(12) STANDARD PATENT APPLICATION (11) Application No. **AU 2023203386 A1**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Novel Construction Method for Windows, Screens or Similar Assemblies

(51) International Patent Classification(s)
E06B 3/68 (2006.01) ***C03C 27/08*** (2006.01)
B32B 3/26 (2006.01) ***E06B 3/58*** (2006.01)
B32B 17/06 (2006.01) ***E06B 3/64*** (2006.01)

(21) Application No: **2023203386** (22) Date of Filing: **2023.05.30**

(30) Priority Data

(31) Number	(32) Date	(33) Country
2022901485	**2022.05.31**	**AU**

(43) Publication Date: **2023.12.14**
(43) Publication Journal Date: **2023.12.14**

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2023203386 30 May 2023

ABSTRACT

[0001] The present invention is a series of perforated plates (or other approximately planar materials), the combination of which creates structural members (with an approximately 'H' shaped cross-section) in the groove of which plate glass (or other approximately planar material) is mechanically held, usually in a co-planar or near-coplanar configuration, whilst remaining visible due to perforations in the outermost plates. The resulting structure provides a novel method of constructing 'Leadlight' and 'Stained-Glass' windows in which the traditional Lead Came structure is replaced with this series of perforated plates. Unlike previous attempts at innovation, the present invention retains the segmented-glass window structure which is the defining feature of 'Leadlight' and 'Stained-Glass' windows; but also offers the significant advantages of: eliminating the need to utilise toxic Lead; a streamlined and less labour-intensive construction process; enabling greater fidelity and detail to be achieved in artistic designs; thinner reinforcements and tighter radius curves; greater structural integrity and impact resistance; a novel, non-destructive repair method; all whilst retaining the characteristic segmented-glass structure and medium of artistic expression (namely the arrangement, cutting and staining of glass pieces) from which Leadlight and Stained-Glass windows derive their fundamental value. The present invention may also be used to create lampshades, mosaics, or freestanding artwork, which may or may not be set into a broader wall or surface.

DRAWINGS

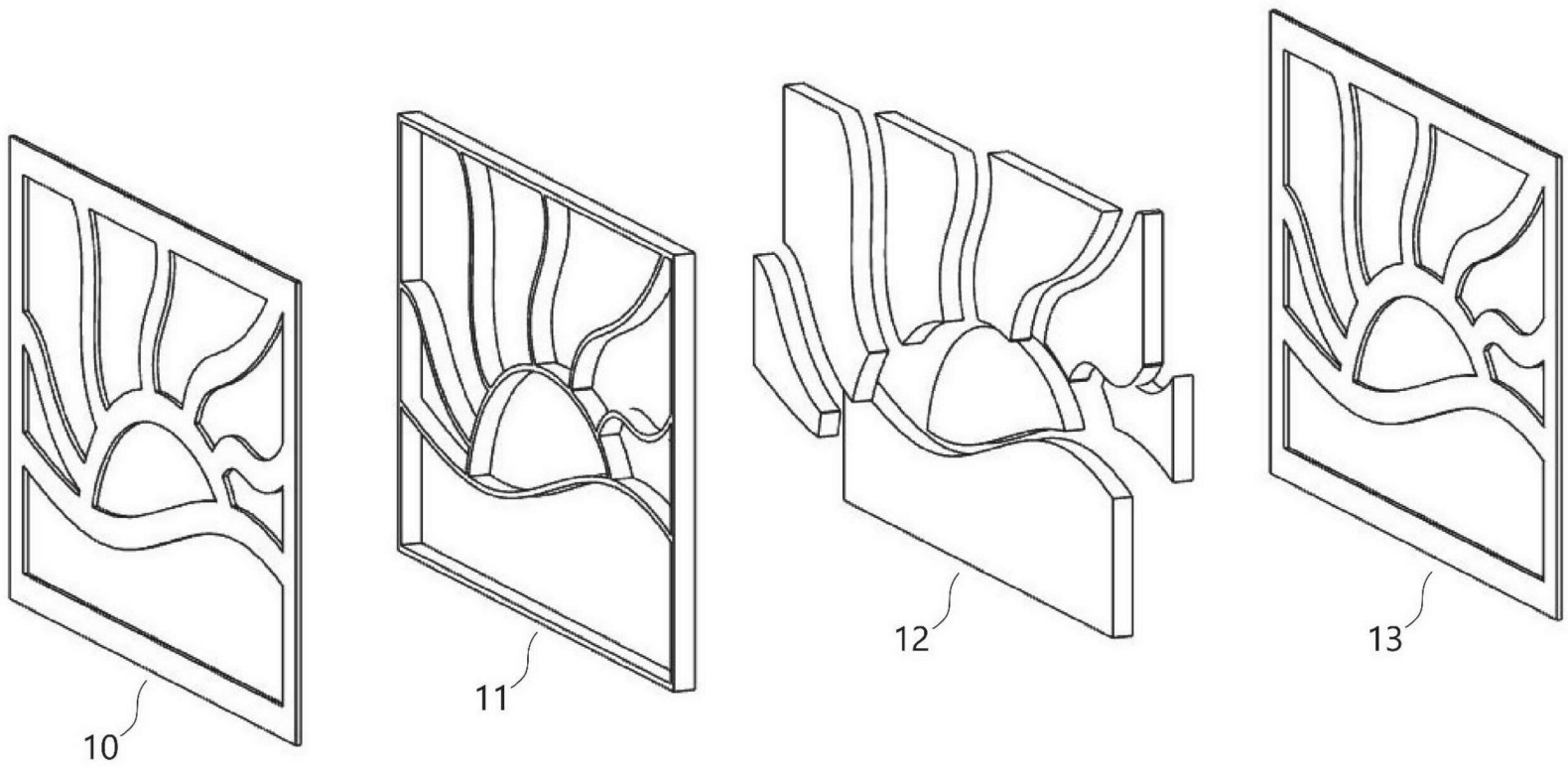

FIGURE 1

CROSS REFERENCE

[0002] This application claims priority from Australian Provisional Patent Application no. 2022901485, filing date 31 May 2022, the entire contents of which are incorporated into this specification by this reference.

TECHNICAL FIELD OF INVENTION

[0003] The present invention relates to a segmented-glass window structure, such as is used in 'Leadlight' and 'Stained-Glass' windows. It should be noted that these two traditional artforms share a common construction method, the distinction being that in the latter case the glass panels undergo additional colouration or 'staining'. The present invention relates to the common method of construction which for convenience will hereafter be referred to as a 'segmented-glass' window structure. Whilst the present invention will find primary application in 'Leadlight' and 'Stained-Glass' windows, it may also find application in other window styles, in lampshades, or in other artforms, such as a mosaic. It should also be noted that the style of artistic window to which the present invention relates may or may not be mounted in a surrounding wall structure, existing also as a freestanding artform. In this document, when the word 'window' is used, the reader should take this to mean the entire glass/frame assembly, which may function as a window, but also encompasses the other freestanding artistic applications mentioned above.

BACKGROUND OF INVENTION / PRIOR ART

[0004] The following background material is included to facilitate the reader's understanding of the invention. It does not indicate that the information was published or commonly known at the date of application.

[0005] It should be noted that 'Leadlight' windows and 'Stained-Glass' windows are constructed using a common method. If the glass pieces were coloured or textured during their manufacture, but not subsequently, the window is commonly referred to as a 'Leadlight' window. If the glass pieces receive additional staining after manufacture, it is usually called a

'Stained-Glass' window. In this document, the umbrella term 'segmented-glass window' is used to refer to the common method of construction shared by these two artforms.

[0006] **Traditional Method.** To facilitate the reader's understanding, the traditional method for constructing 'Leadlight' and 'Stained-Glass' (segmented-glass) windows is described below:

[0007] Firstly, a pattern is drawn on paper, usually in 1:1 scale, using thick (approximately 3mm) lines. These lines represent the inside of the Lead frame member, called 'Cames'.

[0008] The pattern is attached to a cork backing board and secured with timber strips on two external edges.

