Dec. 13, 1938. E. L. WIEGAND 2,139,786

ELECTRICAL HEATING ELEMENT

Original Filed April 19, 1937

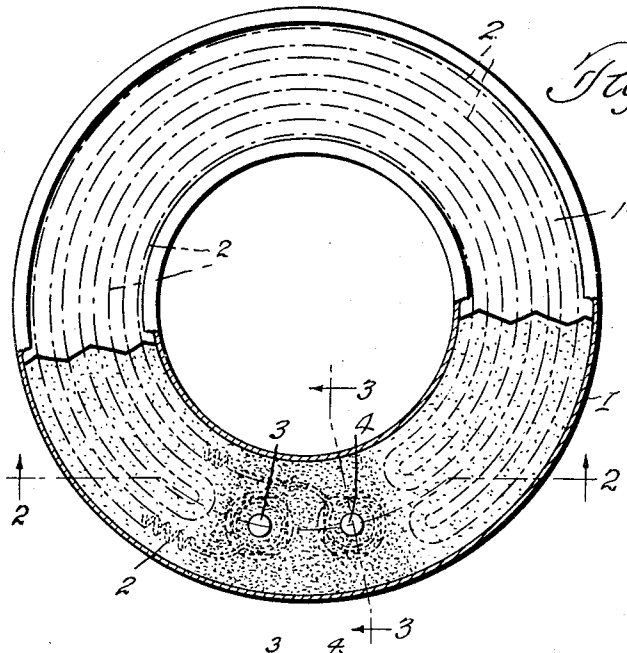

Fig. 1

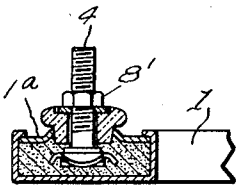

Fig. 3

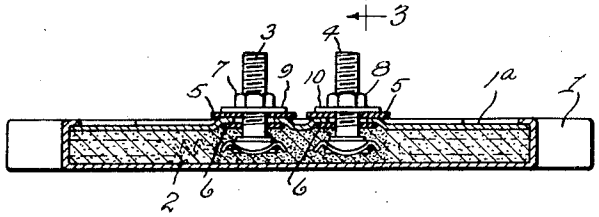

Fig. 2

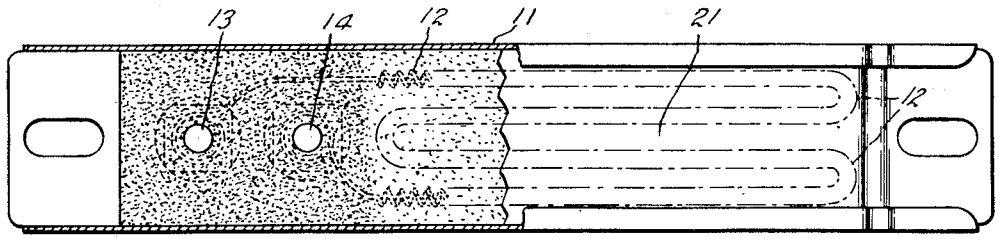

Fig. 4

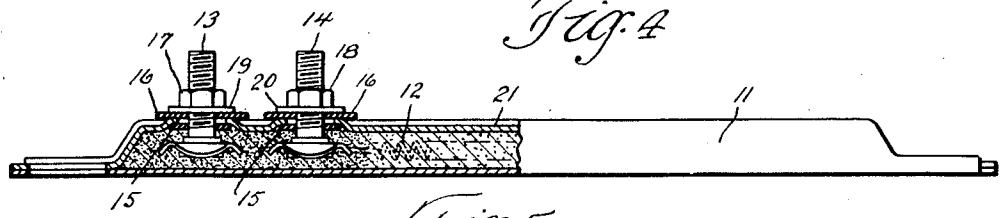

Fig. 5

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ELECTRICAL HEATING ELEMENT

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2 Claims. (Cl. 201—64)

This invention relates generally to electrical heating elements of the type wherein a resistor is enveloped or embedded in granular, ceramic or mineral refractory electrical insulation and to a method of making such an element. More specifically, the heating element preferably consists of a sheet metal sheath of any desired shape or configuration and which is preferably, though not necessarily, made up of a plurality of parts and in which is arranged a resistor which is insulated from the sheath by a mass of granular refractory insulating material which is compacted about the resistor, the resistor being provided with terminals which are accessible through an opening or openings in the sheath.

