United States Patent

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[33] **Great Britain**
[31] **16,881/69;**
June 6, 1969, Great Britain, No. 28,775/69

[54] **ELECTRICAL HEATING ELEMENTS**
7 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **219/529,**
219/212, 219/544, 219/549, 252/502, 260/502
[51] **Int. Cl.** **H05b 3/36**
[50] **Field of Search** 219/211–12,
527–29, 544, 545, 549, 552; 252/502;
260/502

[56] **References Cited**

UNITED STATES PATENTS

2,432,785	12/1947	Moberg	219/212
2,708,235	5/1955	Kaplan	219/212
2,735,926	2/1956	Langlois	219/528
3,107,152	10/1963	Ford et al.	252/502 X
3,146,340	8/1964	Dewey et al.	219/544 X
3,205,342	9/1965	Smith et al.	219/549
3,218,436	11/1965	Edwards et al.	219/544
3,255,337	6/1966	Willat	219/528
3,257,492	6/1966	Westeren	219/529 X
3,367,851	2/1968	Filreis et al.	260/502 X
3,385,959	5/1968	Ames et al.	219/549

OTHER REFERENCES

Metal Progress, " Graphitized Textiles Have Many Uses," May, 1959, pp. 115–116.

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ABSTRACT: An electrical heating element, comprising an electrically conducting carded fibrous carbon web contacted by electrodes, a supporting layer of loosely woven fabric overlying and united to one face of said web and a fitted fabric surface layer overlying and united to the other face of said web, there being a finishing layer overlying the supporting layer.

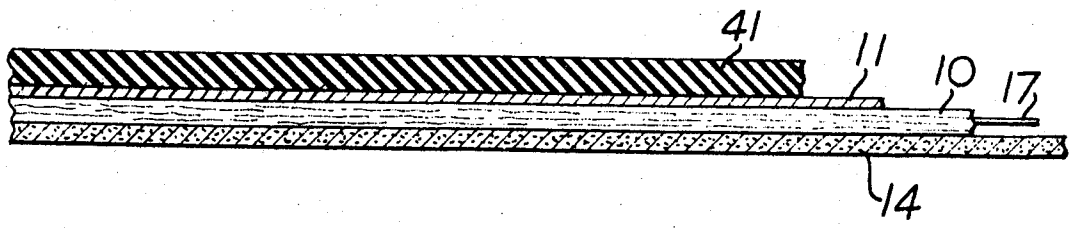

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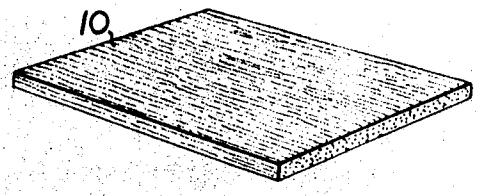
Fig. 1.



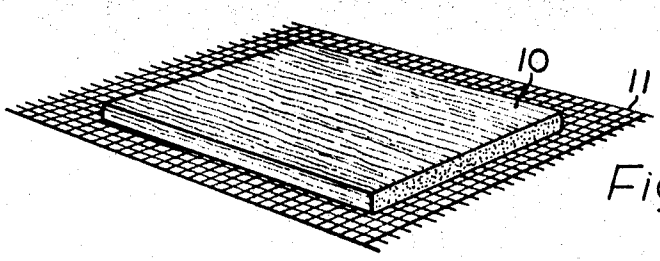
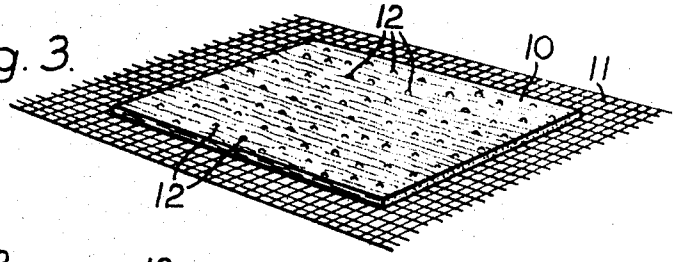
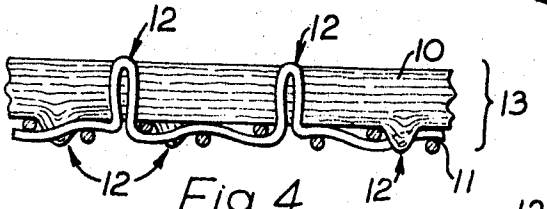


Fig. 2.

