May 15, 1956 E. REISMAN 2,745,930

ELECTRIC RESISTOR

Filed June 6, 1952

Fig. 1.

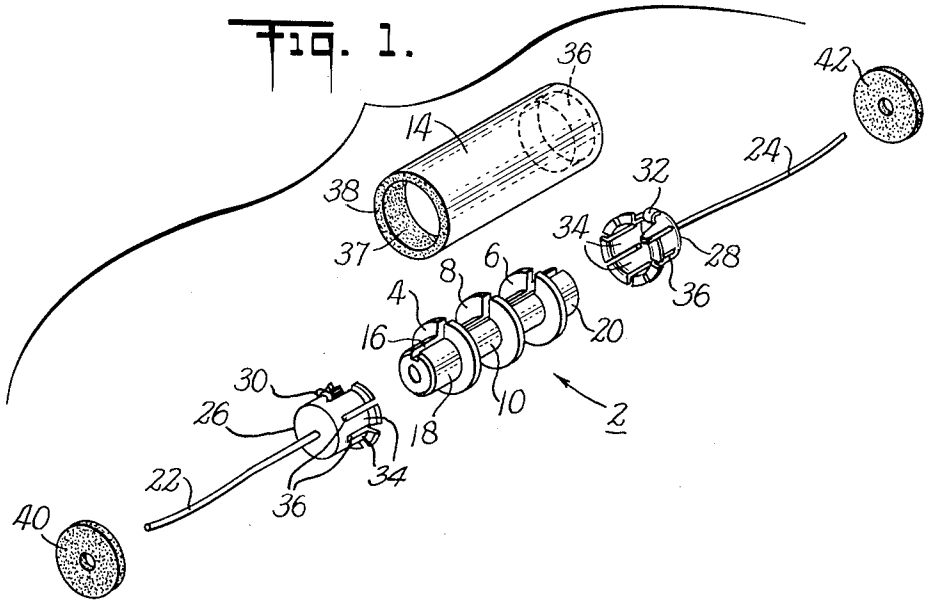


Fig. 2.

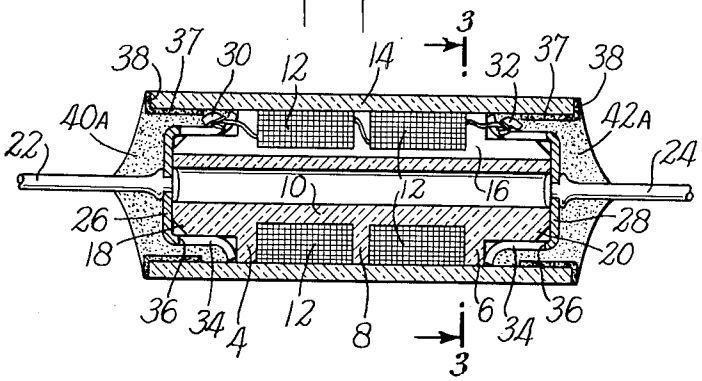


Fig. 3.

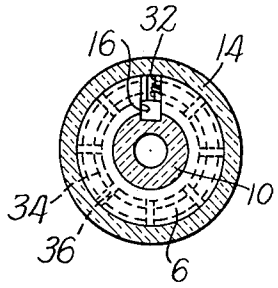
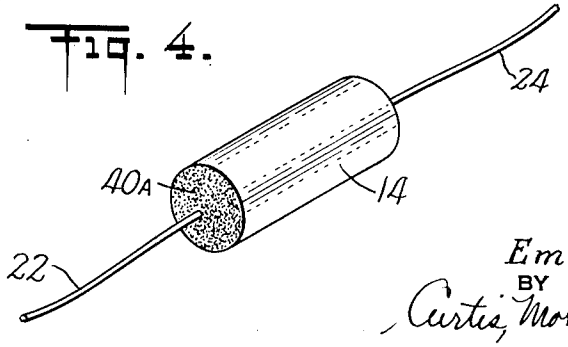


Fig. 4.



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United States Patent Office 2,745,930 Patented May 15, 1956

2,745,930

ELECTRIC RESISTOR

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Application June 6, 1952, Serial No. 292,041

6 Claims. (Cl. 201—67)

This invention relates to electrical units such as resistors, inductance units, and the like. More particularly, it relates to an improved hermetically-sealed unit and the method of making it.

