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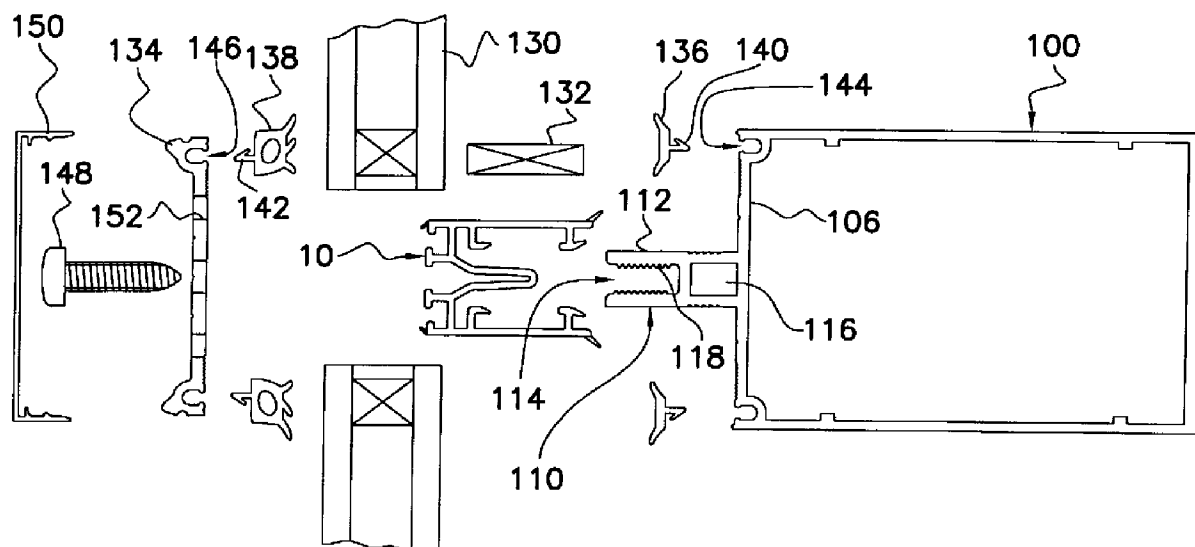
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(54) Title: THERMAL BARRIER FOR USE ON THE FRONT FLANGE OF A MULLION IN A CURTAIN WALL



(57) Abrégé/Abstract:

The thermal barrier is used on a flange projecting out from the front portion of a mullion in a curtain wall. The curtain wall comprises horizontal and vertical mullions defining a plurality of subsections, each enclosing a windowpane. This thermal barrier comprises a front section and two side sections transversally projecting from opposite edges of the front section. The front and side sections define a flange-receiving housing. The thermal barrier is shaped and sized so that a rear edge of at least one side section is in a positive engagement with the front portion of the mullion when the thermal barrier is installed over its flange. This thermal barrier replaces the conventional thermal barrier without changing the structural resistance of the curtain wall. It provides an improved thermal insulation and corner plugs are no longer necessary to fill the spaces between perpendicular flanges. Smaller amounts of caulking are also required to seal the space created by the expansion joint between two vertical mullions since that space is much smaller than the one left by conventional thermal barriers. The installation of the curtain wall is thus simplified and more rapidly completed. The quality of the work is also likely to be more constant. A further advantage is that each thermal barrier entirely covers the flange so that a windowpane, during its installation in a subsection, is less likely to be damaged since the edges thereof never directly make contact with the hard aluminum interior surface of the flanges.



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CERTIFICATE OF RE-EXAMINATION**

N° de brevet - Patent No: **2,249,513**

Par la présente, les soussignés certifient que le brevet susmentionné a été réexaminé selon les paragraphes 48.1 à 48.3 de la *Loi sur les brevets* et que le Conseil de réexamen convient de ce qui suit:

The undersigned hereby certify that the above-noted patent has been re-examined pursuant to section 48.1 to 48.3 of the *Patent Act* and that the Re-examination Board has determined the following:

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Claim(s) brevetable(s) et est/sont rejetée(s).
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- (iv) La/Les nouvelle(s) est/sont brevetable(s) et fait/font partie du
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May 14, 2004

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Application No. : **2,249,513**
Owner : **A. & D. PREVOST INC.**
Title : **THERMAL BARRIER FOR USE ON THE FRONT FLANGE OF A
MULLION IN A CURTAIN WALL**
Classification : **E04B-2/96**
Your File No. : **004327-0004**

Dear Sir/Madam:

Please find enclosed your registration certificate number 5271949 for your Re-Examination.

Yours truly,


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Date : 2004/05/14

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AUTRE DOCUMENT
OTHER DOCUMENT

Un document a été enregistré au Bureau des
brevets, visant le ou les numéros de brevet(s) et/ou
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BREVET(S)/PATENT(S)

2,249,513

A document has been registered in the Patent Office,
against the following patent(s) and/or application(s)
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ABSTRACT

The thermal barrier is used on a flange projecting out from the front portion of a mullion in a curtain wall. The curtain wall comprises horizontal and vertical mullions defining a plurality of subsections, each enclosing a windowpane. This thermal barrier comprises a front section and two side sections transversally projecting from opposite edges of the front section. The front and side sections define a flange-receiving housing. The thermal barrier is shaped and sized so that a rear edge of at least one side section is in a positive engagement with the front portion of the mullion when the thermal barrier is installed over its flange. This thermal barrier replaces the conventional thermal barrier without changing the structural resistance of the curtain wall. It provides an improved thermal insulation and corner plugs are no longer necessary to fill the spaces between perpendicular flanges. Smaller amounts of caulking are also required to seal the space created by the expansion joint between two vertical mullions since that space is much smaller than the one left by conventional thermal barriers. The installation of the curtain wall is thus simplified and more rapidly completed. The quality of the work is also likely to be more constant. A further advantage is that each thermal barrier entirely covers the flange so that a windowpane, during its installation in a subsection, is less likely to be damaged since the edges thereof never directly make contact with the hard aluminum interior surface of the flanges.

THERMAL BARRIER FOR USE ON THE FRONT FLANGE OF A MULLION IN A CURTAIN WALL

BACKGROUND

5

A curtain wall is an assembly generally used to form an outer wall of a building or a portion thereof. It has a framework that comprises a plurality of elongated horizontal and vertical beams called "mullions". These mullions are typically made of aluminum and divide the curtain wall in a plurality of adjacent subsections. Each subsection defines a space, usually rectangular, in which a windowpane is installed.

Typically, an upper end of each vertical mullion is anchored to the structure of the building. The lower end of the vertical mullion is coupled to the upper end of another vertical mullion that is in registry therewith. The ends of the two superposed vertical mullions are slightly spaced apart, generally of 10 to 13 mm, to form an expansion joint that compensates for the thermal dilatation of the materials and the deflection of the structure. An inner element, called "sleeve", is anchored to the lower vertical mullion by screws or bolts. The sleeve is inserted through the bottom end of the upper vertical mullion and is free to slide with reference thereto. The ends of each horizontal mullion are then connected to a vertical mullion by means of a bracket that is bolted or otherwise fastened to the side thereof.

The weight of each windowpane is supported by a longitudinal U-shaped flange projecting out of the front portion of the corresponding lower horizontal mullion and extending across the entire length thereof. Shims, usually made of neoprene blocks, are used to prevent direct contact of the bottom edge of the windowpane with the flange. The vertical mullions and the upper horizontal mullion of a subsection are identical to the lower horizontal mullion. Because they all have

flanges, the entire periphery of each windowpane is surrounded by flanges. These flanges allow retaining pressure plates to be anchored thereto by means of self-tapping screws or bolts. The pressure plates are used to apply a retaining pressure on the edges of the windowpane to secure it in place. Each pressure
5 plate generally secures two adjacent windowpanes, depending on its location. It should be mentioned at this point that other kinds of panels are often used in addition to the windowpanes, depending on the architectural design of a given building. Such panels are made of materials other than glass. Therefore, the words "windowpane" and "windowpanes" in the present description and in the
10 claims include the other kinds of panels for a curtain wall.