Fig. 3.





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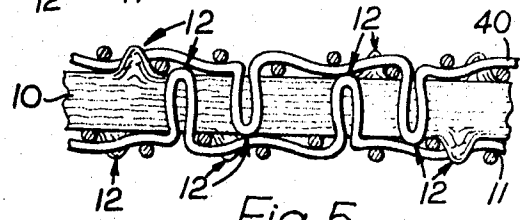

Fig. 5.

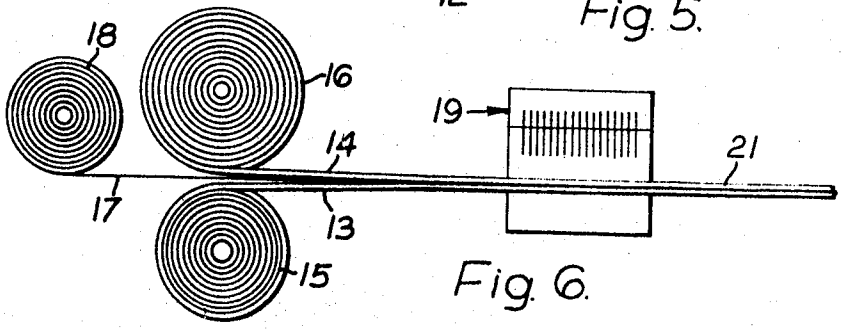

Fig. 6.

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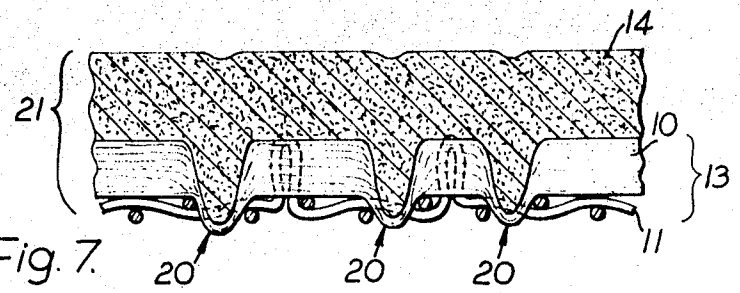
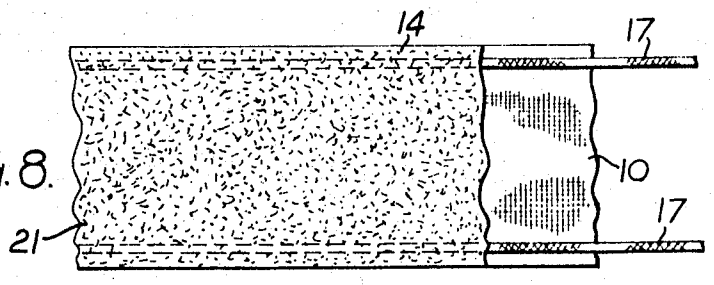


Fig. 7.



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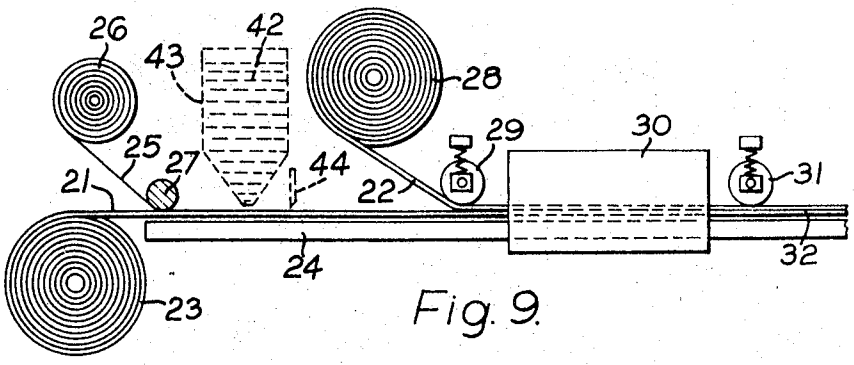

Fig. 9.

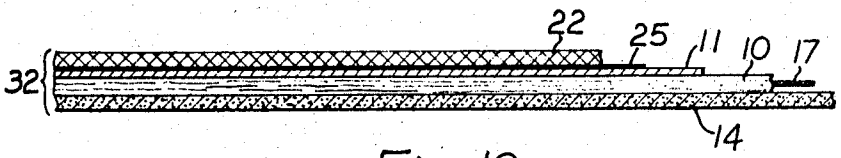

Fig. 10.

