

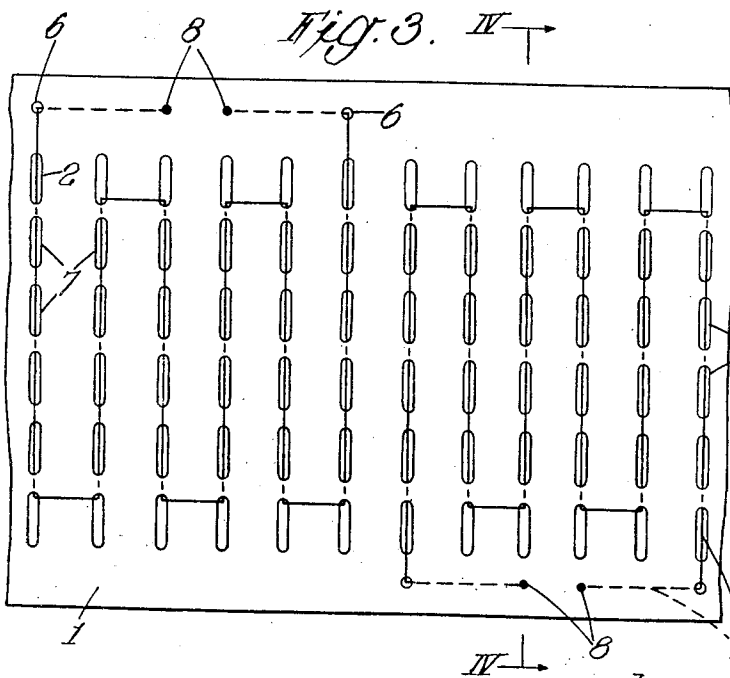
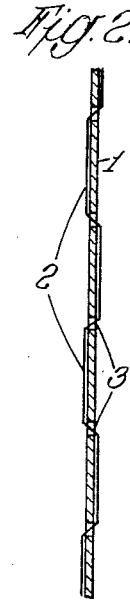
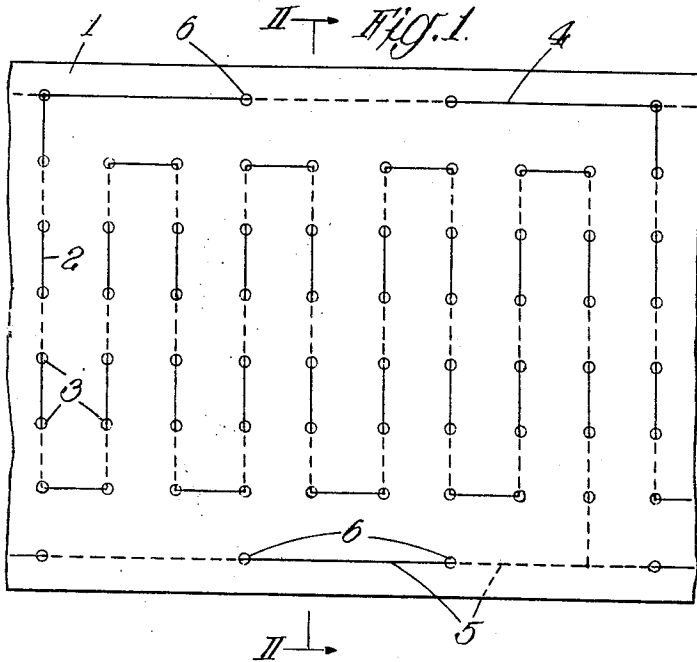
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ELECTRICAL HEATING ELEMENT