As aforesaid, a curtain wall forms the outer wall or a portion of the outer wall of a building. As a result, it is subjected to the usual atmospheric conditions, including rain and other solid precipitation. Water must thus be prevented from entering
15 inside the curtain wall. To do so, exterior glazing gaskets are provided between the pressure plates and the edges of the windowpanes. These gaskets also allow the pressure from the pressure plates to be efficiently applied without damaging the glass. Corresponding interior glazing gaskets are also interposed between the rear side edges of the windowpane and the front portion of each mullion.

20

Small defects may appear in the exterior glazing gaskets over time and allow some water to enter. A defective part may do the same soon after the installation is completed. If this happens, a large portion of the water goes to the bottom of the defective subsection or subsections under the effect of gravity. Weep holes are
25 therefore provided in the pressure plates to drain the water out. It should be mentioned that these holes also provide some natural ventilation and equilibrate the pressure between the exterior of the curtain wall and the periphery of the windowpane inside the curtain wall.

Whenever water enters a subsection, it must be controlled and directed to drain to the outside. A water infiltration inside a building is very difficult to locate and repair if water can run from one subsection to another. Prevention must thus be taken to limit to a minimum the propagation of water to adjacent subsections, especially the subsections underneath. Each subsection is then sealed and any water therein is drained through weepholes in the pressure plates. The seal between adjacent subsections is achieved by a flexible component between the mullions and the pressure plate, or by a bead of caulking. All openings of the subsections, such as the expansion joints and the corner gaps, are blocked and sealed.

Thermal barriers of the prior art are elongated strips that provide a minimal thermal insulation between the flanges of the mullions and the pressure plates. They are also used to seal each subsection for preventing water from reaching an adjacent subsection. They are made of a resilient, usually polymeric material and almost cover the entire periphery of each subsection, with the exception of a space between each end of a flange of a horizontal mullion and the flange of the adjacent vertical mullion in all four corners, and the gaps left by the expansion joints to compensate for thermal dilatation of the framework.

As a standard feature, the flanges of the mullions are U-shaped so that screws or bolts may be inserted at any location of the front channel that they each define. In the prior art, each thermal barrier comprises a front section and a small V-shaped section. The V-shaped section is inserted into the front channel of the corresponding flange. The width of the front section of the thermal barrier corresponds to that of the flange. The center of each pressure plate is directly engaged on the corresponding thermal barrier.

FIGS. 18 to 20 illustrate a typical assembly that uses a thermal barrier according to the prior art. There are some drawbacks. For instance, the thermal insulation provided by the thermal barrier is minimal. Moreover, each subsection has to be

provided with corner plugs to fill the spaces between the flange of the horizontal and vertical mullions. Each corner plug is made of a resilient material and is snugly fitted within a respective space. A bead of caulking is applied by the installer to seal the periphery of each corner plug. If, for any reason, a corner plug has to be replaced, the corresponding front portions of the mullions would have to be completely cleaned to remove any trace of the old bead. Further, the gaps left by the expansion joints need to be filled with an important amount of resilient caulking to completely seal the subsection.

10 Among other drawbacks, there is the fact that screws or bolts completely go through the thermal barrier. As a result, the thermal insulation between the flanges and the pressure plates is reduced. Yet, water inside the subsection is in direct contact with a large portion of the material of the flanges, which might lead to some corrosion over time.

SUMMARY

The present invention is aimed at resolving many of the above-mentioned drawbacks. Some embodiments are also believed to resolve all these drawbacks. Additionally, the present invention provides other advantages, as indicated in the description.

20 In summary, the present invention relates to a thermal barrier that is provided for use on a U-shaped flange projecting out from a front wall of a mullion in a curtain wall. This thermal barrier comprises a front section and two substantially flat side walls transversally projecting from opposite edges of the front wall. The front section and side walls define a flange-receiving housing. The thermal barrier is shaped and sized so that a rear edge of at least one side wall is in a positive engagement with the front wall of the mullion when the thermal barrier is installed over its flange.

A non restrictive description of various embodiments will now be given with reference to the appended figures.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is an end view of a first and preferred embodiment of a thermal barrier according to the present invention.

5

FIG. 2 is an exploded end view of a lower part of a curtain wall subsection, with the thermal barrier of FIG. 1.

FIG. 3 is an end view of the lower part of the subsection shown in FIG. 2, once the elements are assembled.

10

FIG. 4 is a perspective and partially exploded view of a corner of a curtain wall subsection, using thermal barriers such as the one shown in FIG. 1.

15

FIG. 5 is a perspective view of the subsection corner of FIG. 4, once the elements are assembled.

FIG. 6 is an end view of a thermal barrier according to a second embodiment of the present invention.

20

FIG. 7 is an end view of the lower part of a curtain wall subsection, with the thermal barrier of FIG. 6.

25

FIG. 8 is an end view of a thermal barrier according to a third embodiment of the present invention.

FIG. 9 is an end view of the lower part of a curtain wall subsection, with the thermal barrier of FIG. 8.

30

FIG. 10 is an end view of a thermal barrier according to a fourth embodiment of the present invention.

5 FIG. 11 is an end view of the lower part of a curtain wall subsection, with the thermal barrier of FIG. 10.

FIG. 12 is an end view of a thermal barrier according to a fifth embodiment of the present invention.

10 FIG. 13 is an end view of the lower part of a curtain wall subsection, with the thermal barrier of FIG. 12.

FIG. 14 is an end view of a thermal barrier according to a sixth embodiment of the present invention.

15 FIG. 15 is an end view of the lower part of a curtain wall subsection, with the thermal barrier of FIG. 14.

20 FIG. 16 is an end view of a thermal barrier according to a seventh embodiment of the present invention.

FIG. 17 is an end view of the lower part of a curtain wall subsection, with the thermal barrier of FIG. 16.

25 FIG. 18 is an exploded end view of a lower part of a curtain wall subsection, with a typical thermal barrier according to the PRIOR ART.

FIG. 19 is an end view of the lower part of the subsection shown in FIG. 18, once the elements are assembled.

30

FIG. 20 is a perspective view of a corner of a curtain wall subsection, using thermal barriers such as the one shown in FIG. 18.

5

IDENTIFICATION OF THE COMPONENTS

The following is a list of the reference numerals, along with the names of the corresponding components, that are used in the appended figures and in the description.

10

- 10 thermal barrier (of the present invention)
- 12 front section
- 14 side sections
- 16 flange-receiving housing
- 15 18 median plane
- 20 flat wall
- 22 supporting legs
- 24 V-shaped section
- 26 flexible strip (of a side section)
- 20 27 orthogonally projecting flange (of a side section)
- 28 hollow chamber
- 30 flexible strip (of a front section)
- 100 horizontal mullion
- 102 vertical mullion
- 25 104 bracket
- 105 screws or bolts (to be connected to a bracket)
- 106 front portion (horizontal or vertical mullion)
- 110 U-shaped flange (horizontal or vertical mullion)
- 112 side portions (of the flange)
- 30 114 front channel (of the flange)

- 116 hollow intermediary chamber (of the flange)
- 118 inner ridges (of the flange)
- 120 expansion joint (between two vertical mullions)
- 122 sleeves
- 5 123 screws or bolts (of a sleeve)
- 130 windowpanes
- 132 shims
- 134 pressure plates
- 136 interior glazing gaskets
- 10 138 exterior glazing gaskets
- 140 wedge-type back strip (of each interior glazing gasket)
- 142 wedge-type back strip (of each exterior glazing gasket)
- 144 grooves (in the front portion of each mullion)
- 146 grooves (in each pressure plate)
- 15 148 screws or bolts (for each retaining plate)
- 150 cover
- 152 weep holes (in a retaining plate)
- 154 opening (at the expansion joint)
- 200 thermal barrier (PRIOR ART)
- 20 202 corner plug (PRIOR ART)
- 204 side gaps (PRIOR ART)

DESCRIPTION

- 25 Many embodiments of a thermal barrier according to the present invention are illustrated in FIGS. 1 to 17. In all instances, the thermal barrier is referred to as numeral 10. A typical example of a thermal barrier found in the prior art is illustrated in FIGS. 18 to 20 and is referred to as numeral 200. To simplify the figures, some elements are not referred to in some figures if they were already
- 30 identified in a precedent figure.

Curtain wall

It should be noted that the construction of a curtain wall is well known in the art and is beyond the scope of the present invention. A basic description of a typical curtain wall is provided in the background section of the present description.