Resistors and other electrical elements are commonly provided with flexible pigtail leads that are used for making electrical connection to the unit and which are used sometimes for mechanical support. However, such flexible leads often provide a path whereby gases or moisture creep into the interior of the unit, causing deterioration and ultimate failure. Such failures are particularly likely to occur when these pigtail leads are used for mechanical support. The present invention provides an electrical unit, such as a coil, resistor, or the like, which offers the convenience of the flexible connecting leads and a rugged hermetically-sealed unit in which all of the supporting and connecting members are entirely within the hermetically-sealed chamber. The unit is sealed at each end by a metal end-surface through which only the pigtail lead extends, the seal being so mechanically permanent that the unit can be mounted on the pigtail leads without danger of creepage of gases along the leads into the sealed chamber. The all-metal seal construction insures against failure at elevated operating temperatures.

These and other aspects, objects, and advantages of the present invention will be in part pointed out in and in part apparent from the following description of a preferred embodiment of the invention, considered in connection with the accompanying drawings, in which:

Figure 1 is an exploded view of the components used to make up a sealed resistor embodying the invention;

Figure 2 is a sectional view of a completed unit;

Figure 3 is a sectional view taken along line 3—3 of Figure 2; and

Figure 4 is a perspective view of the completed resistor.

In order to support the wire which forms the resistive element of the unit, a ceramic spool or bobbin, generally indicated at 2, is provided having two circular shoulders or end flanges 4 and 6 and one or more divider flanges 8 spaced along a cylindrical core portion 10. These flanges form spool-segments that carry the resistance wire 12 (Figure 2). As in the usual practice, the wire may be wound in opposite directions in each segment to reduce the inductive reactance of the unit. In addition, these flanges also serve to center the bobbin 2 in a ceramic tube 14.

The bobbin 2 has a radial slot 16 extending longitudinally the full length of the bobbin including the flanges 4, 6, and 8 so that the resistance wire can pass from one of the end portions 18 of the bobbin through each winding segment to the other end portion 20, as will be described in more detail later.

In order to make a permanent electrical connection between the ends of the resistance wire and the pigtail leads 22 and 24, two metal end-caps 26 and 28 are connected mechanically to the leads 22 and 24 and fit respectively over the end portions 18 and 20 of the bobbin. One end of the resistance wire is connected to a small nib 30 on the end-cap 26 and the other end of the wire is connected to a similar nib 32 on the other end of the wire.

The end-caps are identical in construction so that only the end-cap 26 is described in detail. This end-cap is cup-shaped with several, for example eight, flared "petals" 34, separated by slits 36, forming the sides of the cup. The circular base portion of the end cap has a centrally-positioned hole through which the end of the pigtail lead 22 extends. The pigtail lead is "headed-over" or riveted inside the cup, as best shown in Figure 2, to form a strong mechanical connection.

The end-cap is dimensioned to form a press-fit with the end portion 18 of the bobbin 2 and is preferably of such diameter that when the cap is pressed onto the end portion 18, the flared ends of the petals 26 are forced radially outwardly a very small distance. The ends of the petals 26 fit closely within the tube 14 and so form a barrier against the flow of solder along the interior of the tube as will be explained presently. The end-caps may be formed of copper or other metal and preferably are tin-plated so that solder will adhere readily to them.

In order to form the connecting nib 30 a portion of one of the petals 34 is cut longitudinally along its length and the separated part curled outwardly as shown in Figure 1.

It is not necessary that these end-caps be of split construction. For example, they may be drawn from thin sheet stock and dimensioned so that they can be forced onto the ends of the bobbin 2 and will expand outwardly to form a tight fit.

To assemble the unit, the end-caps 26 and 28 carrying the pigtail leads 22 and 24 are pressed onto the respective end-portions 18 and 20 of the core 2; the nibs 30 and 32 are positioned adjacent the longitudinal slot 16. One end of the resistance wire 12 is stripped of its insulation and wrapped around and soldered to the nib 30; the wire is then passed along the slot 16 and through the flange 4. The desired amount of wire is then wound on this segment of the core 10 between the flanges 4 and 8; the wire is then passed through the slot 16 in the flange 8 into the next winding segment where the remainder of the wire is wound between the flanges 8 and 6; the latter winding may be reversed in direction if desired to reduce inductive effects. The resistance of the wire is then checked and adjustment made if necessary. The wire is then passed along the slot 16 through the flange 6 and the stripped end-portion of the wire is wrapped around and soldered to the nib 32. If desired, the nibs 30 and 32 may be flattened downwardly to provide a firm mechanical grip on the wire 12.

