# United States Patent [19]

**Strengholt**

[11] **3,892,947**

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[54] **ELECTRICALLY HEATED PANEL WITH ANTI-SHOCK CONDUCTIVE STRIPS**


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[52] **U.S. Cl.** ..... **219/522;** 174/68.5; 219/203; 219/541; 219/543; 338/309

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

[58] **Field of Search** ..... 219/203, 522, 541, 543, 219/544; 338/308, 309; 174/68.5



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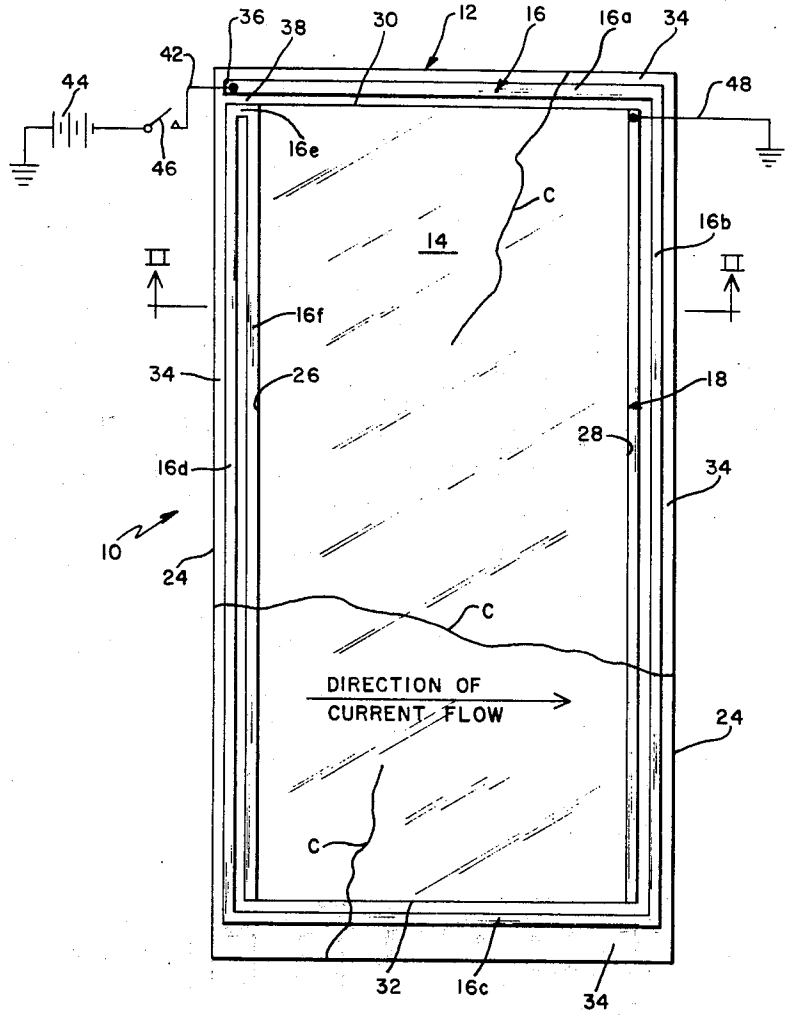
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[57] **ABSTRACT**

An anti-fogging, electrically heated, frangible panel or windowpane especially adapted to prevent electrical shocks to persons who might come in contact therewith after fracture or breakage. The pane includes an uncoated, insulating, marginal band which extends completely around a transparent, electrically conductive coating. An electric current conductive strip is adhered in the marginal band and extends substantially completely around the coating before contacting an edge thereof. Fracture or breakage of any portion of the windowpane severs the conductive strip at some point around the periphery of the pane preventing current flow through the coating.