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2 Sheets-Sheet 1



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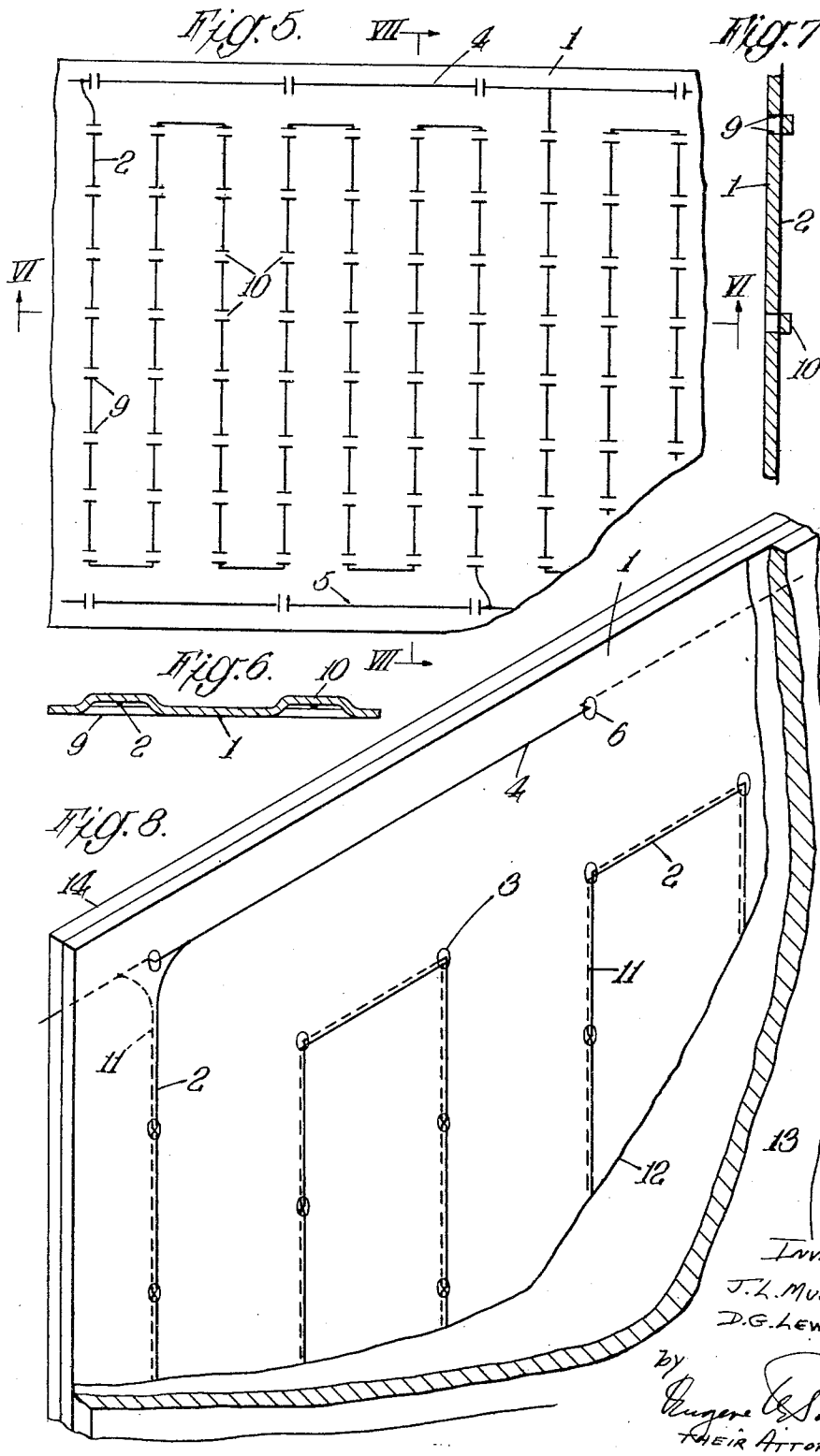
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UNITED STATES PATENT OFFICE

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ELECTRICAL HEATING ELEMENT

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5 Claims. (Cl. 219—19)

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The present invention relates to electrical heating elements employing resistance wire or tape (referred to throughout this specification comprehensively as "wire") and made in the form of sheets or strips which may be either plane or curved. Such elements are especially suitable for the heating of buildings, being for this purpose made up in the form of panels adapted to be incorporated in walls and/or ceilings. The main object of the invention is to simplify the construction and manufacture of electrical heating elements of the kind referred to.