Heating elements of this general character are old in the art and disclosed in my prior Patents Nos. 1,613,426, 1,614,330 and 1,614,938. In these patents, the insulating materials referred to are magnesium or aluminum oxide, or zirconium silicate, or any one of them used either alone or together and with a binding material such as clay when desirable for any reason.

When a binding material such as clay is used in combination with refractory insulating material, the heat conducting and electrical insulating properties of the insulating material are affected, especially at high temperatures. The clay serves to form a filling and bond between the granules of insulating material. In many cases, it is desirable to reduce or to omit any permanent binder from the refractory material which surrounds the resistor or the high temperature zone of the heating element; although it is sometimes desirable to make use of a permanent bonding material in that portion of the heating element which contains the terminals so that the terminals may be wholly or partially embedded in the refractory material. The use of a bonded refractory insulating material immediately adjacent the terminals enables me to manufacture such heating element without securing the terminals solely to the sheath or otherwise before inserting the insulating material and also adapts the article to be produced by means of established processes and equipment. I also may use unbonded or underbonded or merely temporarily bonded refractory material in the resistor zone and may make such elements by the same process and with the same tools as are employed in handling a wholly bonded insulation and further permits the terminals to be conveniently brought out through the cover of the sheath without anchoring or securing the terminals exclusively to the sheath or to the cover portion thereof. However, it is entirely practical and feasible to use a temporary bonding material in the area immediately adjacent the terminals, if desired. By temporary binding material is meant a material which will be vaporized or destroyed when the element is heated to high temperature. The presence of the binding material is purely a mechanical desideratum either in respect to the completed article of manufacture or its intended shape or use or in the process of manufacture.

By using an unbonded or underbonded or temporarily bonded material in the heat zone I am able to secure higher electrical resistivity of the insulation on account of a lesser proportion of binding materials which are usually of less electrical resistivity at high temperature or on account of the binding material being merely temporary and not at all required as a mechanical desideratum in the finished product. Of course, in constructing such a heating element with unbonded or underbonded or temporarily bonded insulating material in the high temperature zone, it may, in some cases, be necessary to use more pressure in emplacing the resistor in the insulating material than would otherwise be required with bonded insulating material in order to adapt the units for economical commercial production. This is well understood by those skilled in this art. The amount of binding material may of course vary, depending upon the exigencies of the occasion. The compounding or mixing of the insulating material is a separate art the requirements of which vary with various types of heating elements depending upon the size, voltage, wattage, the type of resistor to be employed, and the use to which the element is to be put, so that the particular character of the binding material forms no part of this invention.

The main object of the invention, therefore, is to provide an electrical heating element and method of making the same which will retain the advantages and avoid the difficulties hereinbefore mentioned and in which the terminals are embedded in a body of insulating material of considerable mechanical value both during the process of manufacture and in the finished element and in which the resistor proper is enveloped in a mass of unbonded or underbonded or temporarily bonded refractory insulating material in the high temperature zone. It is of course understood that when a temporarily bonded refractory insulating material is used in the high temperature zone, the binder will be vaporized or driven off when the element is heated or baked so that

the high temperature zone of the finished element will contain no bonded insulating material, or only such remainder of the bonding material as is permanent.