[0009] A piece of glass is cut (usually by hand, but occasionally by machine) to fit each void space in the pattern. Typically, glass is placed over the pattern and scored along each contour with a scriber. This score mark is sufficient to create a weak point along which the glass can be snapped by hand. However, the deeper the curve and the more textured the glass, the harder this is to achieve without shattering or chipping the glass. This is one of the skills of the craft. Fine adjustments to the shape can be made using a grinding wheel.

[0010] Once prepared, the glass segments are joined together using Lead 'Cames'. These are supplied in long strips with an 'H' cross-section, which allows pieces of glass to be inserted into the groove on either side and mechanically held in place. The Lead Cames are cut to the appropriate length for each contour and bent to match the profile of the glass edge. Lead is utilised because it is soft enough to be bent to match the profile of each glass piece, but strong enough to hold the window together once completed. Few (if any) other materials possess the required combination of strength and ductility for this application. Most materials are either too stiff to be bent to shape, too brittle to deform without breaking, or too soft/pliable to hold the window together once complete. It is for this reason that Lead continues to be used, despite its severe toxicity to humans.

[0011] Once all the Lead Cames have been cut and bent to shape, the window is 'dry' assembled with all pieces in their correct positions.

[0012] Next, the Lead Cames are soldered together at each juncture point, first on one side of the window, and then the other. Typically 60/40 or 50/50 Lead/tin solder is used. Care must be taken not to crack the glass through extreme localised heating. Soldering is a challenging task, and it takes significant practice and skill to solder Cames together cleanly, without swelling the juncture points with an excess of solder which obscures the original design of the window.

[0013] Once the soldering is complete, putty/grout is applied under each flange of the Lead Came to remove any play between the glass and the Lead, and to make the window watertight. The finished product is referred to as a 'Leadlight' window.

[0014] A 'Stained-Glass' window is also constructed as described above. Additionally, however, after the glass is cut – but before the window is Leaded and soldered together – some or all of the glass pieces are 'stained' using any of a wide variety of enamel glazes, paints, or finishes. Typically (but not always) these are a vitreous enamel, suspended in liquid. Once applied, the pieces are typically fired in a kiln, which permanently fuses the stain to the piece of glass.

[0015] **Issues with Traditional Method.** A major drawback of the traditional method is that Lead is a highly toxic metal, with prolonged exposure causing brain damage, infertility, nerve damage, kidney damage, high blood pressure, learning difficulties and aggressive behaviour. Occupational exposure is the most common cause of Lead poisoning.[1] However, material substitution is difficult, since few (if any) other materials possess the necessary mix of ductility and strength in the appropriate proportions.

[0016] This risk of exposure is significant, since Lead Cames must be measured, cut, bent and fitted by hand to match the contours of the glass. The wearing of gloves significantly hampers the dexterity and finesse required for such work and as such, most professional window constructors do not utilise protective gloves.

[1] Needleman H (2004). "Lead poisoning". Annual Review of Medicine. 55: 209–22. doi:10.1146/annurev.med.55.091902.103653. PMID 14746518.

[0017] The soldering of the joins produces fumes which are a further source of Lead exposure for workers, and which require sophisticated filters to trap. Again, many workers eschew breathing apparatus due to the encumbrance.

[0018] The traditional method is very labour intensive, as each Lead Came must be individually measured, cut, bent and adjusted by hand. Only a skilled craftsman with significant experience is able to cut and fit the Lead Cames with a sufficient degree of accuracy and intricacy to form detailed patterns.

[0019] Another drawback of the historical method is that the strength and stiffness of Lead is insufficient to hold a very large window or assembly together. In this case, the window must be divided into smaller sub-assemblies, and reinforced with bracing made from steel, stone, or other structural materials, the thickness of which disrupts the continuity of the pattern.

[0020] The softness of the Lead Cames means they are easily damaged, both during transport and once fitted in the final window. Gouges, nicks, cuts and deformations are unavoidable. Cames are almost always damaged in transport from the manufacturer, and must be refurbished prior to use. Even once part of the finished window, they continue to sustain damage.

[0021] The intricacy of the window design which is achievable is limited by the 'H' profile of the Lead Came. During bending, the internal flanges buckle with excess material, whilst the external flanges must stretch and elongate. This limits the tightness of the radius to which it can be bent, and hence, limits the intricacy of the pattern. Furthermore, the softness of Lead means that the Cames must be relatively thick, further inhibiting the fidelity of the pattern.

[0022] The simultaneous elongation/compression of external/internal flanges during bending leads to unevenly distributed stresses within the structure, leaving it more prone to failure. The varying behaviour of elongation versus compression also creates visual inconsistencies.

[0023] The traditional method of construction makes it very difficult to repair a Leadlight or Stained-Glass window, since the structure is soldered shut. Glass in need of repair can only be removed by destroying the surrounding Lead structure, or by destroying the piece

of glass itself. In order to repair or fit a new piece of glass, the surrounding flanges of the Lead came must be destructively removed. Once the glass has been repaired and replaced, bespoke replacement flanges must be fashioned to fit, cut to size, and reattached using the soldering process. It is not possible to non-destructively repair a traditional Stained-Glass or Leadlight window.

[0024] **Prior Art Developments.** Several attempts have been made to streamline or improve the construction of Leadlight and Stained-Glass windows, but none have succeeded without compromising the characteristic segmented-glass window structure which utilises distinct pieces of glass.

[0025] For example, the Sky Glass company[2] developed a CNC machine which deposits a continuous bead of resin on the face of a continuous piece of clear glass in patterns which imitate the appearance of the Came structure. Thereafter, they coloured the area between these boundary lines can be coloured with paints and dyes. Whilst this does streamline the process, they have lost the defining feature of Leadlight and Stained-Glass windows: the combination of distinct pieces of glass (potentially with varying colour, texture, properties or origin) in a segmented-glass window structure. The loss of this defining feature means the Sky Glass method cannot be identified as true 'Stained-Glass' or 'Leadlight' and is, at best, 'Imitation' or 'Faux'. Ultimately, the Sky Glass Company method is just a single sheet of continuous glass with the image of a Stained-Glass or Leadlight window artificially painted over the top.

[0026] Another attempt to streamline the process has been made by inventor "Jimmy DiResta".[3] He used a waterjet cutter to create holes in a sheet of acrylic, and cut corresponding pieces of acrylic which he inserted like a puzzle. He then used some form of adhesive (such as glue or cement) to fasten the acrylic pieces into the frame. Whilst this bore a visual similarity to a traditional window, unlike the traditional method, it lacked any mechanical constraint for the inserted pieces, which is a key element of the traditional segmented-glass window. Without it, the inserted pieces in DiResta's method are prone to loss or breakage. Moreover, though

[2] Sky Glass Company. (2014, Jun 17). SKY_GLASS - The Best CNC stained glass machine. Retrieved from Youtube: https://www.youtube.com/watch?v=5hJ1nyaDM8A

[3] DiResta, J. (2020, Feb 8). DiResta WAZER Stained Glass Window. Retrieved from Youtube: https://www.youtube.com/watch?v=gwAId02ssYs&t=38s

the adhesive fixative he used is weaker than a mechanical connection, it also makes it even more difficult to remove the pieces for repair or replacement. Hence, DiResta's technique magnifies the drawbacks of a traditional window whilst losing many of its advantages.

[0027] A later development by DiResta[4] was to replace the acrylic sheet inserts with a liquid resin. This further exacerbates the limitations of the previous method: it is now impossible for them to be removed non-destructively, yet they still lack the mechanical constraint of a traditional window. This further development also lacks the defining feature of a segmented-glass window – the use of distinct pieces of glass with varying colour, texture, properties, or origin.

[0028] Another approach was undertaken by restorers at Canterbury Cathedral in 2018.[5] They used a waterjet cutter to cut silhouettes in a continuous piece of clear glass, into which other pieces of 'show glass' were inserted. To hold this assembly together, a large, continuous, unperforated piece of clear glass was placed on either side. The resulting panel did not retain the appearance of a traditional Stained-Glass or Leadlight window; instead it created a new phenomenon, whereby the inserted glass appeared to 'float' within the window, with no structural frame supporting it. Not only was the resulting window significantly heavier (consisting of three layers of glass, instead of one), but it provided no innovation to the window's support structure, as these feature panels were inserted into a traditional, Lead came frame. Another drawback of this method is that the clarity of the 'show glass' could be inhibited by the clarity of the external sheets, particularly when dust or contaminants collect in the gaps between the three layers of glass. Again, the use of traditional Lead Cames excludes the possibility of non-destructive repair. In summary, the Canterbury method offers no innovation or improvement to the window's supporting structure itself; instead it represents a new way of displaying a piece of glass within a single panel of a traditionally constructed Leadlight or Stained-Glass window.

