Sept. 28, 1943. E. L. WIEGAND 2,330,652

ELECTRICAL HEATING ELEMENT

Filed June 27, 1940

Fig. 1.

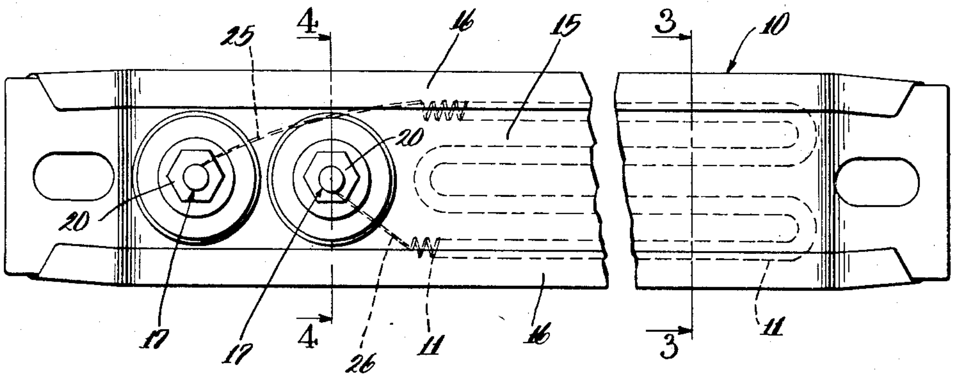


Fig. 2.

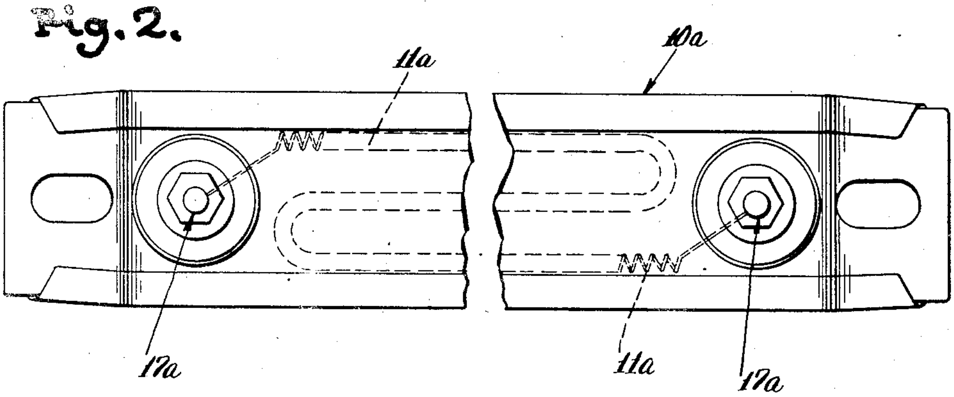


Fig. 3.

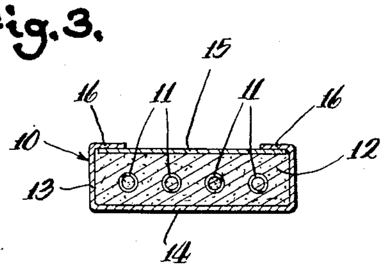
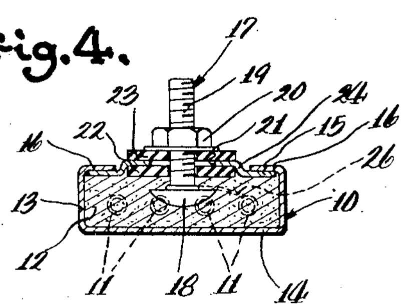


Fig. 4.



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2,330,652

ELECTRICAL HEATING ELEMENT

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13 Claims. (Cl. 201—67)

My invention relates to electrical heating elements 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:

Figures 1 and 2 are fragmentary plan views of strip types of heating elements, and

Figures 3 and 4 are sections taken on the lines **3—3** and **4—4** respectively of Figure 1.

The heating element illustrated in Figures 1, 3, and 4 comprises a sheet metal sheath **10** here shown as of elongated rectilinear form. The sheath **10** has disposed therein a resistor **11** suitably insulated from the sheath by insulating material **12**. The resistor **11** is here shown as made of helically wound wire, 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 channel **13** of elongated rectilinear form providing a plane wall **14**, and a sheet metal cover plate **15**, the marginal portions **16** of the sides of the channel **13** being bent or crimped over the cover plate **15**.

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 cover plate **15** has apertures **21** through which the shanks **19** are disposed, and the shanks are suitably insulated as by mica washers **22**, **23**.

