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C. W. MEYERS

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HEATING ELEMENT

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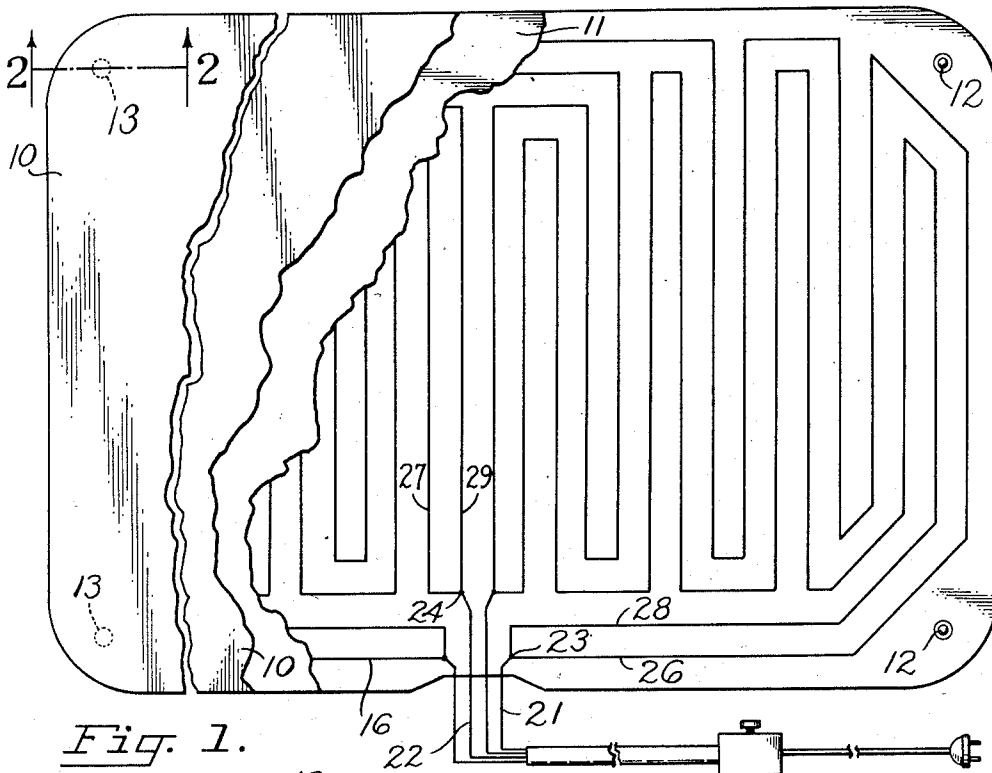


Fig. 1.

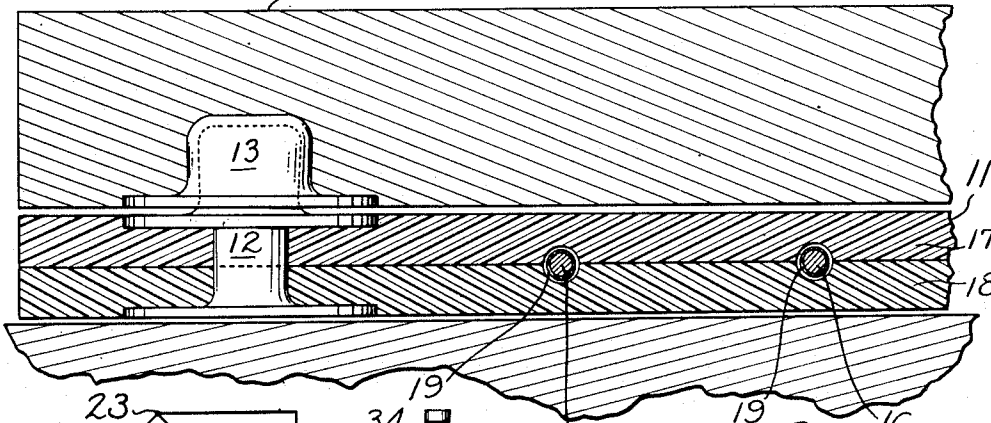


Fig. 2.

