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(54) CORRUGATED SHEAR PANEL AND ANCHOR INTERCONNECT SYSTEM

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Related U.S. Application Data

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(60) Provisional application No. 60/215,290, filed on Jun. 30, 2000.

Publication Classification

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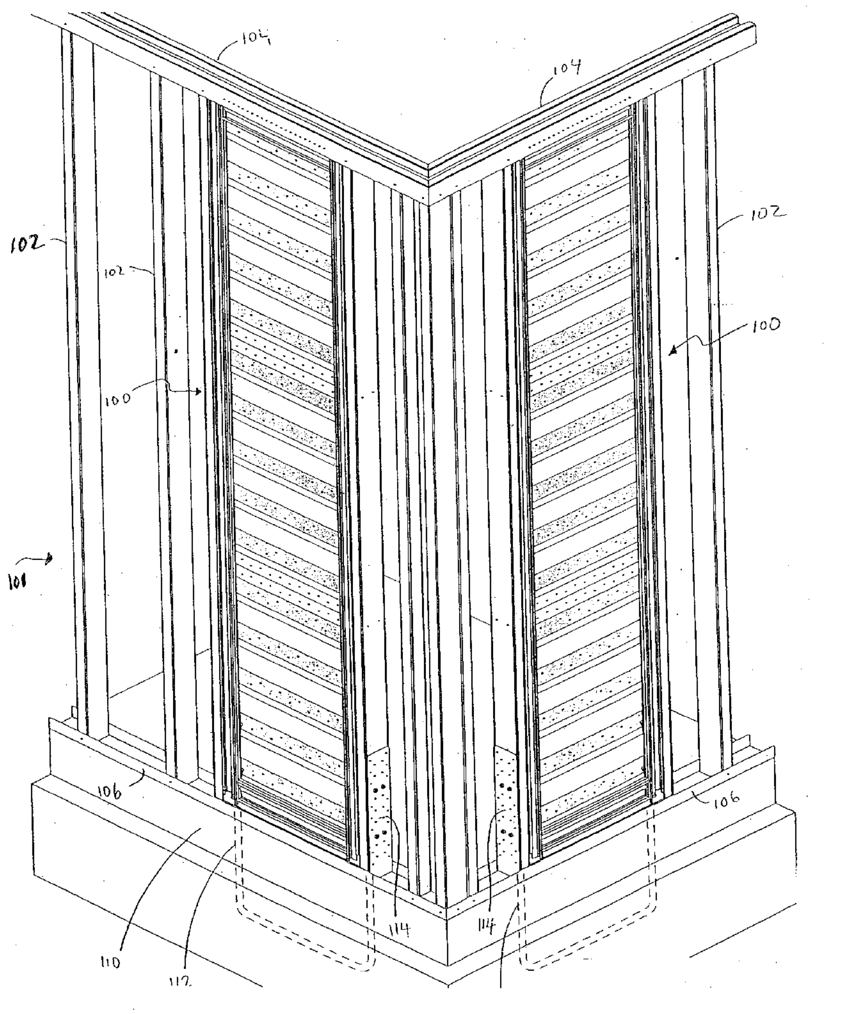
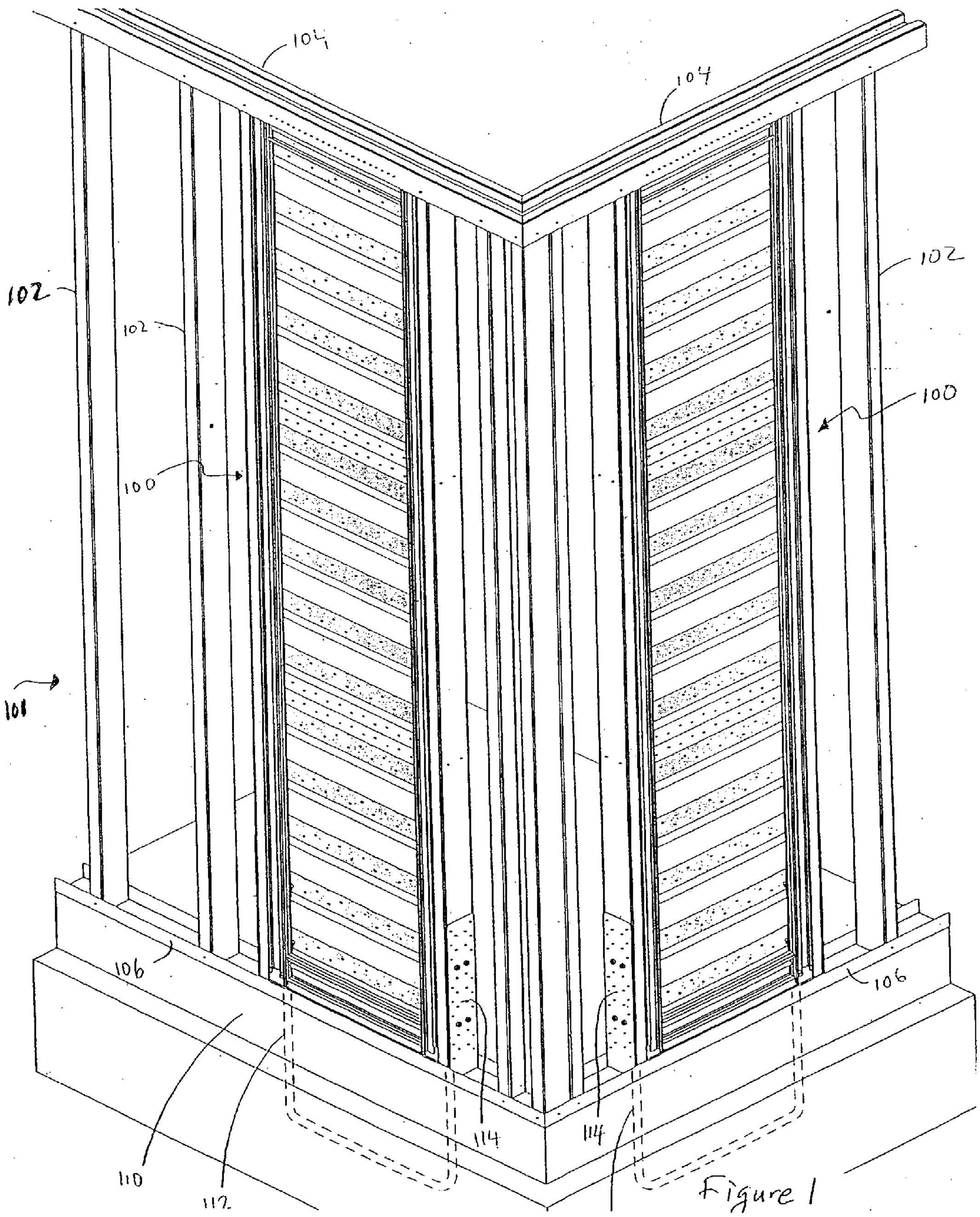
(57) ABSTRACT

A system for inhibiting unwanted movement between a building and an underlying foundation, the system including at least one shear panel assembly including corrugated portions and configured to resist bending and twisting distortion and at least one hold-down assembly configured to attach to the at least one shear panel assembly and to attach to at least one anchor member rigidly engaged with an underlying building foundation so as to resist uplift, downward movement, and lateral movement of the at least one attached shear panel assembly, the at least one hold-down assembly configured to provide a range of vertical attachment adjustment to accommodate a range of extended length of the at least one anchor member.





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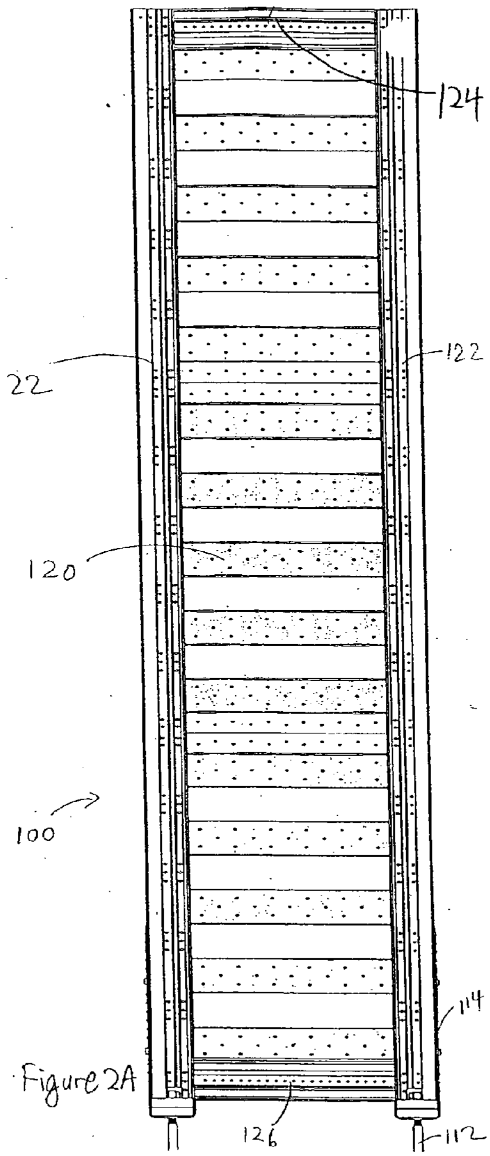

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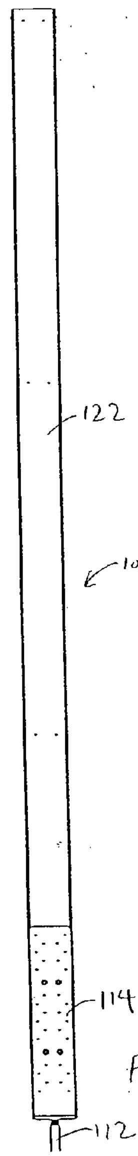

Figure 2B

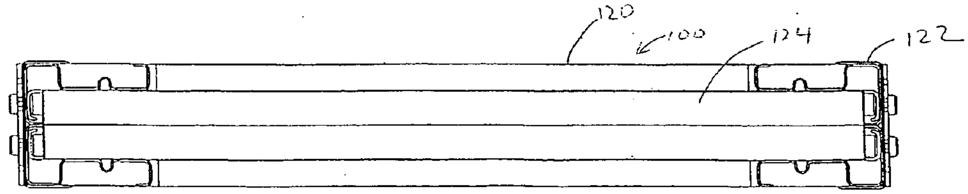

Figure 2C

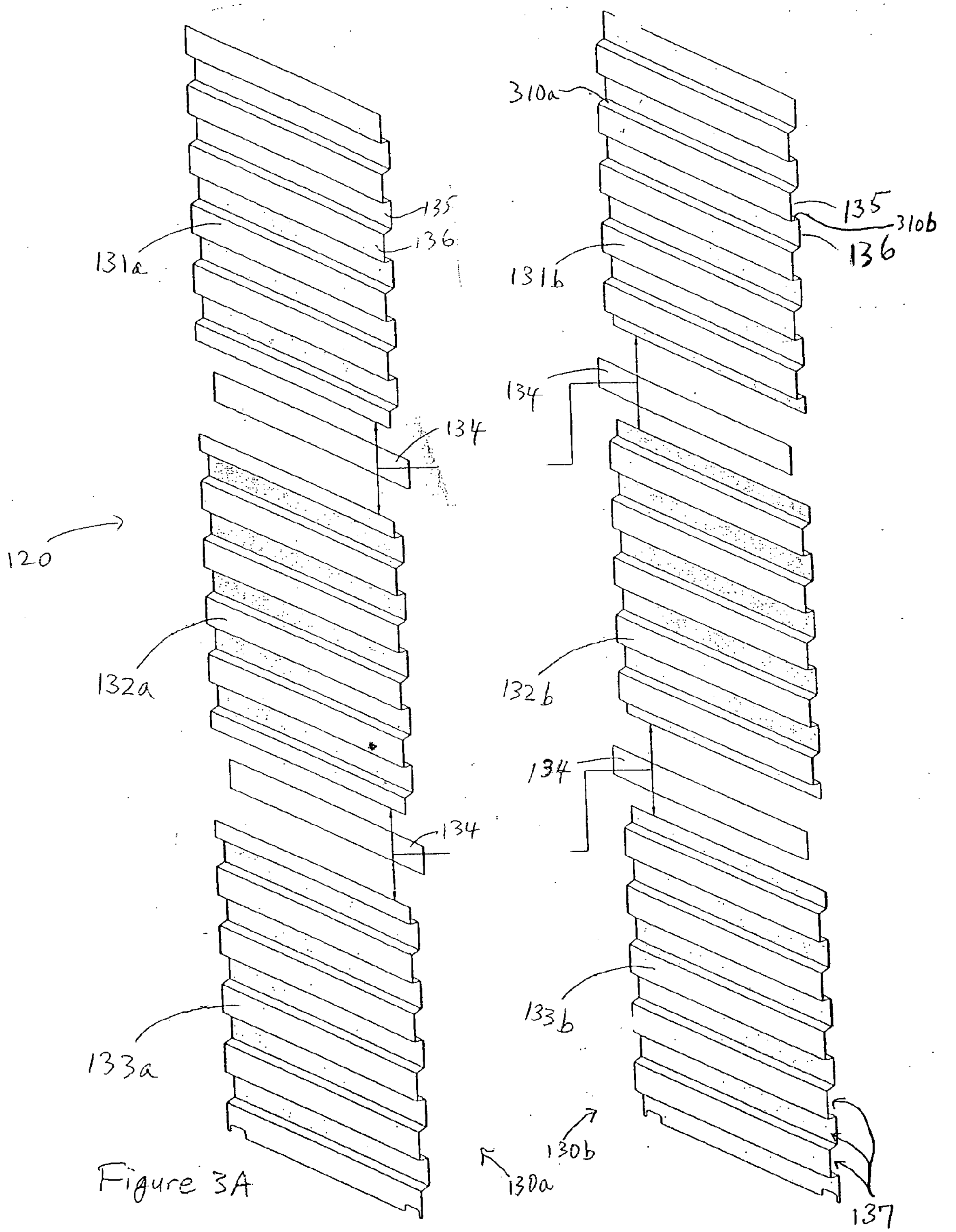

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Figure 3A

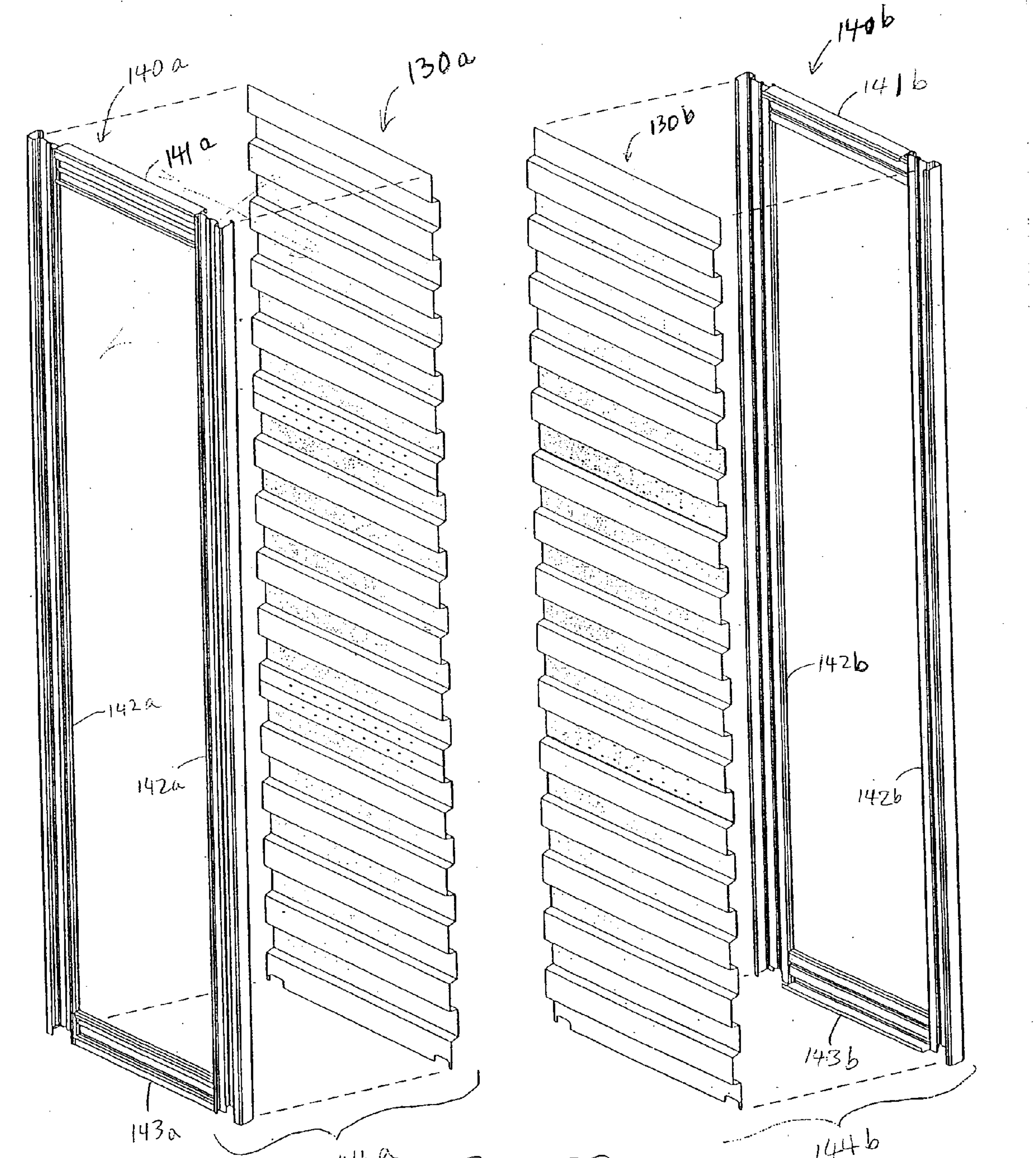
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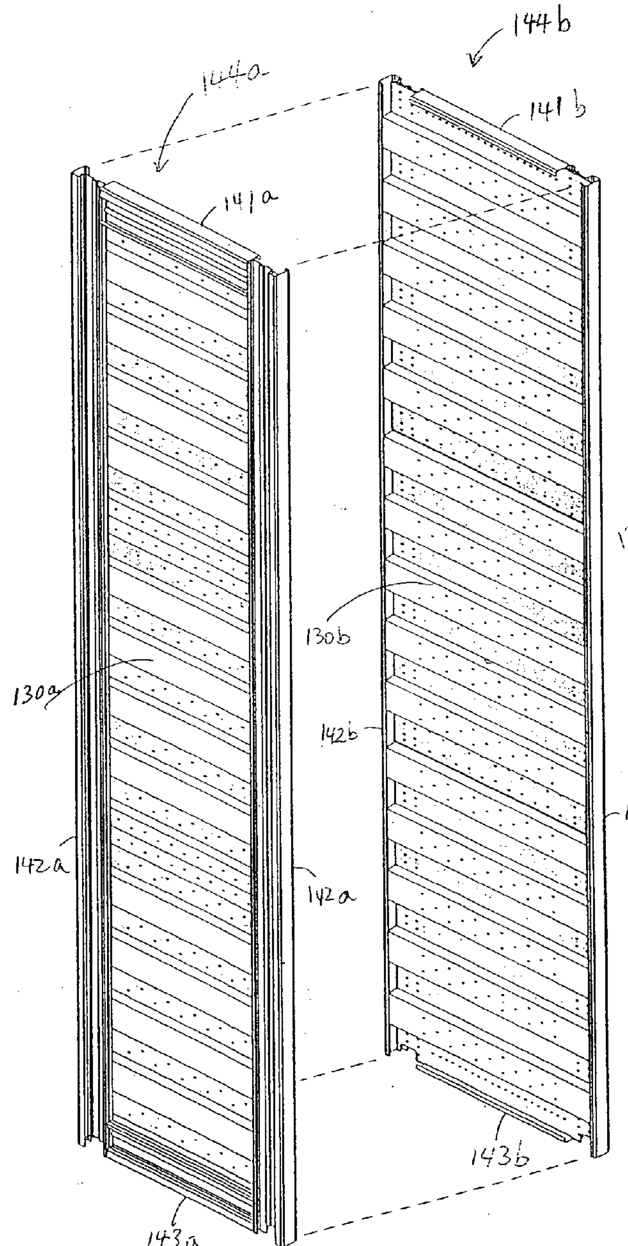
Figure 3B