In Figure 1 the studs **17** are shown as mounted side-by-side in suitably spaced relation, at one end of the heating element, and the cover plate **15** may have an embossed portion **24** in the region of the studs **17**.

The ends **25**, **26** of the resistor **11** are suitably connected to the studs **17** respectively, the intermediate helical portion of the resistor being disposed longitudinally of the sheath **10** and looped back and forth a desired number of times so as to provide a desired number of strands, in this instance four in number, it being understood that the number of strands may be of any other number. The extremities of the sheath **10** contain no insulating material and are pressed flat so as to close the ends of the sheath, as is well understood in the art.

One way of constructing the heating element illustrated in Figures 1, 3, and 4 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, 1935, 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**, carried by the tool, is introduced into an open coverless channel, such as **13** before the margins **16** are crimped, 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 **11** 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, over the embedded resistor, and the insulating material may then be compressed to a desired density. The cover **15** and washers **22** being applied, the margins **16** are crimped over the cover, and the element subjected to high pressure to compact the insulating material **12**. The element may be subjected to various drying or baking steps, or both, at various intermediate stages of manufacture, before and after the cover is applied, and as a final treatment if desired.

Figure 2 shows another strip heating element which is similar to the heating element shown in Figures 1, 3, and 4 except that the element of Figure 2 has terminal studs **17***a* disposed at opposite ends of the sheath **10***a*, and a resistor **11***a* which provides three strands of resistor instead of four as in the case of Figures 1, 3, and 4. The resistor **11***a* is embedded in insulating material in the same way as described in connection with Figures 1, 3, and 4. The terminal studs **17***a* may of course be disposed at any other desired location.

The body of insulating material **12** 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.

Hitherto in the use of naturally granular material, such as zircon for example, only natural grain zircon has been used. By this I mean the natural zircon obtained by removing the impurities such as ilmenite, monazite, and perhaps other foreign materials from commercial zircon concentrates. The more usually obtainable natural grain zircon may be screened through a 60 mesh screen. Very little, if any, of this material will pass through a 200 mesh screen, the bulk of the material lying between 100 and 120 mesh size. These figures are given merely by way of one example and not limitation. Different sources of zircon may provide natural grain zircon of different screen analysis.

I have found that by using ground zircon, and more particularly by using zircon grains of different sizes, of controlled mesh analysis, an improved body of insulating material may be produced. Among other things, the puncture or breakdown voltage at operating temperature is higher than when natural grain material only is used. The improved results are not dependent upon the exclusive use of zircon, and beneficial results may be obtained with other suitable granular refractory electrical insulating material. Furthermore, while a strip type of heating element has been illustrated, my invention is not limited to that type but may be embodied in any type of heating element as will be apparent to those skilled in the art.

I may use ground zircon alone, where a bonding material or other component is not necessary, or in combination with another material or materials. For example, I may mix the ground zircon with talc or with clay or with both clay and talc. When clay is used I prefer to use kaolin. Ball or semi-ball clays may also be used, and in some instances may be used in combination with kaolin as will appear.

Natural grain zircon desirably may be put through grinding apparatus of impact type, for example, to secure an aggregate containing a desired amount of fines of desired mesh size. One suitable aggregate contains 25% of −200 mesh size. In general, it appears that the fines tend to fill the voids between the larger grains in a body of insulating material comprising such an aggregate. Furthermore, substantially all of the grains above 200 mesh size become more or less chipped in the grinding process, so that the particles of the aggregate mesh together more securely in a compacted body of insulating material made therefrom. A ground aggregate may be selected containing fines of smaller mesh size, for example, −400 mesh. The percentage of fines may be selected as desired. My invention is not limited to particular sizes of fines or percentages of fines these depending upon the characteristics desired in the resultant body of insulating material.

A suitable mixture containing a bonding material and talc is approximately as follows:

I

	Per cent
Zircon, comprising 25% of −200 mesh size	75.8
Kaolin	18.2
Talc	6.0

For certain purposes a ground aggregate is used in combination with unground natural grain material. The combination may comprise approximately 20% to 80% or more of unground zircon, for example, the remainder of the combination being a ground zircon aggregate of desired screen analysis. These selected combinations of zircon of different screen analysis may be used alone where a bonding material or other component is not necessary, or as components of mixtures containing one or more other components, such as a bonding material or talc or a bonding material and talc. The following mixtures containing a bonding material and talc may be given as typical:

II

	Per cent
Zircon comprising 28% of −200 mesh	20.2
Zircon comprising 22% of −200 mesh	40.5
Natural grain zircon, −60 mesh size	15.1
Kaolin	18.2
Talc	6.0