[4] DiResta, J. (2021, Mar 21). DiResta 2 Giant Epoxy Panels. Retrieved from Youtube: https://www.youtube.com/watch?v=2MGtiM_ux0I&t=24s

[5] Canterbury Cathedral. (2018, Jun 21). Canterbury crafts new window for Abbey from long-lost glass. Retrieved from Youtube: https://www.youtube.com/watch?v=ePgiiyqs_JI

SUMMARY OF INVENTION

[0029] The present invention is a series of perforated plates, the combination of which provides a novel method of constructing 'Leadlight' and 'Stained-Glass' windows, which retains the characteristic, defining feature of a segmented-glass window structure; but which offers the significant advantages of: eliminating the necessity of using toxic Lead; a streamlined and less labour-intensive construction process; greater fidelity and detail possible in designs, with thinner reinforcements and tighter radius curves; greater structural integrity and impact resistance; a novel, non-destructive repair method; all whilst retaining the characteristic segmented-glass structure, and also retaining the medium of artistic expression, namely the arrangement, cutting and staining of glass pieces, from which Leadlight and Stained-Glass windows derive their fundamental value.

[0030] The present invention is a plurality of perforated plates, or other approximately planar materials, the combination of which creates structural members (with an approximately H cross-section), in the groove of which pieces of glass (or other approximately planar materials) are mechanically held. By combining multiple perforated plates, structural members with an approximately 'H' cross-section are created, the grooves of which allow the glass inserts (or approximately planar materials) to be mechanically held in a similar manner to the traditional Lead came structure. However, by replacing the end-to-end construction method of a traditional Leadlight or Stained-Glass window with a layer-on-layer method, the present invention eschews the need for the structural members to be bent to match the contour of the glass. Instead, contours are created through material removal by perforating a plate of approximately planar material (such as with a waterjet or laser cutter) according to the desired design, with multiple plates combining to form the H shaped structural member which holds the glass in place. The perforations also enable the inserted glass (or other approximately planar materials) to remain visible. This plurality of perforated plates replaces the traditional Lead came structure, whilst retaining the traditional segmented-glass layout and appearance of a Leadlight or Stained-Glass window.

[0031] Where the glass meets the edge of the frame or design, or where there is only glass on one side, the cross-sectional profile may resemble a 'C' or 'U' shape. This should also be taken to be an embodiment of the present invention.

[0032] Eliminating the need for the structural members to be bent to follow the contour of the glass eliminates the need for them to be made of soft and ductile materials. Hence, one of the advantages of the present invention is the opportunity to substitute Lead with other materials such as metal, timber or acrylic.

[0033] In the preferred embodiment of the invention, the structure composes 3 perforated plates: two external plates to form the retaining flanges, and one internal perforated plate, which forms the core member of the 'H' cross section. Laser or waterjet cutting would be the ideal method for producing such plates, however they could also be produced through milling, casting, 3d printing, machining, manual material removal, or other manufacturing techniques.

[0034] In order to create structural members which adequately constrain the glass, the perforations may need to be arranged in particular ways. In most (but not necessarily all) embodiments of the invention, the perforations in the outer plates will smaller be than those of the inner plates, but follow similar contours and shapes. When the plates are combined, this will create an overhanging flange which mechanically constrains the glass.

[0035] This plurality of plates can be held together by any means, including bolts, screws, rivets, adhesives, glues, soldering, magnets, external clamping, or other methods. In the preferred embodiment of the invention, a small hole of the same diameter is included in each plate at various locations, through which a bolt & nut, screw or rivet assembly may be fastened. The use of a nut & bolt assembly allows for rapid and non-destructive disassembly and repair of the window, which is a significant advantage over the traditional method. In another embodiment of the invention, the plates could be mechanically held together by the external frame into which they are placed. However, the plates could also be held together in any other of a number of ways.

[0036] Throughout this document, the present invention is described as 'replacing' the traditional Lead Came structure. It should be noted that this means 'functionally replaces'. That is, the primary application of the present invention is not merely to replace the Came structure of existing Leadlight and Stained-Glass windows, but also to be used in the construction of new windows. Hence, a newly constructed window which uses only this method, having never possessed a Lead Came structure, still falls within the scope of the present invention.

[0037] The putty or grout which is inserted between the Came and glass in a traditional Leadlight or Stained-Glass window can also be used in conjunction with the novel method of construction which is the present invention. Alternatively, a different material could be used to provide sealing between the frame and the glass inserts, such as silicone. Another possibility would be to eschew any sort of sealant altogether. Regardless of whether sealant is used or not, or what kind of sealant is used, all of these should be taken to be embodiments of the present invention.

[0038] If a nut and bolt, screw or rivet style fastener is used to connect the plates, the head may be visible from either side of the window. This head could be obscured with putty, resin, paint or another substance. In particular, this deposit of material could be made to look visually similar to the bead of solder deposited on the juncture points in a traditional Leadlight or Stained-Glass window.

[0039] The present invention could be further enhanced by perforations in one or both of the outer plates, shaped such to form an additional design which adds detail to the overall design without piercing the glass insert, instead resting atop it as a silhouette.

[0040] Ultimately, the present invention provides a method which retains the segmented-glass structure which is the defining feature of Leadlight & Stained-Glass windows, whilst eschewing the complex, costly and hazardous Lead came structure.

[0041] **Advantages of the Invention.** This novel method of construction offered by the present invention has significant advantages over both the traditional method and subsequent prior art developments, as listed below:

[0042] Firstly, it retains the traditional, segmented-glass aesthetic and structure of a Leadlight or Stained-Glass window, wherein distinct pieces of glass or similarly planar material are mechanically held without adhesive or glue.

[0043] Secondly, the novel method of construction means the frames can be produced through novel manufacturing techniques such as waterjet or laser cutting manufacturing techniques.

[0044] By doing so, it allows the Lead to be substituted with many other novel materials such as: ferrous metals, brass, copper, bronze, aluminium, timber, plywood, acrylic, plastic, or any other approximately planar material.

[0045] This allows for the removal of the toxic substance (Lead) which is extremely hazardous to human health, removing the need for it be handled, cut or soldered.

[0046] Furthermore, in the case of all of the above, it significantly reduces the weight of the overall window, as Lead has one of the highest densities of any material / element.

[0047] Furthermore, the substitution of Lead with Ferrous metals, brass, bronze, copper, timber, polycarbonate, acrylic and some other materials significantly increases the strength, toughness, durability and impact resistance of the overall window, as these materials are stiffer and stronger than Lead.

[0048] The present invention also allows for the window structure to be made of novel materials such as ferrous metals, bronze, brass, timber, plywood, acrylic or other materials for novel and interesting aesthetic effects.

[0049] The substitution of Lead with stronger and stiffer materials, such as metal or timber, also enables the use of thinner structural members, which increases the intricacy and fidelity of artistic designs which can be realised.

[0050] Similarly, by removing the need for structural members to be bent to match the profile of the curve, the present invention allows for tighter radius curves to be implemented in the design; again, allowing the artist to achieve more complex shapes of greater intricacy and fidelity.

[0051] Furthermore, the present invention increases the accuracy with which the window's structure can match the contours of the glass pieces, eliminating or minimising gaps, which create play and create a repository for dust, dirt or mould.

[0052] Furthermore, it eliminates the need for the Lead came structure to be serviced and wholly replaced every 100 years, as is the case with Leadlight and Stained-Glass windows constructed using the traditional method.

[0053] Importantly, the present invention eliminates the need for repairs to be carried out destructively. When the plates are connected with reversible fastening methods (such as, but not limited to, threaded nut & bolt assemblies), the invention enables rapid and straightforward repairs to be completed by removing one of the external plates.

