

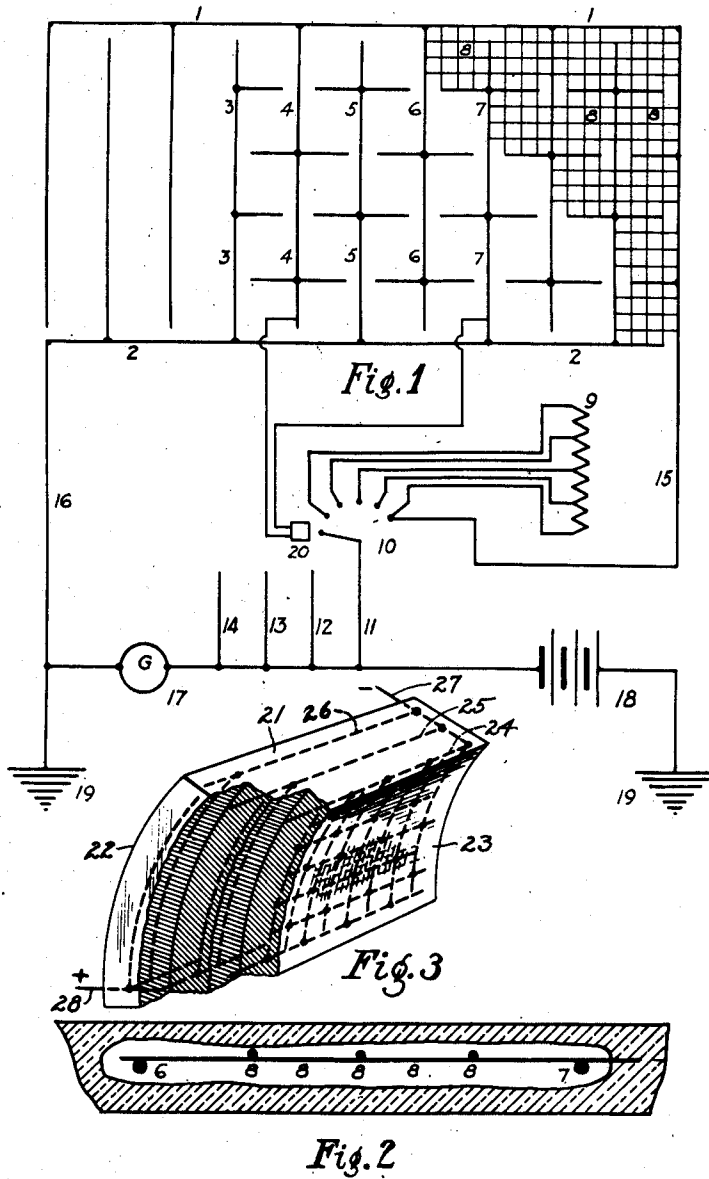
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ELECTRICAL HEATING DEVICE

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## UNITED STATES PATENT OFFICE

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## ELECTRICAL HEATING DEVICE

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My invention relates to improvements in electrical heating devices, and more particularly to the disposition of the electrical resistors and supply conductors for generating uniform heat in a body. One application of my invention is to windows and windshields whereby they not only perform their ordinary function of transmitting light, and of permitting visibility of outside objects, but also obtain a uniform distribution of heat therein. The invention, however, is not limited to windows, windshields and the like, but is applicable to all types of electrical heating elements, one of which is in furnace walls or elements.

In electrical heating units as heretofore generally used, relatively long resistors have been employed which are usually placed in electrical series connection with each other. These resistors often take the form of coils. The dimensions of the resistor elements are appreciable as a considerable voltage is applied across the entire heating unit. When any one of the resistors becomes defective the entire heating apparatus is rendered inoperative. The size of the conductor used in the resistors is such that it interferes with the visibility of transparent materials such as windows, windshields and the like, in which it is embedded.

An effort has heretofore been made to embed commercial wire fabric in materials and utilize the fabric as a heating element. In such cases the electrical supply conductors are attached to the edges of the fabric with a resultant high voltage drop across the entire sheet. The current transfer across the sheet has been in a unilateral direction with areas of unequal heat distribution, because of the failure to recognize that electrical interlinkage is necessary at each wire crossing in the fabric, and when established there results unequal generation of heat between the single wires and the wrapped wires.

I provide an electrical heating unit in the form of a network of resistive connectors. The network is supplied by electrical conductors of better electrical conducting characteristics arranged in groups of opposite polarity and connected to the resistors at

a large number of points to provide a plurality of short current paths through the network between supply conductors of different polarity. These paths are in parallel so that upon the failure of any one path the device is not rendered inoperative.

