

Nov. 4, 1952

F. E. HASLEY
ELECTRIC HEATER

2,617,002

Filed Nov. 27, 1951

3 Sheets-Sheet 1

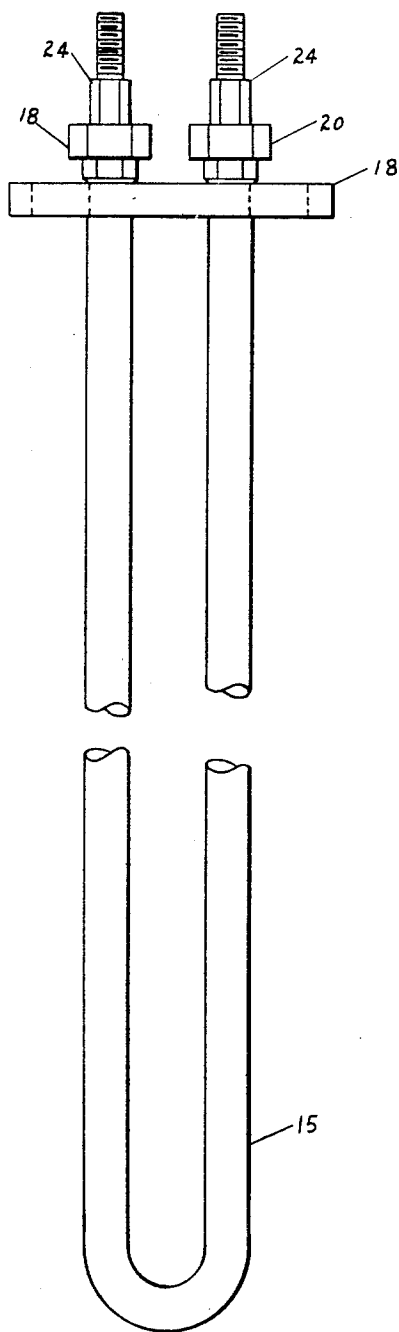


FIG-1

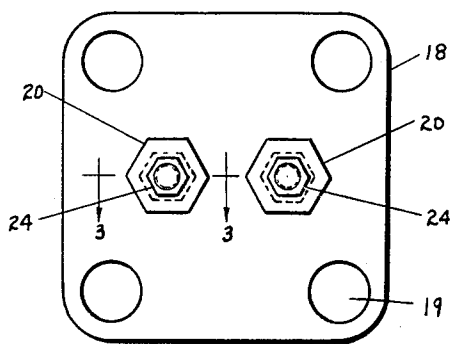


FIG-2

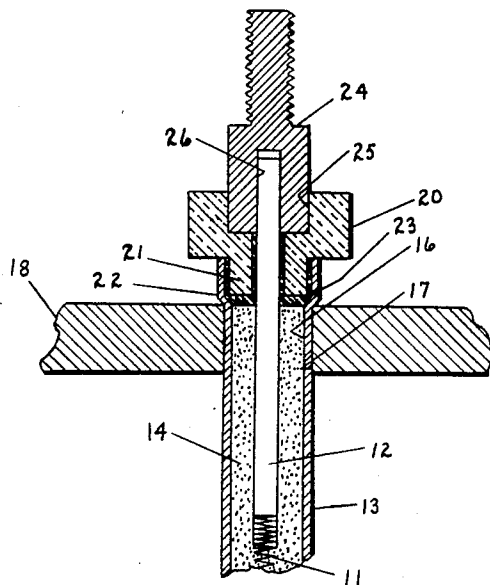


FIG-3

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3 Sheets-Sheet 2

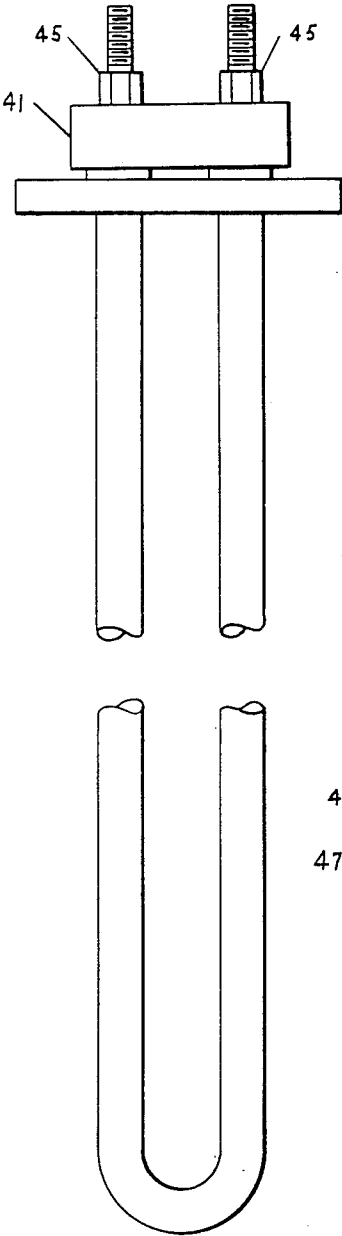


FIG- 4

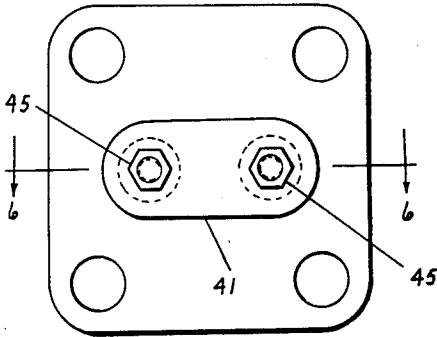


FIG- 5

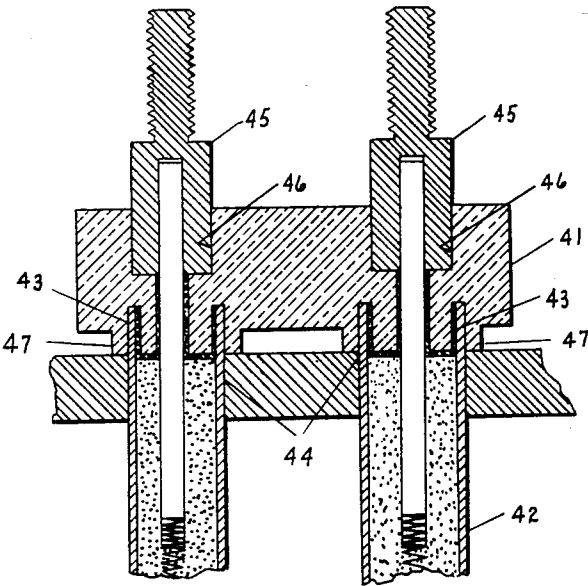


FIG- 6

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3 Sheets-Sheet 3

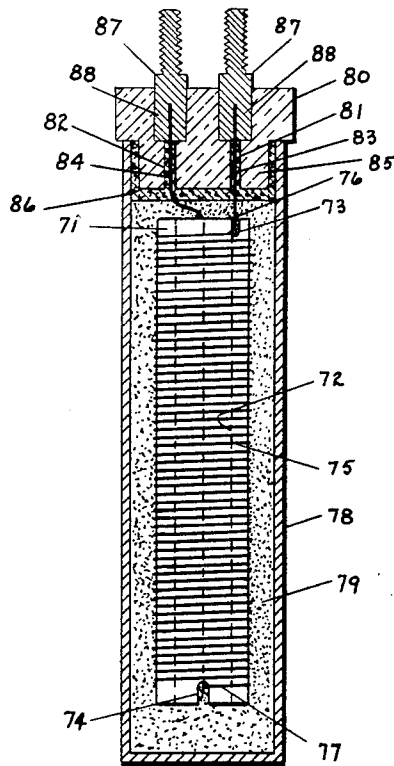


FIG-7

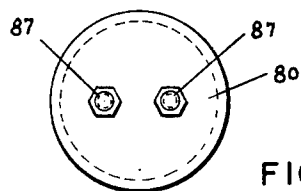


FIG-8

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UNITED STATES PATENT OFFICE

2,617,002

ELECTRIC HEATER

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Application November 27, 1951, Serial No. 258,447

11 Claims. (Cl. 201—63)

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This invention pertains to electric heaters, and the principal object of the invention is to provide new and improved electric heaters, and particularly in respect to the terminal portions thereof. This application is a continuation-in-part of application, Serial No. 94,649, filed May 21, 1949, for Electric Heaters.