Some basic elements of a curtain wall are shown in FIGS. 2 to 20. These figures have been simplified to show only the elements of a curtain wall that are required to understand the functions of the thermal barrier (10) of the present invention, in contrast to the thermal barrier (200) of the prior art. In particular, these figures show a horizontal mullion (100) connected to a vertical mullion (102). FIG. 4 shows a side bracket (104) that connects an end of the horizontal mullion (100) to the vertical mullion (102). Screws or bolts (105) lock the horizontal mullion (100) onto the bracket (104), as shown in FIGS. 4, 5 and 20.

As shown in FIG. 2, the front portion (106) of each horizontal (100) or vertical mullion (102) comprises a substantially U-shaped front flange (110). The flange (110) comprises two parallel side portions (112) defining a front channel (114) that is opened on the front side. A hollow intermediary chamber (116) is usually present in the flange (110). A plurality of parallel inner ridges (118) is provided on each side portion (112) of the flange (110) and are used to cooperate with the threads of the fasteners, as explained hereinafter.

FIGS. 4, 5 and 20 show an example of a sleeve (122) that is inserted inside the vertical mullions (102) to link the bottom of one vertical mullion to the top of an adjacent lower one. Screws or bolts (123) are used to retain each sleeve (122) in place, usually to the upper end of the lower vertical mullion (102).

As aforesaid, the weight of each windowpane (130) rests on shims (132), which are generally small blocks made of neoprene. In the prior art, and as shown in FIGS. 18 and 19, the shims (132) rest directly on the upper surface of the flange (110) of a horizontal mullion (100). Other shims (not shown) are inserted between the windowpane (130) and the flanges (110) of the other mullions (100,102) to adjust the final position of the windowpane (130). Each windowpane (130) is then held in place by the pressure plates (134). The edges of the windowpane (130) are engaged by the interior (136) and exterior glazing gaskets (138) which are made of a resilient material to prevent harder materials from damaging the glass when the mechanical pressure is applied and to obtain an optimum positive engagement. Each glazing gasket (136,138) comprises a respective small wedge-type back strip (140,142) connected to corresponding shallow grooves (144,146) that are provided in the front portion (106) of the mullions (100,102) and the pressure plate (134), respectively. There are many possible shapes and sizes for the glazing gaskets (136,138). As apparent to a person skilled in the art, the width of the windowpane (130) and the models of the glazing gaskets (136,138) are chosen to match the width of the flange (110) so that an optimum retaining pressure is reached. Screws or bolts (148) are inserted in the front channel (114) of the flange (110) and tightened. These screws or bolts (148) are tapping the inner ridges (118) of the flange (110). Holes are already made through each pressure plate (134) to accommodate them.

A cover (150) is removably interlocked onto each pressure plate (134) to hide the heads of the screws or bolts (148), thereby enhancing the esthetical appearance of the curtain wall. Weep holes (152) are provided in the pressure plate (134). Others (not shown) are provided at the bottom of each horizontal cover (150).

The thermal barrier

FIG. 1 is an enlarged end view of a thermal barrier (10) according to a first and preferred embodiment of the present invention. This embodiment is also shown in
5 FIGS. 2 to 5. Many other alternative embodiments are possible. Some are shown in FIGS. 6 to 17.

The thermal barrier (10) comprises a front section (12) and two elongated side sections (14) transversally projecting from opposite edges of a front section (12).
10 The front section (12) and side sections (14) define a flange-receiving housing (16) that is to be inserted onto the flange (110) of the horizontal (100) or vertical mullions (102). At least one side section (14) is in a positive engagement with the front portion (106) of the corresponding mullion (100,102) when the thermal barrier (10) is installed on its flange (110). The positive engagement means that the rear
15 edge of the side section or sections (14) is pressed against the surface of the front portion (106).

The thermal barrier (10) is preferably always symmetrical with reference to a median plane (18) thereof so that both side sections (14) are in positive
20 engagement with the front portion (106) of the mullion (100,102). It prevents the installer from having to look for the right orientation of the thermal barrier (10). In particular, at least the bottom of each individual subsection of the curtain wall has to be sealed from the adjacent subsections because water, if present, would accumulate at that location under the effect of gravity.

25

Preferably, each side section (14) comprises a substantially flat wall (20) and at least two supporting legs (22) projecting under the wall (20) to keep it in a spaced relationship with the flange (110) when the thermal barrier (10) is installed thereon. These legs (22) are generally L-shaped or T-shaped. As shown in FIGS. 3, 9, 11
30 and 13, they are substantially aligned with the center of a respective glazing of a

windowpane (130). Of course, these legs (22) are strong enough to support the weight of the windowpane (130) when used on a horizontal mullion (100).

In some embodiments, the front section (12) is divided in two parts, both linked
5 together by an elongated and opened V-shaped section (24) projecting rearwards
in the housing (16). This V-shaped section (24) is to be set in the front channel
(114) of the flange (110). The V-shaped section (24) is sized and shaped to
receive the screws or bolts (148). It is thus wide enough to accommodate each
10 screw or bolt (148). However, when a screw or bolt (148) is inserted, its threads
shape corresponding inner threads inside the material. It simultaneously pushes
the material against the inner ridges (118), thereby ensuring a solid anchoring of
the pressure plate (134).

Preferably, the positive engagement with the front portion (106) is also a sealing
15 engagement, for instance achieved by an elongated flexible strip (26) made of a
material that is more flexible than the other parts of the side section (14). It may be
integrated within the material of the thermal barrier (10), as apparent to a person
skilled in the art. In other embodiments, such as in FIGS. 6, 7, 10 and 11, a small
amount of caulking is added to seal the junction between the rear edge and the
20 front portion (106) of the mullion (100,102). In FIGS. 12 and 13, the flexible strip
(26) is replaced by an orthogonally projecting flange (27). A small amount of
caulking may also be added to complete the sealing. If all the individual thermal
barriers (10) are symmetrical, the entire periphery of the subsection will be sealed.

25 As best shown in FIG. 1, each part of the front section (12) may comprise a hollow
chamber (28). Moreover, a front edge of each part of the front section (12) may
further comprise a small flexible strip (30) projecting therefrom to allow an
optimum sealing engagement between the thermal barrier (10) and the pressure
plate (134).

Preferably, the wall (20) of each side section (14) defines a mild closing angle of a few degrees with reference to the median plane (18). This facilitates the installation of the thermal barrier (10) since it will better hold in place before the pressure plate (134) is set thereon.

5

The thermal barrier (10) is preferably made of an extruded polymeric material, such as polyvinyl chloride (PVC). This material is advantageous since it is easily extruded with portions of different flexibility.

10 Installation of the thermal barrier

As shown in FIGS. 4 and 5, a horizontally-disposed thermal barrier (10), made according to the present invention, is directly engaged on the side of a vertically-disposed thermal barrier (10). More particularly, it is preferably engaged against
15 the facing ends of two successive vertically-disposed thermal barriers (10) to cover the space between them. This space is present to compensate for the thermal dilatation of the vertical mullions (102). It is not in registry with the expansion joint (120) between the vertical mullions (102) themselves since this would create a direct opening between adjacent subsections of the curtain wall. Instead, an upper
20 small portion of one thermal barrier (10) overlaps the expansion joint (120) and a small length of the upper vertical mullion (102). FIG. 5 shows how intersecting thermal barriers (10) should be disposed. Referring back to FIG. 4, one may see that the glazing gaskets (136) are also overlapping the expansion joint (120) and a short portion of the upper vertical mullion (102). Small amounts of caulking are
25 provided to seal the small opening (154) created by the expansion joint (120) between two vertical mullions (102). Each small opening (154) is located between the corresponding sleeve (122) and rear of the corresponding thermal barrier (10) that overlaps the expansion joint (120).

As aforesaid, alternative embodiments of the thermal barrier (10) are shown in FIGS. 6 to 17. In FIGS. 6 and 7, the thermal barrier (10) has only the very minimal elements, namely the front section (12) and side sections (14) that engage the front portion (106).

5

In FIGS. 8 and 9, the thermal barrier (10) is similar to the one shown in FIG.1, but is not provided with a V-shaped section.