[0054] It also replaces the laborious and costly hand-assembly of the Lead came structure with a method which can be computerised (e.g. through waterjet or laser cutting) which reduces time and labour costs, yet also results in increased accuracy.

[0055] The invention retains the artistic skill medium from which Leadlight and Stained-Glass windows derive their value: namely, the design, arrangement, cutting and staining of glass pieces. A common flaw of modern innovations in traditional crafts is that they replace or reduce the level of artistic skill, and thus worth, of the overall piece. Conversely, this method replaces the laborious frame construction, whilst retaining the segmented / cut glass medium through which artists are able to communicate their designs. Ultimately. this method allows artists more time and fidelity to finesse their creative expression of the glass art form whilst streamlining the frame construction process.

BRIEF DESCIPTION OF DRAWINGS

[0056] The following figures are included to facilitate an understanding of the present invention but are not exhaustive. They illustrate some but not all embodiments of the present invention.

[0057] Figure 1 is an exploded view of the preferred embodiment of the present invention, consisting of 3 perforated plates.

[0058] Figure 2 is an assembled view of the same embodiment of the present invention shown in Figure 1.

[0059] Figure 3 is a cross-sectional view of one structural member within the assembly shown in Figure 2.

[0060] Figure 4 is an extrapolation of Figure 3 with slight dimensional variations.

[0061] Figure 5 is an extrapolation of Figure 3 with alternative dimensional variations.

[0062] Figure 6 is a cross-sectional view co-located with Figure 3 but showing a different embodiment of the invention consisting of only 2 perforated plates.

[0063] Figure 7 is a cross sectional view co-located with Figures 3 and 6 but showing another embodiment of the present invention consisting of 2 perforated plates.

[0064] Figure 8 is a cross-sectional view which demonstrates one embodiment of how a hole in each plate could allow for fastening using a nut and bolt assembly.

[0065] Figure 9 is a cross-sectional view of other potential profiles which also lie within the scope of the invention.

[0066] Figure 10 is a cross-sectional view which shows how a 'C' or 'U' profile also lies within the present invention.

[0067] Figure 11 is a cross-sectional view which shows how the function of inner plate may be performed by an external surface such as a wall.

[0068] Figure 12 is an exploded view which gives an example of how any artistic design utilising the claimed multi-plate construction method should be considered an embodiment lying within the scope of the present invention.

[0069] Figure 13 gives an assembled view of the components shown in Figure 12.

[0070] Figure 14 gives an exploded view of how the external plate may be enhanced with further designs which add decorative detail on the surface of the glass.

[0071] Figure 15 gives an assembled view of the components shown in Figure 14.

DETAILED DESCRIPTION

[0072] **Important Notes.** These drawing are included to facilitate the reader's understanding of the invention, and outline possible embodiments of the invention. However, it should be noted that the scope of the invention is not limited to the embodiments which are detailed in the included drawings. There are a plurality of ways which the invention could be realised, only a few of which are shown here.

[0073] In particular, there are many methods in which the distinct components of the structure could be fastened together. The present invention should be taken to encompass all methods of fastening the components together.

[0074] The embodiment of the present invention depicted in Figures 1 through 15 is presented as consisting of a steel frame with glass inserts and is conceived of as a window. As described above, these materials could be substituted for a wide variety of other materials whilst remaining within the scope of the present invention. Accordingly, references to 'steel' and 'glass' components in the following descriptions should be taken to apply equally to the same components if made of different materials.

[0075] Similarly, the assemblies depicted in the attached drawings are referred to as a 'window'. However, this assembly may also be employed as a decorative stand-alone artwork, independent of a broader wall or surface. It may also find application in lampshades, screens, or other applications. As such, the present invention should be taken to encompass any utilisation of the described techniques and methods of construction, regardless of whether the resulting assembly is employed as a window or otherwise. Accordingly, all references to the 'window' assembly should be taken to apply equally to other applications.

[0076] **Figures:** Figure 1 illustrates the various components of the novel method of construction which is one embodiment of the present invention. In this embodiment, three perforated plates 10, 11 and 13 are combined to form a structure which mechanically holds the glass pieces 12 in position, as shown in Figure 2. These inserts could be made of glass or any other approximately planar material and be of varying colour, texture, nature or origin. They may be stained or unstained.

[0077] As shown in Figure 2, the combination of plates 10, 11 and 13 forms frame members with an approximately 'H' shaped cross section. These mechanically constrain the glass pieces 12 from movement and replaces the Lead came structure traditionally used in Leadlight and Stained-Glass windows.

[0078] Where the glass or other inserted material meets the edge of the frame or design, or where there is glass on only one side, the cross-sectional profile may resemble a 'C' or 'U' shape, as shown in Figure 10. This should also be taken to be an embodiment of the present invention. Alternatively, as shown in Figure 11, a wall or other external surface 17 may

be able to fulfill the constraining function normally performed by inner frame 11. This should also be considered an embodiment of the invention.

[0079] In most (but not necessarily all) embodiments of the invention, the perforations in the outer plates (such as 10 and 13 shown in Figures 1 through 3) will follow similar contours and shapes to the perforations of the inner plate. However, as shown in Figures 1 through 3, the perforations in the outer plates will usually be smaller than those in the inner plates, which in turn means the individual structural members will be wider. This difference creates an overhanging flange, as shown in Figure 3, which mechanically constrains the glass.

[0080] As shown in Figure 2, the perforations in plates 10 and 13 allow the glass inserts 12 to be viewed from either side of the window. The perforations also allow a viewer to see through the frame to the other side.

[0081] The perforations in plate 11 are voids into which pieces of glass or other materials can be inserted and held securely. In another embodiment of the invention, some or all of these could be left empty if desired.

[0082] In the embodiment of the invention depicted in Figures 1, 2 and 3, the width of individual frame members [B] contained within the outer plates 10 and 13 is wider than the distance between two adjacent glass inserts [A], creating an overhanging flange that mechanically secures the glass. The exact amount of overhang desired or required can vary according to the requirements of the application, but all should be taken to be within the scope of the present invention. These flanges may have tapered or rounded edges, or contain further perforations and these should also be taken to lie within the scope of the invention.

[0083] In the preferred embodiment of the present invention, perforated plate 11 is approximately equal in thickness to the material inserts 12, whilst the outer plates 10 and 13 are significantly thinner. However, in other embodiments of the invention these ratios may be altered, whilst still remaining within the scope of the invention.

[0084] In the embodiment of the present invention shown in Figure 3, the width of individual frame members contained within plate 11 matches exactly the distance between adjacent glass inserts [A], such that there is no gap between them.

[0085] In other embodiments of the invention, such as is shown in Figure 4, the width of individual frame members within plate 11, which is [C], may be less or greater than the width between the two pieces of adjacent glass [D]. The former case, as depicted in Figure 4, creates void spaces 14 which allow for some small movement of the glass pieces, which may be useful for absorbing imperfections in manufacturing tolerances; whilst the latter may be used to create an interference fit.

[0086] Similarly, in the embodiment of the invention shown in Figure 3, the thickness of the inner plate 11 is depicted as being of similar thickness to the glass inserts 12; but in other embodiments of the present invention, such as is shown in Figure 5, plate 11 may be of greater or lesser thickness than glass inserts 12, in the former case creating useful void spaces 15 for absorbing imperfections (Figure 5), and in the latter creating an interference fit.

[0087] It is anticipated that many embodiments of the invention may employ the small void space as described in paragraphs [0085] and [0086] simultaneously, as a means of adjusting for inconsistencies and tolerances during manufacture. In some embodiments of the present invention, either or both of the void spaces 14 and 15 may be filled with a grout, putty, silicone or other substance.

[0088] Figure 6 depicts an embodiment of the present invention in which two outer plates 18 and 19, having an approximately 'T' cross-section, are combined to create a structural member with a similar 'H' cross section.

[0089] Figure 7 depicts an embodiment of the present invention in which two outer plates, plate 20 having an approximately rectangular cross-section, and plate 21 having an approximately 'T' shaped cross section, can be combined to create a similarly shaped structural member with approximately 'H' cross section.

