Jan. 4, 1927. 1,613,426

E. L. WIEGAND

PROCESS OF PRODUCING ELECTRICAL HEATING ELEMENT

Original Filed August 31. 1923

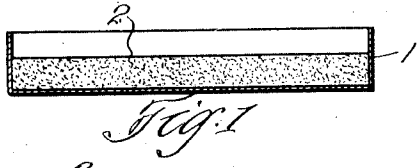


Fig. 1



Fig. 2

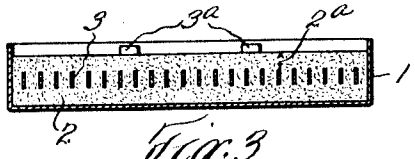


Fig. 3

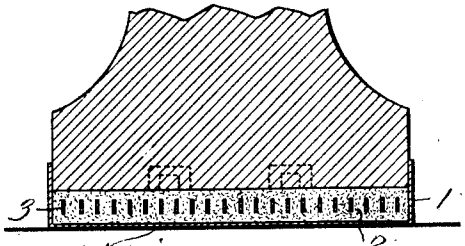


Fig. 4

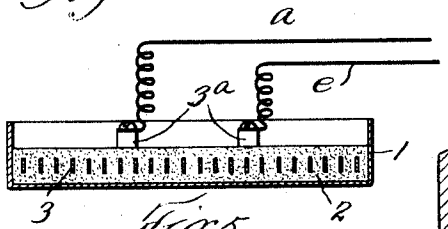


Fig. 5



Fig. 6

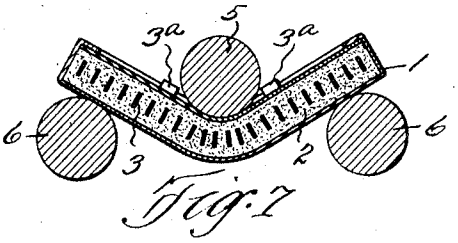


Fig. 7

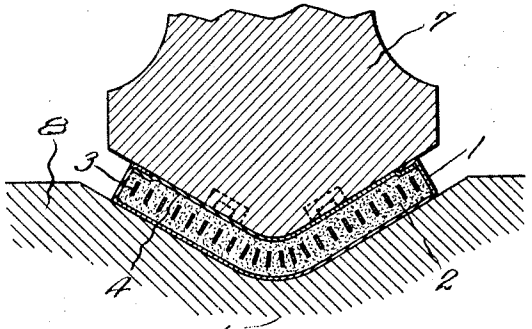
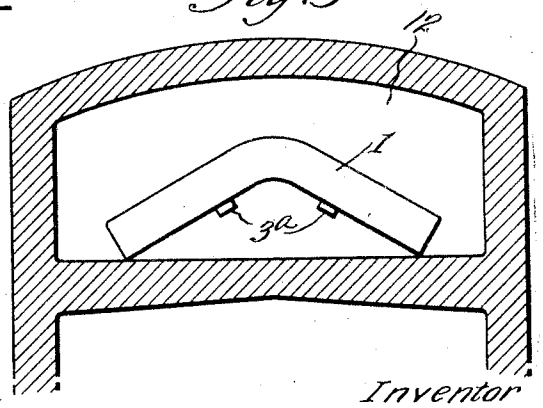


Fig. 8

Fig. 9



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UNITED STATES PATENT OFFICE.

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PROCESS OF PRODUCING ELECTRICAL HEATING ELEMENT.

Original application filed August 31, 1923, Serial No. 660,294. Divided and this application filed January 22, 1925. Serial No. 3,942.

This invention relates to a process of producing electrical heating elements of the sheathed class, the process and several modifications of the product being disclosed in my co-pending application Serial No. 660,294, filed August 31, 1923, and whereof this application is a division.

The object of the invention is to provide a process whereby sheathed electrical heating elements of a high quality may be conveniently and expeditiously produced in a very efficient manner and at a comparatively low cost.

In the drawing, Fig. 1 shows a sheet metal receptacle containing a quantity of impressionable or plastic refractory insulating material, thus illustrating the results of the first step of the process; Fig. 2 shows a resistor embedded within the refractory insulating material and illustrates another step in the process; Fig. 3 shows the results of the next step wherein additional insulating material is introduced into the casing; Fig. 4 is illustrative of the step wherein the material, with the resistor embedded therein, is highly compressed; Fig. 5 illustrates the drying step; Fig. 6 is illustrative of the step wherein a cover is applied and the edge wall of the receptacle turned over the periphery of the cover to clamp it in place; Fig. 7 shows the bending step of the process; Fig. 8 shows the step of compressing the element; and Fig. 9 is a sectional view of an oven with the element therein and is illustrative of the final drying or baking step.

