Feb. 14, 1928. 1,658,990

A. D. KEENE

ELECTRIC HEATING UNIT

Filed March 26, 1925

Fig. 1.

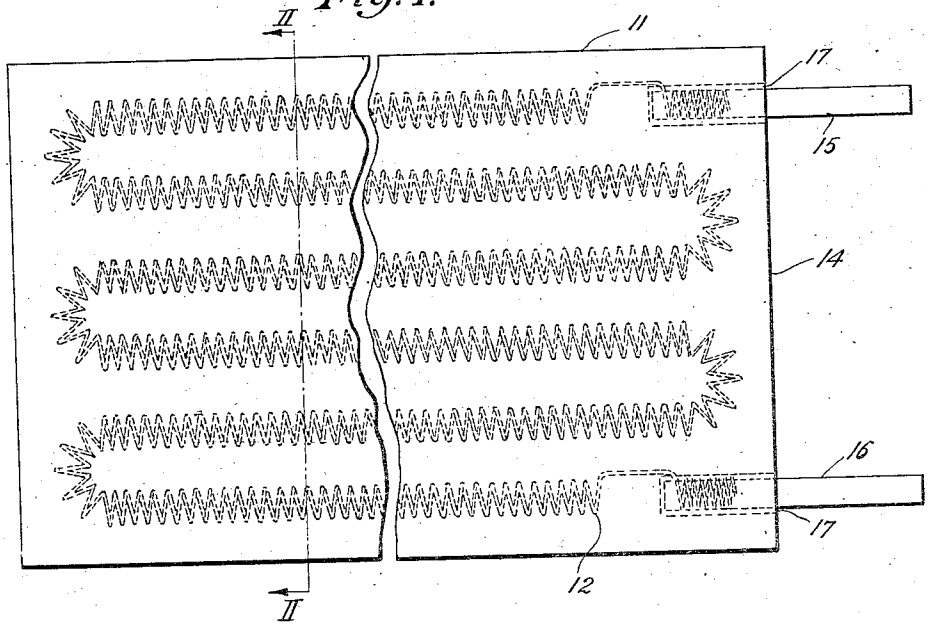



Fig. 2.

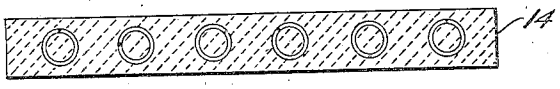



Fig. 3.

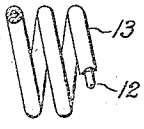



Fig. 5.

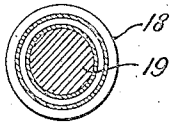



Fig. 4.

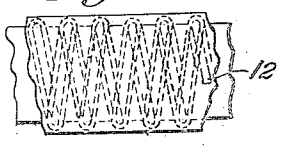
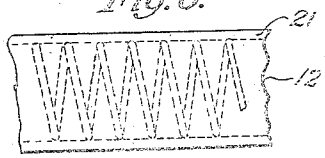



Fig. 6.




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# UNITED STATES PATENT OFFICE.

ALVIN D. KEENE, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

## ELECTRIC HEATING UNIT.

Application filed March 26, 1925. Serial No. 18,425.

My invention relates to electric heating devices and particularly to embedded electric heating units.

The object of my invention is to provide an electric heating unit that shall be capable of operation at relatively high temperatures without a resistor member embodied therein becoming oxidized.

In practicing my invention, I provide a resistor wire, preferably wound into an open helix, and cover the same with a comminuted electric-insulating material, and then embed the same in a mass of powdered, heat-and-electric-conducting material that is then tightly compressed thereon.

In the single sheet of drawings,

Figure 1 is a top plan view of an electric heating element embodying my invention,

Fig. 2 is a view, in lateral section therethrough, taken on the line II—II of Fig. 1,

Fig. 3 is a fragmentary enlarged view of an insulated resistor member comprising a part of the device embodying my invention,

Fig. 4 is a view of a modified form of device embodying my invention,

Fig. 5 is an end view thereof, and

Fig. 6 is a fragmentary view, in side elevation, of a further modification of a heating element embodying my invention.

An electric heating element, designated generally by the numeral 11, comprises a resistor wire 12 that is preferably wound to helical form after which the respective turns thereof are spaced apart. If desired, the wire may be wound with the adjacent turns spaced apart and as this requires a much longer form or mandrel upon which to wind the wire, I prefer to effect the spacing after the coil has been wound. Any desired diameter of helix may be employed in accordance with the requirement of either the furnace or the device, with which the heating element is to be associated, as well as in accordance with the amount of resistance which it is desired that the completed resistor member shall have.

After the helix has been wound and the turns spaced, it is dipped into moistened, comminuted, electric-insulating material, such as alundum, a sufficient number of times until a coating, designated by the numeral 13 in Fig. 3, has been formed around and over the entire length of the resistor member 12. While dipping may be employed to effect such coating, any other suitable or desired method that will effect the desired results may be employed. The coating is permitted to dry and the insulated resistor member is then wound on a suitable former of any kind desired, that will hold the helically wound resistor member in the final position of the individual parts thereof relatively to each other. Such former may be made of relatively simple form, such as a wooden plate having pegs therein, around which the helix may be wound to the form illustrated particularly in Fig. 1 of the drawing.