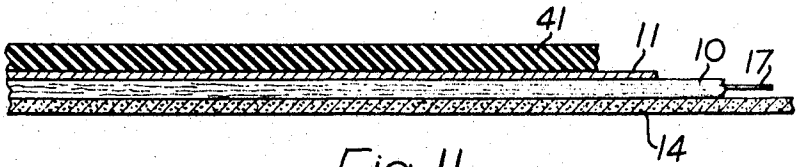

Fig. 11.

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ELECTRICAL HEATING ELEMENTS

This invention relates to electric heating elements.

It has already been proposed to employ fabrics incorporating carbon fibers as padlike heating elements, heat being generated by passing an electric current through the fabric. Carbon fibers, as such, are quite brittle and abrasive, and do not possess very good cohesive properties. It is for this reason that hitherto they have generally been proposed to be incorporated with the yarns of woven fabrics or the like to maintain the cohesion thereof, but so far no satisfactory commercially marketable product capable of enduring normal wear and tear, for example in use as fabric for heated clothing, heated carpet underlays or the like, has emerged.

An object of this invention is to provide a form of electrical heating element which incorporates carbon fibers as aforesaid, which operates efficiently for the generation of heat upon passage of an electric current therethrough, and which is of enduring construction not susceptible to deterioration under normal conditions of use or due to being folded, rolled or otherwise handled for storage and/or transportation purposes, as well as a method of making the same.

With this object in view, the present invention provides, a laminar electrical heating element comprising a nonwoven fibrous carbon web having two spaced-apart electrodes in contact therewith and having a supporting or holding layer of loosely woven textile fabric united thereto at one face thereof, a surface layer of felted fabric united thereto at the other face thereof, and a finishing layer overlying the supporting or holding layer.

The supporting or holding layer is preferably an open weave scrim fabric, and there may be a second such holding layer disposed between the surface layer of felted fabric and the fibrous carbon web.

The finishing layer may, for example, be a decorative or other woven fabric, in which case the heating elements may be employed in or as part of heated clothing or the like; alternatively it may be of a foamed plastics material, for instance where the heated element is required to be used as a heated underlay for a carpet or other floor covering. Obviously other finishing layers may be incorporated according to the intended use thereof.

The supporting or holding layer or layers and/or the surface layer may be united to the carbon web by needling, but the finishing layer is preferably united by bonding, e.g. by means of an adhesive. Needling has the effect of causing intermingling of the needled fibers, and accordingly should be avoided in relation to the finishing layer, so that no carbon fibers are exposed thereon in the finished heating element.

The invention further provides a method of making a laminar electrical heating element which comprises applying two spaced-apart electrodes to a nonwoven fibrous carbon web, uniting a supporting or holding layer of loosely woven textile fabric to said carbon web at one face thereof, uniting a surface layer of felted fabric to the web at the other face thereof, and then bonding or adhering a finishing layer over the supporting or holding layer.

In carrying out such method, the uniting of the supporting or holding layer with the web and the uniting of the surface layer with the web is preferably effected by needling.

The method may, if desired, include the further step of uniting a second supporting or holding layer with the web at the said other face thereof, prior to uniting the surface layer with the web.

The supporting or holding layer may be an open weave scrim fabric, e.g. of cotton, and the surface layer may, for example, be of wool or a mixture of wool and other suitable fibers.

In order that the invention may be fully understood, it will be described further, by way of example, with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic perspective view illustrating a section of a carded fibrous carbon web as employed in a preferred embodiment of the heating element of the invention;

FIG. 2 is a view similar to FIG. 1 but showing the carbon web applied to a supporting or holding layer;

FIG. 3 is a view comparable with FIG. 2 but showing the web with the supporting or holding layer united to one face thereof by needling, thereby illustrating one of the steps involved in the method of the invention;

FIG. 4 is an enlarged an diagrammatic fragmentary sectional elevation illustrating a part of the united web and supporting or holding layer of FIG. 3;

FIG. 5 is a view similar to FIG. 4 but illustrating a modification wherein the web has a second supporting or holding layer united to the other face thereof;

FIG. 6 is a diagrammatic side elevation, to a reduced scale, illustrating the united web and supporting layer of FIGS. 1 to 4 having electrodes and a surface layer applied thereto, thereby illustrating further ones of the steps involved in the method of invention;

FIG. 7 is an enlarged and diagrammatic fragmentary sectional elevation, comparable with FIG. 4, but showing the structure resulting from uniting the surface layer to the carbon web and supporting layer as illustrated in FIG. 6;

FIG. 8 is a diagrammatic plan view, to a reduced scale, illustrating the structure of FIG. 7;

FIG. 9 is a diagrammatic side elevation, to a reduced scale, illustrating the application, to the structure of FIG. 8, of a finishing layer to achieve the finished heating element;

FIG. 10 is a diagrammatic enlarged cross-sectional side elevation of a portion of the finished heating element as obtained according to FIG. 9; and

FIG. 11 is a view similar to FIG. 10 but illustrating another modification.

