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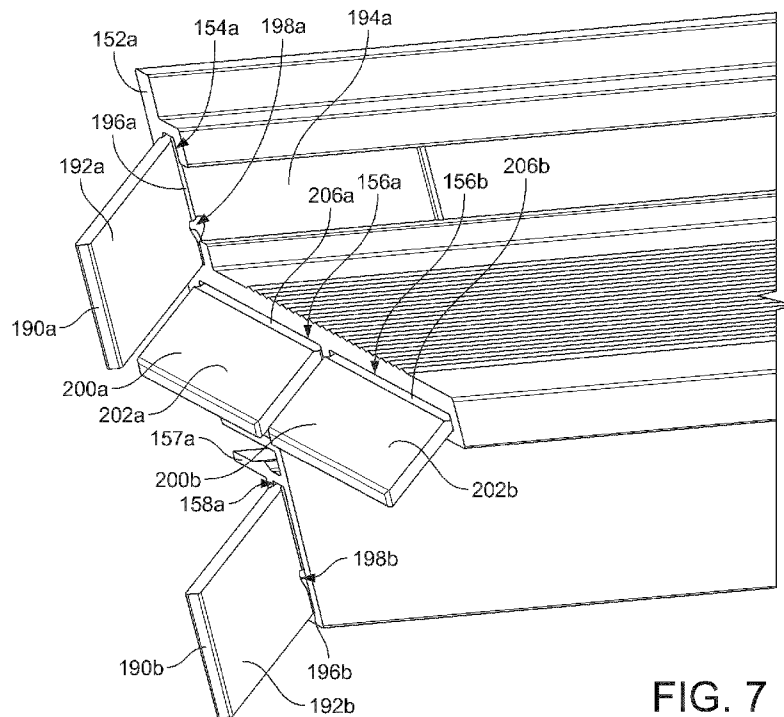


FIG. 7

(57) Abstract: A window frame structure to be installed in an opening formed in the wall or roof of a building for supporting a glazing unit having an inner pane and an outer pane, the frame structure comprising two or more elongate frame members joined at abutting end faces to form joints, wherein the elongate frame members have matching cross-sectional profiles each including a recess, and wherein a cleat is provided extending across each joint at the abutting end faces and disposed within the recesses of the profiles adjacent the joint.



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Metal Window Frame Construction

Technical Field

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The present invention relates to a window frame structure, to a window assembly comprising such a window frame with a glazing unit mounted therein, and to methods of manufacturing and installing such window frames and window assemblies.

10 Background of the Invention

A window assembly can be arranged to be openable or fixed (non-opening).

15 An openable window assembly consists of two parts, a base structure or frame which is fixed to the structure of the wall or roof opening, and a casement which is typically attached via a hinge to the base structure. Glazing is carried by the structure of the casement. A fixed window assembly has the glazing carried directly by the base structure or frame.

20 This invention relates to such window assemblies in general, and in particular to metal rooflights, that is to say a window or skylight fitted in a roof and comprising glazing which is carried on the roof structure through at least one metallic frame. The glazing typically consists of a double glazed unit fixed in the casement or base frame, although triple- and quadruple-glazed units are also known. Such rooflights can be designed either to be
25 mounted onto a flat roof or a pitched roof.

For an openable rooflight, the casement is normally arranged to be opened outwards and to close onto the base frame by being articulated through hinges on the base.

30 Metal rooflights share with other metal-framed windows the problem of condensation from the atmosphere under certain conditions of temperature and humidity. GB 2 492

380 A aims to provide an improved thermal shield to provide an adjustable level of thermal insulation, and to provide a rooflight with very low levels of air permeability.

Another challenge still faced in the design of metal windows is to minimise heat losses
5 through the thermally conductive metal frame in order to provide a desirable or required level of thermal insulation.

Another problem that has been identified is to make the glazing unit replaceable. Sometimes a glazing unit will break, sealants may eventually erode or deteriorate due to
10 UV light, or the metal casement may suffer from corrosion or other weathering effects. With many existing designs, replacement of the glazing unit or casement is not possible without removing the entire window assembly, including the base frame. For rooflights mounted on pitched rooves, this can require removing surrounding roof tiles externally, as well as damaging internal plasterwork to unmount the frame, requiring significant
15 repair and redecoration.

For window assemblies made from aluminium, providing a construction that is relatively easy to manufacture fast and with reliable tolerances, while ensuring adequate structural rigidity to support a glazing unit in a rooflight orientation (mounted on a pitched roof, or
20 horizontally on a flat roof), has also been a challenge.

Summary of the Invention

Aspects of the invention are defined in the independent claims. Preferred features and
25 optional embodiments are defined in the dependent claims.

Brief Description of the Drawings

To enable a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example only, to the
30 accompanying drawings in which:-

Figure 1 shows a perspective view of a window assembly according to a first embodiment of the present invention;

5 Figure 2 shows a perspective view of the window assembly of Figure 1 with the glazing unit removed;

Figure 3 shows a perspective cross-sectional view in the region of an elongate frame member of the window assembly of Figures 1 and 2;

10 Figure 4 shows a cross-sectional profile view in the region of an elongate frame member of the window assembly of the window assembly of Figures 1 to 3;

15 Figure 5 shows an enlarged perspective view of the corner of the window assembly of Figures 1 to 4, indicating the protective end cap provided to the exterior edges of the corner;

Figure 6 shows a similar perspective view of the corner of Figure 5 with the protective end cap removed;

20 Figure 7 shows an enlarged perspective view of the corner construction of the window assembly of Figures 1 to 6 seen from laterally inside the window frame, and having one of the elongate frame members removed so as to reveal cleats disposed in recesses of the remaining elongate frame member;

25 Figure 8 shows another detailed view of the corner construction shown in Figure 7, rotated to look substantially along the line of the end face of the elongate frame member;

Figure 9 shows in isolation the vertical and lateral cleats used in the corner construction of the frame assembly of Figures 1 to 8;

Figure 10 shows a detailed view of the corner construction similar to Figures 7 and 8, but from laterally outside the window frame;

5 Figure 11 shows a perspective view of a window assembly according to a second embodiment of the present invention;

Figure 12 shows a perspective view of the window assembly of Figure 11 with the glazing unit removed;

10 Figure 13 shows a cross-sectional profile view in the region of an elongate frame member of the window assembly of Figures 11 and 12;

Figure 14 shows a detailed view of the corner and cleat construction used in the corner joints of the window assembly of Figures 11 to 13, as seen from laterally inside the
15 window frame;

Figure 15 shows a detailed view of the corner construction of the window assembly of Figures 11 to 14 as seen from laterally outside the window frame;

20 Figure 16 shows a cross-sectional perspective view in the region of an elongate frame member of the window assembly of Figures 11 to 15;

Figure 17 shows the same cross-sectional perspective view to that of Figure 16, with the glazing unit removed for maintenance or repair;

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Figure 18 shows a detailed view of the external edge construction of the base plate of the window assembly of Figures 11 to 17;

Figure 19 shows a further enlarged view of the constructional detail of the laterally outer edge profile of the corner of the window assembly shown in Figure 18, with the edge
30 profile piece removed;

Figure 20 shows a perspective view of a window assembly according to a third embodiment of the present invention;

5 Figure 21 shows a perspective view of the window assembly of Figure 20 having the glazing unit removed;

Figure 22 shows a detailed view of the corner edge construction of the window assembly of Figures 20 and 21, detailing end caps applied to the exterior edges of the corners of the
10 base frame and casement frame;

Figure 23 shows a cross-sectional profile view in the region of elongate frame members of the base frame and casement frame of the window assembly of Figures 20 to 22;

15 Figure 24 shows a cross-sectional profile view in the region of elongate frame members of the base frame and casement frame of the window assembly of Figures 20 to 23, along the hinged side of the window assembly;

Figure 25 shows an enlarged cross-sectional profile view of the hinge construction of the
20 window assembly of Figures 20 to 24;

Figure 26 shows a perspective view of a window assembly according to a fourth embodiment of the present invention;

25 Figure 27 shows a perspective view of the window assembly of Figure 26 with the glazing unit removed;

Figure 28 shows a detailed view of the corner construction of the window assembly of Figures 26 and 27, detailing end caps provided to the exterior edges of the corners of the
30 base frame and casement frame;

Figure 29 shows a cross-sectional profile view in the region of elongate frame members of the base frame and casement frame of the window assembly of Figures 26 to 28;

5 Figure 30 shows a cross-sectional profile view in the region of elongate frame members of the base frame and casement frame of the window assembly of Figures 26 to 29 along a bottom side edge of the window assembly, additionally detailing a support member positioned between the base frame and the thermal shield;

10 Figure 31 shows a cross-sectional profile view in the region of elongate frame members of the base frame and casement frame of the window assembly of Figures 26 to 30, along the hinged edge of the window assembly.

Detailed Description

15 In the following, the terms “exterior” or “external” are used to refer generally to the side of the window assembly which is in contact with the outside environment external to the building in which the window assembly is installed in use, and references to the outward direction or outer side or surface should be construed accordingly, unless dictated otherwise by context. Similarly, “interior” or “internal” is used to refer generally to the
20 side of the window assembly which is in contact with the space inside the building in which the window assembly is installed or to be installed, and references to the inward direction or inner side should be construed accordingly, unless dictated otherwise by context.

25 In a similar context, the term “lateral” is used to define a direction substantially parallel to the plane of the window panes, when the window is installed (and in its closed configuration, where applicable). Furthermore, lateral directions are generally given with reference to the opening in which the window frame is to be installed, such that a
30 laterally inward direction is a direction parallel to the plane of the window pane in a direction from the outside of the frame towards the inside of the frame. A laterally outward direction has the corresponding meaning but in the opposite direction.

Reference is also made generally to metal windows, this meaning that the base frame and/or casement frame of the window is made of metal. These frames may be of any suitable metal, such as steel or aluminium, or alloys thereof, although the present invention is not limited to this. In general, for the windows disclosed herein, it is preferred that at least elongate frame members of both the base frame and the casement frame are made of aluminium or aluminium alloy.

In general such metal frames may be made by casting or forging, or may be made by press-forming or by fabrication from pieces made in any of these ways. One well known method is to fabricate the metal frames from pieces that are laser cut from sheet metal. Aspects of the invention, however, have particular applicability in the context of window assemblies having elongate frame members that are made from extruded aluminium or aluminium alloy, such frame members typically being cut to a desired length from supplies of the extruded profile provided in stock lengths.

The following description also refers generally to window assemblies, although it will be noted that the following description relates specifically to embodiments in the form of rooflights. It will be appreciated that the present invention is not restricted to use with rooflights, and may be used in conjunction with other forms of window assembly. Nevertheless, the present disclosure finds particular application in the context of rooflights, i.e. window assemblies configured to be installed on a flat or pitched roof.

A first embodiment of the present invention is shown in Figures 1 to 10.

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With reference to Figure 1, there is shown a perspective view from the outer side of a window assembly 100. The window assembly 100 includes a frame (or base frame) 150 configured to surround an opening in a wall or roof of a building. In this embodiment, the frame 150 is configured to be mounted around the opening in a flat roof, to form a rooflight. The frame 150 supports a glazing unit 110 mounted therein, and sealed within

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the frame around its laterally outer edges by a strip of sealant 115 between the glazing unit 110 and the frame 150.

In this example, the frame 150 is formed in substantial part by 4 elongate frame members 5 152 which are disposed along its lateral side edges to form a substantially square or rectangular shaped frame, as viewed from above. The elongate frame members 152 extend along each lateral edge of the frame and are formed with abutting end faces at each corner, to form joints. The joints may be formed in any known manner, but in the present embodiment the elongate members 152 are joined at the joints between 10 abutting end faces by adhesive. Herein, abutting does not require full engagement across the end faces 152A of the elongate members 152, although this is the design condition, but indicates a mutual alignment and a construction having the ability to transfer forces between the elongate frame members 152 across the joints.

15 In order to provide elongate members 152 of the desired length, it is economical and efficient for these to be provided as stock lengths of aluminium or aluminium alloy extrusions having a desired cross-sectional profile. It is furthermore convenient if the stock lengths of aluminium or aluminium alloy extrusion are provided already powder coated, eliminating the need for subsequent treatment or coating after assembly of the 20 frame.

Such a method of manufacturing and assembly does however have the consequence that, when the stock lengths are cut to desired lengths to form the elongate members 152, the cut ends become exposed and are not powder coated. This can have negative 25 consequences, such as risk of corrosion, due to the intended use of the elongate members as frame members for a window assembly on the exterior of a building, where they will be subjected to a variety of weather conditions. In order to mitigate this problem, protective end caps 170 are provided over the corners of the elongate frame members 152, adhesively sealed to the external corners of the frame 150 to prevent 30 exposure of the cut ends to moisture and to inhibit corrosion.

The bottom portions of elongate members 152 are provided with means for affixing the frame 150 to the opening in the building, typically by inserting screws through a lower portion of the frame into wooden joists defining the opening in the building. Protective covers 160 are provided along the bottom edges of the frame 150 to cover and protect the screws or other fixing means used to hold the frame in place around the opening. These will be described in further detail below.

Turning to Figure 2, a corresponding perspective view of the window assembly is shown, but with the glazing unit 110 removed, so that only the frame 150 of the window assembly remains.

As will be apparent from Figure 2, the elongate frame members 152 are formed with mitred cut ends such that their end faces will abut to form a joint at a desired angle, in this case substantially equal to 90 degrees at every corner. It will, of course, be appreciated that window frames may be formed in any desired size and shape, by adjusting the length and shape of the elongate members and the angle of the joints. As well as straight elongate members, such as the elongate frame members 152 used in the present embodiment, it will be appreciated that curved or otherwise shaped elongate frame members may be used to form a window frame of any desired shape, with joints formed at appropriate angles between abutting frame members. For example, circular, oval, triangular, hexagonal and octagonal windows are all known whilst any other polygonal shape is contemplated. Nevertheless, the embodiments of the present invention are preferably square or rectangular in shape, with substantially straight elongate members forming the sides of frames.

Figure 2 also shows a thermal shield 120 extending laterally inwardly from the frame 150, around the inside of the opening in the frame 150. In this embodiment, the thermal shield is also formed from extruded members similarly cut to desired lengths corresponding with the lengths of the elongate frame members 152, and having mitred end faces serving to form an abutment joint at the corners.

As shown on the right hand side of Figure 2, the thermal shield includes a structural member having a lateral leg 122 extending laterally into the opening from the elongate frame members 152, and exhibiting an inner lip 126 along the laterally inner side thereof. The same structural members are used on the left hand side of Figure 2, but in addition
5 there are shown insulation members 124 mounted along the outer surface of the lateral legs 122. Insulation members 124 are also to be provided to the outer surfaces of lateral legs 122 of the elongate members of the thermal insulation shield 120 shown on the right hand side of Figure 2, but these insulation members have been removed in Figure 2 for illustration purposes to show the structural element of the thermal insulation shield 120
10 including lateral legs 122 and laterally inner lips 126.

Figure 3 shows a perspective cross-sectional view through the window assembly 100, in a region including and adjacent to one of the elongate frame members 152. This view may be considered in conjunction with Figure 4, which shows a corresponding cross-sectional
15 end or profile view of a cut through the window assembly 100, at the location of one of the fixing holes 159 which are visible in Figure 3.

As shown in Figures 3 and 4, the window assembly 100 includes a glazing unit 110 mounted in the frame 150. The glazing unit 110 includes an outer pane 114 located on an
20 outer or exterior side of the glazing unit 110 and of the window assembly 100, and an inner or interior pane 112 located on the side of the window assembly 100 which faces into the building in which the window assembly is to be mounted. The glazing unit 110 in this embodiment has a typical double glazing construction, with frame members 116 extending along the lateral edges of the glazing unit between inner pane 112 and outer
25 pane 114, and with a sealant 118 provided around the external perimeter of the glazing unit 110 so as to seal the glazing unit 110 with an inert gas filling the space between the inner pane 112 and outer pane 114.

As shown in Figures 3 and 4, the elongate frame members 152 and the structural element
30 of the thermal shield 120 have a cross-sectional profile exhibiting a number of desirable features.

Elongate frame member 152 is formed with a cross-sectional profile including an outwardly extending leg 154 arranged to extend outwardly in a direction substantially perpendicular to the surface of the roof on which the window assembly 100 is to be mounted. Outwardly extending leg 154 forms the laterally outer side surfaces of the frame 150 as shown in Figures 1 and 2.

At an inner end of the cross-sectional profile, a fixing profile is provided for securing the frame 150 in position around the opening in the building in which it is to be installed. The fixing profile includes a laterally inwardly extending leg 155, extending laterally inwardly from the outwardly extending leg 154, and an inwardly extending leg 158 extending inwardly from the lateral leg 155, so as to form the fixing profile with a stepped-in configuration. Holes 159 are formed through the inwardly extending leg 158, to receive screws, bolts or other fixing means there through, for fixing the frame securely to the structure of the building, such as by screwing the frame 150 to rafters or other wooden substructure.

The cross-sectional profile of elongate frame member 152 additionally includes, as part of the fixing profile, laterally outwardly extending legs 157a, 157b, which define a channel in which the fixing members such as screws are introduced in order to pass through holes 159 into the substructure against which they are fixed. Outer and inner lateral legs 157a, 157b are formed with snap-fit features on their outer and inner surfaces, respectively, for providing an engagement with protective cover 160. Protective cover 160 includes laterally inwardly extending legs 162, 164 at outer and inner sides thereof, respectively, and which respectively include snap-fit features on their inner and outer surfaces for engaging with the corresponding snap-fit features on the outer and inner surfaces of the outer and inner lateral legs 157a and 157b. These snap-fit features allow protective cover 160 to be press-fitted onto the frame 150 after it has been secured in place with appropriate fixing means such as screws extending through holes 159. The protective cover 160 encases the screws or other fixing means in order to protect them from the elements, and provide a decorative finish. Protective cover 160 may also prevent or

inhibit unauthorised tampering with the screws or other fixing means after the window assembly 100 has been installed on a building.

Advantageously, the protective cover 160 includes a recessed groove or notch 166 forming part of the cross-sectional profile of the protective cover 160 along its length. This groove or notch can be engaged by a tool for removing the protective cover 160, when it is desired to remove the window assembly. This permits authorised access to the fixing means such as screws or bolts extending through holes 159, when appropriate for maintenance, repair or replacement purposes.

Elongate frame member 152 additionally includes a laterally inwardly extending leg 156, which provides the shelf or ledge on which glazing unit 110 is supported. As shown, glazing unit 110 is securely fixed to the shelf or ledge provided by lateral leg 156 by means of a strip of adhesive or adhesive tape (shown but not labelled) to secure the glazing unit 110 securely in place. Glazing unit 110 is additionally secured in place by seal end 115 around the perimeter edge of the glazing unit 110 between the lateral outer edge of outer pane 114 and the laterally inner edge of outwardly extending leg 154.

In addition to the glazing unit 110 being secured on the outer surface of the lateral leg 156, the thermal shield 122 is secured to the inner surface of lateral leg 156 as shown in Figures 3 and 4.

The thermal shield 120 includes a structural element and thermal insulation member 124. In this embodiment, the structural element includes a laterally inwardly extending leg 122, which is secured by adhesive or adhesive strips to the inner side of the lateral leg 156 of elongate frame member 152. An outwardly extending leg 125 extends outwardly from the laterally inner end of the laterally inwardly extending leg 122 to a position proximate to the inner surface of the inner pane 112 of the glazing unit 110. A lip 126 extends laterally from the outer end of outwardly extending leg 125, terminating in an inwardly extending hooked portion at its laterally inner end. The structural element of thermal shield 120 is formed from a thermally insulative material, such as uPVC, having

low thermal conductivity relative to inner pane 112 of the glazing unit 110 or the elongate frame member 152. Thermal insulation member 124 is adhesively secured between the outer surface of lateral leg 122 of the structural element and the inner surface of the inner pane 112. Thermal insulation member 124 additionally serves the function of a sealing member, providing an airtight seal between the structural element of the thermal shield and the inner pane 112 of the glazing unit 110. Thermal insulation member 124 is formed of a thermally non-conductive material, which may comprise polyisocyanurate foam, or may comprise alternative polymer foams comprising, for example, polyurethane, polystyrene or phenolic resin. In this embodiment, polyurethane foam is used. Alternatively, the thermally non-conductive material may comprise an aerogel or other thermal insulation material. The thermal insulation material has a lower thermal conductivity than the inner pane 112 of glazing unit 110 or the material from which the structural element of the thermal shield is formed, which typically may be uPVC.

This arrangement of the thermal shield beneficially improves heat losses through the window assembly from the interior of the building the external environment. A number of mechanisms serve to enhance the thermal insulation properties of the window assembly 100, by virtue of using this thermal shield construction. Firstly, the inner lip 126, together with the thermal insulation member 124, serves to define a pocket 185 between the outer surface of inner lip 126 and the inner surface of inner pane 112. This pocket 185 is also described as a "static air pocket", as it defines only a small gap between the inner lip 126 and the inner surface of the inner pane 112. As a result, air in the pocket 185 is unable to freely circulate and remains statically in place, substantially regardless of thermal air currents within the interior of the building in which the window assembly is installed. As air is not a good conductor of heat, the pocket of static air thus created acts as a thermal insulator and provides a barrier to heat transfer from the interior of the building towards the exterior of the building, with reduced thermal conduction through the frame construction of the window assembly.

The inner lip 126 also defines a recess 127 on its inner side, formed to receive a plasterboard sheet or other equivalent material of a standard thickness, for finishing the

laterally inner surface of the opening in which the window assembly is to be installed. It will be appreciated at the space between such a plasterboard sheet and the elongate frame member 152 will typically be filled by substructure, such as wooden joists, which are of low thermal conductivity, and/or additional thermal insulation material provided in the gap, so as to also provide a low degree of thermal conductivity through the building substructure to the frame 150 of the window assembly 100.

Accordingly, heat seeking to escape from the warm internal space in the interior of the building to the outside through the window assembly 100 must find a thermal conduction path either along the structural element of the thermal shield (which has a low thermal conductivity, in any event), outwardly through the glazing unit 110 (which also has a low thermal conductivity), or, lastly, laterally along the inner pane 112 of the glazing unit 100 to the frame 150.

In prior art window assemblies, this thermal conduction pathway along the inner pane of the glazing unit may not have been fully recognised, since thermal conductivity through the frame itself was greater in other areas, or may have been considered unavoidable. Where conductive pathways were recognised through the frame members, in known aluminium window frame designs, a thermal break is included, such as by providing a polyamide structure between adjacent aluminium frame members, to reduce conductivity through the frame. However, such arrangements tend to require a sizeable polyamide structure to decouple the metal frame components and reduce conductive heat transfer, which has the effect of compromising the structural integrity of the aluminium frame structure, reducing its strength and rigidity.

Nevertheless, heat conducted along the inner pane 112, once it reaches the proximity of the laterally inner edge of the elongate frame member 152 (which is assumed to be made from metal), will be readily conducted through the elongate frame member 152 to the exterior of the building and the external environment, due to the high thermal conductivity of the metal elongate frame member 152. The thermal shield of the present invention is thus constructed to increase, to the extent possible and reasonable, the

length of the thermal conduction pathway between the laterally inner edge of the inner lip 126, indicated by the letter B in Figure 4, to the laterally inner edge of the elongate frame member 152, indicated by A in Figure 4. The points A and B are determined by taking the point on the inner surface of the inner pane where the line normal to the inner surface of the inner pane intersects the innermost edge of the elongate frame or inner lip, respectively. This applies for determining the points for measuring all such lengths between laterally inner edges as referenced herein.

The increased length of the thermal conduction path along the inner pane 112 is achieved because there are no thermal conduction pathways of significantly greater thermal conductivity from the interior of the building to the exterior of the building through the window assembly 100 except along the designated thermal conduction path along the inner pane 112. Greater heat conduction along and through the inner pane 112 is mitigated by the thermal insulation member 124, as well as by the presence of thermal insulation chamber 180 which is formed by the bounding members of the thermal insulation member 124, the lateral leg 122 of the thermal shield, the inner pane 112 and the lateral leg 156 of the elongate frame member 152. Heat conducted along inner pane 112 cannot easily jump from the inner pane 112 to the lateral leg 156 of the elongate frame member through the air trapped in the thermal insulation chamber 180, but will instead preferentially conduct along the inner pane 112 until closely proximate to the laterally inner edge of the lateral leg 156, as denoted by A in Figure 4.

Heat conduction through and around the window assembly 100 is thus minimised by ensuring that the thermal conduction path along the inner pane 112 of the glazing unit 110, from the laterally inner edge B of the air pocket 185 to the laterally inner edge A of the frame 150 is the path of least thermal resistance between the opening and an exterior of the building.

This is generally achievable where the length of the thermal conduction path from B to A is not shorter than 35 mm, preferably not shorter than 50 mm, more preferably not

shorter than 59 mm, most preferably not shorter than 75 mm. In the present embodiment, the distance from B to A is set to approximately 59 millimetres.