**16 Claims, 2 Drawing Figures**



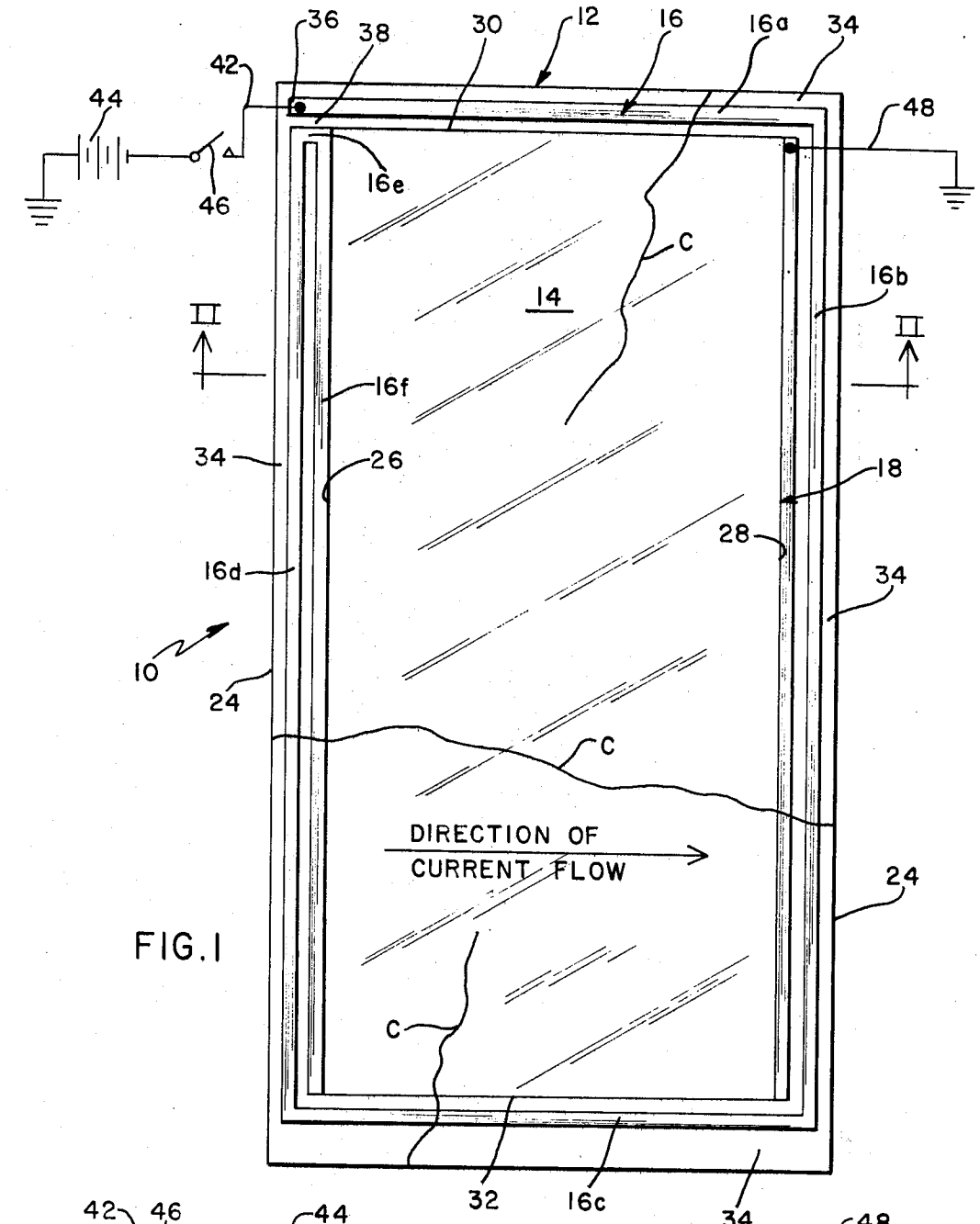

36
38
30
12
16
16a
34
42
44
48
16e
46
C
14
16b
16f
34
26
18
28
16d
34
10
24
C
DIRECTION OF
CURRENT FLOW
24
C
32
16c
34

FIG. 1

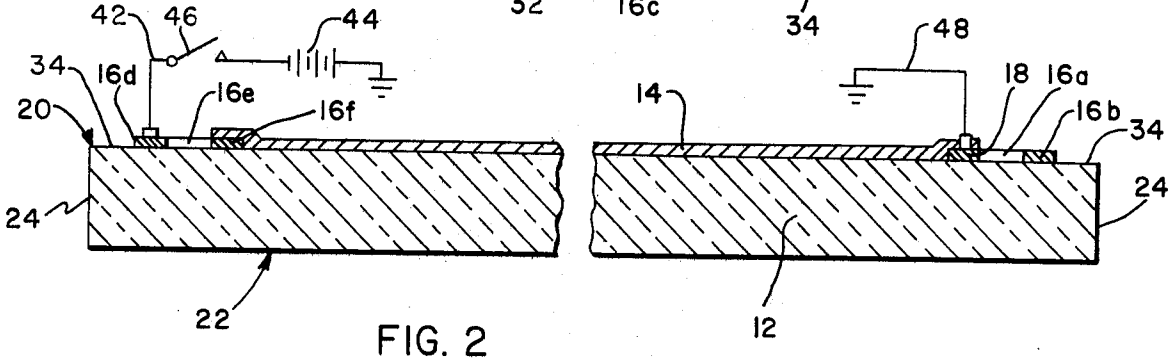

42
46
44
34
16d
16e
16f
20
24
22
14
48
18
16a
16b
34
24
12

FIG. 2

# ELECTRICALLY HEATED PANEL WITH ANTI-SHOCK CONDUCTIVE STRIPS

## BACKGROUND OF THE INVENTION

This invention relates to electrically heated frangible panels and especially electrically heated, anti-fogging windowpanes. More particularly, the invention relates to an electrically heated panel or windowpane including conductive strips arranged to prevent continued current flow and the occurrence of electrical shocks upon fracture or breakage of the panel or windowpane.

Electrically heated panels and windowpanes adapted to prevent the obstruction of vision due to fogging or the accumulation of condensation are very well known. Typically, such windowpanes or panels include transparent conductive coatings and conductive strips or bus bars arranged to conduct electricity to such coatings for heating the panel or windowpane. The conductive strips extend into contact with an elongated edge portion of the conductive coating such that electric current passes through the coating substantially over the entire area of the coating to produce uniform heating of the panel. A common use of such panels is in refrigerator or freezer doors to provide a means for viewing through the closed door even though a large temperature differential exists which otherwise causes the formation of condensation or fogging if the window were not heated.

