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[54] **ELECTRICALLY HEATED MULTIPLE GLAZED WINDOW**
21 Claims, 1 Drawing Fig.

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[56] **References Cited**
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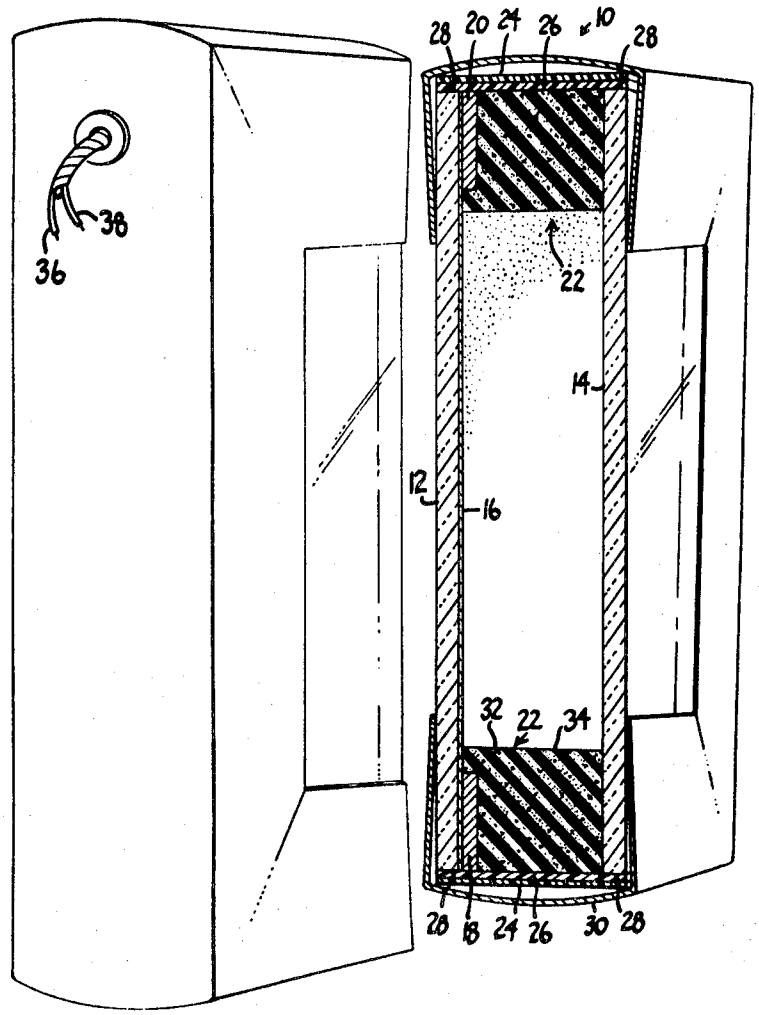
ABSTRACT: A heated, multiple glazed insulating unit having a marginal edge spacer element composed of electrically insulting material.