The invention is particularly adapted for use with a sheathed embedded-resistor electric heater wherein the resistor element is disposed within the sheath and is embedded in an electrical insulating heat conducting refractory material. For illustrative purposes the invention will hereinafter be described in connection with an electric heater comprising a tubular metallic sheath having a resistor element therein embedded in an electric insulating heat conducting refractory material, and in which the terminal pin of the resistance element extends outwardly from an open end of the tubular sheath.

That the refractory embedding material must be thoroughly dried and protected against moisture in order to preserve the insulating and heat conducting characteristics of the refractory material is well known, and that the provision of a protective closure or seal has presented a considerable problem is evidenced by various patents such, for example, as the patent to Sutton 1,992,787, which discloses the use of a vitreous material such as glass as a closure medium. Another patentee, Abbott, in Patent 1,770,824, proposes the use of a material such as Bakelite as the closure medium, and Charbonneau et al. in Patent 2,489,998 proposes the use of a solid rubber plug which is inserted into the open end of a tubular sheath and then placed under longitudinal compression to distort at least one end of the rubber plug into engagement with the internal wall of the sheath and the external diameter of the terminal pin.

The use of vitreous or other material which hardens to become a substantially inflexible solid has several disadvantages, one of which is that the material used as the closure medium must have substantially the same coefficient of expansion and contraction as the materials going to make up the sheath and the terminal pin. Otherwise, temperature changes will produce a separation between the sheath wall, the terminal pin and the closure medium. Another disadvantage of a solid practically inflexible closure medium is that such a medium does not provide sufficient flexibility to protect the heater terminal against damage from shocks or blows. The

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solid rubber plug as disclosed by Charbonneau et al. has the disadvantage that it must be distorted and must be maintained under such longitudinal compression as to provide the required distortion, and with rubber under pressure, the material will acquire a permanent set and consequently compression pressure on the sealing plug becomes useless and sealing qualities are destroyed.

In accordance with this invention the refractory embedding material is terminated short of the open end of the sheath to provide a pocket or chamber. To close the open end of the sheath and protect the refractory material from the deteriorating effect of moisture, the pocket or chamber is filled with a preferably initially flowable adherent material which is or becomes and remains elastic, and which material has the characteristic of expanding under the influence of heat as it cures or polymerizes into a rubbery elastic state. A cover or bushing, having an opening therein through which the terminal pin passes, covers the open end of the sheath in a manner to closely confine the sealing material within the pocket or chamber, and means are provided for maintaining the cover or bushing in close overlying relation with the open end of the sheath. On use of the heater, heat from the resistance element is conducted through the refractory material, the sheath and the resistor terminal to the sealing material, which expands under the influence of heat, and which also cures into an adherent flexible rubber-like material. Such expansion within the limits defined by the closed pocket or chamber produces tight sealing engagement with the inner wall of the sheath and the outer diameter of the resistor terminal. In at least one stage of its change to a rubbery flexible material, the material is tacky and adheres tightly to the inner wall of the sheath and the external diameter of the terminal pin, and such material retains its expanded tight-sealing condition in its flexible rubber-like state.

Various other objects and advantageous features of the invention may be had from the following description and taken in conjunction with the accompanying drawings wherein:

Figure 1 is a side elevation of a heater embodying one mode of carrying the invention into practice;

Figure 2 is a top view of the heater of Figure 1;

Figure 3 is an enlarged partial section on the line 3—3 of Figure 2;

Figure 4 is a side elevation of a heater embody-

ing a second mode of carrying the invention into practice;

Figure 5 is a top view of the heater shown in Figure 4;

Figure 6 is an enlarged partial section on the line 6—6 of Figure 5;

Figure 7 is a vertical section of a heater embodying a third mode of carrying the invention into practice; and

Figure 8 is a top view of the heater shown in Figure 7.

The heater shown in Figures 1 through 3 is of the type commonly used for heating liquids, and comprises a resistor 11 designed for the passage of an electric current and the consequent generation of the desired heat, terminal pins 12 to which the ends of the resistor 11 are suitably secured, a sheath 13 suitable to the temperatures to be experienced and commonly of metal, and refractory material 14 embedding the resistor 11 and the inner ends of the pins 12 and serving both to electrically insulate the resistor and pins and also to conduct the heat from the resistor to the sheath.

In the illustrated embodiment the heater is bent upon itself providing a body portion 15 suitable to be inserted into the liquid to be heated, and through an opening in the wall of the tank or other vessel in which the liquid is contained, and in furtherance of this arrangement the two substantially parallel end portions 16 are welded or otherwise secured fluid-tight in openings 17 in a plate 18 containing further openings 19 by means of which the plate 18 may be bolted or otherwise suitably secured to the wall of the tank or other vessel marginally of the opening through which the body portion of the heater has been inserted.