This entire sub-assembly is then inserted into the tube 14 and positioned as shown in Figure 2. The tube 14 is formed of ceramic and its outside surface is glazed to render it impervious to moisture. The inner surface of the tube 14 immediately adjacent each end is metallized as at 37; this metallized coating extends over the end surfaces of the tubing as at 38. This metallized coating may be applied by any one of the known techniques whereby a thin metal layer, for example silver, is in intimate and permanent molecular contact with the ceramic surface. This coating may be formed, for example, of successive electro-deposited layers of silver, copper and tin. Or the metal coating may be applied by vacuum sputtering, chemical deposition, or in any other way so long as a thin metal coating is obtained that forms a substantially integral surface layer of the ceramic. This coating which forms an internal peripheral ring at each

end of the tube 14 permits the ends of the tube to be hermetically sealed with metal solder.

For this purpose, two discs 40 and 42 of solder, each having a central opening, are slid over the pigtail leads 22 and 24 and positioned within the tube 14 adjacent the metallized coating 36 and against the base of the respective end-cap. Before the solder is melted, the parts preferably treated with soldering flux, such as rosin, or the flux may be incorporated in the solder so as to cover the parts when the solder is melted.

The tube 14 is then positioned on end with the solder disc 42 on the top; the solder disc 42 is then melted by induction heating, by an ordinary soldering iron, or by other means, so that the solder flows into intimate contact with: (1) the outer surfaces of the end-cap 28; (2) the stripped end-portion of the wire 12 where it is wrapped around the nib 32; (3) the pigtail lead 24 adjacent the end-cap 28; (4) the metallized coating 36 on the interior of the tube 14; and (5) the metallized coating 38 on the end surfaces of the tube 14. The outwardly-curved petals 34 of the end-cap help to prevent the molten solder from penetrating to the central portion of the tube 14; the flanges 4 and 6 provide a further seal preventing any molten solder from passing beyond these flanges. The solder disc 42 has thus formed a complete end seal, as at 42A, which forms a firm mechanical and electrical bond between the pigtail 24, the end-cap 28, the wire 12, and the metallized coating at 36 and 38. The resistor unit is then inverted and the other disc 40 of solder melted to form a similar seal 40A at the other end of the tube 14. The solder is prevented from passing through the slits 35 in the end-caps and through the space between the ends of the petals 34 and the inner surface of the tube 14 into the space between the flanges 4 and 6 by the surface tension of the molten solder and because of its preferential wetting of the metal surfaces.

It will be noted that the seals 40A and 42A enclose the entire resistance-forming unit including all of the resistance-supporting structure. The entire surface areas of these seals is unbroken except for the pigtail leads 22 and 24. The solder readily wets and adheres to these leads so that a good seal is formed; the wire is small in circumference so that the chance of an imperfect seal is very small. The end-caps 26 and 28 are in contact with the bobbin 2 over a substantial surface area; these end-caps are in intimate contact with the solder seals 40A and 42A. Maximum dissipation of heat from the core of the bobbin is thus attained.

From the foregoing, it will be apparent that the electrical resistance unit embodying the invention is well adapted for the attainment of the ends and objects hereinbefore set forth that it can be assembled easily and rapidly from fewer component parts to form a hermetically-sealed, rugged, reliable resistor unit capable of sustained operation at relatively high temperatures. It is apparent that various modifications may be made in the sequences and series of steps set forth herein and in the mechanical configurations of the various parts all without departing from the scope of the present invention. For example, the washer-shaped discs 40 and 42 of solder can be replaced with globules or beads of solder or pieces of solder of other form having holes or slots for the pigtails or with short lengths of solder wound around the pigtail leads. A perfectly satisfactory seal can be made with a conventional soldering iron and using rosin core solder.

Resistors may be made in accordance with the procedure set forth above which are substantially smaller in size than hermetically-sealed resistors manufactured in other ways. For example, these resistors may be ½ inch or less in length and ⅜ inch or less in diameter. Also various features of the invention can be used at times to advantage without a corresponding use of other features. For example, the washers or beads of solder may not be used and the ends of the resistor unit sealed by pouring or dropping molten solder around the pigtail leads.

