

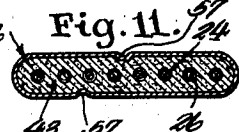
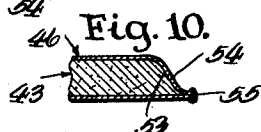
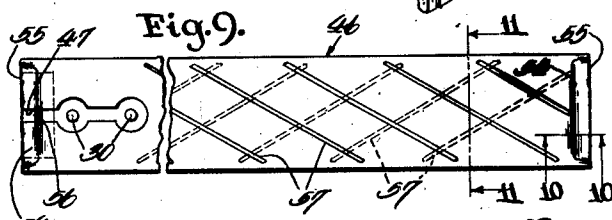
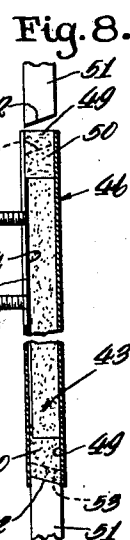
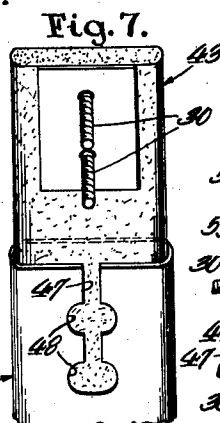
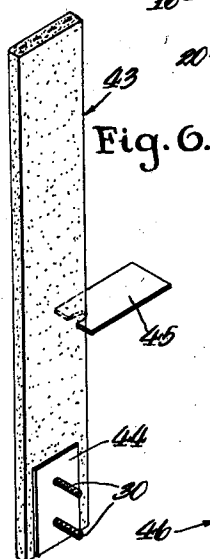
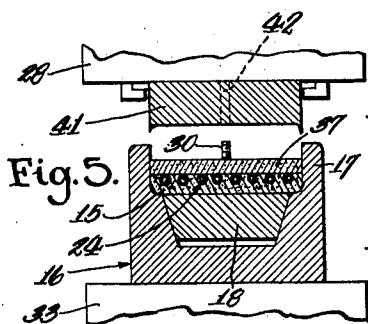
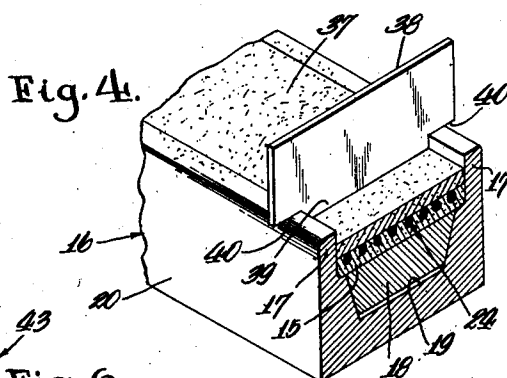
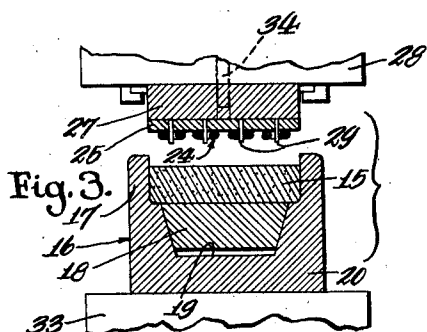
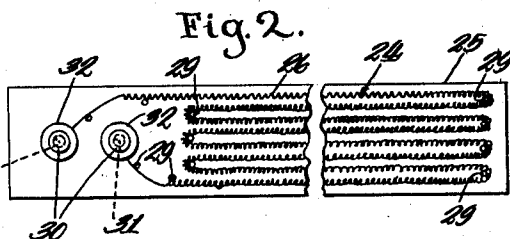
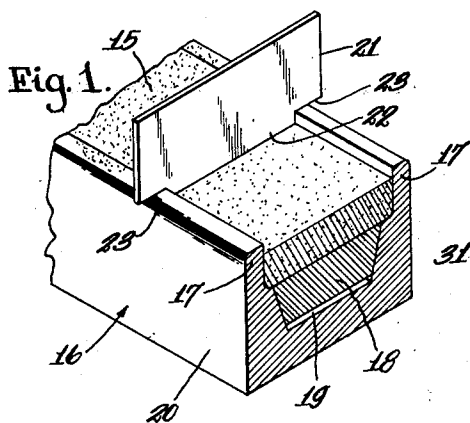
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E. L. WIEGAND

2,284,078

METHOD OF MAKING ELECTRICAL HEATING UNITS

Filed Aug. 28, 1939



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METHOD OF MAKING ELECTRICAL
HEATING UNITS

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14 Claims. (Cl. 201-64)

My invention relates to methods of making electrical heating units, and the principal object of this invention is to provide new and improved methods of making electrical heating units.

