United States Patent [19]

Newman et al.

[11] **3,876,862**

[45] **Apr. 8, 1975**

[54] **ELECTRICALLY-ENERGIZED GLASS PANEL AND CIRCUIT BREAKER COMBINATION**

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[22] Filed: **Feb. 27, 1974**

[21] Appl. No.: **446,429**

[52] **U.S. Cl.** **219/509;** 219/203; 219/522; 219/543

[51] **Int. Cl.** **H05b 1/02;** H05b 3/06

[58] **Field of Search** 219/202, 203, 509, 511, 219/522, 541, 543

[56] **References Cited**

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Primary Examiner—Volodymyr Y. Mayewsky
Attorney, Agent, or Firm—Howson & Howson

[57] **ABSTRACT**

An electrically-energized glass panel is provided with a circuit breaker connected in a main power circuit and operable in conjunction with a breakage-sensing circuit to interrupt the flow of current to the panel upon breakage thereof. The circuit breaker includes a solid-state electronic device having a control gate, and the sensing circuit includes a frangible strip disposed in a predetermined pattern on the panel. The sensing circuit is connected to the gate and the main power circuit and causes the device to conduct as long as the sensing circuit is continuous. However, when the panel breaks, one or more cracks propagate across the frangible sensing circuit to interrupt the same for de-energizing the control gate and thereby interrupting electrical power to the panel.

25 Claims, 10 Drawing Figures

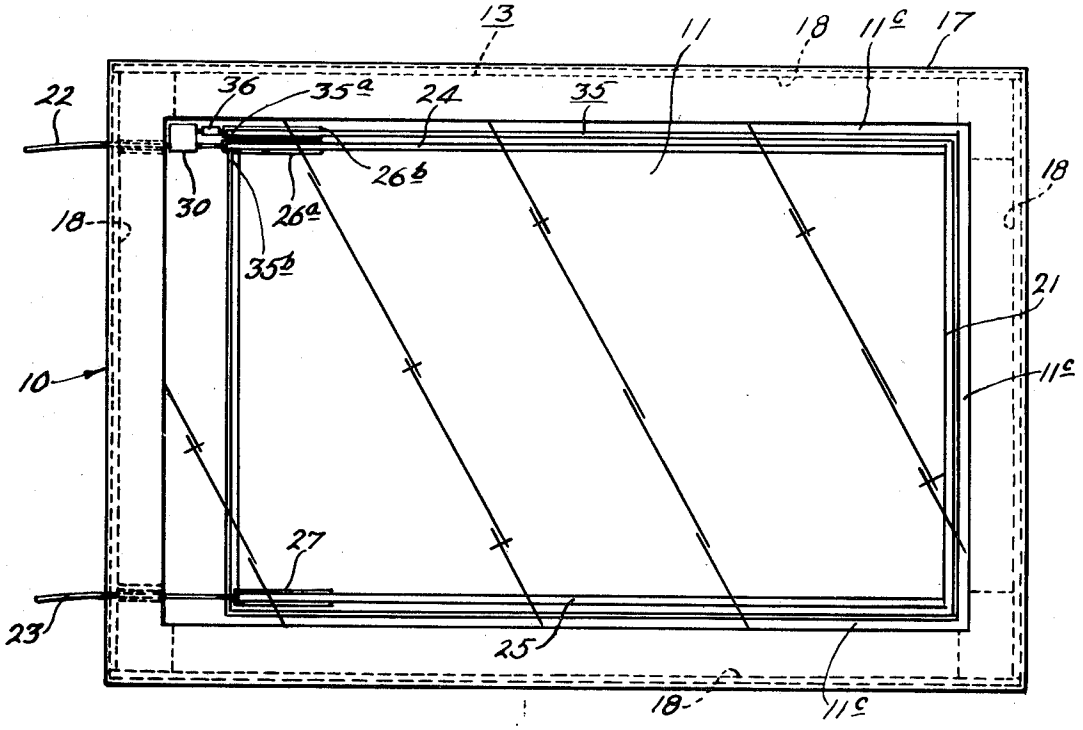


FIG. 1.