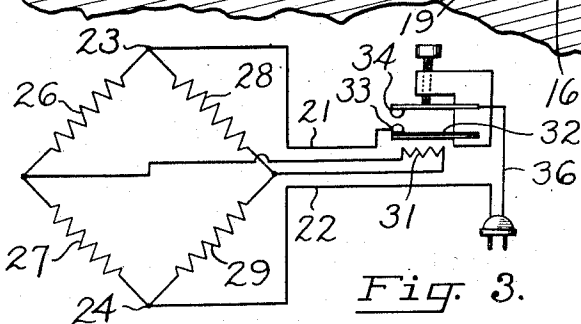


Fig. 3.

INVENTOR.  
Cornelius W. Meyers  
BY Ramsey and Kolisch  
Attys.

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## HEATING ELEMENT

Cornelius W. Meyers, Portland, Oreg.

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3 Claims. (Cl. 219—34)

This invention relates to electric heating apparatus, and more particularly to electrically heated panels and the like suitable for use as auxiliary heating units.

It is recognized that heating units in the form of panels or pads for heating specified areas, such as cold floor spots, are well known. Heating devices which have heretofore been suggested, however, have been subject to a number of disadvantages. For many applications, it has been found desirable to have electrical heating units of this type in the form of relatively thin panels of substantially rigid construction, heating devices of such a construction being particularly useful, for example, as under-foot heating devices for cold floor areas. Units of this type have usually been constructed by embedding within the panel the suitable heating elements. Such devices, however, by reason of their rigid construction, have been found to warp, twist, and buckle after the generation of heat over any extended period. It has been found that much of this distortion arises from the thermal contraction and expansion of the electric heating elements employed in the panel. In the more aggravated cases, short circuits occur in the panel when the deformation has progressed to such an extent as to permit the heating elements within the panel to be displaced and come in contact with one another.

I have found that a particularly serviceable heating panel may be obtained by providing a panel comprised of two separate layers, or sheets loosely secured together, so as to permit flexure of one independently of the other. One of the sheets is of fairly rigid construction, having an upper surface designed for exposure to wear and characterized by such properties as abrasion resistance and/or hardness, etc. Disposed beneath this sheet and loosely secured thereto is placed a thin, flexible sheet wherein the heat is generated. This second sheet, by reason of its flexibility, may bend or twist in response to any thermal distortion of the heating elements disposed within the sheet without appreciable destruction thereof.

Since the sheet is flexible and pliant, any distortion of the sheet tends to be only temporary in nature. The entire assembly, therefore, possesses a serviceable life greatly extended over those of heating panels known heretofore.

The flexible sheet wherein the heat is generated, in addition to being capable of slight flexure in response to distortion of the heating element disposed therein, is characterized by a novel construction which has been found to minimize substantially the extent of any of these flexures which may be generated in the sheet. By reason of such a construction, the assembled panel of this invention tends at all times to lie substantially flat upon the surface supporting the panel, the distortions of the flexible sheet being of such a minor nature that they do not disturb the placement of the rigid sheet placed thereon. In fact, the nature of the flexible sheet is such that it may be used for limited periods without the inclusion of a rigid overlying panel, providing, however, that

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such use is limited to intervals of such duration that destruction of the sheet from continued abrasions, tearing stresses, etc. does not occur.

Generally, therefore, it is an object of this invention to provide a novel heating panel assembly of unusual durability which is highly resistant to recurrent distortions of the heating elements supplying heat to the panel.

Another object of this invention is to provide a heating unit for electrically generating heat so constructed that it will yield slightly in response to any distortions of the heating elements disposed within the unit.

Having described in a general way the nature of this invention, there follows a more detailed description thereof, various other novel features and advantages of which will become more fully apparent as the description is read in conjunction with the accompanying drawings, wherein:

Fig. 1 is a plan view of one embodiment of the panel of this invention, partly broken away and partly in section, showing portions of the rigid and flexible sheets employed in the panel, and the disposition of the heating elements within the flexible sheet;

Fig. 2 is a sectional view along the line 2—2 in Fig. 1, showing the manner in which the heating elements are embedded within the flexible sheet; and

Fig. 3 is a schematic wiring diagram of an electric circuit which may be used for supplying heat to the panel.

Referring to Figs. 1 and 2 of the drawings, wherein one embodiment of this invention is illustrated, the assembled heating panel in general comprises a pair of relatively thin sheets 10 and 11 which are substantially coextensive and which are disposed one on top of the other. The upper sheet 10 is of a rigid construction, having a smooth planar upper surface of wear resistant qualities, and may consist of any suitable material, preferably an electrically insulating material, such as hardboard, compressed corkboard, plywood, etc. Sheet 10 is relatively thin, for most purposes varying usually from about one-eighth to about three-eighths of an inch in thickness, and substantially flat so as to lie close to the floor and eliminate as much as possible any hazards to persons walking thereacross.

