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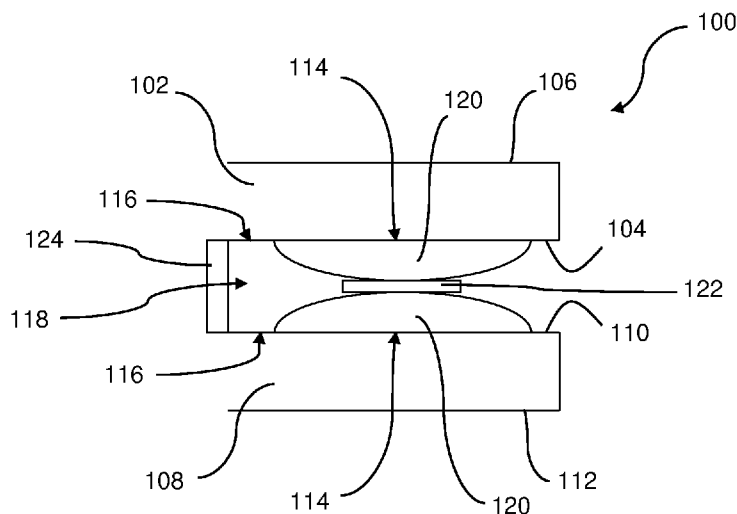


FIG. 1

(57) Abstract: A method of forming an edge seal between a pair of glass panes for use in the production of a vacuum insulated glazing unit (100), the method including the steps of: providing a first pane (102) and a second pane (108), wherein each pane (102, 108) has an inner side (104, 110) and an outer side (106, 112); depositing a substrate material (120) on a surface region (114) extending along a periphery of the inner side (104, 110) of each of the first and second panes (102, 108), wherein the surface region (114) bounds an interior region (116) of the inner side (104, 110) of each of the first and second panes (102, 108); positioning a sealing intermediate (122) on an upper portion of the substrate material (120) of each of the first and second panes (102, 108); bonding a lower portion of the substrate material (120) to the surface region (114) of each of the first and second panes (102, 108) whilst simultaneously bonding the upper portion of the substrate material (120) to a lower portion of the sealing intermediate (122) of each of the first and second panes (102, 108); pairing the first and second panes (102, 108) so that the interior regions (116) of each of the inner sides (104, 110) of the first and second panes (102, 108) are generally aligned and opposite each other to define a cavity (118) therebetween and so that

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VACUUM-INSULATED GLAZING UNIT AND METHOD OF MAKING THE SAME

FIELD

[0001] The present invention relates to a vacuum insulated glazing unit, as well as to methods of forming an edge seal for use in the production of a vacuum-insulated glazing unit.

[0002] The present invention has particular application in the field of commercial production of vacuum insulated glazing units utilising annealed or tempered glass, and it will be convenient to describe the invention herein in this exemplary context. It will be appreciated, however, that the invention is not limited to this particular application, but may also be employed in domestic or industrial applications or in the production of other glass-based containment devices.

BACKGROUND

[0003] Vacuum insulated glazing (VIG) units are typically constructed from two sheets or panes of glass separated by an evacuated gap or cavity, and hermetically sealed over their outside perimeter or edge using solder glass (also known as glass frit). An array of high strength spacers is placed in the cavity between the glass panes to maintain a constant distance of separation between the glass panes.

[0004] This process of forming the edge seal using solder glass requires the VIG unit to be placed in a furnace under atmospheric conditions and heated to temperatures of about 300-450°C depending on the material composition of the deposited solder glass material. In addition to the time taken to heat and then cool the whole unit, the edge seal is formed over a minimum time period of 10 to 80 mins, again depending on the material composition. The disadvantages of this process, therefore, are the dispensing time and manual labour required, the high temperatures and long times required to form the edge seal, and the requirement that the whole process be performed at atmospheric pressure. Moreover, if tempered glass panes are used, the high temperatures which the panes are subjected to may undesirably anneal the temper of the glass.

SUMMARY OF INVENTION

[0005] It is an object of the present invention to substantially overcome, or at least ameliorate, one or more of the above disadvantages.

[0006] There is disclosed herein a method of forming an edge seal between a pair of glass panes for use in the production of a vacuum insulated glazing unit, the method including the steps of:

- providing a first pane and a second pane, wherein each pane has an inner side and an outer side;

- depositing a substrate material on a surface region extending along a periphery of the inner side of each of the first and second panes, wherein the surface region bounds an interior region of the inner side of each of the first and second panes;

- positioning a sealing intermediate on an upper portion of the substrate material of each of the first and second panes;

- bonding a lower portion of the substrate material to the surface region of each of the first and second panes whilst simultaneously bonding the upper portion of the substrate material to a lower portion of the sealing intermediate of each of the first and second panes;

- pairing the first and second panes so that the interior regions of each of the inner sides of the first and second panes are generally aligned and opposite each other to define a cavity therebetween and so that upper portions of each of the sealing intermediates are opposite each other; and

- bonding the upper portions of each of the sealing intermediates together to seal the cavity.

[0007] In one or more embodiments, the substrate material of each of the first and second panes is comprised of solder glass.

[0008] In one or more embodiments, the sealing intermediate of each of the first and second panes is in the form of a gasket of metal or glass.