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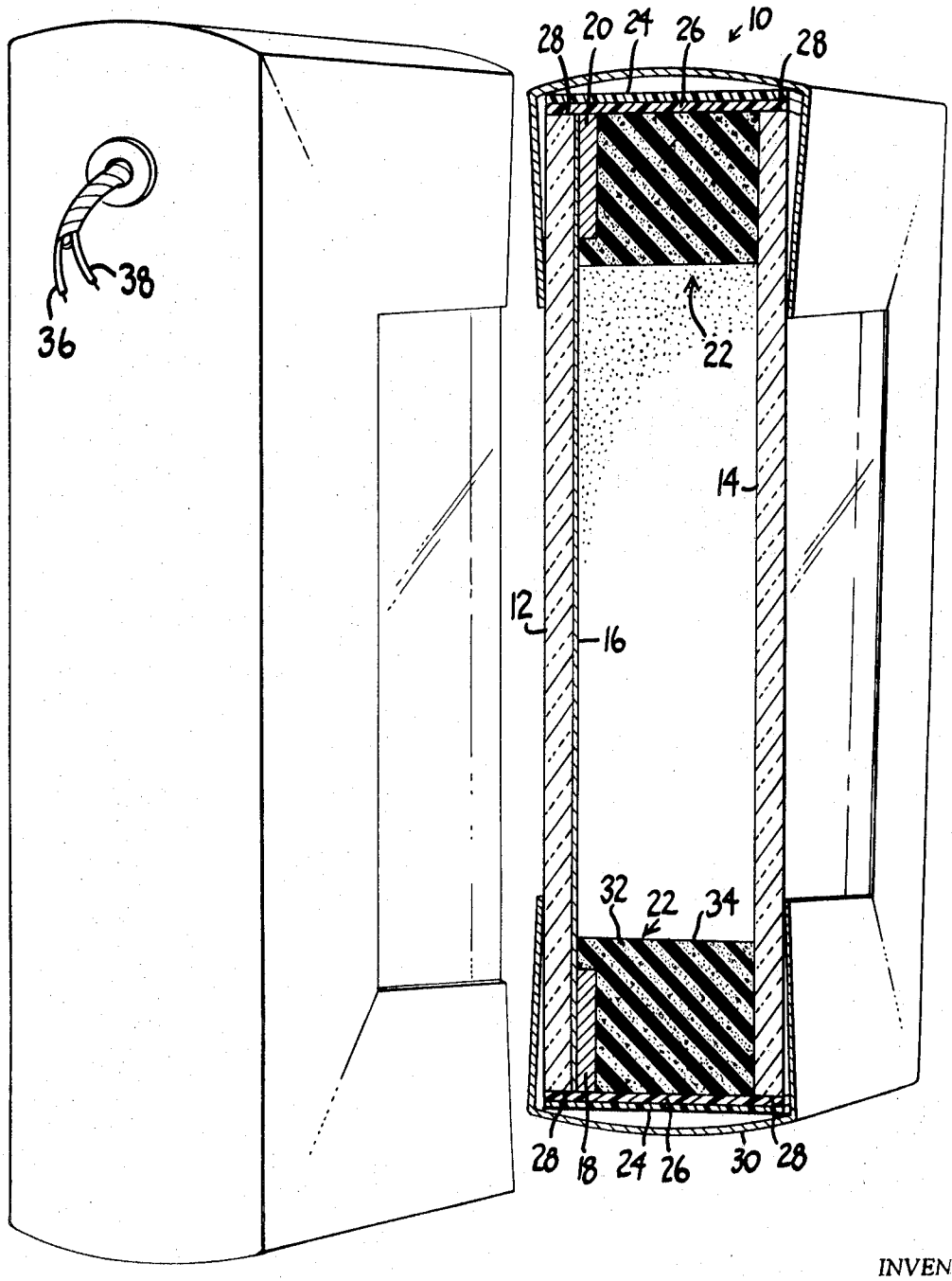

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ELECTRICALLY HEATED MULTIPLE GLAZED WINDOW

BACKGROUND OF THE INVENTION

This invention relates to an electrically heated multiple glazed unit and, more particularly, to a multiple glazed unit having a marginal edge spacer element separating a pair of glass sheets and an electroconductive heater, such as an electroconductive film, attached to bus bars and to the inner or air space surface of at least one of its glass sheets. In accordance with the present invention, the marginal edge spacer is an electrically insulating element that contains a desiccant.

Moreover, in the preferred practice of this invention, the bus bars are disposed in the same marginal glass sheet area occupied by the adjacent spacer and thus are in a position to be readily concealed from view by a peripherally surrounding frame and/or mounting sash. In addition, in accordance with this invention the bus bars can, but need not necessarily, be rigidly affixed with respect to the electroconductive heating circuit. In at least one aspect of this invention, the spacer is a flexible or resilient member that compressively supports the bus bars, under slight pressure, in physical contact only with the electroconductive heater. Accordingly, the spacer component of the multiple glazed unit of this invention can be used not only to separate the glass sheet components of the unit and dehydrate the air space therebetween, but also to: electrically insulate the electroconductive heater from any metallic frame and/or mounting sash that may be provided for the unit; hide or completely conceal the bus bars; support and uniformly apply pressure to bus bars held only in pressure contact with the electroconductive heater; eliminate the need to delete electroconductive film away from marginal edge portions of the filmed surface of a glass sheet substrate and/or remove oversprayed film material from the exterior surface of a glass substrate; and eliminate the procedures required to rigidly affix bus bars with respect to the electroconductive heater, if so desired.

The foregoing and other objects, features and advantages of this invention will become more apparent from the description that follows, when taken in conjunction with the drawing, which is a perspective view, partly in section, of a multiple glazed unit embodying the principles of this invention.