10

In FIGS. 10 and 11, the thermal barrier (10) comprises a wedge-shaped front section (12).

In FIGS. 12 and 13, the thermal barrier (10) is similar to the one shown in FIG.1, but is provided with orthogonally projecting flanges (27).

15

In FIGS. 14 and 15, the thermal barrier (10) does not comprise legs or the like to keep the side wall in a spaced relationship with reference to the flange (110).

20

In FIGS. 16 and 17, the thermal barrier (10) is installed over another model of the flange (110).

25

Although preferred embodiments of the invention have been described in detail herein and illustrated in the accompanying drawings, it is to be understood that the invention is not limited to these precise embodiments and that various changes and modifications may be effected therein without departing from the scope or spirit of the present invention. For instance, many other embodiments may be devised with the design principles set forth in the present description and in the claims. Materials used for the thermal barrier may be different than those described herein. Yet, the thermal barrier may be modified if the standard shape of the framework of a curtain wall changes.

WHAT IS CLAIMED IS:

1. A thermal barrier for use on a U-shaped flange projecting out from a front wall of a mullion in a curtain wall, the thermal barrier comprising:

- 5 - a front section;
 - two substantially flat side walls transversally projecting from opposite edges of the front section and defining a flange-receiving housing therewith, a rear edge of at least one side wall being in a positive engagement with the front wall of the mullion when the thermal barrier is installed over its flange.

10

2. A thermal barrier according to claim 1, wherein each side wall has an outside face and an inside face and at least two support legs projecting from the inside face to keep the wall in a spaced relationship with the flange when the thermal barrier is installed thereon.

15

3. A thermal barrier according to claim 2, wherein each side wall defines a mild closing angle with reference to the median plane.

20

4. A thermal barrier according to claim 1, 2 or 3, wherein the front section is divided in two parts, both linked together by a front-opened V-shaped section projecting rearwards in the housing, the V-shaped section being set in a front channel of the flange of the mullion when the thermal barrier is installed thereon.

5. A thermal barrier according to claim 4, wherein each part of the front section comprises a hollow chamber.

6. A thermal barrier according to claim 4 or 5, wherein a front edge of each part of
5 the front section comprises a flexible strip projecting therefrom.

7. A thermal barrier according to claim 4, 5 or 6, wherein the front section, the V-shaped section and the side walls are symmetrically disposed about a median plane.

10 8. A thermal barrier according to anyone of claims 1 to 7, wherein the rear edge of the at least one side wall is in a sealing engagement with the front wall of the mullion, when the thermal barrier is installed on the flange thereof.

9. A thermal barrier according to claim 8, wherein the rear edge comprises a flexible
15 strip.

10. A thermal barrier according to anyone of claims 1 to 9, wherein the thermal barrier is made of an extruded polymeric material.

20 11. A thermal barrier according to claim 10, wherein the polymeric material is polyvinyl chloride.