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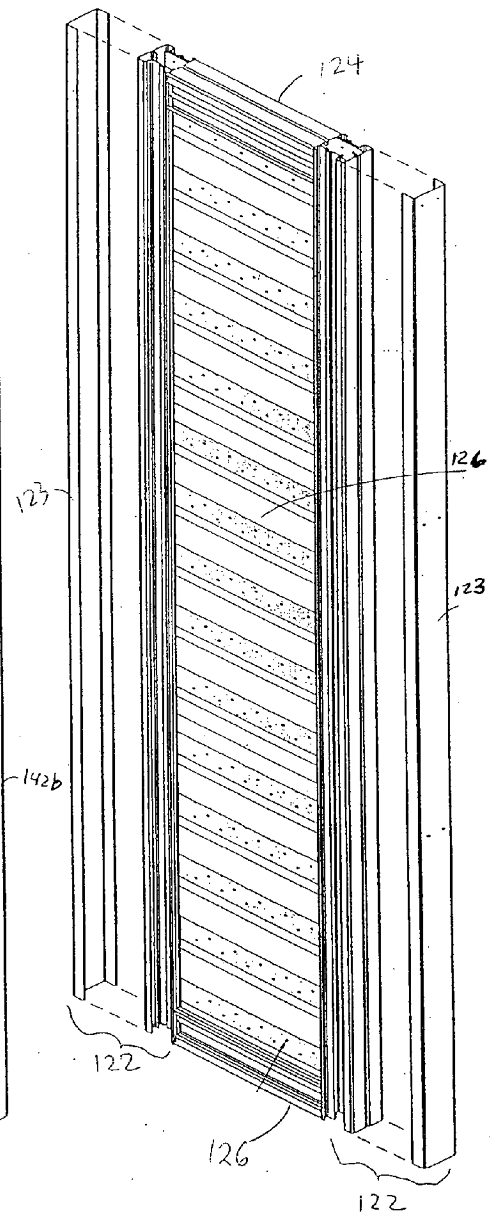

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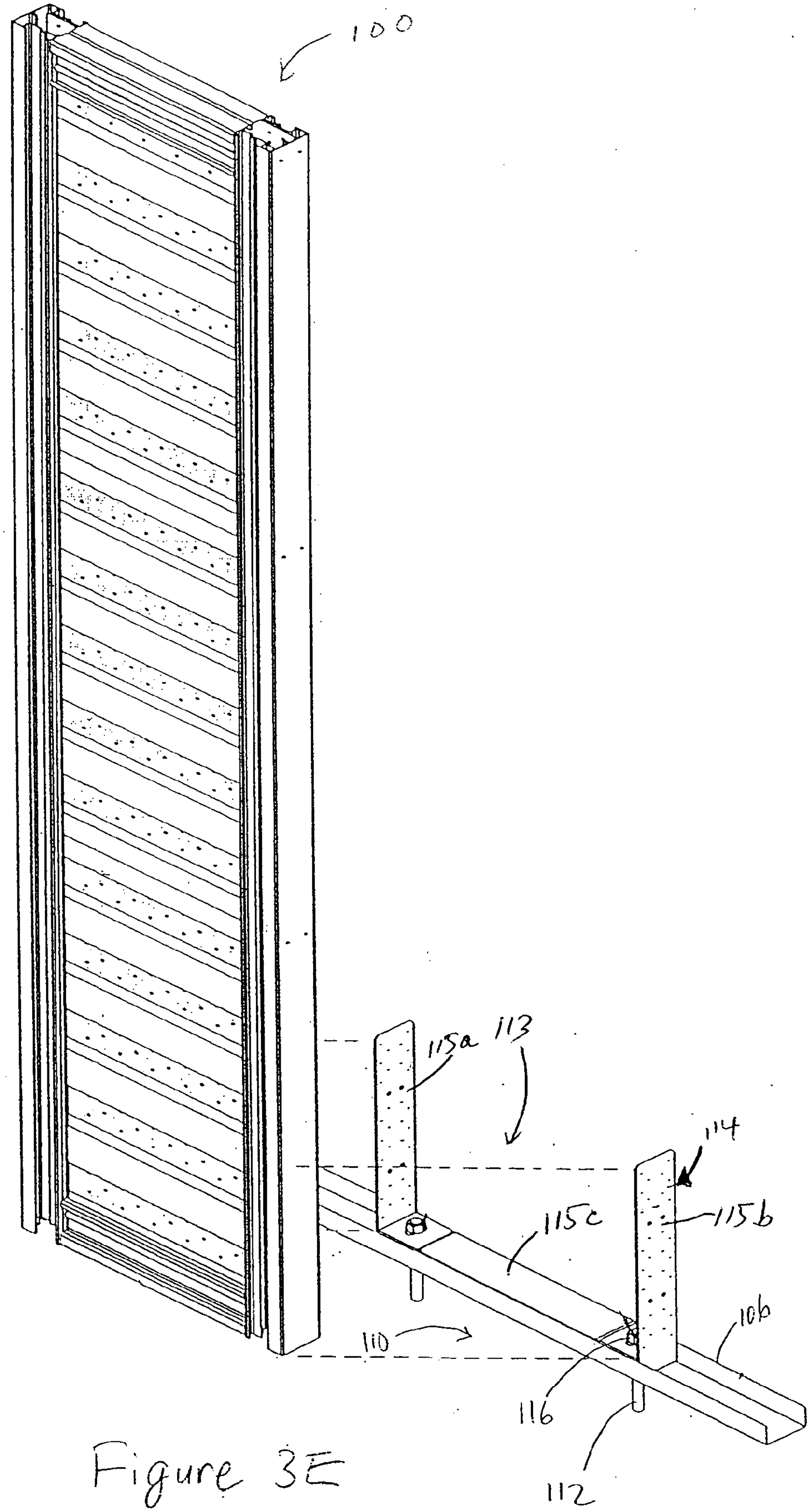

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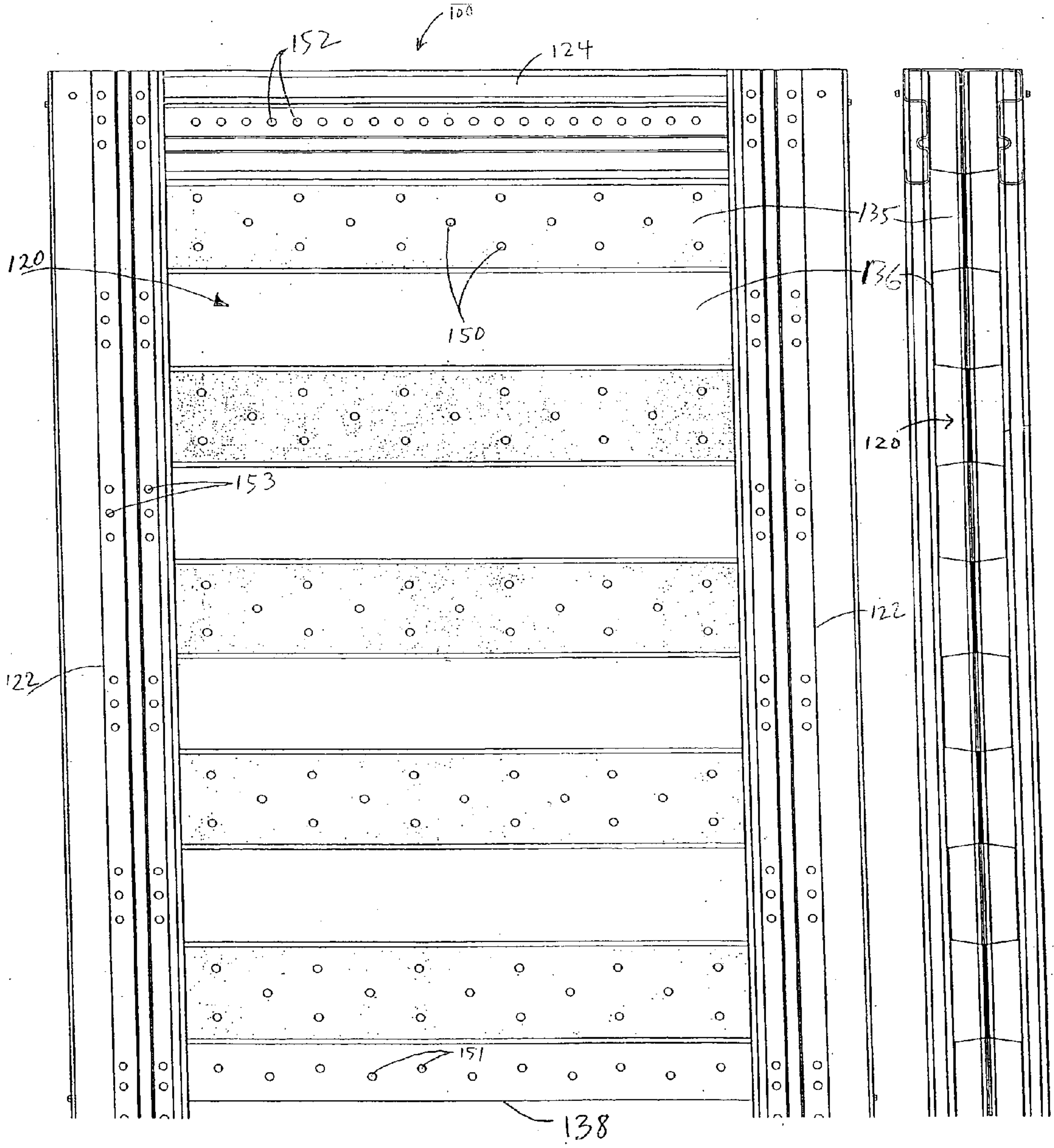

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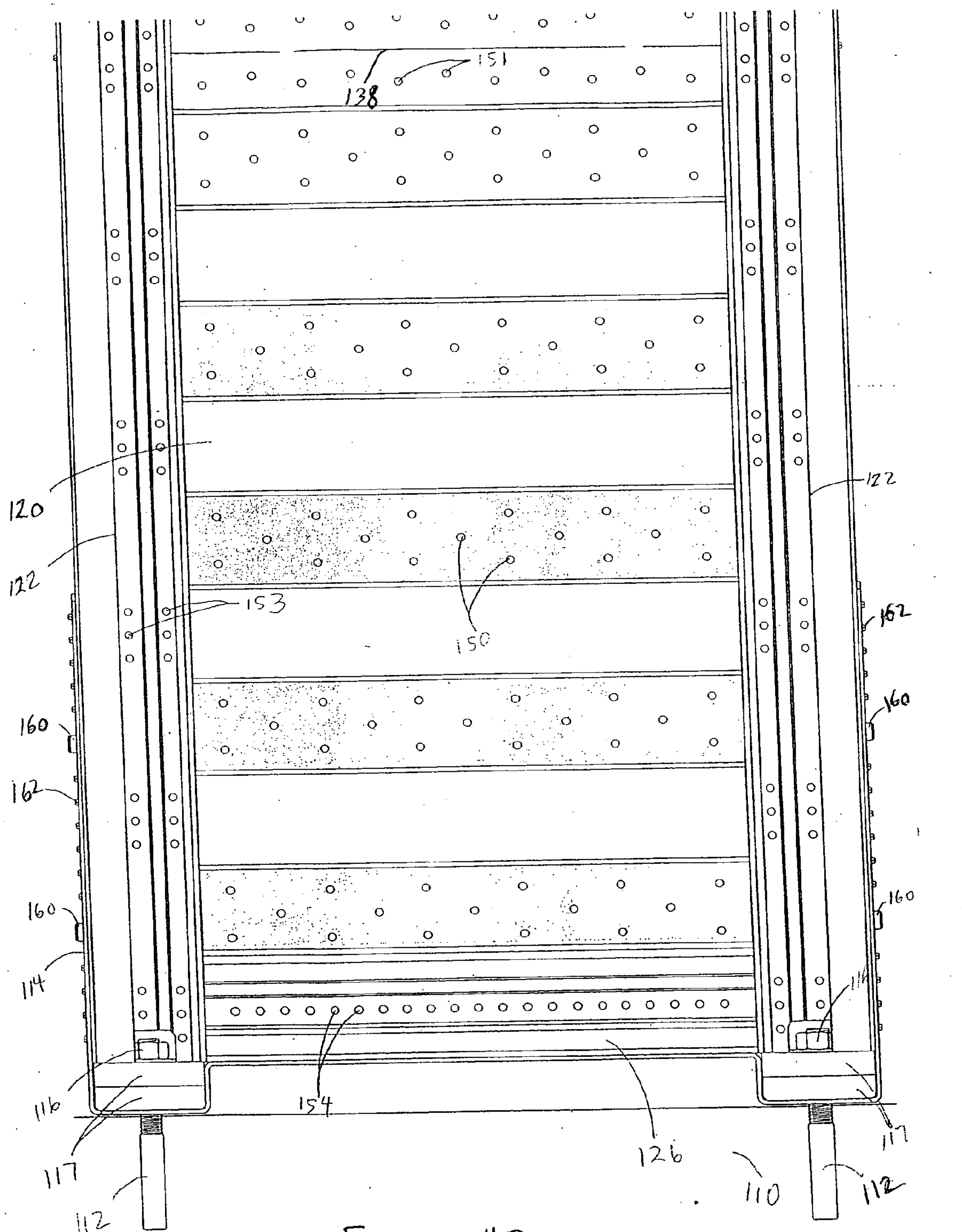
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Figure 4B

