Aug. 5, 1958 N. B. THORNHILL 2,846,537

ELECTRIC HEATERS

Filed March 3, 1954 2 Sheets-Sheet 1

Fig. 1

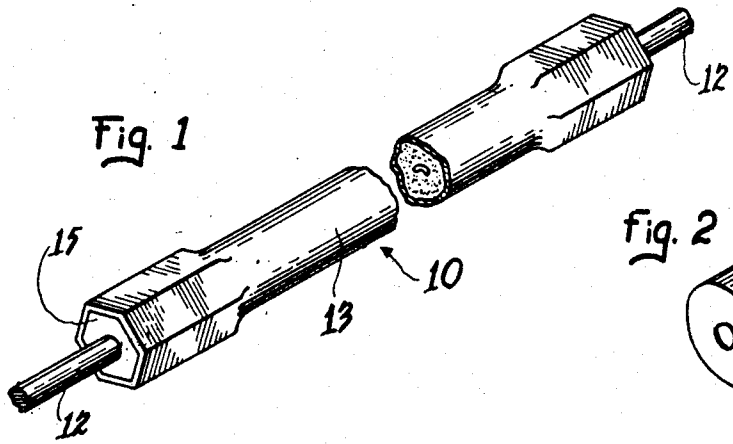


Fig. 2

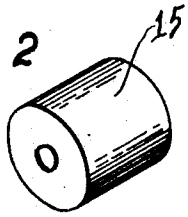


Fig. 3

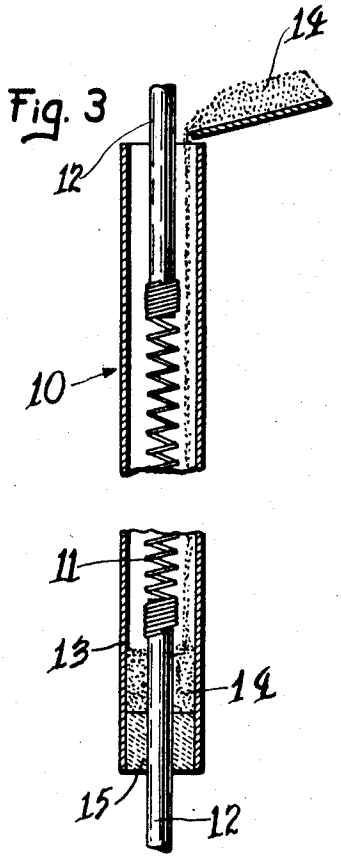


Fig. 4

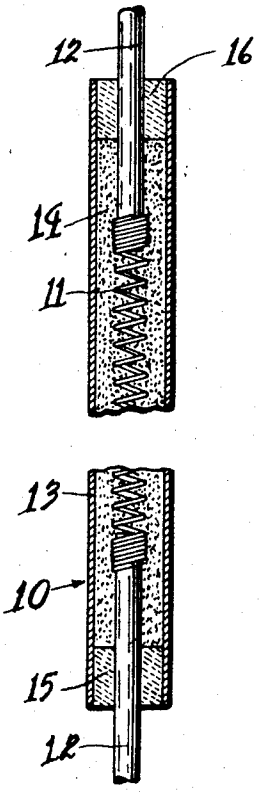
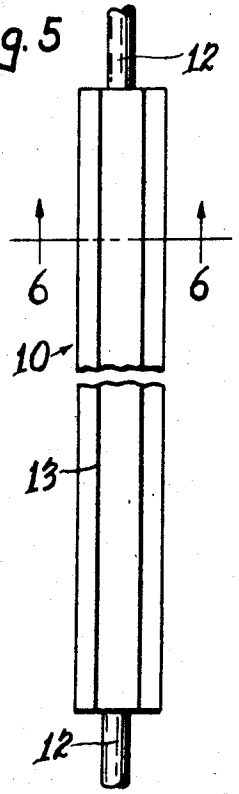


Fig. 5



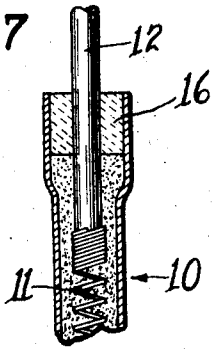
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ELECTRIC HEATERS

