Dec. 31, 1940. O. R. SCHURIG 2,227,159

ELECTRIC HEATER

Filed March 1, 1940

Fig.1.

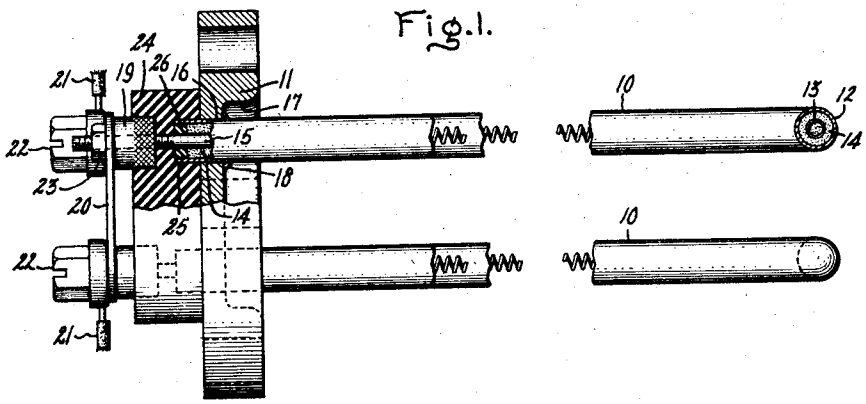


Fig.2.

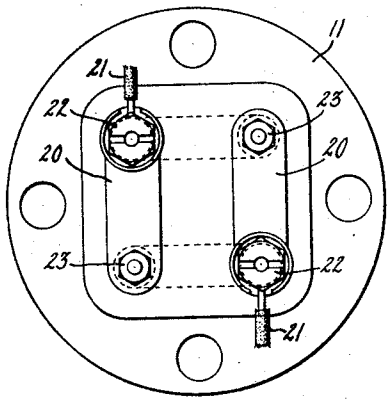
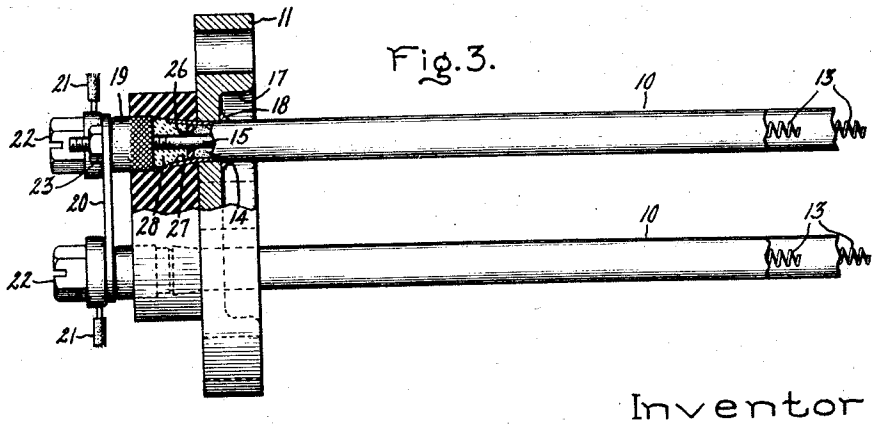


Fig.3.



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2,227,159

ELECTRIC HEATER

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7 Claims. (Cl. 201—64)

This invention relates to electric heaters and more particularly to electric heaters of the metallically sheathed type and has for its object the provision of an improved terminal structure for heaters of this character which is mechanically strong and fluid-tight, which is capable of withstanding high impulse voltages, and which is relatively simple and inexpensive to manufacture and assemble.

Although this invention has other applications, it is particularly useful in connection with electric immersion heaters of the sheathed heating unit type. One immersion heater of this type is described and claimed in United States Patent 2,155,239 to C. P. Randolph dated April 18, 1939. As there described, the sheathed heating unit comprises a resistance element which is embedded in a mass of heat refractory electrically insulating material and is enclosed in an outer metallic protective casing. The heating unit assembly is formed in the shape of a hairpin so that the terminal ends thereof are adjacent each other and these terminal ends are embedded in a large mass of homogeneous sealing and insulating material which forms a terminal block for the terminal ends of the unit. Some difficulty has been experienced with the terminal construction of some of these heating units due to the formation of voids or gas pockets at the junction between the mass of sealing material and the insulating material within the protective sheath. These voids or gas pockets produce a poor bond between the two materials which manifests itself in electrical breakdown of the unit when it is subjected to high impulse voltages such as occur during severe electrical storms.