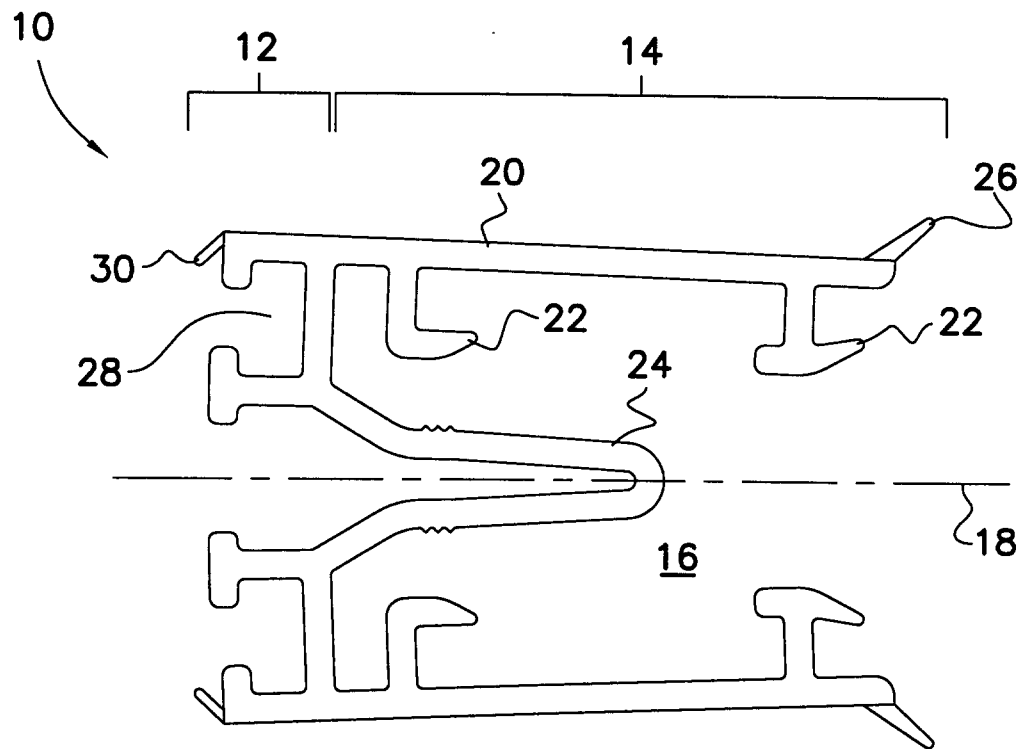


FIG.1

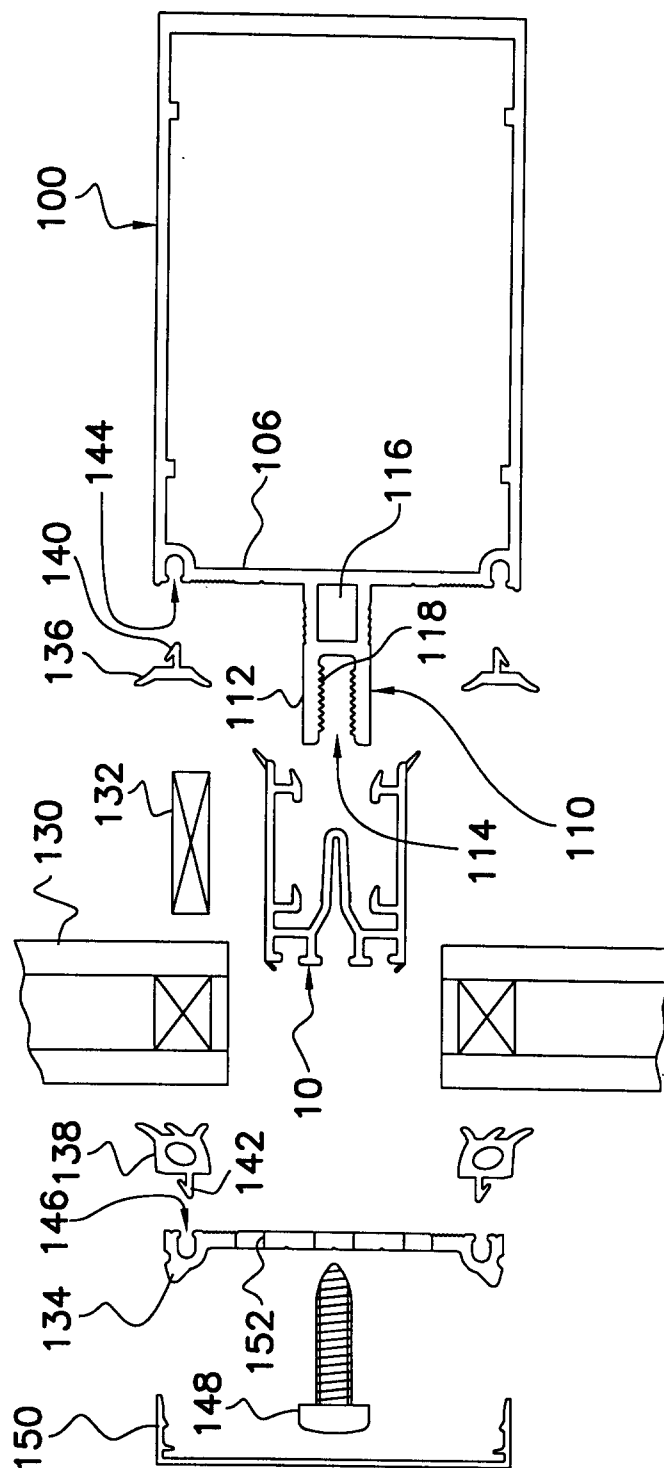


FIG. 2

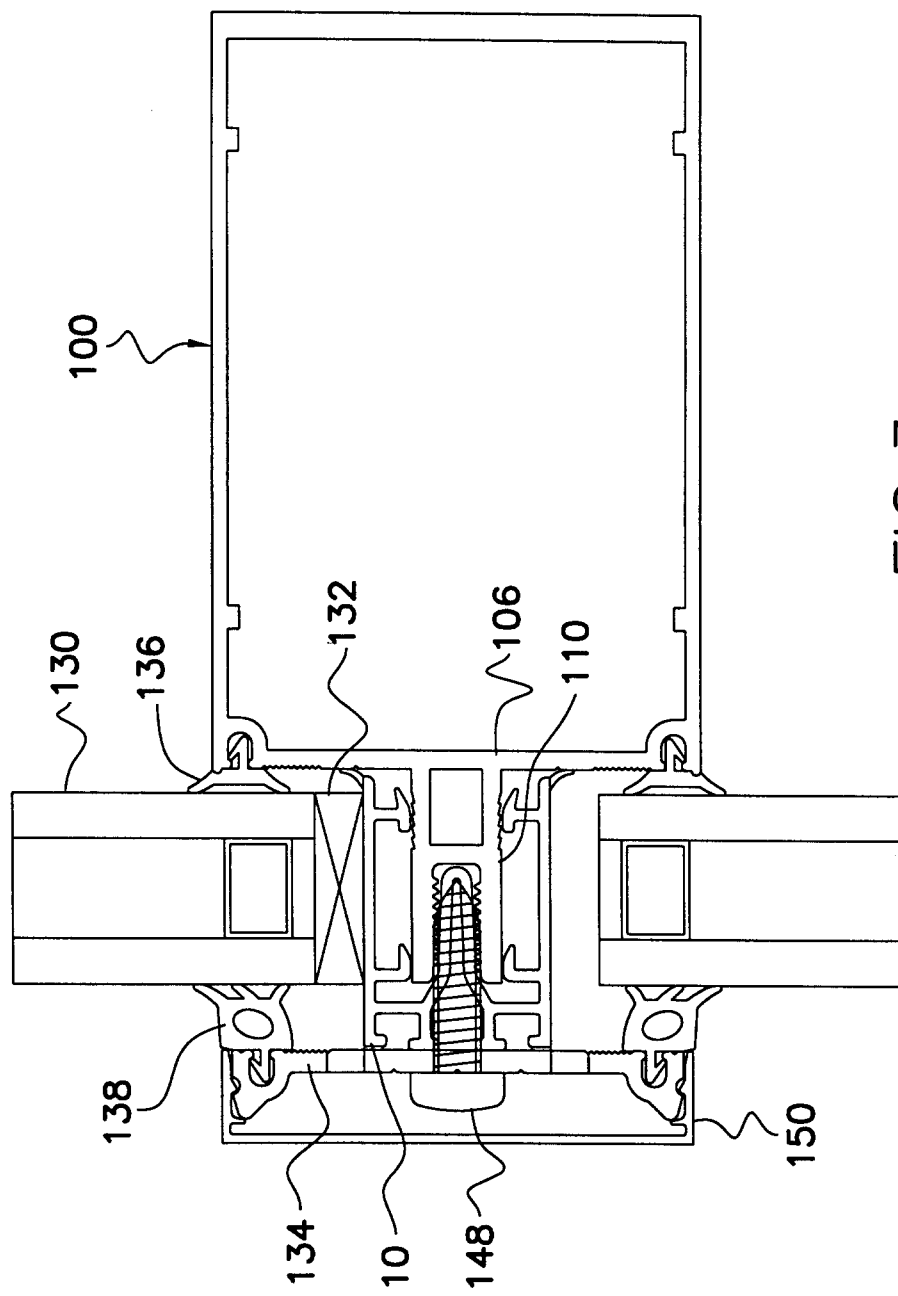


FIG.3

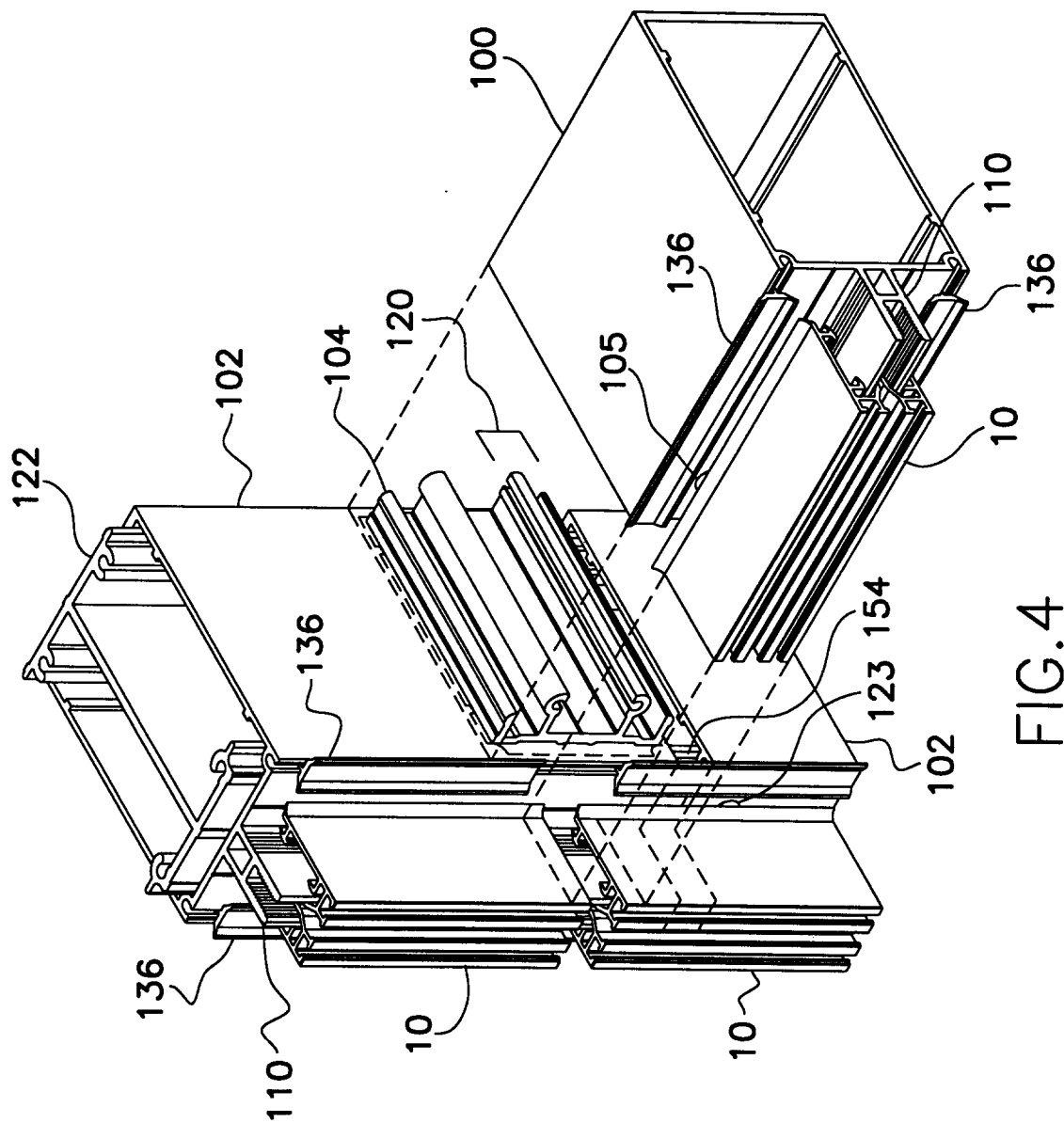


FIG. 4

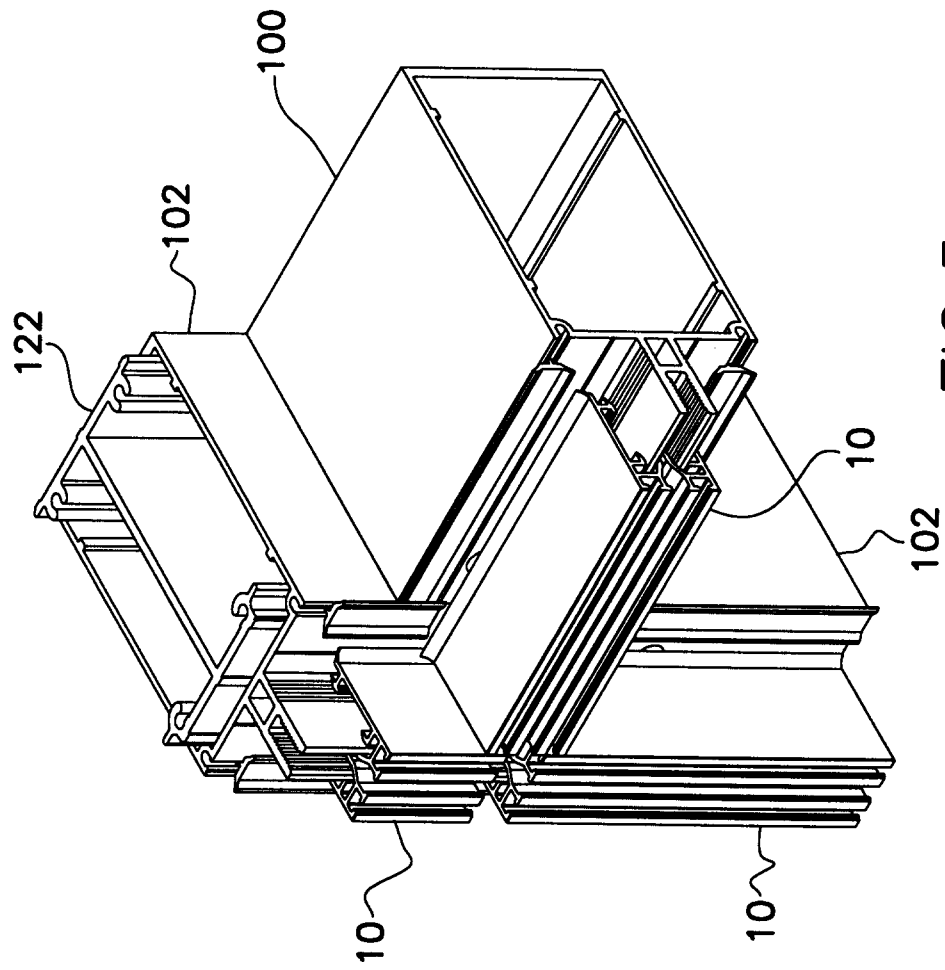


FIG. 5