In order to ensure the greatest possible thermal efficiency, whilst remaining within reasonable structural sizes and tolerances, it is preferable to ensure that the thermal transmittance for heat flowing along the thermal conduction path from B to A along the inner pane 112 of the glazing unit 110 and through the frame (around the whole frame) is not more than 10% greater than the thermal transmittance for heat passing directly through the glazing unit 110 from the inner pane 112 to the outer pane 114 (across the whole area of the glazing unit). This value should, for comparison, be determined for a nominal window size and shape according to standard testing methods EN ISO 10077-1 and 10077-2. Such a determination may usefully be made via computer simulation using known thermal conductivity and transmissivity values. Internal and external air temperatures will not typically affect the location of the thermal conduction pathways through the materials, but in case of doubt, any assessment should be determined based on an internal air temperature within the building of 20°C and an external air temperature of 0°C, in accordance with the cited standards.

With regard to the formation of the static air pocket 185, the outer surface of the inner lip 126 is preferably spaced from the inner surface of the inner pane 112 by 10 mm or less, preferably by 8 mm or less, and most preferably by 6 mm or less, in order to minimise the circulation of air within the pocket 185. As regards the lateral extent of the pocket 185, it is desirable to minimise the lateral extent of the thermal shield, including the inner lip 126, as this either reduces the size of the opening formed in the building or otherwise increases the size, weight and cost of the window assembly as a whole by increasing its outward lateral extent. The inner lip 126 will accordingly preferably have a lateral extent between 20 mm and 25 mm, more preferably between 22 mm and 23 mm. This should be measured from the laterally inner edge of the inner lip at the location marked by B, to the laterally inner edge of the thermal insulation member 124, at the point where it meets the inner surface of the inner pane 112.

As will be appreciated, the thermal shield 120 so arranged acts to provide a barrier to thermal heat conduction from the warm internal air of the building to the frame 150 of the window assembly, which frame will typically be highly thermally conductive due to being constructed from metals such as aluminium or aluminium alloy, and through which
5 significant heat losses may otherwise occur.

With continued reference to Figures 3 and 4, additional structural features of the construction of the elongate frame member 152 will now also be described. In particular, it can be seen that a number of recesses are provided in the cross-sectional profile of the
10 elongate frame member 152. Specifically, a recess 154a is formed along the outwardly extending leg 154 on its laterally inner side, recesses 156a and 156b are formed along the lateral leg 156 on its inner side, and a recess 158a is formed along the inwardly extending leg 158 of the fixing profile on its laterally outer side. In the present embodiment, the recesses 154a, 156a, 156b and 158a are formed as open sections, although they could
15 equally be formed as closed box sections, if desired. These recesses 154a, 156a, 156b and 158a serve to enhance the structural integrity of the frame 150 at the joints formed at its corners between the elongate frame members 152 by receiving one or more cleats therein to support the elongate frame members 152 at the corner joints.

20 With reference to Figures 7 to 10, additional constructional detail of the corner construction of the Frame 150 is shown.

Figure 7 shows a perspective view of one elongate frame member 152 having cleats 190a, 190b, 200a, 200b inserted in the recesses 154a, 156a, 156b and 158a thereof. Figure 8
25 shows a similar view to Figure 7 but from an angle facing substantially along the line of the corner joint, to assist in visualising certain features. Figure 9 shows the cleats 190a, 190b, 200a, 200b with the elongate frame member 152 removed but the cleats 190a, 190b, 200a, 200b otherwise remaining in the same position as shown in Figure 8, to further assist in visualising their construction. Figure 10 shows the same corner as shown
30 in Figures 7 and 8, but from the lateral outside of the corner facing in, rather than from

the lateral inside of the corner facing out, to assist in visualising certain features of the corner construction.

As noted above, it is considered to be economical to manufacture the window frames of the present invention from stock lengths of extruded aluminium profiles, cut to the
5 desired lengths to form elongate frame members of the window assembly frame. The elongate frame members 152 are cut with mitred ends so that the end faces 152A of the elongate members 152 can be abutted together to form a corner joint.

10 One known method for joining steel window frame structures is, for example, welding. The embodiments described herein seek to provide an economical alternative assembly method for the frames. To this end, the profiles of the elongate members 152 are designed to facilitate joining the abutting elongate members 152 at their corners by way of adhesive joints.

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In order to provide additional structural integrity to the adhesive joints, in particular for improved rigidity as well as providing larger surface areas for the adhesive to act on, cleats are provided in the recesses 154a, 156a, 156b, 158a of the elongate frame members so as to extend across the joints between abutting end faces 152A of the
20 elongate frame members 152.

As shown in Figure 9, two particular types of cleats are contemplated, lateral cleats having a substantially planar construction, such as cleats 200a, 200b, and which are essentially chevron shaped and intended to lie in a lateral plane across the corner joints,
25 and vertical such as cleats 190a 190b which are formed of two outwardly extending planes joined at an angle substantially corresponding to the angle of the corner joint between the elongate members 152.

The outwardly extending vertical cleats 190a 190b are essentially formed from two legs
30 192a, 194a, intended to be inserted into respective elongate frame members 152 on either side of the joint at the corner. The cleats 200a, 200b which lie in a lateral plane are

constructed to extend across the joint in a similar way, with first legs 204a, 204b being received in the recesses of a first elongate frame member 152 and second legs 202a, 202b being received in the recesses of a second elongate frame member 152 abutted to the first elongate frame member 152.

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As shown in Figure 7, the first leg 194a of upper outwardly extending cleat 190a is received in the recess 154a of the outwardly extending leg 154. The joining leg 192a of the outwardly extending cleat 190a will fit in the corresponding recess 154a of an abutting elongate frame member 152. Similarly the leg 194B of lower outwardly
10 extending cleat 190b is received in the recess 158a of the inwardly extending leg 158, whilst the adjoining leg 192b will be received in the recess 158a of an adjoining elongate member 152.

For the laterally extending cleats 200a, 200b, the first leg 204a of laterally outer cleat
15 200a is received in the recess 156a of the lateral leg 156 while the first leg 204b of the laterally inner lateral cleat 200b is received in the recess 156b of the laterally extending leg 156. Second legs 202a and 202b of the laterally extending cleats 200a, 200b are received in the corresponding laterally outer recess 156a and laterally inner recess 156b formed in the lateral leg 156 of an abutting elongate frame member 152.

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According to a preferred method, in order to assemble the frame 150, the elongate frame members 152 are placed into a jig, the cleats 190a, 190b, 200a, 200b are inserted into the end of one of the elongate members 152 at each corner joint, and the adjoining elongate frame members 152 are then brought into alignment with the cleats and the cleats 190a,
25 190b, 200a, 200b are introduced into the corresponding recesses 154a, 156a, 156b, 158a of the adjoining elongate member 152 so that the frame 150 is loosely assembled in the jig. Adhesive is applied to the cleats at the joints, and the jig is tightened in order to simultaneously approximate the end faces 152a of the elongate members 152 at each of the corner joints (in the present case, at all four corners of the square or rectangular
30 frame 150). The jig is preferentially configured so as to provide a simultaneous tightening that will allow a small degree of movement between the elongate frame members 152, as

the abutting end faces 152A of the elongate frame members 152 are brought into closer approximation and abutment. This is to allow for manufacturing tolerances at the cut end faces 152A of the abutting elongate frame members 152, and to allow the four elongate frame members 152 as a whole to find the natural and most stable orientation, which will provide for greater structural integrity once the adhesive has set or cured.

It will be appreciated that by providing large surface areas on the legs 192a, 194a, 192b, 194b, 202a, 202b, 204a, 204b of the cleats 190a, 190b, 200a, 200b, the adhesive has a greater area across which to form an adhesive bond, thus improving the strength of the attachment between the cleats 190a, 190b, 200a, 200b and the elongate members 152 on each side thereof. Correspondingly, a significantly stronger bond is achieved between the abutting elongate frame members 152 than if these were simply adhesively bonded along their abutting end faces 152A.

Since the frame 150 is intended to be used on the exterior of a building and subject to varying environmental weather conditions, it is imperative not only to form a strong structural bond between the adjacent elongate frame members 152 at the joints, but also one which is watertight and will prevent fluid ingress, as well as preventing airflow in and out of the window frame 150 via the corner joints.

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To this end, the cleats 190a, 190b, 200a, 200b are arranged to provide adhesive distribution paths along the corner joints between abutting elongate members 152. In the present embodiment, these are provided by way of channels 196a, 196b, 206a, 206b provided along the cleats 190a, 190b, 200a, 200b in the region between the adjacent legs 192a, 194a, 192b, 194b, 202a, 204a, 202b, 204b, as most readily seen in Figure 9. These channels 196a, 196b, 206a, 206b, provide a pathway along which adhesive can be injected into the joint and along which the adhesive will flow in order to fill up and seal any gaps between the abutting end faces 152A of the elongate frame members 152.

To assist in injecting adhesive into the corners between abutting elongate frame members 152, injection ports 198a, 198b are provided at least in the outwardly extending

vertical cleats 190a, 190b, as can be seen in Figures 7 to 10. It will be appreciated that, due to the open recess on 154a provided along the outwardly extending leg 154 of the elongate members 152, adhesive can be injected into the injection port 198a from the inside of the frame 150, in order to provide an effective seal along the corner joint. When
5 injected, the adhesive will flow along the channels 196a, 206a and 206b in order to properly seal the joint in this region.

As best seen in Figure 10, the open structure of the recess 158a allows similar access into the injection port 198b of the lower outwardly extending cleat 190b to permit injection of
10 adhesive into this portion of the frame at the corner joint, so as to flow along the channel 196b and effectively seal the corner in this region.

As well as providing structural integrity, and sealing the corner joints against water ingress or the escape of warm air therethrough, as noted above, it is also desirable to
15 protect the cut ends of the elongate frame members 152 to prevent corrosion. It is also likely that, after injecting adhesive into the corner joints via the ports 198a, 198b, and as otherwise necessary, an excess of adhesive will remain around the perimeter of the corner joint. It is intended to utilise this excess of adhesive to attach the protective caps
20 170 onto the outside corners of the frame 150, as illustrated most clearly in Figure 5. In this case, it may be desirable to provide the protective caps 170 in two or more separate pieces, for example with an outer piece 170a arranged to cover the outwardly extending leg of 154a of the elongate member on either side of the joint after sealing the joint with adhesive as noted above. The lower protective cap 170b may be arranged to cover the
25 corner joint between the protective covers 160, which is fitted after installing the window frame 150 around the opening. The protective cap 170b may thus be separately installed as a later step during the installation of the window assembly onto a building. Alternatively, the protective caps 170 may be arranged cover the full corner section at the time of assembly, in which case the protective covers 160 are made shorter to fit between the end caps 170 at either end thereof.

Figures 5 and 6 merely detail the formed corner joint of the window assembly 100 with the protective caps 170a and 170b in place, as shown in Figure 5, and with the covers removed, as shown in Figure 6. The protective caps 170a, 170b in the present embodiments are made from painted or otherwise coated metal such as zinc, zinc alloy, aluminium or aluminium alloy, but may instead be made from any other suitable corrosion resistant material that may be affixed to the outer edge corners of the window frame 150, such as suitable plastics materials.

It will, of course, be appreciated that the elongate frame members 152 having the above described cross-sectional profiles and made of aluminium or aluminium alloy are advantageous, due to strength, rigidity, light weight and low cost, for example as compared with other known window designs, regardless of the method used for joining the elongate members 152 at the corners.

It will also be appreciated that in the described embodiments of the present invention, the elongate frame members of each disclosed frame have an identical cross-sectional profile along each edge of the frame, such that when they are cut with mitred edges, the end faces will match and align when abutted together. It would of course be possible to provide adjacent elongate frame members having different cross-sectional profiles, when viewed in the direction of the long axis of the elongate members, i.e., as shown in the drawings of the present application, but arranged so that when the frame members are cut at appropriate angles then the respective cross-sectional profiles will nevertheless meet and match across the joint. To this end, it is not required for the elongate frame members to have identical cross-sectional profiles, although they do in the embodiments described herein, and it is envisaged that this will be the best solution for most practical applications.

A second embodiment of the present invention will now be described with reference to Figures 11 to 19.

Many of the constructional and structural aspects, as well as the functional requirements and considerations, described in relation to the first embodiment of Figures 1 to 10 are identical for the embodiment of Figures 11 to 19, and as such the description of the second embodiment of the invention will focus primarily on variations from the first embodiment in order to avoid extensive repetition. The description of the first
5 embodiment should thus be taken to apply equally in all respects to the second embodiment unless noted otherwise.

In Figures 11 to 19, corresponding features for those described in respect of the first
10 embodiment are accordingly given corresponding reference numbers, but incremented by 200. Thus, the window assembly 300 corresponds to window assembly 100, glazing unit 310 corresponds to glazing unit 110, etc.

Figure 11 shows a perspective view of the window assembly 300 of the second
15 embodiment.

As show in Figure 11, the window assembly 300 includes a glazing unit 310 mounted in frame 350 and sealed around the outer perimeter of the glazing unit 310 by a strip of sealant 315. In contrast with the frame 150 of the first embodiment, the frame 350 of the
20 second embodiment includes a base plate extending laterally outwardly from the outwardly extending wall 354 of each elongate frame member 352. The base plate is formed by a laterally outwardly extending leg 355 forming part of the cross-sectional profile of each elongate frame member 352, as described further below.

This base plate renders the window assembly 300 suitable for being mounted to a pitched
25 roof, in contrast to the arrangement shown in Figure 1, which is configured for being mounted to a flat roof. As with the window assembly 100, window assembly 300 is fixed (i.e., non-openable).

30 Three of the lateral outside edges of the base plate are provided with an edge profile 360, which is arrange to cooperate with the laterally extending leg 355 to form a water

channel so that, when mounted on an inclined roof, the base plate will provide a channel for water to flow around and away from the window opening. In particular, the edge profile 360 shown in Figure 11 is designed to lie underneath the edges of the adjacent roof tiles, which will overlap the edge profile 360 so as to integrate the window assembly 300 into the roof and ensure a weatherproof installation. One of the outer side edges, as shown in Figure 11, is arranged to form the bottom edge of the window, and so is formed without such an edge profile, as this portion of the base plate will lie above the adjacent roof tiles so that water can run off the base plate onto the roof below.

Turning to Figure 11, the frame 350 is shown with the glazing unit 310 removed. This is similar to the view of the frame 150 shown in Figure 2, with the notable exception (in addition to the provision of the base plate) that elongate carrier members 330 are provided along each elongate frame member 352, as will be described in more detail below.

Turning to Figure 13, there is shown a cross-sectional view through the window assembly 300 in the region adjacent to one of the elongate frame members 352.

In this embodiment, the elongate frame member 352 has a cross-sectional profile including an outwardly extending leg 354 arranged to extend substantially perpendicular to the plane of the roof in which the window assembly 300 is to be mounted.

As noted above, a laterally outwardly extending leg 355 extends laterally outwardly from the outwardly extending leg 354, to form a base plate. The base plate terminates in an edge profile 360 at its laterally outer edge, for the elongate members 352 along three of the side edges of the frame 350, as noted above. The edge profile 360 defines a recess 360a, in which an edge profile piece 365 is mounted. Advantageously, the edge profile 360 and recess 360a provide a modular edge construction for the elongate members 352, allowing different edge profile pieces to be mounted in the edge profile 360, depending on the requirements for a particular installation. The edge profile piece 365 in the embodiment of Figures 11 to 19 simply defines a right angled bend, so as to define the

channel between edge profile 360 and the outwardly extending leg 354, for draining water (from rainfall) away from the window assembly 300 and into the roof drainage system. In particular, the lateral edge profile 360 is designed to be installed in a roof beneath the laterally adjacent rows of roof tiles, which will overlap the edge profile piece 365 and ensure that any rain water or other precipitation will be guided along the channel formed by the base plate, and will not be directed under the tiles into the building in which the window assembly is installed.

The edge profile 360 is shown in more detail in Figures 18 and 19, in which Figure 18 shows the edge profile 360 with edge profile piece 365 inserted in the recess 360a. Here, it can be seen that edge profile piece 365 includes an outwardly extending leg 366 and a laterally inwardly extending leg 367, extending laterally inwardly from the outer end of the outwardly extending leg 366. As best seen in Figure 19, outwardly extending edge profile 360 and outwardly extending leg 361 are provided with respective protruding ribs or ridges extending along the longitudinal length of the elongate frame member 352 on the opposed wall surfaces of the recess 360a. Laterally inwardly facing ridges 362a, 362b are formed on the laterally inner face of the edge profile 360, and corresponding laterally outwardly facing ridges 363a, 363b and formed on the laterally outer face of the leg 361. These ridges 362a, 362b, 363a, 363b may serve to grip and hold the edge profile piece 365 in place when the laterally outwardly extending leg 366 is inserted into the edge profile recess 360a. However, they are primarily provided for alignment. The edge profile pieces 365 are secured in place using self-tapping screws or other suitable fixing means. Independently of the provision of laterally inwardly facing ridges 362a, 362b and laterally outwardly facing ridges 363a, 363b, it will be noted that, as illustrated, the legs 360 and 361 are of different lengths. This is to allow the laterally outer leg 360 to terminate flush with the upper side of laterally inwardly extending leg 367, while the underside of laterally inwardly extending leg 367 extends over the top of the laterally inner leg 361. Laterally outer leg 360 is thus longer than laterally inner leg 361.

In this manner, different edge profile pieces can be inserted along the lateral outer edges of the base plate, according to need. Whilst the edge profile piece 365 is configured to sit

underneath an overlapping layer of tiles along the lateral side edges and the top edge of the window frame when installed on a pitched substantially planar roof, alternative edge profiles may be required or desirable, along one or more of the side edges, when mounting the window assembly in different locations. For example, a different edge profile may be desirable when mounting the window assembly 300 adjacent to a wall of a building, or when two such window assemblies 300 are to be mounted adjacent to one another, without overlapping tiles being present in either case. The interchangeable edge profiles may be used to create a superior fit and finish of the installed window assembly 300, and also to create a weather proof seal with adjacent structures such as an adjoining wall or an adjacent similar window assembly.

Returning to Figure 13, the elongate frame member 352 further includes a laterally inwardly extending leg 356, extending laterally inwardly on the opposite side of the outwardly extending 354 from the laterally outwardly extending leg 355. Laterally inwardly extending leg 356 is similar to the the laterally inwardly extending leg 156 in the embodiment of Figures 1 to 10, but has a reduced inward lateral extent.

In this embodiment, the thermal shield 320 is attached to the inner side of the inwardly extending lateral leg 356, in the same manner as for the embodiment of Figures 1 to 10, and a corresponding thermal conduction path is defined along the inner pane in 312 of the glazing unit 310, from the laterally inner edge of the inner lip 326, as noted by the letter B, to the laterally inner edge of the part of the elongate frame member closest to the inner pane 312, as noted by the letter A, which in this case is the laterally inner edge of the carrier member 330.

Again, a static air pocket 385 is defined between the outer surface of the inner lip 326, the inner surface of the inner pane 312 and the laterally outer edge of the thermal insulation member 324.

Similarly, a thermal insulation chamber 380 is formed between the laterally outer edge of the thermal insulation member 324, the outer surface of the lateral leg 322 of the

structural member of the thermal shield 320, the laterally outer sides of the elongate frame member 352 and the inner surface of the inner pane 312.

5 Unlike in the embodiment of Figures 1 to 10, in which the glazing unit 110 is fixed directly to the inwardly extending the lateral leg 156 of the elongate frame member 152, the embodiment of Figures 13 to 19 includes an alternative fixing arrangement for the glazing unit 310.

10 Specifically, an outer laterally inwardly extending leg 357 is provided extending laterally inwardly from the outwardly extending leg 154, defining a recess 357a facing towards the outside of the window assembly 300. One or more carrier members 330 are mounted to each elongate frame member 352, so as to be supported on the outer surfaces of the inwardly extending lateral leg 356 and the outer laterally inwardly extending lateral leg 357, as shown. The carrier members 330 are secured in place by removable fixing means, 15 such as screws, threaded through the carrier members 330 and into the outer laterally inwardly extending leg 357 to be received in the recess 357a. The carrier member has a substantively rectangular-Z-shaped construction, including an outer laterally inwardly extending leg 336, an inwardly extending leg 334 extending inwardly from the laterally inner edge of the leg 336, and an inner laterally inwardly extending leg 332, extending 20 inwardly from the inner end of leg 334. In this embodiment, the laterally inner end of the lateral leg 332 defines the laterally inner edge of the frame, as noted above, as heat will preferentially conduct along inner pane 312 to the carrier member 330, as opposed to jumping across the wider gap to the laterally inwardly extending leg 356 of the elongate frame member 352.

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The outer lateral leg 336 of carrier member 330 is supported on the outer lateral leg 357 of elongate frame member 352, whilst the lateral leg 332 of the carrier member 330 is supported on the lateral leg 356 of elongate carrier member 352. However, the carrier member 330 is only fixedly attached to the elongate frame member 352 by the 30 detachable fixing means, such as screws, which are used to fix the outer lateral leg 336 of the carrier member 330 to the outer lateral leg 357 of the elongate frame member 352.

To assist in this attachment, and as best seen in Figures 14 and 17, the outer lateral leg 336 of the carrier member 330 is provided with a groove or notch 331, running along its length. This groove or notch 331 assists in locating a screw tip in position and creating self-tapping initiation point for screwing through the lateral leg 336 and into the recess 357a of the outer lateral leg 357 of the elongate frame member 352. The groove or notch 331 also helps to align the screw with the recess 357a, so that it will affect a secure connection to the elongate frame member 352.

As for the elongate frame members 352, the carrier members 330 are advantageously formed from extruded profiles cut to desired lengths, and in the present embodiment are to be formed from aluminium or aluminium alloy, the same as the elongate frame members 352. Using the same material for carrier members 330 and the elongate frame members 352 prevents undesirable consequences, such as differences in thermal expansion or galvanic corrosion, from occurring between the adjacent components of the frame structure of the window assembly 300.

Glazing unit 310 is fixedly bonded to the carrier member 330, using an adhesive strip or equivalent means, in the same manner as glazing unit 110 is attached to the lateral leg 156 in the embodiment of Figures 1 to 10. A strip of thermal insulation material 338 is then provided around the perimeter edge of the glazing unit 310, covering the outer lateral legs 336 of the carrier members 330 and any visible attaching means, and the outer perimeter of the glazing unit 310 is then sealed to the frame 350 by a sealant 315 between the laterally outer edge of the outer pane 314 and the laterally inner edge of the outwardly extending leg 354 of the elongate frame member 352. In the present embodiment, it can be seen that the outer pane 314 laterally extends beyond the laterally outer edge of the remainder of the glazing unit 310. This is to provide an improved seal between the glazing unit 310 and the elongate frame member 352, as otherwise a significantly wider strip of sealant 315 would be required, which would then be subject to the need to provide a consistent and uniform thickness and finish to the sealant layer without any gaps that would lead to an imperfect seal around the outer perimeter of the glazing unit 310.

The above described window assembly 300 can thus be installed in a building in weatherproof order, and securely holds the glazing unit 310 in place. However, it will occasionally be necessary, for repair or maintenance purposes, to remove or replace the glazing unit 310 from such a window assembly 300. Double glazing units such as the glazing unit 310 of the present embodiment typically have a lifespan of around 10 years before the seals 318 tend to degrade, for example due to the impact of UV radiation from sunlight. This degradation can allow the inner gas located within the double glazing unit 310 to escape and/or permit the ingress of water vapour which will condense inside the glazing unit 310. This will lead to the degradation of thermal efficiency for the glazing unit 310 as well as being visually unacceptable for those looking through the window. It may also be desirable to replace a glazing unit, for example, if it becomes damaged such as by one of the panes being cracked due to impact or otherwise.

With a window assembly such as window assembly 100 which is mounted to a flat roof, the fixing means used to secure the window assembly 100 to the rafters can simply be exposed by removing the protective covers 160, allowing the fixing means to be released and the window assembly as a whole to be removed and exchanged or repaired (by replacing the glazing unit off-site). For window assemblies such as window assembly 300 mounted to a pitched roof, however, one or more of the lateral edges of the base plate are typically overlapped by roof tiles, as noted above. As a result, it is often difficult or extremely disruptive to the surrounding structure to remove the entire window assembly in order to replace a glazing unit. Additionally, the frame structure of the window will typically still be in full serviceable order, even after the glazing unit has deteriorated.

The embodiment of Figures 10 to 19 permits the glazing unit 310 to be replaced whilst the frame 350 remains installed around the opening in the roof or wall of the building. This is achieved by removing the sealant 315, for example using a knife, and by pulling out the thermal insulation strip 338, so as to reveal the screws or other fixing means securing the carrier members 330 to the outer lateral leg 357 of each elongate frame member 352. The carrier members 330 can thus be detached by unscrewing the screws or otherwise,

allowing the glazing unit 310 to be lifted out of the frame 350, with the carrier members 330 sill adhesively attached thereto. The carrier members 330 can then be attached to a new glazing unit 310, or alternatively new carrier members 330 can be used, and then re-attached to the outer lateral legs 357 of the elongate frame members 352 to secure the new glazing unit 310 in the frame 350. Thermal insulation members 338 are installed and a new strip of sealant 315 can then be applied, between the laterally outer edges of pane 314 and the laterally inner edges of outwardly extending legs 354 of the elongate frame members 352, to seal the new glazing unit 310 in the frame 350.

It will also be appreciated that, in order to facilitate this process, the thermal insulation member 324 is beneficially not adhesively attached to the inner surface of inner pane 312. The thermal insulation member 324 will beneficially be formed from a compressible foam, such as a polyurethane foam, so as to form a reliable compressive seal with the inner surface of the inner pane 312 when a glazing unit 310 is installed in the frame 350, with the thermal insulation member 324 being adhered to the outer surface of the lateral leg 322 of thermal shield 320.