It is, therefore, a specific object of this invention to provide an improved terminal structure for electric immersion heaters in which an electrically and mechanically strong bond is formed between the insulating material within the sheath of the unit and the material from which the terminal block of the unit is formed so that voids or gas pockets at the junction between these materials are substantially eliminated and the insulation resistance and dielectric strength of the terminal construction is substantially increased so that electrical breakdown under high impulse voltages will be substantially eliminated.

In accordance with this invention in one form thereof, a layer of resinous material having high insulation resistance and high dielectric strength and having the additional property of bonding to both the insulating material used within the sheath of the immersion heater and the sealing material embedding the terminal ends of the heater is placed in cup-shaped recesses formed at each terminal end of the hairpin-shaped heating unit. By providing such a layer of resinous material, voids or gas pockets at the junction between the terminal block and the insulating material of the unit are eliminated and the insulation resistance and dielectric strength of this joint are increased.

For a more complete understanding of this invention, reference should be had to the accompanying drawing in which Fig. 1 is a fragmentary elevation of an electric heater embodying this invention, portions being broken away and portions being shown in section so as to illustrate certain details of the construction; Fig. 2 is an end elevation of the electric heater in Fig. 1; and Fig. 3 is a view similar to Fig. 1 showing a modified form of this invention.

Referring to the drawing, I have shown my invention in one form in connection with an electric immersion heater which is provided with a pair of sheathed heating units 10 mounted in a suitable supporting member 11. The heating units 10 have substantially the same construction and each heater, as shown, is of the helical coil sheath type described and claimed in United States Patent to C. C. Abbott 1,367,341, dated February 1, 1921. Briefly, each heater comprises an outer metallic sheath 12 in which a helical electrical resistance conductor 13 is embedded in a compact mass of powdered heat refractory electrically insulating material 14, such as magnesium oxide. The resistance conductor 13 has its ends secured in any suitable manner to electrical terminals 15 which project from the ends of the sheath and which have their ends, as shown, embedded in the insulating mass 14. Such units can be bent easily into any desired shape. In the immersion heater shown each heating unit is bent substantially in the form of a hairpin. Clearly, various other arrangements and configurations of the heating unit may be used.

The ends of each hairpin heating unit 10 are directed through suitable spaced apertures 16 provided in the wall of the dished portion 17 of metallic supporting member 17 and are secured in position by a welded joint 18. As shown in Fig. 1, the ends of the heating units pass through from one side to the other of the wall of the supporting member and project somewhat beyond the face of this member, the terminals 15 projecting beyond the ends of the metallic sheath 12. Secured to the outer ends of the terminals 15 are terminal connection members 19

shown to be in the form of nuts threaded onto the terminals. As shown in Fig. 2, the corresponding terminals of the heaters 10 are electrically connected by means of terminal jumpers or strips 20 while the pair of opposite terminals is electrically connected to a source of electrical supply (not shown) by means of leads 21. Relatively large nuts 22 are threaded on the ends of these terminals to secure the leads thereto while relatively small nuts 23 secure the jumpers to the opposite pair of terminals.

As described in the aforementioned Randolph patent, the projecting ends of the heater units and the terminals projecting from these ends are embedded in a single, substantially homogeneous, electrically insulating, disk-shaped mass of sealing material 24 which is preferably formed from a suitable phenol aldehyde condensation product. As shown in Fig. 1, the lower ends of the terminal members 20 are knurled and these knurled portions are also embedded in the insulating mass 24 so as to secure the members 20 rigidly to the terminals and to insulate them from each other.

After the heating units 10 have been formed, a portion of the insulating material 14 is cut out of each of the terminal ends of the heating unit so as to form a cup-shaped recess in each terminal end. In terminal structures of the type described in the aforementioned Randolph patent, this recess 25 was filled by a portion of the insulating mass 24 so that the end of the insulating material 14 was completely covered. Some difficulty has been experienced with some of the units having such a terminal construction due to the existence of a poor bond between the phenol aldehyde sealing material 24 and the magnesium oxide insulating material. This poor bond was produced in part by the formation of voids or gas pockets at the junction between the two materials and its existence caused a low resistance leakage path to be formed at this junction. It was found that the presence of this low resistance leakage path affected the dielectric strength of the terminal structure so that the high impulse voltages to which the units may be subjected during severe electrical storms caused electrical breakdowns to occur at this junction.

