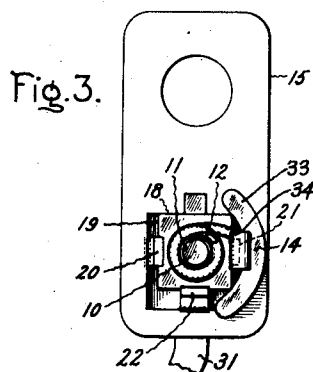
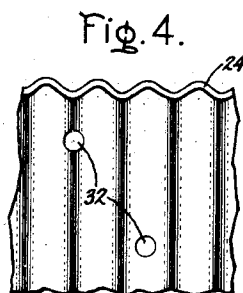
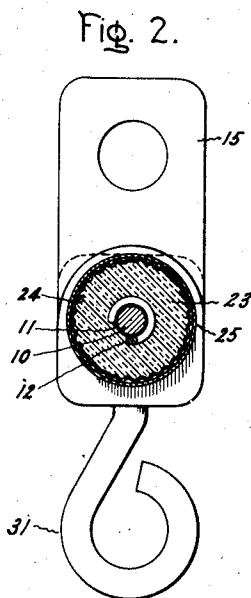
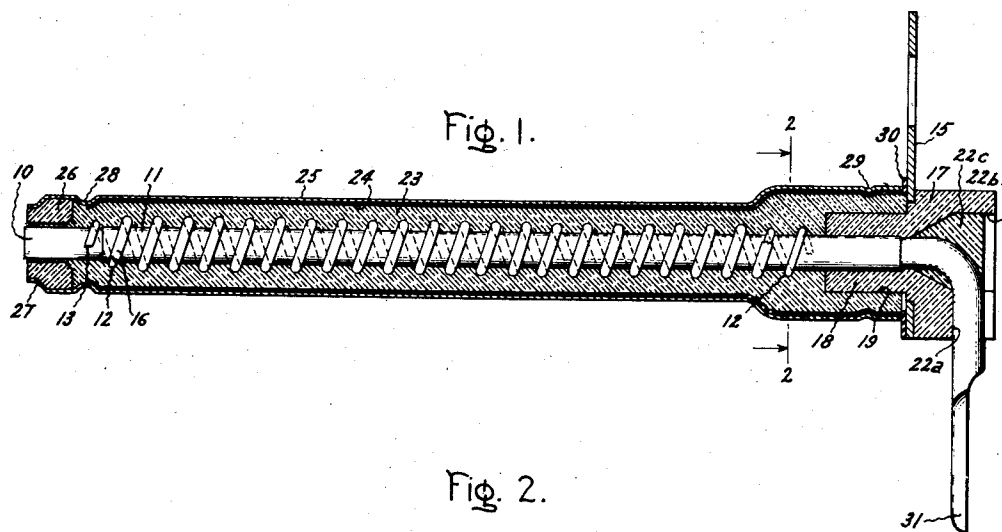


Aug. 28, 1945.

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ELECTRIC RESISTOR

2,383,823

Filed June 15, 1943



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UNITED STATES PATENT OFFICE

2,383,823

ELECTRIC RESISTOR

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Application June 15, 1943, Serial No. 490,872

4 Claims. (Cl. 201—67)

My invention relates to electric resistors, particularly to resistors used in controlling electric circuits, and has for its object a simple and reliable resistor which is adapted to withstand severe shocks.

In carrying out my invention, I provide a rigid supporting member about which the resistance conductor is wound, the supporting member being made of an electrically conducting material so as to serve also as an electric conducting lead or terminal for one end of the resistor. Between the turns of the resistor I apply a mass of hardened powdered electrically insulating material which, upon application, is mixed with water to form a plastic mass. Outside of this insulating material I provide a layer of corrugated mica and enclose the whole in a cylindrical sheath.