However, according to the illustrated embodiment the refractory material 14 is not extended to the ends of the sheath, or is routed out short of the ends of the sheath, as shown, to thereby provide a pocket or chamber adjacent the open end of the sheath. Each end of the heater is provided with a closure having as one of its elements a cover or bushing 20, preferably of ceramic or similar refractory insulating material. In the embodiment here illustrated, the cover or bushing 20 is provided with an axial bore and comprises a shank 21 extending into a respective terminal portion 22 of the sheath 13, the shank 21 being externally smaller than the interior of the respective terminal portions 22 and internally larger than the exterior of the respective terminal pins 12.

Another element of the closure comprises an elastic material 23 filling the spaces between the lower end of the shank 21 and the upper surface of the refractory material 14, between the exterior of the terminal pin 12 and the interior of the shank 21 and the interior of the sheath terminal portion 22. This material is formed in position, for example, by placing a proper quantity of the material in the pocket within the sheath terminal portion 22 and then applying the bushing 20, forcing the shank 21 of the bushing into the material, and thus forcing the material to flow upwardly into the spaces between the exterior of the terminal pin 12 and the interior of the shank 21, and between the exterior of the shank 21 and the interior of the sheath terminal portion 22.

For this method of application the material 23 must necessarily be in a plastic or flowable condition when it is first placed in the pocket or

chamber, and the material 23 is such that it is or becomes and remains elastic and of a nature to adhere to the various surfaces with which it is in contact, and particularly to the exterior of the terminal pin 12, the interior of the shank 21, the exterior of the shank 21, and the interior of the sheath terminal portion 22.

As one example of a satisfactory material to form that part of the closure indicated at 23, a suitable uncured and slow-curing silicone rubber, preferably having admixed therewith up to twice its weight or more of a substance suitable as a filler, may be used. The preferred proportions of the admixture depend on such factors as the specific ingredients and the specific application, a particular example being approximately equal parts of the silicone rubber known commercially as "Silastic 120," and zircon ground to as fine as minus 400 mesh or finer.

The cover or bushing 20 is held tightly in position in overlying relation with the open end of the sheath 13 in order to closely confine the material 23 within a predetermined area in the open end of the sheath whereby expansion of the material 23 on curing will press the material tightly against the surfaces and provide a very tight and effective seal. As shown in Figures 1 to 3 of the drawings, the bushing 20 is held in position by the coaction of a terminal connection 24 which is received and seated in a recess 25 in the head of the cover or bushing, and which is provided with an axial bore 26 accommodating the end portion of the terminal pin 12. The terminal connection is held in position by being swaged or otherwise suitably secured to the end portion of the terminal pin 12, and is so positioned with respect to the cover or bushing 20 that it will hold the cover or bushing tightly against the open end of the sheath 13.

The interior of the sheath terminal portion 22 and the exterior of the shank 21, and the recess 25 and the exterior of the relevant portion of the connection terminal 24, may be made of suitable non-circular contour, as herein shown, in both instances hexagonal, whereby both the cover or bushing and also the connection terminal 24 may be positively held against substantial rotation.

As hereinbefore stated, the material 23 is placed in the pocket or chamber in the end of the sheath in flowable condition, and preferably in such amounts that the material will completely fill the pocket or chamber, assuming that the cover or bushing 20 is not provided with a shank 21, or to completely fill the area about the shank 21 if the cover or bushing is so provided with a shank. With the cover or bushing secured tightly against the open end of the sheath and overlying the pocket or chamber so as to confine the material 23 closely within a predetermined area, the heater element is ready for use, and upon use of the heater element by flowing a suitable current through the terminal pin 12 on the resistor element 11, some heat generated by the resistor element 11 will be conducted through the refractory material 14, the sheath 13 and the terminal pin 12 to the material 23 which causes the material to relatively slowly "cure" or polymerize. In at least one stage of the curing or polymerization the material 23 assumes a tacky condition and adheres tightly to or bonds with the surfaces with which it is in contact. Likewise, during the curing or polymerization, the material 23 expands, and since it is closely confined within a predetermined area the ma-

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terial is pushed tightly against all surfaces defining that area. While the complete cause of such expansion of the material 23 on curing or polymerization under the influence of heat is not fully known, it might be assumed that the evolution of gases, during at least the initial stages of curing or polymerization, is responsible. The material 23 ultimately reaches the stage of substantially complete curing or polymerization and becomes a relatively flexible rubberlike mass, and still remains in its expanded condition, thereby providing an effectively tight seal which will protect the refractory material 14 from moisture.

