

[54] **PROCESS FOR THE MANUFACTURE OF FLAT HEATING CONDUCTORS AND FLAT HEATING CONDUCTORS OBTAINED BY THIS PROCESS**

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[58] Field of Search.....**338/210, 211, 212, 214, 322; 174/121 R; 29/610, 611**

[56]

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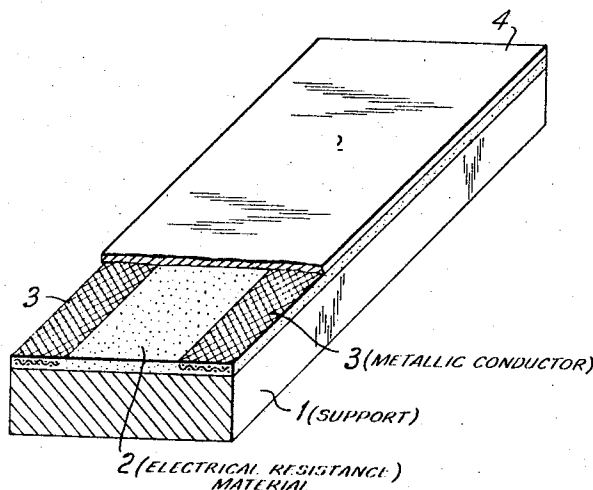
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ABSTRACT

In the manufacture of a flat heating conductor, i.e., an electrical resistance heating element, at least two metallic conductors are embedded in a layer of a film-forming plastics dispersion which has been filled with carbon black, whereupon the plastics dispersion is dried.

10 Claims, 3 Drawing Figures



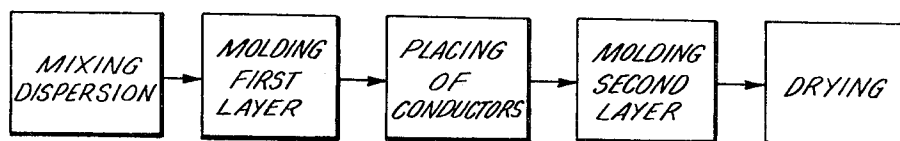
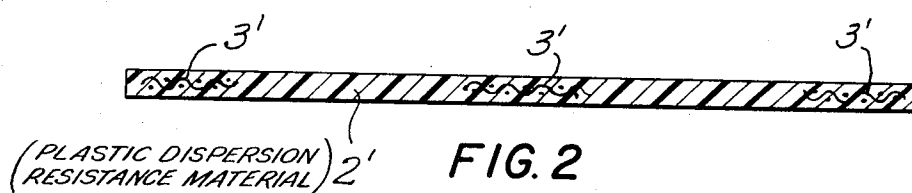
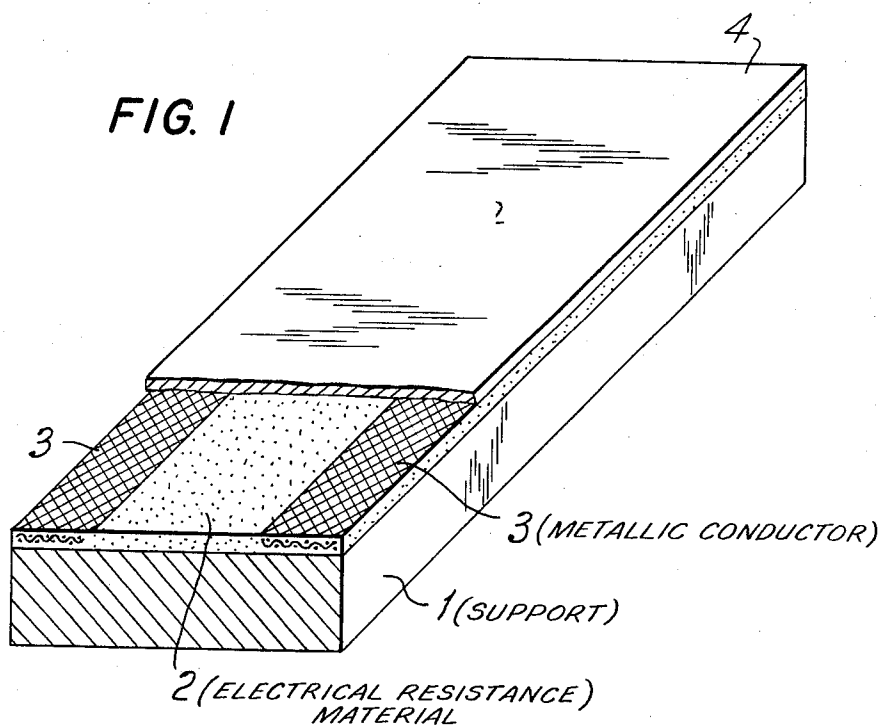


FIG. 3

PROCESS FOR THE MANUFACTURE OF FLAT HEATING CONDUCTORS AND FLAT HEATING CONDUCTORS OBTAINED BY THIS PROCESS

The present invention relates to a process for the manufacture of flat heating conductors and flat heating conductors obtained by this process.