In order to overcome this difficulty, there is provided in the recess 25 a layer 26 of resinous material which is a good insulator and which bonds readily to both the phenol aldehyde molding material 24 and to the magnesium oxide insulating material 14. Materials which have been found to be particularly suitable for this purpose are synthetic resins such as polyvinyl acetate resins produced by polymerizing pure vinyl acetate, or thermoplastic alkyd resins produced by reacting a polybasic acid in a polyhydric alcohol and, if desired, containing modifiers such as oil, rosin or the like. Each of these materials has the requisite dielectric insulation properties and, in addition, they can be applied in the molten state without excessive decomposition or gasification. Furthermore, it has been found that such materials readily adhere to both magnesium oxide and the phenol aldehyde molding composition. While these materials have been found suitable, any other resinous materials having these same properties might be used.

Because it more readily lends itself to manufacturing processes, it is preferred to use the polyvinyl acetate synthetic resin and in particular the polyvinyl acetate resin known as "Gelva 15" which has a softening point of about 131° C. and a molar solution of which in benzol has a viscosity of 15 centipoises at 20° C. This particular material is solid at room temperature and may be formed in the form of washers and placed in the recess 25. The application of heat thereto causes the material to soften and bond to both the phenol aldehyde sealing material and to the magnesium oxide.

In manufacturing the heater element described above, the heating units will first be constructed in the form of hairpins and the ends of the sheath will be reamed out to provide the recesses 25. The sheath ends will then be projected through the apertures 16 provided for them in the support 11 welded to the support at 18. The units are then placed in a drying or baking oven and, after they have been baked sufficiently long, they are removed and the washer or disk 26 of polyvinyl acetate material is inserted over the ends of the terminal 15 and pressed against the insulating material 14. The terminal members 20 and 21 are then threaded on the terminals 15 and the mass of insulating material 24 is applied. This material may be applied in any suitable fashion but preferably it will be applied automatically in a simple molding machine. Since the heating units are hot when the disk 26 of sealing material is applied thereto, this material softens and the pressure applied during the molding of the insulating material 24 forces the still soft bonding material 26 to make a good bond between the phenol aldehyde molding material and the magnesium oxide insulating material within the sheath. The unit is then allowed to cool and the molding material and sealing material sets to form a mechanically strong terminal block arrangement. The operating temperature of the terminal structure when the heating unit is used is insufficient to cause any change in the terminal block or the sealing bond 26 and hence a terminal construction is provided having high dielectric and insulation resistance properties and having the mechanical properties essential for a water heater construction.

In Fig. 3 I have shown a modified form of my invention. Like numerals have been used to indicate parts already described in connection with Figs. 1 and 2. The modification of Fig. 3 relates to the particular manner in which the resinous bonding material is applied to the terminal end. In this form of my invention the sheath 12 of the heater unit is flared outwardly a slight amount and the insulating material 14 is cut back as in Fig. 1 to form a flared recess 27. In constructing this unit the procedure outlined above is followed and a thin washer 26 of resinous material, preferably polyvinyl acetate resin, is placed in position over the terminal stud 15. There is then mounted over the terminal stud a lava bushing 28 which has a flared portion extending downwardly into the flared portion 27 of the heater unit and has a head portion which extends outwardly from the end of the heater unit sheath. The terminal screw 18 is then threaded onto the stud 15 so as to press the lava bushing firmly into position in the flared portion 27 of the heater unit and since the washer 26 of resinous material and the lava bushing 28 are applied when the unit is hot, as previously described, the washer 26 will soften and will be pressed into position so as to form a tight bond between the lava bushing and the insulating material 14 of the heater unit. The entire end of the unit is then provided with the molded insulating block 19 of phenol material as described above.

From the foregoing, it will be observed that

there is provided in accordance with this invention a simple and relatively inexpensive arrangement for obtaining a terminal construction for an immersion heater unit which is mechanically strong and has improved electrical properties so that it is capable of withstanding high impulse voltages without breakdowns.