A major problem encountered with such electrically heated windowpanes and other frangible panels has been the substantial shock hazard present in such windows upon their fracture or breakage. Such problem results when the pane of glass only partially breaks or fractures and the conductive strips allow the conduction of electricity through the conductive coating on at least a portion of the unbroken glass. Should a person come in contact with the conductive coating during such time, the person's body may act as a ground connection and the electrical current may pass through him or her, possibly resulting in severe injury.

Several attempts have been made in prior panels to overcome this substantial safety hazard. A first commonly known method is to connect appropriate electrical or electronic circuitry in series with the power supply supplying electrical current to the heated panel. The circuitry is responsive to a drop in either current flow or voltage which results from a partial breakage of the heated panel. When the current or voltage is reduced, the circuitry automatically opens shutting off the electricity. Not only does the provision of such circuitry add to the cost of such panels, but its reliability is often subject to question.

Another method is to position the electrical strips or bus bars conducting electricity to the electrically conductive coating so as to fracture and thus shut off current flow upon the breakage of the glass. One such panel is disclosed in U.S. Pat. Stromquist et al. No. 3,524,920. Although intended to prevent current conduction after any fracture of the glass, it has been found that the panels disclosed therein do not completely eliminate the shock hazards described above. With such panes, it is possible that the glass could fracture from the center of the pane outwardly through only a portion of one of the bus bars, leaving another portion of that same bus bar conducting electricity through a portion of the conductive coating thereby producing a serious shock hazard. Accordingly, the prior known



electrically heated panels and windowpanes have not completely overcome the hazard of electrical shock present therein when the windowpane or panel is broken.