The heater as shown in Figures 4 through 6 is generally of the same construction as the heater shown in Figures 1 through 3, but instead of the separate bushings 29 of the heater of Figures 1 through 3, the heater of Figures 4 through 6 comprises a single block 41 of a suitable refractory electrically insulating material, and which block 41 coacts with both ends of the sheath 42, whereby the block 41 is inherently held against rotation. Rotation of the connection terminals 45 may be prevented merely by the block recesses 46 and the exteriors of the relevant portions of the connection terminals 45 being of suitable non-circular contour, again herein shown as hexagonal.

The block 41, as shown, also may comprise twin bosses 47 surrounding the sheath terminal portions 43, serving both to insure correct alignment of the block 41 in the event the ends of the sheath 42 are at somewhat different elevations, and also to further close the ends of the sheath.

The heater shown in Figures 7 and 8 is of the type commonly known as a cartridge heater, and comprises a core 71 formed of suitable electric insulating material and provided with a central bore 72 and with upper and lower peripheral slots 73 and 74, and a resistor 75 wound on the core 71 and held in position by the passage of its end portions 76 and 77 through the core slots 73 and 74 and having its lower end portions 77 extending upwardly through the core bore 72, a suitable sheath 78 and refractory material 79 embedding the resistor and serving both to electrically insulate the resistor and to conduct heat from the resistor to the sheath.

In the embodiment illustrated, the refractory material 79 is not extended to the upper end of the sheath, or is routed out short of the upper end of the sheath, to provide a chamber or pocket, and the upper end of the heater is provided with a closure having as one of its elements a cover or bushing 80 of suitable insulating refractory material and provided with apertures 81 and 82 into which extend the terminal portions 83 and 84 of the ends of the resistor 75, and including a shank 85 extending within the upper end of the sheath 78.

With the foregoing construction, the shank 85 is externally smaller than the interior of the upper end of the sheath 78, the apertures 81 and 82 are larger in cross section than the resistor terminal portions 83 and 84, and thereupon the closure comprises as another element, elastic material 86 filling the spaces between the lower end of the shank 85 and the upper end of the surface of the refractory material 79, between the exteriors of the resistor terminal portions 83 and 84 and the interiors of the bushing apertures 81 and 82, and between the exterior of the shank 85 and the interior of the upper end of the sheath 78.

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The material 86, being the same as the material 23, may be formed into position in a manner corresponding to the manner described in respect to the material 23 of the heater of Figures 1 through 3, and preferably is of the nature described in respect to the material 23.

In the illustrated embodiment the bushing 80 is held in position also by the coaction of connection terminals 87 received and seated in recesses 88 in the head of the bushing, each provided with an axial bore 89 accommodating the end portions of the respective heater terminal portions 83 or 84, and each swaged or otherwise suitably secured to the end portions of the respective resistor terminal portions 83 and 84.

The bushing recesses 88 and the exteriors of the relevant portions of the connection terminals 87 may be made of suitable non-circular contour, herein shown as hexagonal, thereby to hold the connection terminals 87 against substantial rotation at least relative to the bushing 80, and if it be desired also to hold the bushing against rotation relative to the sheath, the exterior of the bushing shank and the interior of the sheath and portion also may be made of non-circular contour, for example, hexagonal.

What is claimed is:

1. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising an uncured silastic material which becomes and remains elastic on curing, and which material cures under the influence of heat and expands during curing, disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such material within the pocket whereby curing and expansion of the material under the influence of heat produces a tight seal for the terminal opening of the sheath.