According to the invention, an electrical heating element of the type set forth comprises a sheet or strip of material having a number of perforations through which resistance wire is threaded, the lengths of the wire extending between those sections of the wire located in the perforations lying substantially against one face or other of the sheet or strip. The resistance wire employed may be bare or insulated and may be applied to the sheet or strip either by hand or by a suitable mechanical device. If bare wire be employed, the sheet must be of insulating material and this is the form of construction chiefly referred to in the specification, it being understood, however, that if insulated wire be used it is not essential that the sheet or strip be insulating. The sheet with its incorporated conductor or conductors may be encased in any suitable manner, for instance by embedding it in insulating compound or covering it with material in sheet form with or without the interposition of appropriate adhesive or embedding compound.

Generally the perforations will be arranged in rows, and in the simplest case they consist of round holes equispaced in each row and each of a diameter somewhat greater than that of the outside diameter of the resistance wire whether bare or insulated. Alternatively the perforations may take the form of slots, or, according to another construction, slits are formed in the sheet, the wire being threaded through the slots or slits as the case may be.

In a convenient construction there extend, in proximity to opposite edges of the insulating sheet or strip, two conductors constituting bus-bars connected to the power circuit, and these are suitably respectively threaded in and out through the rows of perforations nearest to the above opposite edges. Any number of lengths of resistance wire may then be connected between these bus-bars, and normally, in order to accommodate the required length of resistance wire, it will be applied to the insulating sheet or strip in

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the form of a zigzag. In other cases terminals mounted on the sheet or strip are employed instead of bus-bars.

In order that the invention may be clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawings, which illustrate by way of example various forms of heating elements and the manner in which such elements may be made up in the form of a panel. In the drawings:

Figure 1 is a plan view of a portion of a heating element wherein the perforations in the supporting sheet or strip consist of round holes,

Figure 2 is a section on the line II—II of Figure 1 to an enlarged scale,

Figure 3 is a view similar to Figure 1, the perforations being in the form of slots,

Figure 4 is a section on the line IV—IV of Figure 3 to an enlarged scale,

Figure 5 is a view similar to Figure 1, the perforations being in the form of slits,

Figures 6 and 7 are respectively sections on the lines VI—VI and VII—VII of Figure 5 to an enlarged scale, and

Figure 8 is a perspective view of a heating element made up into the form of a panel, certain parts being shown as broken away for the sake of clearness in illustration.

Referring to Figures 1 and 2, the sheet or strip of material 1 which serves to support a length of resistance wire 2 which constitutes the heating element proper may be made of insulating material, such as plywood, paper, cardboard, a plastic substance or asbestos, in which case the resistance wire 2 may be bare; alternatively, the sheet or strip 1 may be of metal or other conductive material, in which case it is necessary that the resistance wire 2 shall be covered with insulating material.

Formed in the sheet 1 is a series of perforations 3 in the form of round holes, through which the wire 2 is threaded as indicated so that a portion of this wire lies on each side of the sheet 1. For the purpose of connecting the wire 2 to a power circuit, there are provided in proximity to opposite edges of the sheet 1 conductors 4 and 5 which serve as bus-bars between which any number of resistance wires 2 may be connected by soldering or by any appropriate clip or corresponding device. The bus-bars 4 and 5 are conveniently supported by threading them through a series of perforations 6. Normally the length of a single resistance wire 2 to be connected between the bus-bars 4 and 5 will exceed the dis-

tance between the latter, and, accordingly, as indicated in the drawing, the resistance wire 2 is usually disposed in the form of a zigzag. It is convenient to arrange that the spaces between the perforations 3 shall be equal, and under such conditions approximately half of the total length of the resistance wire 2 will lie on each side of the sheet 1. However, if it be desired that a greater proportion of this total length shall lie on one side than on the other, this result is readily secured by varying the spaces between the perforations 3.