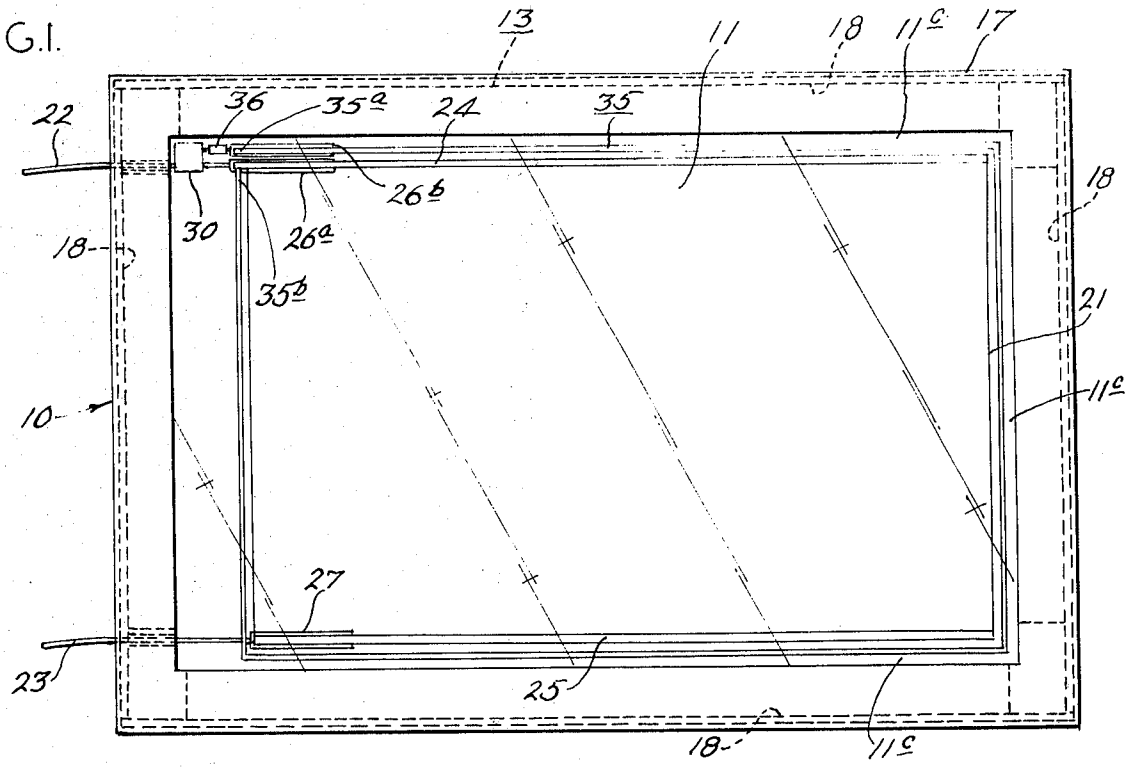


FIG. 2.

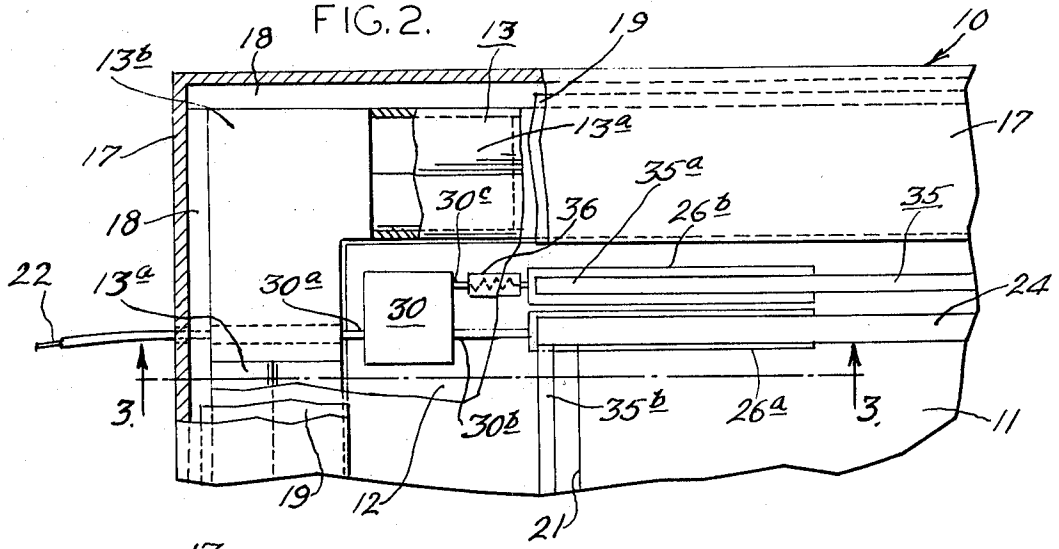


FIG. 3.

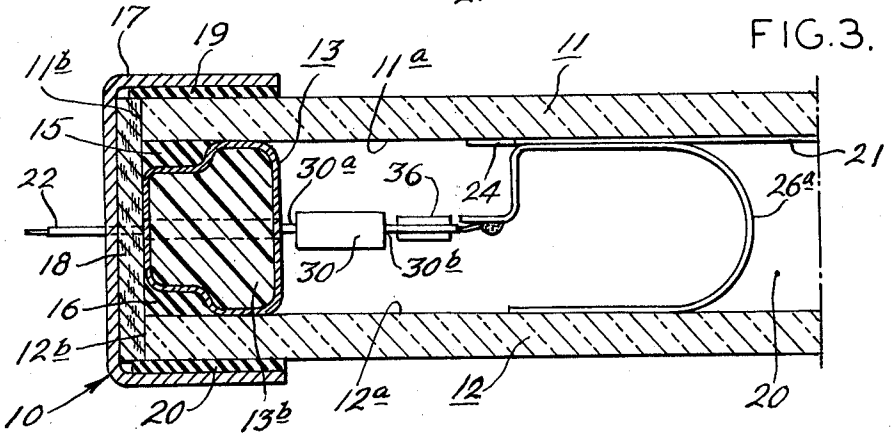


FIG. 4.