In the drawing, there is shown a typical electrically heated multiple glazed unit of this invention. As shown, multiple glazed unit **10** is comprised of two sheets of glass **12** and **14** arranged in parallel relationship and spaced from one another to provide an insulating air space between the sheets. The glass sheets **12** and **14** may be tempered, colored, laminated, tinted, coated, or have other special strength, optical or solar control properties.

As is further illustrated, glass sheet **12** is provided with an electroconductive heater which comprises a transparent electroconductive coating or film **16** on its inner or air space surface. Electroconductive film **16** is provided to heat the adjacent glass sheet substrate **12**. The principal reason for this type of unit construction is that these units are intended to be used to fenestrate areas occupied by people to provide an insulating window that has its interior glass sheet heated to avoid discomfort due to air drafts and/or a glass panel that is heated to eliminate formation of condensation thereon.

In connection with the present invention, any desired method may be employed to provide an electroconductive heater, such as film **16**. For example, one preferred method that may be employed, in which a transparent, electroconductive, copper film having excellent solar control properties is deposited on a glass sheet surface, is fully disclosed in application Ser. No. 636,464, filed May 5, 1967, and assigned to the assignee of the present invention. Another method that may be used, in which a transparent electroconductive tin oxide film is provided on a glass sheet substrate, is fully disclosed in U.S. Pat. No. 3,107,177, also assigned to the assignee of the present invention. Accordingly, the disclosures of both of the above inventions are specifically relied upon and incorporated herein by reference. Other methods that may also be used include sputtering and vacuum deposition of electroconductive films, as well as methods for providing an electroconductive circuit comprised of fine wires and the like, such as disclosed in U.S. Pats. Nos. 2,813,960 and **2,932,710**. Thus, it is within the contemplation of this invention that any electroconductive heater or film may be used and any means or method may be employed to produce the desired heating circuit.

As is shown in the drawing, glass sheet **12** and, more particularly, electroconductive film **16** is also provided with a pair of bus bars **18** and **20** located on opposite marginal edge portions of the glass sheet and in electrical contact with the transparent electroconductive film. For reasons that will become more apparent hereinafter, bus bars **18** and **29** may, but need not necessarily, be rigidly affixed to glass sheet **12** and/or to electroconductive film **16**. Also, other arrangements of the bus bars than the one shown, including the use of additional bus bars on glass sheet **14** interconnected with the bus bars on glass sheet **12**, may be employed if desired. As will be obvious, the bus bars **18** and **20** are connected to wires **36** and **38** in a suitable manner to conduct current from an outside source (not shown) to the film **16** and thereby heat the film and its adjacent glass sheet substrate.

In accordance with the preferred practice of the present invention, the glass sheets **12** and **14** are separated at their marginal edges by an electrically insulating spacer-dehydrator element **22**. The spacer-dehydrator element **22** shown has an essentially rectangular cross-sectional shape and extends completely around the periphery of each of the glass sheets **12** and **14** in contact with the marginal inner surface portions thereof. Along those opposite marginal edges of glass sheet **12** that are provided with bus bars **18** and **20**, spacer-dehydrator element **22** preferably abuts the bus bars and occupies essentially the same glass sheet area as that occupied by the bus bars.

Although spacer-dehydrator element **22** is not shown as being adhered to the adjacent marginal surface portions of glass sheets **12** and **14** and/or adjacent surface portions of bus bars **18** and **20**, it is within the contemplation of this invention that it could be so adhered, preferably by a continuous film or bead of an adhesive, moisture-resistant, nonelectrically conductive mastic composition that would provide a primary hermetic seal for the unit. In lieu of or in addition to the provision of a primary hermetic seal, there is shown a flexible, moisture-resistant strip **24** having a bead or layer of moisture-resistant, nonelectrically conductive mastic composition **26** adhered thereto and to the peripheral edge of spacer-dehydrator element **22** and the peripheral edges **28** of the glass sheets. Strip **24** and mastic composition **26** extend completely around the perimeter of the unit **10**.