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Fig. 7



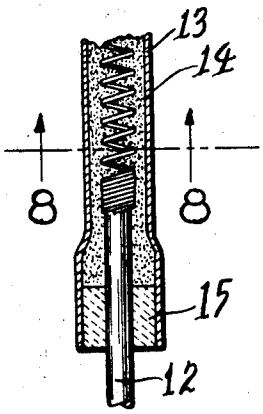


Fig. 6

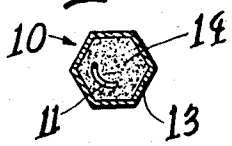


Fig. 8

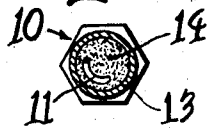


Fig. 11

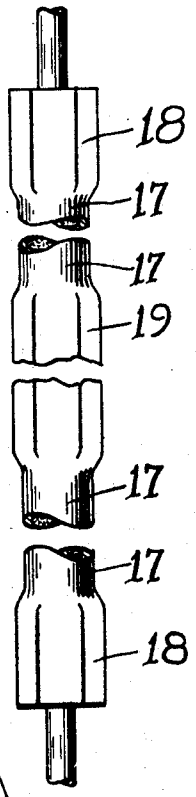


Fig. 9

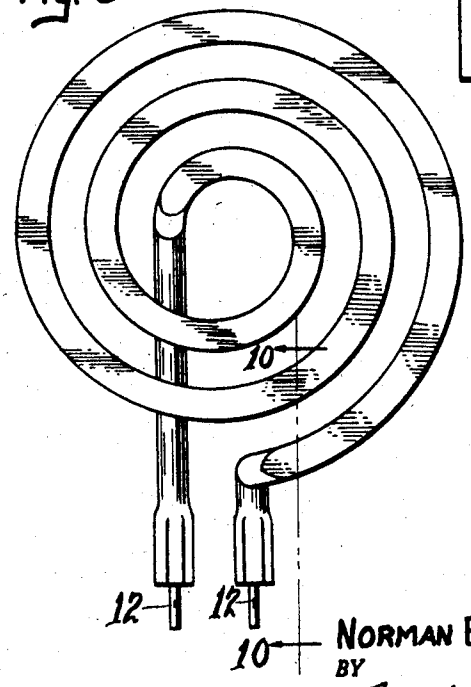
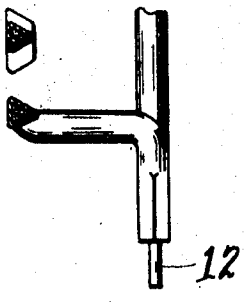


Fig. 10



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United States Patent Office 2,846,537 Patented Aug. 5, 1958

2,846,537

ELECTRIC HEATERS

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Application March 3, 1954, Serial No. 413,920

3 Claims. (Cl. 201—67)

The present invention relates to methods of making sheathed electric resistance heaters and to the article of manufacture produced thereby, and the principal object of my invention is to provide new and improved methods and articles of this character.

In making sheathed electric resistance heaters of the type having an electric resistor disposed within a deformable sheath which is filled with electric-insulating, heat-conductive granular refractory material, it is necessary, after the filling operation, to close the ends of the sheath by some means to prevent loss of the refractory material during subsequent operations.

In many constructions wherein annealing of the heater sheath is a necessary part of the manufacturing operation or wherein the ultimate use of the heater is such that the terminal ends thereof will be subjected to elevated temperatures, considerable difficulty has attended development of a suitable closure for the sheath.

In the past, the ends of the sheath have been closed by an operation known in the trade as end-packing and such operation comprised placing one or more pellets formed of a brittle dielectric material in a respective open end of the sheath and crushing such pellets by repeated blows delivered through such open end until a tightly packed wad of dielectric material had been formed. Following end-packing each end of the sheath, the portion of the sheath intermediate the ends was compressed as by being pressed between dies in a press or the like so as to partially compact the refractory material about the resistor. After partially compacting the refractory about the resistor, it was possible to form the sheath, by bending or the like, to the desirable shape after which the previously mentioned intermediate portion of the sheath was further pressed as between dies or the like, to further compact the refractory material about the resistor.

The above described prior art method of making sheathed electric heaters has been more or less satisfactory; however, this method has been quite expensive and a considerable portion of this expense has been the end-packing operation. Accordingly, it is an object of my invention to simplify and reduce the cost of producing electric heaters of the character described. The means by which this and other objects are achieved will become apparent from a study of the following description and from the drawings appended hereto.