Throughout the drawings similar reference numerals have been allocated to similar parts.

FIG. 1 shows, very diagrammatically, a carded nonwoven fibrous web 10. This web 10, which will, of course, be floppy and will not take up the sharply defined geometrical configuration illustrated, is obtained, for example, by firstly carbonizing a bulk rayon fiber of short staple length, in an inert atmosphere in a furnace whose temperature is increased slowly up to about 1,000° C. and thereafter converting the resulting carbon fiber bulk into a carded web by use of a conventional carding machine or so-called "carding engine".

Because the carded web 10 has very little coherence or intrinsic resistance to separation of the fibers thereof and falling part, so soon as it is obtained from the carding machine it is fed onto a supporting or holding layer 11 which is a loosely woven textile fabric, such as an open weave cotton scrim, and immediately thereafter the supporting or holding layer 11 is united to the web 10 by passing them through a conventional needle loom which serves to needle the two components together, as illustrated diagrammatically in FIGS. 3 and 4. This serves to needle the two components together, as illustrated diagrammatically in FIGS. 3 and 4. This serves to compact the web 10 and causes the fibers thereof and of the supporting or holding layer 11 to become intermingled at a plurality of discrete locations distributed through the areas thereof as indicated at 12 in FIGS. 3 and 4 and illustrated very diagrammatically in FIG. 4 to unite the web 10 and layer 11 to form a readily handleable assembly indicated by reference numeral 13 in FIG. 4. Such assembly 13 can be rolled up for storage quite readily and conveniently, which would not be the case for the web 10 on its own.

Turning now to FIG. 6, this illustrates the application, to the assembly 13 of a surface layer 14 of felted fabric, e.g. of wool or any other suitable fibrous material. As shown, the carbon web/supporting or holding layer assembly 13 is drawn from a roll 15 with its supporting or holding layer 11 downwards, and the surface layer 14 is drawn from its respective roll 16 and brought into face-to-face contact with the upper or carbon web side of the assembly 13. Simultaneously therewith two flexible electrodes 17 are drawn off respective reels 18 (FIG. 6) and one thereof is fed along each longitudinal side of the assembly 13, just spaced in from the edges thereof as can be ascertained from FIG. 8, so as to contact the exposed face of

the carbon web of the assembly 13 and to become entrapped between the latter and the surface layer 14.

These electrodes 17 are each in the form of a braided or woven tape of metallic tinsel, having a very great flexibility whilst not being susceptible to damage or fatigue as a result of flexing.

As shown in FIG. 6, the assembly 13 with the electrodes 17 and the surface layer 14 superimposed thereon is progressed through a conventional needle loom, which has been illustrated very diagrammatically at 19, whereat the surface layer 14 is united to the assembly 13, as indicated diagrammatically at 20 in FIG. 7, in the same way as the supporting or holding layer 11 was united with the carbon web 12 as above described, to form the composite laminated carbon web/supporting or holding layer/surface layer/electrode structure 21. The needling is, of course, effected through the electrodes 17 to unite these with the rest of the structure. This laminated structure 21 can, if so desired, be rolled up.

Turning now to FIG. 9, this figure illustrates the application to the structure 21 of a finishing layer 22. The structure 21 is drawn off a respective roll 23 and is progressed over a table 24 with its exposed supporting or holding layer 11 upwards and the surface layer 14 downwards. A coherent adhesive film 26 is drawn from its respective reel 26 and fed to the upper surface of the structure 21 so as to overlie the scrim supporting or holding layer thereof against which it is pressed by a guide roller 27 whereupon the finishing layer 22, which may be for example, a decorative woven fabric, drawn from a respective reel 28 is applied over the film, 25, against which it is pressed by a respective guide roller 29. Thereupon, the resulting assemblage, being progressed along the table 24, is passed through a steam chamber illustrated diagrammatically at 30 wherein it is subjected to steam which activates the adhesive film 25 causing the later to fuse and bond the finishing layer 22 to supporting or holding layer 11 and the carbon web 10, a pressure roller 31 disposed adjacent the exit from the steam chamber 30 serving to press all of the components of the resulting heating element 32 to ensure intimate bonding of the finishing layer 22.