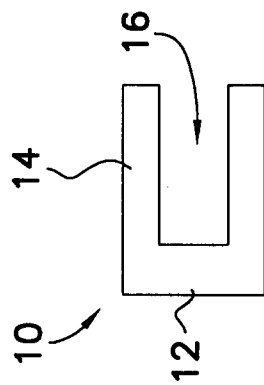


FIG. 6

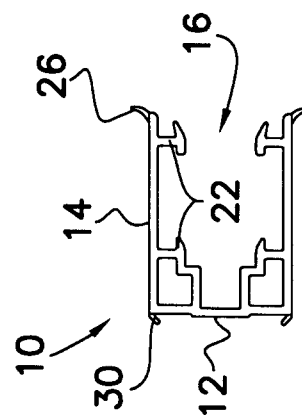


FIG. 8

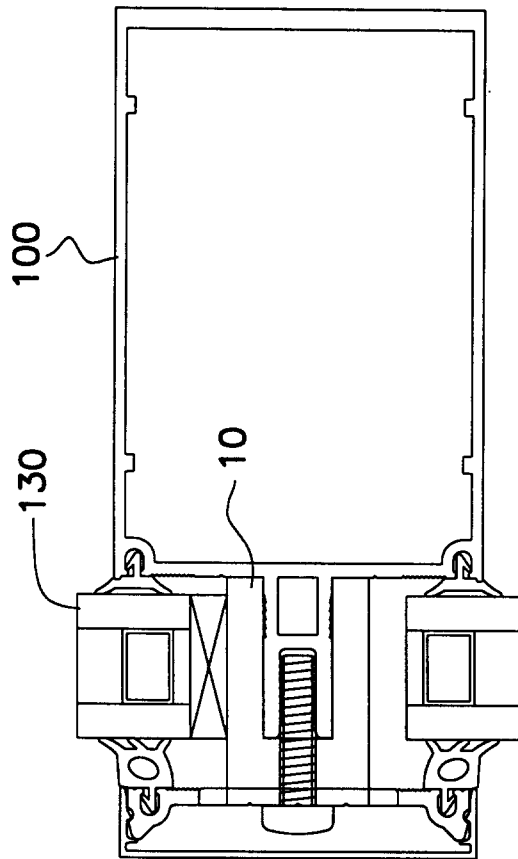


FIG. 7

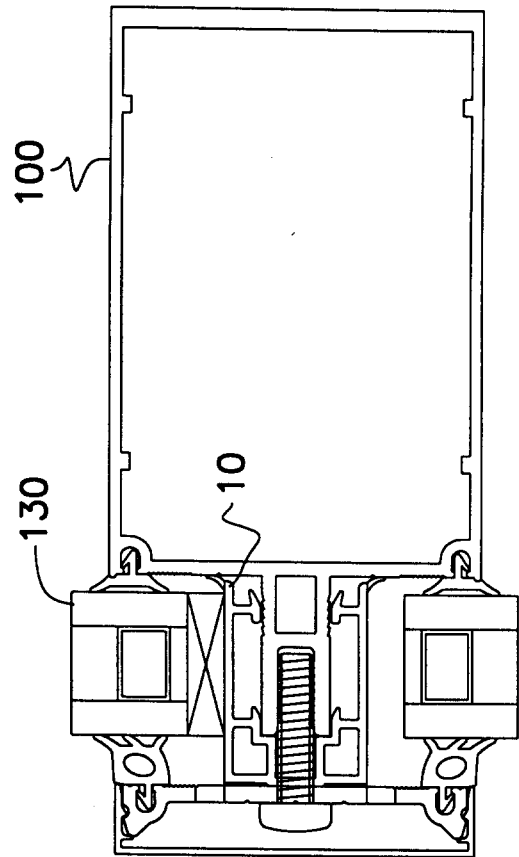


FIG. 9

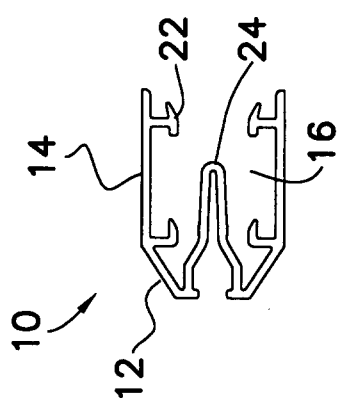


FIG. 10