[0009] In one or more embodiments, the step of bonding the lower portion of the substrate material to the surface region of each of the first and second panes whilst simultaneously bonding the upper portion of the substrate material to the lower portion of the sealing intermediate includes tempering the first and second panes to fuse the lower portion of the solder glass with the surface region of each of the first and second panes whilst simultaneously

fusing the upper portion of the solder glass with the lower portion of the gasket of metal or glass.

[0010] In one or more embodiments, the step of bonding the upper portions of each of the sealing intermediates together includes welding the upper portions of each of the gaskets of metal or glass together.

[0011] In one or more embodiments, the step of welding the upper portions of each of the gaskets of metal or glass is performed by one of inductive heating, ultrasonic welding, and traditional spot welding.

[0012] In one or more embodiments, the method further includes a step of arranging a spacer assembly between each of the aligned interior regions of the first and second panes to maintain the cavity therebetween.

[0013] In one or more embodiments, the method further includes a step of evacuating the cavity to a pressure at or below a vacuum of 0.001 Torr (0.1 Pa) before or during the step of welding the upper portions of each of the gaskets of metal or glass.

[0014] In one or more embodiments, each of the gaskets of metal or glass extends generally past an edge of each of the first and second panes.

[0015] There is also disclosed herein a method of forming an edge seal between a pair of glass panes for use in the production of a vacuum insulated glazing unit, the method including the steps of:

- providing a first pane and a second pane, wherein each pane has an inner side and an outer side;

- depositing a substrate material on a surface region extending along a periphery of the inner side of each of the first and second panes, wherein the surface region bounds an interior region of the inner side of each of the first and second panes;

- bonding a lower portion of the substrate material to the surface region of each of the first and second panes;

- pairing the first and second panes so that the interior regions of each of the inner sides of the first and second panes are generally aligned and opposite each other to define a cavity therebetween and so that upper portions of the substrate material are opposite each other;

positioning a sealing intermediate between the upper portions of the substrate material of each of the first and second panes; and

bonding the upper portions of the substrate material to the sealing intermediate to seal the cavity.

[0016] In one or more embodiments, the substrate material of each of the first and second panes is comprised of solder glass.

[0017] In one or more embodiments, the sealing intermediate is in the form of a gasket of metal or glass.

[0018] In one or more embodiments, the step of bonding the lower portion of the substrate material to the surface region of each of the first and second panes includes tempering the first and second panes to fuse the lower portion of the solder glass with the surface region of each of the first and second panes.

[0019] In one or more embodiments, the step of bonding the upper portions of the substrate material to the sealing intermediate includes heating the gasket of metal or glass to a temperature sufficient to locally heat the upper portions of the solder glass adjacent the gasket of metal or glass to fuse the gasket of metal or glass with the upper portions of the solder glass.

[0020] In one or more embodiments, the step of heating the gasket of metal or glass is performed by inductively heating the gasket of metal or glass.

[0021] In one or more embodiments, the method further includes a step of arranging a spacer assembly between each of the aligned interior regions of the first and second panes to maintain the cavity therebetween.

[0022] In one or more embodiments, the method further includes a step of evacuating the cavity to a pressure at or below a vacuum of 0.001 Torr (0.1 Pa) before or during the step of bonding the upper portions of the substrate material to the sealing intermediate.

[0023] There is further disclosed herein a vacuum insulated glazing unit including:
a first pane having an inner side and an outer side;

a second pane having an inner side and an outer side, wherein the inner sides of each of the first and second panes have a surface region extending along a periphery of each of the inner sides, wherein the surface region bounds an interior region of each of the inner sides, and wherein the first pane is arranged adjacent to the second pane so that each of the surface regions are generally aligned and opposite each other and so that the interior regions of each of the inner sides of the first and second panes are generally aligned and opposite each other to define a cavity therebetween;

a substrate material bonded to each of the surface regions of the first and second panes;
and

a sealing intermediate arranged between and bonded to the substrate material of each of the first and second panes to seal the cavity.

[0024] In one or more embodiments, the substrate material of each of the first and second panes is comprised of solder glass.

[0025] In one or more embodiments, the sealing intermediate is in the form of a gasket of metal or glass.

[0026] In one or more embodiments, the solder glass is fused with the surface region of each of the first and second panes.

[0027] In one or more embodiments, the solder glass of each of the first and second panes is fused with the gasket of metal or glass.

[0028] In one or more embodiments, the sealing intermediate is in the form of a pair of welded gaskets of metal or glass.

[0029] In one or more embodiments, each of the gaskets of metal or glass is fused with a respective upper portion of the solder glass of each of the first and second panes.

[0030] In one or more embodiments, the vacuum insulated glazing unit further includes a spacer assembly arranged between each of the aligned interior regions of the first and second panes to maintain the cavity therebetween.