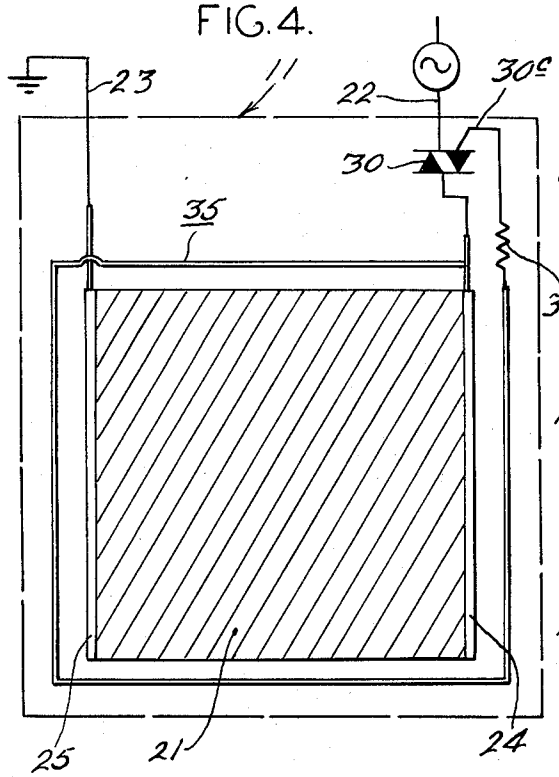
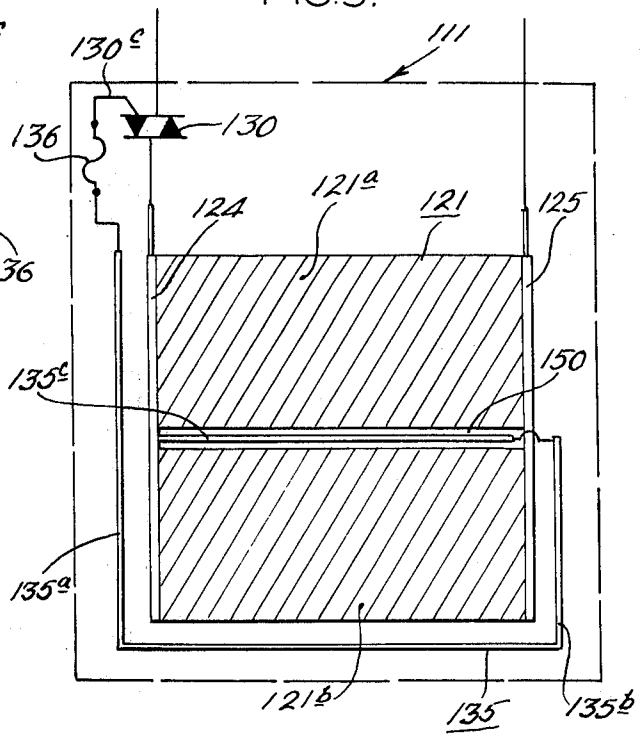


FIG. 5.



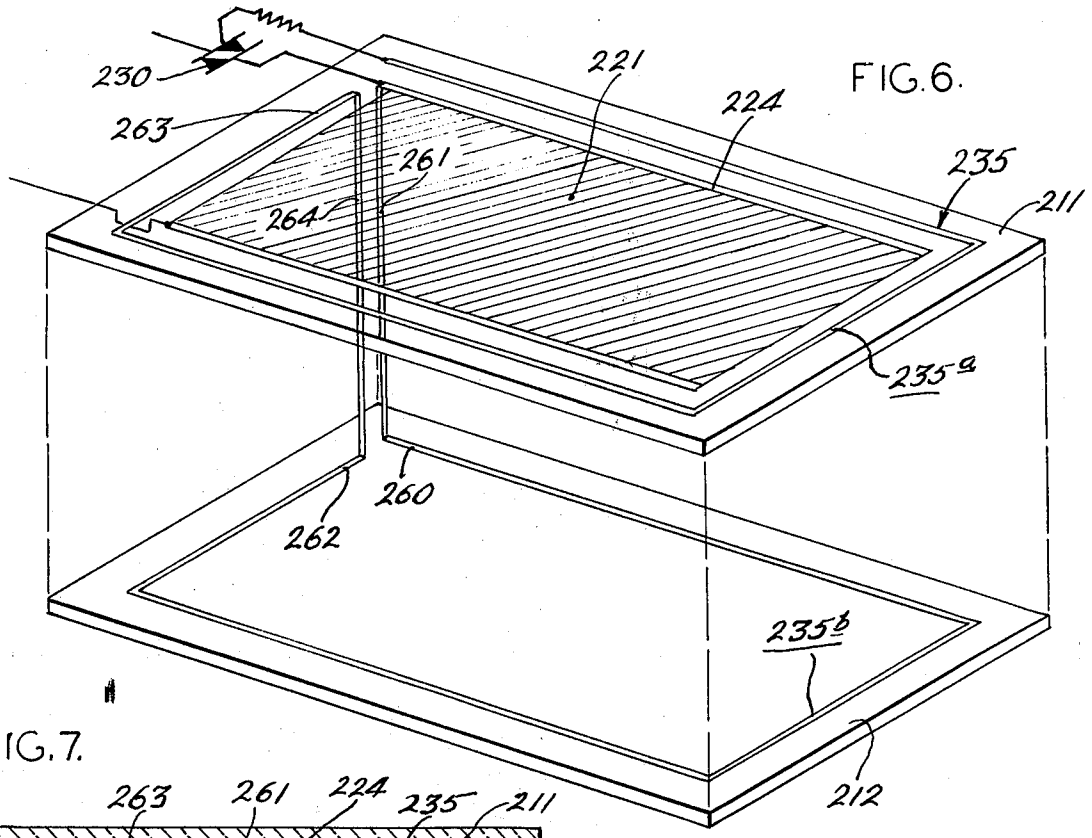


FIG. 6.