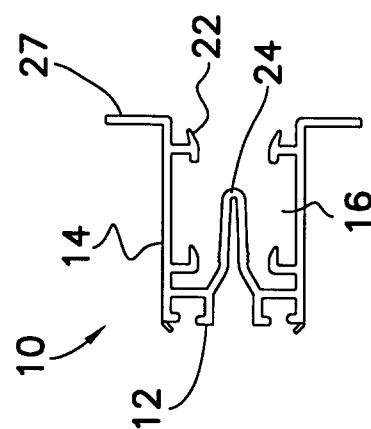


FIG. 12

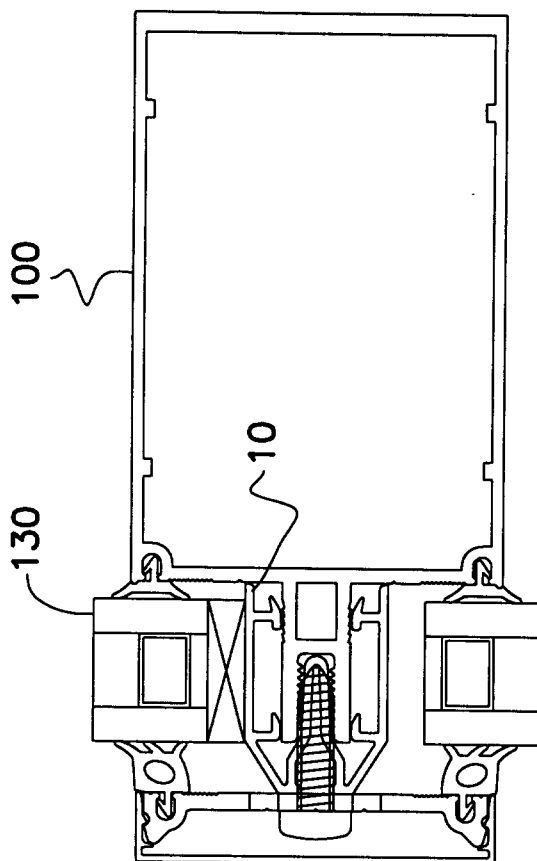


FIG. 11

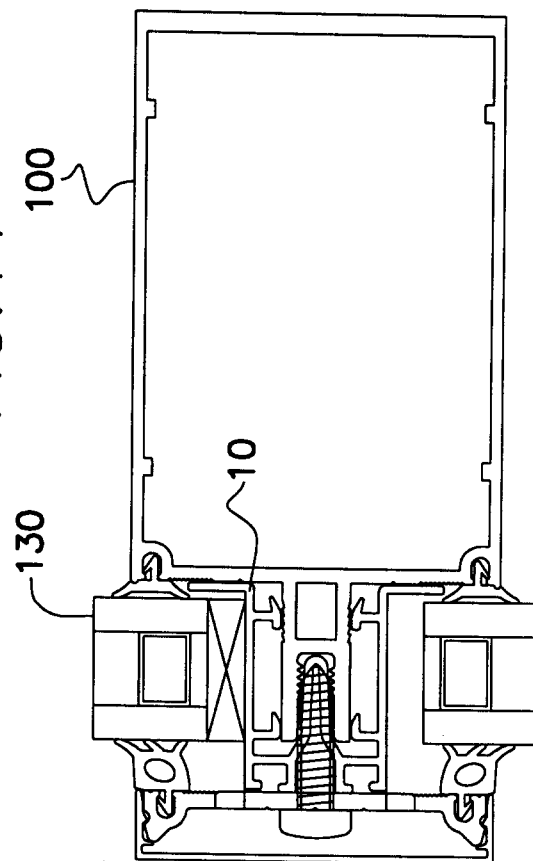


FIG. 13

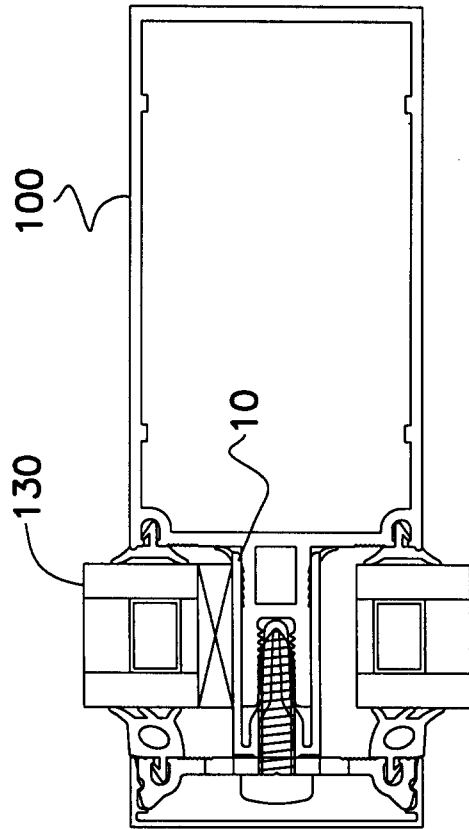


FIG. 15

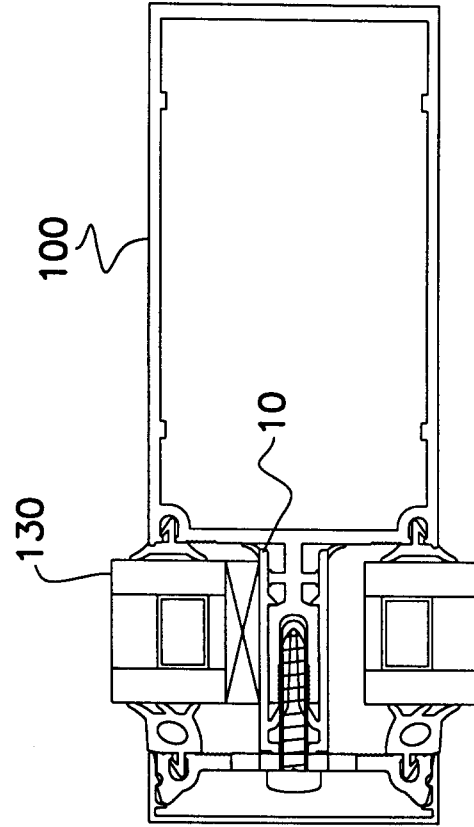


FIG. 17