[0090] The embodiment of the invention shown in Figure 8 demonstrates how a perforation or hole 25 which passes through each of the series of plates could be used to house a fastener 30 such as a nut & bolt, screw or rivet assembly.

[0091] Figure 9 is a cross-sectional view which shows how other profiles which do not exactly resemble an 'H', but which mechanically constrain the plate glass or other comparable planar inserts in a similar manner, should also be considered to lie within the scope of the

present invention. Note that profile 43 does not fully constrain the glass pieces, but is included to demonstrate that embodiments which omit or vary a small part of the claimed invention should also be considered to lie within its scope, even if this results in lesser functionality.

[0092] The present invention is a novel method of multi-plate construction, which can be used to create a supporting structure for a segmented-glass window. Whilst Figures 1-3 use a 'sunrise' design to illustrate the merits of the invention, it should be noted that this is but one embodiment of the present invention; and any design or artistic arrangement which uses this method of construction should be taken to lie within the scope if the invention. For example, Figures 12 and 13 illustrate a different artistic design which has been constructed using the same method of the claimed invention, and thus, illustrates how any artistic design assembled in this manner should be considered an embodiment of the claimed invention.

[0093] Figures 12 and 13 illustrate an embodiment of the invention in which perforated plates 50, 51 and 53 mechanically constrain glass pieces 52. Note that in Figure 12 the glass is presented as opaque, whereas in Figure 13 the glass is presented as transparent so that the groove created by the three plates 50, 51 and 53 can be clearly seen.

[0094] Figure 14 illustrates how the present invention enables the addition of perforations in the outer plate which are so arranged to create additional details, such as the tree silhouette 68, which does not form part of the structural members with approximately 'H' cross section, nor does it pass through the glass, but sits atop the surface of the glass to add detail to the design.

[0095] Figure 15 shows the components from Figure 14 in their assembled configuration.

CLAIMS

1. A series of perforated plates, or approximately planar materials, the combination of which creates structural members of approximately ‘H’ cross section, with a groove or recess in which pieces of plate glass (or other approximately planar material, such as acrylic, polycarbonate, wood, plywood, sheet metal, plastic, etc) are mechanically held in a co-planar or near-coplanar configuration, whilst remaining visible due to perforations in the outermost plates. This structure may be used to create a window, or window-like structure (such as a mosaic or lampshade) which may or may not be set into a broader wall or surface.
2. The invention according to claim 1, wherein the structure is comprised of multiple perforated plates, the combination of which creates members with an approximately ‘H’ cross-section, the grooves of which secure the glass or other approximately planar material. Where appropriate in the design, such as but not limited to when the design meets an external surface or edge, or when glass is only required to be held on one side of the structural member, the cross-sectional profile may instead resemble a ‘C’ or ‘U’ shape. This should also be taken to be an embodiment of the present invention.
3. The invention according to claim 1, wherein the structure is comprised of exactly 3 perforated plates, the combination of which forms structural members with an approximately ‘H’ cross-section, the grooves of which secure the glass or other approximately planar material.
4. The invention according to claim 1, wherein the structure is comprised of a single thick perforated plate, and material is deposited on the plate in order to form flanges, which creates a recess or groove in which the glass or similar material is mechanically held.
5. The invention according to claim 1, wherein two external perforated plates restrain the glass from the outer edges without an inner plate.
6. The invention according to claim 5, wherein a substance is inserted between them into the void between the held pieces of glass or similar material to form the inner member of the ‘H’ shaped cross-sectional construction.
7. The invention according to claim 1, wherein the perforations in the external plates are substituted with a transparent or semi-transparent material, such that the internal layer remains visible.

8. The invention according to claim 1, whereby the perforated plates are formed by a casting or moulding process, before or after the glass or similar material is in place.
9. The invention according to claim 1, wherein the glass or similar material is formed after the claimed structure, whether through moulding, blowing, casting or other method.
10. The invention according to claim 1, wherein the structure is formed through a 3d printing or other manufacturing method, which enables it to be produced as a single piece around the held glass or other material.
11. The invention according to claim 1, wherein the cross-sectional shape does not resemble an 'H', but whose elements nevertheless perform a comparable function, in mechanically constraining the glass or other approximately planar material.
12. The invention according to claim 1, wherein either the perforated plates, inserted planar materials, or both, possess a curvature, which may or may not accrue to form a curvature in the overall piece.
13. The invention according to claim 1, wherein one or both of the external plates are solid, having no perforations, and may or may not be made from a transparent material.
14. The invention according to Claims 1 through 13, in which the series of plates is held together with any of the following: mechanical fasteners (screws, nuts, bolts, rivets), adhesives, clamping, magnetism, soldering, welding, external frames.
15. The invention according to Claims 1 through 13, in which the series of plates is held together with any other method not listed in this document.
16. The invention according to Claims 1 through 15, wherein a putty, grout or other sealant, such as silicone, is inserted between the glass (or other approximately planar material) and the frame structure.
17. The invention according to Claims 14 and 15, wherein the fastener is obscured by a deposit of glue, resin, putty or other material, which may or may not be shaped to appear similar to the bead of solder deposited on the frame members of a traditional Leadlight or Stained-Glass Window.
18. A structure comprising multiple layers of glass or similar approximately planar material, which utilises the multi-plate construction method outlined in Claims 1-15.
19. A structure consisting of multiple embodiments of the invention according to Claims 1 through 16, assembled together in a co-planar, perpendicular or angular arrangement,

in order to create a three-dimensional structure such as a lampshade, box, or any other structure.

20. A combination of perforations in the outer plate which creates a design or silhouette which sits on the surface of the glass (or other approximately planar material), without passing through it or between two adjacent pieces.

