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(54) A FLEXIBLE HEATING SHEET AND A PROCESS FOR ITS MANUFACTURE

(71) We, BALAMUNDI GENVAL, a body corporate, organised under the laws of Belgium, of 18, rue de Rixensart, 1320 Belgium, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to a flexible heating sheet containing a charge of electrically conductive particles and a binder applied to a flexible support and to a process for the manufacture of such a sheet. In such a heating sheet, the conductive particles incorporated in the binder form a conductive layer through which current can pass.

A sheet of this kind is known in which the binder used to bind the conductive particles together is an amylaceous or siliceous substance such as starch or a silicate. It has been found, however, that if such a sheet has a thickness greater than about 30 to 40 microns, it becomes brittle, is liable to rot if exposed to moisture and breakdown of the conductivity of the whole structure is thus caused.

It has been proposed to improve the flexibility of the heating sheet by using as a binder a latex which is flocculated with the conductive particles. However, the layer of floccules obtained has a heterogeneous texture so that the conductivity of the sheet is irregular, giving rise to heating zones of different temperatures.

An objectof the present invention is to provide a flexible heating sheet which does not have these disadvantages, and a process for its manufacture.

According to the invention there is provided a process for the manufacture of a flexible heating sheet, wherein a paste containing at least 70% by weight of an electrically conductive particulate material in an aqueous solution of from 3% to 10% dry weight cationic polyamine polyelectrolyte binder is prepared, the paste is applied to a flexible support, and the paste is dried.

The invention further provides a flexible heating sheet comprising a flexible support carrying a layer containing electrically conductive particles and a cationic polyamine polyelectrolyte binder.

It was surprising to find the properties of the flexible binder of the polyamine polyelectrolyte even when mixed with a predominating quantity of conductive particles such as carbon powder, and its capacity of ensuring that the conductivity of the mixture is evenly distributed when the mixture is applied to a support.

The electrically conductive material preferably consists of carbon powder.

The polyamine polyelectrolyte is preferably a quaternised polyethylene imine having two different alkyl groups on the nitrogen atoms.

The paste may be applied to a flexible support which is covered with a layer of adhesive capable of improving the adherence of the conductive layer to the support.

An insulating layer capable of receiving a decorative surface is advantageously also applied to the electrically conductive layer.

The flexible sheet may be rolled or stamped to bring the conductive particles closer together.

In the accompanying drawings:–

Figure 1 is a schematic sectional view through an embodiment of a flexible heating sheet according to the invention without bus bars:

Figure 2 is a schematic view in perspective, partly broken away, of a heating sheet according to the invention provided with bus bars; and

Figure 3 is a schematic view in perspective, showing the sheet fixed to a support and provided with beading covering the bus bars.

The sheet shown in Figure 1 comprises a flexible support 1, for example of paper, a plastics material or a non-woven fabric, weighing about 100 g/m^2. One side of this support is covered with a layer of glue 2 for fixing it to a wall or the like while the other side is also covered with an adhesive 3 (40g/m^2) provided to improve the subsequent attachment of a layer of conductive material 4 applied to this support. This conductive layer consists of a paste composed at least 70% by dry weight of particles of carbon powder and an aqueous solution of from 3 to 10% by dry weight of a binder consisting of a cationic polyamine polyelectrolyte which binds the particles together. This paste is prepared in a mixer provided with a Cowles type mixing wheel with cutting blades rotating at the rate of about 2730 revs/min. The mixture of polyelectrolyte previously dissolved in water is introduced into the mixer, graphite powder is added and the mixer is rotated for 12 mins. The pH of the paste is 1.34. The paste obtained is then thinned with water to a final concentration of dry matter of 42% and viscosity of 260 poises. The carbon power has a particle size of between 10 and 100 microns and is preferably composed of a mixture of particles of from 10 to 40 microns in proportions of 40% and 60% by weight, respectively.

The paste obtained is then applied by means of an air knife to the paper support, which has previously been covered with 40 g/m^2 of glue, to form on this support a film of material 4 weighing 50 to 100 g/m^2, preferably 90 g/m^2. On this layer of conductive material there is then applied a layer of insulating material 5 of aqueous polyvinyl acetate emulsion weighing 35 g/m^2 dry.

In one modification, instead of or in addition to a layer of aqueous polyvinyl acetate, there is applied a sheet of paper or film of thermoplastic material 6 the internal surface of which is covered with particles of glue (or size) while the internal surface may be decorated.

According to another variation represented in Figure 2, the conductive paste 4, instead of being spread out in the form of a film, is distributed in parallel lines spaced apart so that the protective sheet or layer may subsequently be glued to the parts situated between the lines of carbon particles, thereby ensuring firmer adherence between the layers by direct contact of sheet against sheet. The whole arrangement may be provided with a decorative or plain aluminium sheet 7 which may be connected to earth when the paper is placed in position to ensure the safety of the product in use.

The composite sheet thus formed is stamped or rolled between pressure rollers under a linear pressure of from 150 to 200 kg/cm to join the conductive particles together and improve the conductivity of the conductive layer.

When the composite sheet has been constructed as described above, its two opposite ends are fitted with bus bars 9 and 10 based on copper powder applied by pressure. These bus bars are spaced apart from each other by distances which may vary according to the different current intensities one wishes to obtain from a given voltage.