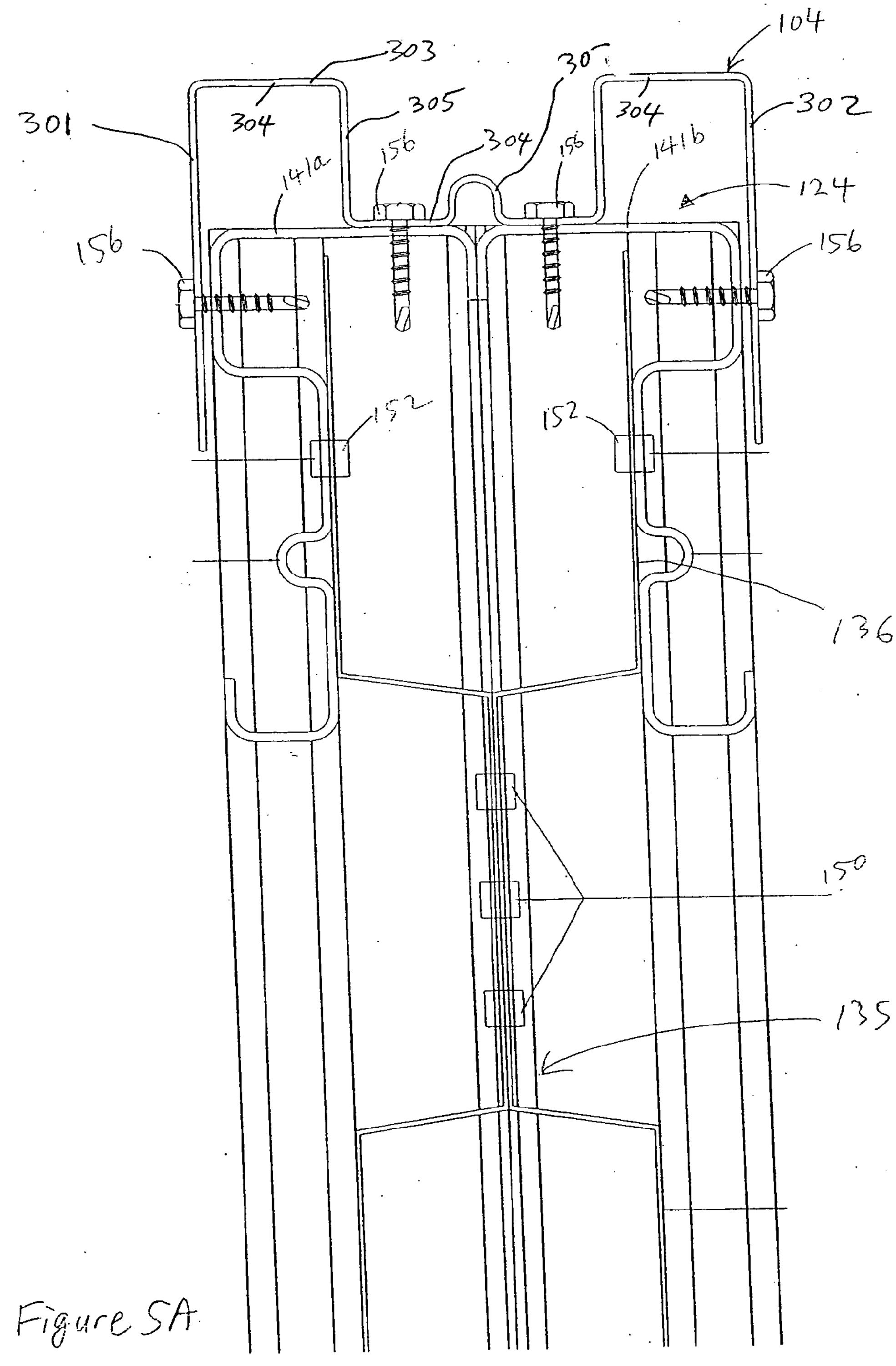
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Figure 5A

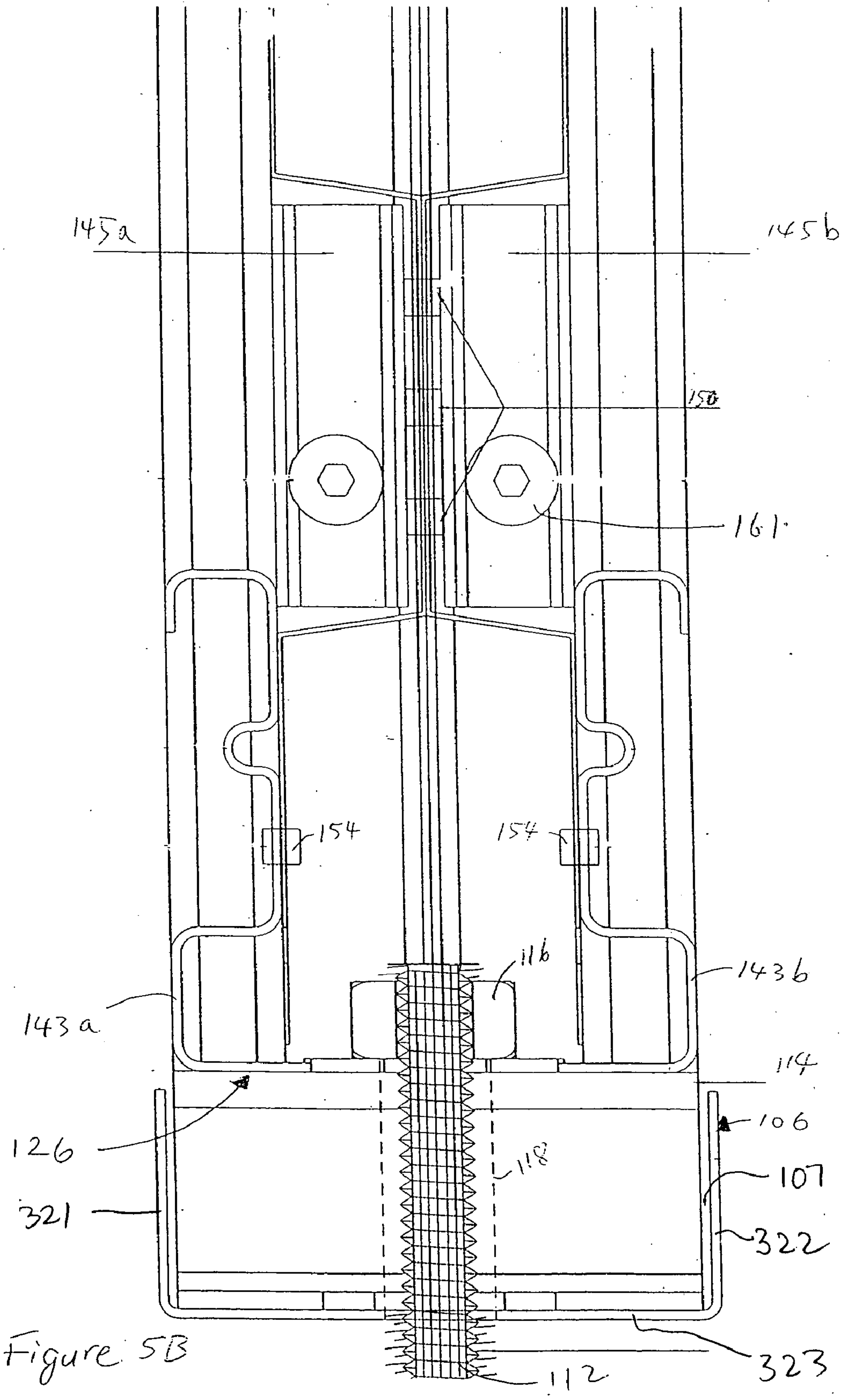
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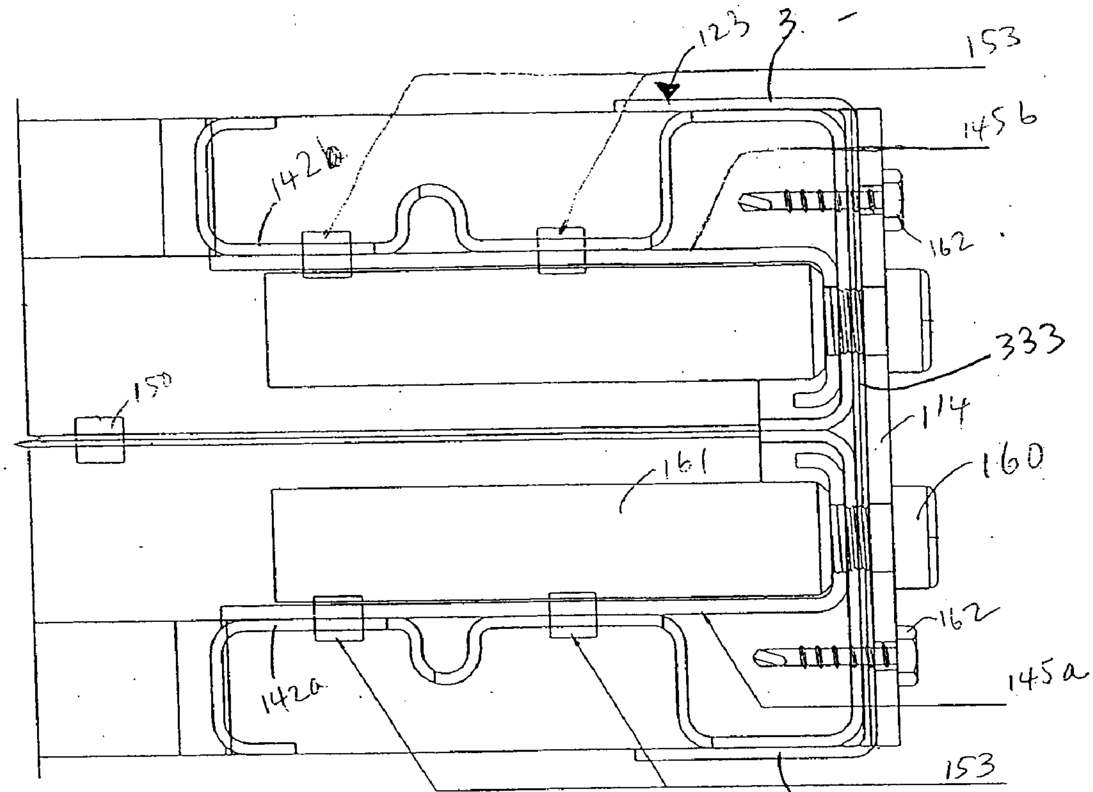
Figure 5B



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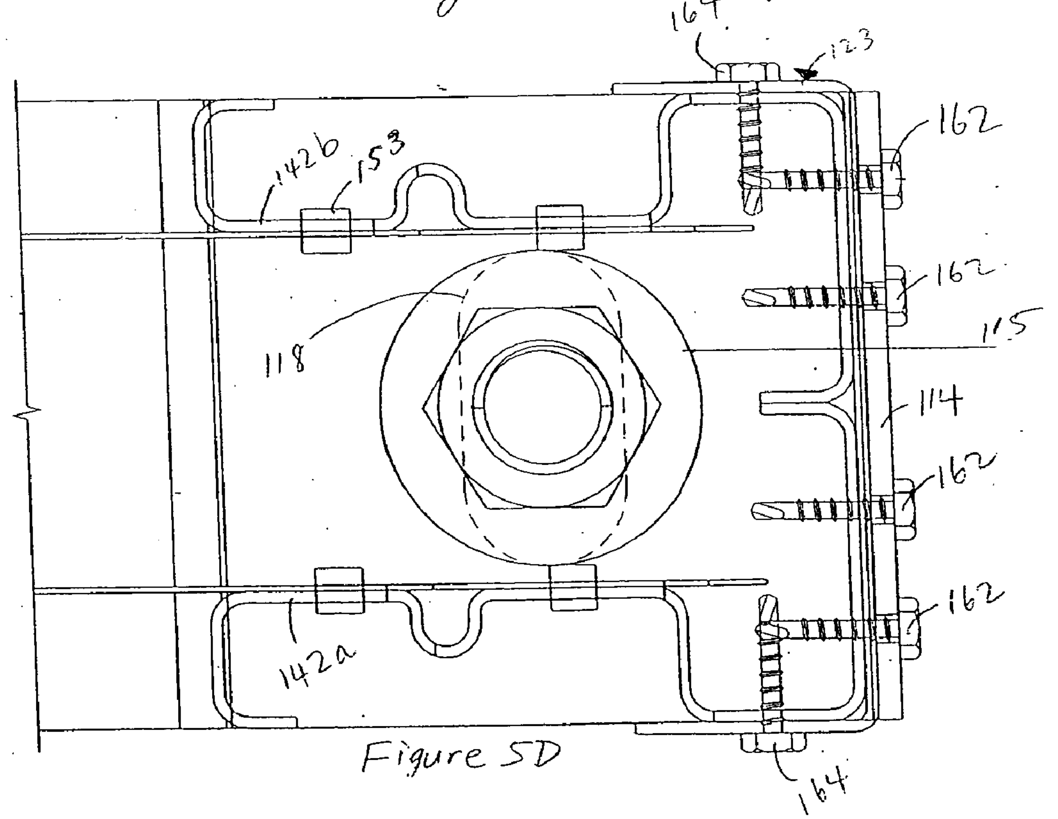

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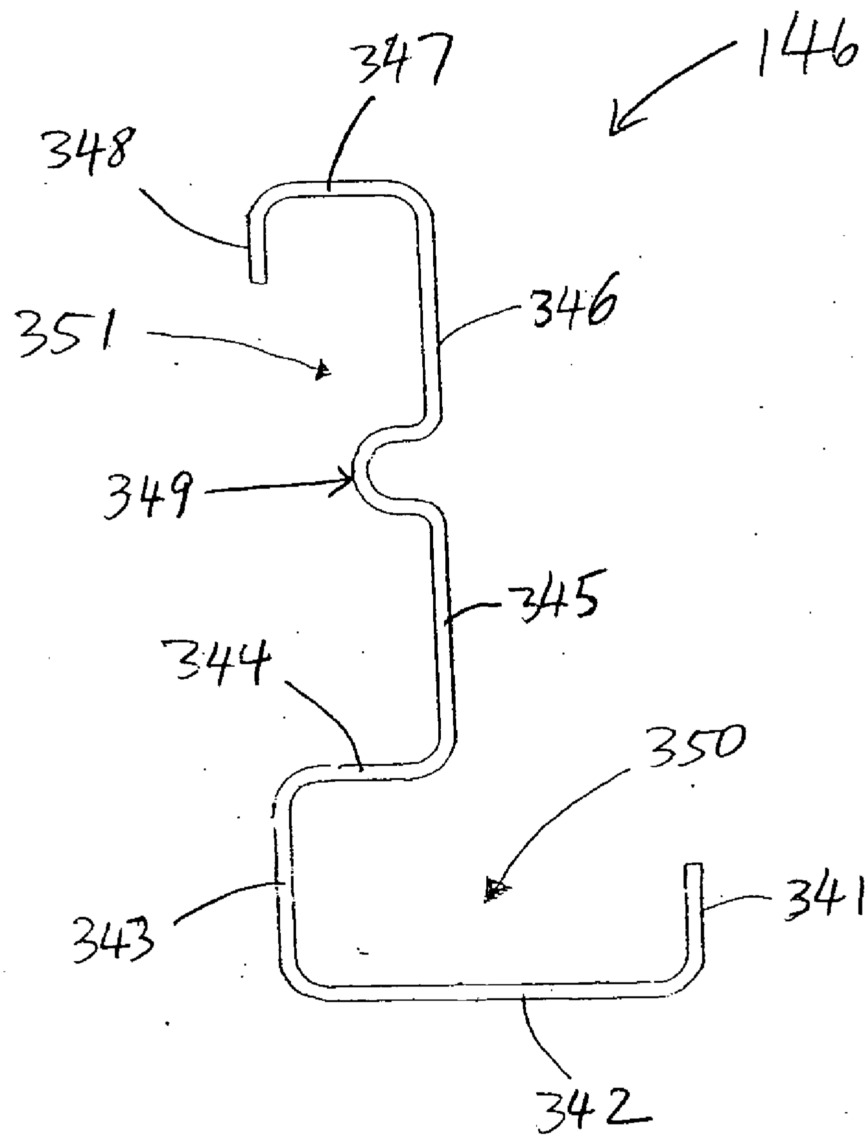

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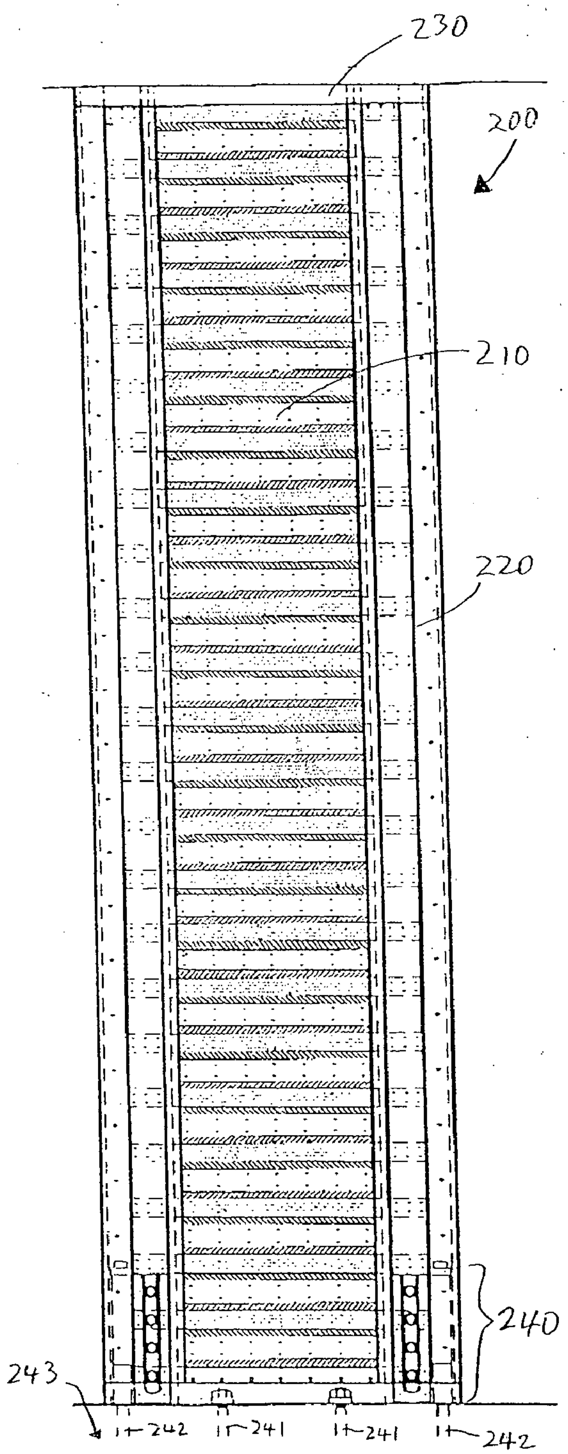