Further and more limited objects of the invention will appear as the description proceeds and by reference to the accompanying drawing in which Fig. 1 is a top plan view with parts broken away of a ring type heating element embodying my invention; Fig. 2 is a sectional view on the line 2—2 of Fig. 1; Fig. 3 is a fragmentary detail view on the line 3—3 of Fig. 1 showing a molded or preformed insulator surrounding the terminal; Fig. 4 is a top plan view with parts broken away of an electric heating element of the strip type embodying my invention; and Fig. 5 is a view partly in side elevation and partly in section of the strip heater shown in Fig. 4.

Referring now to the drawing, my improved heating element consists essentially of a sheet metal sheath or casing 1 which is annular in shape and in which is arranged the electrical resistor 2 in the form of a helical coil disposed and arranged within the sheath, as shown most clearly in Fig. 1. The opposite ends of the coiled resistor are connected with terminals 3 and 4. The sheath is closed by means of a cover plate 1a, the upper edges of the sheath being bent over the cover plate as shown in Fig. 2. The terminals project through openings provided in the cover plate and are insulated therefrom by mica washers 5, 6 one of which is disposed inside and one of which is disposed outside the cover plate. The terminals are secured to the sheath by means of nuts 7 and 8 which bear against metal washers 9 and 10, respectively. The head portions of the terminals are somewhat enlarged and are shaped as shown in Figs. 1 and 2. Both the resistor and the terminals are embedded in a mass of refractory insulating materials which serves to insulate the resistor from the sheath.

While I do not wish to limit myself to any particular kind of refractory insulating material, I prefer to use a stable crystalline material such as zirconium silicate. The insulating material immediately adjacent the terminals preferably has admixed therewith a small amount of binding material, such as clay, which serves to bond the particles of insulating material together and to form a mass having considerable mechanical stability adjacent the terminals which serves to assist in supporting the terminals both in the process of manufacture and in the finished heating element. The insulating material in the high temperature or resistor zone of the heating element is preferably the same basically and is free from any permanent binding material or it may have a small amount of permanent binding material when a binding material is required because of the conditions of use or manufacture.

In Fig. 3 there is disclosed a terminal which is surrounded by a preformed insulator which is secured to the sheath by a nut 8'.

In Figs. 4 and 5 there is disclosed a heating element of the strip type which consists essentially of a sheet metal sheath 11 in which is arranged a resistor 12 which is preferably formed of helically wound nickel chrome wire the opposite ends of which are attached to terminals 13 and 14. The resistor and terminals are preferably enveloped by or in refractory insulating material such as zirconium silicate. The insulating material immediately adjacent the terminals preferably contains about 15% to 25% by weight of suitable binding material, such as clay, which serves to bond the particles of insulating material together and to increase the stability of the terminals both during the process of manufacture and in the finished product. The insulating material in the high temperature zone of the heating element or adjacent the resistor is preferably unbonded or underbonded mineral refractory insulating material such as zirconium silicate which is highly compacted. The terminals are preferably insulated from the sheath by means of mica washers 15 and 16 and are held in place by means of nuts 17 and 18 and washers 19 and 20. The sheath is closed by means of a cover plate 21 which is held in place by means of the turned-over edges of the sheath.

In both the ring type and strip type of heating elements, the element is subjected to a high pressure which serves to highly compact the insulating material about the resistor and terminals. Both types of elements herein described are preferably, though not necessarily, made according to the process disclosed in my prior patents hereinbefore referred to. The terminals and the resistor are preferably embedded within the insulating material simultaneously. The heavily stippled portions in the drawing indicate bonded refractory insulation while the lighter stippled portions indicate unbonded, or underbonded or temporarily bonded insulation.

