June 29, 1943. B. HORSFIELD 2,323,089

ELECTRICAL HEATING ELEMENT

Filed July 25, 1940

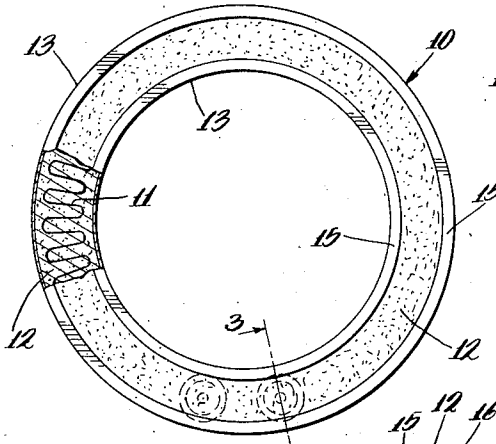


Fig. 1.

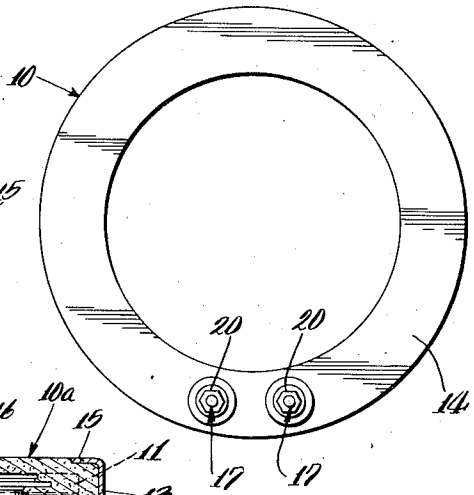


Fig. 2.

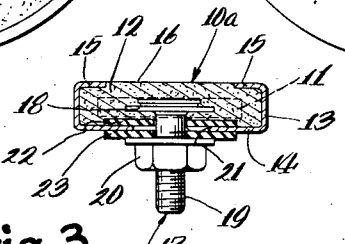


Fig. 3.

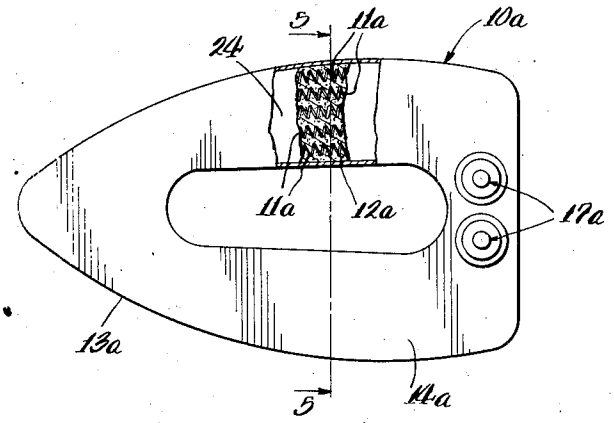


Fig. 4.

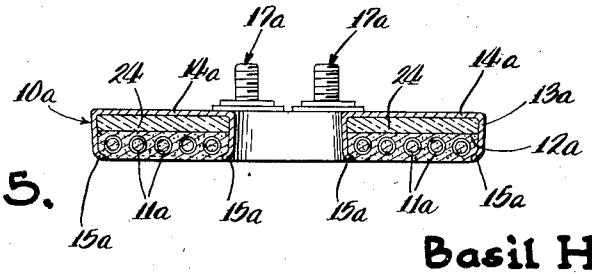


Fig. 5.

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ELECTRICAL HEATING ELEMENT

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17 Claims. (Cl. 201—64)

My invention relates to electrical heating elements of the type comprising a resistor disposed in and insulated from a metallic sheath. The principal object of my invention is to provide new and improved electrical heating elements of said type.

In the drawing accompanying and forming a part of this application, I have shown, for purposes of illustration, several forms of electrical heating elements of the aforesaid type, and in this drawing:

Figure 1 is a plan view of an open face type heating element of annular form,

Figure 2 is a plan view of the opposite side of the heating element shown in Figure 1,

Figure 3 is a section taken on the line 3—3 of Figure 1,

Figure 4 is a plan view, partly broken away, of another form of open face heating element, and

Figure 5 is a section taken on the line 5—5 of Figure 4.