## SUMMARY OF THE INVENTION

Accordingly, it is an object and purpose of the present invention to provide an electrically heated frangible panel or windowpane which substantially completely eliminates the possibility of shock hazard upon breakage of the pane or panel without dependence upon external circuitry or other components. The invention is especially useful in refrigerator or freezer doors as a means for preventing the accumulation of condensation or fogging on windows therein. The invention provides an arrangement of electrical current conducting strips designed to substantially completely and effectively break the electrical current path and prevent current flow through an electrically conductive coating on the window should breakage or even partial fracture of the panel or window occur.

In the preferred embodiment, the invention includes a sheet of transparent material, such as partially tempered or strengthened glass, which is capable of withstanding the application of sufficient heat to prevent fogging and condensation. The sheet includes transparent, electrically conductive coating applied to a portion of one surface thereof, the edges of the coating being spaced back from the peripheral edges of the sheet providing a marginal, insulating band or space extending completely around the sheet. At least one electric current conductive strip or bus bar is fused, bonded or otherwise adhered or applied to the marginal, uncoated, insulating band. The conductive strip extends substantially completely around the conductive coating to a position immediately adjacent its beginning point, from which it extends into electrical contact with the electrically conductive coating. Another electric current conductive strip is positioned across the electrically conductive coating on an edge thereof generally opposing the portion of the first strip contacting the coating to provide a current path which heats the conductive coating and the sheet or glass to which it is applied. Should breakage occur in any direction from the area of the glass covered by the coating outwardly through even one peripheral edge of the glass, the conductive strip extending around the glass will be severed at a position prior to its contact with the electrically conductive coating. Such severence prevents current flow through the coating and eliminates any possible shock hazards. Accordingly, effective use of the invention is dependent on nothing but the arrangement of the conductive strip thereby eliminating the need for any external circuit breakers, electronic circuitry, or the like for completely safe operation.

These and other objects, advantages, purposes, and features of the invention will become more apparent from a study of the following description taken in conjunction with the drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of the present invention including an insulated, electric current conductive strip extending substantially completely around an electrically conductive, transparent coating on a sheet of transparent material prior to its conductive contact with the conductive coating; and

FIG. 2 is a broken, sectional view of the electrically heated panel taken along plane II—II of FIG. 1.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in greater detail, FIG. 1 illustrates the preferred embodiment of the electrically heated panel or windowpane **10** including a sheet or plate of transparent material **12**, a transparent, electrically conductive coating or layer **14**, and a pair of electric current conductive strips or bus bars **16** and **18**. In accordance with the concept of the present invention, the conductive strips **16** and **18** are arranged such that strips **16** extend substantially completely around the electrically conductive coating **14** before extending into contact therewith. Any fracture of the transparent material will sever a portion of the strip or bus bar **16** prior to the location at which it extends into contact with the coating. Electric current flow through the transparent electrically conductive coating **14** is thus prevented in the event of breakage.

The sheet or plate of transparent material **12** is a sheet of annealed glass which becomes partially tempered or strengthened after application of the coating **14** and strips **16** and **18** during manufacture of the present invention. Sheet **12** has generally opposing, planar surfaces **20** and **22** and a peripheral edge **24** extending therearound. Other glass, including glass which is either annealed or fully tempered in its final form after application of coating **14** and strips **16** and **18** herein, may also be used. Although the material of the transparent sheet will typically be glass, other materials such as silica, ceramics, heat-resistant synthetic plastics, and other materials produceable in sheet form may be utilized. Also, it is not necessary to the operation of the invention that the sheet material be transparent although typically its use will be in windows which must be transparent. The only requirement is that the sheet material be capable of withstanding the heat produced in the electrically conductive coating **14** without deforming, melting, or softening.

Typically, the heat required to prevent fogging, misting, or condensation is determined for the area in which the present invention will be used. Then, the thickness of coating **14** is designed to provide the wattage per square inch of coating area required to produce such heat. Thereafter, a suitable sheet material is chosen to withstand the heat required for the particular application. Normally, the sheet will be glass which can withstand great amounts of heat. Typically, the current required for refrigeration applications is 5 to 20 watts per square foot at 110 volts. In applications where lower temperatures are encountered such as in ship windows or the like, up to 400 watts per square foot at 220 or 440 volts may be required. The coating thickness and sheet material thus depend on the desired application. Variables include the number of panels used, temperatures to be encountered, and the like.