A mold (not shown) of substantially rectangular contour may have placed therein a quantity of an initially moistened or comminuted heat-and-electric conducting material, such as carborundum, which material may be mixed with a small quantity, say 5 to 10%, of clay to constitute a binder. The resistor member that has been temporarily placed on the hereinbefore mentioned former is then lightly pressed into the comminuted heat-and-electric-conducting material to an extent sufficient to hold the formed resistor members in their proper operative positions.

If desired, or considered necessary, grooves may be formed in the heat-and-electric-conducting material placed in the mold and the helically wound resistor wire located therein, after which an additional quantity of heat-and-electric-conducting material is sifted over the resistor member which is then tightly compressed until a slab or plate 14, is formed, as is illustrated particularly in Figs. 1 and 2 of the drawing. I prefer to employ a relatively high pressure in order that the material may be in intimate heat-conducting contact with the insulated resistor wire and that it may have some mechanical strength. Such a plate acts not only as a heat-conducting material, but also acts as a muffle when a heating unit of this kind is mounted in an oven or in an electric furnace structure.

A plurality of terminal members 15 and 16 that consist of a rod or bar of a highly refractory metal, such as nichrome, extend into the plate or slab 14 and the ends of the resistor wire 12 are wrapped therearound a number of times. The terminal members 15 and 16 are held in their proper operative positions relatively to the completed heating unit by means provided in the hereinbefore mentioned mold and a layer 17, of electric-

insulating material, such as alundum, may be placed therearound in order to insulate the terminal members from the electric conducting material comprising the slab 14.

The construction of the terminal members is not further described or claimed in this application, as it forms the subject-matter of my copending application, Serial No. 18,424; filed March 26, 1925 which is assigned to the Westinghouse Electric & Mfg. Company.

In Figs. 4 and 5 is illustrated a modified form of heating element embodying my invention, in which the resistor wire is helically wound and remains in the form of a straight rod. After the wire has been wound into helical form and insulated as hereinbefore described (as illustrated in Fig. 3) it is imbedded in a quantity of heat-and-electric conducting material, such as carborundum, as hereinbefore described, but the completed form is that of a rod, as shown particularly in Fig. 4.

To effect such coating, I may employ a suitable process that employs a mold of the same general character and operation as hereinbefore described, differing only in that the material is molded to substantially rod shape, or I may cause the insulated helix of wire to be forced out through a nozzle by pressure applied to a mass of the heat-and-electric-conducting material that is made sufficiently plastic to permit of such extrusion. A mass 18 of this material is located around the outside of the helix and a similar mass 19 is located inside of the helix, the portion 19 serving to conduct the heat outwardly to the surface of the portion 18.

In Fig. 6, of the drawing, I have illustrated a modified form which I may employ when an elongated rod form of heater is suitable. In this form, the resistor wire 12 is not insulated, but is imbedded in a mass 21 of heat-and-electric-conducting material, such as was hereinbefore described, without the interposition of the electric-resisting coating 13.

In the rod form of heating units, any suitable or desired type of terminal construction may be employed, as for instance, the resistor wire may be doubled on itself a number of times or the terminal members 15 and 16 hereinbefore described may be employed.

The use of the electric-insulating coating 13 is necessary when a plurality of parallel-extending convolutions, such as shown in Fig. 1 of the drawing, are employed, as the voltage drop between the ends of the adjacent convolutions may be high enough to cause a current to flow therebetween and cause a burning out of the heating element. However, when the rod form of heating unit is employed, this danger is not present and even if current does traverse the carborundum coating, no particular harm will be done, as the amount thereof is so low as to cause no burning out of the resistor. This is effected by so proportioning the resistor wire proper, the spacing between the adjacent turns thereof, and by so operating the heating unit that the temperature of the embedding material is not high enough to permit a dangerously high current to be diverted from the resistor wire proper. I have found it possible to heat such a heating unit to temperatures up to 1800° F. and have found that both the plate and the rod form of heating unit are relatively strong at that temperature.

Since various modifications and changes may be made without departing from the spirit and scope of the invention, I desire that only such limitations shall be placed thereon as are imposed by the prior art.

I claim as my invention:

1. The method of making an electric heating element that comprises the steps of coating a resistor wire, wound into an open helix, with initially-moistened, powdered electric-insulating material, embedding the same in a mass of initially-moistened, electric-conducting material having high heat-conductivity, compressing said heat-and-electric-conducting material around and into said helix and then heating said element.

2. The method of making an electric heating element that comprises the steps of coating a resistor wire, wound into an open helix, with initially-moistened, powdered aluminum oxide, embedding the same in a mass of initially-moistened, powdered silicon carbide, compressing the same and then heating said element.

In testimony whereof, I have hereunto subscribed my name this 13th day of March, 1925.

ALVIN D. KEENE.