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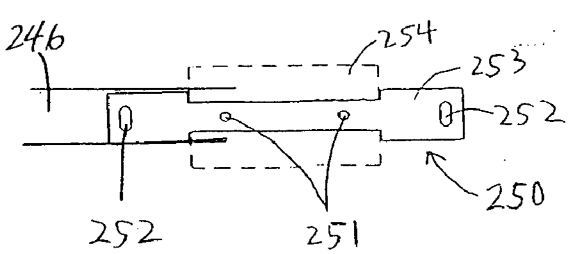

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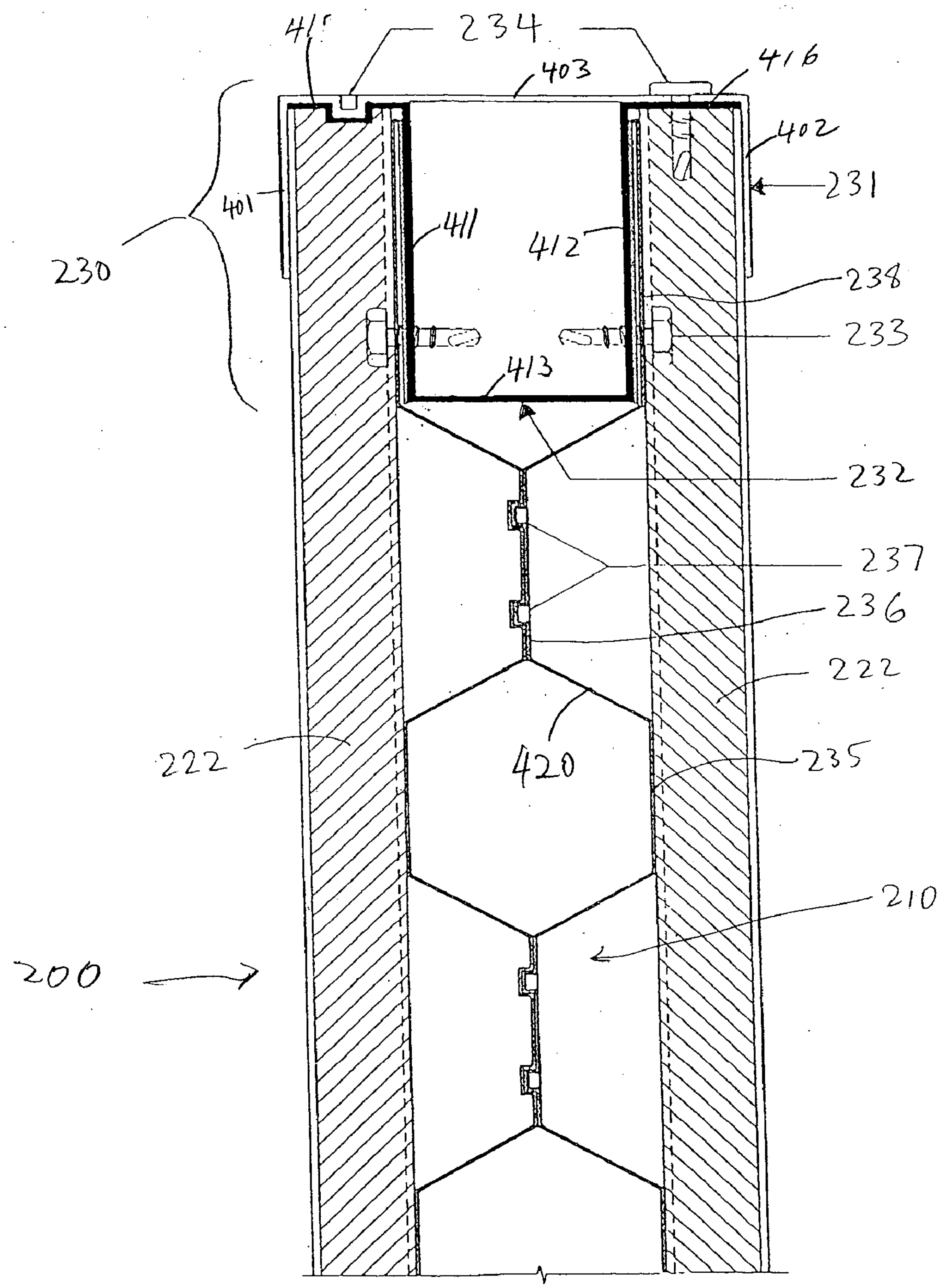
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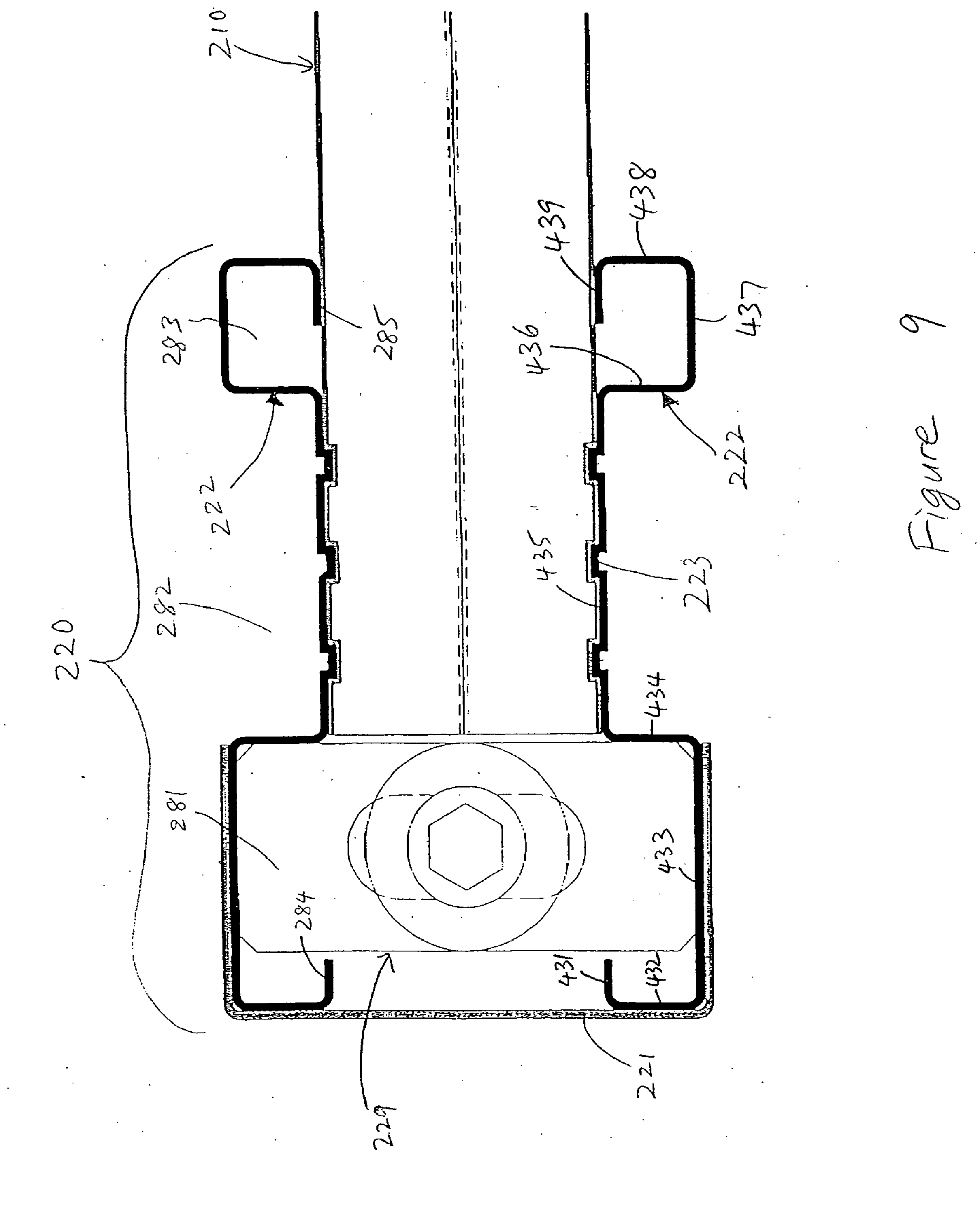
Figure 8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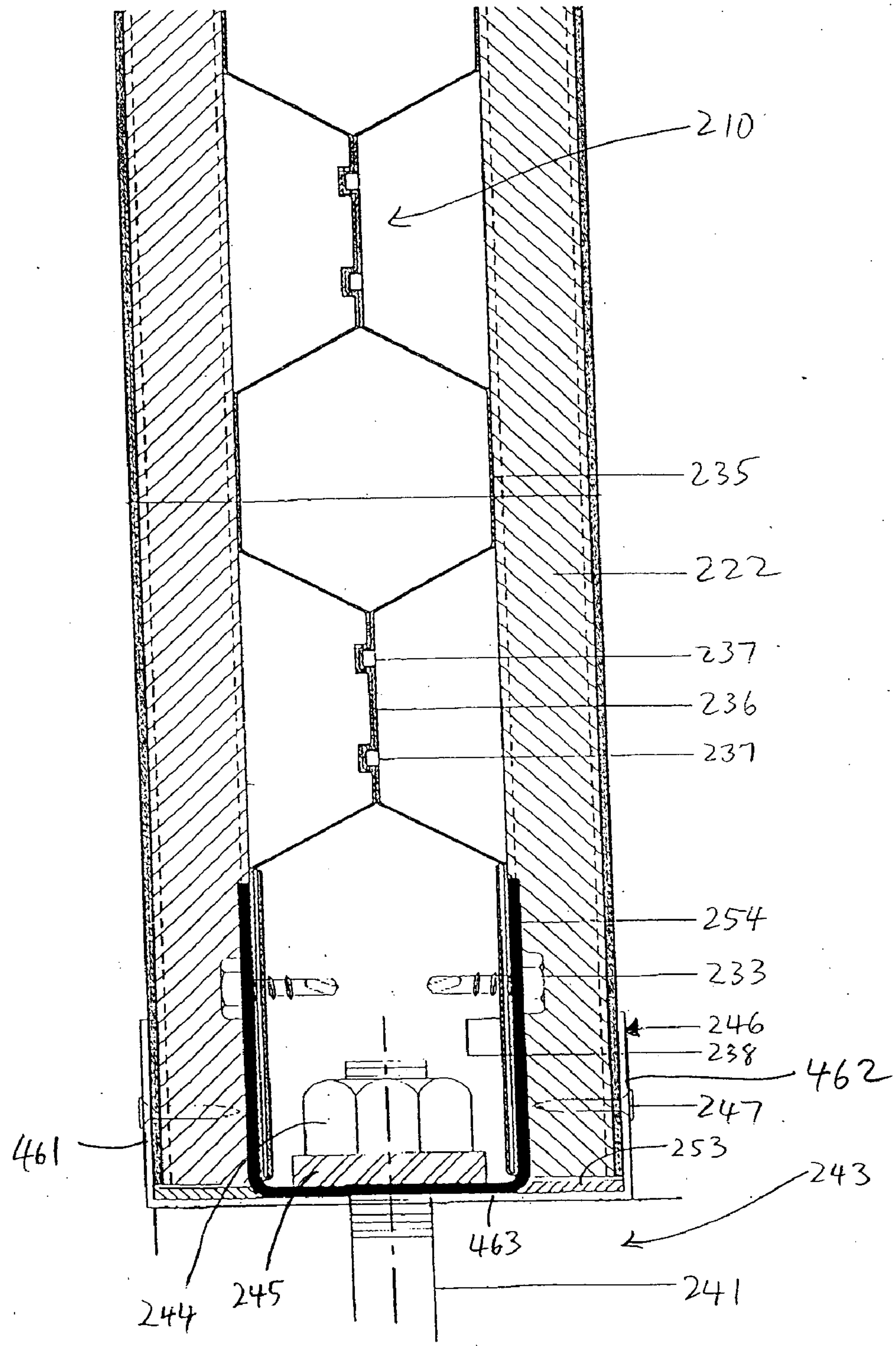
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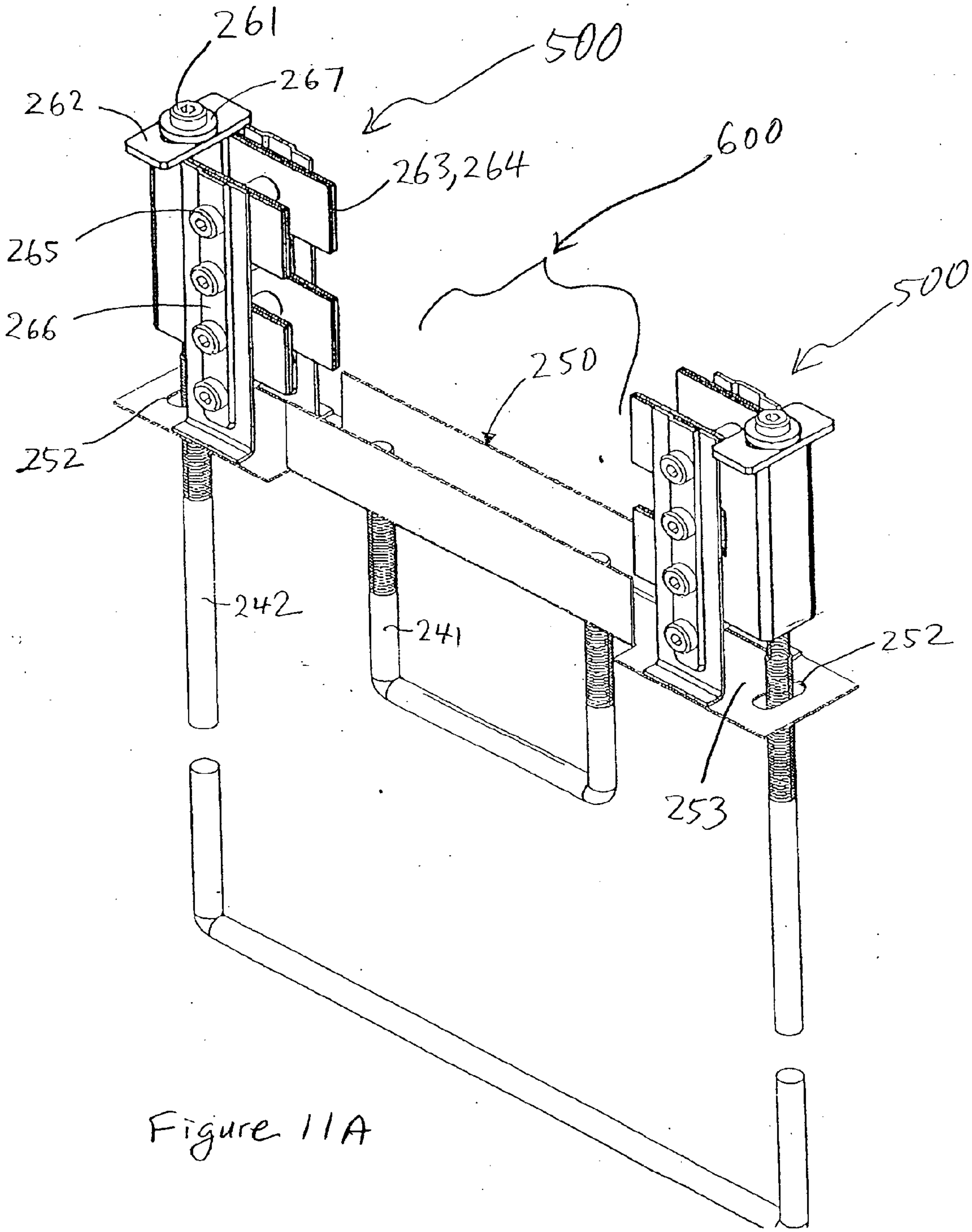
Figure 10