FIG. 7.

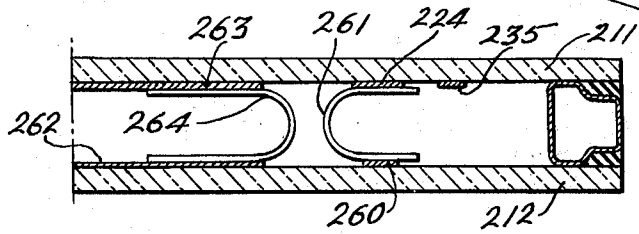


FIG.8.

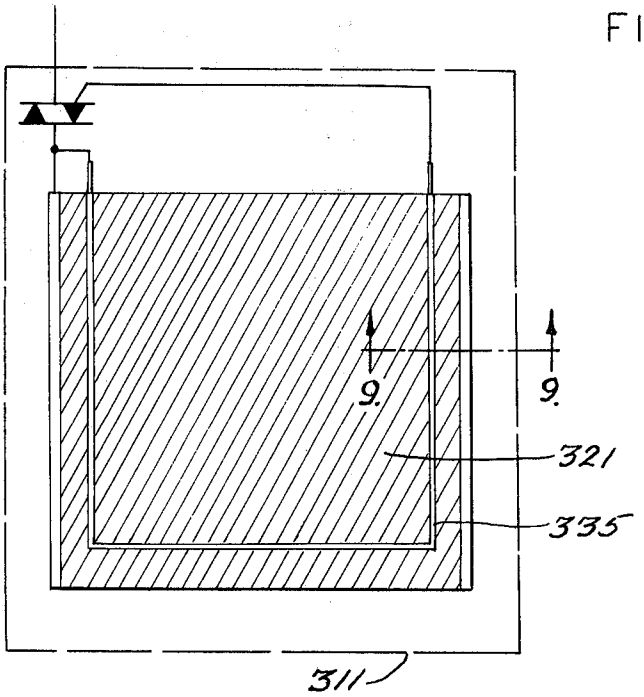


FIG.9

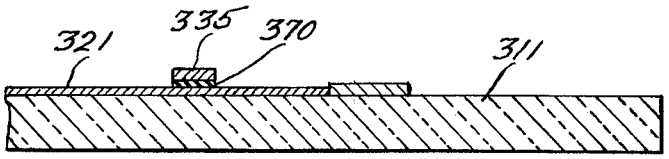
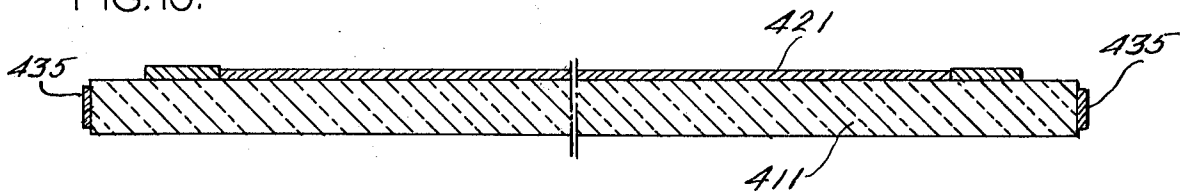


FIG. 10.



ELECTRICALLY-ENERGIZED GLASS PANEL AND CIRCUIT BREAKER COMBINATION

The present invention is described in Disclosure Document No. 024,829 filed Nov. 8, 1973.

The present invention relates to safety devices for glass panel structures; more particularly, the present invention relates to an electrically-heated glass panel having means for interrupting power to the panel in the event of breakage.

Electrically-heated insulated-glass panels are used in a variety of applications, such as in a refrigerated showcase in a supermarket. Because of the temperature differential between the inside of the showcase and the outside of the panel, it is necessary for the panel to be heated in order to prevent condensation from forming on the outside of the panel and obscuring the view of the contents of the showcase. In a typical panel, electrical current is flowed through a layer of electrical resistance material deposited between spaced bus bars on the inner surface of the outer panel.

Although the heated glass panel may function satisfactorily for its intended purpose, it presents a safety hazzard in the event of breakage. This is because it may be possible for a person to receive an electrical shock from accidentally contacting an electrically-energized one of the bus bars and/or the resistive layer. Accordingly, such a panel is not as safe in use as desired.

A circuit breaker has been provided for interrupting power to an electrically-heated panel upon breakage thereof. The circuit breaker is described in U.S. Pat. No. 3,760,157, and although the circuit breaker operates satisfactorily, it has certain limitations. For instance, the circuit breaker operates to detect changes in the flow of electricity through the resistive layer from a pre-set steady state value. The breaker includes a current-responsive solid-state device which operates to interrupt the flow of current in the event that the current falls below a predetermined limit such as would occur, for example, if a hole were to be formed in the resistive layer of the panel and the area of the resistive layer decreased. One drawback of the patented circuit breaker lies in the fact that it must be pre-adjusted for each panel in order to compensate for variations in the resistivity of the resistive layer due to manufacturing tolerances. Another drawback resides in the fact that the breaker must be reset in the event of a complete power loss to the panel, such as may occur if a store were to lose power during a storm. An additional limitation resides in the fact that the patented circuit breaker is relatively complex, and since it must be preset, it is not as inexpensive to manufacture and install as desired. Other known devices are relatively bulky, and they are difficult to install in such panels.