Beneath sheet 10, and substantially coextensive therewith, is a relatively thin flexible lower sheet 11. Means are provided to loosely secure sheets 10 and 11 together so that sheet 10 is held in a stationary, overlying position with respect to sheet 11, but which permit flexure of sheet 11 independently of and without transmitting said flexure to sheet 10. Such means may be illustrated by stud members 12 integral with sheet 11 and disbursed over its upper area. Stud members 12 protrude upwardly from sheet 11 and are received by sockets 13 formed in sheet 10. Stud members 12 and sockets 13 are situated so that they will coincide when sheets 10 and 11 are properly positioned.

Flexible sheet 11 of this invention in general is prepared by bonding together a pair of flexible plastic laminae, such as 17 and 18, which have distributed, prior to bonding of the laminae between the contiguous surface areas of the laminae, a resistance conductor generally indicated at 16. Resistance conductor 16 is arranged as a maze over substantially the entire surface area of the laminae so that heat will be radiated more or less uniformly from all areas of the sheet when the sheet is finally formed.

Referring to Fig. 2, resistance conductor 16, which is in the form of wire having a specified ohm resistance, has applied about its periphery an insulating sheath 19. This insulating sheath may take any of a number of suitable forms, such as lacquer or wound fabric. When the plastic laminae of this invention are bonded together,

they do not adhesively bond to any great extent with conventional electrical insulating material, so that the resistance conductor after bonding is carried relatively loosely between the laminae.

Laminae 17 and 18 may be composed of numbers of different materials. The principal considerations governing the selection of the material employed are that the material be flexible and pliant, and that the material not adhere appreciably to sheath 19 under the conditions used in bonding together laminae 17 and 18. To this end, it has been found that the thermoplastic resins, such as the polyvinyl resins as exemplified by polyvinyl acetate, are particularly valuable. Unlike such materials as rubber, sheets of these materials can be made readily to adhere together without significant interaction with sheath 19 of resistance conductor 16. The vinyl resins have been found to be particularly valuable in that they generally exhibit inability to support combustion, their use constituting an important safety feature.

In the final assembly of sheet 11, laminae 17 and 18 are fused together using conventional methods wherein heat and pressure are applied to the laminae. If desired, a suitable adhesive resin may be deposited between the laminae on the contiguous surface areas of the laminae lying between the resistance conductor 16. When prepared in this manner, no substantial bond will be created between sheath 19 of the resistance conductor and the inner surface of the plastic laminae.

By reason of the construction of sheet 11 described above, thermal elongation or contraction of resistance conductor 16, which normally occurs when electricity is supplied to the conductor, is permitted relative to the surrounding plastic laminae. The relative movement so provided, together with the flexible nature of the sheet material, minimizes the internal stresses built up within the sheet upon activation of resistance conductor 16, and has been found greatly to enhance the life of such a sheet.

In the manufacture of flexible sheet 11 of this invention, it has been found particularly desirable to arrange the resistance conductor 16 so as to include the four legs of a Wheatstone bridge circuit. By employing in resistance conductor 16 various resistance elements having differing temperature resistance coefficients, all four legs of a heat sensitive Wheatstone bridge circuit can be incorporated in resistance conductor 16, resistance conductor 16 thus serving the dual function of heat generation and thermostatic control. It is obvious that economies in manufacture may be thus achieved. However, heretofore such construction has not been practical due to the distortions which occur through the use conjointly of different types of resistance elements. Conductors having different temperature resistance coefficients have almost invariably been accompanied by different thermal expansion coefficients so that their use together has produced aggravated stresses in a heating member prepared therefrom. By reason of the novel construction of sheet member 11, which permits relative movement of the resistance element 16 within the sheet, such a construction now becomes highly practical.