As is best seen in FIG. 2, the transparent, electrically conductive coating **14** is applied or coated directly on the surface **20** of sheet **12** in only a portion of that surface area. In the embodiment shown in the drawings, sheet **12** is rectangular in shape and coating **14** is also applied in a rectangular area. Thus, coating **14** includes two sets of parallel edges **26, 28** and **30, 32** extending parallel to the peripheral edges **24** of sheet **12** but spaced inwardly therefrom. The spacing of the edges **26, 28, 30,** and **32** from the peripheral edges **24** defines an uncoated, insulated, nonelectrically conductive, marginal strip or band **34** extending about the entire periphery of sheet **12** and thus surrounding the coating **14**. The insulating band **34** provides a barrier to the conduction of electricity thereby limiting that condition to the coated area **14** on surface **20** of sheet **12.**

Coating **14** is typically applied in a layer several hundred angstroms thick (typically 300–400 angstroms). The thickness, of course, will depend on the wattage and heat desired to be produced on sheet **12** as mentioned above. One of any or several types of transparent coatings of various light transmissibility and conductivity such as tin, tinindium or tin-zinc coatings, or combinations thereof, may be used.

In accordance with the concept of the invention, the conductive strip **16** is applied or coated substantially in the middle of the marginal, uncoated band **34. Strip 16** includes a first portion **16***a*, including beginning end **36,** which extends parallel to coating edge **30.** Similarly, portions **16***b*, 16*c*, and **16***d* extend along and parallel to coating edges **28, 32,** and **26** respectively. As a position immediately adjacent the beginning end **36** of strip **16,** a short strip portion **16***c* extends perpendicularly to portion **16***d* into portion **16***f* of strip **16.** Strip portion **16***f* extends parallel to and in electrical contact with the entirety of edge **26** of coating **14.** The strip **16** is normally applied first to sheet **12** so that coating **14** actually extends up and over strip portion **16***f* for effective electrical contact (see FIG. 2). However, it is also possible to apply coating **14** to the sheet first followed by application of the strip **16** with portion **16***f* over the coating. Portion **16***f* is parallel to portion **16***d* and is substantially coextensive therewith although it is spaced and insulated therefrom by a portion of band **34.** Electric current conductive strip **18** is positioned across the conductive coating **14** in general opposition to portion **16***f* of strip **16** such that electric current will flow from portion **16***f* through coating **14** to strip **18** in the direction indicated in FIG. **1** at substantially all portions of the coating.

In the preferred embodiment, short portion **16***e* of strip **16** is spaced a distance less than or equal to the generally uniform width of the entirety of strip **16** from beginning end **36.** The spacing or gap **38** between end **36** and portion **16***e* may be made smaller than the strip width but it must be large enough to maintain sufficient insulation such that no current will flow thereacross. The usual electric current passes through strip **16** and coating **14** is small enough to prevent the current from sparking or jumping across gap **38,** i.e., approximately 5–20 watts per square foot at 110 volts, as mentioned above. Portions **16***a*, 16*b*, 16*c*, and **16***d* are also spaced a distance approximately equivalent to the width of the strip **16** from edge **30,** strip **18,** edge **32,** and edge **26,** respectively. Thus, strip **16** extends substantially completely around the entire coating **14** after which it extends into contact with one edge portion of the coating generally opposite the edge contacted by ground strip **18.**

Preferably, strips **16** and **18** are formed by applying a paste of silver, platinum, or other metals or conductive substances in the strip configuration in the marginal band **34** after which the paste is bonded or fused to the uncoated sheet surface **20** by the application of heat in a furnace or the like. Such heat causes the originally annealed glass sheet used in the preferred em-

bodiment to become partially tempered or strengthened. One of the many conductive substances suitable for making the conductive strips **16** and **18** is silver paste which may be commercially obtained from E. I. Du Pont de Nemours & Co. under the product designation Conductive Silver No. 7713.