As will be appreciated from Figures 13 to 15, the elongate frame member 352 also includes recesses for receiving cleats, in a similar manner as the elongate frame member 152 of the embodiment of Figures 1 to 10.

In this embodiment, there is only a single outwardly aligned recess 354a, arranged along the inner side of the outwardly extending leg 354. Two lateral recesses are provided, a first in the laterally inwardly extending leg 356, a similar manner as for the recesses 156a and 156b provided to the laterally inwardly extending leg 156 in the embodiment of Figures 1 to 10. However, in the embodiment of Figure 13 only a single recess 356a is provided along the inner side of the laterally extended leg 356, due to the reduced lateral extent of this laterally inwardly extending leg 356. The second recess is a recess 355a provided along laterally outwardly extending leg 355, on the inner side thereof.

As shown in Figures 14 and 15, chevron-shaped lateral cleats 400a and 400b are inserted in the recesses 356a and 355a of the elongate frame member 352, in corresponding manner as for the lateral cleats 200a, 200b used in the embodiment of Figures 1 to 10. Lateral cleats 400a, 400b similarly are formed with first and second legs 402a, 404a and 402b, 404b respectively. In Figures 14 and 15, the legs 404a and 404b are inserted in the recesses 356a and 355a, respectively.

A vertical cleat 390a is provided in a corresponding manner to the vertical cleats 190a, 190b in the embodiment of Figures 1 to 10, the vertical cleat 390a having a first leg and a second leg 392a and a second leg 394a, with the second leg 394a inserted in recess 354a in the arrangement show in Figures 14 and 15. Additionally, the edge profile pieces 365 may beneficially be provided with an extended cleat leg 392b, arranged to extend across the joints at the abutting corners of the elongate frame members 352, and providing structural support across the joint at the location of the outer edge profile 360, as shown in Figure 14. As shown in Figure 14, the cleat leg 392b forms an extension of the edge profile piece 365 provided in the recess 360a of the elongate frame member 352.

Again, in a similar manner as for the embodiment of Figures 1 to 10, the cleats 390a, 400a and 400b and the cleat leg 392b are provided with channels 396a, 406a and 406b and channel 396b, respectively, providing an adhesive distribution pathway along the joined corner edges where the abutting end faces 352a of the elongate frames 352 meet at the joint. This allows a watertight seal to be achieved along the exterior edge corners of the frame structure. Figures 14 and 15 also show the provision of adhesive injection ports 398a and 398b, with the port 398a formed in the vertical cleat 390a and the port 398b formed in the edge profile piece 365, at the location of the corner junction between the edge profile piece 365 and the cleat extension leg 392b. The injection port 398a is accessible due to the open structure of recess 354a, as noted above in respect of the embodiment of Figures 1 to 10. In order to allow access to the adhesive injection port 398b, the edge profile pieces 365 are made marginally shorter than the elongate frame members 352, in order to provide an adhesive injection gap between the otherwise abutting outer lateral legs 367 of the profile edge pieces. This can be seen most clearly in

Figure 17, although the lateral offset of the cut end face of the lateral leg 367 of edge profile piece 365 can also be discerned in Figures 14 and 15. Alternatively, an injection opening can be machined through the outer edge profile 360 to give access to the adhesive injection port 398a.

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End caps are also to be applied to the outer edge corners of the window frame 350, in a similar manner to the end caps 170 used in the window assembly 100 of the first embodiment, but these are not illustrated in Figures 11 to 19. However, the end caps would essentially correspond to the end caps 770 of the fourth embodiment of the present invention, as shown in Figures 26 to 31, and with particular reference to Figure 10 28. Such protective end caps would be adhesively attached around the exterior portions of the corner joints to protect the cut end faces 352a of the elongate frame members 350 against corrosion due to environmental conditions, e.g. weather.

15 A third embodiment of the present invention will now be described with reference to Figures 20 to 25.

Many of the constructional and structural aspects, as well as the functional requirements and considerations, described in relation to the first embodiment of Figures 1 to 10 and 20 the second embodiment of Figures 11 to 19 are identical for the third embodiment of Figures 20 to 25, and as such the description of the third embodiment of the invention will focus primarily on variations from the first and second embodiments in order to avoid extensive repetition. The description of the first and second embodiments should thus be taken to apply equally in all respects to the third embodiment unless noted otherwise.

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In Figures 20 to 25, corresponding features for those described in respect of the first and second embodiments are accordingly given corresponding reference numbers, but, respectively, incremented by 400 or 200. Thus, the glazing unit 510 of the third embodiment corresponds to glazing unit 310 of the second embodiment and glazing unit 30 110 of the first embodiment, etc.

The window assembly 500 of the third embodiment of the present invention relates to an openable window configured and intended to be mounted on a flat roof section.

Window assembly 500 includes a glazing unit 510 mounted and supported in a frame structure. The frame structure includes a base frame 550 arranged to be mounted around the opening formed in a wall or roof of a building, in this case an opening formed in a flat roof. The glazing unit 510 is mounted in casement frame 530 to be securely fixed therein and supported thereby. Casement frame 530 is mounted to the base frame 550 via a hinge, so as to be able to open away from the base frame 550 or to close onto the base frame 550 by pivoting about the hinge.

Both the base frame 550 and the casement frame 530 are formed from elongate frame members 552 and 532, respectively, joined at abutting end faces to form corner joints of the respective base frame 550 and casement frame 530. The base frame 550 and the casement frame 530 thus each have a similar construction to the frames 150 and 350 of the first and second embodiments. It would, of course, be possible to form one or the other of the base frame 550 or the casement frame 530 in a different manner from the constructional arrangement used to form the other frame from elongate frame members.

As with the previous embodiments, glazing unit 510 is mounted in the casement frame 530 and is sealed around its outer perimeter by a strip of sealant 515. In this embodiment, the openable window assembly 500 has a substantial square or rectangular shape, although any desirable shape of the window assembly 500 is possible, as noted above in the first and second embodiments.

Casement frame 530 is formed from 4 elongate casement frame members 532, joined at abutting end faces to form corner joints of the casement frame 530. Similarly, the base frame 550 is formed from 4 elongate base frame members 552, similarly joined at abutting end faces to form corner joints.

As with the first and second embodiments of the present invention, the elongate frame members 530, 550 are joined at the abutting end faces by adhesive, having been cut from stock lengths of powder coated extruded profiles. Protective end caps 575 and 570 are accordingly provided to seal the exposed exterior corners of the casement frame 530 and
5 base frame 550 respectively, to protect against corrosion damage.

In a similar manner as for the first embodiment of the present invention, the base frame 550 of the third embodiment is adapted to be fixed to joists or other substructure of the flat roof by screws, bolts or other fixing means passing through a lower portion of the
10 base frame 550. Protective covers 560 are thus provided along the inner edges of the base frame 550 to cover the screws, bolts or other fixing means and to protect against corrosion damage and unauthorised tampering.

Turning to Figure 21, the frame structure of the second embodiment is shown with the
15 glazing unit 510 removed, exposing the thermal shield 520 provided around the inner peripheral edge of the base frame 550 for forming an airtight seal with the inner surface of the inner pane 512 of the glazing unit 510 when the casement frame 530 is closed onto the base from 550, in the closed position of the window assembly 500. Also visible are structural support members 571, which are identical in form and function with the
20 support members 771 to be described below in relation to the fourth embodiment of the present invention. These serve to provide structural support to the thermal shield in identical manner as will be described in relation to the fourth embodiment.

Turning to Figure 22, there is shown an enlarged view of the exterior of the corner of the
25 frame structure detailing the protective end caps 575 and 570 applied to the exterior edges of the corners of the casement frame 530 and base frame 550, respectively. It is noted that, in this example, the corner end cap 570 of the base frame 550 extends inwardly to cover and protect the corner of the fixing profile at the inner end of the inwardly extending leg 559 (formed by the laterally inwardly extending leg 555, inwardly
30 extending leg 558 and laterally outwardly extending legs 557a and 557b). The protective end cap 570 is applied at the time of assembly of the base frame 550, before the

protective covers 560 are snap fitted onto the fixing profile. To this end, as can be ascertained from Figure 22, the protective covers 560 are cut to a length slightly shorter than the length of the elongate base frame members 552 in order to fit in between the end caps 570. As such, it is unnecessary to attach a separate end cap after the window assembly 500 has been installed onto the substructure of a roof.

The frame structure has a common cross-sectional profile around 3 of the lateral sides of the window assembly, as shown in Figure 23. The window assembly has a separate cross-sectional profile along the fourth side of the window assembly, this being the side which includes the hinge structure allowing the casement frame 530 to pivot relative to the base frame 550 for opening and closing the window. This cross-sectional hinge profile is illustrated in Figure 24, and shown in enlarged view in Figure 25. Except in respect of the hinge structure, the cross-sectional profiles of Figures 23, 24 and 25 are substantially identical.

In fact, in this embodiment the elongate base frame members 552 and the elongate casement frame members 532 are identical for all 4 sides of the frame, with the difference in cross-sectional profiles between the hinge side and the non-hinged sides of the window assembly 550 being obtained by the provision of different modular profiles attached to the elongate frame members 552 of the base frame 550, as shall be described in further detail below.

With reference to Figure 23, the base frame 550 is formed from 4 elongate base frame members 552. The elongate base frame members have a cross-sectional profile having an outwardly extending leg 554 carrying a sealing profile at an outer end thereof. The sealing profile is replaced by a hinge profile in the arrangement along the otherwise identical hinge side of the base frame shown in Figure 24.

A laterally extending leg 556 extends laterally both inwardly and outwardly from the outwardly extending leg 554, in a similar manner to the inwardly extending lateral legs 156 and 356 described in respectively first and second embodiments.

An inwardly extending leg 559 extends in parallel to the outwardly extending leg 554, and extends further inwardly beyond the lateral leg 556. A fixing profile is provided at the inner end of the inwardly extending leg 559, formed by laterally inwardly extending leg 555, inwardly extending leg 558 extending inwardly from the laterally inner end thereof, and outwardly extending lateral legs 557a and 557b. This fixing profile is identical to that described in relation to the first embodiment of the invention, in respect of the laterally inwardly extending leg 155, inwardly extending leg 158 and laterally outwardly extending legs 157a and 157b. Corresponding snap fit features are provided on the laterally outwardly extending legs 557a and 557b for engaging with the protective cover 560 which has snap fit features fitted to the laterally inwardly extending legs 562 and 564 thereof. Similarly, the protective cover 560 has a recess 566 provided for engagement with a tool for removing the protective cover, as desired. Although not illustrated, fixing holes are provided in the fixing profile, distributed along the lateral length of the inwardly extending leg 558, in corresponding manner as for the fixing holes 159 shown in respective first embodiment, and allowing the base frame 550 to be securely fixed to the substructure of a building wall or roof.

An outer lateral leg 551 is provided in parallel to the lateral leg 556, extending laterally inwardly from the outer end of the inwardly extending leg 559 to meet with the outwardly extending leg 554 and so form a box section between outwardly and inwardly extending legs 554 and 559 and lateral legs 556 and 551. This box section in itself provides structural rigidity to the base frame 550, resisting twisting or bending of the frame structure. In addition, the box structure is provided, on opposed internal faces thereof, with a plurality of recesses. These include recesses 553a on the inwardly facing face of lateral leg 551 and recesses 553b on the outwardly facing face of lateral leg 556. Recesses 553a and 553b are provided in corresponding matching pairs opposed to one another across the box section.

These recesses 553a and 553b are arranged to receive strengthening bars therein, for locally increasing the rigidity of the box section and consequently the base frame 550 as a

whole. Strengthening bars, although not shown, may simply be in the form of plainer sheets of metal having a thickness substantially corresponding to the width of the recesses 553a and 553b, to be adhered in the recesses such as to provide additional support to the box structure. Such an arrangement is advantageous, since it allows a common cross-sectional profile to be used for different sizes and shapes of the base frame 550. In particular, it will be appreciated that as the lengths of the elongate base frame 550 members increase, the size and consequently the weight of the glazing unit 510 and indeed the window assembly 500, as a whole, will increase. This will put increasing strain on the components on the base frame 550 as the size and weight of the window assembly 500 increases. Thus, for larger window assemblies, strengthening bars may be adhered in the box section so as to increase the structural strength and rigidity of the base frame 550 wherever this is locally required. In particular, it is noted that the elongate base frame member 552 provided along the hinge side of the window assembly 550 will tend to carry larger and more variable loads due to the opening and closing of the window assembly by pivoting of the casement frame 530 about the hinge. Strengthening of the box section along the hinge side is therefore particularly envisaged using the recesses 553a and 553b with strengthening bars adhesively fixed therein.

In common with the first and second embodiments of the invention, a thermal shield 520 is supported on the inner side of lateral leg 556. Thermal shield 520, however, has a modified construction from the thermal shield 120 or 320 of the first and second embodiments, in view of the increased depth of the frame structure for accommodating opening and closing of the casement frame 530, mounted by a hinge to base frame 550.

The thermal shield 520 includes a structural element including a lateral leg 522 fixedly attached to the inner side of the lateral leg 556 of the elongate base frame member 552. An outwardly extending leg 525 extends from the lateral leg 522 outwardly towards the glazing unit 510. An outer laterally inwardly extending leg 526 extends laterally inwardly from the outer end of the outwardly extending leg 525, substantially parallel to the inner pane 512. It will, however, be identified that the outer laterally extending leg 526 is inclined with respect to the inner surface of the inner pane 512, so as to slope inwardly

and laterally outwardly relative to the inner surface of the inner pane 512. This is to promote run-off of any condensation which may form within the chamber 580.

The outer laterally inwardly extending leg 528 includes, at its laterally inner end, an inner lip 526 formed in similar fashion to the inner lips 126 and 326 of the thermal shields 120 and 320 of the first and second embodiments. On the outer side of the laterally inwardly extending leg 528, a recess 528a is formed, configured to receive a bubble seal 549. Although illustrated as a circular cross-section overlapping with the inner pane 512, the bubble seal 549 is a deformable rubber or polymeric seal member and is arranged to be compressed when the casement frame 530 is closed, bringing the inner surface of the inner pane 512 into contact with the seal 549.

As described in respect of the first and second embodiments, the inner lip 526 forms, between itself, the inner pane 512 and the inner lateral edge of the seal 549, an air pocket 585 arranged to create a zone of static air that is resistant to motion imparted by thermal air currents within the interior of the building in which the window assembly 500 is installed. As with the first and second embodiments, the static air pocket 585 creates a zone of thermal insulation which will force heat from warm air within the interior of the building to travel conductively along the inner pane 512 in order to escape to the exterior of the building. A corresponding thermal conduction path exists from the laterally inner end of the inner lip 526, marked by letter A, to the laterally inner end of the casement frame member 532, marked by letter B. As with the first and second embodiments, the thermal shield is arranged to promote an increase in the length of the conductive path along the inner pane 512, so as to reduce the overall thermal conductivity through the window assembly 500.

This effect is enhanced by the provision of thermal insulation member 524 mounted within the structural element of the thermal shield 520. The thermal insulation member 524 may be made of similar materials to the thermal insulation member 124 or 324 of the first and second embodiments. In this embodiment, the thermal insulation member is made of expanded polyisocyanurate foam.

The thermal insulation member 524 is mounted so as to be partially enclosed within the structural element of the thermal shield 522. In this respect, an upper edge of the thermal insulation member 524 is enclosed by lateral leg 528 of the thermal shield, a laterally outer edge of the thermal insulation member 524 is enclosed by outwardly extending leg 525 of the thermal shield, and an inner side of the thermal insulation member 524 is partly enclosed by the lateral leg 522 of the thermal insulation shield. Importantly, substantially the whole laterally interior face and the remaining part of the inner face of the thermal insulation member 524 are left uncovered. This is to deny a conduction path along the structure of the structural element of the thermal shield, and to prevent heat conduction laterally through the window assembly 500, except by passing through the thermal insulation member 524 or along the inner pane 512. In previous thermal shield designs, the inner face and laterally inner face of the thermal insulation member have been completely enclosed by the structural element of the thermal shield, with the result that a conduction path is formed along the laterally- and inwardly-/outwardly- extending legs of the structural element itself, providing an additional route for heat to escape. This is prevented by the arrangement of the thermal shield shown in Figure 23, according to which the thermal insulation member 524 is only partially enclosed around two complete sides and one part of a side.

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As with the first and second embodiments, the inner lip 526 also defines an inwardly facing recess 527 arranged to receive a plasterboard sheet of standard width, for providing a decorative finish around the interior of the opening defined by the window assembly.

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The structural element of the thermal shield 520 is again ideally formed from an extruded material such as uPVC, in the same manner as the structural elements of the thermal shields in the first and second embodiments. In addition, due to the increased depth of the structural element in the inward/outward direction, a ratchet profile 577 may also be provided on the laterally outer side of the outwardly extending leg 525 of the structural element of the thermal shield 520. This profile is arranged to receive a corresponding

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ratchet profile of a support member (not shown), as will be described below in relation to the fourth embodiment of the invention and support member 771.

As well as the thermal shield 520 sealing the laterally inner side of the thermal insulation chamber 580 when the window assembly 500 is closed, the laterally outer side of the thermal insulation chamber 580 should also be sealed, between the casement frame 530 and the base frame 550, in this configuration. To this end, the outer end of the outwardly extending leg 554 of the elongate base frame member 552 is provided with a sealing profile fixedly attached thereto. To support this, an outermost laterally extending leg 545 extends laterally inwardly from the outer end of outwardly extending leg 554, and provides a recess 545a. A separate sealing profile piece is mounted onto the outer end of the outwardly extending leg 554 and is supported by the outermost laterally extending leg 545. It will be appreciated from Figures 23 to 25 that the outermost laterally extending leg 545 is curved or inclined in order to receive the sealing profile piece. The sealing profile piece includes an outwardly extending leg 542 and a laterally inwardly extending leg 544. Laterally inwardly extending leg 544 is curved and inclined inwardly as it extends laterally inwardly.

A groove 541 is formed in the outer surface of the lateral leg 544 to guide and facilitate insertion of a fixing means, such as a screw, being driven through the lateral leg 544 into the recess 545a formed in outermost lateral leg 545, for securely fixing the sealing profile to the outwardly extending leg 544. The outwardly extending leg 542 of the sealing profile is received in recess 551a provided on the outer side of the lateral leg 551 for creating a rigid connection between the sealing profile and the elongate base frame member 552. A recess 542a is also provided on the laterally outer side of the outwardly extending leg 542 of the sealing profile, to receive a flap seal 547 therein. Flap seal 547 is a deformable rubber or polymeric seal arranged to deform when the casement frame 530 is closed onto the base frame 550 and engaged by boot portion 537b of the casement frame profile.

The outermost surface of the sealing profile is provided as a curved, crenelated surface facing outwardly towards the inner surface of the casement frame 530, and arranged to engage a bubble seal 543 supported by the casement frame 530. The bubble seal 543 is the same as bubble seal 549, and will deform when brought into contact with the sealing profile, to provide a double seal between the base frame 550 and the casement frame 530, provided by flap seal 547 and bubble seal 543. The curved crenelated surface of the lateral leg 544 of the sealing profile is advantageous in providing a reliable seal when the casement frame 530 is closed onto the base frame 550. This curved crenelated surface allows for minor variations in dimensional placement of the seal and sealing profile relative to one another, for example, due to thermal expansion and contraction and manufacturing tolerances.

Turning to the casement frame 530, it will be seen that the cross-sectional profile of elongate casement frame member 532 is arranged to complement and engage with the cross-sectional profile of the elongate base frame member 552 of the base frame 550 so as to form the double seal therewith.

Casement frame elongate member 532 includes an outwardly extending leg 534 arranged to align substantially with the inwardly extending leg 559 of the base frame 550, these together forming the outer external side surfaces of the window assembly 500. A laterally inwardly extending leg 531 is provided extending laterally inwardly from the outwardly extending leg 534, and to which the glazing unit 510 is securely mounted via adhesive strips or the like, in a similar fashion as the mounting of the glazing unit 110 or 310 of the first and second embodiments. An inner laterally extending leg 536 is provided in parallel with the outer laterally extending leg 531, forming a box section together with an inner inwardly extending leg 543 provided at the laterally inner ends of the lateral legs 531 and 536. At the inner end of the outwardly extending leg 534, a hinge profile is formed including an inner boot portion 537b and an outer curved camming surface 537a, which are primarily useful for forming the hinge between the casement frame 530 and the base frame 550 along the hinge side of the window assembly 500. Along the other lateral sides of the window assembly, the boot portion 537b of the hinge profile forms a

seal with the flap seal 547 held in the recess 551a of the sealing profile. On an inward facing surface of the inner lateral leg 536, a recess 536a is formed, which receives the bubble seal 543 arranged to form the secondary seal with the crenelated outer surface of the lateral leg 544 of the sealing profile mounted on the outer end of the elongate base frame member 552.

As with the first and second embodiments of the invention described above, the elongate frame members 552 and 532 of the base frame 550 and the casement frame 530 are provided with recesses for receiving lateral and vertical cleats therein. The arrangement of recesses and cleats in the elongate base frame member 552 is substantially the same as in the frame 150 of the first embodiment, with vertical cleats being received in the recess 554a formed along the outwardly extending leg 554, and in the recess 558a formed along the inwardly extending leg 558 forming part of the fixing profile. Similarly, first and second lateral cleats are received in the laterally outer recess 556a and laterally inner recess 556b of the lateral leg 556. The cleats are provided with channels and adhesive injection ports in identical and/or corresponding manner as for the cleats 190a, 190b, 200a and 200b used in the first embodiment.

Cleats are also provided for the corner joints of the casement frame, with a vertical cleat being provided in the recess 534a formed along the outwardly extending leg 534 of the elongate casement member 532. Additionally, a novel arrangement is provided within the box section formed by parallel lateral legs 531 and 536 and the outwardly extending leg 534 and inwardly extending leg 543. In particular, when defining an extruded cross-sectional profile for an elongate frame member to be formed from extruded aluminium or aluminium alloy, there are limitations on the maximum and minimum dimensions which can be achieved for any box section. In practice, it is problematic to form a box section having an internal open dimension substantially smaller than 6 mm. On the other hand, the typical thickness of a cleat, such as the lateral cleats 200a, 200b used in the first embodiment, is of the order of 3 mm. Accordingly, in order to accommodate an additional lateral cleat in the casement frame member 532, the box section profile has been formed with projections on the inner and outer surfaces thereof at laterally offset

locations. Accordingly, projections 533a are provided on the inner side of the outer lateral leg 531, and projections 533b are provided on the outer side of the inner lateral leg 536. The projections are offset from one another laterally, so that between each projection and the inner surface of the opposed lateral leg, a minimum clearance exists for forming a box section between the lateral legs and the projection. At the same time, a spacing is provided between the innermost surfaces of projections 533a and outermost surfaces of projections 533b which is substantially equal to the thickness of a lateral cleat, allowing such a cleat to be inserted into this recess and securely held in place for extending across the joint between abutting end faces of the elongate casement frame members 532 at the joints.

It will be appreciated that the vertical cleat provided to recess 534a may also be provided with an appropriate adhesive distribution channel and adhesive injection port, and that a suitable adhesive distribution channel will be provided to the lateral cleat to be inserted in the box profile between lateral legs 531 and 536.

Turning now to Figure 24, corresponding elements of the base frame elongate member 552 and casement frame elongate member 532 are shown extending along the hinge side of the window assembly 500. The only significant variation in construction along this side of the window assembly 500 is in respect of the hinge profile provided at the outer end of outwardly extending leg 554 of the elongate base frame member 552. In this case, the hinge profile replaces the sealing profile used along the three other lateral sides of the base frame 550.

The hinge profile has an identical construction to the sealing profile in respect of the lateral leg 554 and outwardly extending leg 524 received in recess 551a of the elongate base frame member 552. In addition, instead of being provided with a recess 551a to receive a flap seal 547, a hinge profile leg 546 is provided on the lateral outside of the profile. Hinge profile leg 546 primarily consists of a curved sliding surface 546a and an inner toe 546b connected therewith.

The hinge leg 546 is formed as a male hinge profile, arranged to fit inside the female hinge profile provided by the curved siding surface 537a and boot profile 537b provided at the inner end of the outwardly extending leg 534 of the elongate casement frame member 532. The hinge profile leg 546 is arranged to fit within the hinge profile portions of the casement frame 530 such that the hinge toe 546b acts as the central pivot point around which casement frame 530 may rotate, whilst curved hinge profiles 546b, 537b provide mating camming surfaces which rotatably slide relative to one another. A similar rotational sliding surface exists at the contact points between the toe 546b of the hinge profile leg 546 and the inner surface of the boot profile 537b forming part of the casement frame 530. These hinge profiles thus form interlocking rotatably sliding parts which act as a hinge to allow the casement frame 530 to rotate relative to the base frame 550 for opening and closing the window assembly 500.

Advantageously, as the hinge profiles of the hinge profile piece and of the casement frame elongate member 532 are closely fitted and extend along the whole width/length of the elongate casement frame member 532 and elongate base frame member 552, the hinge forms a substantially watertight seal along the whole width/length of the hinge at the side of the window assembly 500. Whilst this is of less relevance for a window assembly arranged to be mounted on a flat roof, it is of significant benefit for a window assembly, such as window assembly 700 of the fourth embodiment, which is arranged to be mounted on a pitched roof, where the hinge side of the window assembly is intended to be arranged at an uppermost side of the opening formed in the roof, and which may be subjected to deluge when rain water landing on the roof flows downwardly onto the hinge along the upper edge of the window assembly. The full width/length of the hinge profile in these embodiments obviates the need for additional sealing elements to be provided to cope with such inclement weather conditions, and provides a beneficially weathertight arrangement for the window assemblies 500 and 700.