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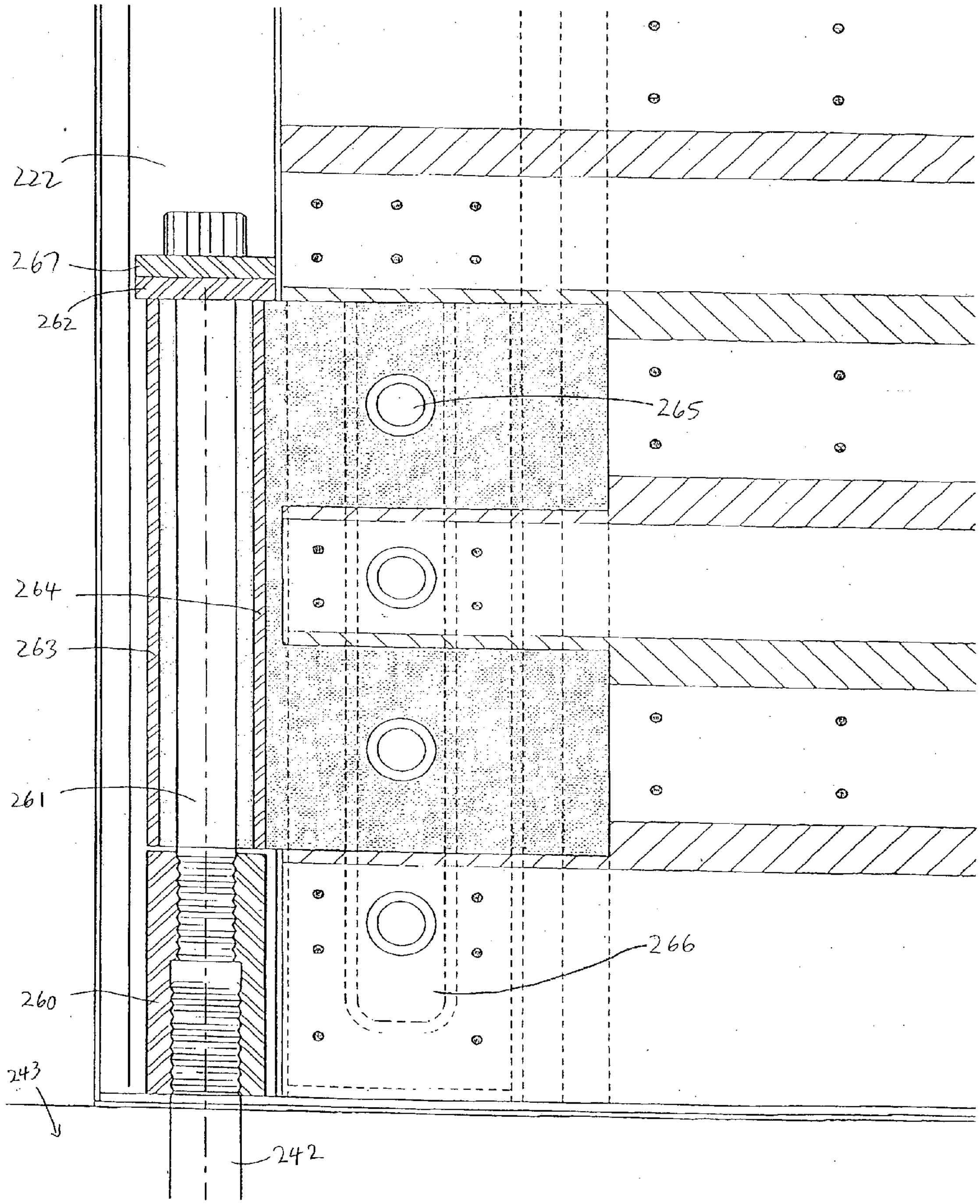

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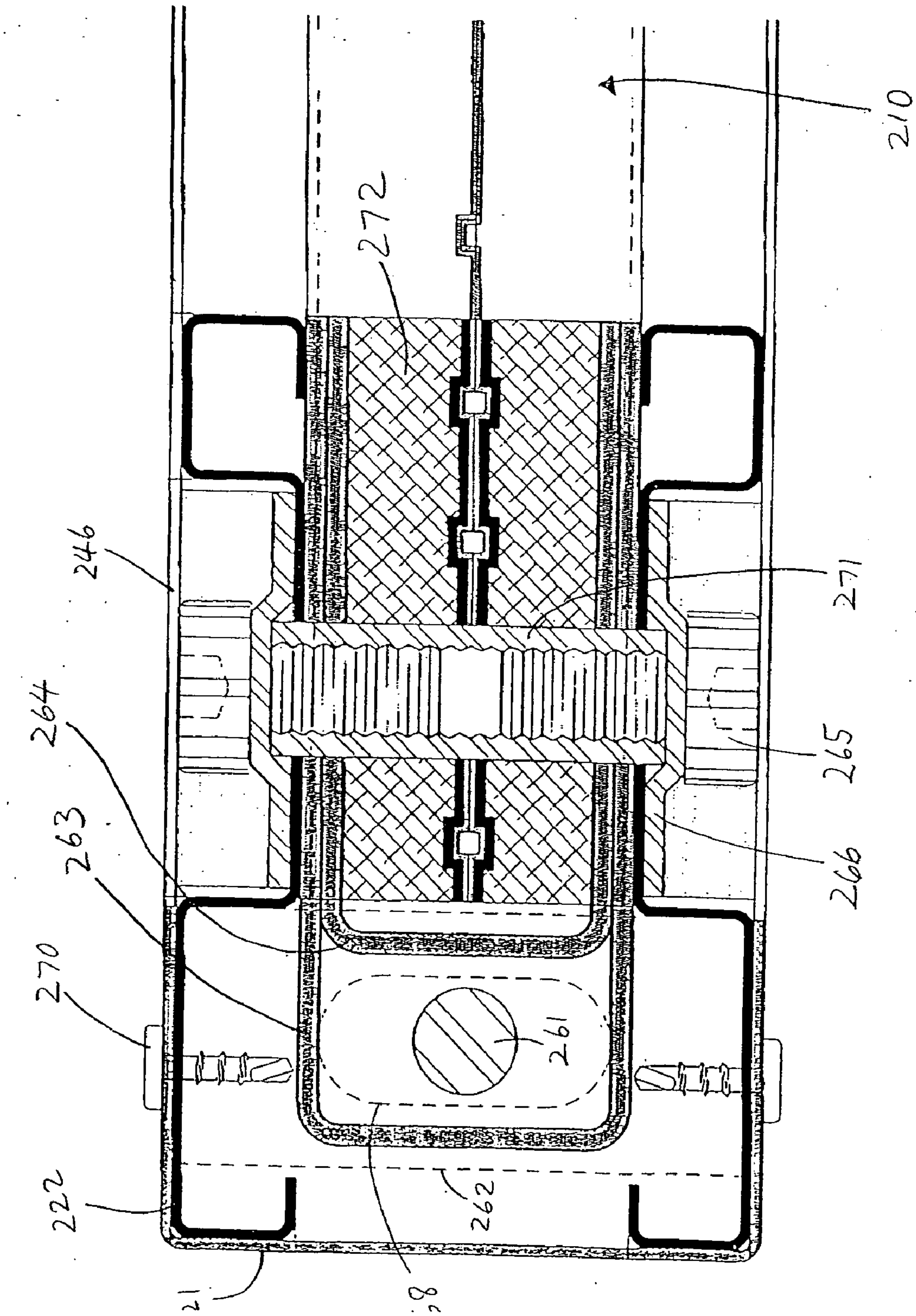

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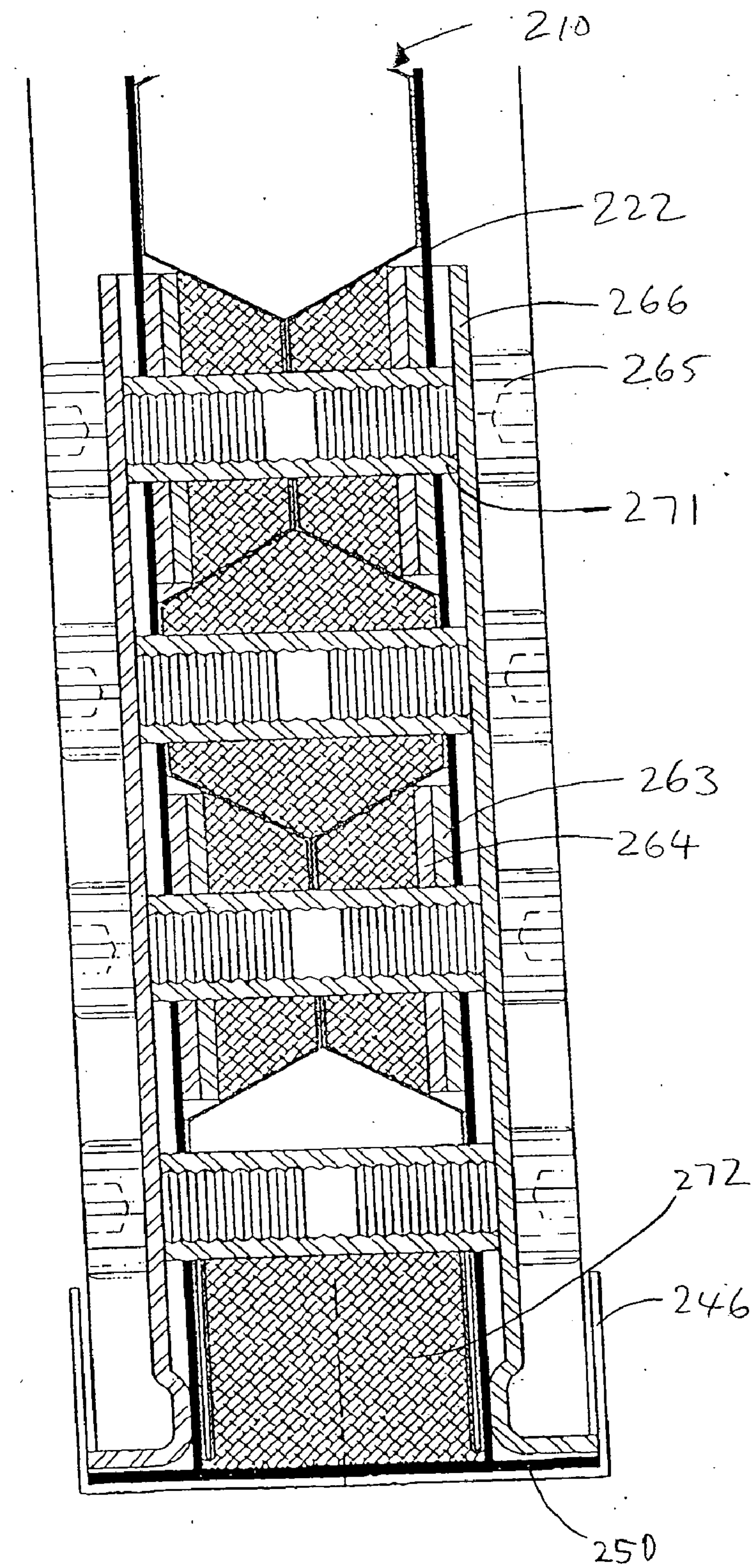

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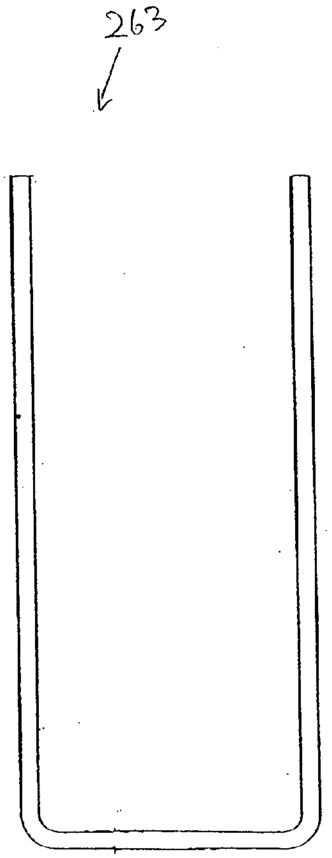

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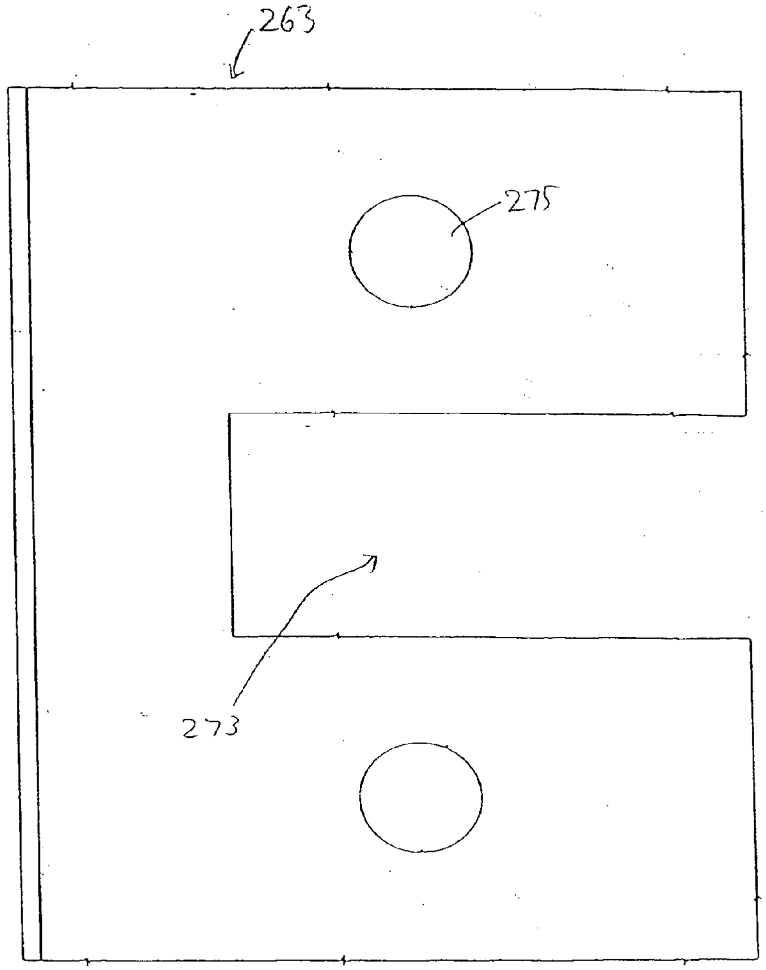

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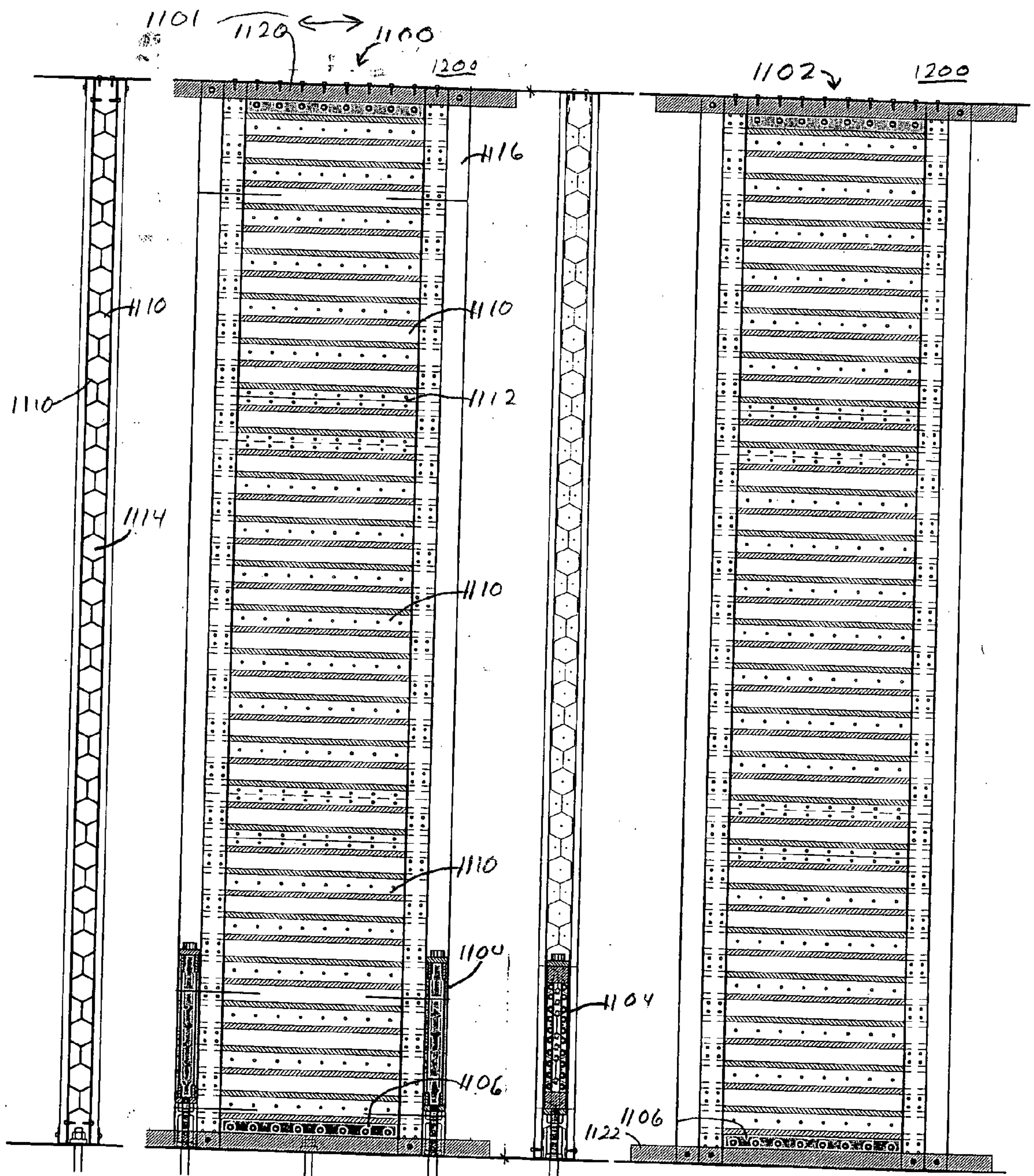
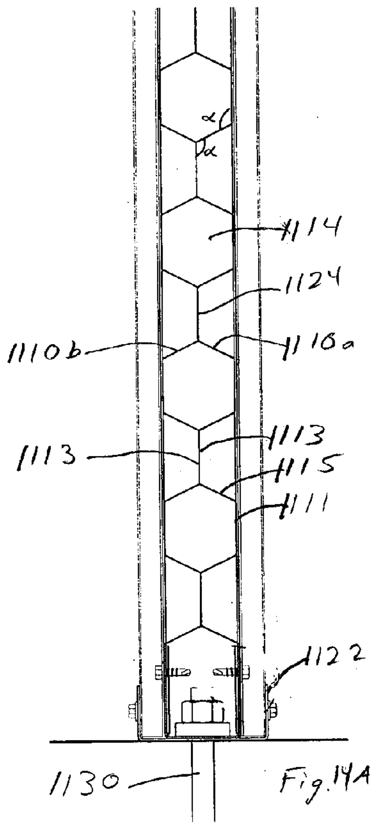