In the drawing accompanying the specification, and forming a part of this application, I have shown, for purposes of illustration, one way in which my invention may be practiced, and an electrical heating unit resulting therefrom.

In the drawing:

Figures 1 through 8 show steps in making electrical heating units,

Figure 9 is a broken plan view of a completed heating unit,

Figure 10 is an enlarged fragmentary sectional view corresponding generally to the line 10-10 of Figure 9, and

Figure 11 is an enlarged transverse sectional view corresponding generally to the line 11-11 of Figure 9.

In making the heating unit, a quantity of suitable compactible refractory insulating material 15 in granular or finely subdivided form and of an impressionable character is placed into a mold 16. The mold 16 is preferably of the type illustrated in the drawing, and comprises side walls 17 and a removable bottom 18, defining a cavity for receiving the refractory insulating material. The shape of the cavity depends upon the desired cross-sectional shape of the heating unit, and in the embodiment herein illustrated, the cavity is relatively wide and thin in cross-section, and of any desired length. As shown, the bottom 18 is preferably wedge-shaped, and fits within a wedge-shaped recess 19 formed in the body 20 of the mold.

The amount of material placed within the cavity of the mold 16 is preferably gauged to a uniform depth throughout the mold. One way of gauging the depth is by the use of a scraper 21 having a gauging part 22 extending into the mold cavity a predetermined amount limited by shoulders 23 which ride on the upper surfaces of the walls 17, as clearly shown in Figure 1.

A resistor element 24 is positioned in the mold 16, preferably after the refractory material 15 is disposed in the mold and gauged to uniform depth. The resistor element herein shown is in the form of a helical coil 26, although it is to be understood that the resistor element can be of the ribbon type or of any other suitable type. As best shown in Figures 2 and 3, the re-

sistor element 24 is preferably arranged against displacement on a form 25, which in this particular case is part of a die which also includes a base plate 27 adapted to be secured to the movable part 28 of a press, such as a hydraulic press. The base plate 27 has a plurality of pins 29 extending therefrom, and extending through cooperating apertures in the form 25, the extending ends of the pins 29 providing pegs about which the resistor element 24 may be wound.

In the embodiment illustrated, the resistor terminals 30 extend transversely to the plane of the resistor 24, and in this case the form 25 has additional apertures 31 for receiving the stud ends of respective terminals. Washers 32 are secured to the respective terminal studs, the washers holding the resistor ends to the respective terminals, and limiting passage of the terminal studs through respective apertures 31. The form 25 is assembled with the base plate 27 by inserting the pins 29 through respective apertures in the form, and the base plate 27 and the form 25 may be removably held assembled in any suitable manner. In the particular embodiment illustrated, the base plate 27 has apertures for receiving the stud ends of the terminals. The form 25 is assembled with the base plate 27, and the resistor 24 is wound on the pins 29 preferably when the die is removed from the press, and this operation may be carried on at the time refractory material is being placed into the cavity of the mold 16.

When the resistor is properly wound, the die including the form 25 and the base plate 27 is secured to the movable part 28 of the press, the mold 16 preferably being fixed to a stationary part 33 of the press in alignment with the movable part 28. The movable part 28 of the press is then moved toward the stationary part 33, the form 25 entering the cavity of the mold 16 a predetermined amount, emplacing the resistor element 24 in the refractory insulating material disposed within the cavity of the mold 16, and preferably simultaneously compacting this insulating material a desired amount. The movable part 28 of the press is then withdrawn from the stationary part 33, the resistor 24 being stripped from the pins 29, in any suitable manner, before the form 25 is caused to withdraw from pressing engagement with the refractory material, as for example by means of a finger 34 which engages the form 25 at the proper time and causes a predetermined amount of relative movement between the form 25 and the base plate 27, the movement being of a sufficient amount to draw

the extending ends of the pins 29 into the form 25. With the resistor 24 stripped from the pins 29 and held in place in the compacted refractory material, the form 25 and base plate 27 are withdrawn from the cavity of the mold 16. This operation results in compacting the refractory material 15 a desired amount, and leaving the resistor element 24 emplaced within the material 15, so that the resistor portions extend inwardly from the top of the compacted refractory material, referring to Figure 4, but are properly spaced from each other and from the bottom and sides of the material 15.