DRAWINGS

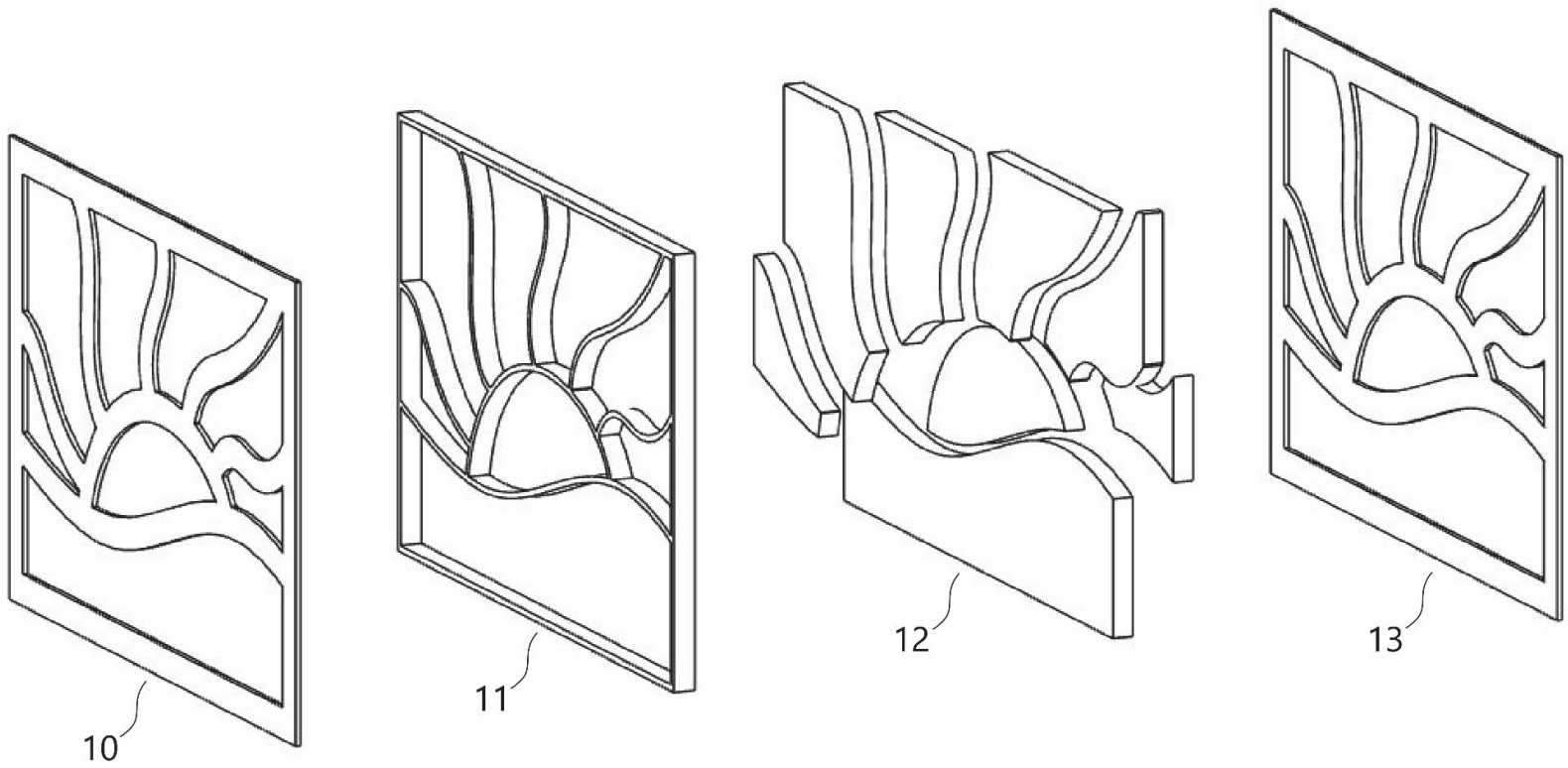

FIGURE 1

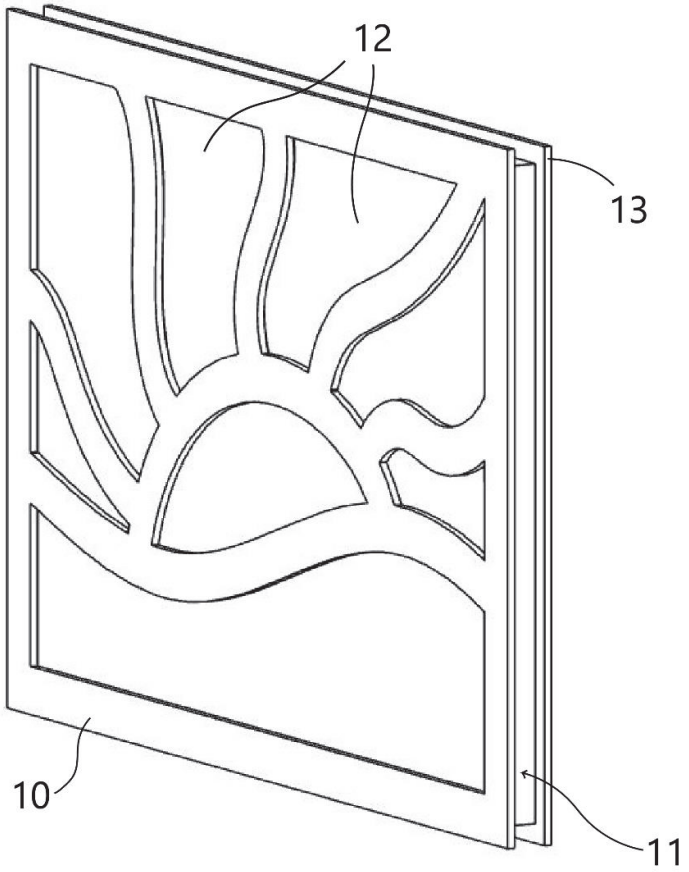

FIGURE 2

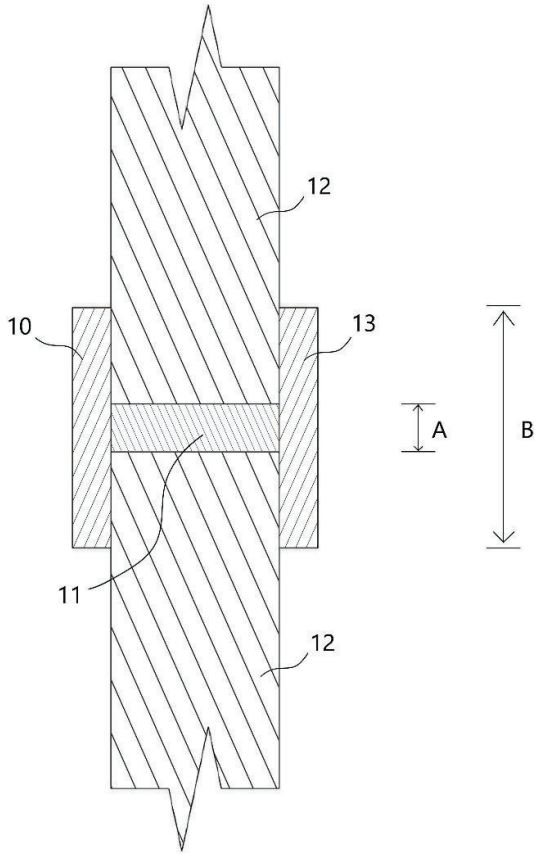

FIGURE 3

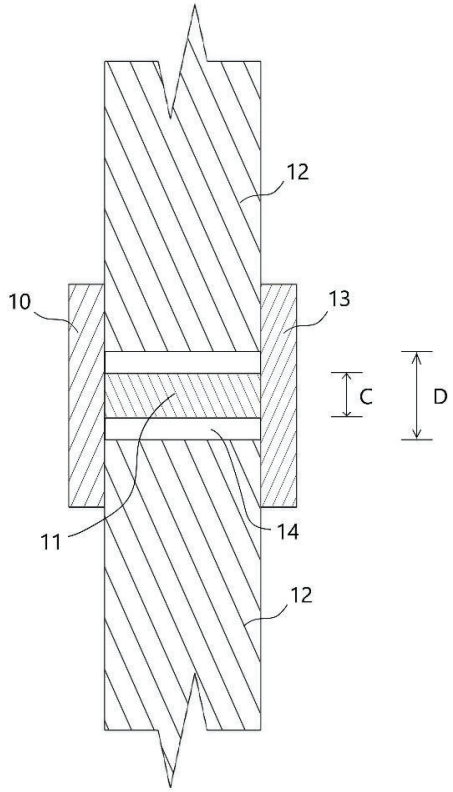

FIGURE 4

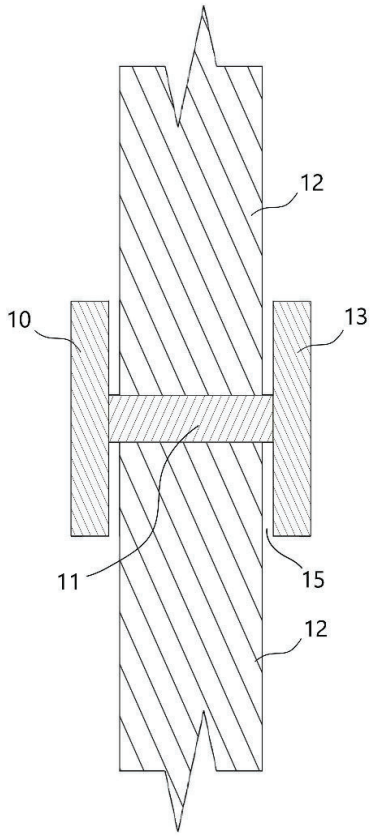