Also shown extending completely around the perimeter of the unit **10** is a rigid frame member **30** of essentially U-shaped cross section. Frame member **30** is generally composed of several sections of metal channeling that are joined or butted together at their ends. The angle that the flanges or sides of the channel members form with the central or web portion of the channel members is slightly less than 90°. When the channel members are affixed to the edges of the glass sheets, these sides are held apart to allow the glass to be inserted therebetween. These sides are then released and they spring back into contact with the faces of the glass sheets. The channel member is thus held on under tension or, stated differently, exerts a slight compressive force on the components of the unit disposed therebetween. Accordingly, while frame member **30** obviously protects the edges of the glass sheets, it also serves to compressively hold the unit together, particularly where a mastic or adhesive is not employed to hermetically seal spacer-dehydrator element **22** to the inner surfaces of glass sheets **12** and **14** and/or adjacent surface portions of bus bars **18** and **20**. Moreover, the compressive holding force exerted by frame member **30** is sufficient to support bus bars **18** and **20** in positive electrical contact with film **16** without the necessity of rigidly affixing the bus bars with respect to

film **16**, as by soldering the bus bars to film **16** or firing metal-ceramic bus bars on glass sheet **12**.

The spacer-dehydrator element **22** shown is composed of a desiccant material **32** dispersed in an electrically insulating, moisture vapor transmittable, matrix material **34**. The electrically insulating, moisture vapor transmittable, matrix material **34** functions to provide an electrically insulating spacer, as well as providing the required communication between the air space of the unit **10** and the desiccant material **32**, so that moisture from the air within the unit will be adsorbed by the substantially uniformly dispersed desiccant. In addition to the foregoing properties, matrix material **34** is preferably also a material that is flexible or readily conformable at room temperature to any shape or contour that may be encountered, such as by compressively conforming to or about adjacent surface portions of bus bars **18** and **20**.

One preferred spacer-dehydrator element that exhibits all of the foregoing properties is disclosed in application Ser. No. 749,758, filed Aug. 2, 1968 and assigned to the assignee of the present invention. In accordance with application Ser. No. 749,758, the disclosure of which is specifically relied upon and incorporated herein by reference, spacer-dehydrator element **22** is preferably a thermoplastic, elastomeric member prepared in the following manner and having the following composition:

Ingredient	Parts by Weight
Thermolastic 226 (Shell Chemical Co.)	100
Linde Molecular Sieve 13X (Union Carbide Corp.)	50
Carbon Black (Statex G)	5

Pellets of the Thermolastic 226 are added to a two-roll mill heated to a temperature of about 250° F. the pellets are allowed to soak approximately 5 minutes before the mill is turned on. The pellets are then thoroughly milled until a uniform sheet of the material is formed. Powered Linde Molecular Sieve 13X is added slowly to the sheet of Thermolastic 226 and, after the addition of all of the molecular sieve material, the resultant sheet is stripped and returned to the mill at least 5 times. This process of addition of material, stripping and returning to the mill is then repeated with the addition of the carbon black. Carbon black is used merely as a coloring agent and its use is not essential. The completed composition is removed from the mill and cut into ½-inch strips which are stored in a sealed container in preparation for subsequent extrusion to the desired shape.

A die is selected to provide the desired shape for the spacer-dehydrator element. This die is placed in a Killion 100 extruder. The barrel of the extruder is heated to approximately 250° F. and the die is heated to approximately 240° to 260° F. The extruder screw speed setting is approximately 2.5. The previously prepared ½-inch strips of material having the desired composition for the spacer-dehydrator element are then added to the feed hopper and extruded to the desired shape.

Thermolastic 226 is a specific example of a particularly suitable member of a family of electrically insulating, moisture vapor transmittable, thermoplastic elastomers, such as are now disclosed in U.S. Pat. No. 3,265,765. However, in connection with this invention, other electrically insulating, thermoplastic, moisture vapor transmittable materials, as well as electrically insulating, moisture vapor transmittable thermosetting materials and vulcanizable materials, may also be used. Examples of materials in addition to Thermolastic 226 that may be used include: polyacrylate elastomers, acrylonitrile-butadiene copolymers, polybutadiene elastomers, silicone elastomers, polyamide resins, urethane elastomers, epoxy resins, polyester resins, phenolic resins, ureaformaldehyde resins, cellulose acetate resins, polycarbonate resins, polystyrene resins polyvinyl alcohol resins, vinyl chloride-vinyl acetate copolymers, ethylene-vinyl acetate copolymers and the like.

The preferred type or class of desiccant materials that may be used in connection with the practice of this invention, and which are now covered by composition of matter patents, are the synthetically produced crystalline metal alumino-silicates or crystalline zeolites. Linde Molecular Sieve 13X, in powdered form, is a specific example of a synthetically produced crystalline zeolite that is particularly satisfactory and which is covered by U.S. Pats. Nos. 2,882,243 and 2,882,244. However, other desiccant or adsorbent materials may also be used, such as anhydrous calcium sulfate, activated alumina, silica gel and the like.