The engagement between the hinge profile piece and the corresponding hinge profile portions of the casement frame elongate member 532 are shown enlarged in Figure 25. From this figure it can particularly be appreciated how the siding engagement is achieved

between the outer surface of curved hinge leg 546a and the inner surface of curved hinge profile 537a, as well as similar curved sliding engagement between the outer surface of toe portion 546b of the hinge profile piece and the inner curved surface of the boot portion 537b of the hinge profile at the inner most end of the outwardly extending leg 534 of the elongate casement frame member 532.

What is also evident from this figure is that, as the casement frame 530 is rotated clockwise in Figure 25 beyond the extent of engagement and overlap between the siding surfaces of the profiles 546a and 537a, then these radially outer hinge profile sections will disengage from one another. This will allow the boot portion 537b of the hinge profile of the casement frame 530 to drop out of engagement with the toe 546a of the hinge profile leg 546, such that the casement frame 530 can be detached from the base frame 550. In this manner, it is possible to remove the casement frame 530 from the base member 550, which may be beneficial when replacements or repair of the glazing unit 510 is required. This will allow the casement frame 530 to be removed without also requiring the base frame 550 to be removed from the structure of the building in which it is installed, which can cause damage to the internal decorative finish around the opening of the window and thus result in additional cost and inconvenience. By virtue of the detachable inter-engagement between the hinge profiles of the base frame 550 and casement frame 530, maintenance and repair of the window assembly 500 may thus be improved. The reverse operation for mounting the casement frame 530 onto the base frame 550 is similarly quick and facile, which also assists in the manufacturing/assembly process.

Turning to Figures 26 to 31, a fourth embodiment of the present invention will be described.

As already intimated above, many of the constructional and structural aspects, as well as the functional requirements and considerations, for the window assembly 700 of the fourth embodiment are common with features already described in relation to the first, second and third embodiments, and repeated discussion of the same features shall be avoided. The following description of the fourth embodiment of the invention will

therefore focus primarily on variations from the first to third embodiments in order to avoid extensive repetition. The description of the first to third embodiments should thus be taken to apply equally in all respects to the fourth embodiment unless noted otherwise.

5

In Figures 26 to 31, the corresponding features have again been given corresponding reference numerals as for the first, second and third embodiments, but incremented by 600, 400 and 200 respectively. As such, for example, glazing unit 710 corresponds to glazing unit 110 of the first embodiment, glazing unit 310 of the second embodiment and
10 glazing unit 510 of the third embodiment, etc.

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Window assembly 700 is again configured as an openable window similar to the openable window provided by window assembly 500 of the third embodiment. Additionally, the window assembly 700 is intended and adapted to be mounted on a pitched roof, and thus
15 includes a base plate surrounding the outwardly extending wall of the base frame 750, in a similar manner to the base plate provided to the window assembly 300 of the second embodiment.

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Figure 26 shows a perspective view from the exterior of window assembly 700, exhibiting
20 glazing unit 710 mounted in casement frame 730 and sealed around the exterior perimeter between the glazing unit 710 and the casement frame 730 via a strip of sealant 715. The frame 730 is mounted by a hinge to a base frame 750 of a corresponding size and shape. As with the previous embodiments, the casement frame 730 and the base frame 750 are formed from elongate members 732 and 752, respectively, joined at
25 abutting end faces thereof to form corner joints at the corners of the frame. The joints are again intended to be fixed by adhesive, including the vertical and lateral cleats described in relation to the first, second and third embodiments. The elongate members are also intended to be cut from stock lengths of extruded profiles which have already been powder coated. As such, protective end caps are fitted on the exterior edges of the
30 joints, with end caps 775 provided to the casement frame 730 and end caps 770 provided to the base frame 750, as shown in Figures 26, 27 and 28. These end caps 770, 775

protect the otherwise exposed cut ends of the elongate frame members 732, 752 from corrosion damage, as described above.

As already described in relation to the second embodiment, the base plate extending laterally outwardly from the outwardly extending wall of the base frame 750 is formed by lateral legs 755, which extend laterally outwardly from outwardly extending legs 754 of the base frame. As can be seen with a reference to Figure 29, the laterally outwardly extending legs 755 in this embodiment represent an extension in the laterally outward direction of the lateral leg 556 shown in the third embodiment, for example in Figure 23.

As with the second embodiment, the laterally outer edges along three of the size of the window assembly 700 are provided with lateral edge profiles 760, fitted with edge profile pieces 765, thus providing the window assembly 700 with a modular edge profile in the same and corresponding manner as described in relation to the second embodiment.

As shown in Figure 27, which has the glazing unit 710 removed, thermal shield 720 is provided around the laterally inner sides of the opening surrounded by the base frame 750, in corresponding manner as for the thermal shield of the third embodiment. As compared with the cross-sectional profile of base frame elongate member 552 of the third embodiment, the base frame elongate member 752 of the fourth embodiment has an inwardly extending leg 758 without any fixing profile at the inner end thereof, this inwardly extending leg forming an extension of an outwardly extending leg 754, as opposed to an extension of the inwardly extending leg 559 in the third embodiment.

In all other respects, the engagement between the casement frame 730 and the base frame 750, in particular as regards to the formation of the double seal between the inner surface of the casement frame 730 and the sealing profile fitted to the outer end of the outwardly extending leg 754 of the base frame elongate member 752, and as regards the arrangement of the thermal shield 720 being configured to engage the inner surface of the inner pane 712 of the glazing unit 710 when the casement frame is 730 is closed onto

the base frame 750, is fully in conformity with the structure and function of the corresponding features of the window assembly 500.

Similarly, recesses are also provided for receiving cleats for reinforcing the structure of the corner joints between abutting end faces of the elongate frame members 732 of the casement frame 730 and elongate frame members 752 of the base frame 750. Vertical cleats are received in recess 734a of the casement frame 730 and recess 754a of the base frame 750. Lateral cleats are received in the box section formed by lateral legs 731 and 736, the outwardly extending leg 734 and the inwardly extending leg 739 of the casement frame 730, with corresponding projections 733a and 733b for securing the cleat within the box section. Lateral cleats are also received in the recesses 756a and 755a of the base frame 755, in corresponding manner as for the second embodiment of the invention having cleats received in recesses 356a and 355a. All other constructional details of the corner joints will be equivalent as for the earlier described embodiments, including the provision of adhesive distribution channels and adhesive injection ports for sealing the corner joints.

Figure 30 shows a corresponding cross-sectional view through the window assembly 700 as for Figure 29, but along the lowermost side of the window frame that is arranged to sit at the bottom of the window when installed on a pitched roof. As can be seen, the laterally outer edge of the lateral leg 755 forming the base plate along this side of the base frame 750 does not include an edge profile 760, as this side edge is intended to allow for or run off of water at the bottom edge of the installed window.

It will be seen that Figure 30 additionally shows the support member 771, which is one of plural support members mounted in the thermal insulation chamber 780 at intermittent positions along the sides of the base frame 750, as also previously noted above in the respect of the third embodiment, and as further identified in Figure 27 in respect of the present fourth embodiment of the invention. Support member 771 is formed as a clip, which is made from extruded aluminium or aluminium alloy cut to a desired length, but may alternatively be made of suitable plastics material such as uPVC, and is arranged to

be fixed to the laterally inner side of the elongate base frame member 752. In this embodiment, the aluminium or aluminium alloy support member 771 is fixed to the elongate base frame member 752 by a self-tapping screw, but may be fixed by other means such as with adhesive. In this embodiment, the support member 771 is fixed at the laterally inner end of the outermost lateral leg 745. The support member 771 includes a fixing profile 772 for adhesion or otherwise being fixed to the laterally inner surface of the elongate base frame member 752 and a lateral leg 773 extending laterally inwardly therefrom. A ratchet leg 774 extends outwardly from the laterally inner end of the lateral leg 773, and is formed with a ratchet profile that is arranged to engage with the corresponding ratchet profile 777 formed on the laterally outer side of the outwardly extending leg 725 of the thermal shield 720.

This support member 771 provides additional structural rigidity and support to the thermal shield at selected locations around the perimeter of the base frame 750, as shown in Figure 27, for holding the thermal shield 720 in place. In particular, it will be appreciated that by opening and closing the casement frame 730, an inward force will be imparted on the bubble seal 749 and, correspondingly, on the outer lateral leg 728 of the thermal shield 720. Through repeated opening and closing of the window assembly 700, and depending on the degree of approximation between the inner surface of inner pane 712 and the outer surface of the lateral leg 728, as well as depending on how securely the thermal shield 720 is supported on its innermost side by the substructure of the roof elements to which the window is mounted around the opening in the building in which it is installed, it may be desirable to provide such support members 771 to limit the extent of deflection of the thermal shield 720 and prevent it from working loose or otherwise becoming damaged.

In the foregoing embodiments, the window frame structures include frames 150; 350; 550 and 750 which each include two laterally extending recesses 156a, 156b; 355a, 356a; 556a, 556b; and 755a, 756a, for receiving respective lateral cleats 202a, 202b; 404a, 404b; etc.

In a preferred alternative, the separate lateral recesses 156a, 156b; 355a, 356a; 556a, 556b; and 755a, 756a may instead be formed as a single lateral recess extending across the lateral width of, and replacing, both lateral recesses in the cross-sectional profiles of the present embodiments. The two respective lateral cleats 202a, 202b; 404a, 404b; etc. of the foregoing embodiments are also replaced by single lateral cleats having an increased lateral width corresponding to the increased lateral width of the single lateral recesses. These laterally wider lateral cleats provide the frame structures with increased structural rigidity and resistance to bending or twisting of the frame, in particular at the corner joints, as compared with the above embodiments. The frame construction is otherwise the same, with the lateral cleats being fixed in the lateral recesses by adhesive.

Claims:

1. A window frame structure to be installed in an opening formed in the wall or roof of a building for supporting a glazing unit having an inner pane and an outer pane, the frame structure comprising two or more elongate frame members joined at abutting end faces to form joints, wherein the elongate frame members have matching cross-sectional profiles each including a recess, and wherein a cleat is provided extending across each joint at the abutting end faces and disposed within the recesses of the profiles adjacent the joint, wherein distribution pathways are formed at the joints for distribution of liquid sealant, preferably an adhesive, injected therein to seal the joints.
2. The window frame structure of Claim 1, wherein protective caps are provided around at least a portion of the exterior edge, preferably all of the exterior edge, of each of the joints, the protective caps preferably being fixedly attached by adhesive; and/or wherein one or more of the cleats has a groove formed in it arranged along the joint to provide one of said liquid distribution pathways; and/or wherein injection ports are formed in the cleats and/or in the abutted elongate members to facilitate injection of liquid sealant into the distribution pathways.
3. A window frame structure to be installed in an opening formed in the wall or roof of a building for supporting a glazing unit having an inner pane and an outer pane, the frame structure comprising two or more elongate frame members joined at abutting end faces to form joints, wherein the elongate frame members have matching cross-sectional profiles each including a recess, and wherein a cleat is provided extending across each joint at the abutting end faces and disposed within the recesses of the profiles adjacent the joint, wherein protective caps are provided around at least a portion of the exterior edge, preferably all of the exterior edge, of each of the joints, the protective caps preferably being fixedly attached by adhesive.

4. The window frame structure of Claim 1, 2 or 3, wherein each cleat either is a lateral cleat being generally planar and being chevron shaped at an angle to match the joint angle, or is a vertical cleat formed by two generally planar sheets joined at an angle between the two planes that is substantially equal to the joint angle, optionally wherein
5 each joint has a vertical cleat and a horizontal cleat; and/or
wherein at least one recess is formed as a closed box section; and/or wherein at least one recess is formed as an open box section; and/or
wherein each cleat is fixed with adhesive in the recesses in which it is disposed; and/or
10 wherein the abutting end faces are mitred to form a corner joint; and/or
wherein the elongate members are made of aluminium or aluminium alloy, preferably extruded profiles of aluminium or aluminium alloy; and/or
wherein the window frame structure comprises a base frame configured to be secured around the opening and a casement frame for supporting the glazing unit
15 therein, the casement frame being movably connected to the base frame for opening and closing the window.
5. A window assembly comprising:
a window frame structure according to any preceding claim; and
20 a glazing unit fixed in the frame and including an inner pane arranged on an inner side of the glazing unit and an outer pane arranged on an outer side of the glazing unit,
the window assembly optionally further comprising a thermal shield mounted or mountable to the frame to be located between the frame and the opening,
25
6. A method for manufacturing a frame structure of a window assembly, comprising:
providing two or more elongate frame members, wherein the elongate members have end faces with matching cross-sectional profiles each including a recess, the end faces arranged to abut one another to form joints;

disposing a cleat within the recess of at least one of the elongate members of each joint adjacent an end face of the at least one elongate frame member; and

abutting the end faces of the elongate frame members of each joint such that the cleat extends across each joint and is disposed within the recesses of the profiles of the elongate members forming the joint,

wherein disposing includes mounting the elongate members in an assembly jig with cleats loosely positioned in the recesses of each elongate member at each joint; and

abutting includes tightening the assembly jig to simultaneously approximate the loose joints at every corner to abut all end faces at all joints substantially simultaneously.

7. The method of Claim 6, further comprising fixing the cleats in the recesses with adhesive, optionally wherein the adhesive for fixing the cleats in the recesses is applied before tightening the jig; and/or

further comprising sealing the joints to make them watertight by injecting a liquid sealant, preferably an adhesive, along distribution pathways along the joints.

8. A method for manufacturing a frame structure of a window assembly, the frame structure having two or more elongate frame members joined at abutting end faces to form joints, the method comprising injecting a liquid sealant, preferably an adhesive, into the joints along one or more distribution paths formed between the abutting end faces of the elongate members.

9. The method of Claim 8, wherein injection ports are formed in the cleats and/or elongate members for injecting the liquid sealant into the distribution paths; and/or

wherein the distribution paths are formed by channels formed in cleats provided across the joint between elongate frame members.

10. The method of any one of claims 6 to 9, further comprising attaching protective caps onto the outside of the elongate members, the caps extending around at least a

portion of the exterior edge of the joint between the abutting end faces, preferably along all of the exterior edge of the joint.

11. A method for manufacturing a frame structure of a window assembly, the frame structure having two or more elongate frame members joined at abutting end faces to form joints, the method comprising attaching protective caps onto the outside of the elongate frame members, the caps extending around at least a portion of the exterior edge of the joint between the abutting end faces, preferably along all of the exterior edge of the joint.

12. The method of Claim 11, wherein the method further comprises:
abutting the end faces of the two or more elongate frame members to form joints;
and
applying adhesive to the elongate members at and/or adjacent to the end faces to fix and/or seal the joints, and
wherein attaching the protective caps onto the outside of the elongate members includes attaching the protective caps with said adhesive at and/or adjacent to the end faces before it has set or cured,
optionally wherein the method includes injecting the adhesive, into the joints along one or more distribution paths formed between the abutting end faces of the elongate members.

13. The method of any one of Claims 6 to 12, wherein the method further comprises: cutting the elongate members from stock lengths of extruded profiles; and joining the elongate members together at their cut ends; and/or

wherein the stock lengths of extruded profiles are powder coated before being cut; and/or

wherein the method further comprises providing the elongate members with mitred end faces to form corner joints between the abutting end faces at desired angles; and/or

wherein the elongate members are made from aluminium or aluminium alloy.

14. A building comprising:

a window having a frame structure according to any one of Claims 1 to 4 installed

5 in or on the building; or

a window assembly according to Claim 14 or 15 installed in or on the building.

15. A method of glazing a building comprising:

installing a window having a frame structure according to any one of Claims 1 to 4

10 in or on the building; or

installing a window assembly according to Claim 5 in or on the building.

16. A method of manufacturing a window assembly comprising:

fixing a glazing unit in a frame structure according to any one of Claims 1 to 4; or

15 fixing a thermal shield to a frame structure according to any one of Claims 1 to 4;

or

fixing a thermal shield to the frame structure of a window assembly according to

Claim 5.