Additional compactible refractory insulating material 37 is then placed into the cavity of the mold 16, in position overlying the already compacted material 15. The material 37 is preferably gauged to a uniform depth, as by means of a scraper 38 having a gauge portion 39 extending into the cavity of the mold 16 a predetermined amount limited by shoulders 40 which ride along the top surface of the walls 17. A die 41 is then secured to the movable part 28 of the press, the die 41 in the embodiment shown having apertures 42 for passing the ends of the terminals 30 of the resistor element 24. The movable part 28 of the press is then moved toward the stationary part 33, the die 41 entering the cavity of the mold 16 a predetermined amount so as to compact the additional material 37, such compacting also resulting in uniting the additional material 37 with the initial material 15 to form a self-sustaining body of refractory insulating material in which is enclosed the resistor element 24. The movable part 28 of the press is then withdrawn from the stationary part 33, so as to withdraw the die 41 from the cavity of the mold 16, and the self-sustaining body formed by the hereinbefore described operations is removed from the mold 16, as by lifting the removable bottom 18 from its recess 19, this operation being preferable to the purpose that the edges of the body will not be broken. The body formed by the particular mold cavity and die herein illustrated is in the form of a slab 43, best shown in Figure 6, and is elongated in length and thin and wide in cross-section. However, as before pointed out, the size and cross-sectional shape of the body may be varied. A thin sheet of mica 44 is assembled with the slab 43, either before or after it is removed from the mold 16, the mica being apertured to pass the stud ends of the terminals 30, and being of such size as to overlie portions of the slab 43 adjacent the terminals 30.

In some instances it may be desirable to shape the edges of the slab 43, and in the embodiment shown, the edges are trimmed, as by means of a scraper 45 which is run along the edges of the slab 43 so as to smooth and round these edges. In some instances, the slab may be dried and baked and used in that form.

In other cases, as illustrated in Figure 7, the slab 42, before drying or baking, is preferably disposed within a sheath, as for example the metallic seamless tube 46. The slab 43 is inserted endwise into the sheath 46, and since the terminals 30 herein shown project laterally from the slab 43, one surface of the sheath 46 is formed with a slot 47, recessed as at 48, to receive the terminals 30, the mica sheet 44 underlying this surface of the sheath. The sheath 46 is preferably slightly larger in its cross-sectional dimension than the slab 43, so that the slab 43

can be inserted into the sheath without gouging the edges of the slab.

As best shown in Figure 8, the sheath 46 is slightly longer than the slab 43, so that when the slab 43 is properly positioned within the sheath 46, spaces 49 are provided at the opposite ends of the sheath. Loose compactible refractory insulating material 50 is placed within the spaces 49, and this material is compacted, as by means of tamping bars 51 having a cross-section substantially equal to the cross-section of the sheath. The tamping bars 51 are preferably formed with inclined surfaces 52, so that after the tamping operation, the material 50 in the ends 49 is formed with a smooth inclined surface 53.

The article thus far produced is now preferably dried, to remove substantially all moisture from the refractory insulating material. After the drying operation, the ends of the sheath 46 are closed, it being preferable in the embodiment illustrated to press down one upper flat surface, as shown at 54, to cause it to follow the contour of the inclined surface 53 of the material 50. The edges defining the opening into the sheath are then sealed, as by welding as shown at 55. The end containing the terminals 30 preferably has a metal insert 56 disposed therein before this end is closed, to provide for effective sealing of the slot 47 which accommodates the terminals 30.

After the sheath 46 has been sealed, the article thus far produced is placed in a press, and the sheath 46 is pressed into intimate engagement with the refractory material within the sheath 46, this pressing preferably also corrugating the sheath so as to tighten the sheath about the enclosed refractory material. In the embodiment shown, the corrugations take the form of grooves 57 formed in the wide flat surfaces of the sheath 46 and extending diagonally with respect to the longitudinal axis of the sheath, the grooves 57 on the one flat surface preferably running in a direction opposite to the grooves in the opposite flat surface, so as to further strengthen the sheath 46. The article may then be baked, at a suitable temperature and for a suitable length of time. The interior surface of the grooves 57 grip spaced-apart portions of the refractory material, so that during baking, any differential expansion between the sheath 46 and the refractory material enclosed therein may cause only extremely slight and inconsequential gaps to be formed in some of the spaced-apart portions of the refractory material, instead of one or more large gaps which might be formed if the corrugations or other suitable holding means were not used.

The heating unit is ideally suited for immersion heating, since the refractory material is entirely sealed within the sheath, thus making it impossible for any foreign material to enter the sheath and destroy the effectiveness of the heating unit. Of course, the heating unit is also very satisfactory for use other than immersion heating.

As an example of the refractory material that can be used in producing the heating unit, I have found a mixture of 78% to 82% of zircon and the balance of suitable bonding material, such as bonding clay, to be satisfactory, a certain amount of moisture being added to this mix so that it may be compacted somewhat like founder's sand. Of course, the proportions and the materials given are only illustrative, and any

other suitable materials and proportions are intended to be included in this invention.

