering and said base member, a yieldable sleeve member of woven fibrous insulating material disposed over said covering, and terminal means having a band portion mounted on and supported by said fibrous sleeve, said terminal means being electrically connected to the resistance element.

2. The method of making an electrical unit which comprises preforming a cylindrical base member of insulating material, arranging an electrical element on said base member, arranging a sleeve of woven fibrous material within the base member, spraying powdered insulating material on said base member, and thereafter heating said powdered material while supporting the base member through said sleeve whereby said material is fused to said base member to form an integral unit.

3. The method of making an electrical unit which comprises preforming a cylindrical base member of insulating material, arranging an electrical element on said base member, and simultaneously spraying and heating powdered insulating material on said base member while supporting said member internally on a fibrous sleeve and rotating said member to provide an integral unit.

4. The method of making an electrical unit which comprises preforming a cylindrical base member of insulating material, arranging an electrical element on said base member, and spraying and heating powdered insulating material progressively longitudinally of said base member while supporting it internally on a fibrous sleeve, to fuse said material to said base member to afford an integral unit.

5. The method of making an electrical unit which comprises preforming a base member of insulating material, disposing electrical terminal means on said base member, arranging an electrical element on said base member and connecting said element to said terminal means, fusing an outer coating of insulating material to said base member whereby an integral unit is formed with said electrical element sealed in said unit, arranging a fibrous sleeve over said coating, and mounting external terminal means in embracing relation on said sleeve and connecting said external terminal means to said first-mentioned terminal means.

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6. In an electrical unit, a cylindrical base member of insulating material, a resistance coil encompassing the base member, a first terminal electrically connected to the resistance element having a band portion encompassing the base member, a covering sleeve of insulating material encompassing the resistance coil, said terminal having a portion projecting radially through the covering sleeve, and a second terminal larger than the first terminal, said second terminal being electrically connected to the projecting portion of the first terminal and having a band portion encompassing and secured to said covering sleeve.

7. The method of making an electrical unit which comprises preforming a hollow cylindrical base member of glass, arranging a wire coil on said base member, and fusing an outer covering sleeve of glass on said base member while internally supporting the hollow base member on an insulating sleeve carried by an inserted mandrel.

8. The method of making an electrical unit which comprises preforming a hollow cylindrical base member of glass, arranging a wire coil on said base member, and fusing an outer covering sleeve of glass on said base member while internally supporting the hollow base member on an inserted mandrel.

9. An electrical unit comprising an internal hollow glass sleeve of predetermined thickness,

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an electrical element comprising a wire coil encompassing and fused onto the outer surface of the sleeve, an external hollow glass sleeve encompassing the internal sleeve and wire coil, the internal surface of the external sleeve being fused onto the wire coil and the external surface of the internal sleeve forming an integral unit, and the thickness of said sleeves being substantially equal whereby to equalize the thermal expansion characteristics of the unit externally and internally of the wire coil, and terminals fixed to the unit and electrically interconnected with said wire coil.

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