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HEATING ELEMENT

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FIG. 1

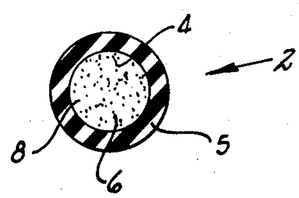
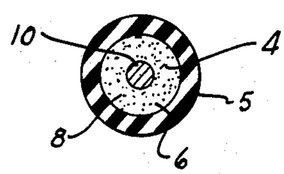


FIG. 2



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HEATING ELEMENT

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This invention relates to an electrical resistance heating element, useful for example as the heat source in an electric blanket.

Objects of the invention are to provide an electrical resistance element wherein:

(1) The heat output of the element is automatically regulated without using any extraneous thermostat mechanisms, and

(2) The element is capable of formation by low cost extrusion processes.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

Fig. 1 is a sectional view through a resistance heating element constituting one embodiment of the invention.

Fig. 2 is a sectional view through a second embodiment of the invention.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

In Fig. 1 of the drawings there is shown a resistance heating element **2** including a core or strand of partially conductive material **4** and a covering of dielectric material **5**. The term "partially conductive" is used to indicate a material wherein a portion of the material is a conductor of electricity and another portion is a non-conductor of electricity. The conductor portion comprises finely divided conductive particles **6**, and the non-conductive portion comprises a dielectric thermally expansible material **8**.

Particles **6** are thoroughly mixed or dispersed in material **8** so as to define a number of electrically conductive paths through core **4**. The conductive particles may be formed of different materials, as for example carbon, a metal such as copper or aluminum, silicon, silicon carbide, lead sulfide, iron sulfide or molybdenum sulfide. I have found carbon in the form of carbon black to be most suitable.

The volumetric proportions of conductive particles **6** and expansible material **8** vary somewhat depending on the nature of the conductor and its particle size. Metals, in particle sizes larger than about 40 microns, for example, preferably comprise about 75 percent of the core volume. In the case of carbon black, in particle size of about 20–500 millimicrons, the conductor preferably occupies about 40 percent of the core volume.

Although, as indicated, I may use relatively larger particle sizes (e. g. 40 microns) in relatively higher volumetric proportion (e. g. 75 percent), I have found that the most suitable compositions are those which include a more finely divided conductor (e. g. 20–500 millimicrons) in a relatively smaller proportion (e. g. 40 percent). It is probably for this reason that carbon black has been found to be the most suitable conductor. In addition to its contribution in the form of small particles, carbon black has stability at high temperatures and proper resistance at low concentration.

The purpose of thermally expansible material **8** is to (1) spread conductive particles **6** apart as the temperature of core **4** is increased, and (2) thereby increase the resistance of core **4** to current flow. The increased resistance is effective to choke off the current through core **4** so as to regulate the heat output at a desired maximum value. The thermally expansible, non-conductive material may be formed of different materials, as for example waxes, paraffin, polyethylene or polysiloxane. The term "thermally expansible material" will be understood to refer to a material which undergoes a substantial increase in its volumetric displacement when its temperature is increased. The term "non-conductive" will be understood as being used in a relative sense to indicate a material having substantially greater resistance to current flow than the dispersed conductive particles, it being appreciated that the "non-conductive" material conducts small quantities of electricity but offers a higher resistance to its passage than the conductive particles.

Covering **5** may include one or more dielectric materials, as for example a coating of nylon immediately adjacent core **4** and an outer coating of polyethylene or rubber for moisture resistance. Core **4** may be formed by a low cost extrusion operation and cut to desired length after application of covering **5**.

Operation of the Fig. 1 element is such that when element **2** is first connected into an electrical circuit particles **8** are quite close together so as to form a great number of conductive paths through material **4**. Continued current flow through material **4** heats up expansion material **8**. Material **8** is thereby expanded so as to spread particles **6** apart. Spreading of particles **6** apart increases the effective resistance of material **4** to current flow and thereby regulates the current and wattage through the element. As a result the heat developed by the current flow is regulated at a desired maximum value in accordance with the transition temperature range of the particular material chosen for material **8**. It will be understood that different ones of the expansion materials undergo the major portions of their expansions at different temperatures or different temperature ranges. The higher the expansion temperature of a given expansion material the greater will be the regulated heat output of the resistance element. Of course the length and cross sectional area of the element will also be factors in determining the total heat output.

It is contemplated that a plurality of resistance elements, each containing a different expansion material, could be incorporated into a heating blanket or other heating device. By connecting the various elements to different ones of the terminals on a conventional multi-step switch different heat levels may be obtained in accordance with the switch setting.

The Fig. 2 construction is in many respects similar to the Fig. 1 construction, and similar reference numerals are employed wherever applicable. The essential difference between the Fig. 1 construction and the Fig. 2 construction is that the Fig. 2 construction includes a continuous length of conductive high resistance wire **10**, preferably formed of Nichrome. The purpose of wire **10** is to provide for continued current flow in the event that broken spots or gaps should be formed in material **4**. Preferably the diameter of the wire is so chosen that the resistance of the wire is more than the cold temperature resistance of material 4. By using a relatively thin high resistance wire the heat output of the wire can be held at a minimum and the action of material 4 whereby its resistance increases with temperature increase can be retained. Wire **10** can be economically incorporated into the element by utilizing wire **10** as the core around which material 4 is extruded during formation of the element.

I claim:

1. An electrical resistance element comprising a wire-like strand of partially conductive material; said strand of material being formed of solid, finely divided electrically conductive particles dispersed in a softenable thermally expansible dielectric material; and a covering of solid sealing material surrounding said strand, said covering material being a non-conductor of electricity; whereby the finely divided particles are caused to develop heat during the passage of an electric current, with said thermally expansible dielectric material undergoing a volumetric expansion so as to increase the spacing between adjacent ones of the finely divided particles in such manner as to control current flow through the strand and thereby limit its heat output.

2. The combination of claim 1 wherein the conductive particles are carbon.

3. The combination of claim 1 wherein the expansible material is polyethylene.

4. The combination of claim 1 wherein the finely divided particles are of a particle size in the range of about 20 millimicrons to about 40 microns, and the finely divided particles occupy between 40% and 75% of the partially conductive material volume.

5. The combination of claim 1 wherein the finely divided particles have a particle size of about 40 microns, and the finely divided particles occupy about 75% of the partially conductive material volume,

6. The combination of claim 1 wherein the finely divided particles have a particle size in the range of about 20–500 millimicrons, and the finely divided particles occupy about 40% of the partially conductive material volume.

7. The combination of claim 1 wherein the finely divided particles are carbon black having a particle size in the range of about 20–500 millimicrons; the finely divided particles occupy about 40% of the partially conductive material volume; and the thermally expansible material is polyethylene.

8. An electrical resistance element comprising a wire-like strand of partially conductive material; said strand of material being formed of solid finely divided electrically conductive particles dispersed in a softenable thermally expansible non-conductive material; a continuous strand of conductive-resistive material extending along the partially conductive material; said conductive-resistive material having a higher electrical resistance than the partially conductive material; and a covering of solid sealing material surrounding said partially conductive material; said covering material being a non-conductor of electricity; whereby the finely divided particles are caused to develop heat during the passage therethrough of an electric current, with said thermally expansible material undergoing a volumetric expansion so as to increase the spacing between adjacent ones of the finely divided particles in such manner as to control current flow through the strand and thereby limit its heat output.

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