Referring to Fig. 3, resistance conductor 16 is shown arranged in such a manner. More specifically, a pair of input conductors 21 and 22 are connected to a pair of terminals 23 and 24, respectively. Between these terminals a parallel circuit is arranged, one segment comprising a pair of resistance elements 26 and 27, and the other segment comprising a pair of resistance elements 28 and 29. Resistance elements 26 and 29 have high temperature resistance coefficients, and resistance elements 27 and 28 have lower temperature resistance coefficients. A shunt connecting the jointure of resistance elements 26 and 27 and the jointure resistance elements 28 and 29 is provided, this shunt including a low temperature resistance coefficient resistor element 31. A temperature responsive element, such as bimetal strip 32, is associated with resistor element 31, so as to separate a pair of contacts

33 and 34 connecting input conductor 21 with a supply conductor 36 when a predetermined temperature is attained in resisting element 31, and thus interrupt the supply of electricity to the resistance conductor 16. By reason of such a construction, when the temperature of one of the resistance elements making up the legs of the Wheatstone bridge becomes excessive, the Wheatstone bridge will become unbalanced and an electrical flow will occur through resistor element 31. This in turn will cause the bimetallic strip 32 to flex, so as to open the contacts 33 and 34.

As will be apparent from the above, the high temperature resistance coefficient resistance elements are the ones which exert the most substantial amount of control over the balance in the Wheatstone bridge circuit. Accordingly, these resistance elements should be distributed substantially uniformly over the entire heating area of sheet member 11, necessitating that the lower temperature resistance coefficient resistance elements be distributed about the heating area of sheet 11 in close proximity to the high temperature resistance coefficient resistance elements. The resistance elements are arranged in serpentine formation and with elements of differing thermal expansion lying adjacent and interspersed with each other. The elements are arranged as a single layer without crossover of the elements. As mentioned above, because of the thermal expansion characteristics which normally accompany the use of materials having differing resistance coefficient characteristics, the arrangement of resistance elements in this manner heretofore resulted in the formation of unduly high internal stresses in any sheet incorporating the resistance elements. It will be seen, therefore, that the novel construction of flexible sheet 11 contemplated by this invention has particular utility and advantages in connection with the use of a resistance conductor arranged in the manner just described, wherein the resistance elements in the conductor have varying thermal expansion characteristics.

From the foregoing, it should be apparent that a highly practical and satisfactory heating panel has been devised. By providing that the panel be composed of a rigid and a flexible sheet, loosely secured together so as to permit flexure of one irrespective of the other, the warping and twisting normally present in a heating panel is substantially eliminated. Furthermore, the novel construction of the flexible sheet itself, wherein the resistance conductor is held comparatively loosely while embedded within the sheet, minimizes any distortion which does occur in the flexible sheet and results in substantial reduction of any stresses formed within the sheet.

While there has been described only a few embodiments of this invention, it is desired not to be limited thereby, and it is intended to cover all modifications of this invention which would be apparent to one skilled in the art and come within the scope of the appended claims.

I claim:

1. A heating panel comprising the combination of a relatively thin rigid upper sheet member and a relatively thin flexible lower sheet member substantially coextensive therewith and disposed thereunder, said lower sheet member being comprised of a pair of relatively thin flexible thermoplastic laminae bonded together and having embedded therebetween an electric resistance conductor, said upper and lower sheet members being loosely secured together so as to permit flexure of said lower sheet member independently of said upper sheet member.

2. A heating panel comprising the combination of a relatively thin rigid upper sheet member and a relatively thin flexible lower sheet member substantially coextensive therewith and disposed thereunder, said lower sheet member being comprised of a pair of relatively thin thermoplastic laminae bonded together and having embedded therebetween an electric resistance conductor, said resistance conductor having an electrically insulating sheathing disposed about said conductor, said conductor

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and sheathing being carried relatively loosely between the laminae of said lower sheet member whereby thermal distortion of the resistance conductor is permitted relative to the laminae, said upper and lower sheet members being loosely secured together to as to permit flexure of the lower sheet member independently of said upper sheet member.

3. An electric heating pad comprising a pair of relatively thin flexible thermoplastic laminae bonded together and having embedded therebetween an elongated electric resistance conductor, said resistance conductor being comprised of elongated resistance elements having differing thermal expansion coefficients, the resistance elements being arranged in serpentine formation with elements of differing thermal expansion coefficients lying adjacent and interspersed with each other, said resistance elements having an electrically insulating sheathing disposed about said resistance elements, said resistance elements

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and sheathing being carried relatively loosely between the laminae of said pad whereby thermal distortion of the resistance elements is permitted relative to the plastic laminae, said resistance elements being distributed throughout the pad as a single layer and without crossover of the elements.

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