What is claimed is:

1. An electrical unit that is hermetically sealed and capable of continued operation at elevated temperatures comprising an impervious tubular casing having metallized surface portions adjacent each end, an element-supporting member positioned within said tube, first and second metal end-members secured mechanically to opposite ends of said element supporting member, two internal element leads each secured to one of said end-members, two externally-extending connecting leads secured to said end-members and extending axially of said casing, and a metal seal over each end of said casing, each of said seals being in intimate soldered contact with said metallized surface and with the junctions of one of said internal leads and one of the external leads with the adjacent end-member, said end-members being entirely within said casing and fully enclosed by said metal seals and said casing.

2. An electrical unit that is hermetically sealed and capable of continued operation at elevated temperatures comprising an impervious tubular casing having metallized surface strips extending internally around the casing adjacent each end and extending over the end surfaces, an element-supporting member positioned within said tube, first and second end caps secured mechanically to opposite ends of said element-supporting member, two internal element leads each secured to one of said end caps, two axially-directed connecting leads secured to said end caps and extending from opposite ends of said casing, and a metal seal over each end of said casing, each of said seals being in intimate soldered contact with said metallized surface and with the adjacent end cap, said end caps being entirely within said casing and fully enclosed by said metal seals and said casing.

3. An electrical unit that is hermetically sealed and capable of continued operation at elevated temperatures comprising an impervious tubular casing having internal metallized surface portions adjacent each end, a resistance element positioned within said tube, first and second end caps secured mechanically to opposite ends of said element, said end caps each having a base portion and a plurality of outwardly flared petals the ends of which are substantially in contact with the inner surface of the casing, two internal elements leads each secured to one of said end caps, two externally-extending connecting leads secured to the center of the base portion of said end caps and extending axially of said casing, and a metal seal over each end of said casing, each of said seals being in intimate soldered contact with said metallized surface and with the outer surfaces of said petals, said ends caps being entirely within said casing and fully enclosed between said metal seals.

4. An electrical impedance component comprising an impervious tube, a metallized coating forming two spaced peripheral rings in intimate contact with the inner surface of and adjacent the ends of said tube, an impedance element positioned within said tube, and first and second metal end members having a base portion positioned at opposite ends of said tube adjacent said metallized rings, means connecting said impedance element with said end members, first and second leads each extending outwardly from the ends of said tube and engaging one of said end members, and first and second end seals of fusible metal each forming a complete peripheral soldered connection with one of said metallized rings and a hermetic soldered connection with one of said leads, said seals forming continuous smooth end surfaces penetrated only by said leads, said seals and tube completely and hermetically enclosing the impedance element, the end members, and the junctions between the end members and the leads.

5. An electrical component comprising an impervious ceramic tube, a metallized coating forming two spaced peripheral rings on the inner surface of and adjacent the ends of said tube, a bobbin positioned within said tube and having outwardly-extending end portions, an imped-

ance element supported by said bobbin, first and second metal cup-shaped end-caps each having a base portion and a side portion formed of circumferentially-spaced outwardly-flared side members, each of said end-caps being positioned over one of said end portions and adjacent said metallized coating, each end of said impedance element being connected to one of said end caps, first and second pigtail leads each extending along the axis of said tube and in contact with one of said end-caps, and first and second end seals of solder each forming a complete peripheral soldered connection with one of said metallized rings and a hermetic soldered connection with one of said pigtails, and forming a soldered connection with the end-cap, said seals having continuous smooth end surfaces penetrated only by said pigtail leads, said seals completely enclosing the bobbin, the impedance element, the end-caps, and the junctions between the end-caps and the pigtail leads.

6. An electrical resistor comprising an impervious ceramic tube, a metallized coating forming two spaced peripheral rings on the inner surface and adjacent the ends of said tube, said coating extending over the ends of said tube, a ceramic bobbin positioned within said tube and having cylindrical outwardly-extending end portions, resistance wire wound on said bobbin, first and second metal cup-shaped end-caps each having a base portion with a central opening and a side portion formed of circumferentially-spaced outwardly-flared side members, each of said end-caps being positioned over one of said end portions and adjacent said metallized coating, each end of said resistance wire being connected to one of said end caps, first and second pigtail leads each extending along the axis of said tube and through the central opening in one of said end-caps, and first and second end seals of fusible metal and each forming a complete peripheral soldered connection with one of said metallized rings and a hermetic soldered connection with one of said pigtails, and forming a soldered connection with the end-cap and said resistance wire, said seals being substantially flush with the ends of said tube and forming continuous smooth end surfaces penetrated only by said pigtail leads, said seals completely enclosing the bobbin, the resistance wire, the end-caps, and the junctions between the end-caps and the pigtail leads.

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