2. An electrical heating device comprising a sheath, an electrical resistance conductor within said sheath, a terminal pin electrically connected to said resistance conductor and extending outwardly from an open end of said sheath, electrical insulating and heat conducting material protecting said conductor from contact with the inner wall surface of said sheath, said material stopping short of said open end and cooperating with the adjacent inner peripheral wall of said sheath to define a pocket, a rigid closure for the open end of the sheath including a sleeve disposed within said pocket in spaced relation with respect to said inner peripheral wall and surrounding said terminal pin in spaced relation, and yieldable sealing means in the space between said sleeve and said inner peripheral wall and in the space between said sleeve and said terminal pin, said sealing means comprising a mixture of finely divided uncured silastic and refractory materials, which mixture is initially flowable and disposed within said pocket and disposed by the insertion of said sleeve to occupy the spaces hereinbefore mentioned, and said sealing means having properties of expanding during curing of the silastic and adhering to the surfaces defining such spaces to seal against passage of foreign matter, yet having sufficient resiliency to yieldably support said sleeve and said terminal pin in operative position.

3. An electrical heating device comprising a sheath, an electrical resistance conductor within said sheath, a terminal pin electrically connected

to said resistance conductor and extending outwardly from an open end of said sheath, electrical insulating and heat conducting material protecting said conductor from contact with the inner wall surface of said sheath, said material stopping short of said open end and cooperating with the adjacent inner peripheral wall of said sheath to define a pocket, a rigid closure for the open end of the sheath including a sleeve disposed within said pocket in spaced relation with respect to said inner peripheral wall and surrounding said terminal pin in spaced relation, and yieldable sealing means in the space between said sleeve and said inner peripheral wall and in the space between said sleeve and said terminal pin, said sealing means comprising a mixture of finely divided uncured silastic and refractory materials, which mixture is initially flowable and disposed within said pocket and displaced by the insertion of said sleeve to occupy the spaces hereinbefore mentioned, and said sealing means having properties of expanding during curing of the silastic and adhering to the surfaces defining such spaces to seal against passage of foreign matter, yet having sufficient resiliency to yieldably support said sleeve and said terminal pin in operative position, and means on said terminal pin to hold said closure against displacement.

4. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising an uncured silastic material in flowable condition which becomes and remains elastic on curing, and which material cures under the influence of heat and expands during curing, disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such material within the pocket whereby curing and expansion of the material under the influence of heat produces a tight sealing closure for the terminal opening of the sheath.

5. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising an uncured silastic material in flowable adherent condition which becomes and remains elastic on curing, and which material cures under the influence of heat and expands during curing, disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such material within the pocket whereby curing and expansion of the material under the influence of heat produces a tight sealing closure for the terminal opening of the sheath.

6. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising a mixture of finely divided uncured silastic and refractory materials which becomes and remains elastic on curing, and which material cures under the influence of heat and expands during curing, disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such mixture within the pocket whereby curing and expansion of the material under the influence of heat

produces a tight sealing closure for the terminal opening of the sheath.

7. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising a mixture of finely divided uncured silastic and refractory materials in flowable adherent condition which becomes and remains elastic on curing, and which material cures under the influence of heat and expands during curing, disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such mixture within the pocket whereby curing and expansion of the material under the influence of heat produces a tight sealing closure for the terminal opening of the sheath.

8. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising a finely divided uncured silastic admixed with at least up to twice its weight with a filler, and which admixture becomes and remains elastic on curing under the influence of heat and expands during curing, disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such admixture within the pocket whereby curing and expansion thereof under the influence of heat produces a tight sealing closure for the terminal opening of the sheath.

9. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising a finely divided uncured silastic admixed with at least up to twice its weight with a filler, and which admixture is initially in plastic condition and becomes and remains elastic on curing under the influence of heat and expands during curing, disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such admixture within the pocket whereby curing and expansion thereof under the influence of heat produces a tight sealing closure for the terminal opening of the sheath.

10. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising an admixture of approximately equal parts of a finely divided uncured silastic and a filler, and which admixture becomes and remains elastic on curing under the influence of heat and expands during curing, disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such admixture within the pocket whereby curing and expansion of the admixture under the influence of heat produces a tight sealing closure for the terminal opening of the sheath.

11. A closure for the terminal opening of a sheathed embedded-resistor electric heater wherein the resistor embedding material terminates short of the terminal opening to form with the sheath a pocket above the embedding material, comprising an admixture of approximately equal parts of a finely divided uncured silastic and a filler, and which admixture is initially in plastic condition and becomes and

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remains elastic on curing under the influence of heat and expands during curing disposed in said pocket, and a cover for the terminal opening of the sheath completely confining such admixture within the pocket whereby curing and expansion of the admixture under the influence of heat produces a tight sealing closure for the terminal opening of the sheath.

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10

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