By utilizing short resistor paths in parallel I am able to apply a low voltage to different points of the network within the area to be heated, and I am thus able to use small gauge material for the resistors. In the case where the heating device is used in transparent material such as windows, windshields, and the like, the small resistive conductors do not materially interfere with the visibility through the material.

The provision for generating heat in fine resistors by low voltage applied thereto results in uniformity of heat generation in each elemental resistor. By utilizing a low voltage system a window embodying my invention may be safely used where there is a possibility of persons and articles coming in contact therewith. The use of low voltages also eliminates the tendency for the conductors to burn out due to unequal distribution of heat radiation over long areas.

The invention is particularly applicable to windows, windshields and the like for land, water, or air vehicles where fog, snow and/or ice are liable to be deposited thereon. By applying a heating unit embodying my invention to such surfaces, the deposits of moisture may be removed by the application of heat and without materially affecting the visibility of the window or windshield. The invention is also applicable to heating units having curved surfaces and of material which need not be transparent as the heating unit may be placed in position and the material molded around it and the whole given a surface contour other than of a plane surface. The resistive network may also be arranged in any symmetrical pattern in which the cross wires are electrically interlinked at their crossing points to provide a plurality of current conducting paths in electrical parallelism between supply conductors.

The supply conductors are branched to

apply full impressed voltage across all elemental resistive areas. This arrangement causes substantially equal amounts of thermal energy to be released from all of the elemental resistive areas and small voltages may be used throughout the electrical system.

The accompanying drawings illustrate certain present preferred embodiments of my invention in which

Figure 1 is a diagrammatic plan view of an electrical network embodying my invention connected to the electrical system of an automobile,

Figure 2 is a sectional view through a transparent medium embodying my invention, and

Figure 3 is a broken perspective view of another embodiment of the invention.

Referring to Figs. 1 and 2, an electrical heating unit is outlined by the trunk conductors 1 and 2 of opposite polarity. The trunk conductor 1 is provided with branching feeding conductors 4 and 6 which in turn are provided with branching sub-conductors. Similarly, the trunk conductor 2 is provided with branching conductors 3, 5 and 7 which also have sub-branch conductors.

The rectangle comprised within the lines 1 and 1 and 2 and 2, is a window wind shield or plate of insulating material shown in cross-section in Fig. 2. A low-voltage generator of direct-current type is shown in 17 and a few storage cells at 18 in parallel with said generator and both grounded at 19 and 19, though one ground would be sufficient. The positive supply of electricity passes by wire 11 to the rheostat 10 and the resistance 9. The latter may be placed at any point where its heat may be utilized, or it may be a separate resistive network in the same window or in a separate window. 15 and 16 are conductors leading to the trunk connectors 1—1 and 2—2. The trunk conductors are shown in Fig. 1 in vertical positions at 3—3, 4—4, 5—5, 6—6, 7—7 with the remainder of them unmarked. Sub-trunk conductors are shown branching horizontally from the vertical trunk conductors at 3, 4, 5, 6, 7, others being unmarked.

It is obvious that adjacent trunk conductors and adjacent sub-trunk conductors are alternately positive and negative and apply substantially the full impressed voltage on the resistive network 8, 8, 8, only partially shown but in actuality covering the entire window and windshield. To the left of 3—3 are shown trunk conductors without the sub-trunk conductors and the resistive network system. The view therefore shows separately four of the component parts of one application of my invention, namely, the trunk connectors, the trunk conductors, positive and negative, the sub-trunk conductors, positive and negative to elements of the resistive net-

work at 8, 8, as well as one form of the resistive network system.

It is obvious that multiple groups such as shown within the rectangle 1—1—2—2 may be built up in multiple series combinations, or a given area or space may be networked by elemental multiple groups of resistive and conductive wires, and that these unit multiple groups may be again assembled electrically so that any series multiple arrangement may be formed. Such combinations of circuits give a wide control of the applied voltage and finer control is secured by a rheostat.

An automatic electrical control for the rheostat 10 is shown at 20 with control wires leading to the networks to be regulated and which will reduce or stop the inflow of electricity and heat to the window and windshield depending on the adjustment of the control device.

It is to be understood that different forms of automatic temperature controlling devices may be used in connection with the device if desired.

At 12, 13 and 14 are shown multiple circuits that may be used to control parts of a window windshield and heating device or separate window windshields and heating devices.

Fig. 2, is a cross-section of a window and windshield, showing sub-trunk conductors 6 and 7, with three fine resistive wires and the crossing resistive wires at 8, 8, 8, 8, 8, there being also electrical interlinkage between the conductive and resistive systems at 6 and at 7 in Fig. 2. Referring to Figure 3, the invention is illustrated as applied to a body of material 21 having a non-planar external surface 22 and a curved inner surface 23. A plurality of heating units 24, 25 and 26, each of which is similar to the network shown in Figure 1, are embedded in the material 21 and are connected in parallel between supply conductors 27 and 28 of opposite polarity extending externally of the body of material 21. The body of material 21 is illustrated in the form of a furnace element. The material 21 may be any suitable material such as glass, porcelain, quartz, infusorial earth, asbestos fabric, or other manufactured electrical insulating medium, as I do not wish to be limited to the use of a transparent medium such as glass. Preferably, the material used in connection with the resistive network is electrical insulating material in order that bare wires may be used.