There are known flat heating conductors comprising a fabric or a fleece of textile fibers or glass fibers, on to which carbon has been applied in the form of carbon black or graphite by means of a plastics dispersion or a varnish-like binder. The electrical supply leads are clamped in the form of strips to the edge of the support. In this method the relatively high contact resistance, which produces local overheating, is disadvantageous as well as the fact that the bond strength of the conductive carbon layer decreases upon use. Moreover, the heating conductors cannot readily be adapted to any object to be heated, and the heat transfer occasionally leaves something to be desired.

Now I have found a process for the manufacture of flat heating conductors (also known as electrical resistance heating elements) which enables the flat heating conductors to be adjusted exactly to the object to be heated.

The process according to the invention consists in embedding at least two metallic conductors in a layer of a film-forming plastics dispersion which has been filled with carbon black, whereupon the dispersion is dried.

Fundamentally, a heating conductor is obtained with any type of a carbon black. It was found, however, that for the purpose of the present invention it is most advantageous to use a carbon black which has been obtained by thermal splitting of acetylene. Other types of carbon black when added to the dispersion in the same amounts impart to the heating conductors resistances which are appreciably higher.

When the flat heating conductors according to the invention are applied to a surface they need no special reinforcement. For the manufacture of self-supporting flat heating conductors according to the process of the invention, however, it has proved useful to add short textile fibers, for example, 3 mm to 5 mm long polyester- or polyamide fibers, to the plastics dispersion filled with carbon black.

According to the process of the invention flat heating conductors can be produced directly on the objects to be heated, for example in the form of coatings. In the form of, for example, adhesives for floor coverings, the flat heating conductors may also simultaneously serve as floor heaters. The flat heating conductors may on the surface be provided with a coat of unpigmented dispersions or with a coat of dispersions containing colored pigments (but in a manner such that the dispersions are non-conductive) and are thus electrically insulated.

However, it is also possible to make self-supporting flat heating conductors. To this effect a mold, to whose surface the plastics dispersion does not adhere, is filled with the dispersion to about half the thickness desired. The necessary metallic supply leads are inserted into this layer, and then the mold is filled up with the dispersion until the desired thickness is obtained. The dispersion must then be dried. To this effect it may be heated, in which case care has to be taken that blisters do not

form owing to the evaporation of the water. The heating conductor sheets so obtained are mechanically very stable.

As metallic supply leads there may fundamentally be used wires. However, it has proved especially useful to manufacture the metallic supply leads from fine-meshed screen cloth or wire netting. As material there may be used any type of metal whose electric resistance is low enough. However, aluminum should not be used when there is a possibility that the heating conductors become moist. Copper has proved most useful as a conductive material, the contact resistance in copper being especially low.

The quadratic resistance of the flat heating conductors of the invention depends on different factors. It increases as the sheet thickness decreases and decreases as the content of carbon black increases. On the other hand, it is almost independent of the temperature, and that within a range of from -195° to $+200^{\circ}\text{C}$. A break in the heater in the direction of the current flow does not alter the resistance. When the break occurs vertically to the current flow, the resistance increases but regains its original value after short heating to about 100°C .

The essential elements of the invention are illustrated in the accompanying drawing wherein:

FIG. 1 is a view in perspective of a supported heating conductor; and

FIG. 2 is a view in cross-section through a self-supporting heating conductor,

FIG. 3 is a flow diagram of one method of forming the heating conductors of the present invention.

Referring to FIG. 1, a conductor is illustrated as mounted on a suitable support 1, such as a wall panel, the conductor 2 being provided with a plurality of metallic conductors 3 covered with a cover layer 4 such as wallpaper. The self-supporting heating conductor shown in FIG. 2 consists essentially of a plastic dispersion 2' containing a conductive material such as carbon black and having embedded therein a plurality of strips of metallic conductors 3', e.g., in the form of wire mesh.

The electrical and mechanical properties of the novel flat heating conductors will be shown in the examples following hereunder.

EXAMPLE 1

The specimens were obtained in the following manner:

From

150 parts by weight of a plastics dispersion having a solids content of 50 percent (copolymer of vinyl acetate and dibutyl maleate)

10 parts by weight of carbon black and/or graphite

10 parts by weight of 3 to 5 mm long polyester fibers which had been tempered at 150°C

a homogeneous mass was prepared, with agitation.

As indicated schematically in FIG. 3, the mass was filled into a flat polyethylene mold so as to form a 1 mm thick layer. Two strips of a copper cloth (200 meshes) were inserted into this layer at a distance of 50 mm in a parallel direction to one another whereupon the mold was filled up with the mass until the layer had a thickness of 2 mm. Then the mass was allowed to dry overnight.