With the foregoing in mind, it is a primary object of the present invention to provide a novel circuit breaker for an electrically-energized glass pael.

It is another object of the present invention to provide an improved relatively compact circuit breaker for use with an electrically-energized frangible panel to interrupt power to the panel when the panel is cracked or broken.

Another object of the present invention is to provide a relatively simple circuit breaker which is relatively easy to install in an electrically-heated glass panel and which affords ready replacement of the panel in the event of breakage.

It is a further object of the present invention to provide an electrically-heated insulated-glass panel having a circuit breaker which automatically resets itself in the event of a loss of power to the panel.

Still another object of the present invention is to provide a unique circuit breaker structure which may be installed in a heated glass panel without requiring any pre-adjustment of the breaker.

These and other objects, features and advantages of the present invention should become apparent from the following description when taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a plan view of an electrically-heated insulated-glass panel having circuit breaker means embodying the present invention;

FIG. **2** is an enlarged fragmentary view of the upper lefthand corner of the panel illustrated in FIG. **1** with a portion of the panel being broken away to expose certain details of construction;

FIG. **3** is a sectional view taken along lines **3—3** of FIG. **2**;

FIG. **4** is a circuit diagram schematically illustrating the relationship of the circuit breaker and the frangible breakage sensing strip which surrounds the electrically energized area of the panel and which is connected to the circuit breaker;

FIG. **5** is a diagram similar to FIG. **4** but schematically illustrating a modified embodiment of the present invention;

FIG. **6** is a vertically-exploded perspective view of yet another modified embodiment of the present invention schematically illustrating means for detecting breakage of either of two panels and for interrupting power to a heated one of the panels;

FIG. **7** is an enlarged fragmentary sectional view illustrating means for connecting breakage sensing circuits in the embodiment illustrated schematically in FIG. **6**;

FIG. **8** is a schematic diagram of yet another modified embodiment of the present invention;

FIG. **9** is a transverse sectional view of the panel illustrated schematically in FIG. **8**; and

FIG. **10** is a view similar to FIG. **9** but of a further modified embodiment of the present invention.

Referring now to the drawings, FIG. **1** illustrates a window panel assembly **10** embodying the present invention. As best seen in FIG. **3**, the assembly **10** comprises an upper panel **11** of frangible material such as glass, and a lower panel **12** of like construction. The panels **11** and **12** have inner confronting surfaces **11***a* and **12***a*, respectively, and the panels are separated from one another by a hollow spacer **13** which is composed of straight sections **13***a* and corner pieces **13***b* which connect the straight sections at right angles as illustrated in FIG. **2**, The spacer **13** extends between the confronting surfaces **11***a* and **12***a* at the peripheries of the panels **11** and **12**. The spacer **13** is permanently sealed to the surfaces **11***a* and **12***a* by layers of mastic material **15** and **16** interposed between recesses in the spacer **13** and the inner surfaces **11***a* and **12***a* of the panels. A U-shaped metal frame **17** encloses the edges **11***b* and **12***b* of the upper and lower panels **11** and **12**, and a layer of cork **18** or other resilient thermally-nonconductive material **18** is interposed between the edges **11***b* and **12***b* of the panels and the frame **17**. In addition, layers of mastic **19** and **20** are interposed between outer peripheral margins of the panels **11** and **12**

and the frame **17** to provide a sealed air gap **20** between the panels **11** and **12.**

As noted above, there are instances when it is desirable for one, or the other, or both of the panels **11** and **12** to be heated in order to prevent moisture from condensing on the outer surfaces thereof. For this purpose, and as best seen in FIG. **1,** a layer of optically-transparent electrical resistance material **21** is provided in an area on one of the panels, such as the inner surface **11***a* of the upper panel **11,** and electrical power of alternating or direct current is supplied to the layer **21** by a main circuit having a positive voltage or "hot" line **22** and a ground or return line **23.** Preferably, the layer of resistance material extends between a pair of spaced parallel electrically-conductive bus bars **24** and **25** applied on the inner surface **11***a* of the panel **11.** In the illustrated embodiment, as best seen in FIG. **3,** the positive line **22** is connected to the positive bus **24** by a U-shaped spring clip **26***a* which is disposed between the panels **11** and **12** and which applies an outward pressure between the panels **11** and **12.** A similar spring clip **27** (FIG. **1**) is provided to electrically connect the ground bus **25** to the ground line **23.**

As described thus far, the window panel assembly **10** is conventional. Hence, when the power lines **22** and **23** are electrically energized, voltage is applied across the bus bars **24** and **25,** and current flows through the resistive layer **21.** As the current flows, heat is generated in the panel to prevent moisture from condensing on the outer surface of the panel **11.**

It is customary for the bus bars **24** and **25** to be energized with a 110–120 volt alternating current supply. Depending upon the resistivity of the layer **21,** its size, etc., a current of the magnitude of 1 ampere or more can be expected to flow from the positive bus bar **24** to the ground bus bar **25.** Since the panel **11** which is provided with the resistive layer **21** and the bus bars **24** and **25** is the one which is located outboard in a display case, it should be apparent that if the panel **11** were broken, and a person were accidentally to contact either the bus bar **24** or the resistive layer **21,** the person would receive an electrical shock which could be fatal to an adult, and probably would be fatal to a small child.