Although it has been found preferable to have both ends of the sheath 46 open during the time the slab 43 is inserted therein, so as to provide as much opening as is possible for the egress of air displaced from the sheath by the slab, and also to have such ends open during the time the slab is dried, to provide for ready egress of moisture and/or gases during the drying operation, it is within the contemplation of my invention that one end of the sheath may be partially or completely closed and sealed before the slab 43 is inserted.

From 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 also will be apparent to those skilled in the art that the embodiment 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 embodiment is illustrative only, and that my invention is not limited thereto.

I claim:

1. The method of making an electrical heating unit, which comprises: placing compactible insulating material containing at least some moisture into an elongated mold, positioning an electric resistor in the mold, compacting the insulating material, placing additional compactible insulating material containing at least some moisture into the mold to cover the already compacted insulating material, compacting this additional insulating material and uniting it with the initially compacted insulating material and forming an elongated self-sustaining body capable of being handled without support, removing the body from the mold and inserting it endwise into a metallic sheath having a continuous cross-section, placing compactible insulating material in the ends of the sheath and compacting this material against the body, drying the insulating material in the sheath, closing the ends of the sheath, pressing the sheath into intimate contact with the body, and baking the unit thus formed.

2. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising embedding material and resistor means, including, compacting said material into press-caked condition; and while said material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath.

3. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising embedding material and resistor means, including, compacting said material into press-caked condition; while said material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath; and thereafter pressing said sheath to effect intimate

heat conducting condition from said resistor means to said sheath.

4. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising embedding material and resistor means, including, compacting said material into press-caked condition; while said material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath; and thereafter setting said material.

5. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising embedding material and resistor means, including, compacting said material into press-caked condition; while said material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath; and thereafter, pressing said sheath to effect intimate heat conducting condition from said resistor means to said sheath, and setting said material.

6. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising embedding material and resistor means, including, compacting said material into press-caked condition; while said material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath; thereafter pressing said sheath to effect intimate heat conducting condition from said resistor means to said sheath; and thereafter setting said material.

7. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising embedding material and resistor means, including, compacting said material into press-caked condition under sufficient pressure that said core is self-sustaining; and while said material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath.

8. The method of making a relatively long, relatively small cross-section, relatively thin and wide cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long, relatively small cross-section, relatively thin and wide cross-section, composite core, comprising embedding material and resistor means, including, compacting said material into press-caked condition under sufficient pressure that said core is self-sustaining; and while said material remains in said condition, inserting said core into a correspondingly relatively long, relatively small cross-section, relatively thin and wide cross-section, tubular sheath, endwise through an open end of said sheath.

9. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising resistor means and embedding material composed at least largely of particles of granular refractory electrical insulating material, including, compacting said embedding material into press-caked condition; and while said embedding material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath.

10. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising resistor means and embedding material composed at least largely of particles of granular refractory electrical insulating material, including, compacting said embedding material into press-caked condition; while said embedding material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath; and thereafter pressing said sheath to effect intimate heat conducting condition from said resistor means to said sheath.

11. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising resistor means and embedding material composed at least largely of particles of granular refractory electrical insulating material and bond material, including, compacting said embedding material into press-caked condition; while said embedding material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath; and thereafter setting said bond material.

12. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which com-

prises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising resistor means and embedding material composed at least largely of particles of granular refractory electrical insulating material and bond material, including, compacting said embedding material into press-caked condition; while said embedding material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath; and thereafter, pressing said sheath to effect intimate heat conducting condition from said resistor means to said sheath, and setting said material.

13. The method of making a relatively long, relatively small cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long and relatively small cross-section composite core comprising resistor means and embedding material composed at least largely of particles of granular refractory electrical insulating material, including, compacting said embedding material into press-caked condition under sufficient pressure that said core is self-sustaining; and while said material remains in said condition, inserting said core into a correspondingly relatively long and relatively small cross-section tubular sheath, endwise through an open end of said sheath.

14. The method of making a relatively long, relatively small cross-section, relatively thin and wide cross-section, tubular sheath, embedded resistor, electric element, which comprises: constructing a correspondingly relatively long, relatively small cross-section, relatively thin and wide cross-section, composite core, comprising resistor means and embedding material composed at least largely of particles of granular refractory electrical insulating material, including, compacting said embedding material into press-caked condition under sufficient pressure that said core is self-sustaining; and while said material remains in said condition, inserting said core into a correspondingly relatively long, relatively small cross-section, relatively thin and wide cross-section, tubular sheath, endwise through an open end of said sheath.

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