In broad aspect, the invention consists in producing a sheathed electrical heating element by placing within a suitable receptacle a resistor that is enveloped in a mass of refractory insulating material and closing the receptacle. Then, if the use to which the element is to be put requires it, the element may be bent to a given shape. Before or after or in the absence of bending, the element may be compressed to compact the refractory insulating material and render more intimate its contact with all parts of the resistor and sheath.

The process, according to my present preference, is carried out, with optional alternation and omission of certain of the steps, depending upon the character and design of the element to be produced, in the manner illustrated in the drawing, by first introducing into a receptacle 1, as shown in Fig. 1, a mass of receptive refractory insulating material, designated 2, which may possess some degree of moisture. A class of material found especially suitable for the purpose is composed of magnesium or aluminum oxide or zirconium silicate, either individually where possible or a compound of them, together when desirable with a binding material such as clay to give the necessary plasticity during fabrication and to effect homogeneity in the final product.

I next emplace within this mass of refractory material a previously formed resistor 3 which may consist of a flat wire or ribbon of suitable resistance metal bent into a sinuous or serpentine formation (as will be seen by reference to my application above identified). This step, illustrated by Fig. 2, may be performed by means of the apparatus disclosed and claimed in any of my following Letters Patent: No. 1,133,347, dated March 30, 1915; No. 1,312,657, dated August 12, 1919; Reissue No. 15,479, dated October 24, 1922, and No. 1,476,126, dated December 4, 1923.

The third step consists in introducing additional refractory material, designated 2^a in Fig. 3, into the receptacle; and, as the fourth step, the material is compressed (Fig. 4) to a greater or less degree.

In most cases the insulating material, if it be moist is next dried. This may be accomplished by externally heating the element by suitable means, or by internally heating it by directing current through the resistor 3. Fig. 5 is illustrative of this step, the opposite sides of an electric circuit, represented by the conductor *a* and *b*, being connected to the resistor terminals 3^a.

The sheath is now completed by closing the open side of the receptacle as by means of a cover 4 and turning the edges of the side walls of the receptacle inwardly over the margin of the cover, this step being illustrated in Fig. 6.

As brought out in the application whereof this is a division, the heating elements disclosed in said application are capable of being bent into various shapes so as to suit them better to specific purposes. For example, the element may be formed to the contour of an object that is to be heated so

that it may be brought into intimate contact with the object throughout the entire area of its operating face and thus greatly enhance the efficiency of the element and reduce the operating temperature of the resistor by reason of the more rapid dissipation of the heat.

The bending of the element may be performed as the next step of the process. This step is conventionally illustrated in Fig. 7, where the element is shown as disposed between relatively movable abutments 5 and 6.

A further step, illustrated in Fig. 8, is the compressing of the element. This may be accomplished between the parts 7 and 8 of suitable pressing apparatus.

In some cases there is a final step of baking the element, and this is represented in Fig. 9 where the element is shown in an oven 12.

From the foregoing it will be seen that the process, in its preferred form, comprises all or a part of the following steps:

(*a*) Introducing into the receptacle a mass of refractory insulating material (Fig. 1);

(*b*) Embedding the resistor in the material (Fig. 2);

(*c*) Introducing additional material into the receptacle (Fig. 3);

(*d*) Moderately compressing the material (Fig. 4);

(*e*) Drying the material (Fig. 5);

(*f*) Closing the receptacle (Fig. 6);

(*g*) Bending the element, (Fig. 7);

(*h*) Compressing the element (Fig. 8); and

(*i*) Baking the element (Fig. 9).

Regardless of the size, shape and exact nature of the element that is to be produced, the first four steps of the process (*a* to *d* above and represented by Figs. 1 to 4) are preferably but not necessarily performed in the order named. In most cases the step (*e*) of drying the insulating material (Fig. 5) follows *d;* then comes the step (*f*) of closing the receptacle (Fig. 6) and, where the element is not to be bent, the step *f* is succeeded by the step (*h*) of compressing the element (Fig. 8), and this, of course, may be followed by the step (*i*) of baking the element if desired.

With respect to elements of large continuous area, such as those specifically claimed in my co-pending application above identified, and which are to be bent, the bending is done before final compressing. Also, in cases of this kind, where the cover or receptacle are perforated, as in certain modifications shown in my above mentioned applications, the insulating material is left moist until after the closing of the receptacle and the bending of the element, any vapor resulting from the drying of the material escaping through the perforations of the sheath.

In the case of strip type heaters and annular type heaters, with their various ramifications, shown and described in the above mentioned application, and in earlier divisions thereof bearing Serial Nos. 697,446, and 757,798, respectively, the element may be and preferably is bent after being otherwise practically completed. In other words, the insulating material may be dried and the element compressed, and then bent. After being bent, the element may again be compressed if such should be found necessary or desirable.