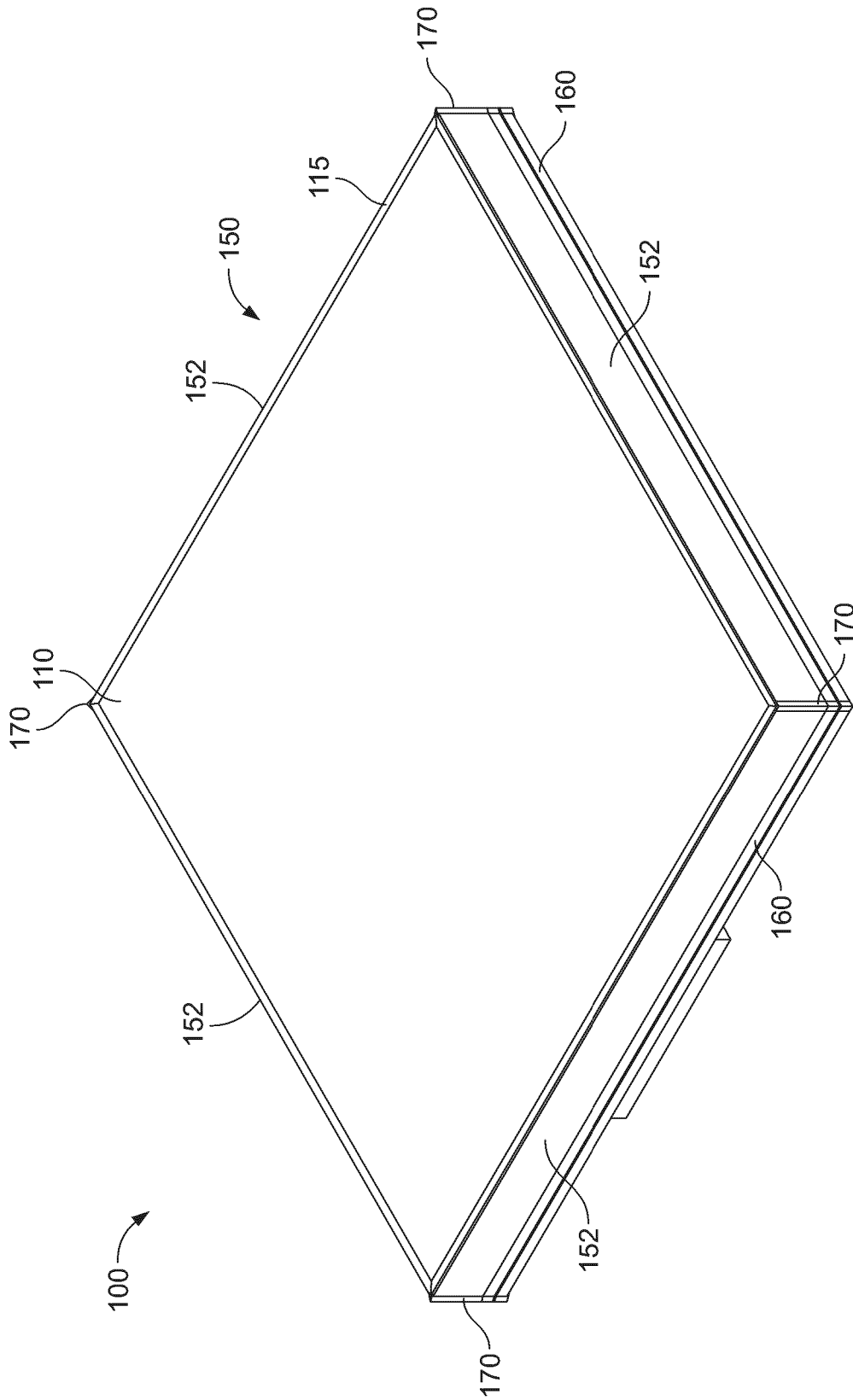


FIG. 1

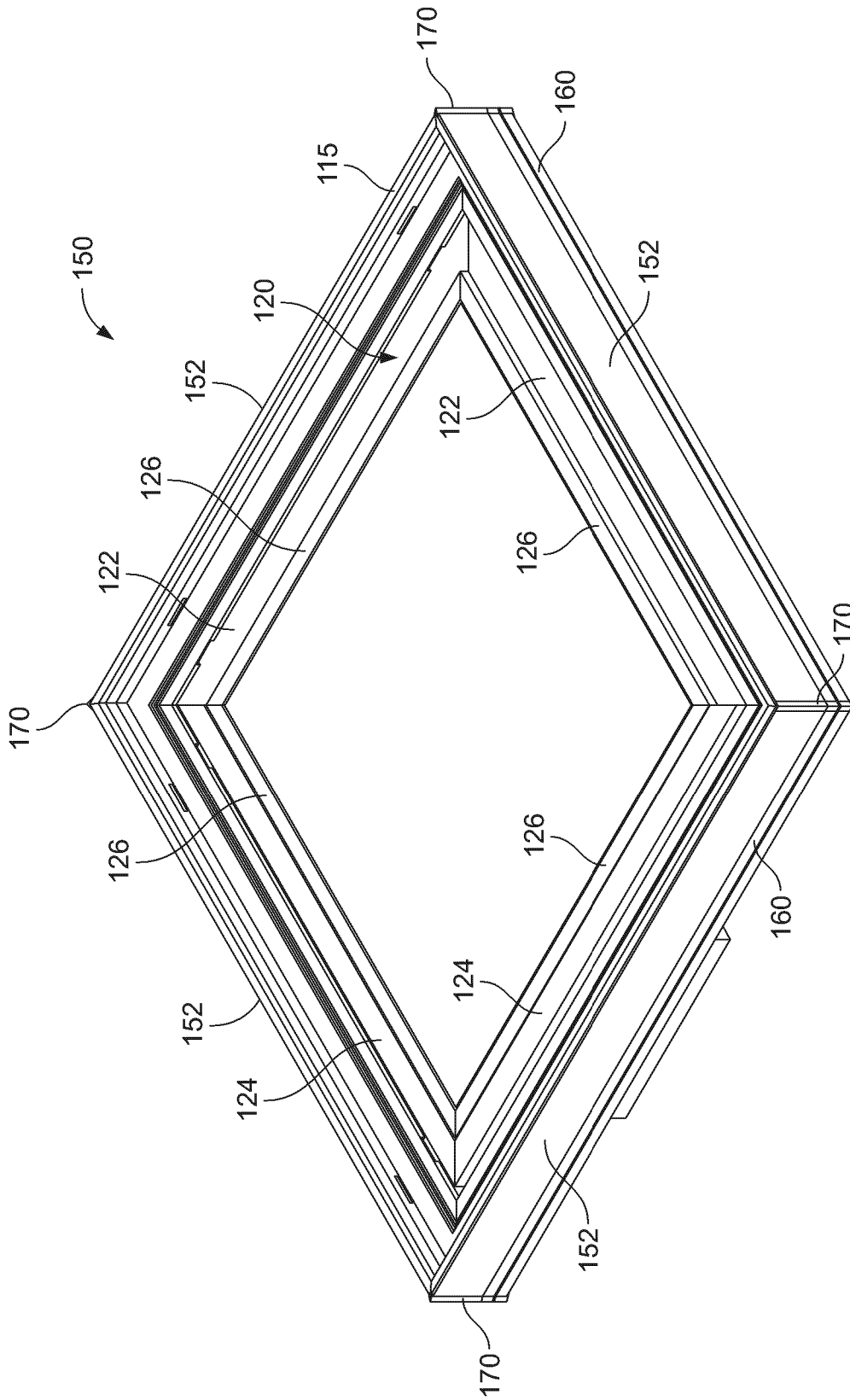


FIG. 2

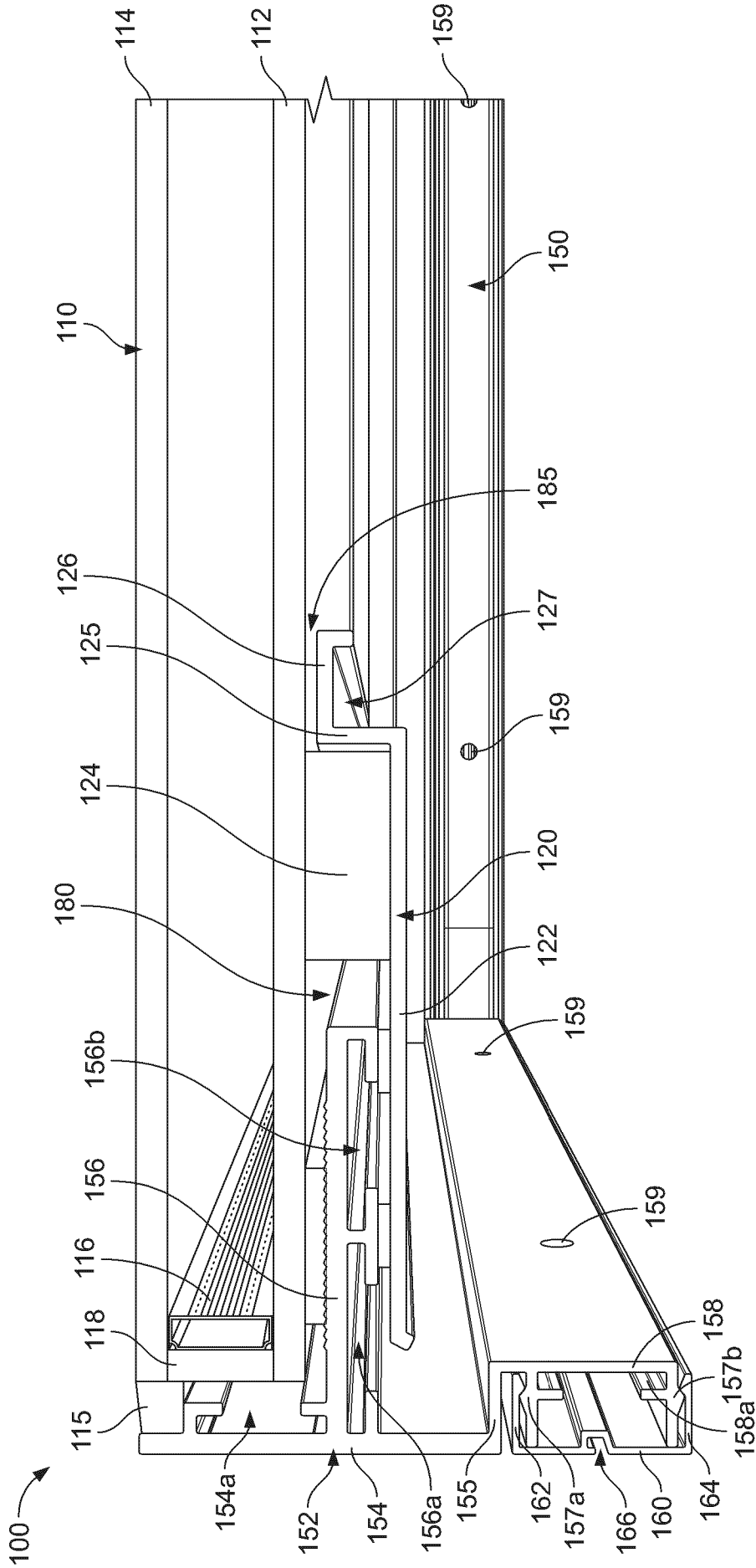


FIG. 3

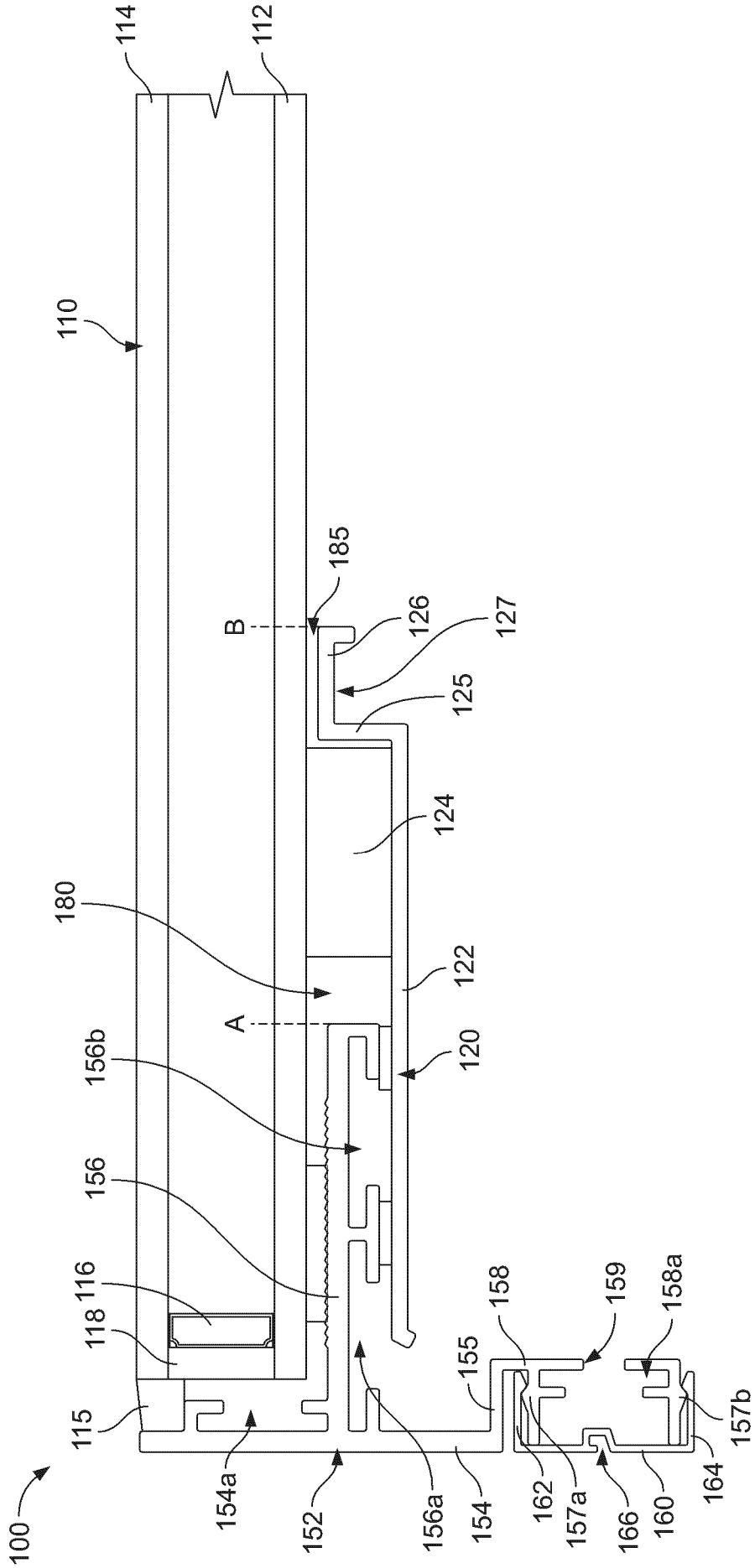


FIG. 4

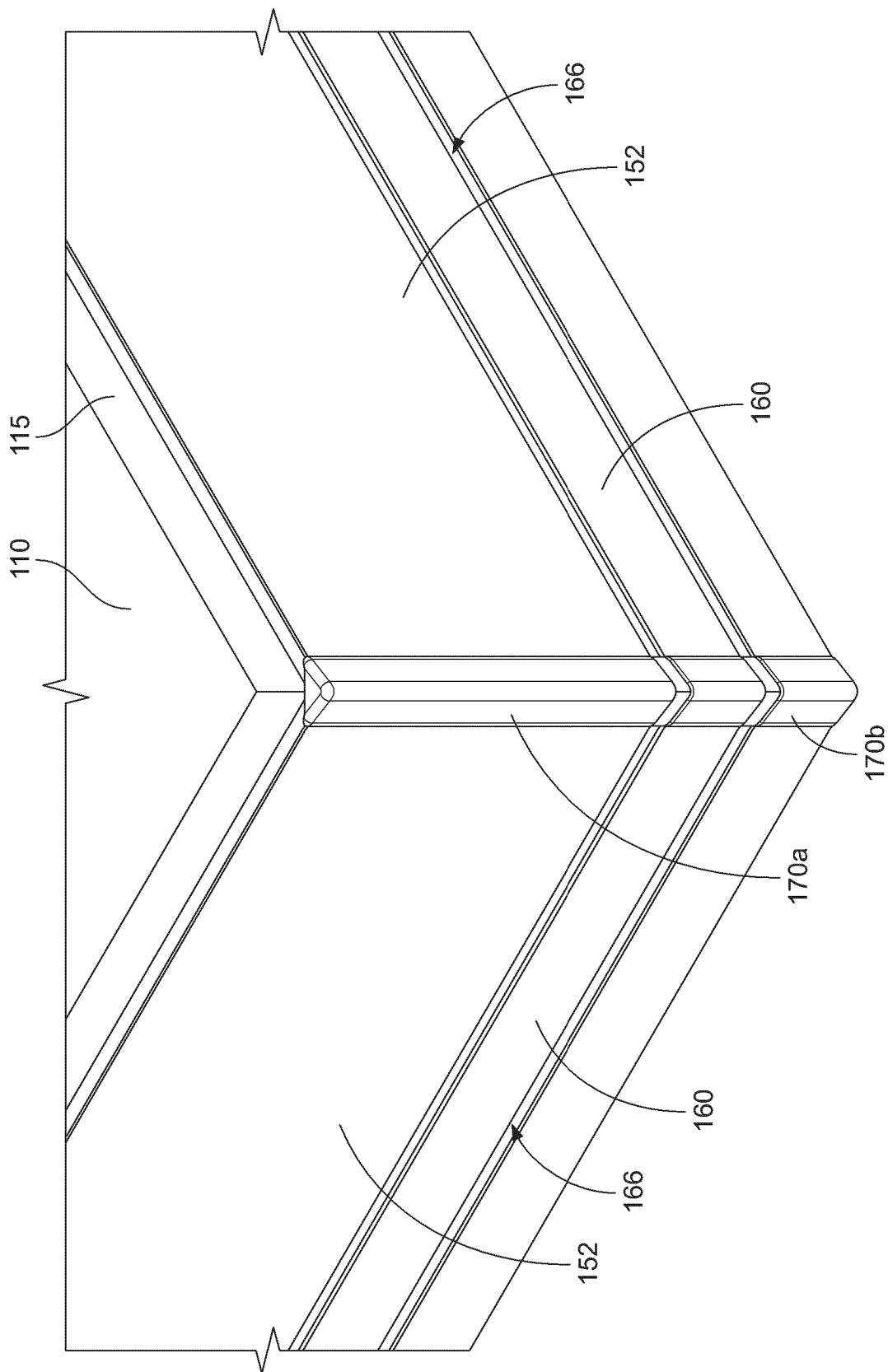


FIG. 5

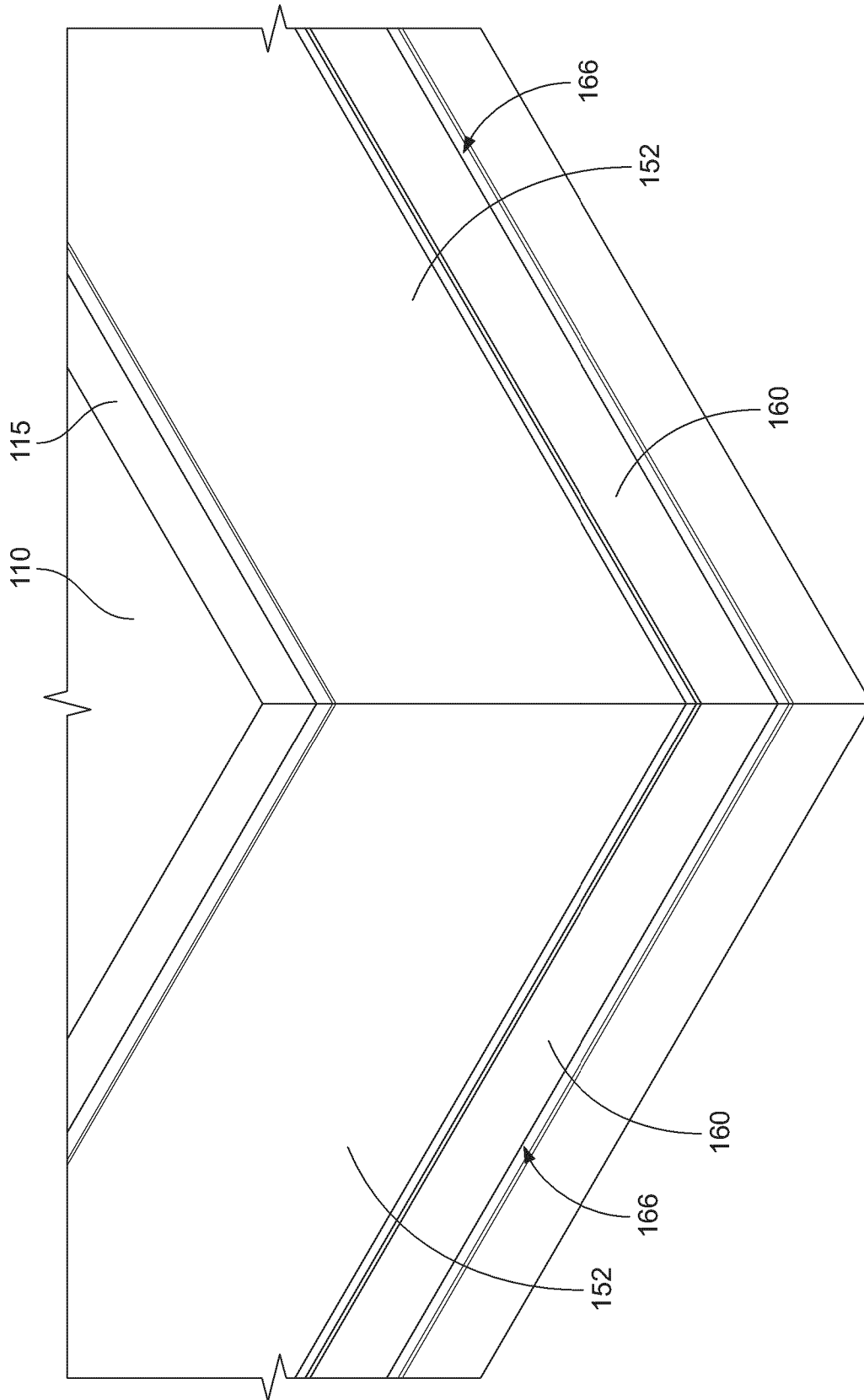


FIG. 6

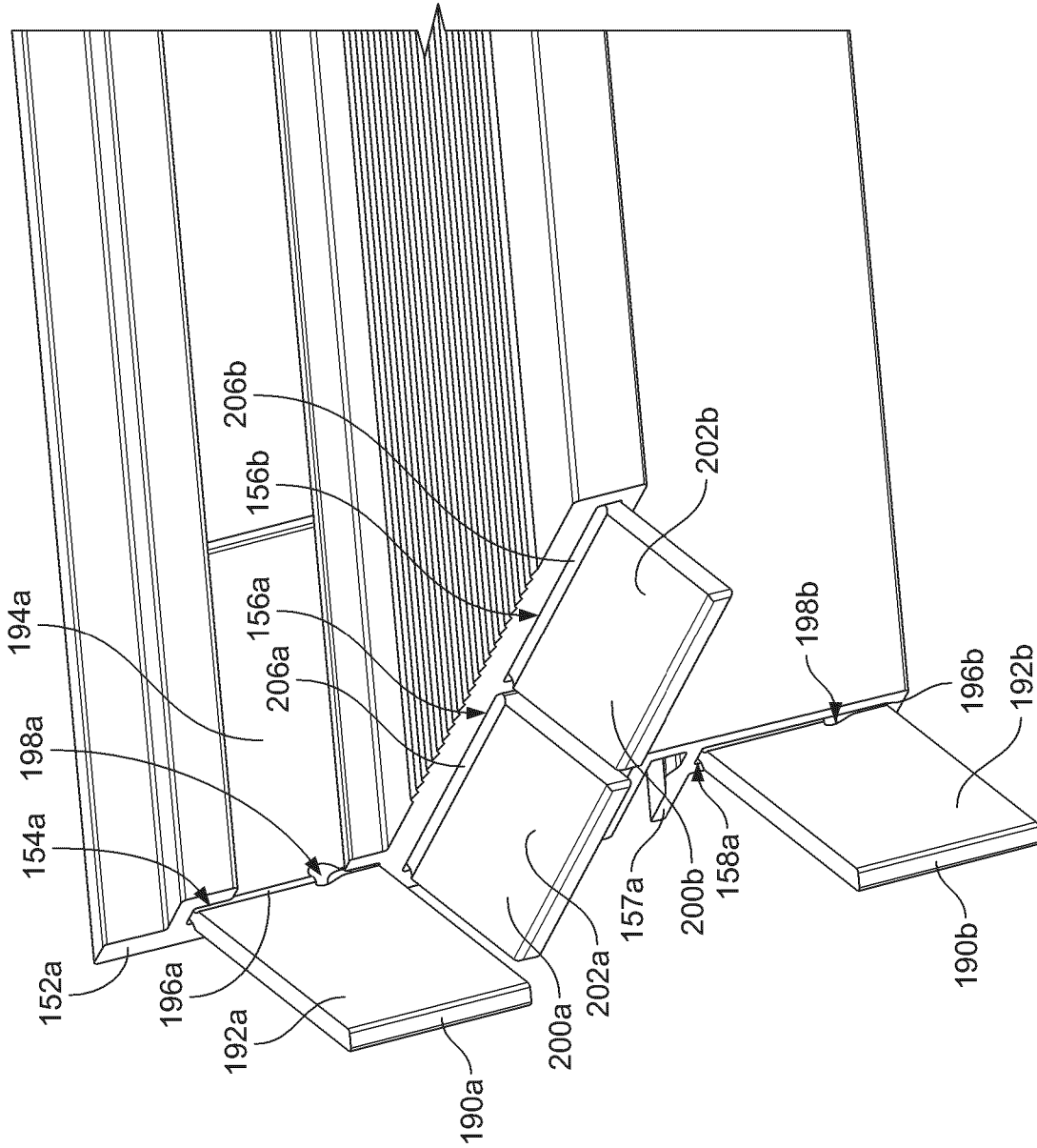


FIG. 7

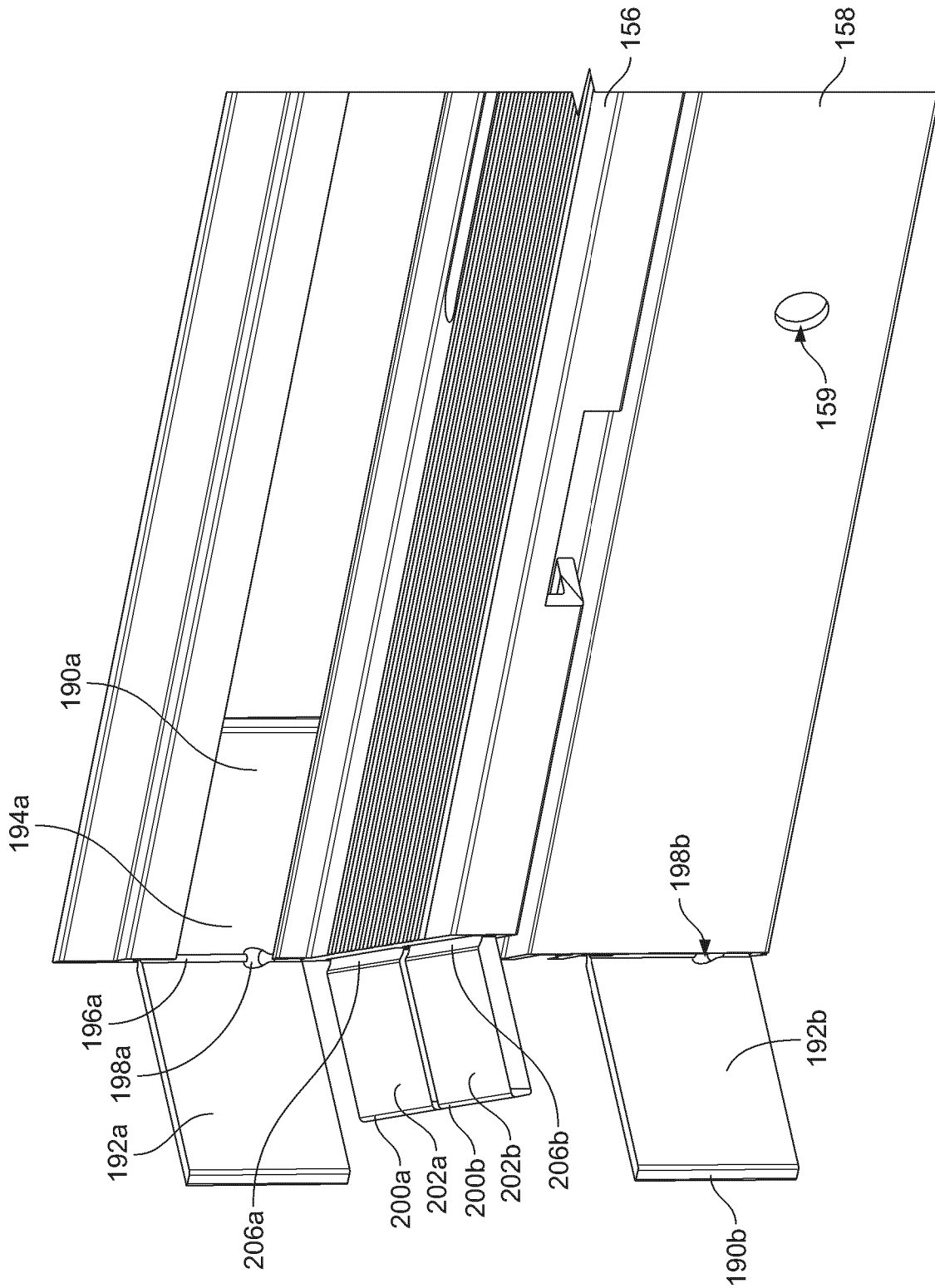


FIG. 8

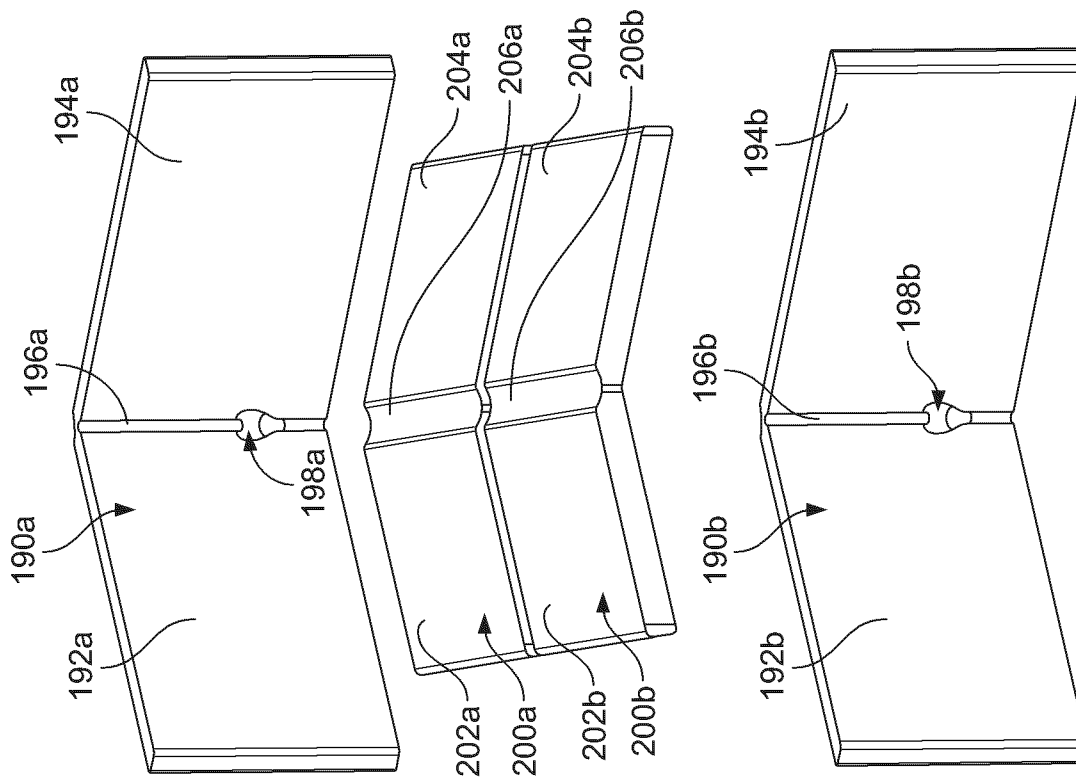


FIG. 9

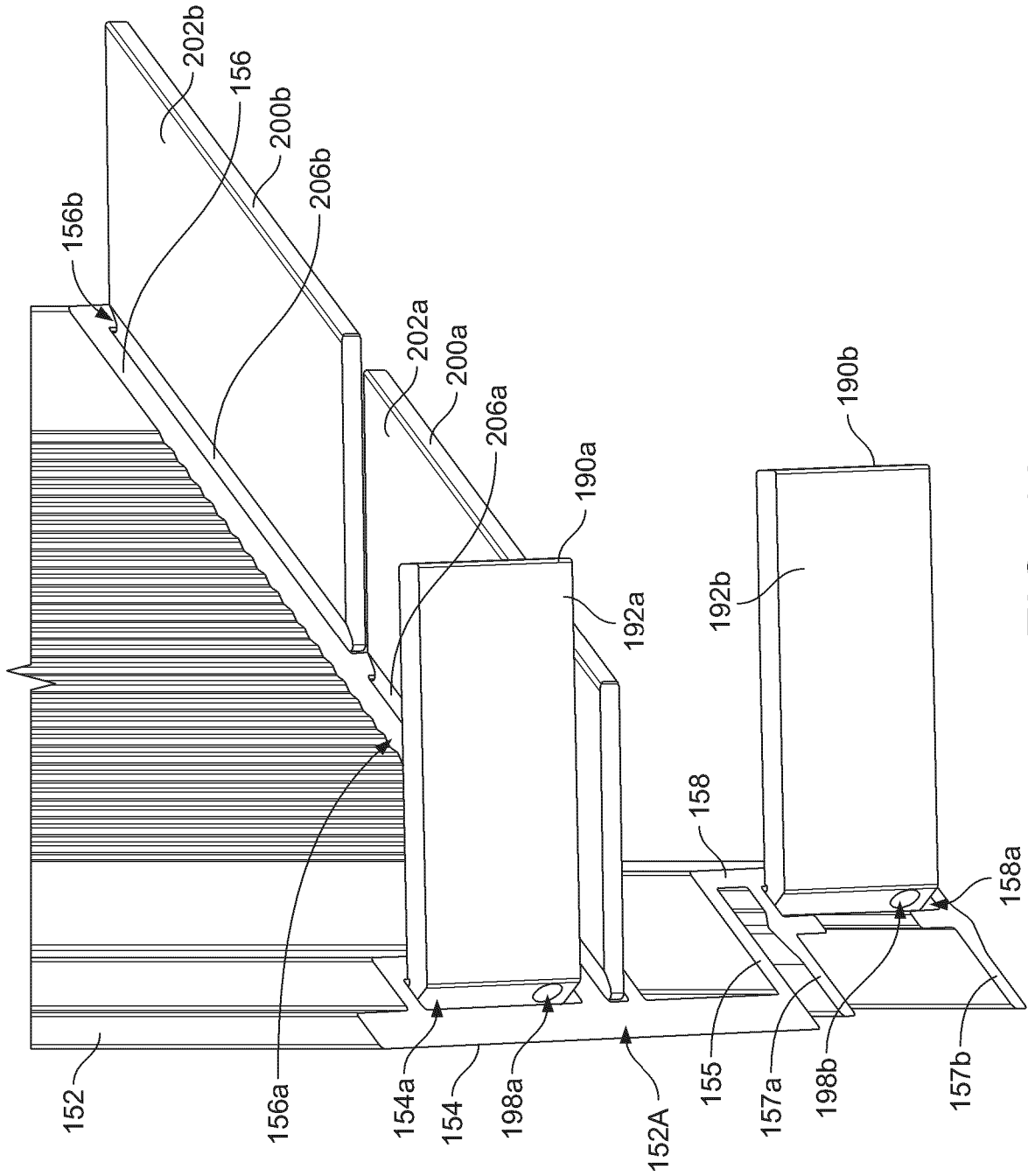


FIG. 10

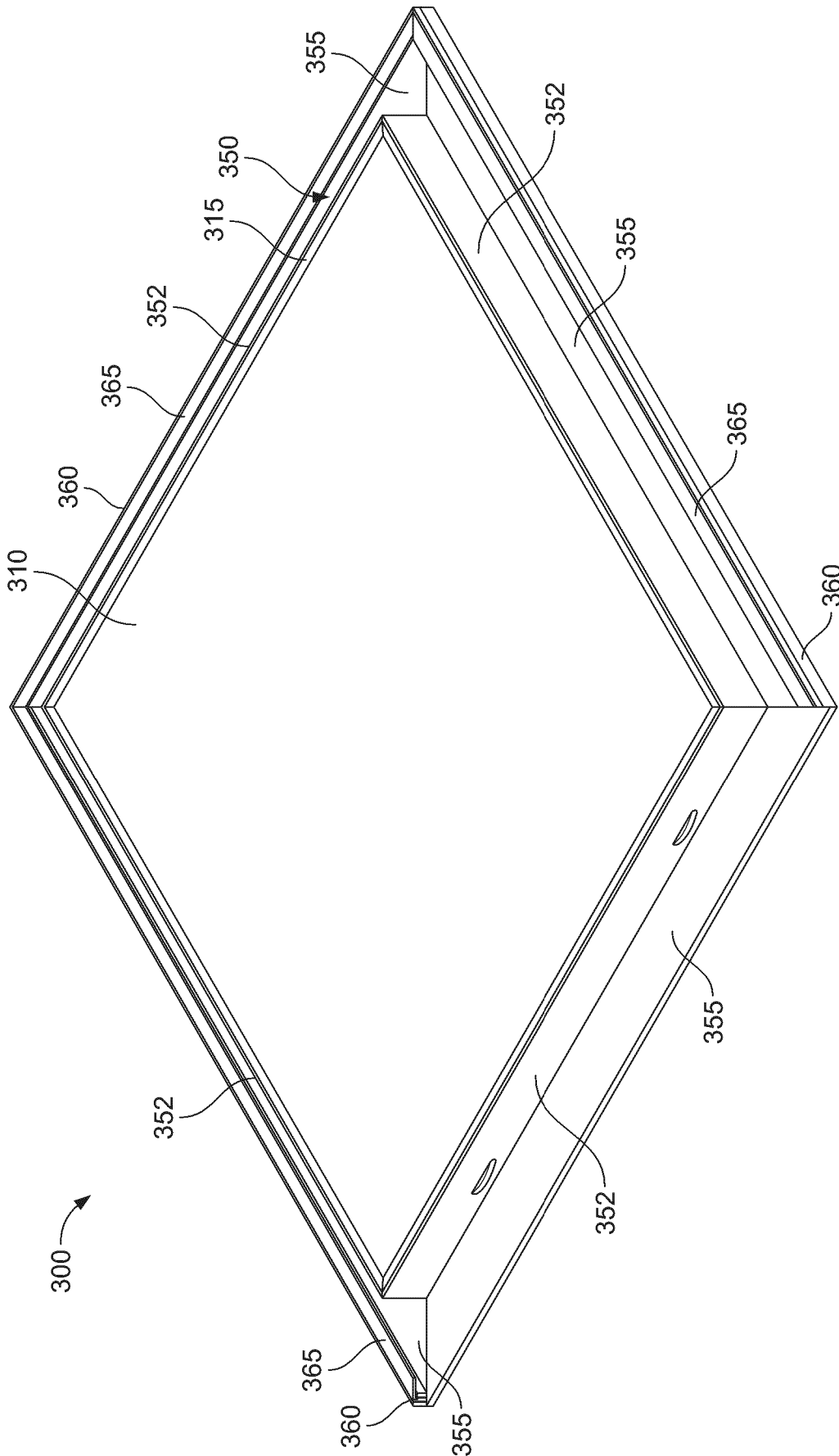


FIG. 11

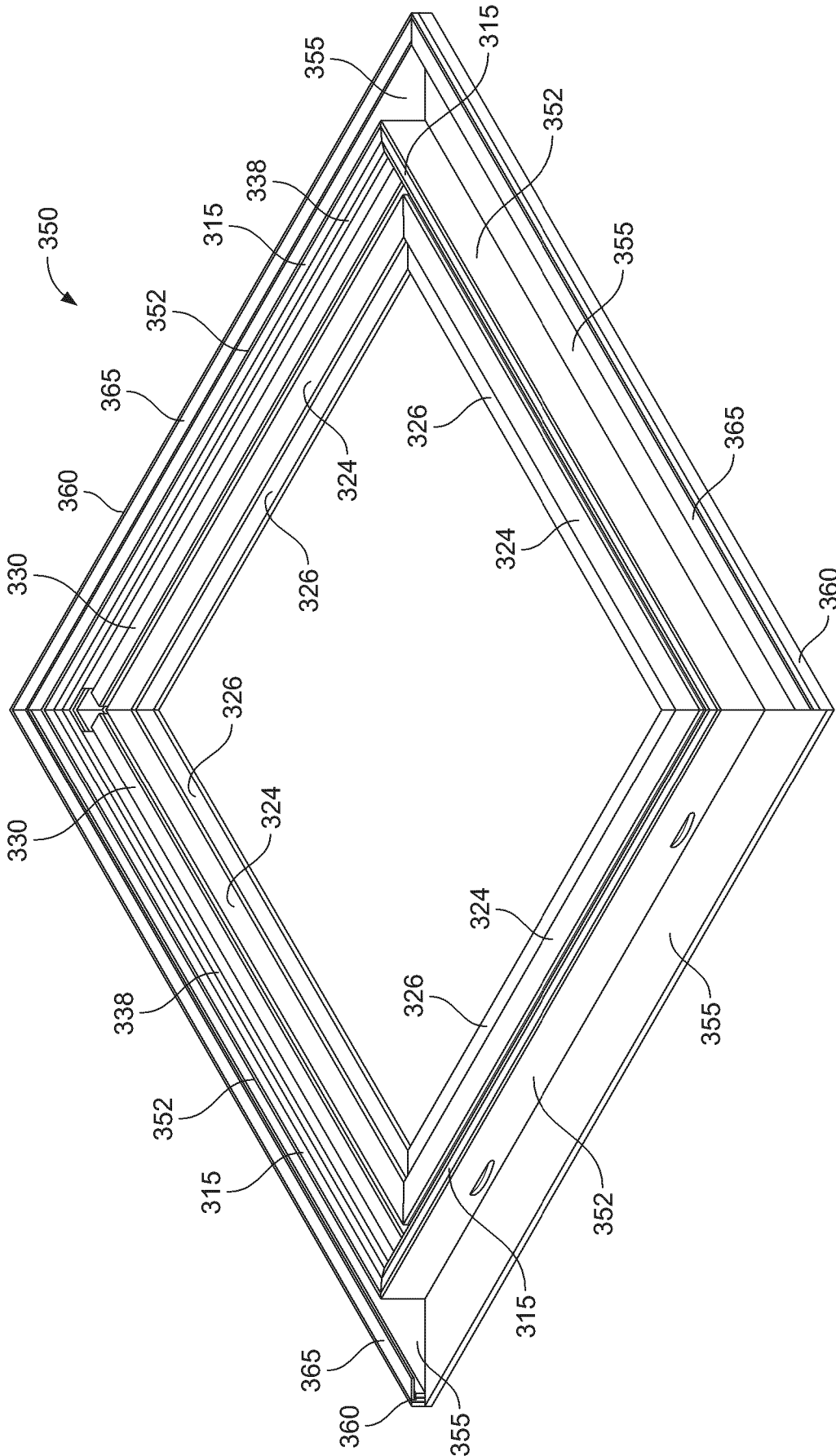


FIG. 12

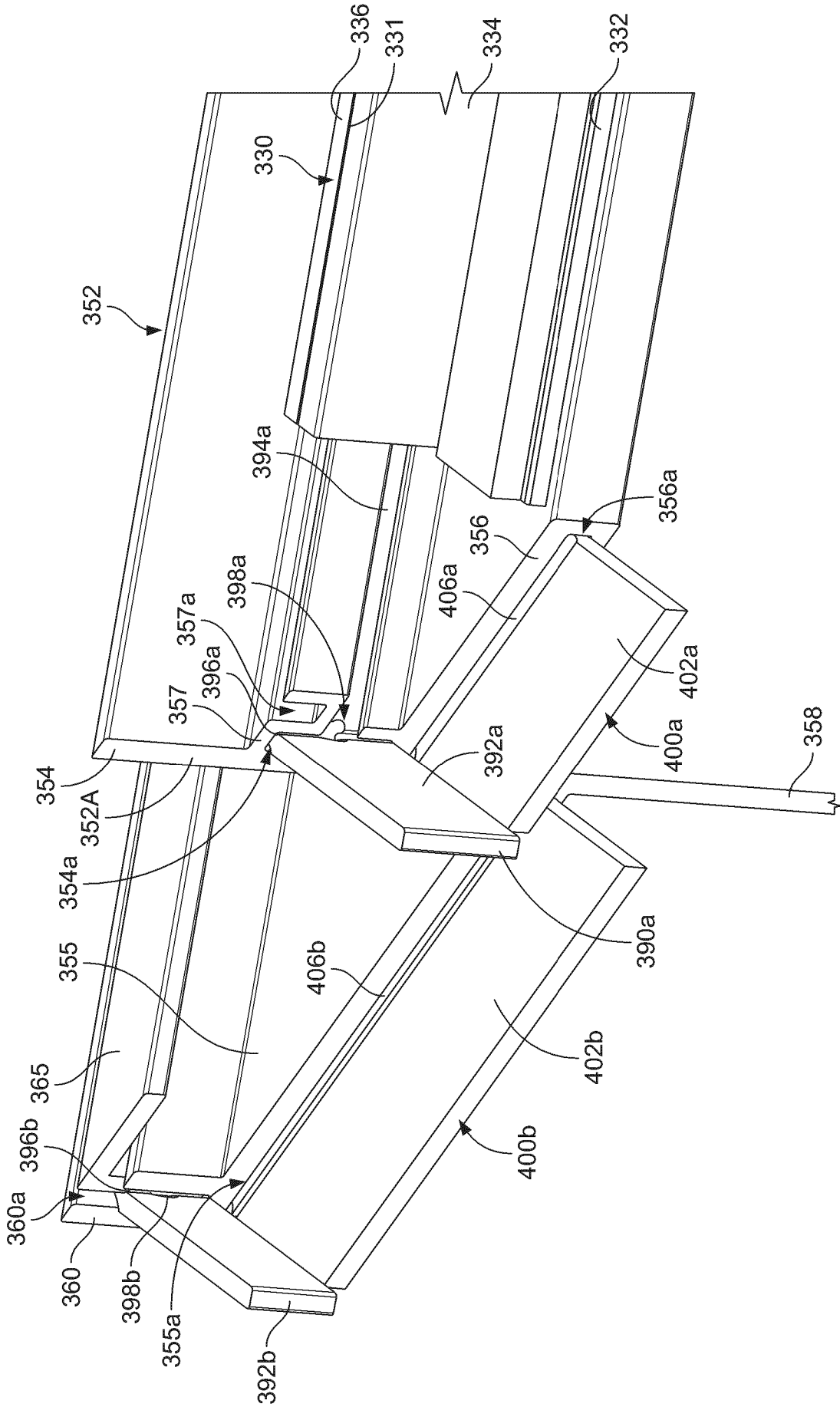


FIG. 14

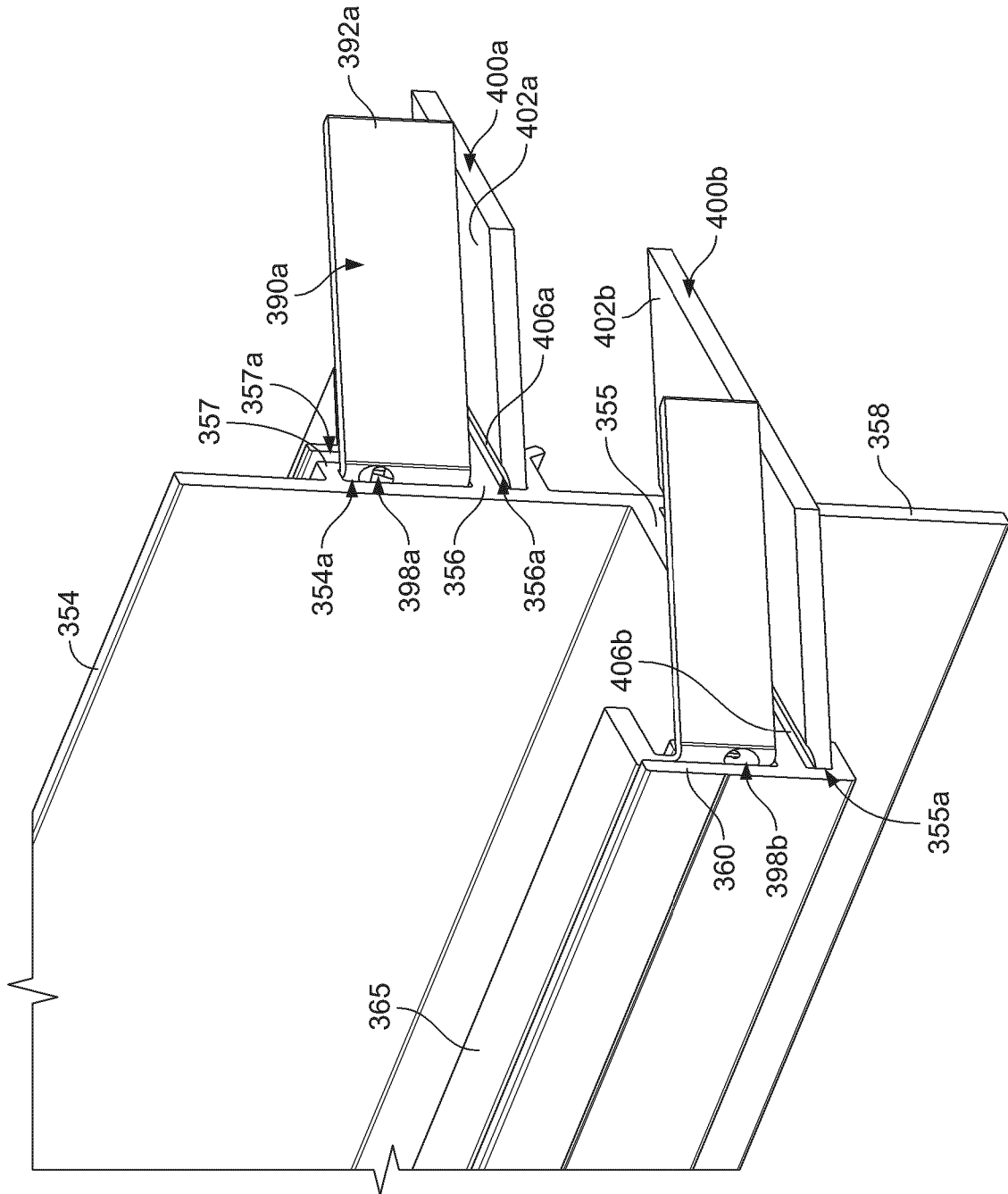


FIG. 15

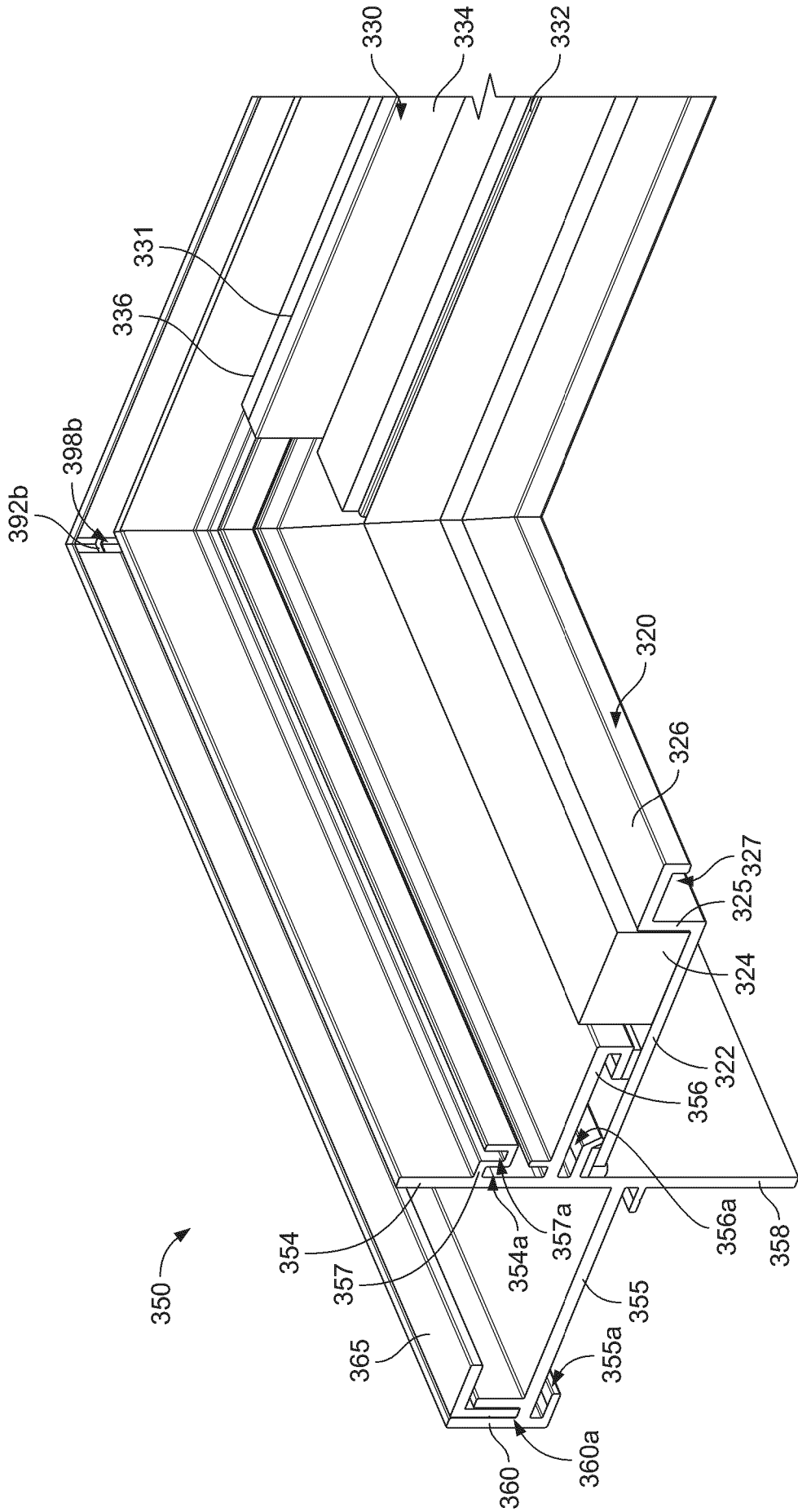


FIG. 17

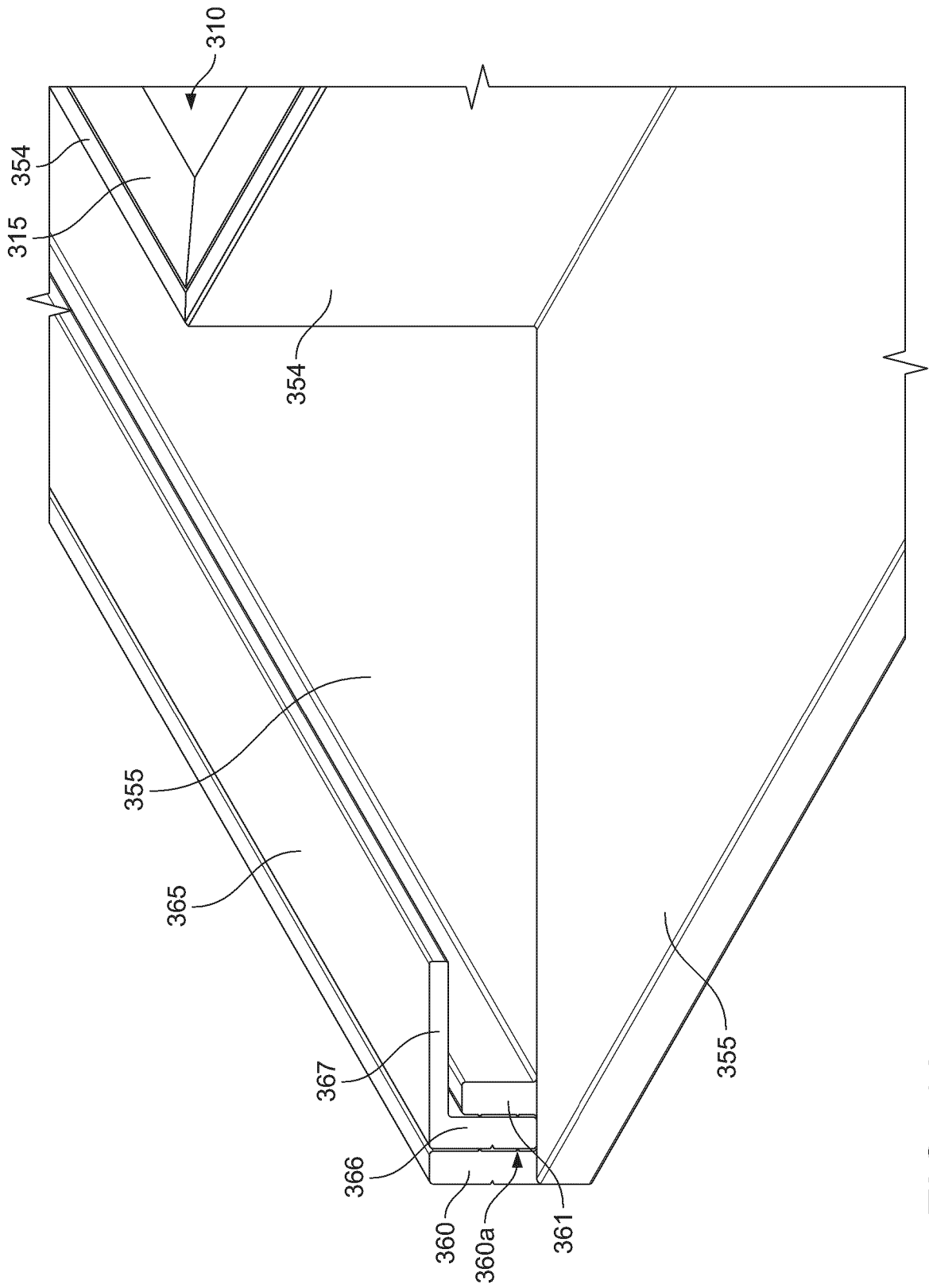