While I have illustrated two forms of my invention, it is clear that other modifications could be made therein and I, therefore, intend to cover in the appended claims all such modifications as are 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. A terminal construction for a sheath type heating unit having a metallic sheath and a resistance unit located within said sheath and embedded in a compact mass of electrically insulating heat conducting material comprising a terminal block of substantially homogeneous electrical insulating sealing material molded over the terminal ends of said heating unit, and a layer of resinous material within said sheath adjacent the terminal ends thereof, said resinous material having high dielectric strength and the property of readily bonding to said terminal block material and to said insulating material within said sheath so as to form a joint between said terminal block and said insulating material capable of withstanding high impulse voltages.

2. A terminal construction for a sheath type heating unit having a sheath, a resistance unit in said sheath embedded in a compact mass of magnesium oxide, comprising a terminal block of phenol aldehyde insulating material molded to the terminal ends of said heating unit, and a bonding layer of resinous material within said sheath adjacent the terminal ends thereof, said resinous material having high dielectric strength and the additional property of firmly adhering to said phenol aldehyde terminal block and to said magnesium oxide within said sheath so as to form a joint between the magnesium oxide and the phenol aldehyde block capable of withstanding high impulse voltages.

3. A terminal construction for a heating unit of the sheath type having a resistance unit located within a metallic sheath and embedded in a compact mass of magnesium oxide comprising a terminal block of phenol aldehyde molding material molded over the terminal ends of said heater unit, and a bonding layer of polyvinyl acetate resin within said sheath adjacent the terminal ends thereof, said bonding layer firmly adhering to said magnesium oxide and said phenol aldehyde molding composition so as to form a joint between said oxide and said composition which is capable of withstanding high impulse voltages.

4. An electric heater comprising a resistance conductor, a metallic sheath encasing said conductor, terminals within the end portions of said sheath connected with said resistance conductor and projecting from said ends, a mass of electrically insulating heat conducting material embedding said resistance conductor and the inner ends of said terminals, a mass of electrically insulating sealing material molded over said ends of said sheath and embedding said terminals, and means comprising a resinous material interposed between said insulating material within said sheath and said molding material so as to form a joint between said materials which is capable of withstanding high impulse voltages.

5. An electric heater comprising a resistance conductor, a metallic sheath encasing said conductor, terminals within the end portion of said sheath connected with said resistance conductor and projecting from said ends, a mass of electrically insulating heat conducting material embedding said resistance conductor and the inner ends of said terminals, bushings of electrically insulating material mounted on the projecting ends of said terminals, a mass of substantially homogeneous electrically insulating and sealing material molded over said ends of said sheath and embedding said bushings and said terminals, and a layer of resinous material interposed between said bushings and said insulating material within said sheath so as to form a junction of high dielectric strength between said bushing and said insulating material.

6. An electric heater comprising a resistance conductor, a metallic sheath encasing said conductor having its ends adjacent each other, terminals within the end portion of said sheath connected with said resistance conductor and projecting from said ends, a mass of electrically insulating heat conducting material embedding said resistance conductor and the inner ends of said terminals, said mass extending not quite to the ends of said sheath so as to leave recesses in said ends, a mass of substantially homogeneous electrically insulating sealing material molded so as to embed the projecting ends of said sheath and the projecting ends of said terminals, and a bonding layer of resinous material mounted on said terminals and lying in said recesses, said material substantially filling said recesses and bonding to said sealing material and to said embedding material in said heater so as to form a joint between said materials having high insulation resistance and high dielectric strength so that a terminal construction is provided which is capable of withstanding high impulse voltages.

7. An electric heater comprising a resistance conductor, a metallic sheath encasing said conductor and having its ends adjacent each other, terminals within the end portion of said sheath connected with said resistance conductor and projecting from said ends, a mass of electrically insulating heat conducting material embedding said resistance conductor and the inner ends of said terminals, said mass extending not quite to the ends of said sheath so as to leave recesses in said ends, a metallic support having spaced apertures extending therethrough through which the ends of said sheath are passed from one side to the other of said support so as to project beyond the latter side of said support, a mass of phenol aldehyde sealing material molded on said one side and projecting therefrom to embed the projecting ends of said sheath and the projecting ends of said terminals, and a bonding layer of polyvinyl acetate resinous material mounted on said terminals and lying in said recesses, said material substantially filling said recess and bonding to said sealing material and to said embedding material in said heater so as to form a joint therebetween which is capable of withstanding high impulse voltages.

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