According to the present invention, the electrically-heated window **10** is provided with circuit breaker means **30** which operates to interrupt power to the positive voltage bus **24** and the resistive layer **21** in the event of breakage of the panel **11.** In the embodiment illustrated in FIG. **1,** the circuit breaker means **30** includes a solid-state electronic device which is mounted inside the frame **17** adjacent the upper lefthand corner thereof. The circuit breaker **30** has an input **30***a*, an output **30***b*, and a control gate or trigger **30***c*. As best seen in FIG. **2,** the input **30***a* is connected to the positive voltage line **22,** and the output **30***b* is connected to the spring clip **26** and hence to the bus bar **24.** Preferably, the circuit breaker **30** is normally nonconductive in the absence of a small amount of voltage and current applied to its input **30***a* and its gate **30***c*. A class of devices which may be utilized satisfactorily include thyristors such as silicon control rectifiers (for D.C. supply) and triacs (for A.C. supply). In a silicon control rectifier, the anode is the input **30***a*; the cathode is the output **30***b*; and the gate is the trigger **30***c*. In a triac, the main terminal one is the input **30***a*; the main terminal two is the output **30***b*; and the other terminal is the gate **30***c*. A triac has been tested and found satisfactory and is preferred.

In the present invention, a breakage-sensing circuit is associated with a triac **30** and the main power circuit to cause the same to conduct electricity to the resistive layer **21** until such time as the panel **11** breaks. To this end, the breakage sensing circuit includes an elongated relatively-narrow frangible strip of electrically-conductive material **35** (FIG. **1**) which is deposited in a predetermined continuous pattern on the inner surface **11***a* of the panel **11** adjacent the resistive layer **21.** In the embodiment of FIGS. **1–4,** the frangible strip **35** has one end **35***a* connected through a resilient clip **26***b* and a current-limiting device **36** to the control gate **30***c* of the triac **30.** Both the output clip **26***a* and the gate clip **26***b* extend away from the triac in spaced relation and cooperate with the corner member **13***b* to provide means for mounting the triac centrally in the gap between the panels and adjacent the frame. The spring clips **26***a*, **26***b* and **27** also afford ready removal and replacement of the outer panel **11** and connection of the traic **30** in the breakage sensing circuit and the resistive means. As best seen in FIG. **1,** the frangible strip **35** has a pattern which surrounds substantially the entire resistive area **21,** and the strip **35** has another end **35***b* which is preferably connected to the positive bus **24** adjacent the output **30***b* of the triac **30.** The panel **11** has a peripheral margin **11***c* which surrounds the layer **21** and which spaces the same from the frame **17,** and the frangible strip **35** is located in the margin **11***c* intermediate the layer **21** and the frame **17** and is spaced outwardly of the area **21.** Hence, both the area **21** and the strip **35** are electrically insulated from the frame and from one another.

In operation, power applied across the lines **22** and **23,** causes the triac **30** to conduct by virtue of the continuity of the frangible strip **35** which supplies triggering voltage to the triac gate **30***c*. The triac **30** thereby applies a voltage across the busses **24** and **25** to flow current through the resistive layer **21** for heating the panel **11.** The current flows as long as the panel **11** remains unbroken. When the panel **11** is struck by a hard object, however, one or more cracks propagate outwardly from the point of impact, and the cracks extend across the frangible strip **35** and rupture the strip to remove triggering voltage from the gate **30***c* of the triac. When the triggering voltage to the gate **30***c* of the triac is removed, the triac **30** ceases to conduct, and power to the positive bus **24** is interrupted. Thus, it would not be possible for a person to receive an electrical shock by touching either the positive bus **24** or the resistive layer **21** after the panel **11** is broken.

In the above-noted embodiment, the frangible strip **35** extends around substantially the entire periphery of the heated area **21.** Although arrangement of the frangible strip **35** in such a pattern is desirable because the strip **35** is likely to be intersected by a crack propagated in any direction from the area **21,** it is possible to arrange the frangible strip **35** in different patterns on the panel **11** as long as one end of the frangible strip **35** is connected to a triggering voltage supply and the other end is connected to the gate of the triac. For instance, as best seen in FIG. **5,** a modified embodiment of the present invention is provided wherein a panel **111** has a resistive layer **121** which is divided into two sections **121***a* and **121***b* by a narrow uncoated zone **150** which extends transversely between a positive bus **124**

and a ground bus **125**. A frangible strip **135** of electrically-conductive material extends around a major portion of the area **121**, having one portion **135***a* to the left of the layer **121** and another portion **135***b* to the right of the layer **121**. The right portion **135***b* terminates intermediate the length of the left portion **135***a* adjacent the zone **150**. The frangible strip also has a portion **135***c* which extends in the zone **150** and which is connected at one end to the positive bus **124** and at the other end to the upper end of the right hand portion **135***b* of the frangible strip as by a spring clip bridging across the bus **125**. With this structure, the transverse portion of the frangible strip **135***c* is electrically insulated from the layers **121***a* and **121***b* by the uncoated space on opposite sides thereof, and since the frangible strip **135***c* is located centrally of the panel **111**, it is capable of detecting cracks which may not, for some reason, propagate to the periphery of the panel **111**.