FIG. 18

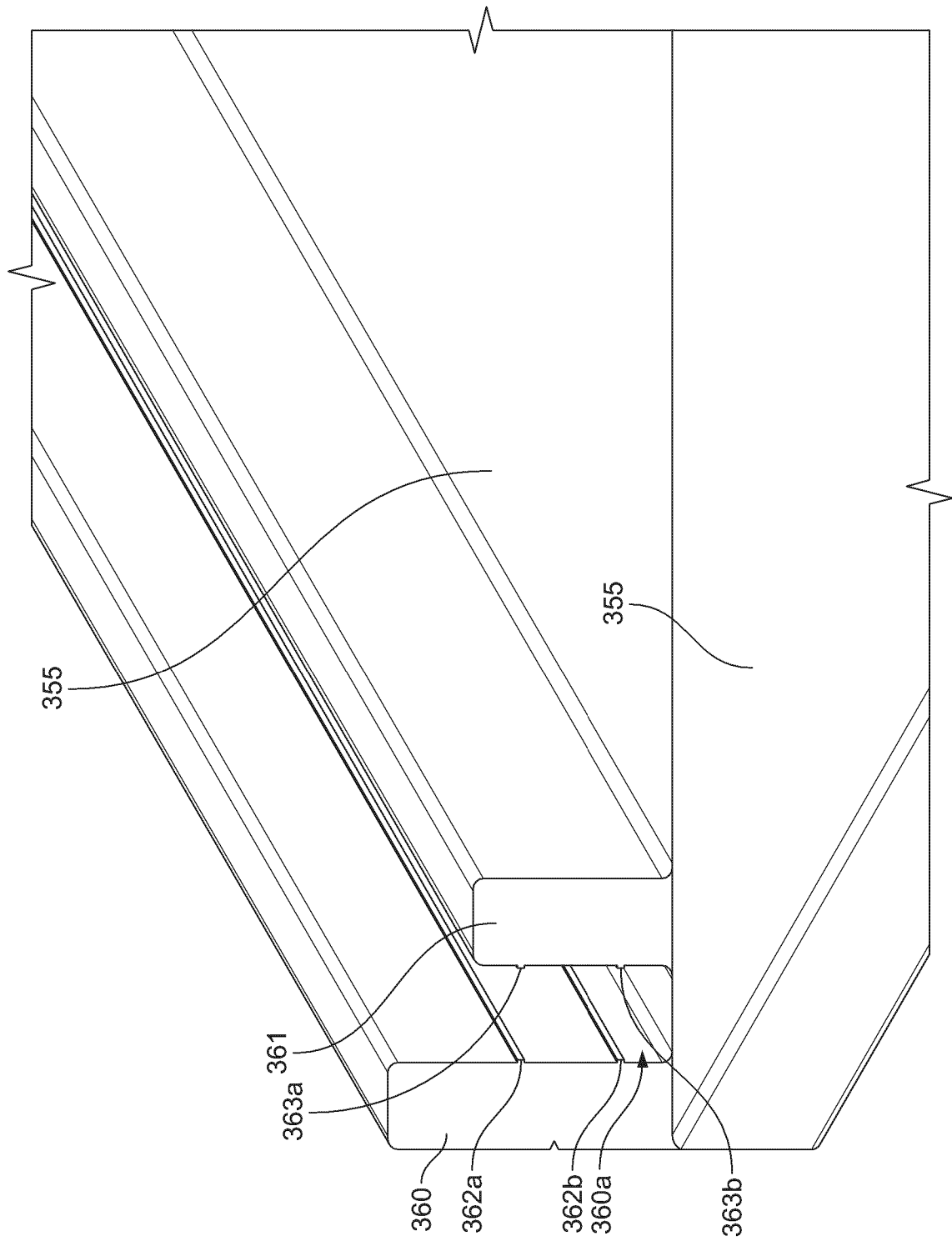


FIG. 19

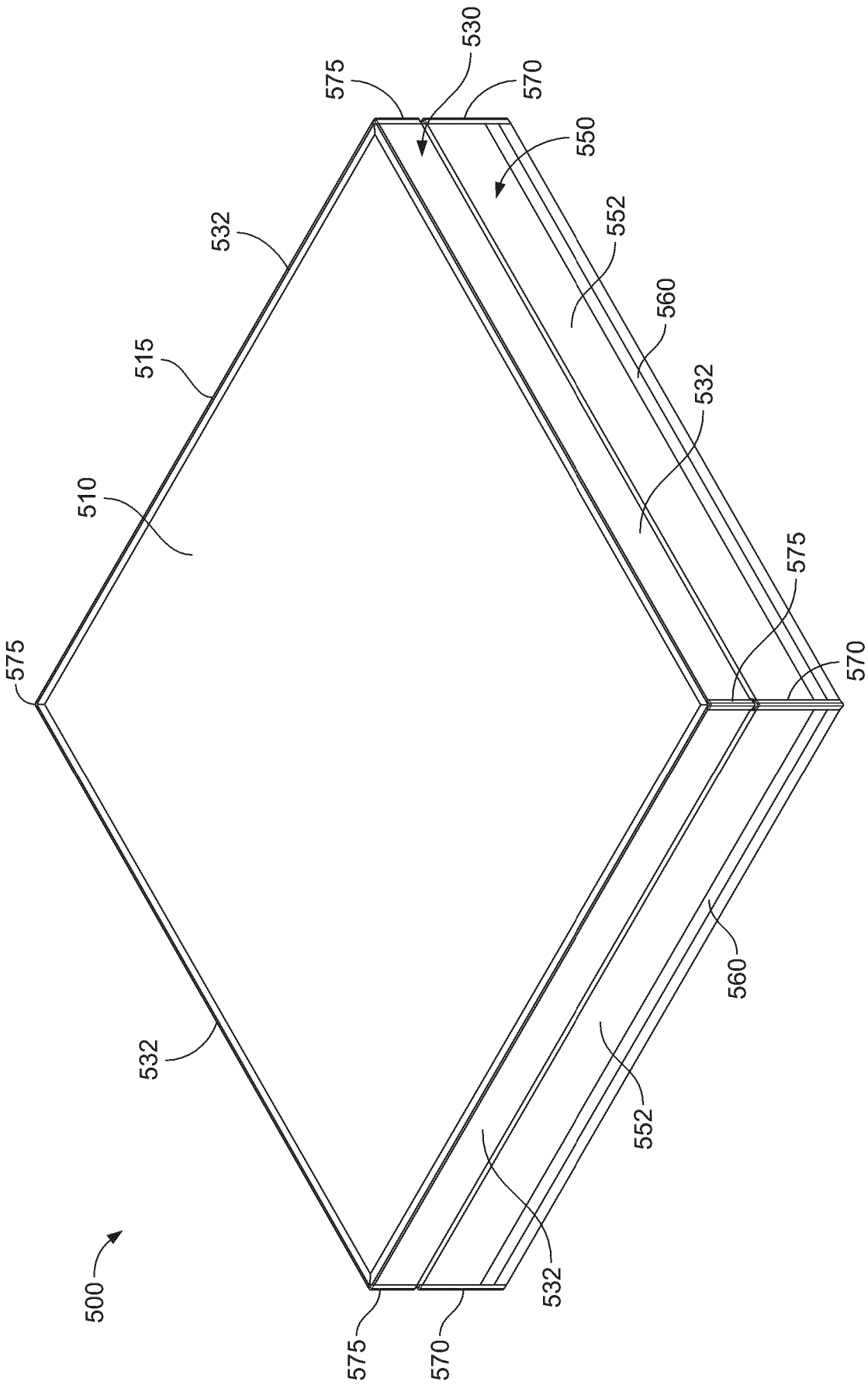


FIG. 20

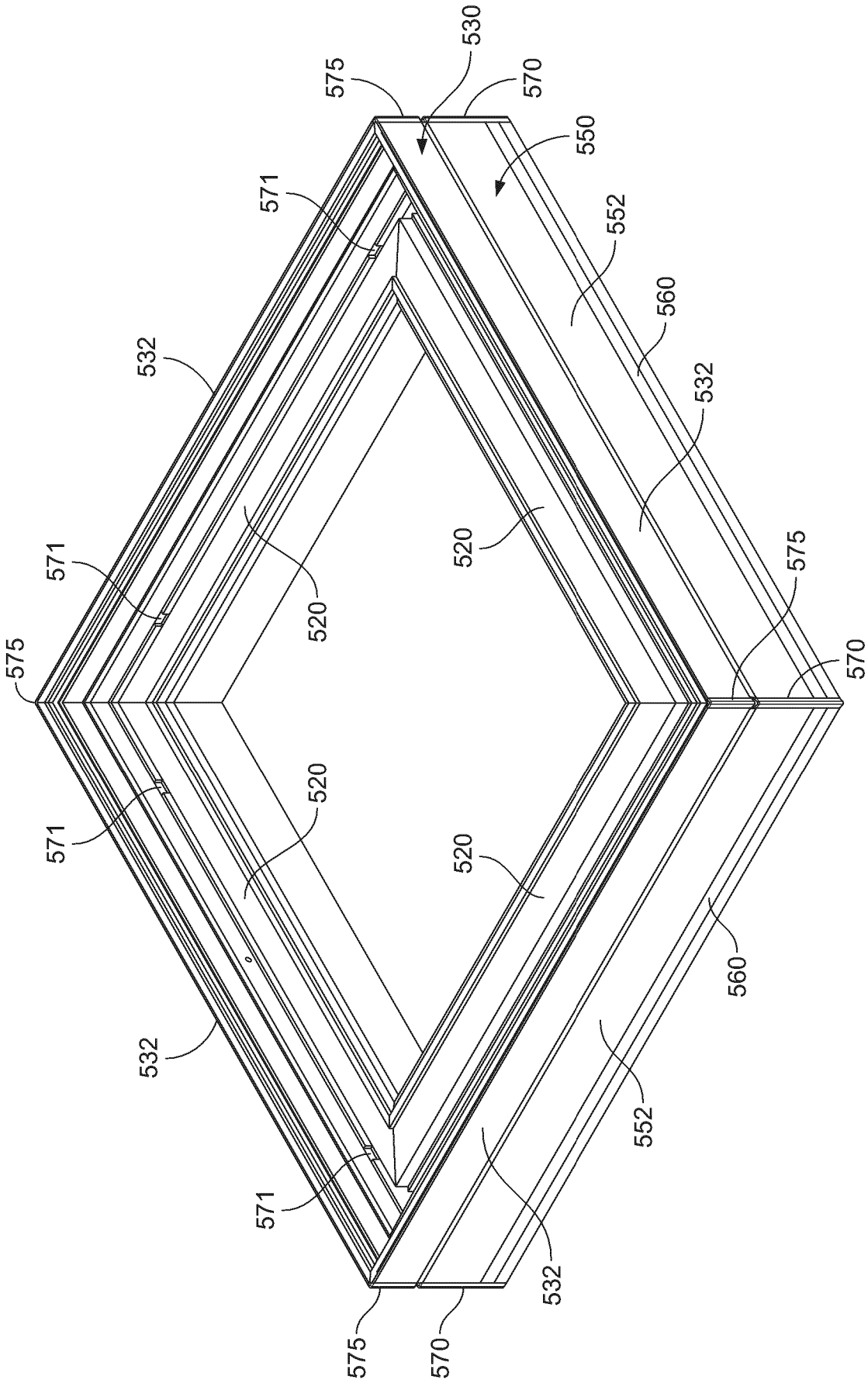


FIG. 21

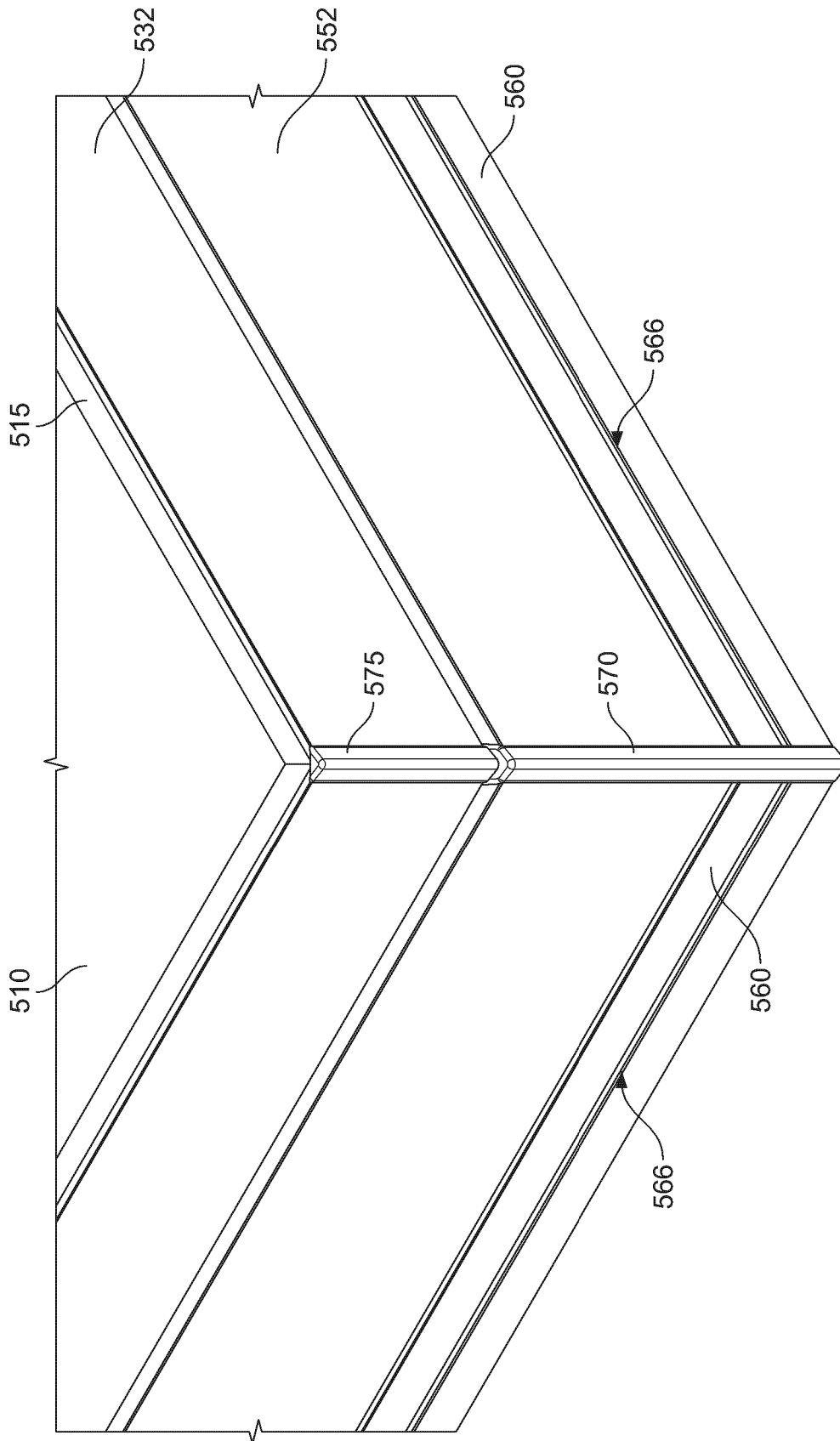


FIG. 22

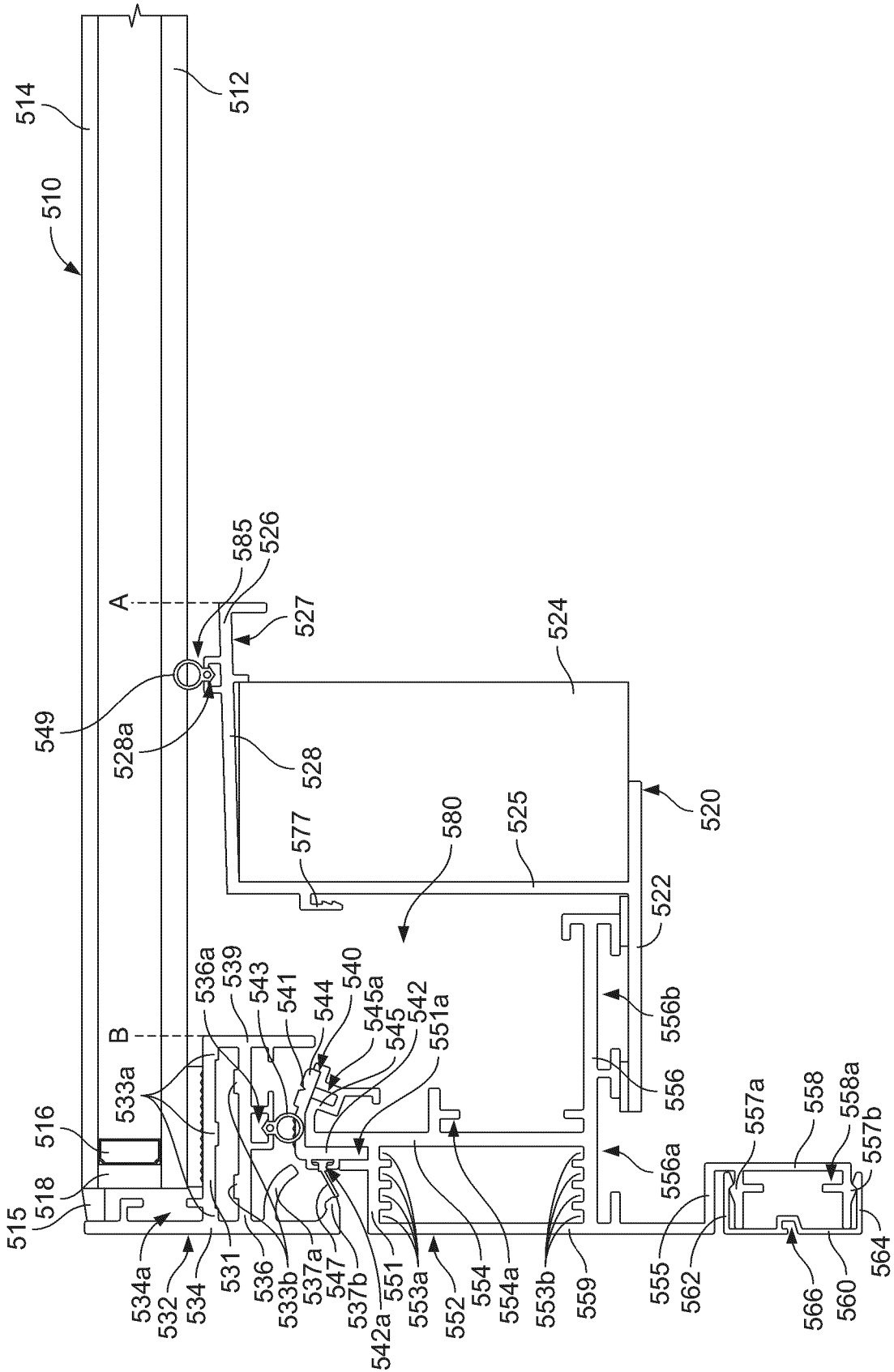


FIG. 23

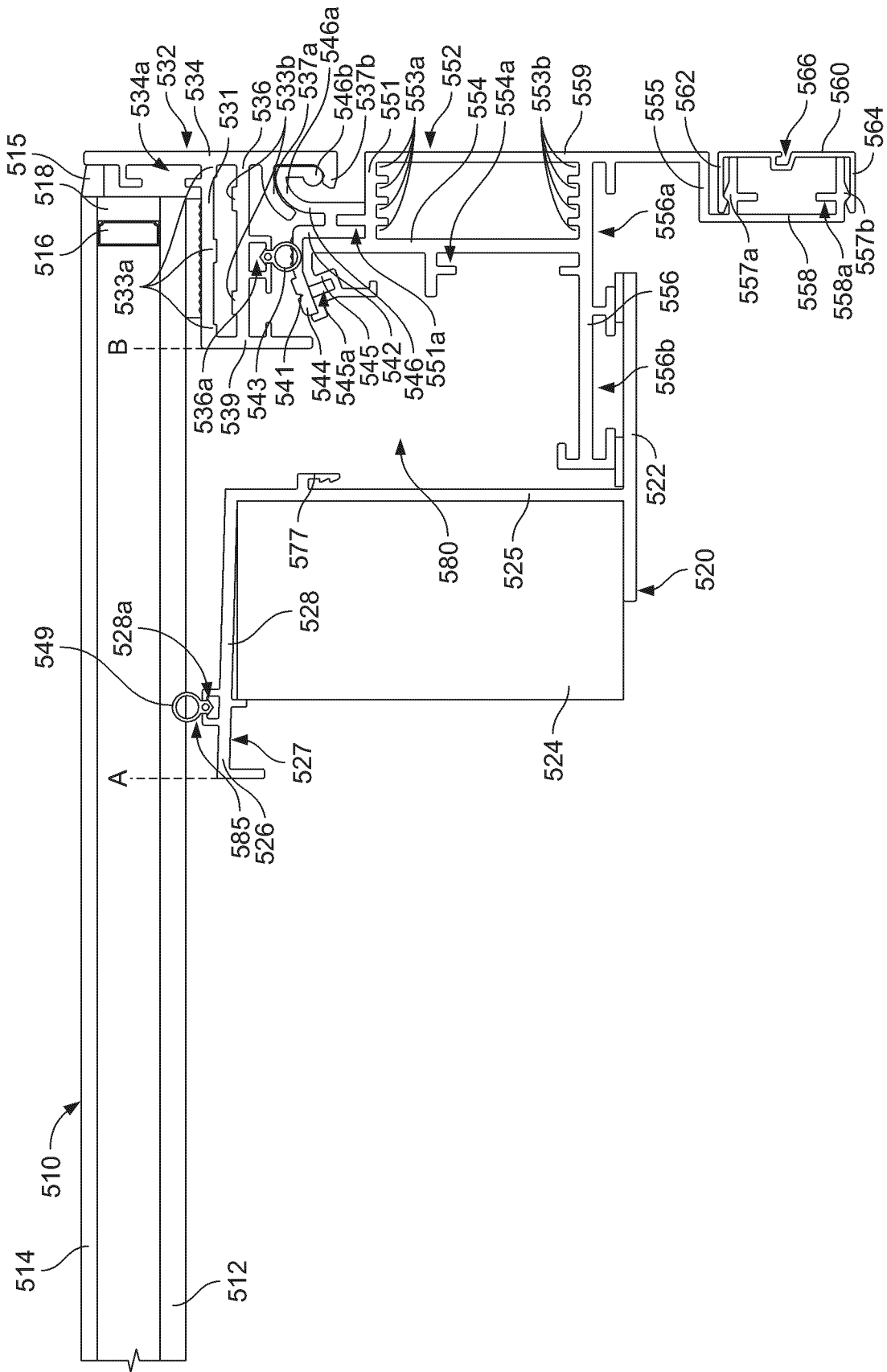


FIG. 24

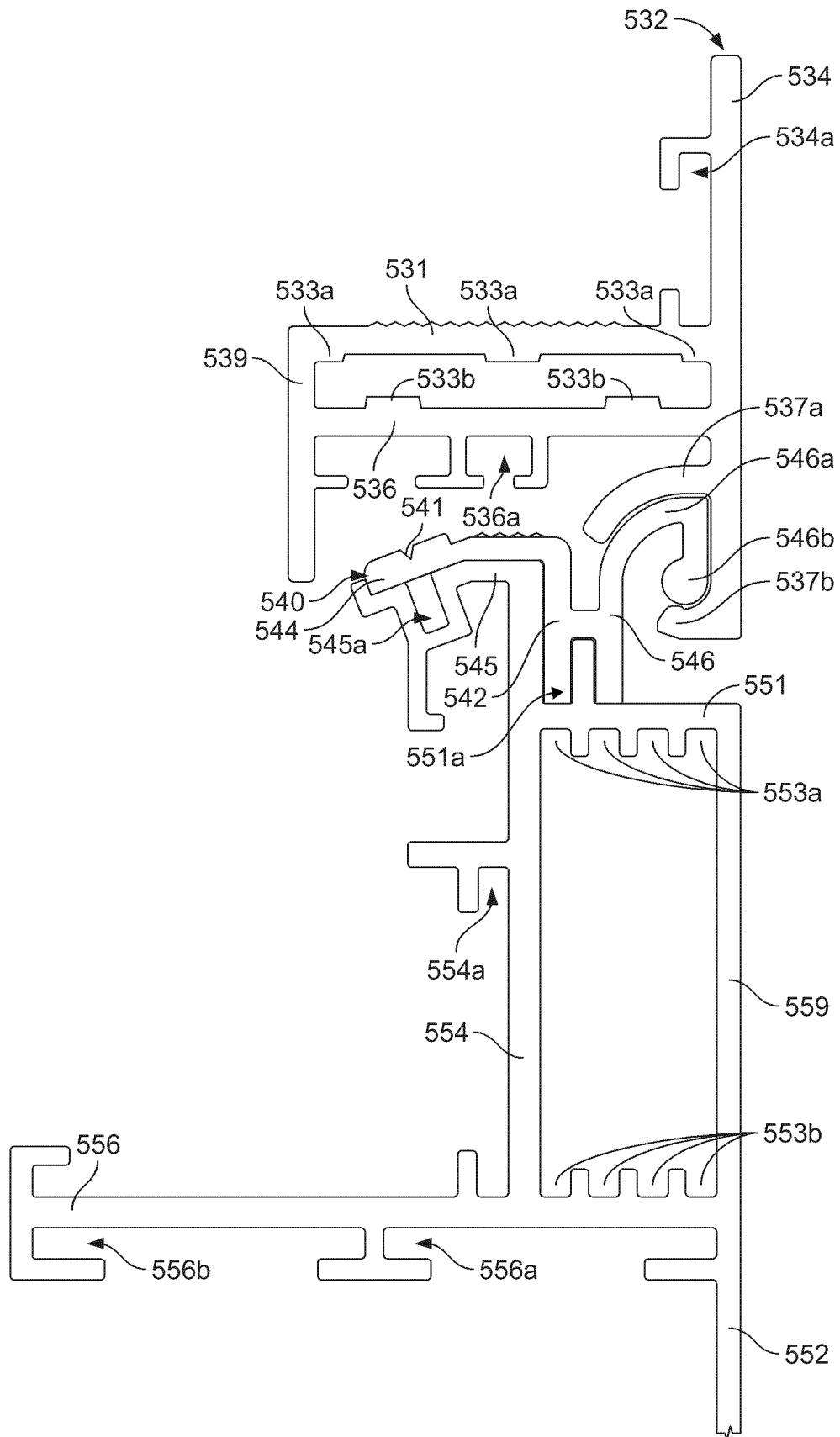


FIG. 25

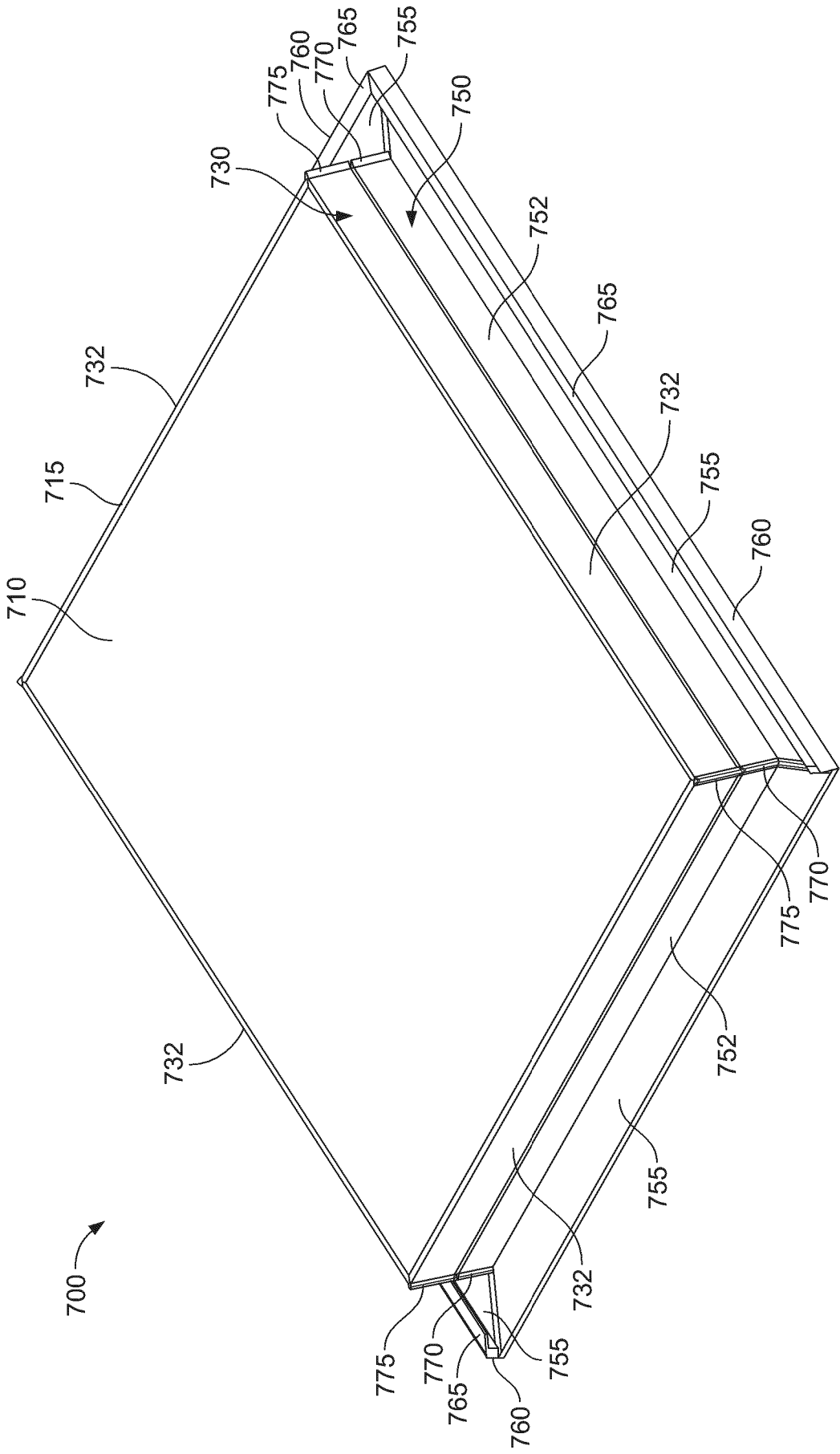


FIG. 26

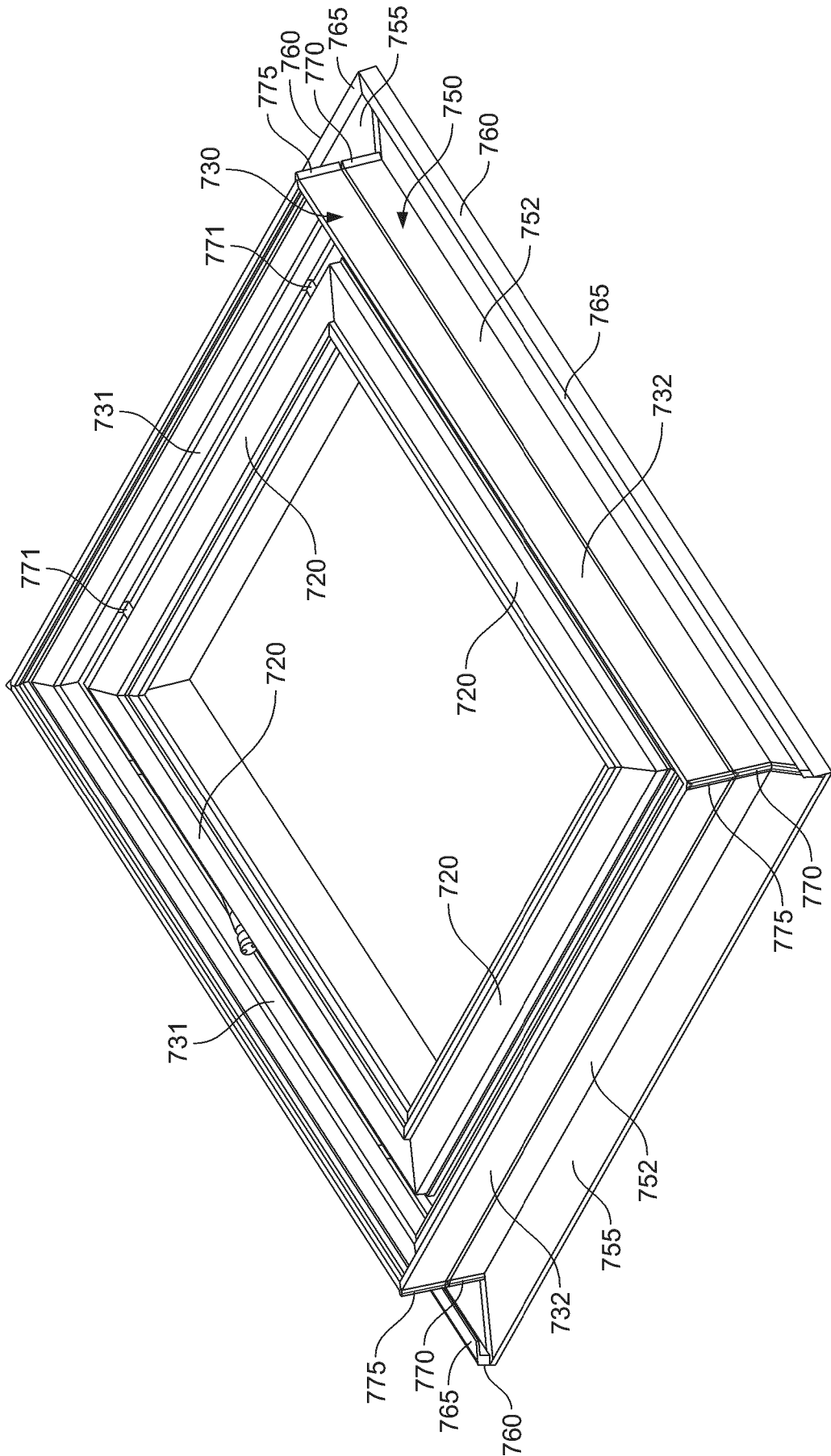


FIG. 27

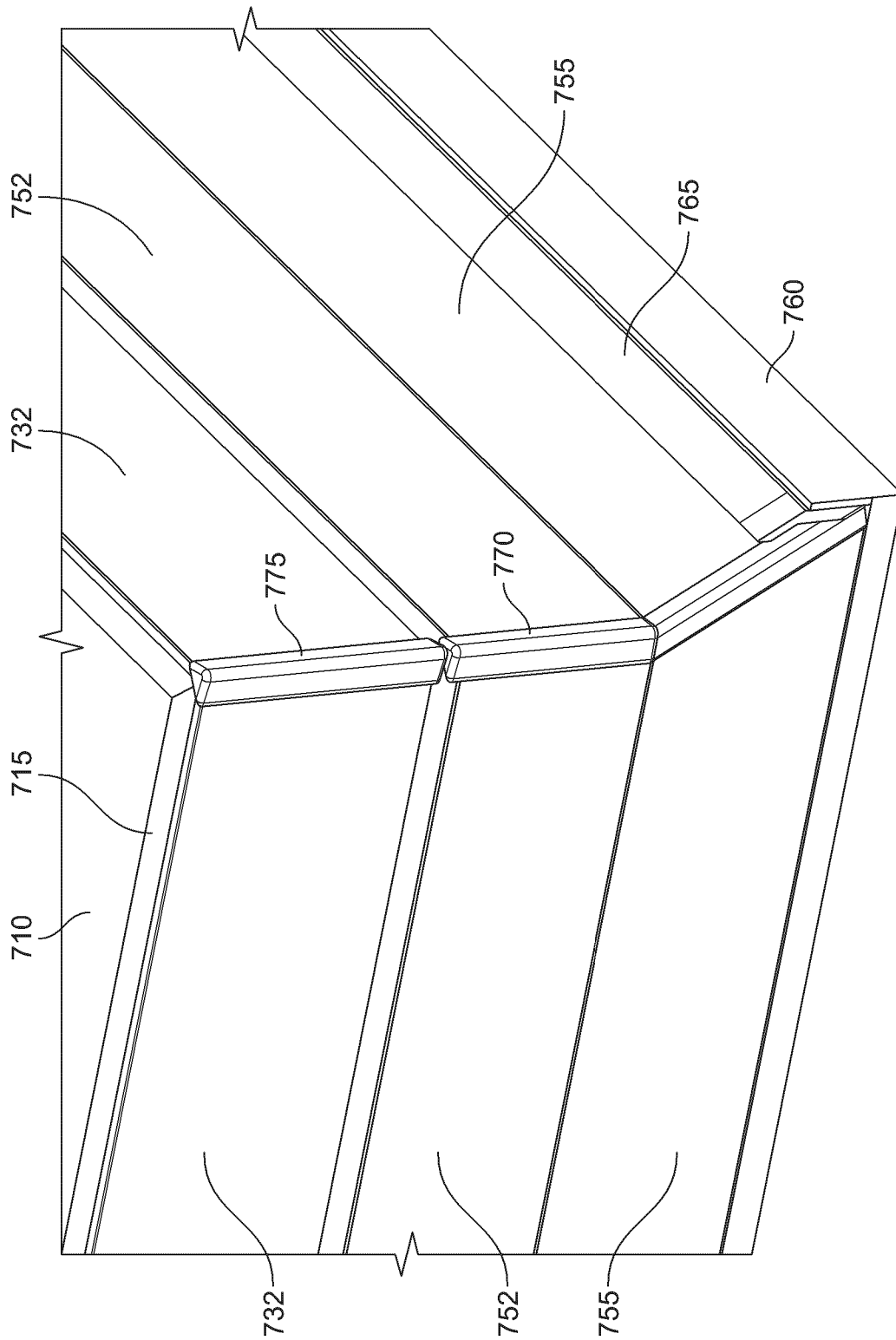


FIG. 28

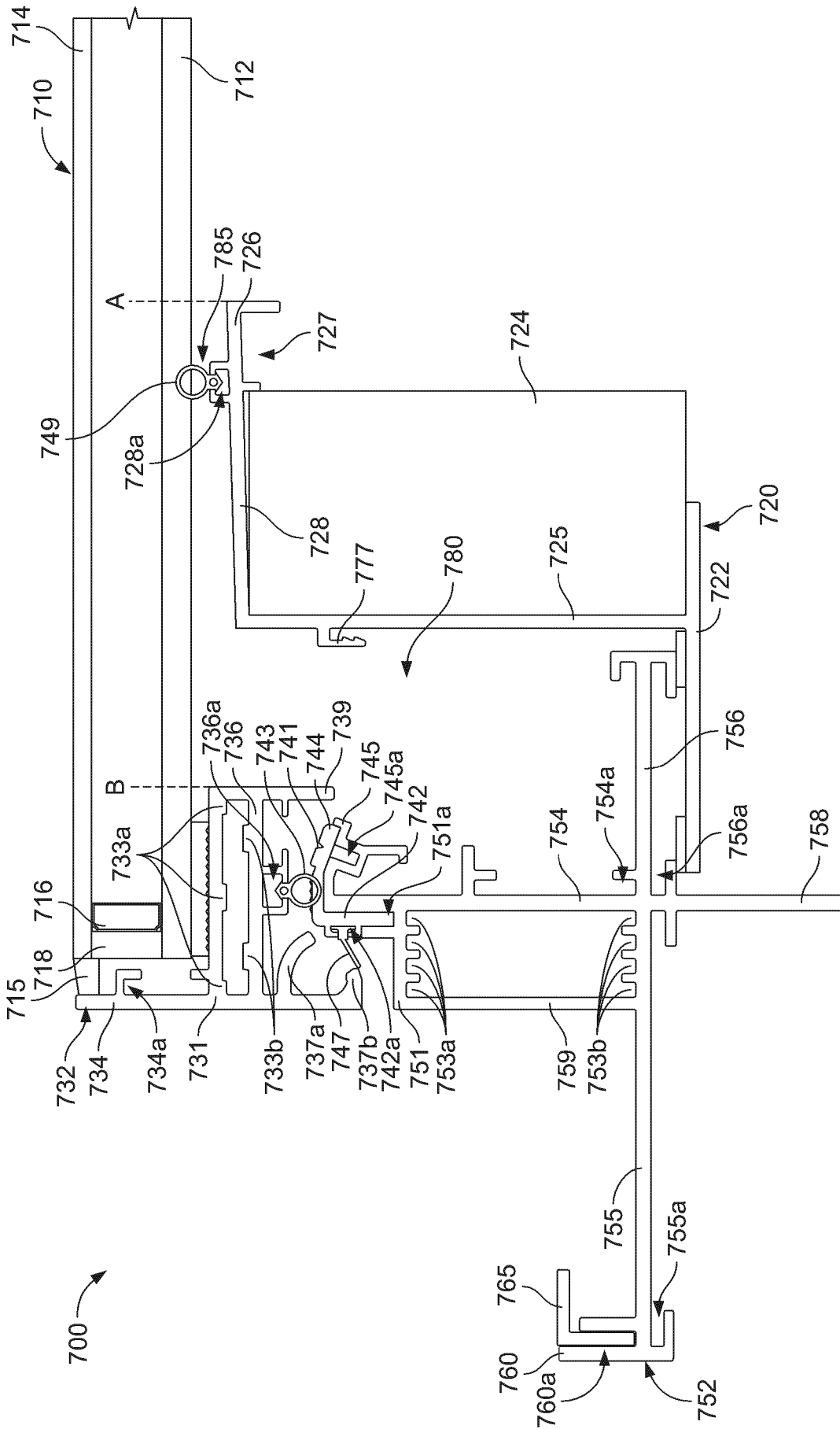


FIG. 29

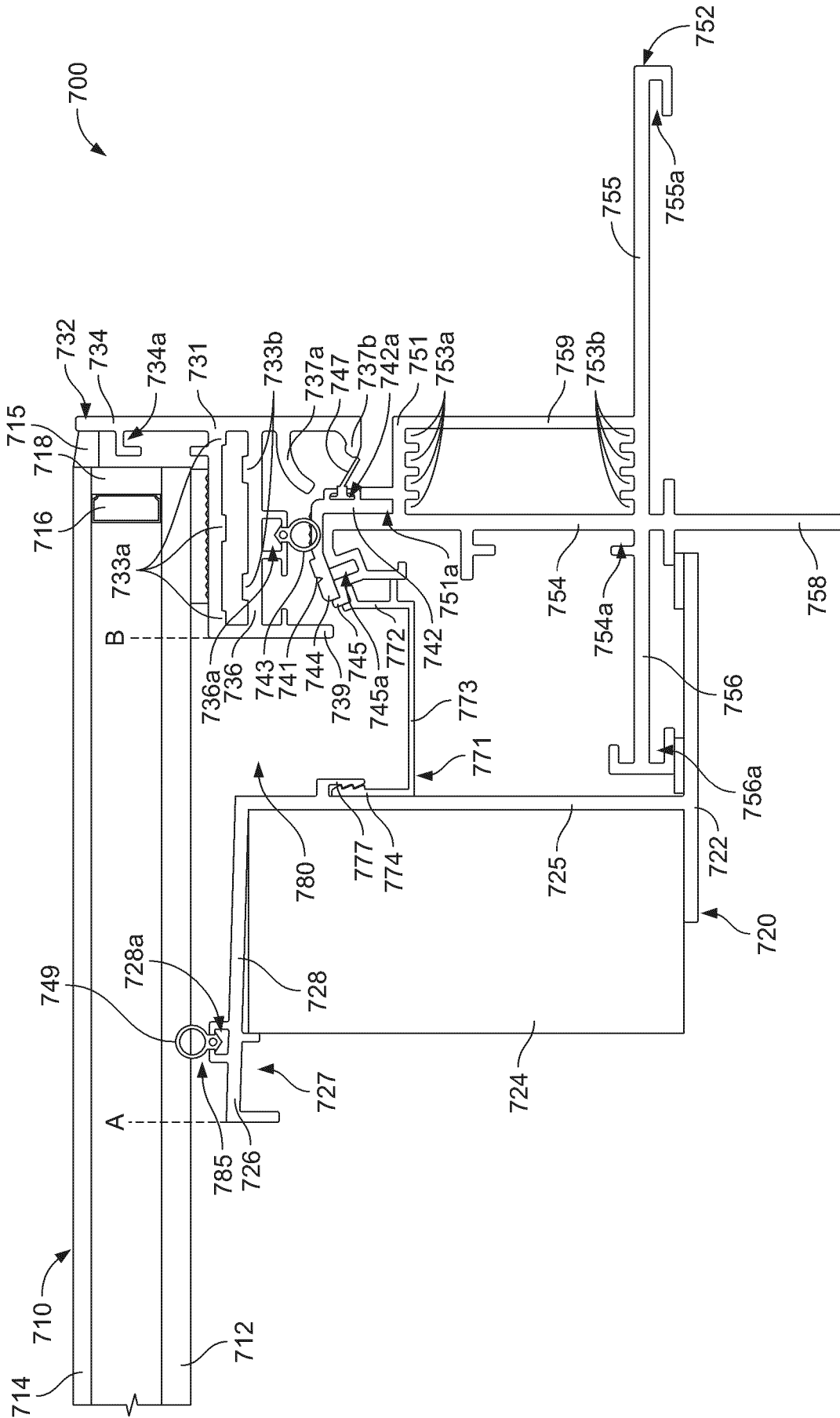


FIG. 30

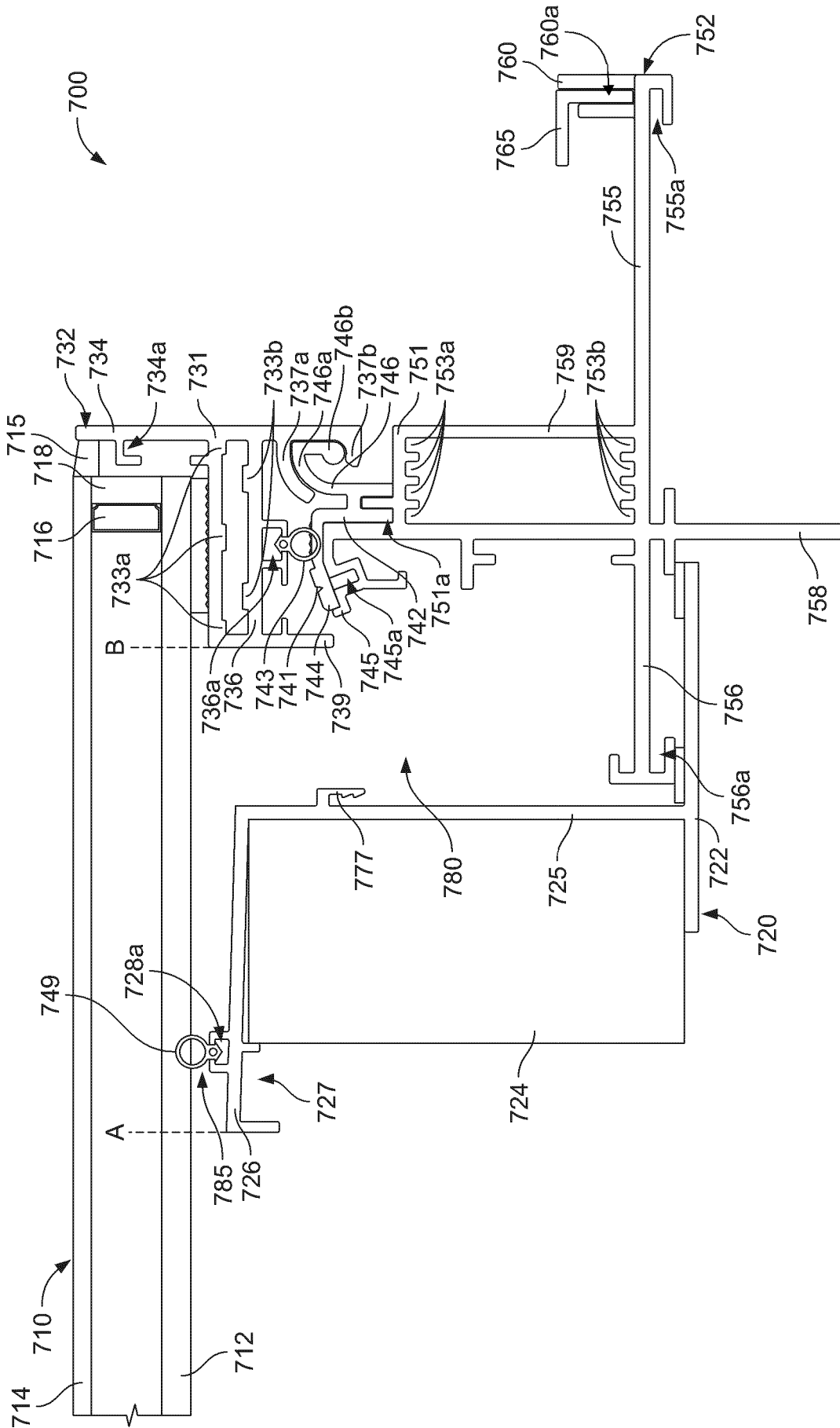


FIG. 31

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/073640

A. CLASSIFICATION OF SUBJECT MATTER