III

	Per cent
Zircon comprising 50% of −200 mesh	14.9
Natural grain zircon, −60 mesh	59.7
Kaolin	15.5
Ball clay (Paris White Top)	2.4
Talc	7.5

IV

	Per cent
Zircon comprising 77% of −400 mesh	10.4
Natural grain zircon, −60 mesh	64.2
Kaolin	15.5
Ball clay (Paris White Top)	2.4
Talc	7.5

It will be understood that any selected one of these mixtures is introduced into the sheath of the heating element to embed the resistor, in a suitably moist condition, and when dried and baked produces a mechanically strong cake which also conducts heat rapidly. Furthermore, in drying, these mixtures will not shrink as much as in mixtures containing only unground zircon.

Mixtures I through IV are particularly adapted for use in the making of strip type heaters, but are not limited to that use. Mixtures III and IV are preferred where uniform lack of shrinkage is important, particularly in the drying of the material in the channel 13 before the cover 15 is applied. In these mixtures the Paris White Top ball clay may be replaced by any ball clay having desirably low shrinkage, particularly in drying.

When a bonding material such as clay is used, better results are obtained if certain requirements are observed. For example, alkalies may be in 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.

When talc is used I prefer to use an electrical insulator grade of talc or steatite. It is of course understood that talc when heated or burned is converted into steatite. The talc desirably should be low in lime and alkali salts, and should burn satisfactorily. A pure dead white talc which is white-burning is preferred. A talc which contains a considerable percentage of magnetic material and iron oxide will burn a light brown and such a talc, while it may be used, is not as good as white-burning talc. The talc used in mixtures embodying my invention is desirably finely ground.

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 embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of granular electrical-insulating heat-conducting refractory material, and the granular refractory content of which consists at least 10% of impact-chipped particles of granular refractory material.

2. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of granular electrical-insulating heat-conducting refractory material of hardness at least approximately 6 Mohs, and the granular refractory content of which consists at least 10% of impact-chipped particles of granular refractory material.

3. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of zircon, and the zircon content of which consists at least 10% of impact-chipped particles.

4. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of zircon, and the zircon content of which consists at least approximately 20% of natural grain zircon and at least 10% of impact-chipped particles.

5. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of granular electrical-insulating heat-conducting refractory material, and the granular refractory content of which consists at least 10% of impact-chipped particles of granular refractory material having a minus 200 mesh content approximately 5 to 25% of said granular refractory content.

6. An embedded-resistor electric heating element having a body of eelctrical insulation consisting at least approximately two-thirds of particles of zircon, and the zircon content of which consists at least approximately 20% of natural grain zircon and at least 10% of impact-chipped particles having a minus 200 mesh content approximately 5 to 25% of said zircon content.

7. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of granular electrical-insulating heat-conducting refractory material, comprising also binding material uniting said particles, and the granular refractory content of which consists at least 10% of impact-chipped particles of granular refractory material.

8. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of granular electrical-insulating heat-conducting refractory material, comprising also binding material uniting said particles, and the granular refractory content of which consists at least 10% of impact-chipped particles of granular refractory material having a minus 200 mesh content approximately 5 to 25% of the granular refractory content.

9. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of granular electrical-insulating heat-conducting refractory material of hardness at least approximately 6 Mohs, and the granular refractory content of which consists at least approximately 20% of natural grain granular refractory material and the remainder ground granular refractory material having a minus 200 mesh content approximately 5 to 25% of said granular refractory content.

10. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of granular electrical-insulating heat-conducting refractory material of hardness at least approximately 6 Mohs, and the granular refractory content of which consists at least approximately 20% of natural grain granular refractory material and at least 10% of ground granular refractory material having a minus 200 mesh content approximately 5 to 25% of said granular refractory content.

11. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of zircon, and the zircon content of which consists at least approximately 20% of natural grain zircon and at least 10% of ground zircon having a minus 200 mesh content approximately 5 to 25% of said zircon content.

12. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of granular electrical-insulating heat-conducting refractory material of hardness at least approximately 6 Mohs, comprising also binding material uniting said particles, and the granular refractory content of which consists at least approximately 20% of natural grain granular refractory material and at least 10% of ground granular refractory material having a minus 200 mesh content approximately 5 to 25% of said granular refractory content.

13. An embedded-resistor electric heating element having a body of electrical insulation consisting at least approximately two-thirds of particles of zircon, comprising also binding material uniting said particles, and the zircon content of which consists at least approximately 20% of natural grain zircon and at least 10% of ground zircon having a minus 200 mesh content approximately 5 to 25% of the zircon content.

EDWIN L. WIEGAND.