FIGURE 5

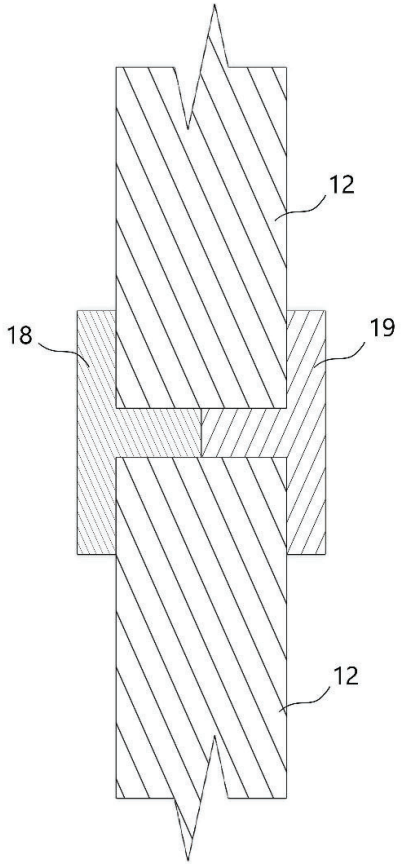

FIGURE 6

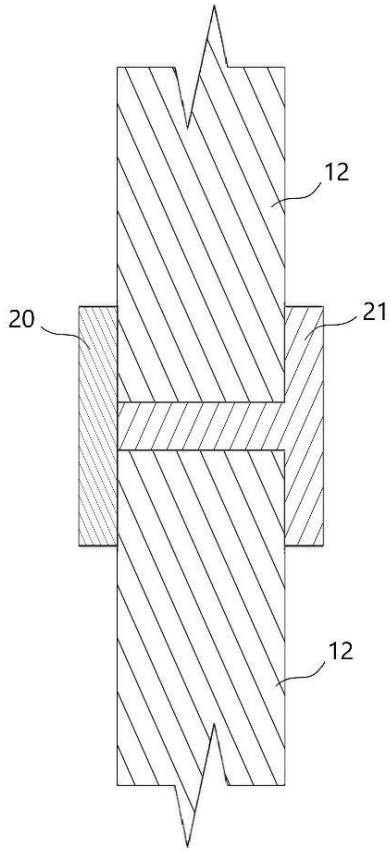

FIGURE 7

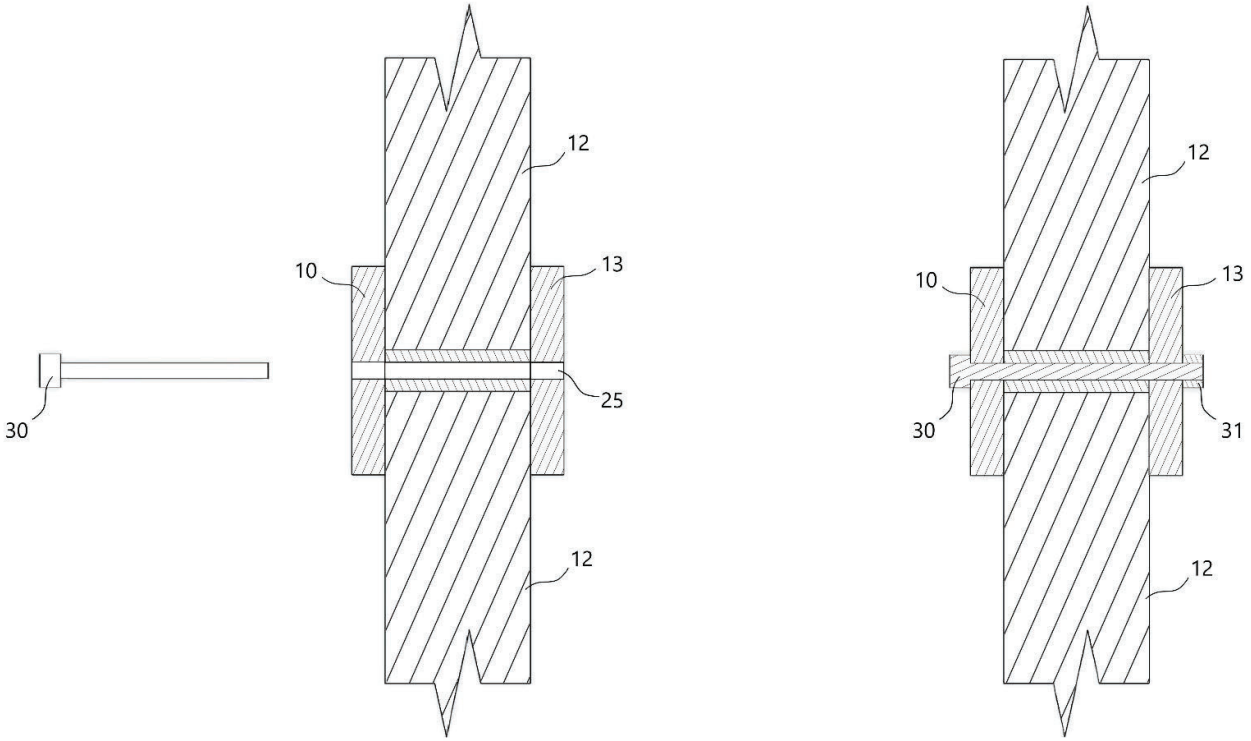

FIGURE 8

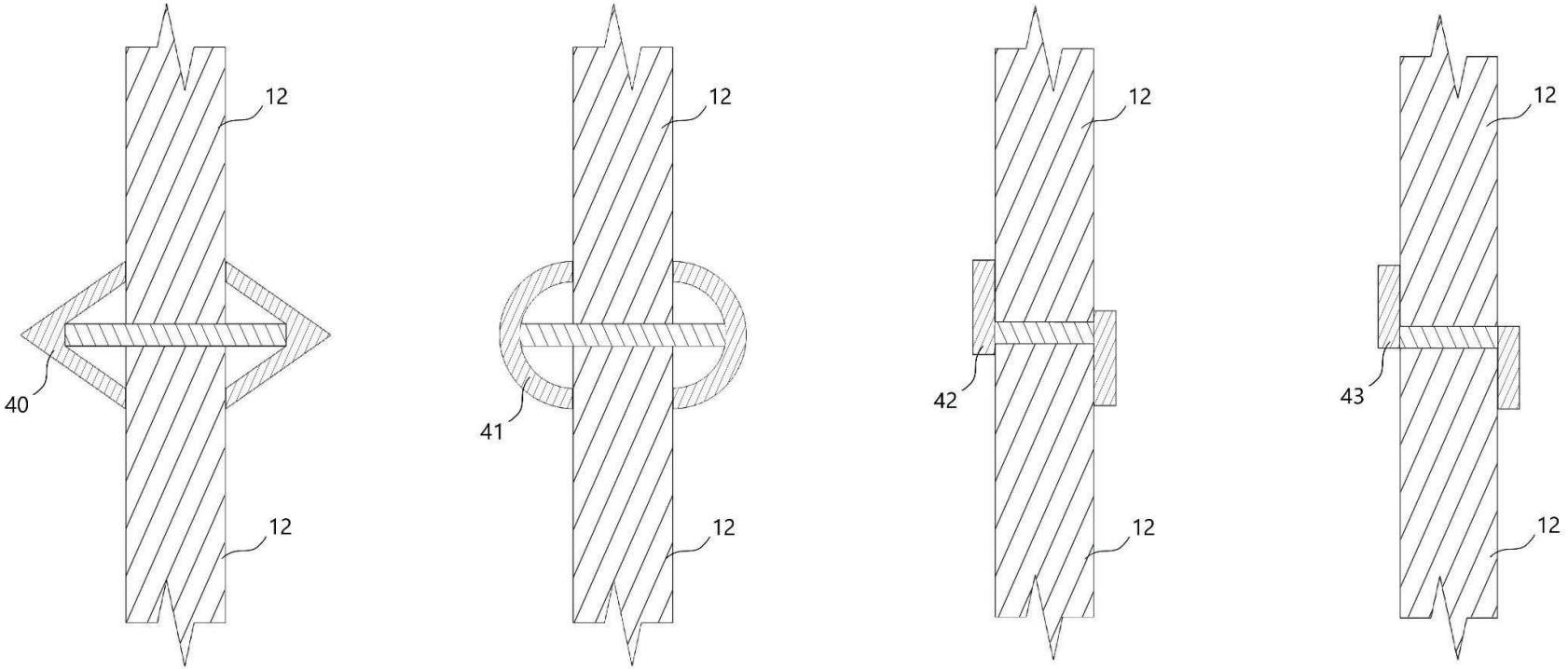

FIGURE 9

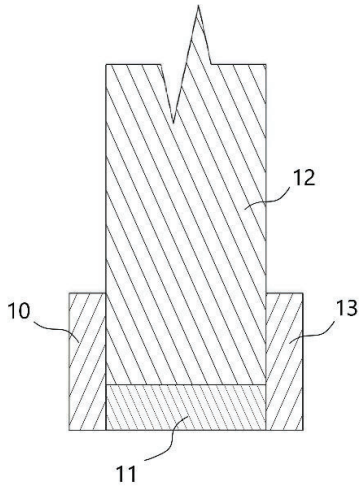

FIGURE 10