The heating element illustrated in Figures 1, 2, and 3 comprises a sheet metal sheath 10. The sheath 10 is of annular form and has disposed therein a resistor 11 suitably insulated from the sheath 10 by insulating material 12. The resistor 11 is here shown as made of material of ribbon form, bent to sinuous form, but it will be apparent to those skilled in the art that it may be made of other forms of electric resistance material, wound or bent in other ways.

The sheath 10 is here shown as comprising a sheet metal annular channel 13 providing an annular plane wall 14, the other side of the channel being left open, except that, desirably, relatively small marginal portions 15 of the sides of the channel are bent over the insulating material. The surface 16 of the insulating material 12 is accordingly left exposed and, if desired, may be brought into direct contact with the part to be heated.

The heating element is provided with terminals in the form of studs 17 having any suitable form of heads 18, the shanks 19 of the studs being desirably threaded to receive nuts 20. The wall 14 has apertures 21 through which the shanks 19 are disposed, and the shanks are suitably insulated as by mica washers 22, 23. The ends of the resistor 11 are suitably connected to the studs 17 respectively.

One way of constructing the heating element illustrated in Figures 1, 2, and 3 is as follows. The resistor 11 and studs 17 are supported on a suitable tool or form (not shown) analogous to the tool shown in the patent to Wiegand 1,133,347, March 30, 1915, the tool, of course, having a resistor-supporting part which is of such shape and size that it will fit into the channel 13. The resistor 11, desirably arranged on and carried by the tool, is introduced into an open channel, such as 13 before the margins 16 are bent, the channel 13 being partly filled to a predetermined level with insulating material which, whether it is mixed with a binder or not, is in a plastic, plastoid, or impressionable condition, and consequently the resistor becomes embedded in the insulating material. The tool is then withdrawn, leaving the resistor 11 embedded in the insulating material. Additional insulating material is then introduced in the channel 13, over the embedded resistor, and the insulating material may then be compressed to a desired thickness. The margins 16 are bent over, and the element subjected to high pressure to compact the insulating material. The element may be subjected to various drying or baking steps, or both, at various intermediate stages of manufacture, and as a final treatment if desired.

Figures 4 and 5 show a heating element of the general type shown in Figures 1, 2, and 3, but of a shape adapted for use particularly for the heating of sole plates or flat irons. The element here shown comprises a sheath 10a of the general shape of a sole plate, having disposed therein a resistor 11a suitably insulated from the sheath by insulating material 12a. The resistor is here shown as made of helically wound wire, but may be of any other form. The sheath 10a comprises a sheet metal channel 13a providing a plane wall 14a, the other side of the channel being left open. Here too, margins 15a of the sides of the channel are desirably slightly bent over the insulating material 12a. The element is provided with terminal studs 17a similar to the terminal studs 17 of the element of Figure 1.

The resistor 11a may be looped back and forth within the sheath 10a any desired number of times, to provide any desired number of strands, and its ends are suitably connected to the terminal studs 17a respectively. The element may be made in a manner similar to that stated in connection with Figure 1.

The element shown in Figures 4 and 5 may be cemented into a recess in a sole plate, as described in the patent to Wiegand 1,994,676, March 19, 1935. If desired a member of heat-insulating material 24 may be interposed between the insulated resistor 11a and the wall 14a.

The body of insulating material embedding the resistor of the heating elements must of course

be refractory, and it is desirable that as the chief component of the body of insulating material a material be selected that has suitable properties, as, for example, zircon (zirconium silicate), or any other refractory material having suitable electrical-insulating properties, desirably of mineral character, and desirably having good heat-conducting properties. In the manufacture of the type of heating elements herein shown, a desired amount of clay or other bonding material may be mixed with the principal material so as to give a desired workability to the mass of insulating material during certain stages of the process of manufacture and, in general, to give the body of insulating material in the various stages of manufacture, and in the finished element, desired mechanical characteristics, but certain aspects of my invention are not limited to the use of bonding material.