In the drawings accompanying this specification and forming a part of this application there is shown, for purpose of illustration, two embodiments which my invention may assume, and in these drawings:

Figure 1 is a broken perspective view of a sheathed electric heater constructed in accordance with my invention,

Figure 2 is a perspective view of a detail,

Figure 3 is a broken, longitudinal sectional view of an electric heater illustrating one step in the manufacture thereof,

Figure 4 is a view similar to Figure 3 but illustrating the heater after another step,

Figure 5 is a broken, elevational view of the electric heater illustrating its appearance following still another step,

Figure 6 is a sectional view generally corresponding to the line 6—6 of Figure 5,

Figure 7 is a fragmentary view of the heater illustrated in Figure 1 but somewhat enlarged and shown in longitudinal section,

Figure 8 is a sectional view generally corresponding to the line 8—8 of Figure 7,

Figure 9 is a plan view of another type heater constructed in accordance with my invention,

Figure 10 is a fragmentary view generally corresponding to the line 10—10 of Figure 9, and

Figure 11 is a broken fragmentary elevational view illustrating a step in the formation of the heater shown in Figure 9.

In carrying out my invention of providing sheathed electric heaters 10 of the type shown in Figure 1, I preferably employ the conventional steps of positioning a coiled resistor 11 having a current-carrying terminal pin 12 conventionally secured to each end thereof within a round, deformable hollow sheath 13 whereby each terminal pin 12 extends beyond a respective end of the sheath 13 as shown (see Figure 3). The sheath 13 is adapted to be filled with any well-known electric-insulating, heat-conducting refractory material 14 which is, in the presently disclosed embodiment, granular in form. Any suitable means may be employed to fill the sheath 13; for example, any suitable commercially available filling machine may be utilized and since such machines are well-known in the art, a detailed description thereof is believed to be unnecessary.

During the filling operation as herein disclosed, the sheath 13 is adapted to be positioned generally vertically and the refractory material 14 is introduced into the uppermost end of the sheath and allowed to gravitate down to fill the sheath. At the present time it is preferable to close the bottom of the sheath by means of a plug 15 (see Figure 2) which is of a size to closely fit within the sheath 13 and which is apertured to pass the lower terminal pin 12 with a minimum of clearance.

The plug 15 may be formed of any suitable dielectric material which is deformable without excessive crumbling and which is capable of withstanding elevated temperatures. I have found that a plug machined from a fine-grained igneous mineral substance commonly known as lava is well-suited for the purpose since its density is high and it is easily handled yet is sufficiently deformable to withstand a limited amount of compression without crumbling; it possesses satisfactory dielectric qualities; and, it easily withstands the highest temperatures to which the heater will normally be exposed. During filling, the plug 15 may be held within the sheath by frictional engagement therewith or by any other suitable means such as by engagement with an abutment which may form a part of the filling machine.

Another type of plug found suitable for use in the present invention is one formed of compacted, powdered aluminum oxide held together by any suitable bonding agent. This type of plug possesses at least a minimum of the desirable characteristics of the above described lava plug and additionally is considerably lower in cost since it may be made by an extrusion process instead of being machined.

After the sheath 13 has been filled with refractory material, a plug 16, similar in all respects to plug 15, may be positioned in the upper end of the sheath (see Figure 4). It will be appreciated that the sheath will not be completely filled with the refractory material but that sufficient space will be provided for receiving the plug 16.

With the sheath filled with refractory material and the plugs 15, 16 in position in the ends of the sheath, the sheath ends will next be compressed laterally to secure

the plugs tightly in position to prevent loss of refractory material through such ends. Since as a prerequisite to subsequent operations it is usually necessary to partially compact the refractory material **14** about the resistor **11**, it is preferable at the present time to compress the entire length of the sheath so as to both secure the plugs tightly in position and partially compact the refractory material in a single operation.

At the present time, it is preferred that the sheath be compressed to a hexagonal configuration (see Figures 5 and 6); however, it will be appreciated that the sheath could be compressed to any other suitable configuration. Any desirable means may be employed to compress the sheath in the manner disclosed; for example, the sheath may be compressed between suitable dies carried by a press or the like or fed between suitably arranged rolls which will accomplish the desired result.

After the heater has been formed as shown in Figures 5 and 6 and depending upon the nature of the material from which the sheath is made, it is customary to subject the heater to a temperature of at least 1950 degrees Fahrenheit for approximately fifteen minutes in order to anneal the sheath for further operations.