In the embodiments illustrated schematically in FIGS. **4** and **5**, the triacs **30** and **130** interrupt power to the positive buses **24** and **124**, respectively. If the frangible strips were connected directly to the gates **30***c* and **130***c* of the triacs **30** and **130**, respectively, and the panel were broken, there would be the possibility that a person could receive an electrical shock by touching the strip **35** or **135** between its break and the triac. In order to prevent this, there is provided means to limit the current flow in each frangible strip to a level below about 0.010 amperes which corresponds substantially to the current which causes a person to feel a mild sensation of pain. In the embodiment illustrated in FIG. **4**, the current limiting means **36** is provided by a resistor having a value in the range of 10,000 to 20,000 ohms, and preferably 15,000 ohms, when the line voltage is the customary 110–120 volts. In the embodiment illustrated in FIG. **5**, the current limiting means **136** is provided by a fuse which blows when the current exceeds the above-noted value. By employing either of these two current limiting means, or their equivalents, it would not be possible for a person to receive a shock by touching the strip after the panel is broken.

If desired, yet another embodiment of the present invention may be provided wherein power to the heated area is interrupted upon breakage of either one or the other of the glass panels in the assembly. This embodiment is illustrated schematically in FIG. **6**. As seen therein, the frangible breakage-sensing circuit **235** has a portion **235***a* which surrounds the resistive layer **221** on the lower surface of the upper panel **211**, and the breakage-sensing circuit has another portion **235***b* which is disposed on the upper surface of the lower panel **212**. The upper portion of the sensing circuit **235***a* is disposed on the panel **211** and connected to a triac **230** in a manner similar to the embodiment of FIG. **4**. The lower portion **235***b* of the sensing circuit, on the other hand, has an end **260** which terminates across from the positive bus **224** and which is connected thereto by a resilient U-shaped spring member **261** which extends across the gap between the two panels and which applies an outward pressure to the end and the bus. The lower portion of the sensing circuit **235***b* has a termination **262** adjacent the termination **263** of the upper portion **235***a*. The terminations **262** and **263** are electrically connected by a U-shaped spring clip **264** which extends across the gap between the panels, as the clip **261**. Thus, the upper portion **235***a* is connected in series with the lower portion **235***b* in the triac gate circuit. With this structure, breakage of the upper panel **211** causes a crack to interrupt current flow through the upper portion **235***a* of the frangible sensing circuit, and breakage of the lower panel **212** causes a crack to interrupt current flow through the lower portion **235***b* of the sensing circuit. Interruption of either portion interrupts power to the bus **224** on the heated panel **211**.

A further embodiment of the present invention is illustrated schematically in FIG. **8**. As seen therein, a frangible breakage sensing strip **335** is superimposed on a resistive coating **321** on a panel **311** and is electrically insulated therefrom by means of a frangible layer of insulating material **370** (FIG. **9**). In this embodiment, the strip **335** has a U-shaped configuration and is located completely interiorily of the coated area rather than exteriorily as in the aforementioned embodiments.

Still another embodiment is illustrated in FIG. **10** wherein a breakage sensing strip **435** is located on the peripheral edge of a frangible panel **411**, the glass of the panel insulating the strip **435** from the resistive area **421**.

In each of the illustrated embodiments, the breakage-sensing strip is connected to the output side of the triac. It could, of course, be connected to the input side; however, an additional resistor would have to be provided in the sensing circuit adjacent its connection to the input if a comparable margin of safety is to be provided. Also, the breakage-sensing strip could be connected to the ground line; however, this would have the effect of consuming more power. Preferably, the value of the current limiting means is selected so that the triac conducts during at least about a 95 percent of the alternating current cycle.

One of the advantages which flows from the use of a triac resides in the fact that the circuit breaker does not have to be preadjusted to compensate for variations in the resistivity of the resistive layer. Another advantage lies in the fact that the triac is rendered conductive upon application of power to the main circuit, thereby avoiding the necessity of resetting the circuit breaker in the event of a complete power loss. Also, the triac is commercially available at relatively moderate prices enabling a completely safe window to be manufactured relatively inexpensively.

Preferably, the frangible breakage-sensing strip is an electrically-conductive paint such as an air dried or epoxy type applied directly on the surface of the panel. Since only a small current flows through the sensing strip, the circuit breaker arrangement of the present invention is capable of interrupting power even when the panel is merely cracked. For instance, if the frangible strip were to surround the resistive area and were arranged to conduct the full current to the positive bus bar, it is possible that breakage of the panel would not interrupt power to the resistive layer because the current flow through the frangible strip may tend to cause the strip to arc when interrupted, thereby continuing to power the bus. Depending on the location of the sensing circuit strip relative to the window frame, such arcing could also present a fire and/or electric shock hazard.

In view of the foregoing, it should be apparent that the present invention provides a novel circuit breaker arrangement for an electrically-energized insulated

glass panel. The circuit breaker arrangement is relatively simple and does not have to be pre-adjusted when the panel is manufactured. Moreover, the circuit breaker is automatically resetable in the event of an interruption in power. The present invention also provides means for detecting breakage of one or the other of a pair of panels to interrupt power to an electrically-energized one of the panels.

While preferred embodiments of the present invention have been described in detail, various modifications, alterations and changes may be made without departing from the spirit and scope of the present invention as defined in the appended claims.