BRIEF DESCRIPTION OF DRAWINGS

[0031] For a more complete understanding of the present invention, exemplary embodiments of the invention are explained in more detail in the following description with reference to the accompanying drawing figures, in which like reference signs designate like parts and in which:

[0032] Fig. 1 is schematic cross-sectional view taken through an edge seal of a vacuum insulated glazing unit according to an embodiment;

[0033] Fig. 2 is schematic cross-sectional view taken through an edge seal of a vacuum insulated glazing unit according to another embodiment;

[0034] FIG. 3 is a flowchart that schematically illustrates steps associated with a method of forming an edge seal between a pair of glass panes for use in the production of a vacuum insulated glazing unit according to FIG. 1; and

[0035] FIG. 4 is a flowchart that schematically illustrates steps associated with a method of forming an edge seal between a pair of glass panes for use in the production of a vacuum insulated glazing unit according to FIG. 2.

[0036] The accompanying drawings are included to provide a further understanding of the present invention and are incorporated in and constitute a part of this specification. The drawings illustrate particular embodiments of the invention and together with the description serve to explain the principles of the invention. Other embodiments of the invention and many of the attendant advantages of the invention will be readily appreciated as they become better understood with reference to the following detailed description.

[0037] It will be appreciated that common and/or well understood elements that may be useful or necessary in a commercially feasible embodiment are not necessarily depicted in order to facilitate a more abstracted view of the embodiments. The elements of the drawings are not necessarily illustrated to scale relative to each other. It will also be understood that certain actions and/or steps in an embodiment of a method may be described or depicted in a particular order of occurrences while those skilled in the art will understand that such specificity with respect to sequence is not actually required.

DESCRIPTION OF EMBODIMENTS

[0038] Referring to FIG. 1 of the drawings, a vacuum insulated glazing (VIG) unit 100 according to a first embodiment is illustrated. The VIG unit 100 includes a first glass pane 102 having an inner side 104 and an outer side 106, and a second glass pane 108 having an inner side 110 and an outer side 112. The inner sides 104, 110 of each of the first and second panes 102, 108 have a surface region 114 extending along a periphery of each of the inner sides 104, 110. The surface region 114 bounds an interior region 116 (only part of the interior region 116 is shown in FIG. 1) of each of the inner sides 104, 110. The first glass pane 102 is arranged adjacent to the second glass pane 108 so that each of the surface regions 114 are generally aligned and opposite each other. In this arrangement, each of the interior regions 116 of each of the inner sides 104, 110 of the first and second glass panes 102, 108 are generally aligned and opposite each other to define a cavity 118 therebetween.

[0039] A substrate material in the form of solder glass 120 is bonded to each of the surface regions 114 of the first and second glass panes 102, 108 by fusing a lower portion of the solder glass 120 to the surface region 114 during a tempering process.

[0040] A sealing intermediate in the form of a gasket 122 of metal or glass is arranged between and fused with the upper portions of the solder glass 120 on either side of the gasket 122 to seal the cavity 118.

[0041] The VIG unit 100 further includes a spacer assembly having an array of support spacers 124 arranged between each of the aligned interior regions 116 of the first and second glass panes 102, 108 to maintain the cavity 118 therebetween. The cavity 118 is at a pressure at or near a vacuum.

[0042] FIG. 2 shows a VIG unit 200 according to a second embodiment. The VIG unit 200 is similar to that of the VIG unit 100, but instead of one gasket 122, the VIG unit 200 includes a pair of gaskets 222 of metal or glass extending generally past an edge of each of the glass panes 202, 208. A lower portion of each gasket 222 is fused with a respective upper portion of the solder glass 220. The upper portions of the gaskets 222 are welded together (indicated by arrows) to seal the cavity 218. Accordingly, features of the VIG unit 200 that are identical to those of the VIG unit 100 are provided with an identical reference numeral, increased by 100. For features that are identical between the VIG unit 100 and the VIG unit 200, it will be

appreciated that the above description of those features in relation to the VIG unit 100 is also applicable to the corresponding identical features found in the VIG unit 200.

[0043] Referring to the flowchart of FIG. 3, steps associated with a method of forming an edge seal between a pair of glass panes according to an embodiment are illustrated. The method is suitable for use in the production of the VIG unit 100.

[0044] In an initial step 300, the first glass pane 102 and the second glass pane 108 are provided. During this initial step 300, the glass panes 102, 108 are cut to size. A relatively small hole (not shown) may be drilled near one corner of one of the glass panes 102, 108 to accommodate a pump-out tube for evacuating the cavity 118 in a later step 350. The glass panes 102, 108 are then washed and dried.

[0045] In a next step 310, the solder glass 120 is deposited or pre-coated on the surface regions 114 of each of the first and second glass panes 102, 108. The solder glass 120 may be pre-coated using screen printing, or with an automated dispenser. The region surrounding the hole for the pump-out tube may also be pre-coated with solder glass 120 at this stage. However, any such pre-coating must not be on the outer sides 106, 112 of the glass panes 102, 108 since the rollers in the tempering machine (not shown) (discussed in a subsequent step 320) will contact the outer sides 106, 112 of the glass panes 102, 118. It will be appreciated that the pump-out tube may also be installed during this step 310. The solder glass 120 is formulated such that its coefficient of thermal expansion is a good match to that of the underlying glass pane with respect to the strain change during the cooling stage from the temperature point of softening, which reduces mechanical stresses in the structure during manufacture.