FIG. 10 serves diagrammatically to illustrate the form of the finished laminated electrical heating element structure 32 produced by the method as described, the various layers thereof having been shown exaggeratedly simply so that the nature thereof can readily be understood. It will be appreciated that the resultant continuous length of the structure 32 will be severed at appropriate locations to form individual heating elements.

Variations may be made to the method of making heating elements as above described. Thus, for example, the carbon web 10 from the carding machine can, if desired, have not only the supporting or holding layer 11 applied thereto, but can have second similar supporting or holding layer 14 overlaid thereover, the two layers 11 and 40 being simultaneously united to the carbon web 10 by needling, prior to the uniting therewith of the surface layer 14, as illustrated in FIG. 5.

FIG. 11 illustrates a modification wherein a formed plastics or like layer 41 is bonded to the carbon web 10 at the side thereof opposite to the surface layer 14 so as to form a construction of heating element which is particularly suitable for use as an underlay for carpets and like floor coverings. In the production of this form of the heating element, as is illustrated in FIG. 9, the structure 23 passing over the table 24, instead of having the adhesive film 25 and finishing layer 22 applied thereto, is coated with an appropriate fluid plastics material 42 from a supply receptacle 43 and passes beneath a a doctor blade 44 which serves to ensure that the coating is even over the entire area of the structure 23. The component 30 through which the coated structure 23 then passes will, instead of being a steam chamber, be a curing chamber wherein the plastics coating is caused to expand and at least partially set to form the layer 41. Naturally, instead of being formed in situ as just described, the foamed plastics layer 41 may be separated formed and caused to adhere to the structure 21 by means of an appropriate adhesive, for example as already described in relation to the finishing layer 22.

The heating element as described can be employed in the manufacture of heated clothing or panels, or electrically heated underlays for floor heating, for example in domestic dwellinghouses, caravans and other locations as has already been mentioned. For such purposes, a low voltage, for example of 12 volts or 25 volts, is preferably employed, and in practice a loading of the order of 15 watts per square foot will provide, in an underlay measuring approximately 12 feet by 12 feet will provide adequate room heating for a room of slightly larger floor area, being slightly in excess of 2 kilowatts.

Obviously, when appropriate elements have been severed from the continuous lengths produces as described with reference to the drawings, the electrodes 17 must be appropriately exposed for connection of current supply leads thereto and this can be effected in any convenient manner, for example by shirring back the layers overlying one end of each electrode 17 and making corresponding soldered connections (not shown) to the resultant exposed ends of the electrodes.

The described method of making the heating element of the invention, wherein the needling of the various layers to the carbon fiber web to unite them is effected prior to the bonding in place of the finishing layer 22 or 41 has the advantage that no carbon fibers are present at the exposed surface of the finishing layer 22 or 41 which would be the case if such finishing layer were united to the rest of the components of the element by needling also.

The heating elements of the invention may incorporate nonwoven fibrous carbon webs produced otherwise than in the manner specifically described, for example by carbonishing a previously felted rayon fiber web. The finishing layer may be a knitted fabric or a nonwoven fabric instead of the described woven fabric or plastics layer.

I claim:

1. A laminar electrical heating element comprising: a nonwoven fibrous carbon web, a pair of spaced-apart electrodes in contact with the web, a supporting layer of loosely woven textile fabric united with the web at discrete needled locations at one face thereof, a surface layer of felted fabric united with the web at the other face thereof, and a finishing layer overlying the supporting layer and united therewith and with the web.

2. A heating element as set forth in claim 1 wherein the fibrous carbon web is a carded web.

3. A heating element as set forth in claim 1 wherein the supporting layer is an open weave scrim fabric.

4. A heating element as set forth in claim 1 and further including a second loosely woven textile fabric supporting layer disposed between the surface layer and web.

5. A heating element as set forth in claim 1 wherein the finishing layer is of a woven fabric.

6. A heating element as set forth in claim 1 wherein the finishing layer is of foamed plastics material.

7. A heating element as set forth in claim 1 wherein the surface layer is united with the web and supporting layer at discrete needled locations.

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