For a more complete understanding of my invention, reference should be had to the accompanying drawing, Fig. 1 of which is a view in section of an electric resistor embodying my invention; Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1 looking in the direction of the arrows but with the powdered insulating material removed so as to disclose the inner construction of the terminal arrangement; Fig. 3 is a fragmentary view showing the insulator and terminals at one end of the resistor; while Fig. 4 is an enlarged fragmentary view of the sheet of corrugated mica insulating material.

Referring to the drawing, in carrying out my invention in one form I provide a cylindrical supporting or terminal rod 10, which is also an electric conductor, so as to form one terminal connection for the resistor. Preferably this rod 10 is made of nickel because of the low resistance of nickel, as well as its ability to withstand high temperatures without detrimental oxidation. The rod is provided with a layer of electrically insulating material 11, preferably a layer of vitreous enamel, which layer extends through the turns of the helical electric resistor 12 surrounding the rod 10. One end 13 of the resistor 12 is electrically connected to the rod near one end, as by brazing. The other end of the resistor is connected electrically by means of a copper connector member 14 to a flat plate-like terminal member 15, brazed joints being provided between the ends of the member 14 and the resistor and the terminal.

As shown in Fig. 1, the resistor 12 is a relatively small wire made of a heat resistant or refractory alloy of nickel and chromium and, as shown, provided with a covering 16 of woven glass fabric-like insulation. In this particular

case the resistor is small and has a relatively high resistance, and the resistance conductor is not stiff enough to be self-supporting. It is therefore provided with the insulation covering 16 and then wound directly on the insulated terminal rod 10.

At its right-hand end, as seen in Fig. 1 of the drawing, the terminal rod extends through a square terminal supporting block or insulator 17 made of a suitable electrically insulating material, such as porcelain. The block has an inner smaller square portion 18 which extends loosely through a square hole 19 in the flat terminal member 15. Also, three lugs 20, 21 and 22 are provided on the terminal member which extend a short distance along the square portion 18 so as to further secure the flat terminal 15 in its transverse relation with respect to the portion 18. The opposite side, or right-hand side as seen in Fig. 1, of the flat terminal is seated against the shoulder formed between the smaller portion 18 and the outer larger square portion of the terminal support 17. The rod 10 extends through a central opening in the porcelain support, is bent at right angles downward, as seen in Fig. 1, and lies in a slot 22a in the insulator. A cavity 22b is provided in the insulator for the bend in the terminal rod. This cavity is filled with a suitable insulating material 22c, preferably a vitreous enamel which secures the two parts together.

A mass 23 of hardened electrically insulating material surrounds the resistor and the terminal rod. Outside of this mass of insulating material is a layer 24 of corrugated mica and the whole assembly is contained in an outer cylindrical metal sheath 25, preferably made of nickel, which is enlarged around the insulator projection 18. A porcelain insulator 26 surrounds the left-hand end of the terminal rod, as seen in Fig. 1, and holds it centrally of the sheath. This insulator is secured in place by crimping or forming peripheral indentations in the sheath at points 27 and 28 on each side of the insulator. The sheath is additionally crimped at the point 29 at its other end so as to secure it to the mass of insulating material 23 and to the terminal insulator 17. A ring 30 of suitable insulating material, preferably mica, is provided at the end of the sheath between the sheath and the flat terminal 15.

In the assembly of the resistor the terminal rod 10 is preformed with the right angle terminal extension and connection loop 31 at one end, and then it is inserted into the insulator 17 through a hole provided for it to the final position shown in Fig. 1. Then the rod 10 is secured

to the insulator by applying the mass of vitreous enamel 22c. In the next step the resistance conductor is wound on the insulated portion of the terminal rod and the brazed connections are made for the ends of the resistance conductor with the rod and the flat terminal 15.

The sheath 25 is prepared for assembly by inserting the insulator 26 in its smaller end and securing it in place by spinning and contracting the sheath on each side of it at the points 27 and 28. Also, the layer 24 of corrugated mica is put inside of the sheath. This is done by forming the mica into a cylinder with the corrugations running lengthwise of the cylinder and inserting the cylinder in the sheath. A tool is then inserted to force the mica outward in place against the inner surface of the sheath. Preferably, the edges of the mica overlap somewhat at the longitudinal joint between them. Also, at this time the groove 29 is formed in the outer enlarged end of the sheath.