[0046] After the glass panes 102, 108 are pre-coated with the solder glass 120, the glass panes 102, 108 are then tempered in a conventional process as a next step 320. In this step 320, the inner sides 104, 110 of each glass pane 102, 108 that is pre-coated with the solder glass 120 must be facing upwards in order that the solder glass 120 is not contacted by the rollers that transport the glass panes 102, 108 through the tempering machine. The solder glass 120 should remain in a vitreous state during the cooling stage after tempering, as the solder glass 120 needs to be re-melted at a later step. Therefore, a non-crystallizing solder glass may be used to form the edge seal. During this step 320, the lower portion of the solder glass 120 melts and fuses with the surface region 114 of each of the glass panes 102, 108.

[0047] As an optional intermediate step 330, the array of support spacers 124 of the spacer assembly is arranged on one of the glass panes 102, 108. The array of support spacers 124 are positioned between the glass panes 102, 108 in order to maintain the separation of the glass panes 102, 108 under the action of atmospheric pressure; which is about ten tonnes per square meter. The spacers 124 can be produced from a high strength material, such as alloy steel, ceramics, and specific glassy materials. The design (size and shape) of the spacer 124 and the spacing of the array should be optimized to prevent stresses and strains reaching levels that cause failure of the spacer and/or glass. To reduce the heat flow through the spacer assembly fewer and/or smaller spacers would be needed. In contrast, to limit the amount of mechanical stresses in the glass panes 102, 108, and in the spacers themselves, to tolerable levels, requires more and/or larger spacers. The design compromise between the two competing constraints results in a VIG unit of defined thermal conductance and acceptable levels of stress in the glass and spacers for a service life of +25yrs. The optimisation according to a preferred embodiment is based on the use of 3 mm thick glass, spacers at 0.5 mm in diameter and 0.2 mm in height, which results in an optimised array separation of 25 mm, and a U-value (winter conditions defined by the ASTM 1991 standard) of $0.8 \text{ W m}^{-2} \text{ K}^{-1}$ (a lowE coating of emissivity 0.04 has been used). Preferably, this optimised design option is used so as to not exceed the Australian Standards AS1288 “long-term loading of float glass” limit of 8 MPa.

[0048] In a following step 340, the glass panes 102, 108 are paired by lowering one of the glass panes on top of the other. Even though the glass panes 102, 108 have a pre-coat of the solder glass 120, there may be benefit from the deposition of a small bead of additional solder glass around the edges of one of the glass panes 102, 108. Depending on the design of pump-out tube, the components for the pump-out tube may be installed at this step 340 of the method. The glass panes 102, 108 are paired so that the interior regions 116 of each of the inner sides 104, 110 of the glass panes are generally aligned and opposite each other to define the cavity 118 therebetween and so that upper portions of the solder glass 120 are generally aligned and opposite each other. During this step 340, the gasket of metal or glass 122 is positioned between the upper portions of the solder glass 120.

[0049] In a next step 350, the gasket 122 of metal or glass is heated via a direct application of electrical current or via a process of electromagnetic induction or photonic heating at defined wavelengths to raise the temperature of the gasket 122 at a defined rate. The heat from the gasket 122 will locally heat and melt the upper portions of the solder glass 120 adjacent the

gasket 122 over a defined thickness thereby to fuse the gasket 122 with the upper portions of the solder glass 120 to hermetically seal the cavity 118. By locally heating just the portion of the solder glass 120 adjacent the gasket 122, the interface between the solder glass 120 and the glass panes 102, 108 will not be substantially affected by heat thereby ameliorating the possibility of reducing the overall strength of the bond between the lower portion of the solder glass 120 and the glass panes 102, 108. The rate of heating is desirably high and the period of heating as short as possible to limit the amount of temper lost locally at the edge. Preferably, the gasket 122 is heated to a temperature in excess of 800°C within a few seconds. The gasket 122 may also be perforated or shaped about its surfaces to enhance surface area contact and ultimate adhesion to the solder glass 120. During this step 350, the cavity 118 is evacuated to a pressure at or lower than 0.001 Torr (0.1 Pa) vacuum via the pump-out tube so that atmospheric pressure can be utilised to clamp the edge and bring the solder glass 120 into sufficient contact with the gasket 122. At the end of the step 350, the gasket 122 will be permanently sealed between the solder glass 120 of each of the glass panes 102, 108 providing further strength and rigidity to the edge seal.

[0050] Referring to the flowchart of FIG. 4, steps associated with a method of forming an edge seal between a pair of glass panes according to another embodiment are illustrated. The method is suitable for use in the production of the VIG unit 200.

[0051] In an initial step 400, the first glass pane 202 and the second glass pane 208 are provided and prepared in a similar manner described above in step 300.

[0052] In a next step 410, the solder glass 220 is deposited or pre-coated on the surface regions 214 of each of the first and second glass panes 202, 208 in a similar manner described above in step 310.

[0053] After the glass panes 202, 208 are pre-coated with the solder glass 220, the gaskets 222 of metal or glass are positioned on the upper portions of a respective layer of the solder glass 220 in a next step 420.

[0054] In a next step 430, the glass panes 202, 208 are then tempered in a conventional process as described above in step 320. During this step 430, the lower portion of the solder glass 220 melts and fuses with the surface region 214 of each of the glass panes 202, 208 whilst,

simultaneously, the upper portions of the solder glass 220 melts and fuses with the lower portion of the gaskets 222.