Fig.13B Fig.13A Fig.13C Fig.13D



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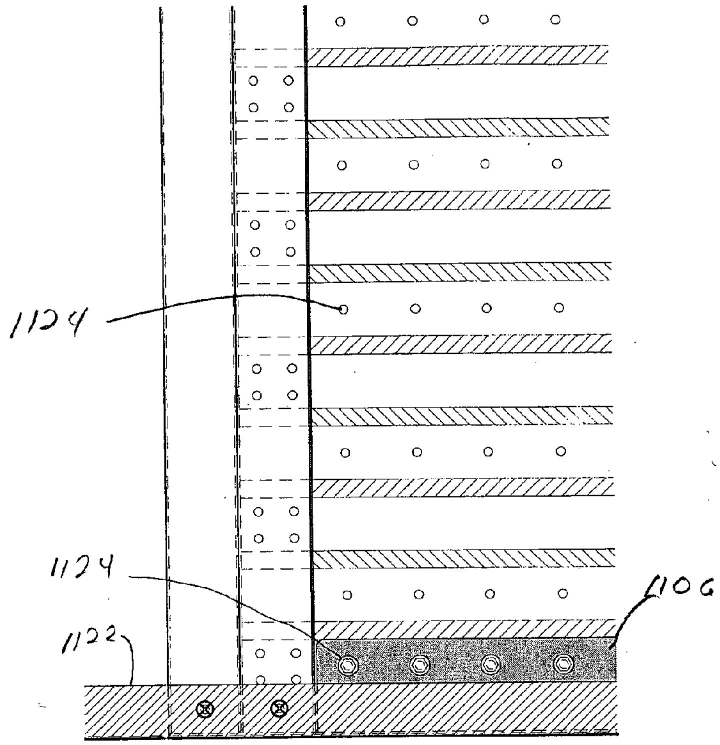

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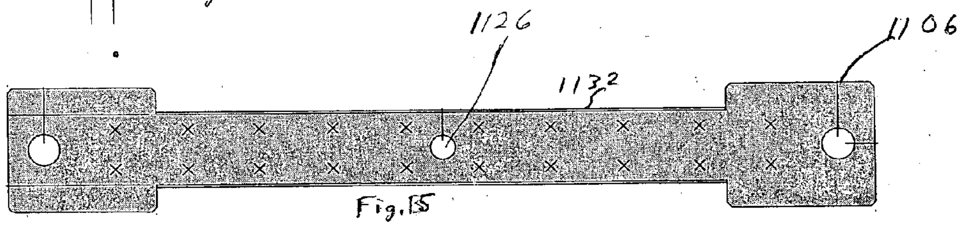

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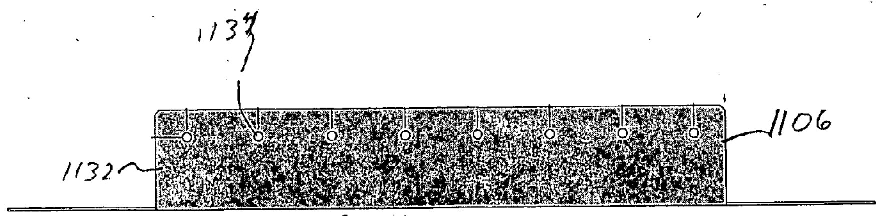

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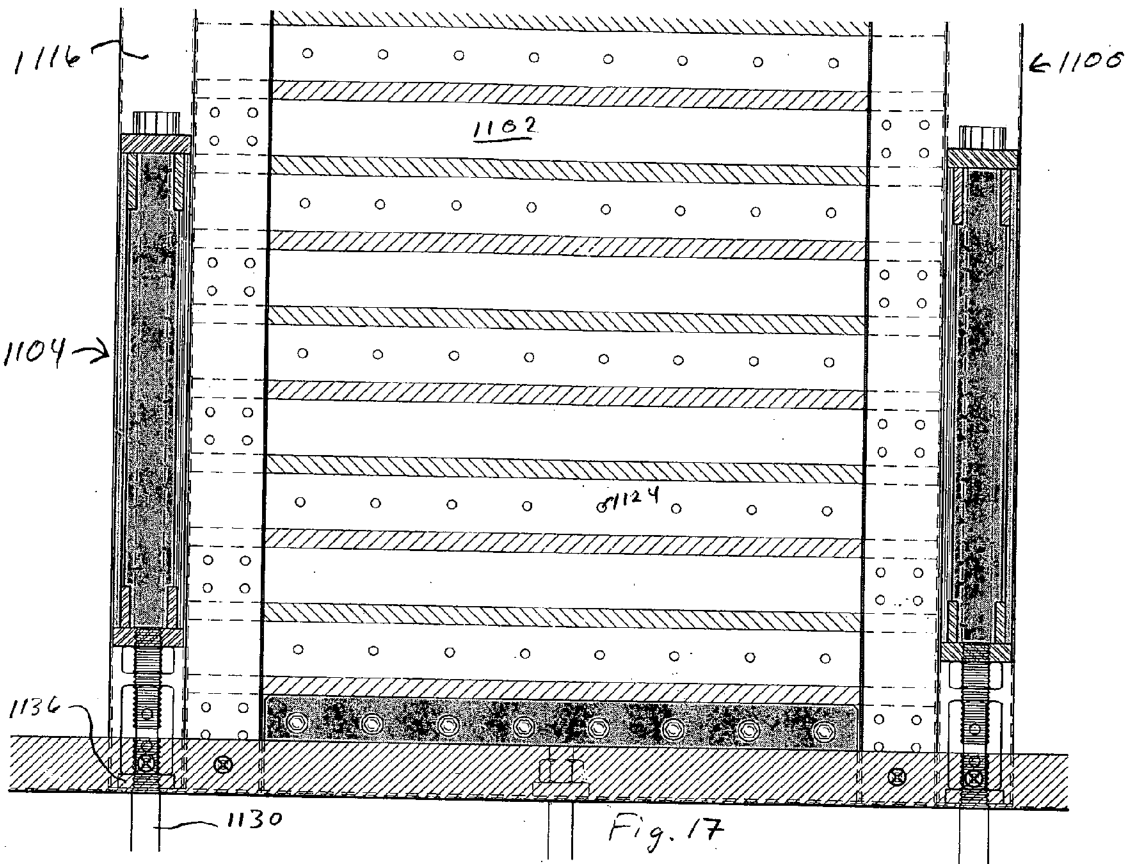

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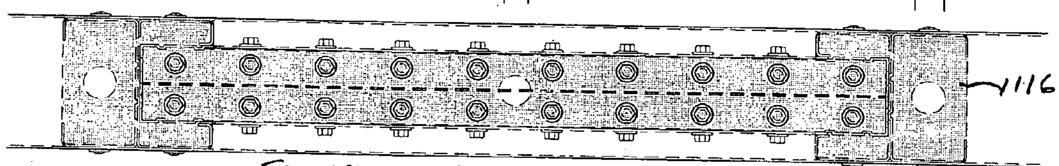

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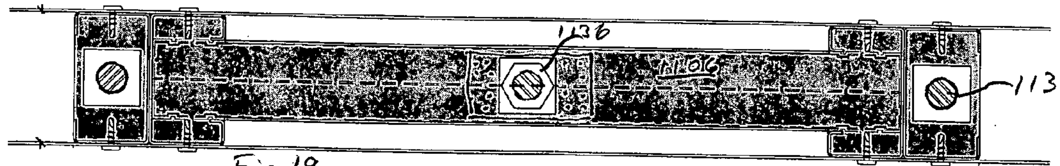

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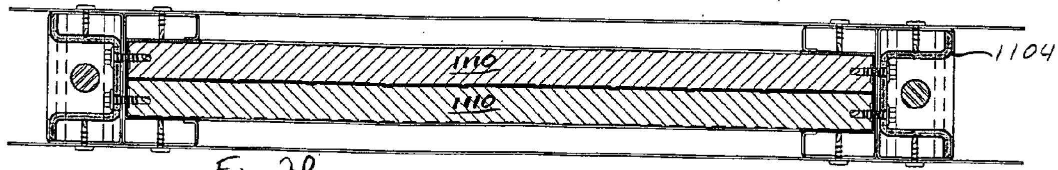

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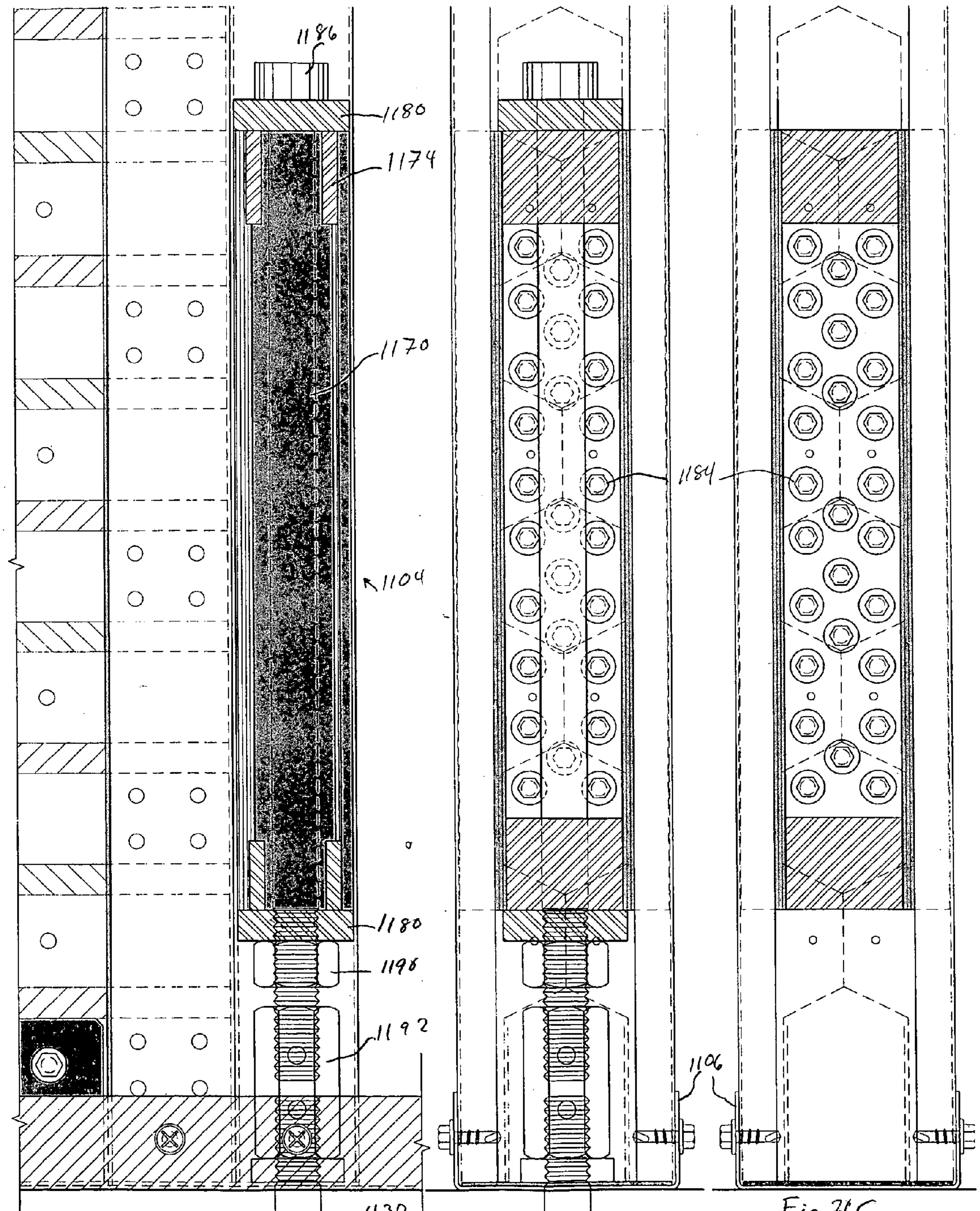


Fig. 21A Fig. 21B Fig. 21C

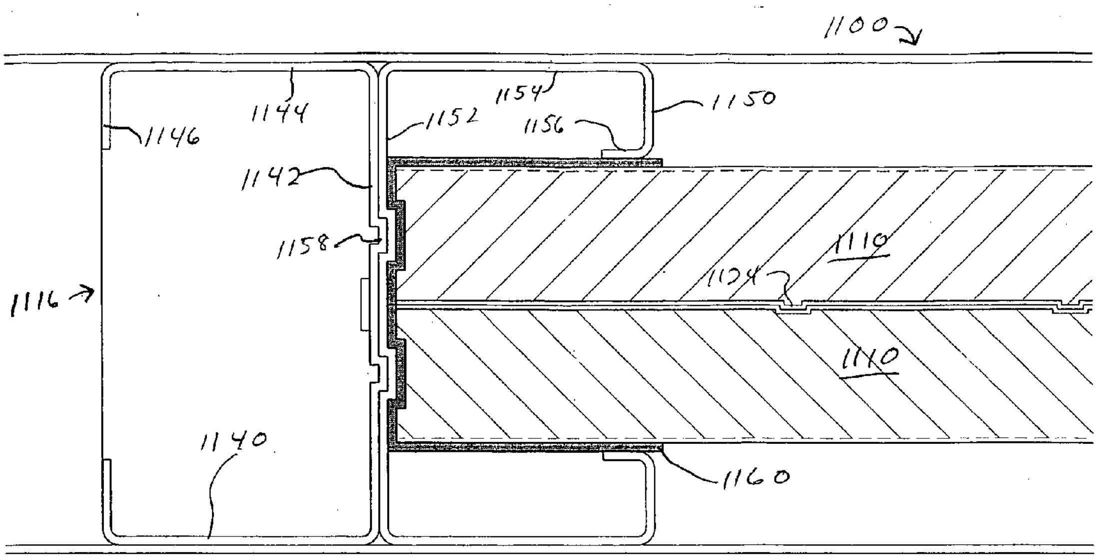
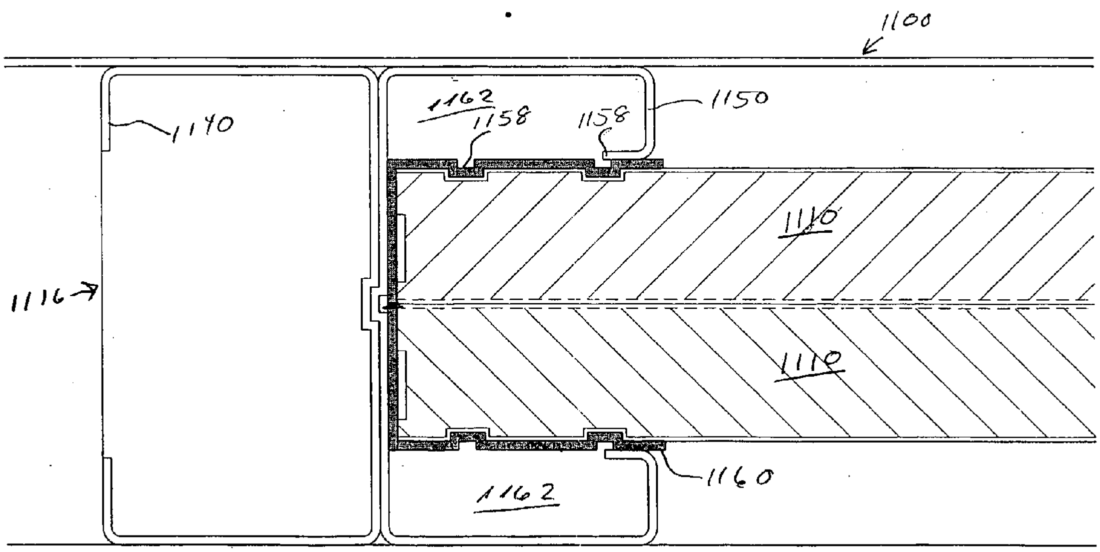


Fig. 22A



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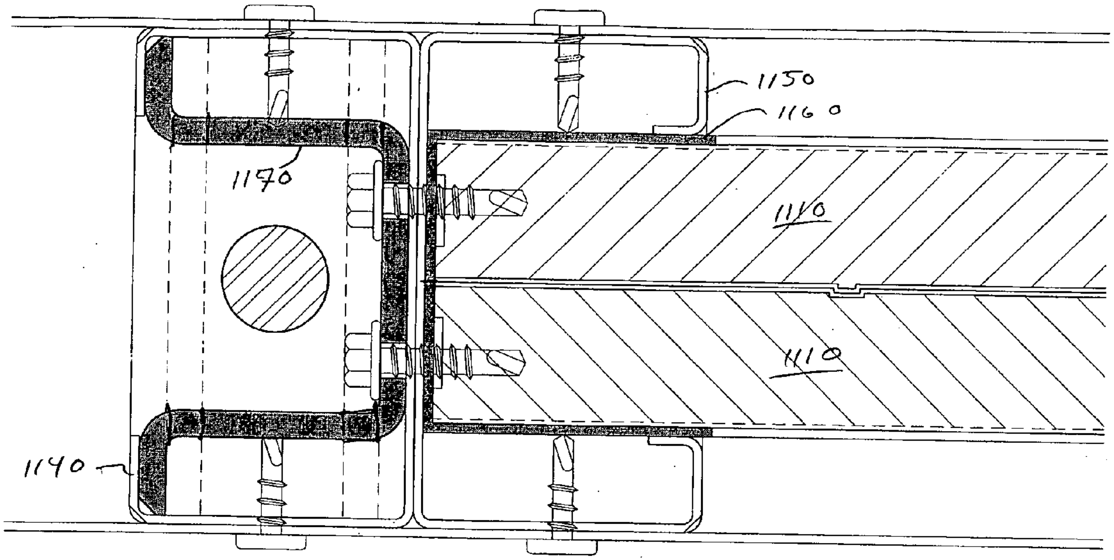