Figures 3 and 4 illustrate a construction wherein the perforations in the sheet 1 are in the form of slots 7 which extend in substantially the same direction as that of each arm in the zigzag into which the wire 2 is formed, this feature being clearly seen in Figure 3. As indicated in Figure 4, the result of employing slots is that the greater part of each length of resistance wire 2 is exposed on both sides of the sheet 1, and further, since in each arm of the zigzag each of the slots lies in the general direction of the wire and, as seen in Figure 4, the wire extends diagonally through each slot, it follows that the bending to which the wire 2 is subjected is necessarily much less sharp than is the case if the perforations be in the form of round holes as in the construction depicted in Figures 1 and 2.

It is also to be noted from Fig. 4 that the gauge of the wire 2 is substantially less than the thickness of the sheet. Thus, a substantial part of the length of wire 2 in the respective slots 7 lies inwardly of the outer surfaces of the sheet 1 and is protected against injury by the slot walls, as when the sheet 1 is being assembled in a panel.

For the purpose of connecting the wires 2 to the power circuit, bus-bars, such as those illustrated in Figure 1, might be employed, but, for the sake of illustration, an alternative means of connection is shown in Figure 3, comprising terminals 8, mounted on the sheet 1, to which the ends of the wire 2 are led, such terminals serving as means of connection for leads to a power circuit. It will be appreciated that, in any of the constructions described and illustrated in this specification as employing bus-bars, terminal connections, as shown in Figure 3, might be substituted.

Referring to Figures 5, 6 and 7, the perforations in the sheet 1 through which the resistance conductor 2 is threaded take the form of slits 9, that is to say that, as illustrated, there is no removal of material from the sheet and between these slits there remain tongues 10 of the material of which the sheet 1 is formed. As seen in Figures 6 and 7, these tongues are preferably raised from the general plane of the sheet 1 by the amount sufficient to allow the wire 2 to pass under each tongue with little or no deviation, with the result that, as indicated in Figure 7, each arm into which the zigzagged conductor 2 is divided takes a form approximating to a straight line.

Conveniently the slits 9 are located in the sheet 1 in pairs, with the result that the tongues 10 are comparatively narrow and the greater part of the wire 2 is therefore exposed on one side of the sheet 1 only. Such an arrangement is not, however, essential, since the slits might be otherwise spaced, in which case half the length of the wire 2 would be exposed on each side of the sheet 1.

Some of the materials suitable for the sheet 1

are conveniently packed in roll form, and in the manufacture of heating elements as above described sheet or strip material in such form may be employed, a length of the roll being unwound and the operation of forming the perforations and threading the conductors through them being then performed and the strip or sheet again rolled up for storage or transport purposes, being ultimately cut into lengths as required. Particularly in cases in which the elements are to be employed in the heating of buildings, it is usual to apply an embedding compound to the sheet or strip, whereby the conductors are retained in position, and also covering material in sheet form. In that case the embedding and/or covering material may be applied to the insulating sheet or strip before it is re-rolled, but in other instances, if such materials be of a comparatively rigid nature for example, it may be more suitable to apply either or both of them after the insulating sheet has been again unrolled for the purpose of cutting it into the lengths required in use. In an alternative mode of production, the lengths required for use are cut immediately after the perforations have been formed and the resistance conductor applied, or even before these operations. Again, the perforations might be cut before the sheet or strip is rolled, the latter being then ready for application of the conductors immediately on unrolling.

In the panel illustrated in Figure 8, a sheet 1, wherein the perforations 3 are in the form of round holes as depicted in Figures 1 and 2, is employed. In addition, however, to the resistance wire 2 there is a second resistance wire 11 connected in parallel with the wire 2 and threaded through the same series of perforations 3. As indicated, however, the direction of threading of the conductor 11 through each perforation is opposite to that of the conductor 2, with the result that a length of resistance wire is exposed on both sides of the sheet 1 over the whole zigzag into which the resistance wires 2 and 11 are formed. It is to be understood that this arrangement of two resistance wires in parallel might be employed in connection with a construction of sheet other than that depicted in Figures 1, 2 and 8, for instance, such a pair of resistance conductors might be applied to a sheet wherein the perforations are constituted by slots, as depicted in Figures 3 and 4.