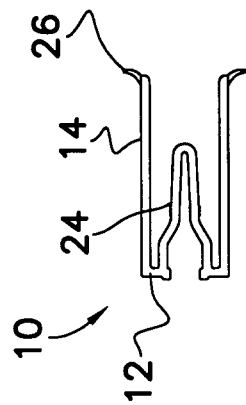


FIG. 14

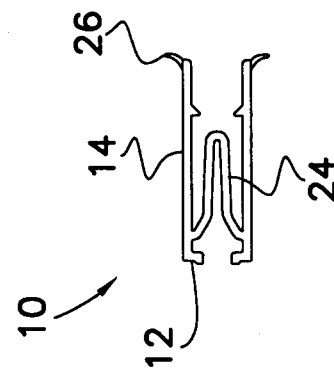


FIG. 16

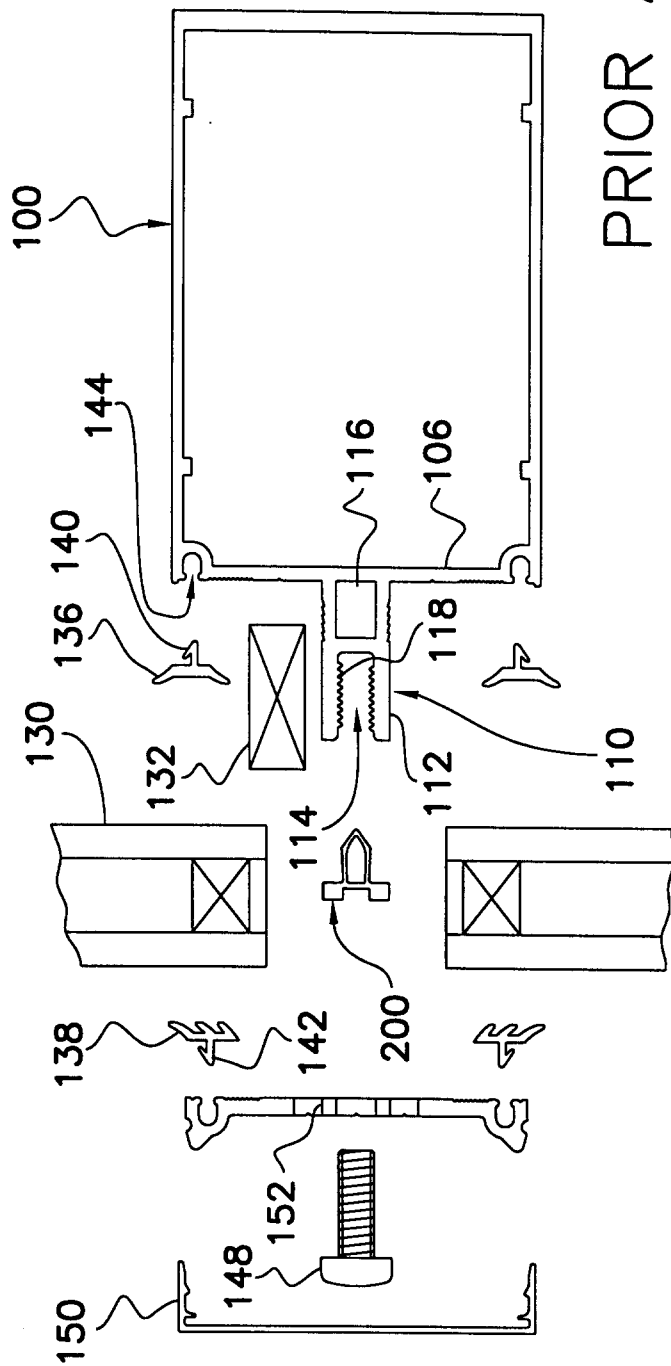
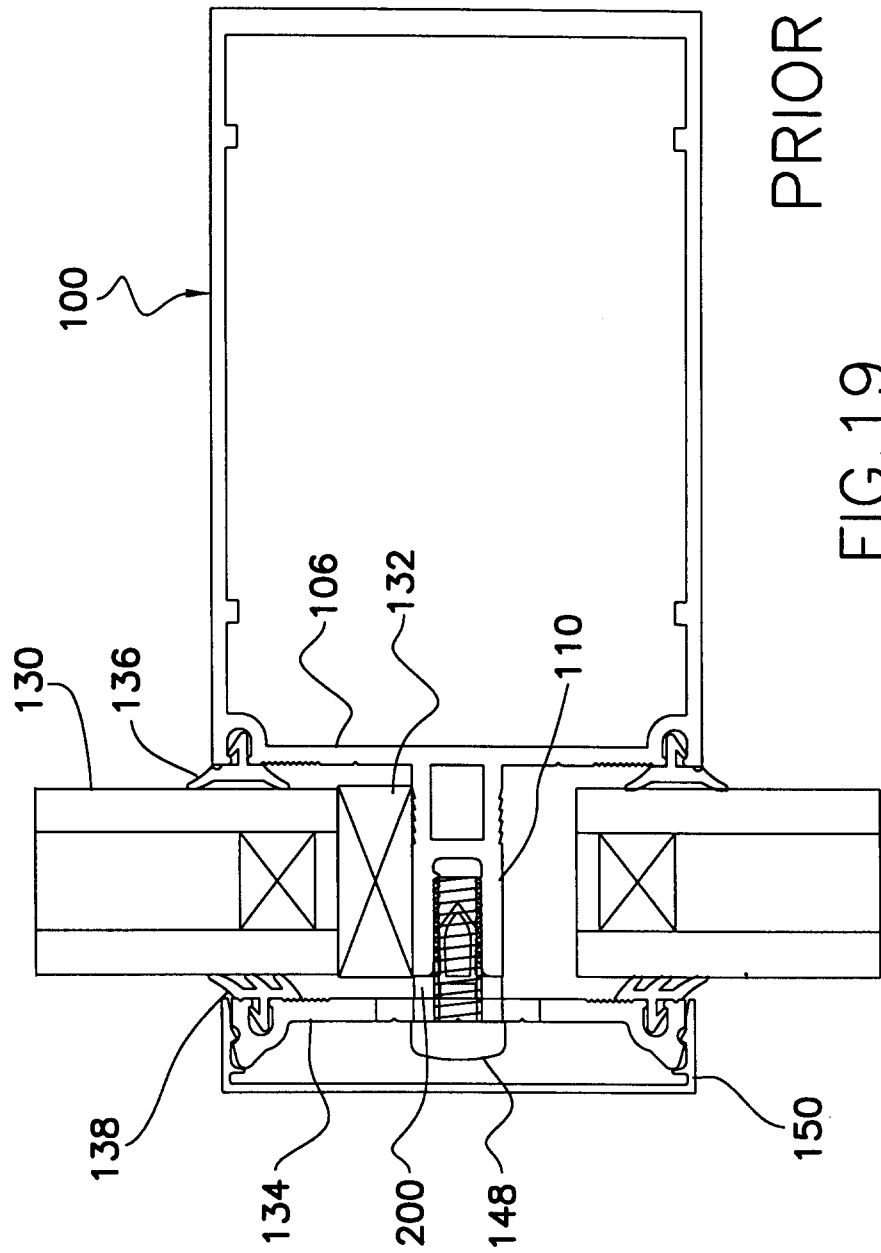


FIG. 18

PRIOR ART



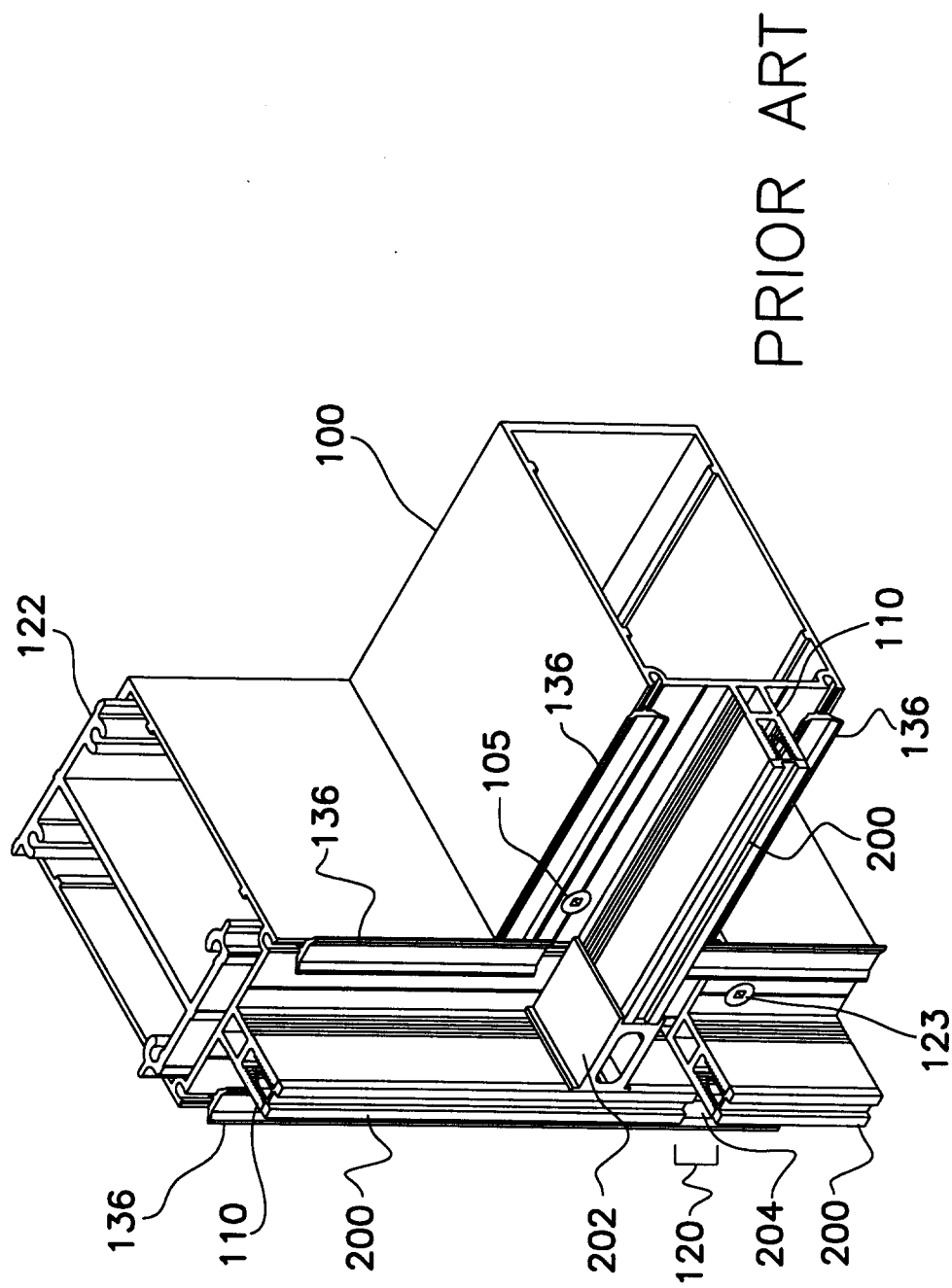


FIG. 20