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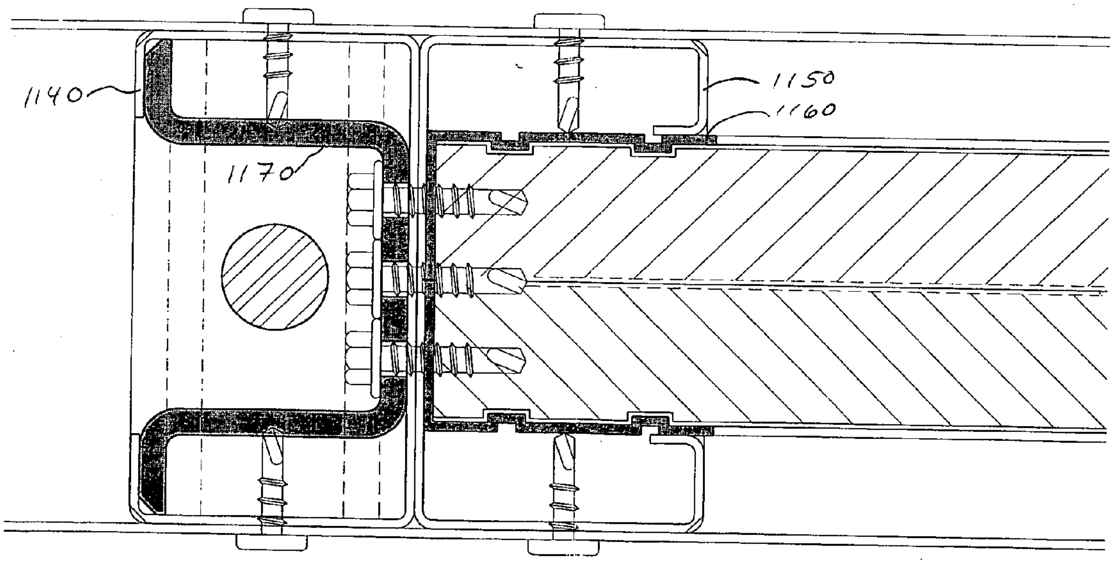

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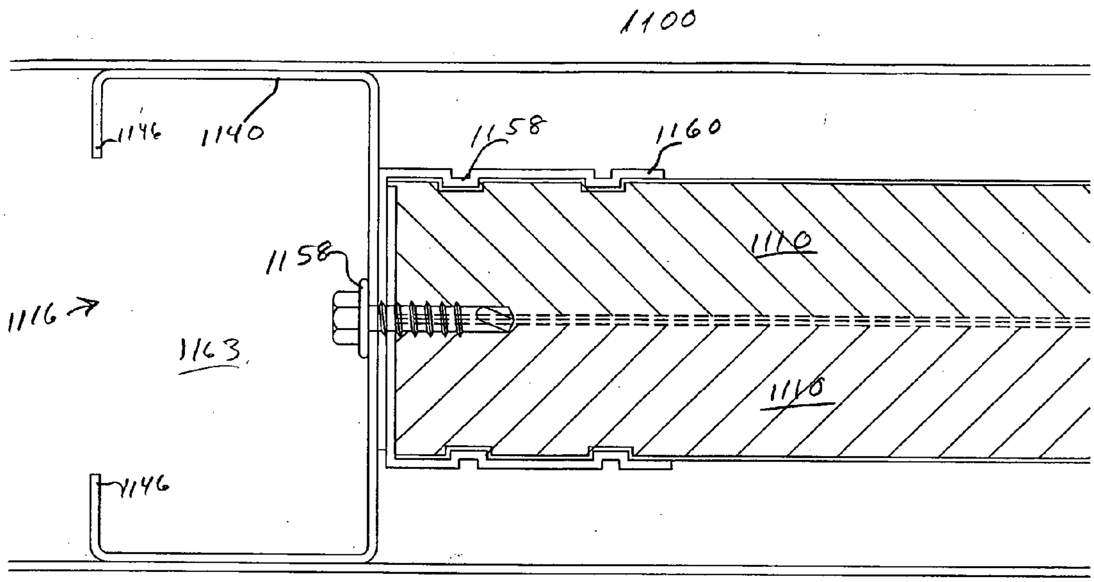

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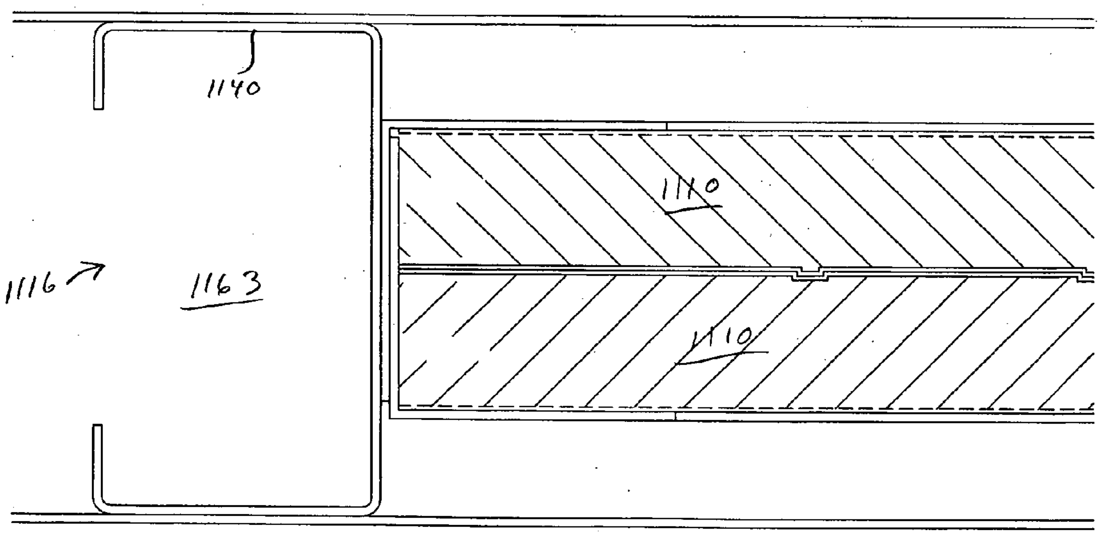

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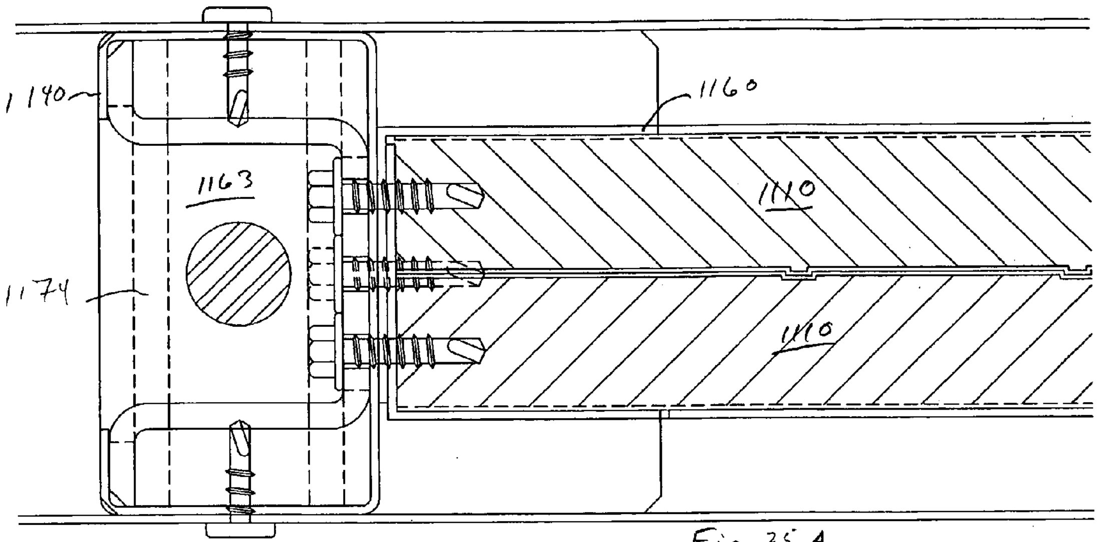

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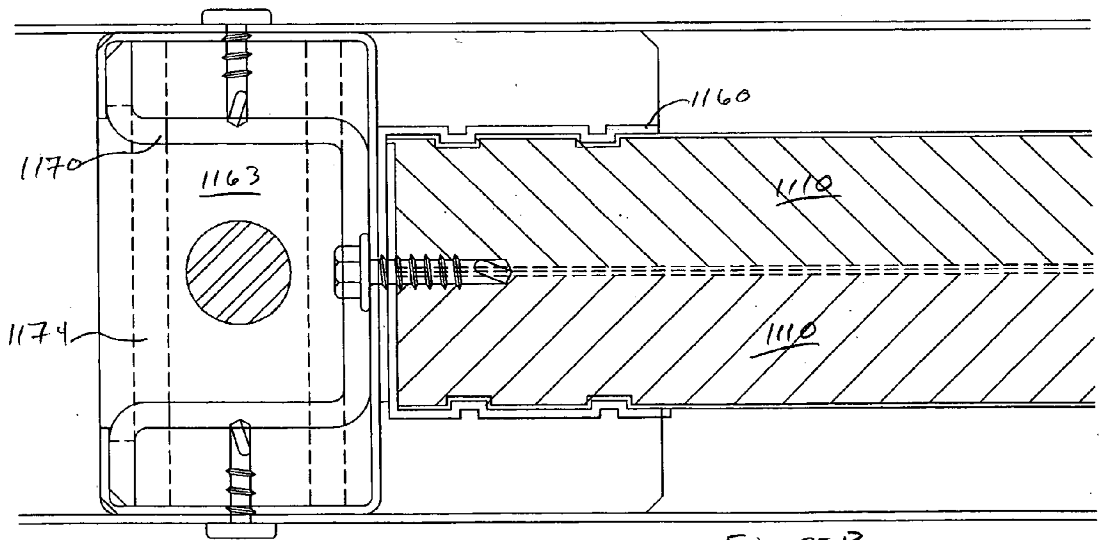

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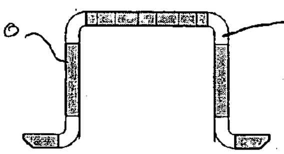

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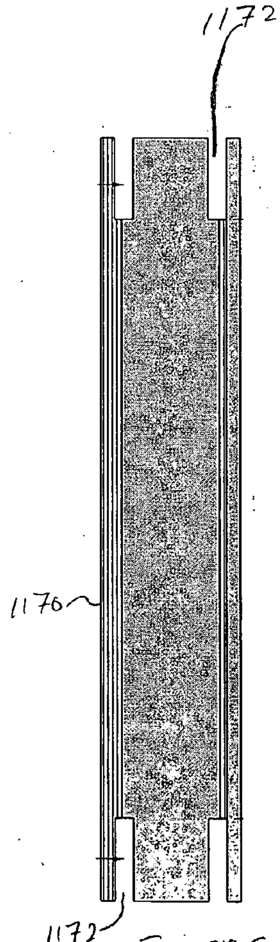

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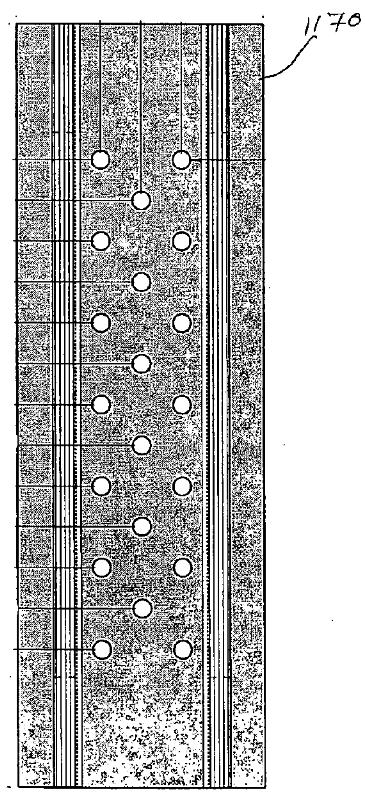

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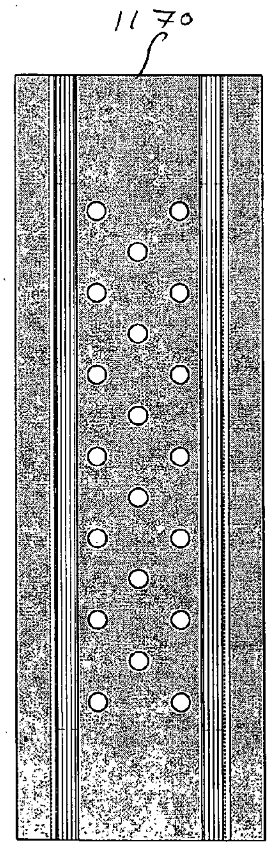

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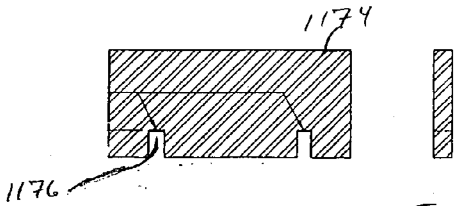


Fig. 27B

Fig. 27A

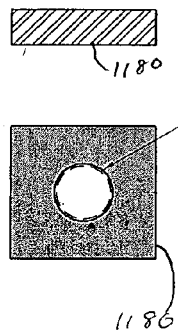
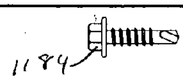


Fig. 28B

Fig. 28A



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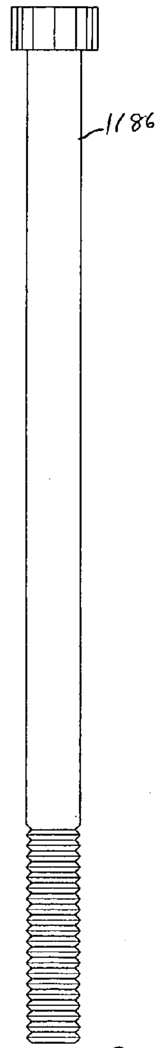

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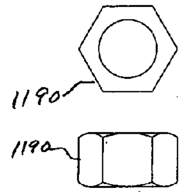


Fig. 31A

Fig. 31B

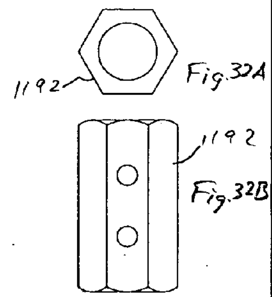
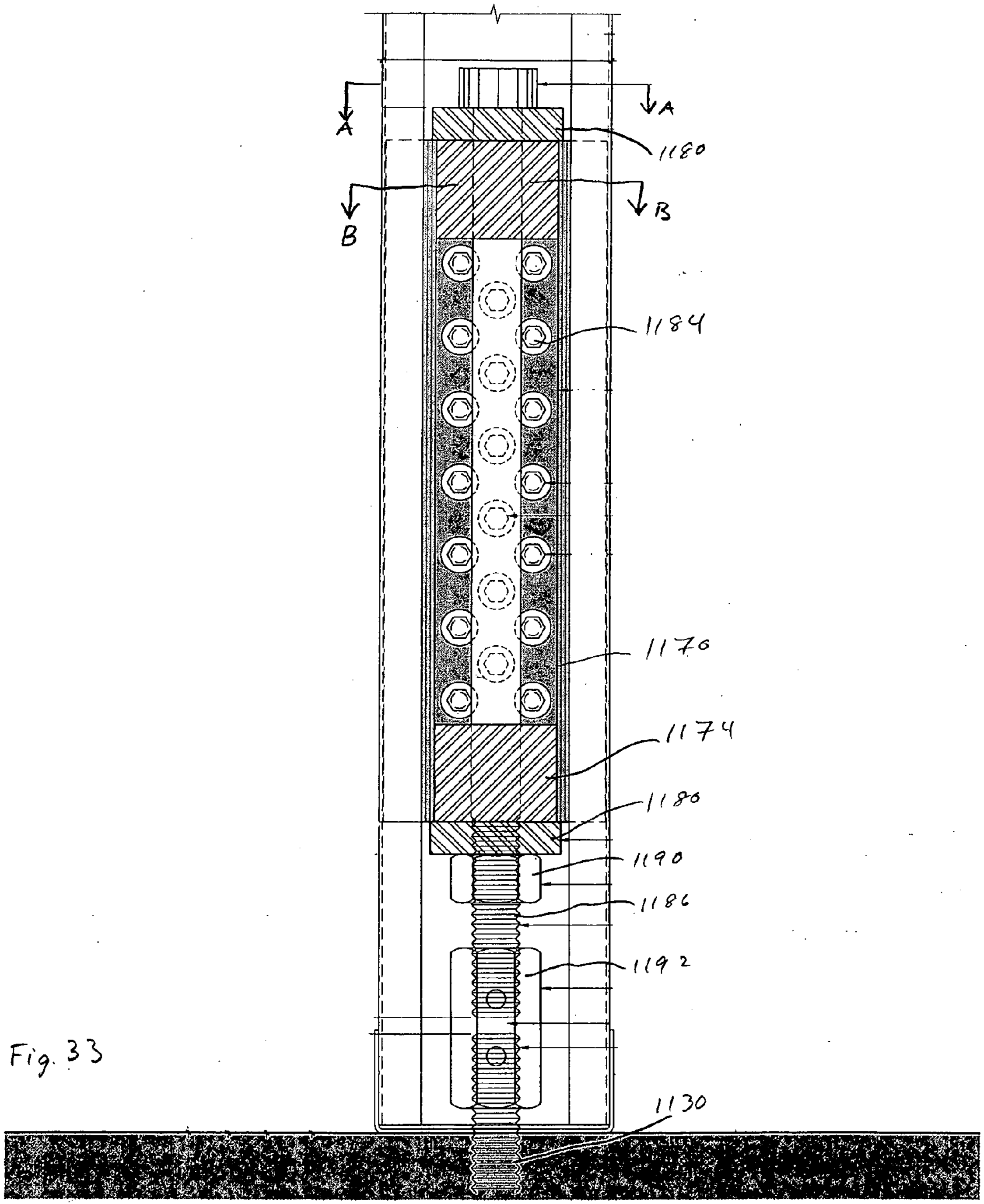