A predetermined quantity of insulating material 23 in the form of a thick liquid or paste is used. Preferably this material is a fine powder consisting of a mixture of sodium silicate, feldspar, flint and waterglass. Water is added to the powder until a fairly thick liquid is formed, somewhat similar in plasticity to cake batter. A predetermined quantity of this thick liquid is then put into the sheath which is held upright with the insulator 26 lowermost. It will be understood that the material is sufficiently solid so that no appreciable amount runs through the opening in the insulator 26. As a matter of fact, in a typical device the dimensions of the sheath were about one-third of the dimensions of the patent drawing, and the hole in the insulator 26 about one-eighth inch in diameter.

Before inserting the terminal rod and resistor assembly in the sheath, a small amount of the insulating material is applied to the resistor between the turns. This is done by inserting the terminal rod and the resistor assembly in a container containing a quantity of the prepared insulating material, the container being rotated as by a suitable motor. In this step the terminal rod is held upright with the insulator uppermost and inserted in the insulating material over the length of the resistor, and also the reduced portion 18 of the insulator. The resistor is then removed from the insulating material and, with the relatively small quantity adhering to it between the turns, is inserted in the sheath. To facilitate this assembly, the terminal rod is appreciably smaller than the hole in the insulator 26, and also the wall of the hole is beveled at its inner end so as to guide the terminal into the hole. The resistor and insulating assembly is pressed into the sheath to its final position, a small excess of the insulating material being forced out at the enlarged right-hand end, as seen in Fig. 1, of the sheath. Possibly some of the insulating material will be forced out through the insulator 26 at this time because of the relatively large clearance around the terminal rod.

Preferably, several holes 32 (Fig. 4) are provided in the layer of mica 24 to provide for small quantities of the insulating material being forced through the holes 32 into direct engagement with the inner surface of the sheath. This provides for increased rigidity of the assembly and prevents loosening of the parts when the device is subjected to extreme shocks. Also the insulating material when dry adheres firmly to the sheath at the points where the insulating material ex-

tends through the holes and thus secures the sheath against longitudinal movement off the terminal rod during severe shocks.

After the assembly of the unit as previously described, the insulating material 23 is dried to a solid compact mass. Another advantage of the substantial clearance between the insulator 26 and the terminal rod is to provide for the escape of moisture at that point. Preferably, the drying operation is carried out slowly at first to assure that moisture from the inside portions escapes before the outer portions have hardened to form a seal. I preferably first dry the unit for twelve hours while holding it over a vessel containing water so as to provide a moist atmosphere. After this preliminary drying operation, the unit is placed in an oven and heated to a temperature of about 200° C. for three hours. This thoroughly dries the insulating material and forms it into a compact hardened mass. During the oven drying operation, the moisture escapes rapidly through the clearance space provided between the terminal rod and the insulator 26. It will be understood that this clearance space will be filled with the insulating material, but the insulating material has sufficient porosity at this time to allow the escape of the remainder of the moisture.

For the purpose of providing for more efficient radiation of heat from the unit, the nickel sheath 25 preferably has its outer surface oxidized to give it a dark finish. This may be done by heating the sheath prior to assembly to a temperature of 1,000° C. for fifteen minutes.

The sheath is further anchored in place on the hardened insulating material by the grooves 28 and 29 at each end. Also, the insulation fills grooves (not shown) in the corners of the insulator portion 18, as well as embedding the terminal connection member 14 and other portions of the insulator 18 thereby further to secure the insulator in place.

When resistance conductors or resistors of larger cross section, giving lower resistance, are used, the resistor itself need not be covered with a layer of electrically insulating material. This particularly applies to resistor wires or strips having sufficient rigidity to be self-sustaining or self-supporting between their ends so that the resistor can be preformed into a helix whose turns are considerably larger than the diameter of the terminal rod 10 and then slipped over the rod and the ends of the resistor secured, as previously described, so that the turns are spaced from the terminal rod as well as from each other. In such case, the insulating material is forced between the turns, and also between the turns and the terminal rod, so as to thoroughly insulate the resistor.