[0055] As an optional intermediate step 440, the array of support spacers 224 of the spacer assembly is arranged on one of the glass panes 202, 208 in a similar manner as described in step 330.

[0056] In a following step 450, the glass panes 202, 208 are paired so that the interior regions 216 of each of the inner sides 204, 210 of the glass panes 202, 208 are generally aligned and opposite each other to define the cavity 218 therebetween and so that upper portions of each of the gaskets 222 are generally aligned and opposite each other.

[0057] In a next step 460, the gaskets 222 of metal or glass are heated to form a crimped-welded seal to seal the cavity 218. Preferably, the method of heating is well controlled. Since the gaskets 222 of metal or glass are thin and basically a loop of material, the edge of the gaskets 222 can be welded by inductive heating, ultrasonic welding, traditional spot/line welding, or using laser of defined wavelengths, methods. During this step 460, the cavity 218 is evacuated to a pressure at or near a vacuum via the pump-out tube so that atmospheric pressure can be utilised to clamp the edge. At the end of the step 460, the gaskets 222 will be permanently sealed between the solder glass 220 of each of the glass panes 202, 208 providing further strength and rigidity to the edge seal. It will, however, be appreciated that the cavity 218 may be evacuated directly through the gaskets before or during the step of sealing the gaskets 222, thereby avoiding the need for a pump-out tube. For example, in one embodiment this step 460 could be performed in a vacuum chamber. In another embodiment, the edges of the glass panes 202, 208 may be held apart whilst the cavity 218 is evacuated and the gaskets 222 are sealed.

[0058] The methods according to embodiments described above permit the manufacture of vacuum glazing using tempered glass. The methods according to embodiments described above also result in a substantial reduction in the time necessary to manufacture vacuum glazing compared with the existing single-step batch manufacturing process. The methods according to embodiments described above retains all of the advantages of the single-step process of enabling tight controls to be maintained on the thickness of the solder glass in the edge seal region, to control and limit the edge seal built-in stresses.

[0059] Although specific embodiments of the invention are illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternative and/or equivalent implementations exist. It should be appreciated that the exemplary embodiment or exemplary embodiments are examples only and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient road map for implementing at least one exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope as set forth in the appended claims and their legal equivalents. Generally, this application is intended to cover any adaptations or variations of the specific embodiments discussed herein.

[0060] It will also be appreciated that in this document the terms "comprise", "comprising", "include", "including", "contain", "containing", "have", "having", and any variations thereof, are intended to be understood in an inclusive (i.e. non-exclusive) sense, such that the process, method, device, apparatus or system described herein is not limited to those features or parts or elements or steps recited but may include other elements, features, parts or steps not expressly listed or inherent to such process, method, article, or apparatus. Furthermore, the terms "a" and "an" used herein are intended to be understood as meaning one or more unless explicitly stated otherwise. Moreover, the terms "first", "second", etc. are used merely as labels, and are not intended to impose numerical requirements on or to establish a certain ranking of importance of their objects.

CLAIMS

1. A method of forming an edge seal between a pair of glass panes for use in the production of a vacuum insulated glazing unit, the method including the steps of:

providing a first pane and a second pane, wherein each pane has an inner side and an outer side;

depositing a substrate material on a surface region extending along a periphery of the inner side of each of the first and second panes, wherein the surface region bounds an interior region of the inner side of each of the first and second panes;

positioning a sealing intermediate on an upper portion of the substrate material of each of the first and second panes;

bonding a lower portion of the substrate material to the surface region of each of the first and second panes whilst simultaneously bonding the upper portion of the substrate material to a lower portion of the sealing intermediate of each of the first and second panes;

pairing the first and second panes so that the interior regions of each of the inner sides of the first and second panes are generally aligned and opposite each other to define a cavity therebetween and so that upper portions of each of the sealing intermediates are opposite each other; and

bonding the upper portions of each of the sealing intermediates together to seal the cavity.

2. The method of claim 1, wherein the substrate material of each of the first and second panes is comprised of solder glass.

3. The method of claim 2, wherein the sealing intermediate of each of the first and second panes is in the form of a gasket of metal or glass.

4. The method of claim 3, wherein the step of bonding the lower portion of the substrate material to the surface region of each of the first and second panes whilst simultaneously bonding the upper portion of the substrate material to the lower portion of the sealing intermediate includes tempering the first and second panes to fuse the lower portion of the solder glass with the surface region of each of the first and second panes whilst simultaneously fusing the upper portion of the solder glass with the lower portion of the gasket of metal or glass.