INV. E06B3/968 E04D13/03
ADD.
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)
E06B E04D
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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 759 111 A1 (ALCAN FRANCE [FR]) 7 August 1998 (1998-08-07)	1,2,5,8, 9,14-16
Y	page 4, line 34 - page 6, line 19; figure 1	6,7, 10-13
X	US 2017/246780 A1 (EGGERT JIM [US] ET AL) 31 August 2017 (2017-08-31)	8
Y	paragraph [0123]	6,7
X	US 3 106 269 A (REVELL DONALD H ET AL) 8 October 1963 (1963-10-08)	3-5,11, 13
Y	column 3, line 15; figures 1,8-16	
Y	US 2019/145104 A1 (SUTRAVE SURESH [AU]) 16 May 2019 (2019-05-16)	3-5
	page 2, line 20 - page 3, line 10; figures 4-5	
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"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</p> <p>"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</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 29 October 2020	Date of mailing of the international search report 06/11/2020
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Leroux, Corentine
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/073640

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 2018/073293 A1 (JEFFRIES MARK STEVEN [US]) 15 March 2018 (2018-03-15) figures 4,7 -----	10-13
Y	AT 506 611 A1 (IFN HOLDING AG [AT]) 15 October 2009 (2009-10-15) figure 6 -----	10-13
A	EP 2 987 936 A1 (AGC LIXIL WINDOW TECHNOLOGY CO LTD [JP]) 24 February 2016 (2016-02-24) figures 56-57 -----	3,4, 11-13
A	FR 2 590 611 A1 (GERLAND ETANCHEITE SA [FR]) 29 May 1987 (1987-05-29) figure 2 -----	3,4, 11-13

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