I have found that the use of mullite as a component of the body of insulating material gives excellent results. Mullite is produced by concentrating the mineral kyanite to a high degree of mineral purity, this being then leached with sulphuric acid to remove the iron oxide in the crevices of the crystals. The material is then calcined at a temperature sufficient to convert the kyanite crystal into a mullite crystal. There is no appreciable difference of composition but merely one of crystal form. Mullite may be obtained in a size —35 mesh and is a rather coarse granular aggregate containing however all of the fines produced during manufacture. The grains of mullite have a slightly porous surface.

I prefer to use mullite in combination with a granular heat-conducting electrical-insulating material which is of a hardness greater than mullite. For example, mullite is softer than zircon and, therefore, allows the zircon to become embedded more or less in the mullite under high pressure. This results in a hard solid cake. Preferably, the harder of the component materials is of a smaller mesh size than the softer material. It will be apparent that the principle of the embedding of a harder grain in a softer grain is applicable whether or not a bonding material is used in addition. Furthermore, because of this principle, if a bonding material is used less is required.

By way of example of a mixture utilizing a bonding material, I may use approximately 16.1% mullite, 65.8% zircon, and 18.1% clay or kaolin. The zircon component of this mixture may to advantage comprise different portions of zircon of different mesh size, for example 42.8% unground zircon of —60 mesh, and 23.0% ground zircon of —200 mesh, the mullite being of —35 mesh size.

Because of the slightly porous nature of the surface of the mullite grains, this material is particularly advantageous where it is used with a bonding material.

The foregoing mixtures are particularly advantageous in the making of electrical heating elements of the open face type herein illustrated, in which the results are very satisfactory both in mechanical workability in the assembly operations, and in the mechanical and electrical characteristics of the finished element. The material does not stick to dies used in the process of manufacture, and the resultant cake is of the desired hardness and avoids difficulties hitherto experienced in the crumbling and cracking of the cake after baking, particularly on high temperature tests. The percentages of the ingredients are of course subject to variation, but I have given those approximate percentages which I have found to give the best results.

While I have given particular mixtures which are especially adapted for use in the open face type of electrical heating elements, it will be apparent to those skilled in the art that the principles of my invention may be applied in other embodiments in other types of electrical heating elements.

When a bonding material such as clay is used, and the best insulating properties are desired, I prefer to use kaolin. Alkalis may be in the clay as a residue of decomposition of the granites, feldspars, or other minerals in the material from which the clay has been kaolinized. I prefer that the alkali content of the clay or kaolin be low, preferably 0.25% or less. Preferably the calcium oxide content also should be low. Furthermore, as clays contain mica, free silica, and other minerals, they often have to be washed and separated from these impurities. In the washing treatment of the clay no chemicals, basic or acid, should be used for agglomeration or dispersion as these are absorbed to some extent, and in clay for the present purpose they are detrimental impurities. After the washing treatment, the material is dried and pulverized to a substantially uniform fineness of air-float size.

In general, in a body of insulating material embodying my invention and comprising a bonding material, such as clay, for example, the clay will of course be hardened somewhat by the baking or other heat treatment hereinbefore referred to, but the heat treating temperatures need not be higher than approximately 1200° F. and, in any event, are kept below the vitrification temperature of the clay, or other bonding material, so that in the completed heating element the body of insulating material is an unvitrified refractory body. The operating temperature of the heating element, that is, the temperature of the heating surface or sheath of the element when the element is operating at full capacity, may be much higher than the temperatures used in the heat treatment but should be below the vitrification temperature of the bonding material.

From the foregoing it will be apparent to those skilled in the art that each of the disclosed embodiments of my invention provides a new and improved electrical heating element, and accordingly, each accomplishes the principal object of my invention. On the other hand, it also will be obvious to those skilled in the art that the disclosed embodiments of my invention may be variously changed and modified, or features thereof, singly or collectively, embodied in other combinations than those disclosed, without departing from the spirit of my invention, or sacrificing all of the advantages thereof, and that accordingly, the disclosure herein is illustrative only, and my invention is not limited thereto.

I claim:

1. An electrical heating element, comprising: a metallic sheath; a resistor in said sheath; and a body of insulating material in said sheath electrically insulating said resistor from said sheath, said body of material comprising approximately 16% mullite of approximately —35 mesh size, approximately 66% zircon of approximately —60 mesh size, and approximately 18% clay.