5. The method of claim 4, wherein the step of bonding the upper portions of each of the sealing intermediates together includes welding the upper portions of each of the gaskets of metal or glass together.
6. The method of claim 5, wherein the step of welding the upper portions of each of the gaskets of metal or glass is performed by one of inductive heating, ultrasonic welding, and traditional spot welding.
7. The method of claim 5 or claim 6, further including a step of arranging a spacer assembly between each of the aligned interior regions of the first and second panes to maintain the cavity therebetween.
8. The method of claim 7, further including a step of evacuating the cavity to a pressure at or near a vacuum before or during the step of welding the upper portions of each of the gaskets of metal or glass.
9. The method of any one of claims 3 to 8, wherein each of the gaskets of metal or glass extends generally past an edge of each of the first and second panes.
10. A method of forming an edge seal between a pair of glass panes for use in the production of a vacuum insulated glazing unit, the method including the steps of:
 - providing a first pane and a second pane, wherein each pane has an inner side and an outer side;
 - depositing a substrate material on a surface region extending along a periphery of the inner side of each of the first and second panes, wherein the surface region bounds an interior region of the inner side of each of the first and second panes;
 - bonding a lower portion of the substrate material to the surface region of each of the first and second panes;
 - pairing the first and second panes so that the interior regions of each of the inner sides of the first and second panes are generally aligned and opposite each other to define a cavity therebetween and so that upper portions of the substrate material are generally aligned and opposite each other;
 - positioning a sealing intermediate between the upper portions of the substrate material of each of the first and second panes; and

bonding the upper portions of the substrate material to the sealing intermediate to seal the cavity.

11. The method of claim 10, wherein the substrate material of each of the first and second panes is comprised of solder glass.

12. The method of claim 11, wherein the sealing intermediate is in the form of a gasket of metal or glass.

13. The method of claim 12, wherein the step of bonding the lower portion of the substrate material to the surface region of each of the first and second panes includes tempering the first and second panes to fuse the lower portion of the solder glass with the surface region of each of the first and second panes.

14. The method of claim 13, wherein the step of bonding the upper portions of the substrate material to the sealing intermediate includes heating the gasket of metal or glass to a temperature sufficient to locally heat the upper portions of the solder glass adjacent the gasket of metal or glass to fuse the gasket of metal or glass with the upper portions of the solder glass.

15. The method of claim 14, wherein the step of heating the gasket of metal or glass is performed by direct application of electric current or inductive electromagnetic heating or photonic heating of defined wavelength heating of the gasket of metal or glass.

16. The method of any one of claims 10 to 15, further including a step of arranging a spacer assembly between each of the aligned interior regions of the first and second panes to maintain the cavity therebetween.

17. The method of claim 16, further including a step of evacuating the cavity to a pressure at or near a vacuum before or during the step of bonding the upper portions of the substrate material to the sealing intermediate.

18. A vacuum insulated glazing unit including:

a first pane having an inner side and an outer side;

a second pane having an inner side and an outer side, wherein the inner sides of each of the first and second panes have a surface region extending along a periphery of each of the inner

sides, wherein the surface region bounds an interior region of each of the inner sides, and wherein the first pane is arranged adjacent to the second pane so that each of the surface regions are generally aligned and opposite each other and so that the interior regions of each of the inner sides of the first and second panes are generally aligned and opposite each other to define a cavity therebetween;

a substrate material bonded to each of the surface regions of the first and second panes; and

a sealing intermediate arranged between and bonded to the substrate material of each of the first and second panes to seal the cavity.

19. The vacuum insulated glazing unit of claim 18, wherein the substrate material of each of the first and second panes is comprised of solder glass.

20. The vacuum insulated glazing unit of claim 19, wherein the sealing intermediate is in the form of a gasket of metal or glass.

21. The vacuum insulated glazing unit of claim 20, wherein the solder glass is fused with the surface region of each of the first and second panes.

22. The vacuum insulated glazing unit of claim 21, wherein the solder glass of each of the first and second panes is fused with the gasket of metal or glass.

23. The vacuum insulated glazing unit of claim 19, wherein the sealing intermediate is in the form of a pair of welded gaskets of metal or glass.

24. The vacuum insulated glazing unit of claim 23, wherein each of the gaskets of metal or glass is fused with a respective upper portion of the solder glass of each of the first and second panes.

25. The vacuum insulated glazing unit of any one of claims 18 to 24, further including a spacer assembly arranged between each of the aligned interior regions of the first and second panes to maintain the cavity therebetween.