As carbon black there were used a furnace carbon black from crude oil, a German gas carbon black and a carbon black obtained by thermal splitting of acetylene. With the use of the latter carbon black a quadratic resistance of 600 ohms was measured. With all other types of carbon black, as well as with graphite and ground charcoal, quadratic resistances above 100 kilohm were obtained when applying the same amounts as in the case of acetylene carbon black. EXAMPLE 2

Dependence of the power input on the filling of carbon black.

The following values were measured in flat heating conductors (dimensions: 50 × 50 × 2 mm), prepared as described above:

ratio solids content of the dispersion : carbon black obtained from acetylene	power input watt/sq.m./40 volts
10 : 1	1280
12.5 : 1	800
15 : 1	150

EXAMPLE 3

Flat heating conductor as floor heater.

A 1 mm thick coat of a dispersion of vinyl acetate/dibutyl maleate was applied to a concrete slab (dimensions: 300 × 300 × 20 mm). Then strips of a copper cloth having a width of 5 mm (200 meshes) were inserted at a distance of 60 mm from one another, and a 1 mm thick coat of the dispersion was applied thereto. The dispersion contained 8 percent by weight (calculated on the solids content) of carbon black obtained from acetylene. A slab (300 × 300 mm) of a needle felt carpet was placed onto the wet adhesive. After drying the heating conductor received 200 watt/sq.m. with the use of a voltage of 17 volts. The temperature in the joint was 21° C above room temperature when the concrete slab was placed on a 20 mm thick sheet of polystyrene rigid foam. When the sheet lying on a wooden board was covered with a similar sheet of rigid foam, the temperature in the joint was 35° C above room temperature.

EXAMPLE 4

Flat heating conductor as street heater.

An electric band heater, prepared in the manner described in Example 1 from a dispersion of vinyl acetate/dibutyl maleate containing 8 percent by weight (calculated on the solids content of the dispersion) of carbon black obtained from acetylene and having the dimensions 300 × 6 × 0.2 cm, was installed in a street beneath a 2 cm thick bituminous carpeting. With the use of a voltage of 30 volts, the band heater was supplied with a current of 3.4 amperes. The following temperatures were measured on a winter-day:

air	-7° C
street surface	-4° C
heated street surface	+2° C
band heater	+13° C

At the date when the application was filed, the band heater had lain for a period of about 10 weeks in a much frequented street beneath a factory gate without having sustained damage.

The novel flat heating conductors afford a wide range of application. They may be used as self-supporting elements for heating streets footpaths, staircases, entrances of garages and the like. They may, furthermore, be employed as coats of paint or adhesives in housing schemes for floor, wall or ceiling heaters. They have proved useful preferably as coats of paint for heating boilers and pipes.

Finally it is possible to manufacture heating mats according to the process of the present invention, which mats may be employed to protect goods susceptible to freezing in the open air or, for example, as floor heaters in tents, caravans or barracks.

I claim:

1. The process for manufacturing electrical resistance heating elements comprising the steps of preparing a liquid plastic dispersion including vinyl acetate, dibutyl maleate and carbon black, molding said dispersion into a predetermined configuration, embedding at least two metallic conductors in said dispersion in spaced relation to each other and thereafter drying said dispersion.

2. The process as defined in claim 1 wherein said dispersion preparing step includes the step of mixing said dispersion in a homogeneous mass including 150 parts by weight of a copolymer of said vinyl acetate and dibutyl maleate, having a 50 percent solids content, and 10 parts by weight of said carbon black.

3. The method as defined in claim 2 wherein said mixing step includes adding 10 parts by weight of fibers to said homogeneous mass, said fibers being selected from the group consisting of polyesters and polyamides.

4. The method as defined in claim 3 wherein said carbon black is obtained by thermal splitting of acetylene.

5. The process for manufacturing electrical resistance heating elements comprising the steps of preparing a liquid plastic dispersion including vinyl acetate, dibutyl maleate, carbon black, obtained by thermal splitting of acetylene, and cut polyester fibers, placing a first layer of said dispersion in a mold having a predetermined configuration, placing at least two metallic conductors on the upper surface of said layer, in spaced relation to each other, thereafter embedding said conductors in said dispersion by placing a second layer of said dispersion in said mold over said conductors and said first layer and drying said dispersion layers with said conductors embedded therebetween.

6. An electrical resistance heating element comprising a sheet of plastic dispersion formed essentially of vinyl acetate and dibutyl maleate filled with carbon black, and at least two metallic conductors embedded in said sheet between opposed surfaces thereof.

7. An electrical resistance heating element as defined in claim 6 wherein said carbon black is obtained by thermal splitting of acetylene.

8. An electrical resistance heating element as defined in claim 7 including fiber cuttings mixed in said dispersion, said fibers being selected from the group consisting of polyesters and polyamides.

9. An electrical resistance heating element as defined in claim 8 wherein said metallic conductors are formed of fine-meshed screen cloth.

10. An electrical resistance heating element as defined in claim 9 wherein said dispersion includes 150

parts by weight of a copolymer of said vinyl acetate and dibutyl maleate, 10 parts by weight of said carbon black, and 10 parts by weight of said fibers.

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