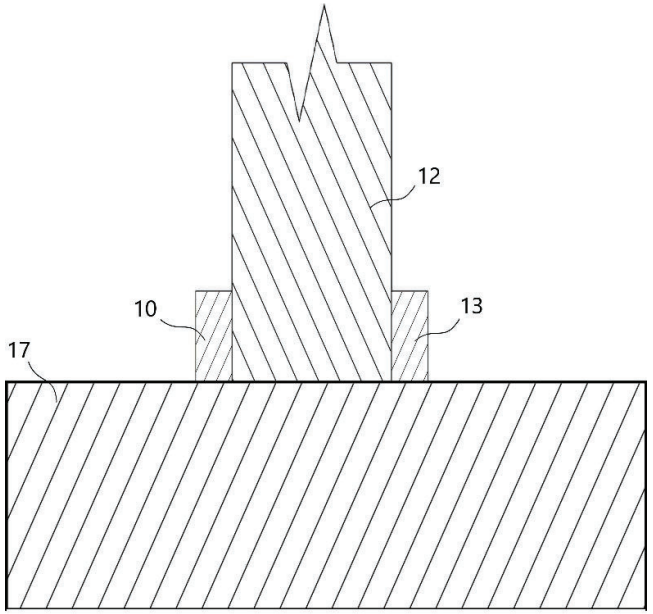

FIGURE 11

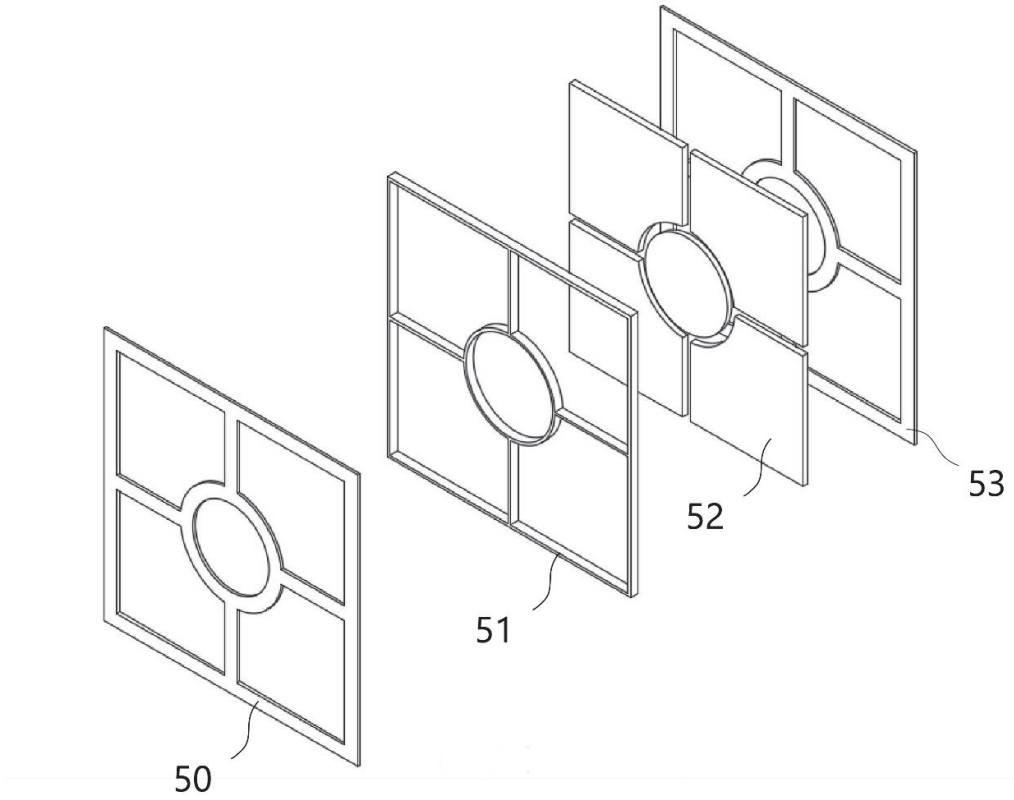

FIGURE 12

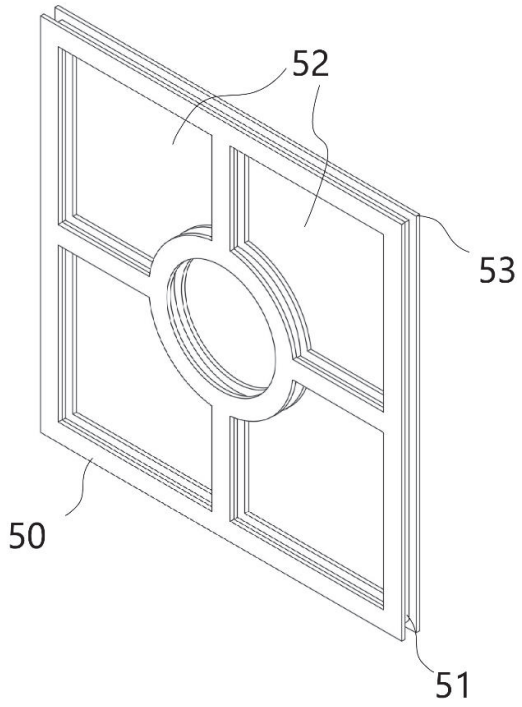

FIGURE 13

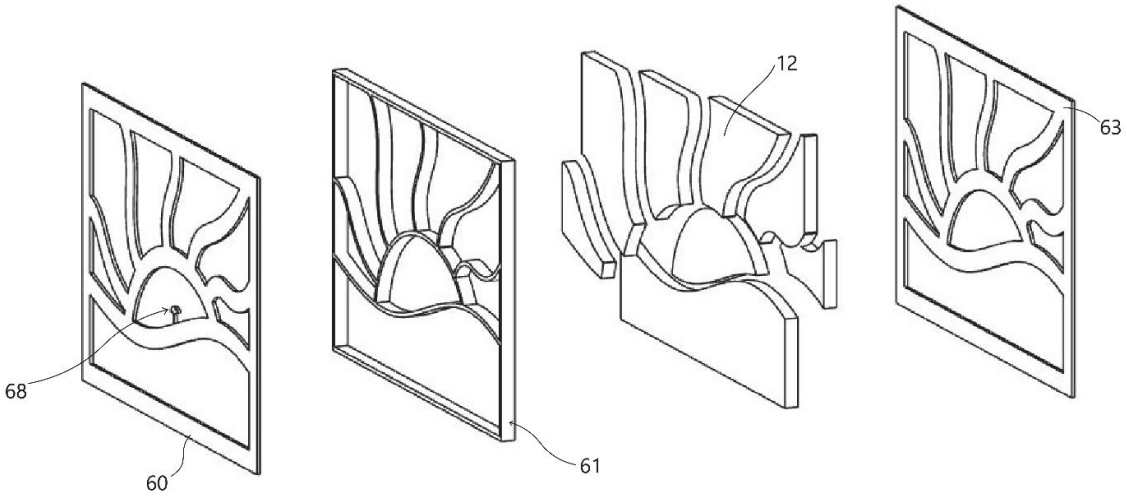

FIGURE 14

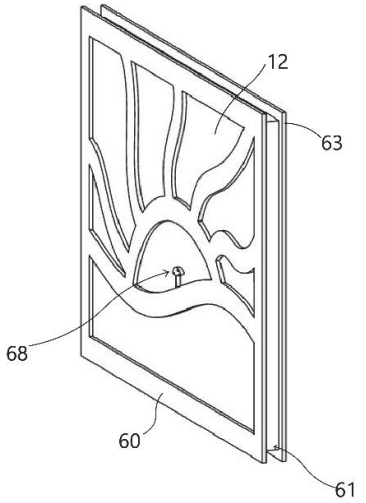

FIGURE 15