In building up a heating panel as illustrated in Figure 8, to a sheet or strip 1 of finite or of indefinite length as above mentioned, with which one or more resistance wires 2 have been previously incorporated, there is applied on one or both faces an embedding compound 12, which may be constituted by a suitable cement, adhesive, resin, gum, or thermoplastic or thermosetting substance. This layer of embedding material is comparatively thin and consequently is represented in Figure 8 by a single line only. On each side of the sheet 1 there are then superposed sheets 13 and 14 of covering material which may suitably be constituted by one of the substances enumerated above as suitable for the sheet 1. These covering sheets are attached to the sheet 1 in any appropriate manner, such, for instance, as stapling, eyeletting, riveting, stitching or lacing, or the cement, adhesive or the like 12, if such be used, with or without the application of pressure and/or heat, may be relied upon for securing the covering sheets. As a further alternative, the insulating sheet with its resistance wires may be incorporated in a laminated

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plastic material, or in a plastic or moulded heat-resisting or refractory material; or the insulating sheet might be placed between layers of dielectric material, such as mica or micanite, and then encased in metal or heat-resisting material.

Certain of the adhesives referred to above as appropriate for attaching covering plates to the insulating sheet, when in the solid condition, are themselves suitable for constituting the latter; thus the resistance wire might be wound in perforations cut in a sheet of uncured phenol formaldehyde resin and the covering plates applied and secured to this insulating sheet by means of pressure and heat.

Obviously, many different ways of covering the insulating sheet or strip bearing the resistance wires might be adopted according to the particular purpose for which the heating element is to be used and having regard to the decorative or other conditions with which it is desired to comply. Also the element may be fashioned to any appropriate form, for instance, flat, corrugated, or curved to any required shape to suit local conditions. Such elements, either alone or made up into panels, may be used for any purpose where heat is required at a temperature within the working temperature limits of the elements. They may be used for drying, heating, cooking or in processing tunnels or compartments; for warming compartments or surfaces in ships, aeroplanes, trains, automobiles, as well as for warming rooms of buildings. They may be applied as independent units, stationary or portable, or attached to or form part of the structure they serve.

What we claim and desire to secure by Letters Patent of the United States is:

1. An electrical heating element for wall panels and the like comprising a sheet of material having perforations in the form of slots, said slots being arranged in rows and each slot being located lengthwise in its row, resistance wire lying in said slots in a row and being of a gauge less than the thickness of said sheet of material whereby a substantial part of the wire in a slot between the ends of the latter will be protected by the side walls of the slot, said wire extending progressively from one face of said sheet to the opposite face of said sheet through said slots.

2. The structure of claim 1, characterized by the space between adjacent slots in a row being less than the length of one slot.

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3. The structure of claim 1, wherein the resistance wire in extending through each slot lies diagonally relatively to the surface of the sheet and lengthwise of the slot.

4. In the art of electrically heated panels for room walls, ceilings and the like, a sheet-form heating element for such panels comprising a sheet of material having perforations in the form of slots, said slots being arranged in laterally spaced rows and each slot being located lengthwise in its row, resistance-wire-provided heating means of a cross-section substantially less than the thickness of said sheet of material, said resistance-wire-providing heating means threaded successively and lengthwise through the slots of each row and alternately from opposite surfaces of said sheet, a substantial part of each portion of the wire between ends of a slot lying inwardly of the plane of the opposite surfaces of the sheet and at an angle inclined from one surface of the sheet to the other whereby to be protected by the side walls of the slot, said wire-provided-heating means lying in close proximity to the surface of the sheet between slots in each row, the sheet portions between slots of each row causing the heating means to partake of a bend of but a few degrees at the exit and entry ends of the slots whereby to avoid liability of breakage of the heating means in service or when the sheet is being installed in a heating panel.

5. The structure of claim 4, characterized by the space between adjacent slots in a row being less than the length of one slot.

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