In some instances when lateral compression is applied to the sheath to secure the plugs and at least partially compact the refractory material, it has been found that the lava plugs have been crushed to an extent wherein voids may appear therein and the annealing heat hereinbefore mentioned accomplishes the further function of maturing or at least partially vitrifying the lava to close any voids. Further, maturing or vitrification increases the strength of the lava plug and thereby off-sets any loss of strength which may be caused by the crushing which took place when the lava bushings were locked in place by the compacting force.

As will later be described, further operations may include bending the sheath to form a convoluted or otherwise shaped heater unit; however, in forming the straight heater illustrated in Figure 1, and following the annealing operation (if employed), the portion of the sheath intermediate the ends thereof will be further compressed to further compact the refractory material **14** about the resistor **11** (see Figures 1, 7 and 8). Any suitable means may be employed to compress this portion of the sheath without disturbing the ends thereof where the bushings **15, 16** are disposed. For example, the sheath may be placed between the dies of a press, the dies being proportioned to exert pressure upon only the intermediate portion of the sheath.

As herein disclosed and with respect to the heater shown in Figure 1, the intermediate portion of the sheath **13** is compressed by action of a press or the like to a round configuration (see especially Figure 8); however, it is to be understood that the intermediate portion of the sheath may be compressed to any other suitable configuration, for example, to a triangular or heart-shaped configuration if desired.

In forming the heater shown in Figure 9, the steps illustrated in Figures 3, 4 and 5 will be employed.

Following the step shown in Figure 5, the heater will be annealed, if necessary, as before described. After annealing, if this operation is used, portions **17** of the heater (see Figure 11) will, as herein disclosed, preferably be compressed to a round cross-section in manner similar to that employed in forming the heater shown in Figure 1. However, as illustrated, only the portions **17** near the ends of the heater will be so compressed, the extreme ends **18** of the heater and the portion **19** intermediate the portions **17** will not be compressed.

After the heater has been formed as shown in Figure 11, the portion **19** of the heater will be formed to a spiral configuration (see Figure 9) and the portions **17** will be bent to provide terminal ends which extend from the spiral as shown.

Following the operation of forming the heater to the spiral configuration disclosed, the spiraled portion **19** of the heater will be compressed to further compact the refractory material about the resistor. At the present time, the portion **19** is placed between dies and compressed to a triangular or heart-shaped configuration (see Figure 10); however, it will be appreciated that the portion **19** could be compressed to a round, oval or any other desired shape.

Under certain circumstances it may be desirable to eliminate the operation of compressing the portions **17** of the sheath and to coil the portion **19** of the heater after it has been formed as shown in Figure 5.

While I have illustrated and described the formation of only two types of heaters, a straight heater and a convoluted or spiral heater, it will be appreciated that any other suitably shaped heater may be formed if desired.

In view of the foregoing it will be apparent to those skilled in the art that I have accomplished at least the principal object of my invention and it will also be apparent to those skilled in the art that the embodiments herein described may be variously changed and modified, without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described, hence it will be appreciated that the herein disclosed embodiments are illustrative only, and that my invention is not limited thereto.

I claim:

1. The method of producing a sheathed embedded resistor electric heater wherein a resistance conductor is disposed within a metal tubular sheath and has a terminal end accessible through an opening in an end of said sheath, and wherein the resistance conductor is surrounded by and embedded in electric-insulating heat-conducting refractory material, the latter stopping short of said tubular opening to form therewith a pocket, which method comprises disposing an apertured lava plug in said pocket in encompassing relation with respect to the accessible end of said conductor, compressing and deforming the sheath radially inward to compress it about said plug and force the latter into intimate engagement with the entire inner wall of said pocket and with the adjoining peripheral surface of said conductor, and thereafter subjecting at least said sheath end to a temperature sufficient to vitrify said lava plug.

2. An electric heating element, comprising a tubular metal sheath, a resistance conductor member having a terminal end extending through an end opening of said tubular sheath, a refractory heat conducting material within said sheath for electrically insulating said conductor member from said sheath, said refractory material terminating short of said sheath opening to form therewith an open pocket in said sheath, and an apertured lava plug held in tight engagement with the entire pocket inner wall and the adjoining exterior surface of said conductor terminal by a transverse deformation of said sheath at its end opening.

3. The construction according to claim 2 wherein said lava plug is vitrified.

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