While I have described quite in detail a desirable form of the invention with certain optional variations, I have also included a broad analysis of the process, and I regard the scope of the invention as commensurate with this range of disclosure.

Having thus described my invention, what I claim is:

1. The process of producing an electrical heating element which comprises the steps of applying in a generally lateral direction to one part of a side opening sheet metal sheath a quantity of granular refractory electrical insulating material and a resistor, securing a complementary part to the former part of the sheath thereby to enclose said insulating material and resistor, and artificially compacting said insulating material.

2. The process of producing an electrical heating element which comprises the steps of applying in a generally lateral direction to one part of a side opening sheet metal sheath a quantity of granular refractory electrical insulating material and a resistor, securing a complementary part to the former part of the sheath thereby to enclose said insulating material and resistor, and compacting said insulating material by subjecting the element to pressure.

3. The process of producing an electrical heating element which comprises the steps of introducing in a lateral direction into a receptacle that is open along one side a quantity of refractory electrical insulating material and a resistor, applying a cover to the receptacle, securing the parts together by turning the edge portion of the peripheral wall of the receptacle over the margin of the cover, and compressing the element.

4. The process of producing an electrical heating element which comprises the steps of introducing into a comparatively shallow sheet metal casing through an open side thereof a quantity of granular refractory insulating material and a resistor, closing the receptacle, and artificially compacting said insulating material.

5. The process of producing an electrical heating element which comprises the steps of introducing into the open side of a relatively shallow sheet metal receptacle, a quantity of granular refractory electrical insulat-

ing material and a resistor, closing the open side of the receptacle, and compressing the element.

6. The process of producing an electrical heating element which comprises the steps of introducing in a generally lateral direction into a receptacle that is open on one side a quantity of granular refractory electrical insulating material and a resistor, closing the receptacle, and bending the element.

7. The process of producing an electrical heating element which comprises the steps of introducing in a generally lateral direction into a receptacle that is open on one side a quantity of granular refractory electrical insulating material and a resistor, closing the receptacle, bending the element, and compressing the element.

8. The process of producing an electrical heating element which comprises the steps of introducing in a lateral direction into a receptacle that is open along one side substantially from end to end a mass of plastic refractory material and a resistor embedded therein, drying the material, closing the receptacle, and compressing the element.

9. The process of producing an electrical heating element which comprises the successive steps of introducing in a generally lateral direction into a receptacle that is open on one side a mass of impressionable refractory material; embedding a resistor in said material; closing the receptacle, and compressing the element.

10. The process of producing an electrical heating element which comprises the successive steps of introducing in a generally lateral direction into a receptacle that is open on one side a mass of plastic refractory material; embedding a resistor in said material; drying the material; closing the receptacle, and compressing the element.

11. The process of producing an electrical heating element which comprises the successive steps of introducing in a generally lateral direction into a receptacle that is open on one side a mass of plastic refractory material; embedding a resistor in said material; drying the material; closing the receptacle; compressing the element, and baking the element.

12. The process of producing an electrical heating element which comprises the successive steps of introducing in a generally lateral direction into a receptacle that is open on one side a mass of moist receptive refractory material; embedding a resistor in said material; compacting the material; drying the same; closing the receptacle; and compressing the element.

13. The process of producing an electrical heating element which comprises the successive steps of introducing in a generally lateral direction into a receptacle that is open on one side a mass of moist receptive refractory material; embedding a resistor in said material; compacting the material; drying the same; closing the receptacle; and compressing and baking the element.

14. The process of producing an electrical heating element which comprises the steps of introducing in a generally lateral direction into a sheet metal receptacle that is open on one side a mass of receptive refractory material; embedding a resistor in said material; closing the receptacle; bending said element to a desired shape; compressing said element, and drying the element.

15. The process of producing an electrical heating element which comprises the steps of, first, introducing in a generally lateral direction into a sheet metal receptacle that is open on one side a mass of impressionable refractory material; second, embedding a previously formed resistor in said material; third, introducing additional refractory material into the receptacle, and, fourth, closing said receptacle and compressing said element.

16. The process of producing an electrical heating element which comprises the steps of, first, introducing into a sheet metal receptacle a mass of impressionable refractory material; second, embedding a previously formed resistor in said material; third, introducing additional refractory material into the receptacle; fourth, compressing said material in said receptacle to effect one integral homogeneous mass with the resistor completely encased therein, and fifth, closing said receptacle and compressing said element.

17. The process of producing an electrical heating element which comprises the steps of, first, introducing into a sheet metal receptacle a mass of moist impressionable refractory material; second, embedding a previously formed resistor in said material; third, introducing additional refractory material into the receptacle; fourth, compressing said material in said receptacle to effect one integral homogeneous mass with the resistor completely encased therein; fifth, drying the material; and sixth, closing said receptacle and compressing said element.