While I prefer to use an insulating material in the high temperature zone of the heating element which has no binding material, I may use a ceramic or mineral refractory insulating material which contains only a very slight amount of binder such as seven and one-half percent to twelve and one-half percent by weight or which contains merely a temporary binder which will be vaporized when the element is heated or baked. Such an element may be formed by the same process and with the same tools as are employed in handling the fully bonded insulating material and further enables the terminals to be conveniently brought out through the cover of the sheath without anchoring or securing the terminals exclusively to the sheath or cover, although this may be partly or entirely accomplished after the assembly of the heating element. It is entirely feasible and practical to use a temporary binder merely for the purpose of facilitating manufacture or handling of the refractory material in a given process of fabrication. Where only a very small amount of binder is used or where a temporary binder is used in the high temperature zone, it may be necessary to use more pressure than is necessary in emplacing the resistor than would be required in case fully bonded insulating material is used. This pressure however depends upon the plasticity and holding action of the insulating material adopted and inasmuch as various mixes may be used and various types of resistors employed in elements of various sizes and shapes and for different conditions of use as to temperature and mechanical conditions, the matter must be left to skill and judgment in each case. If a permanent binder of reduced relative weight or volume is used together with some temporary binder, the element may be baked out before closing, thus facilitating expulsion of the temporary binder while the resistor is still held by the permanent binder sufficiently to enable the completion of the element, after which the refractory is held together against disintegration or shifting by the combined action of the sheath and the binder remaining.

In manufacturing the element, I preferably embed or envelop the resistor and terminals within a sheath in a mass of refractory insulating material. That portion of the insulating material adjacent the terminals preferably contains a small amount of permanent binder such as clay and that portion of the insulating material adjacent the resistor contains either a temporary binder such as tragacanth, or is free from any binder or it may contain a temporary binder or a much reduced amount of permanent binder. The sheath is then closed preferably by means of a cover plate having one or more openings therein through which the terminals extend and the unit so formed is highly compacted. The element is then baked or it may, if moist, be first dried and then baked. The element may also be bent or shaped either before or after being baked, depending upon the particular character of the element. The baking serves to mature that portion of the insulating material containing the permanent binder and to destroy the temporary binder, if any has been used.

It will now be clear that I have provided an electrical resistor heating element and method of making the same which will accomplish the objects of the invention as hereinbefore stated. In the specification and claims I have referred to granular refractory insulating material. By that term I mean to include not only the specific materials herein mentioned but also any suitable ceramic or mineral insulating material which may be pulverulent, granular, powdered or comminuted and which may be used either wet or dry and with or without a temporary or permanent binder and which may be compressed into a mass having considerable mechanical stability, if desired.

It is therefore to be understood that the embodiment of the invention herein disclosed is to be considered merely as illustrative and not in a limiting sense as the invention is not limited to any particular form of insulating material, resistor or binder, and that various changes may be made in the details of construction as well as in the specific method of making the element without departing from the spirit of my invention as the invention is limited only in accordance with the scope of the appended claims.

This application is a division of my application Serial No. 137,642, filed April 19, 1937.

Having thus described my invention, what I claim is:

1. An electrical heating element of the character described comprising a sheet metal sheath in which is arranged a resistor and terminals, the terminals being accessible through one or more openings in the sheath, a highly compacted mass of refractory insulating material enveloping said resistor and terminals, the insulating material adjacent the terminals containing a binder and being compacted into a bonded mass having sufficient mechanical stability to rigidly support the terminals, the insulating material in the region of the resistor differing from the insulating material in the region of the terminals in the amount or character of binding material contained therein and having substantially less mechanical stability and higher heat conducting properties and higher electrical resistivity than the insulating material in the region of the terminals, the entire mass of insulating material being homogeneous and highly compacted.

2. An electrical heating element of the character described comprising a sheet metal sheath in which is arranged a resistor and terminals, the terminals being accessible through one or more openings in the sheath, a highly compacted mass of refractory insulating material enveloping said resistor and terminals, the insulating material adjacent the terminals containing a binder and being compacted into a bonded mass having sufficient mechanical stability to rigidly support the terminals, the insulating material in the region of the resistor differing from the insulating material in the region of the terminals in the amount or character of binding material contained therein and having substantially less mechanical stability and higher electrical resistivity than the insulating material in the region of the terminals, the entire mass of insulating material being homogeneous and highly compacted.

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