## OPERATION

In operation, electric current is supplied to the strips or bus bars **16** and **18** by electrical conduction means including a wire **42** connected in series with a power supply **44** and a switch **46** for starting and stopping the current flow. The end of wire **42** is soldered or otherwise secured in electrical connection with end **36** of strip **16**. A ground wire **48** is soldered to one end of the ground strip **18** to complete the circuit. It is important that the power supply by connected to end **36** of strip **16** such that the current is forced to flow substantially completely around the conductive coating **14** in the various portions of strip **16** before passing through coating **14**.

Once switch **46** is closed, electric current flows through wire **42** and beginning end **36** of strip **16** through portions **16***a*, 16*b*, 16*c*, 16*d*, 16*e*, and **16***f* of strip **16**. The current is conducted from strip portion **16***f* through the electrically conductive coating **14** across all portions thereof to opposing portions of the electrical ground strip **18** such that the electrical potential or voltage between the respective portions of strip **16***f* and strip **18** is generally the same. Should the sheet of glass **12** be struck and fractured or broken in any way, such as along any of the hypothetical cracks C illustrated in FIG. **1**, the portion of the electrically conductive strip **16** through which the crack passes will be severed thereby interrupting the current flow through the remainder of the strip **16** following the crack. Since the partially tempered or strengthened glass preferably used in this type application will always crack outwardly to at least one edge of the sheet, the electric current conducting strip **16** will be severed at some portion prior to the contact portion **16***f* thereby effectively preventing any current flow through the conductive coating. The coating areas on the unbroken portions of the glass or panel are thus isolated from electric current upon the occurrence of virtually any breakage. Current flow is prevented transversely from strip **16** at the point of severance by the insulated spaces of the marginal band **34** on either side of the strip. Also, the present panels or windows are typically used alone or in multiple units wherein framing or other materials cover and insulate conductive strip **16** around the periphery of sheet **12** to prevent direct contact with the strip in such marginal areas.

Although it is conceivable that the sheet **12** could crack only through gap or space **38** thereby allowing continued electric current flow to coating **14**, the chances of that occurrence are so small as to be negligible. Although this is true for virtually any type of transparent sheet material useful in this invention, it is especially true with the originally annealed glass preferably used herein. The manufacturing process used to produce this invention results in the partial tempering or strengthening of the originally annealed glass, as mentioned above. Such strengthened glass typically fractures with a multiplicity of cracks in a "spider-web" pattern or the like. A single crack of the type and size necessary to pass only through gap **38** will, therefore, not normally occur.

While one form of the invention has been shown and described, other forms will now be apparent to those skilled in the art. Therefore, it will be understood that the embodiment shown in the drawings and described above is merely for illustrative purposes, and is not intended to limit the scope of the invention which is defined by the claims which follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

**1.** In an anti-fogging, heated windowpane of the type including a sheet of transparent glass having a pair of generally opposing, planar surfaces, a peripheral edge having a plurality of edge portions, and an electrically conductive, transparent coating applied to a portion of one of said surfaces, the improvement comprising the combination of an uncoated, insulating space extending around the entirety of said one surface of said sheet between the edge of said coating and said peripheral edge; a first elongated strip of electrically conductive material applied to said sheet within said uncoated, insulating space, said first strip having a beginning end located adjacent one portion of said peripheral edge of said sheet and extending around and being insulated from substantially all of the total length of the edge of said coating after which said strip includes a contact portion which extends into electrical contact with a predetermined length of a first portion of said edge of said coating; a second, elongated strip of electrically conductive material applied to said sheet in electric contact with a predetermined length of a second portion of said edge of said coating; said second portion of said coating edge and said second, elongated strip of electrically conductive material being spaced across said coating a predetermined distance apart from and in general opposition to said first portion of said coating edge and said contact portion of said first strip; electrical conduction means for conducting electricity to said first strip and for grounding said second strip, said conduction means engaging said first strip at said beginning end, whereby an electrical current transmitted from said first strip across said coating to said second strip for heating said coating and said sheet is automatically shut off upon fracture of said sheet anywhere along its length which causes a severance of said first strip along its length.

