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[54] **ELECTRICALLY HEATED WINDOW**

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[52] **U.S. Cl.** **219/522,** 219/203, 219/541

[51] **Int. Cl.** **H05b 3/06**

[58] **Field of Search** ... 219/203, 522, 528, 541, 543; 338/212

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[57] **ABSTRACT**

A heavy-duty heated window is constructed with a series of heating units each of which has a plurality of heating elements in parallel.

2 Claims, 4 Drawing Figures

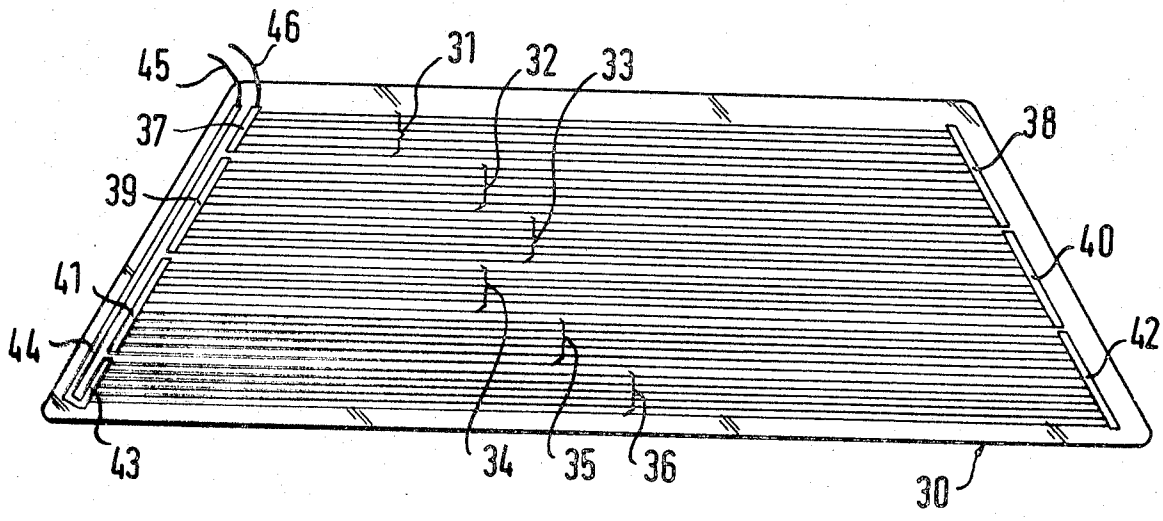


Fig.1

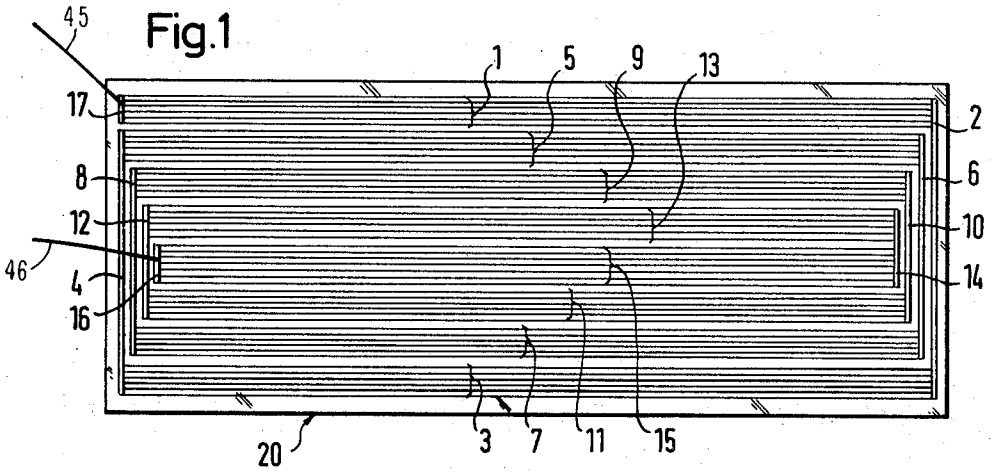


Fig.2

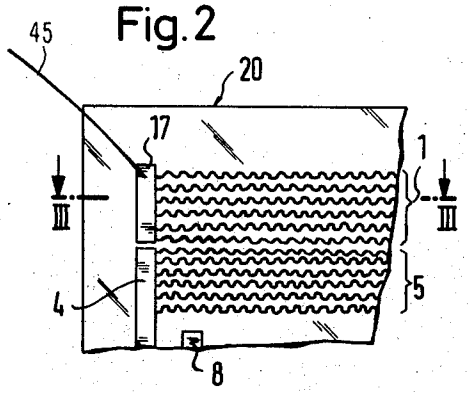


Fig.3

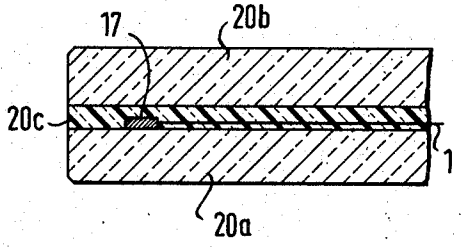
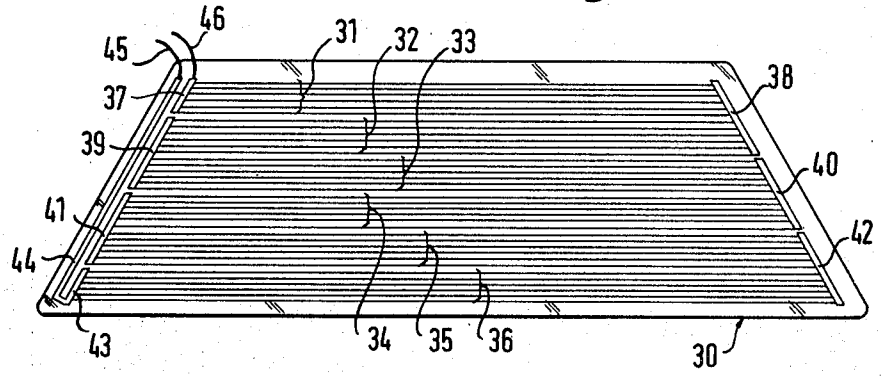


Fig.4



ELECTRICALLY HEATED WINDOW

This invention relates to an electrically heated window provided with thin filaments of resistance type which extend from one edge to the other in a thermoplastic interlayer. Such windows employ tungsten filaments of extreme fineness of which the diameter varies from 8 to 25 microns, which provide very high electric resistance; these filaments are disposed in an undulating path so that the length necessary to obtain the desired resistance is often considerably superior to the distance between the opposed edges of the window. This is notably the case when the dimensions of the window are relatively small or when the voltage supplied is relatively high, which occurs frequently in windows installed in fixed positions, for example, in lighthouses or shop windows, or in the heavy-duty vehicles such as steamships, aircraft and locomotives. In most cases, it is usual to arrange two bus bands along opposite borders of the window and to connect these two bus bands by a certain number of filaments mounted in parallel and proceeding back and forth in the form of multiple segments from one bus band to the other throughout the whole distance separating the bus bands. Such a window is described in German publication OS 1540940. Each resistant filament is laid down by a special machine following an undulating trajectory on the surface of the thermoplastic sheet and reversed in direction before reaching the bus band. It is only occasionally that it extends far enough to be connected to the bus band. Thus, one obtains a network of conductors disposed side by side of which the straight line portions are connected in series to form several heating elements mounted in parallel. Such a disposition is disclosed in German patent No. 909,871.