The bus bars are secured, as shown in Figure 2, by detaching the layers of metal 7, paper 6 and insulation 5 along a strip about 2 cm in height from the layer of carbon particles and fixing the bus bars to this layer of clips. The beading 11 fixed to the ceiling and floor cover the bus bars and insulate them, as shown in Figure 3.

The bus bars are connected by wires 12 and 13 to the terminals of a source of current via a contact thermostat and a switch (not shown).

WHAT WE CLAIM IS:–

1. A process for the manufacture of a flexible heating sheet, wherein a paste containing at least 70% by weight of an electrically conductive particulate material in an aqueous solution of from 3% to 10% dry weight of a cationic polyamine polyelectrolyte binder is prepared, the paste is applied to a flexible support, and the paste is dried.

2. A process according to Claim 1, wherein the electrically conductive material is carbon powder.

3. A process according to Claim 2, wherein carbon powder has a particle size of between 10 and 100 microns.

4. A process according to Claim 3, wherein the carbon powder consists of a particle size mixture of 20 and 40 microns in proportions of 40% by weight 60% by weight, respectively.

5. A process as claimed in any of Claims 1 to 4 wherein the polyamine polyelectrolyte is a quaternised polyethylene imine having two different alkyl groups on the nitrogen atoms.

6. A process according to any preceding claim, wherein the paste is applied to a flexible support sheet, which support sheet is covered with a layer of adhesive capable of improving the bond of the conductive layer to its support.

7. A process according to Claim 6, wherein the flexible sheet is previously covered with adhesive on its free surface.

8. A process according to Claim 6 or 7, wherein the flexible sheet is rolled or stamped to bring the conductive particles closer otogether.

9. A process according to any one of Claims 6 to 8, wherein the flexible sheet is rolled or stamped after application of an insulating layer to the electrically conductive layer.

10. A process according to any one of Claims 1 to 5, wherein an insulating layer capable of receiving a decorative surface is applied to the electrically conductive layer.

11. A process according to Claim 9 or 10, wherein the insulating layer is an aqueous polyvinyl acetate emulsion.

12. A process according to any one of the Claims 9, 10 or 11, wherein a layer of metal is applied to the insulating layer covering the conductive layer in order to earth the sheet.

13. A process according to any one of Claims 9 to 12, wherein an electrically conductive bus bar is interposed between the layer of conductive particles and the insulating layer at the two opposite ends of the sheet.

14. A process for the manufacture of a flexible heating sheet, substantially as herein described with reference to the accompanying drawings.

15. A flexible heating sheet comprising a flexible support carrying a layer containing electrically conductive particles and a cationic polyamine polyelectrolyte binder.

16. A sheet according to Claim 15, wherein the polyamine polyelectrolyte is a quaternised polyethylene imine having two different alkyl groups on the nitrogen atoms.

17. A sheet according to Claims 15 or 16, which comprises a layer of adhesive between the support and the layer of electrically conductive particles.

18. A sheet according to Claim 17, wherein the adhesive is a polyvinyl acetate.

19. A sheet according to any one of Claims 15 to 18, further comprising an insulating layer covering the layer of electrically conductive particles.

20. A sheet according to Claim 19, which comprises, on the insulating layer, a metal film provided with means for connection to earth.

21. A flexible heating sheet substantially as herein described with reference to the accompanying drawings.

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1587279 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

FIG. 1

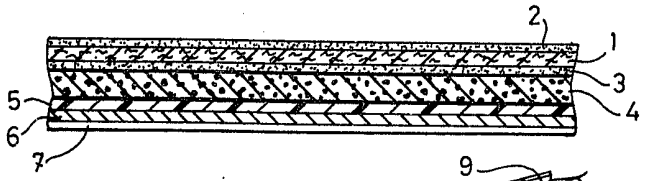

FIG. 2

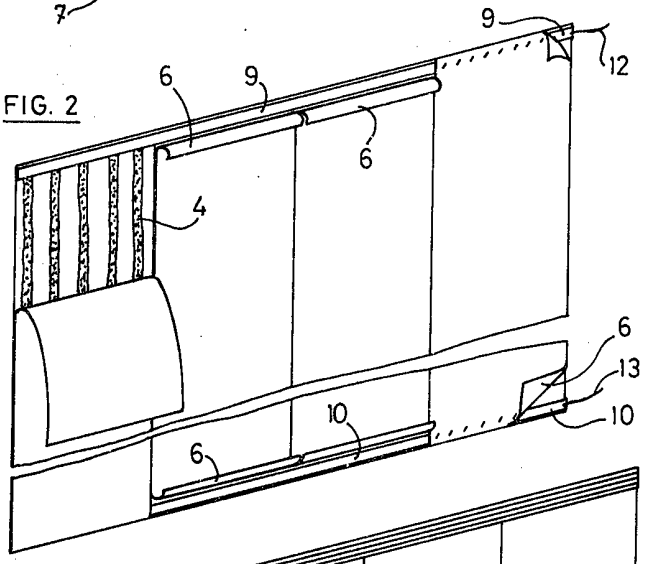

FIG. 3