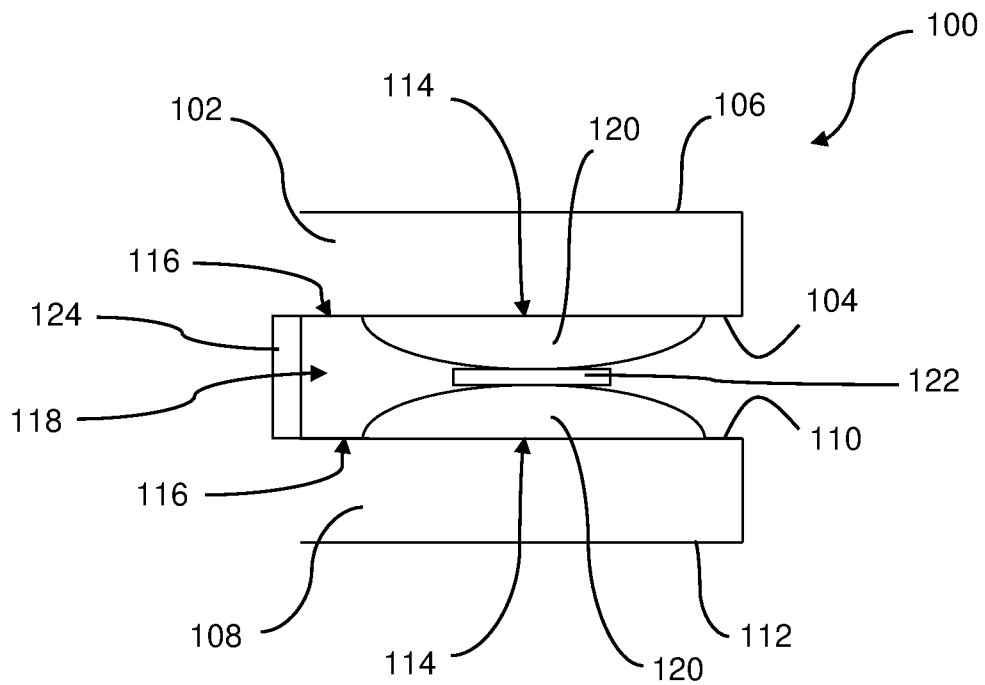


FIG. 1

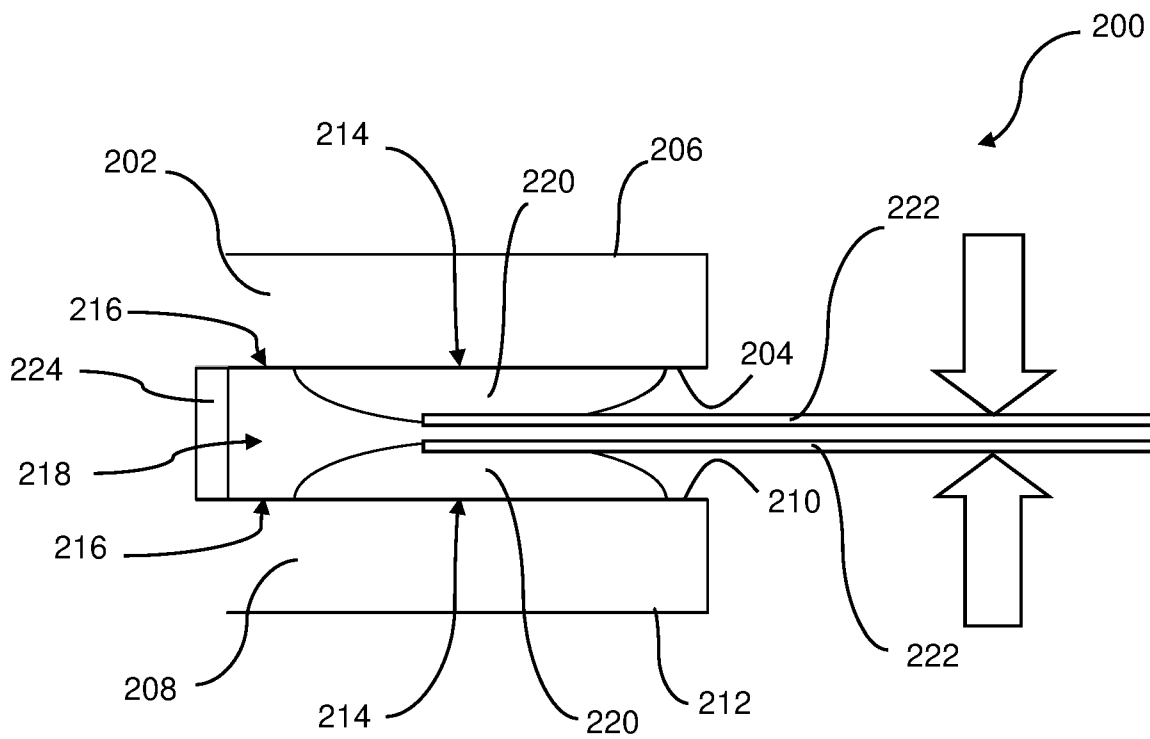


FIG. 2

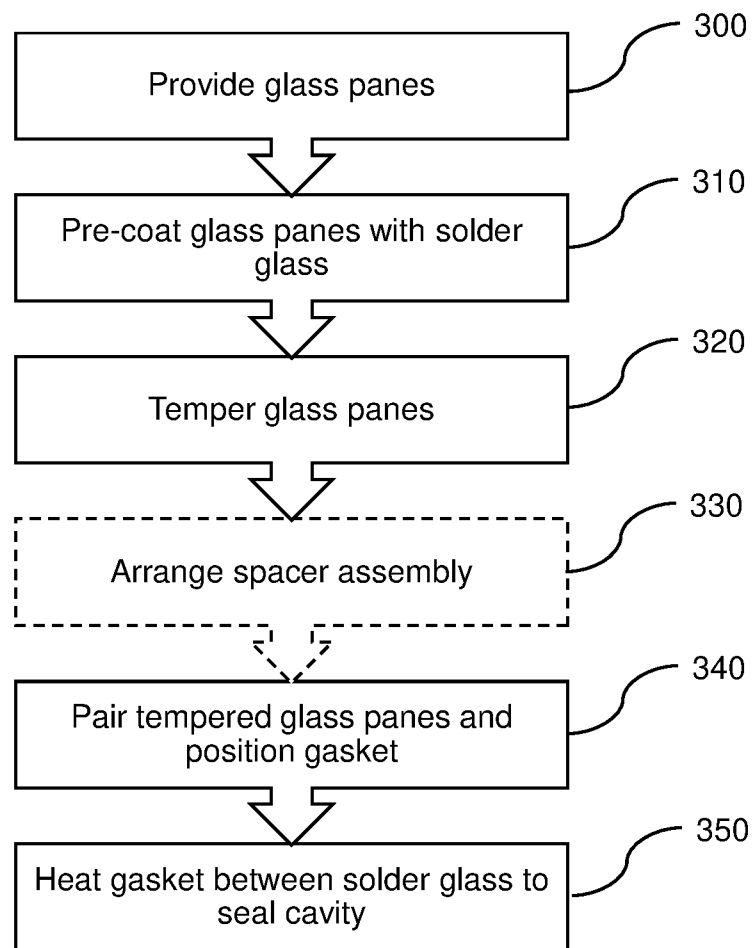
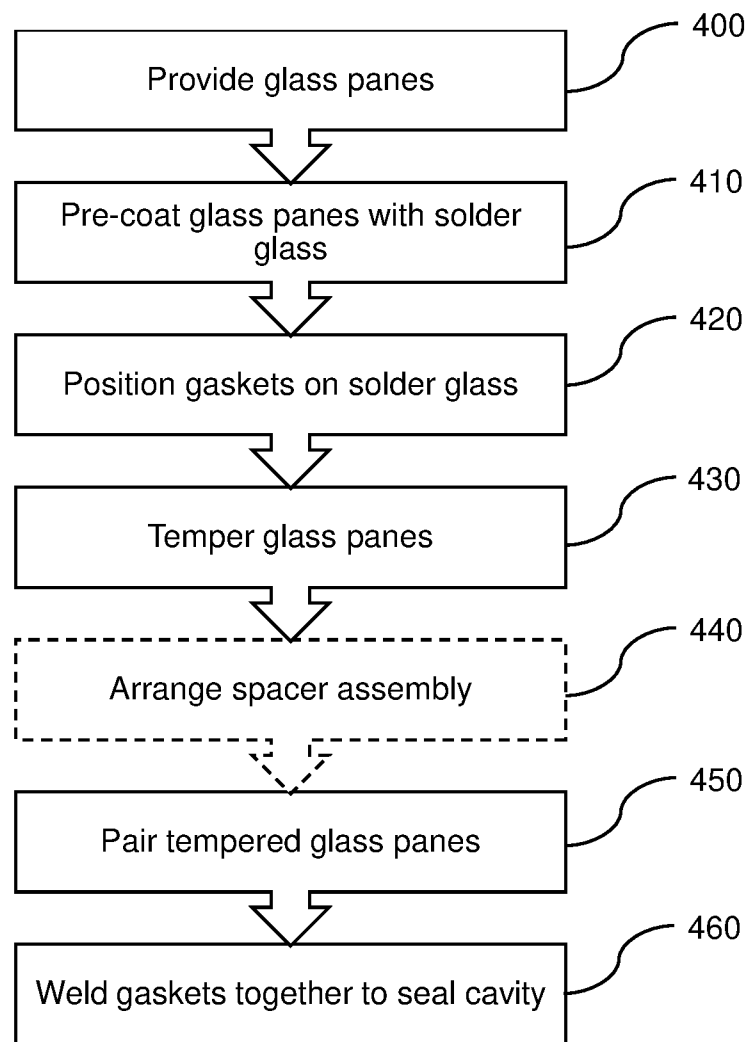


FIG. 3

**FIG. 4**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2020/050190

A. CLASSIFICATION OF SUBJECT MATTER

E06B 3/66 (2006.01) E06B 3/673 (2006.01) C03B 27/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Databases: PATENW, EPODOC & WPIAP: IPC/CPC/low (E06B3/6612, E06B3/673, E06B3/66, C03B27/00 and keywords seal, gasket, inner, sandwich, in-between, pane, glass, glaze, substrate, solder, space, tempering, strengthening) and the likes. Ultracombi (viewed cited and citing of relevant citations).

IP Australia internal databases & AusPat: Applicant/Inventor name search.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"D" document cited by the applicant in the international application	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 1 April 2020	Date of mailing of the international search report 01 April 2020
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaaustralia.gov.au	Authorised officer Dereje Yitagesu AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. +61262104083

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2020/050190
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2012/058938 A1 (LUOYANG LANDGLASS TECHNOLOGY CO., LTD.) 10 May 2012 Abstract, figs 1-10 & pages 2, 6 & 7	1-25
X	AU 2016413863 A1 (LUOYANG LANDGLASS TECHNOLOGY CO., LTD.) 11 January 2018 Abstract & figs 1-4	1, 10, 18 & 25
X	US 7919157 B2 (COOPER) 05 April 2011 Abstract, fig 3 & col 3 ln 30-40	1-3, 10-12 & 18-25
X	US 8950162 B2 (MILLER et al.) 10 February 2015 Abstract & figs 14a-15c	1, 10, 18 & 25

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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			

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Information on patent family members		PCT/AU2020/050190	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/AU2020/050190	
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End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. Form PCT/ISA/210 (Family Annex)(July 2019)			