The heated windows of this type have this imperfection, that any defective contact between a filament and a bus band, and any break in a resistance filament puts a whole unit out of operation and makes the window useless because the unheated area is too large for the adjacent bands to remedy the failure. There are other notable imperfections, in that prior art structure, which appear when, because of the shape of the window, the bus bands are not parallel to each other. For ecample, in trapezoidal windows the bus bands are generally placed on the sides of the trapeze, with the conductive filaments parallel to the bases so that the length of the successive filaments varies from one side to the other. As it is not possible to change the number of segments, except two units at a time, this defect cannot be corrected except crudely and one cannot make the heating power of the different elements uniform. The complementary measures which can be taken such as changing the width of the undulations, or the distance which separates the filaments of an element, distort the optical image and are quite difficult to accomplish.

It is an object of this invention to construct a new type of heated window which is free from such difficulties and which is capable of continuing in operation even when several contacts with the bus bands are defective or when some of the resistant filaments are broken. Furthermore, these new windows have uniform heating effect whatever may be the shape of the window and the variation in the distance separating the bus bands.

The objects of the invention are accomplished generally speaking by a heated window comprising at least one transparent facing layer adherent to a transparent

layer of plastic, a plurality of heating units lodged between the two layers and electrically connected in series, such units comprising a plurality of linear heating resistances connected in parallel.

The novel heated network is composed of a combination of elements or units formed from a reasonably constant number of undulating, parallel, and equidistant filaments interconnected by several bus bands placed at their extremities near the edges of the windows. These bus bands connect the units of these elements in series between the current supply lines. It follows from the construction of this network that all of its elements are traversed by the same current; furthermore, each unit may be composed of the same number of filaments, providing that the electrical resistance per unit of surface and, consequently, the heating power, is the same throughout when the length of the various filaments in a single unit differ little; the length of the filaments of each of the units, and the shape of the heated area has little or no effect and the lengths of the filaments may vary from one border to the other without impairing operation and effectiveness. Furthermore, in the case where, inside of a unit a filament becomes defective because of a bad contact or a break, the unit affected by the defect is so compact that the neighboring filaments assure the heating of the area contiguous to the broken filament without difficulty. It is equally easy to demonstrate that the overall resistance of the whole network is very little affected by such breakages.

The bus bands which interconnect the several filaments of each unit may be disposed parallel to each other in a series of steps. In a particularly efficient form of the invention, these are placed end to end spaced apart by a half length from each side of the window, each of them serving to connect two successive units in series.

The above and further objects and novel features of the present invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. **1** is a diagrammatic representation of a first form of the invention, in plan;

FIG. **2** is a detail of FIG. **1** on an enlarged scale;

FIG. **3** is a section on the line **3-3** of FIG. **2**; and

FIG. **4** is a plan view of a second form of the invention as applied to a trapezoidal window.

Referring to FIGS. **1** and **2**, the input power line **45** is connected to bus band **17** to which are connected six parallel, wavy filaments forming a unit **1** the opposite ends of which are connected to the bus band **2** which extends parallel to the edge of the window and is connected at its lower end to six parallel, wavy filaments of the group **3**, the other ends of which are connected to busband **4**. Another unit of heating filaments **5** is connected to the upper end of the bus band **4** (see FIG. **2**) and extend across the window to connect to the upper end of bus band **6**. It will be observed on FIG. **2** that the spacing between the filaments is substantially equal, evan as to the bottom filament of unit **1** and the top filament of unit **5**. The bus band **6** is connected at its lower end to the ends of the filaments of unit **7**, the other ends of which are connected to bus band **8**, the

upper end of which is connected to the ends of filament unit **9.** Bus band **10** connects the other ends of unit **9** to the righthand ends of the filaments of unit **11,** the lefthand ends of which are connected to bus band **12** which also is connected to and serves unit **13.** A bus band **14** interconnects the ends of units **13** and **15,** the lefthand ends of which are joined by bus band **16** which also serves as the terminal of power line **46.**

It will be observed from this construction that each unit is composed of filaments connected in parallel and that consecutive units are connected in series so that disconnection for any reason, of a filament, will not impair the efficiency of the network as a whole. It will be observed that network **15** has been shown with seven filaments to indicate the possibility of using different units to achieve different heating effects in particular areas. The stepwise arrangement of the bus bands is efficient.