We claim:

1. In combination with a frangible panel having an electrically-energizable layer secured thereto in coplanar relation and main circuit means for supplying electrical power to said layer, the improvement comprising: circuit breaker means connected in said main circuit for interrupting electrical power to said electrically-energizable layer upon breakage of said panel, said circuit breaker means having electrically-actuated control means for causing the breaker means to conduct electricity when said main circuit means is energized; and frangible sensing circuit means carried by said panel to detect breakage thereof, said sensing circuit including an elongated strip arranged in a continuous pattern on said panel and extending around at least a substantial portion of said energizable layer, and including means electrically insulating said strip from said energizable layer, said frangible strip being connected to said control means and said main circuit means for supplying electrical energy to said control means for rendering said breaker means conductive as long as said frangible strip is continuous and for interrupting electrical energy to said control means when said panel breaks and a crack propagates across the frangible strip to fracture the same, whereby power to the layer is interrupted.

2. Apparatus according to claim **1** wherein said circuit breaker means includes a normally nonconductive solid-state device and said control means includes a trigger gate in said device operable to render said breaker means conductive, said breakage sensing circuit means having one end connected to said gate and another end connected to said main circuit means.

3. Apparatus according to claim **2** wherein said solid-state device has an input and an output and said other end of said control circuit means is connected to the main circuit means at the output side of said solid-state device.

4. Apparatus according claim **3** wherein said main circuit means includes a voltage line and said solid-state device is connected in said voltage line and is operable upon application of a voltage to its input and trigger to conduct electrical power to said layer.

5. Apparatus according to claim **4** wherein said solid-state device includes a selected one of a class of thyristor devices.

6. Apparatus according to claim **5** wherein said selected thyristor is a triac.

7. Apparatus according to claim **1** including means connected in said breakage sensing circuit means to limit current flow therethrough to less than about 0.010 amperes.

8. Apparatus according to claim **7** wherein said current limiting means is connected in said breakage sensing circuit adjacent said control means.

9. Apparatus according to claim **8** wherein said current limiting means includes a fuse.

10. Apparatus according to claim **8** wherein said current limiting means includes a resistor.

11. Apparatus according to claim **1** wherein said layer is disposed on one side of said panel and said sensing strip is superimposed in said pattern on said layer with said electrical insulating means interposed between said layer and said strip.

12. Apparatus according to claim **1** wherein said panel is fabricated of an electrical insulation material and has a margin surrounding said energizable layer and said sensing circuit strip is disposed in said margin and is separated from said energizable layer with said panel providing said insulating means.

13. Apparatus according to claim **12** wherein said electrically-energizable layer includes a bus bar connected to said circuit breaker means and located inboard of said elongated strip, said strip extending around a major portion of said energizable layer and having one end connected to said bus bar and another end connected to said breaker control means.

14. Apparatus according to claim **13** wherein said strip extends around substantially the entire area of said layer, and said one strip end connects to said bus bar adjacent one end of the bus bar.

15. Apparatus according to claim **13** wherein said strip has a portion extending across said layer and its one end connects to said bus bar intermediate the ends of the bus bar.

16. Apparatus according to claim **15** wherein said energizable layer includes another bus bar extending alongside said one bus bar with said layer being disposed on said panel between said bus bars and connected thereto, said strip portion extending transversely to said bus bars.

17. Apparatus according to claim **16** wherein said energizable layer is divided into two sections by a narrow zone extending between said bus bars, and said strip portion is located in said zone and spaced from said sections with the spacing insulating the strip portion from the sections.

18. Apparatus according to claim **1** including another frangible panel spaced from said first-mentioned panel with a gap therebetween, said breakage sensing circuit strip having one portion associated with the first-mentioned panel and another portion associated with said other panel, and including means connecting said one portion in series with the other portion, whereby breakage of either panel may be detected to interrupt power to the energizable layer.

19. Apparatus according to claim **18** wherein said panels have confronting inner surfaces and said strip portions are disposed on said surfaces, said connecting means including resilient means extending across said gap and engaging said strip portions with an outward pressure to electrically connect said portions.

20. Apparatus according to claim **19** wherein layer includes a bus bar on the inner surface of said first panel, said one portion of said sensing strip surrounding a substantial portion of said layer and having one termination, said portion of said sensing strip on said other panel having a termination across from said one termination on said first panel and having an end located across from said bus bar on said first panel, said resilient means including one spring element connecting

said terminations and another spring element connecting said end to said bus bar.

21. Apparatus according to claim **1** including a panel spaced from said first-mentioned panel, spacer means interposed between said panels to space the panels apart by a gap, frame means surrounding the peripheries of the panels, and means mounting said circuit breaker means in said gap between said panels adjacent said spacer.

22. Apparatus according to claim **21** wherein said circuit breaker means includes a solid state device having output and gate terminals located inwardly of said spacer, and said mounting means includes a pair of resilient clips extending away from said terminals in spaced relation; said energizable layer and sensing strip having terminal portions located on the inside of said panel and said clips contacting said terminal portions with an outward pressure.

23. Apparatus according to claim **22** wherein said electrically-energizable layer is located inwardly of said spacer means, and said frangible sensing strip is located on said panel intermediate said layer and said spacer means.

24. Apparatus according to claim **1** wherein said frangible breakage sensing strip includes a layer of metallic paint applied onto said panel.

25. Apparatus according to claim **1** wherein said panel has a peripheral edge surrounding said layer, and said breakage sensing strip is located on said edge.

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