18. The process of producing an electrical heating element which comprises the steps of, first, introducing into a sheet metal receptacle a mass of impressionable refractory material; second, embedding a previously formed resistor in said material; third, introducing additional refractory material into the receptacle; fourth, compressing said material in said receptacle to effect one integral homogeneous mass with the resistor completely encased therein; fifth, closing said receptacle and compressing the element; and sixth, baking the element thus formed.

19. The process of producing an electrical

heating element which comprises the steps of, first, introducing into a sheet metal receptacle a mass of receptive refractory material; second, embedding a previously formed resistor in said material; third, introducing additional refractory material into the receptacle; fourth, compressing the said material in said receptacle; fifth, closing said receptacle; and sixth, bending said element to any desired shape and compressing said element.

20. The process of producing an electrical heating element which comprises the steps of, first, introducing into a sheet metal receptacle a mass of receptive refractory material; second, embedding a previously formed resistor in said material; third, introducing additional refractory material into the receptacle; fourth, compressing said material in said receptacle; fifth, closing said receptacle; sixth, bending said element to a desired shape and compressing said element, and seventh, drying said element.

21. The process of producing an electrical heating element which comprises the steps of, first, introducing into a sheet metal receptacle a mass of plastic refractory material; second, embedding a previously formed resistor in said material; third, introducing additional refractory material into the receptacle; fourth, compressing said material in said receptacle; fifth, drying said material, and sixth, closing said receptacle and compressing said element.

In testimony whereof, I hereunto affix my signature.

EDWIN L. WIEGAND.

DISCLAIMER

1,613,426.—*Edwin L. Wiegand*, Pittsburgh, Pa. PROCESS OF PRODUCING ELECTRICAL HEATING ELEMENT. Patent dated January 4, 1927. Disclaimer filed November 2, 1938, by the patentee; and the licensee, *Edwin L. Wiegand Company*.

Hereby enter this disclaimer:

A. To so much of claim 2 of said Letters Patent as may cover any process except for producing an extended-resistor sheet-metal-sheathed electrical heating element relatively thin and wide in cross section and having the resistor embedded in granular refractory electrical insulating material, or any process unless using a part that is relatively shallow channel shape in cross section, binder-containing electrical insulating material at least part of which is unintegrated and has the binder thereof unset, a resistor that is a resistance conductor arranged in a formation correspondingly relatively thin and wide in cross section, and a complementary part that is sheet metal, or any process except a process in which the quantity of electrical insulating material is applied through the open face of the part, securing the complementary part completes a sheet metal sheath relatively thin and wide in cross section enclosing the insulating material and the resistor, the pressure is in a direction generally perpendicular to the major cross-sectional dimension of the element, and subjecting the element to pressure re-forms the unintegrated material and forms the entire material into a compact mass embedding the resistor and in heat-conduction contact both with all parts of the surface of the conductor over substantially the entire length of the conductor and with all parts of the interior of the sheath over all parts of the exterior of the mass, or any process except for producing an element that subsequently is heated to set the unset binder.

B. To so much of claim 5 of said Letters Patent as may cover any process except: The process of producing an extended-resistor sheet-metal-sheathed electrical heating element relatively thin and wide in cross section and having the resistor embedded in granular refractory electrical insulating material, which comprises the steps of introducing into the open side of a relatively shallow sheet metal receptacle, a quantity of granular refractory electrical insulating material and a resistor composed of a resistance conductor arranged in a formation correspondingly relatively thin and wide in cross section, at least part of said material being unintegrated, closing the open side of the receptacle by adding a complementary sheet metal part completing a sheet metal sheath relatively thin and wide in cross section enclosing the resistor and the material, and compressing the element in a direction generally perpendicular to the major cross-sectional dimension thereof re-forming the unintegrated material and forming the entire material into a compact mass embedding the resistor and in heat-conduction contact both with all parts of the surface of the conductor over substantially the entire length of the conductor and with all parts of the interior of the sheath over all parts of the exterior of the mass.

C. To so much of claim 9 of said Letters Patent as may cover any process except: The process of producing an extended-resistor sheet-metal-sheathed electrical heating element relatively thin and wide in cross section and having the resistor embedded in granular refractory electrical insulating material, which comprises the successive steps of introducing in a generally lateral direction into a relatively shallow sheet metal receptacle that is open on one side, through the open face thereof, a mass of impressionable unintegrated granular refractory electrical insulating material containing unset binder; embedding a resistor in said material, said resistor being arranged in a formation correspondingly relatively thin and wide in cross section; closing the receptacle by adding a complementary sheet metal part completing a sheet metal sheath relatively thin and wide in cross section enclosing the resistor and the material, and compressing the element in a direction generally perpendicular to the major cross-sectional dimension thereof re-forming the unintegrated material, and heating the element and setting the unset binder.

[*Official Gazette December 6, 1938.*]