**2.** The improvement of claim **1** wherein said sheet is rectangular; said coating being rectangular with said coating edges extending parallel to said peripheral edges of said sheet and spaced back therefrom to define said insulated space, the edges of said coating including two sets of parallel, opposing edges, the edges in each of said sets being perpendicular to those of the other set; said first strip extending around three entire edges of said coating and substantially all of the fourth edge from said beginning end location in said insulating space to a position immediately adjacent said beginning end location, said contact portion of said first strip extending into electrical contact with the entirety of one of said coating edges in one of said sets from said position immediately adjacent said beginning end location; said second strip extending in electrical contact with the entirety of the remaining edge of said coating in said one set of edges.

3. The improvement of claim 2 wherein said contact portion of said first strip is parallel to, spaced from, and substantially coextensive with the portion of said first strip extending along said fourth edge of said coating.

4. The improvement of claim 1 wherein said first strip is positioned generally midway between said coating edges and said sheet peripheral edges in said insulated space except for said contact portion thereof which extends out of said insulated space into electrical contact with said first portion of said edge of said coating.

5. The improvement of claim 1 wherein said first and second strips comprise silver paste applied to said sheet in the desired locations, said sheet with said paste being heated to bond the paste to the sheet.

6. The improvement of claim 5 wherein said sheet of glass is annealed glass prior to deposition of said silver paste thereon, the heating of said sheet and paste causing said annealed glass to become partially tempered and strengthened.

7. The improvement of claim 1 wherein said windowpane further comprises partially tempered and strengthened glass.

8. An anti-fogging, electrically heated, panel comprising the combination of a sheet of frangible material and electric current conduction means for preventing the occurrence of electrical shocks upon breakage of the panel; said current conduction means including a layer of electrically conductive material applied to a portion of at least one surface of said sheet and defining a marginal, uncoated, insulating, electrically nonconductive band extending around the entirety of said sheet between the edge of said layer and the peripheral edges of said sheet, at least one elongated strip of electric current conducting material applied to said sheet within said marginal band and extending along said band substantially completely around said layer from a first portion to a second position immediately adjacent said first position, said one strip including a contact portion extending from said second position into electrical contact with a predetermined length of one portion of said edge of said layer, another elongated strip or electric current conducting material applied to said sheet in electrical contact with a predetermined length of another portion of said edge of said layer, said other elongated strip and other portion of said layer edge spaced a predetermined distance across said layer and generally opposing said one portion of said layer edge and said contact portion of said one strip, and electrical contact means for supplying electric current to said one strip at said first position and for grounding said other strip whereby current flow from said contact portion of said one strip across said layer to said other strip for heating said panel is automatically stopped upon fracture of said sheet causing severance of at least one portion of said one strip along its length between said first and second positions.

9. The panel of claim 8 wherein said one strip has a predetermined uniform width dimension along its length; said second position being spaced from said first position a distance no greater than said width dimension.

10. The panel of claim 9 wherein the portions of said one strip except for said contact portion are spaced from the edge of said layer a distance at least as great as said width dimension of said strip.

11. The panel of claim 9 wherein said electric current conducting strips are silver paste applied to said uncoated, marginal band of said sheet, said sheet and strips being heated to bond said strips to said sheet.

12. The panel of claim 11 wherein said sheet is a sheet of annealed glass prior to deposition of said silver paste thereon, the heating of said sheet and paste causing said annealed glass to become partially tempered and strengthened.

13. The panel of claim 8 wherein said panel further comprises partially tempered and strengthened glass.

14. The panel of claim 8 wherein said contact portion of said one strip is parallel to but spaced from another portion of said one strip.

15. The panel of claim 8 wherein said layer is rectangular, said generally opposing portions of said layer edge contacted by said contact portion of said one strip and said other strip including a pair of the edges of said rectangle which are parallel to and opposite one another.

16. The panel of claim 15 wherein said one strip extends around three entire edges and substantially all of the fourth edge of said layer rectangle, said contact portion of said one strip extending generally coextensively with, parallel to but spaced from a second portion of said one strip, said second portion of said one strip extending along said fourth edge of said layer rectangle within said marginal band adjacent said fourth edge.

* * * * *