In accordance with the foregoing description of a specific embodiment of this invention, it will be evident that the electrically heated multiple glazed unit herein disclosed can provide a number of unique advantages over similar prior art constructions. Among these advantages are: insulating the electroconductive heater element and bus bars from any metallic frame and/or surrounding mounting sash that may be provided for the unit, hiding or completely concealing the bus bars from view in a direction normal to the unit's glass sheet surfaces by permitting them to occupy the same marginal edge glass sheet areas normally concealed from view and occupied by the spacer element, eliminating the need to delete electroconductive film away from marginal edge portions of a glass sheet substrate that could conduct electrical current to and/or from a spacer element since the spacer of this invention is composed of electrically insulating material and, accordingly, will not conduct electrical current, and eliminating the procedures formerly required to rigidly affix bus bars with respect to the electroconductive heater by use of a compressible spacer that can compressively and uniformly hold the bus bars in positive electrical contact with the electroconductive heater by pressure alone. Also, the preferred unit of this invention possesses excellent aesthetic appeal, not only by reason of concealing the bus bars but also because the perfectly smooth upper surface and black color of the spacer does not attract visual attention to the fact that a spacer is present between a pair of glass sheets.

Although the present invention has been described with particular reference to the specific details of a certain embodiment thereof, it is not intended that such details shall be regarded as limitations upon the scope of the invention except insofar as included in the accompanying claims.

1. A multiple glazed unit comprising a pair of rigid sheets disposed in parallel relation to each other, electroconductive heater means carried on the inner surface of at least one of said sheets, bus bars electrically connected to said electroconductive heater means and an electrically insulating, desiccant-containing spacer-dehydrator covering at least a portion of said bus bars and disposed between opposed marginal edge portions of said sheets.

2. The multiple glazed unit of claim **1** wherein the spacer-dehydrator comprises an electrically insulating element containing a desiccant.

3. A multiple glazed unit comprising a pair of rigid sheets disposed in parallel relation to each other, electroconductive heater means arranged to heat the inner surface of at least one of said sheets and an electrically insulating spacer-dehydrator disposed between opposed marginal edge portions of said sheets, said spacer-dehydrator comprising a desiccant material dispersed in a matrix of electrically insulating, moisture vapor transmittable material.

4. The multiple glazed unit of claim **3** wherein said electrically insulating material comprises a flexible material.

5. The multiple glazed unit of claim **4** which further includes a pair of bus bars disposed between said sheets in electrical contact with said electroconductive heater means.

6. The multiple glazed unit of claim **5** wherein said bus bars are located within the same marginal edge areas occupied by portions of said spacer-dehydrator.

7. The multiple glazed unit of claim 6 wherein said portions of said spacer-dehydrator compressively support said bus bars in electrical contact with said electroconductive heater means.

8. The multiple glazed unit of claim 3 wherein said electrically insulating material comprises a block copolymer of styrene-butadiene rubber.

9. The multiple glazed unit of claim 8 wherein said desiccant material comprises a zeolite.

10. The multiple glazed unit of claim 9 wherein said zeolite comprises a crystalline metal aluminosilicate.

11. The multiple glazed unit of claim 10 which further includes a moisture-resistant adhesive material extending between said rigid sheets and across their peripheral edges.

12. The multiple glazed unit of claim 11 which further includes a moisture-resistant adhesive material extending between said spacer-dehydrator and said rigid sheets.

13. The multiple glazed unit of claim 11 which further includes a metallic frame member extending in circumscribing relation about the periphery of said unit.

14. The multiple glazed unit of claim 3 wherein said electroconductive heater means comprises an electroconductive film on the inner surface of said one of said sheets.

15. The multiple glazed unit of claim 14 wherein said electroconductive film comprises a metal film.

16. The multiple glazed unit of claim 15 wherein said metal film comprises a transparent copper film.

17. The multiple glazed unit of claim 14 wherein said electroconductive film comprises a metal oxide film.

18. The multiple glazed unit of claim 17 wherein said metal oxide film comprises a transparent tin oxide film.

19. The multiple glazed unit of claim 3 wherein said rigid sheets are glass.

2. The multiple glazed unit of claim 19 wherein at least one of said glass sheets has solar control properties.

21. The multiple glazed unit of claim 1 wherein said spacer-dehydrator compressively supports said bus bars in electrical contact with said electroconductive heater means.