2. An electrical heating element, comprising: a metallic sheath; a resistor in said sheath; and

a body of insulating material in said sheath electrically insulating said resistor from said sheath, said body of material comprising approximately 16% mullite of approximately —35 mesh size, approximately 43% zircon of approximately —60 mesh size, approximately 23.0% zircon of approximately —200 mesh size, and approximately 18% clay.

3. An electrical heating element, comprising: a metallic sheath; a resistor in said sheath; and a body of insulating material in said sheath electrically insulating said resistor from said sheath, said body of material comprising a selected granular heat-conducting electrical-insulating refractory material and mullite, mixed in the proportion of approximately one part mullite to four parts of said granular heat-conducting electrical-insulating refractory material, said mullite comprising grains of larger mesh size than said selected material, and said selected material being harder than said mullite.

4. An electrical heating element, comprising: a metallic sheath; a resistor in said sheath; and a body of insulating material in said sheath electrically insulating said resistor from said sheath, said body of material comprising zircon and mullite, mixed in the proportion of approximately one part mullite to four parts of zircon, said mullite comprising grains of larger mesh size than said zircon.

5. An electrical heating element, comprising: a metallic sheath; a resistor in said sheath; and a body of insulating material in said sheath electrically insulating said resistor from said sheath, said body of material comprising approximately 16% mullite, approximately 66% zircon, and approximately 18% clay, said mullite comprising grains of larger mesh size than said zircon.

6. An embedded-resistor electric heating element comprising a body of embedding material a major percentage of which is granular electrical-insulating refractory material approximately 7 to 30% of which is mullite.

7. An embedded-resistor electric heating element comprising a body of embedding material a major percentage of which is granular electrical-insulating refractory material the major percentage of which is appreciably harder than mullite and approximately 7 to 30% of which is mullite.

8. An embedded-resistor electric heating element comprising a body of embedding material a major percentage of which is granular electrical-insulating refractory material the major percentage of which is zircon and approximately 7 to 30% of which is mullite.

9. An embedded-resistor electric heating element comprising a body of embedding material a major percentage of which is granular electrical-insulating refractory material approximately 20% of which is mullite.

10. An embedded-resistor electric heating element having a body of embedding material comprising a major percentage of granular electrical-insulating refractory material and a minor percentage of bonding material, together with mullite in a percentage to appreciably decrease cracking under heat.

11. An embedded-resistor electric heating element having a body of embedding material comprising a major percentage of granular electrical-insulating refractory material appreciably harder than mullite, and a minor percentage of bonding material, together with mullite in a percentage to appreciably decrease cracking under heat.

12. An embedded-resistor electric heating element having a body of embedding material comprising a major percentage of zircon and a minor percentage of bonding material, together with mullite in a percentage to appreciably decrease cracking under heat.

13. An embedded-resistor electric heating element having a body of embedding material comprising a major percentage of granular electrical-insulating refractory material and a minor percentage of bonding material, together with mullite of appreciably larger average grain size in a percentage to appreciably decrease cracking under heat.

14. For use in an embedded-resistor electric heating element, an embedding material comprising a major percentage of granular electrical-insulating refractory material and a minor percentage of bonding material, together with mullite in a percentage to appreciably decrease adhesion to pressing dies or the like.

15. For use in an embedded-resistor electric heating element, an embedding material comprising a major percentage of granular electrical-insulating refractory material appreciably harder than mullite, and a minor percentage of bonding material, together with mullite in a percentage to appreciably decrease adhesion to pressing dies or the like.

16. For use in an embedded-resistor electric heating element, an embedding material comprising a major percentage of zircon and a minor percentage of bonding material, together with mullite in a percentage to appreciably decrease adhesion to pressing dies or the like.

17. For use in an embedded-resistor electric heating element, an embedding material comprising a major percentage of granular electrical-insulating refractory material and a minor percentage of bonding material, together with mullite of appreciably larger average grain size in a percentage to appreciably decrease adhesion to pressing dies or the like.

BASIL HORSFIELD.