The layer 24 of corrugated mica is of particular advantage when the resistor turns are considerably larger than the rod 10 in assuring that the resistor is electrically insulated from the outer sheath 25. Thus when the plastic insulating material is being loaded into the sheath, the enlarged resistor turns might be displaced laterally sufficiently to engage the inner surface of the sheath if the layer of corrugated mica were not used to prevent this. This is especially true when the turns are nearly as large as the inner diameter of the sheath so that the clearance on each side between the turns and the inner surface of the sheath is relatively small.

Referring in particular to Fig. 3, the connector member 14 is in the form of a strap having at one end an arcuate transversely extending portion 33 which is suitably connected as by brazing

to the flat terminal 15, with the connector member 14 extending parallel with the lug 21 and perpendicular to the plane of the paper. This connector member extends along the side of the square portion 18 and projects beyond the left-hand end of the square portion, as viewed in Fig. 1, where a suitable connection such as a brazed joint 24 is provided between it and the end of the resistor 12.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An electric resistor comprising an electrically conducting terminal rod, a layer of electric insulating material on said rod, a solid electric insulating and supporting member on one end of said rod provided with an aperture through which said rod extends, vitreous enamel insulating material securing said rod and said insulator together, a smaller portion on said insulator extending along said rod, a second terminal member provided with an aperture through which said smaller portion extends and with integral lugs extending lengthwise of said smaller portion thereby to secure said second terminal member in laterally extending relation with said smaller portion of said insulator, an electric resistance conductor on said rod, electrical connections between the ends of said resistance conductor respectively and said rod and said second terminal, a mass of hardened insulating material on said rod surrounding said resistance conductor, a layer of corrugated mica surrounding said insulating material, said mica having its corrugations extending substantially lengthwise of said terminal rod, and an outer tubular metal sheath surrounding said mica and having an enlarged portion at one end surrounding said smaller portion of said insulator.

2. An electric resistor comprising an electrically conducting terminal rod, a layer of electric insulating material on said rod, a solid electric insulating and supporting member on one end of said rod provided with an aperture through which said rod extends and with an external groove in which lies a transversely bent

end terminal portion of said rod, vitreous enamel insulating material securing said rod and said insulator together, a small rectangular portion on said insulator extending along said rod, a second terminal member provided with an aperture through which said rectangular portion extends and with integral lugs extending lengthwise of said rectangular portion thereby to secure said second terminal member in laterally extending relation with said rectangular portion of said insulator, an electric resistance conductor wound on said rod, electrical connections between the ends of said resistance conductor respectively and said rod and said second terminal, a mass of hardened insulating material on said rod surrounding the turns of said resistance conductor, and said rectangular portion of said insulator, a layer of corrugated mica surrounding said insulating material, said mica having its corrugations extending substantially lengthwise of said terminal rod, an outer tubular metal sheath surrounding said mica and having an enlarged portion at one end surrounding said rectangular portion of said insulator, an electric insulator between the end of said sheath and said second terminal member, and an insulator on the other end of said rod for centering said rod in said sheath.

3. An electric resistor comprising an electric resistance conductor, an outer metallic sheath surrounding said resistance conductor in spaced relation therewith, a layer of corrugated mica inside said sheath in engagement therewith, said layer being provided with a plurality of apertures, and a mass of hardened electrically insulating material inside said layer surrounding said resistance conductor and extending through said apertures into engagement with said sheath.

4. An electric resistor comprising an electrically conducting terminal rod, an electric resistance conductor wound into turns surrounding said rod, an outer metallic sheath surrounding said terminal rod and resistance conductor in spaced relation therewith, a layer of corrugated mica inside said sheath in engagement therewith, said layer of mica being provided with a plurality of apertures, and a mass of hardened electrically insulating material inside said layer of mica surrounding the turns of said resistance conductor and extending through said apertures into engagement with said sheath.

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