In FIG. **4** is shown a trapezoidal window in which the power line **45** is connected to a band **44** and bus band **43** which subtends the unit **36,** the other end of which is connected to bus band **42** which also serves unit **35.** In this case, the central portion of the bus band, that which lies between the filaments of the two units, constitutes the means which connects the two units in series. The units are arranged in parallel but are connected in series, units **35** and **34** being connected by bus band **41,** units **34** and **33** being connected by bus band **40,** units **33** and **32** being connected by bus band **39,** units **32** and **31** are connected by bus band **38,** and terminal bus band **37** is connected to the power line **46.**

The network is shown in FIG. **3** to be arranged on the interior of a window having outer layers **20***a*, **20***b* of glass which are adhesively conjoined by an interlayer **20***c* of transparent plastic, for instance polyvinyl butyral. The bus bands and filaments are inset in the plastic interlayer as indicated in FIG. **3** at **17** and **1.** The spacing of the different filaments is constant throughout the surface of the window and the filaments are disposed in the undulating or wavy trajectory as illustrated in FIG. **2.** In FIG. **1** the flow of current is in effect spiral, either from power line **45** to **46** or vice versa. In FIG. **4,** the flow of power is back and forth from one side to the other.

The diameter of the tungsten filaments is 20 microns and they are laid down at 1.25 mm. from each other. The distance between the crests of the undulations is 1 mm. and the amplitude of the undulations is 2 mm. The heating power is 12 W/dm^2.

FIG. **4** is trapezoidal and particularly valuable. Six elements **31** to **36,** each unit having six parallel filaments which are parallel to the bases of the trapezoid, are connected in series by the bus bands **37** to **43** to form a back and forth arrangement. The length of each of the bus bands corresponds to the width of adjacent units so that all of the bus bands may be placed in line along the opposite edges of the trapezoid. It is advantageous to place the contact band **44** on the face of the intermediate sheet opposite to that which receives the remainder of the heating network, as this improves the insulating effect.

The advantages of the invention are in the accomplishment of the objects of the invention as discussed hereinabove. This heated window is practically impervious to shocks and even when the breakage of some of its filaments occurs will continue in satisfactory operation. The heating effect of the network is uniform throughout but it can be varied in particular areas by increasing or reducing the number of wires in a unit.

As many apparently widely different embodiments of the present invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments.

What is claimed is:

1. A window comprising two sheets of glass and an intermediate layer of transparent plastic all adhered together, said sheets having a trapezoidal shape, a plurality of heating units each including a plurality of electrically conducting resistive filaments, the filaments of all of said units extending substantially parallel to a base of said trapezoidal shape and occupying together a substantially trapezoidal space geometrically similar to said trapezoidal shape, said window further including a plurality of bus bands each connected to the filaments of two of said pluralities whereby the filaments of each of said heating units are connected electrically in parallel and said heating units are connected electrically in series in a zigzag pattern extending from one end of one base of said shape to one end of the other base of said shape, two electrical terminals, a bus band connecting the filaments of a first of said units to one of said terminals, and a bus band connecting the filaments of a last of said units to the other of said terminals, said filaments and bus bands being embedded in said layer of plastic material, the said bus bands, other than those connecting to the said terminals, being divided into two groups with the bus bands of each of said groups being collinearly disposed parallel to one of the inclined sides of said trapezoidal shape.

2. A window according to claim **1** in which one of said bus bands connecting to a terminal extends parallel to the bus bands of one of said groups and in which said one bus band is spaced from the bus bands of said one group in the direction of the thickness of the window substantially by the thickness of said intermediate layer.

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