While I have shown and described certain present preferred embodiments of the invention, it is to be understood that it may be otherwise embodied within the spirit of the invention and the scope of the appended claims.

What I claim is—

1. As an article of manufacture, a heating body of electrical resistant material having imbedded therein a network of bare electrical

conductors, said network comprising a plurality of electrical resistors for generating heat, and conductors for supplying electromotive force to the heat generating resistors at a plurality of points within the body, said last named conductors together with the heat generating resistors constituting a plurality of electrically connected parallel circuits.

2. As an article of manufacture, a heating body of electrical resistant material having imbedded therein a network of bare electrical conductors, said network comprising a plurality of electrical resistors for generating heat, and conductors for supplying electromotive force to the heat generating resistors at a plurality of points within the body, said conductors and the heat generating resistors constituting a plurality of interconnected circuits, at least some of which are in parallel electrical connection.

3. As an article of manufacture, a heating body of electrical insulating material having a plurality of spaced overlapping conductors imbedded therein, means for connecting said conductors in groups to different poles of a source of electromotive force, and a network of heat liberating resistors connecting said conductors for supplying thermal energy to said body of insulating material, whereby electromotive force of relatively low voltage impressed upon said poles is conducted to said network for uniform distribution between conductors of unlike polarity.

4. As an article of manufacture, a heating body of transparent material having imbedded therein a network of heat generating electrical resistors, a plurality of conductors of different polarity connected to different portions of the network within the body for uniformly distributing electrical current of low potential throughout the body of transparent material, and means for connecting the conductors of different polarities to a source of electromotive force.

5. A heating device comprising a network of heat liberating resistors, conductors for supplying electrical energy thereto, said supply conductors being connected to the heat liberating resistors in a plurality of branches resembling the branches of a tree.

6. In a heating body, a compound network of electrical conductors comprising a resistive network of symmetrical electrical resistors and a group of symmetrically arranged conductors having higher electrical conductivity than said resistors connected to the resistors at small intervals throughout the network for supplying electromotive force to the resistors whereby uniform voltage distribution is had throughout the body to secure uniform generation of heat therein.

7. In a heating body, a compound network of electrical conductors comprising a resistive network of electrical conductors and other conductors in symmetrical groups for supply-

ing electromotive force to the resistive conductors at a plurality of points intermediate the resistive network, whereby uniform voltage distribution is had throughout the resistive network for securing uniform generation of heat.

8. In a heating body, the combination of resistive network of electrical conductors with electromotive force applied at small intervals throughout the network, with a conductive system comprising trunk conductors and radiating branch conductors having cross-sectional areas progressively varying from the trunk conductor, in accordance with the current density in the individual conductors, said trunk and branching conductors having higher conductivity than the conductors of the first-named network for supplying electromotive force to the first-named network, whereby uniform voltage distribution is had throughout the body to secure uniform generation of heat therein.

9. In an electrical heating body the combination of a resistive network interlinked with a compound group of feeding conductors distributed over the resistive network for supplying electromotive force to the resistive network at a plurality of points throughout the interior of the body of the network whereby a plurality of current paths are provided through the resistive network between the feeding conductors of opposite polarity.

10. In a heating body, a resistive network of electrical conductors, a group of branching conductors connected to the resistive network at a plurality of points, and a second group of feeding conductors of different polarity connected to the resistive network for completing a supply circuit for a plurality of current conducting paths through the network between the supply feeders of different polarity.

11. In an electrical heating device, a single symmetrical network of electrical conductors some of which have good current conducting characteristics and terminate within the body and some of which have resistive characteristics and are arranged between the first named conductors so that they are supplied with electrical energy by group parallel feeding to provide uniform voltage in the network for the uniform generation of heat.

12. In a heated body, a body of transparent material, heating means associated with the body of transparent material and comprising a network of interlinked heat liberating conductors and current supplying conductors of different polarity extending into and terminating within the network and in effect dividing the network into a plurality of conducting paths of relatively short length, and having uniform heat distributing characteristics.

13. A heating device comprising a body of electrical insulating material having portions of different contour, a network of electrical

conductors associated with the body of insulating material and conforming to its shape, and a plurality of conductors of different polarities connected at intermediate points in the network for supplying electrical current thereto and defining a plurality of zones of current distribution, the effective conducting paths in said zones having substantially the same heat dissipating characteristics.

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