Fig. 32A

Fig. 32B



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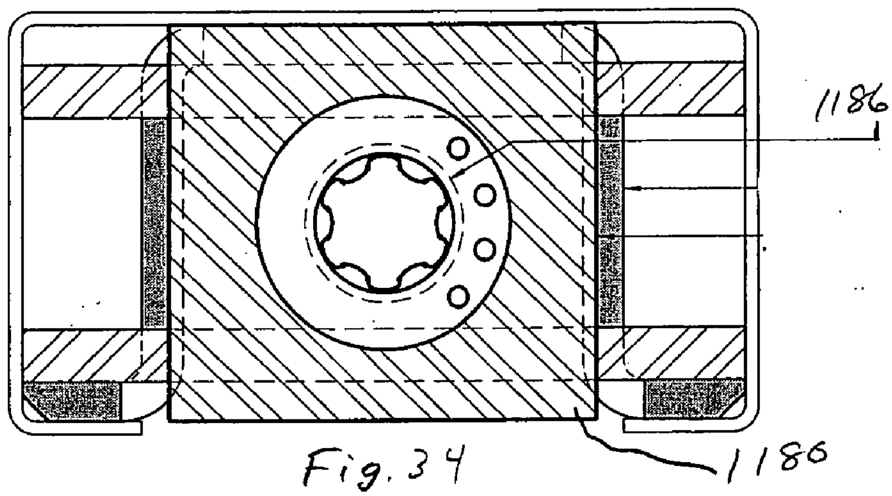

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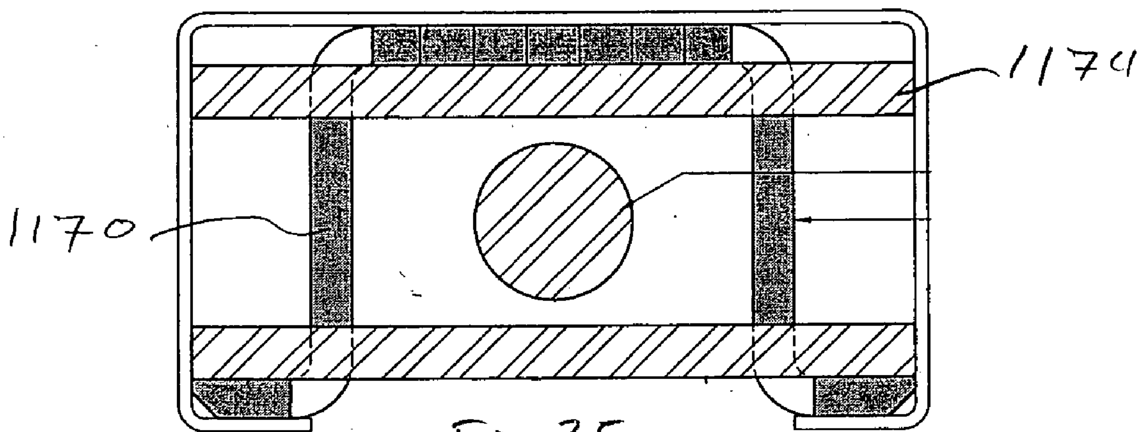

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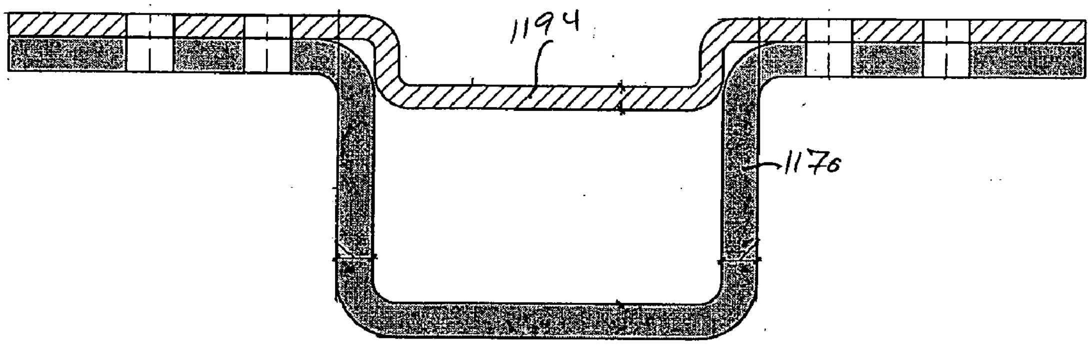

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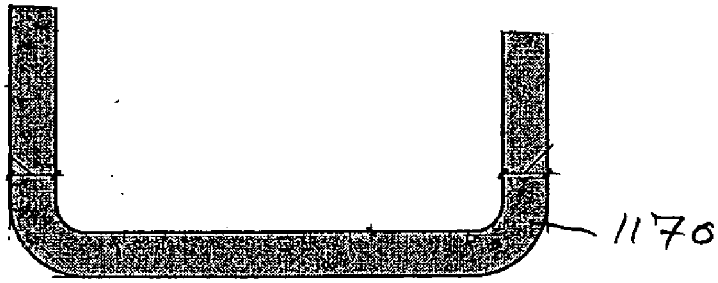

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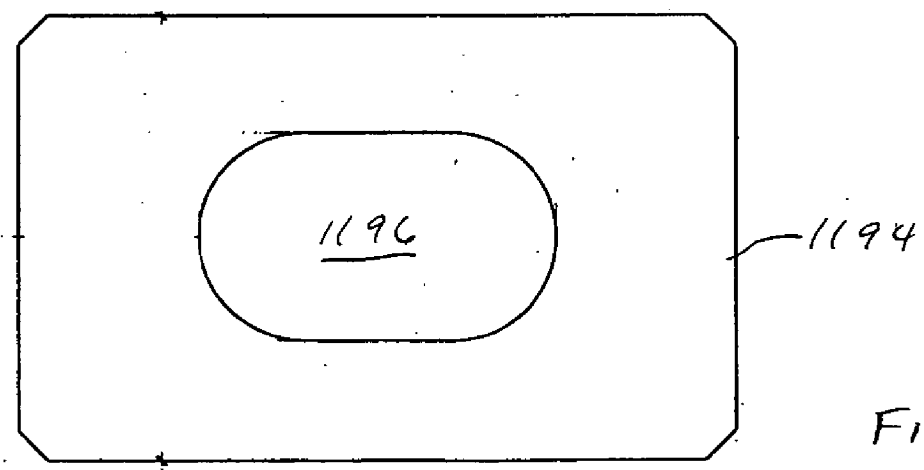

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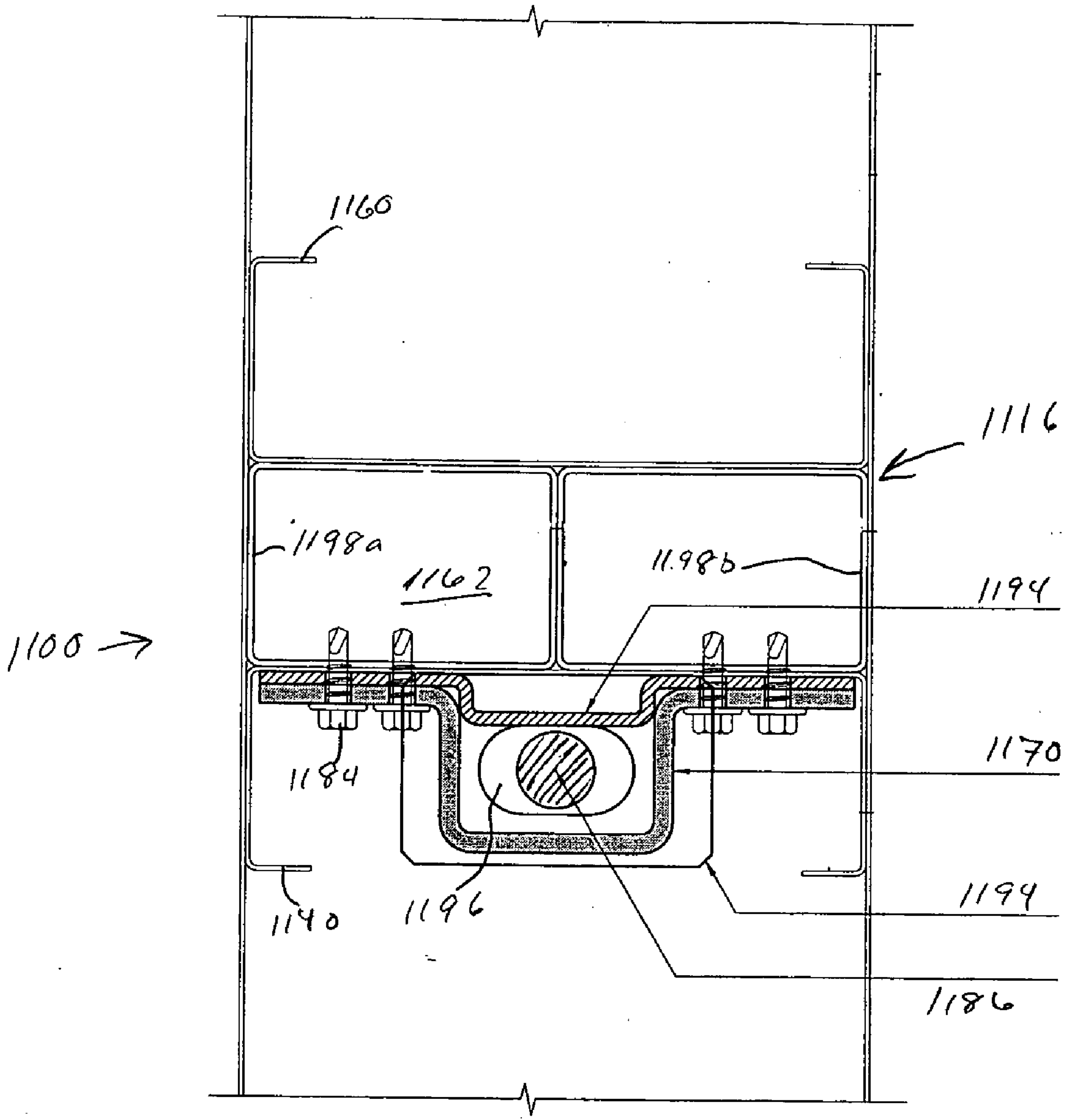
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Fig. 39

CORRUGATED SHEAR PANEL AND ANCHOR INTERCONNECT SYSTEM

RELATED APPLICATIONS

[0001] This application is a continuation in part of U.S. application Ser. No. 09/897,740 filed Jun. 29, 2001 and claims thereby the benefit of U.S. Provisional Application No. 60/215,290, filed on Jun. 30, 2000

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to the construction industry and, in particular, concerns a method of providing lateral strengthening of wall structures using factory manufactured, field installed framed corrugated diaphragm shear panels.

[0004] 2. Description of the Related Art

[0005] In light frame construction, walls are typically constructed using load bearing framing members made from wood or metal. Most often, a series of vertical studs, periodically spaced usually 16" to 24" on center, are secured at top and bottom with horizontal members called plates or tracks so as to form a wall frame. The resulting wall frame is capable of vertical load bearing. However, the rectangular geometry of the wall frame provides minimal strength when subjected to a combination of axial loading and lateral forces applied horizontally at the top or bottom of the frame wall. Such a combined force, as occasioned by seismic or high wind events, tends to cause a racking motion between the top and bottom of the wall, and may cause damage ranging from cracks in the wall's surface finish materials to complete structural failure of the wall resulting in a building collapse.

[0006] One typical method of laterally reinforcing light frame walls involves securing diaphragm sheet panels of plywood, oriented strand board (OSB), or light gauge sheet steel to the wall frame studs. While the conventional, two-dimensional, planar-sheet diaphragm shear panel construction does provide rigidity for the light frame walls and does provide resistance against shear forces, conventional field constructed shear panels do have some drawbacks both in terms of method-of-construction and systems performance.

[0007] The drawbacks relating to method-of-construction pertain to the inherent potential for poor quality control in any field constructed assembly, especially where the efficacy of a system is dependent upon the proper connection and attachment of a multitude of components. A prefabricated factory assembled shear panel of any variety has a better potential for quality control and overall system performance than a completely field constructed assembly.

[0008] The potential system performance drawback to field built sheet diaphragm shear panels relates to the issue of ductility in the wall system. Wood frame systems are generally regarded as being relatively ductile systems which means they do not usually fail in a brittle or catastrophic mode, but rather fail in a gradual manner where they eventually loose their ability to resist forces. However, post earthquake and post hurricane forensic investigations and cyclic testing of sheet diaphragm shear panels has revealed that it is not uncommon for wood sheathing attached to light frame construction to tear apart at the panel edges where fastened with nails or screws. It has also been found that wood sheet diaphragms, when rigidly secured with fasteners at panel boundaries, have a tendency to tear and shear apart in the middle of the sheet diaphragm. This behavior is characteristic of an absence of ductility in the diaphragm element itself. Improvement in the ductile capacity of shear resisting elements in light frame construction whether field constructed or factory assembled and field installed is therefore an improvement in technology which would be beneficial in the design, engineering, and construction industry.

[0009] With respect to improvements in the method-of-construction of shear resisting elements in light frame construction, several patents have been issued since 1998 which disclose methods of providing pre-assembled lateral wall reinforcement. One such prefabricated shear reinforcement system was disclosed in U.S. Pat. No. 5,706,626 to Mueller, wherein a shear panel comprises a steel frame that fits between at least two vertical studs and secures the top and bottom of the wall. The area within the frame is covered by a flat sheet metal diaphragm. The flat sheet metal attached on both of the opposite sides of the vertical and horizontal chord members provides substantial resistance to torsional and lateral buckling in the panel. This reinforcement method is especially beneficial on the compression side of the vertical chord members. Thus the perimeter frame of the panel is braced and reinforced by the sheet diaphragm making the shear panel resistant to lateral deformation. The extent to which the prefabricated shear panel is ductile, however, is a function of the rigidity of the fastened assembly of the various components.

[0010] In recent years since the 1994 Northridge, Calif. earthquake and the 1995 Kobe, Japan earthquake, the architectural and structural engineering community has become increasingly concerned with developing appropriate building design methodologies capable of reducing the degree of structural damage sustained in these natural events. Structural designers and building code writing organizations have come to recognize the benefits of lateral resisting elements and systems in building design which not only resist lateral motion, but which provide a measurable degree of ductility which can absorb and dissipate energy in the process of resisting lateral loads imposed on building structures.

[0011] Cyclic testing of both wood diaphragm shear panels and metal shear panels, including braced frame types, unitary body types, and sheet diaphragm types, has disclosed that an absence of ductility in a panel or frame generally results in a buckling failure mode on the compression side of either the vertical end edge or chord member.

[0012] From the foregoing, it will be appreciated that there is a need for improved methods of shear reinforcing a wall frame so as to provide for the structural integrity of buildings. There is a need for a shear panel that can be substantially prefabricated, and be field installed into a light frame wall in a simple manner with some additional degree of field installation adjustability. There is a need for a shear panel that provides substantial resistance to shear forces and uplifting forces acting on the wall. There is a need for a shear panel with a substantially strong, yet ductile diaphragm that does not require additional lateral braces for over structural integrity.

SUMMARY OF THE INVENTION

[0013] The aforementioned needs are satisfied by the shear panel for transferring force from an upper region of a building to anchors mounted within the foundation of the building. The shear panel comprising of a plurality of frame members are formed so that in cross section, the frame members include laterally displaced sections that are laterally displaced from the axis of extension of the frame member, such that laterally displaced sections provide strength to the chord member so as to resist lateral buckling of the frame member under compression. A diaphragm that is attached to the frame defined by the plurality of frame members so as to transfer uplift forces from one region of the shear panel frame to another. An anchor assembly, connected to the frame of the shear panel so as to interconnect the shear panel to anchors mounted within the foundation of a building.

[0014] In one embodiment, the panel further comprises a first chord member having a laterally displaced section laterally displaced in a first direction. A second chord member having a laterally displaced section laterally displaced in a second direction, opposite of the first direction. Wherein the first and second chord members are secured together so as to define the frame member.

[0015] In yet another embodiment, the first and second chord members comprise a first section that defines a first at least partially enclosed space and a second section that defines a second at least partially enclosed space. Wherein the first and second sections are interconnected at a first end of the first and second sections and wherein the first and second sections are configured so that the first and second at least partially enclosed spaces are elongate and the axis of elongation of the first and second partially enclosed spaces are approximately perpendicular to each other.

[0016] In yet another embodiment, wherein the first section of the first and second chord members are positioned such that the axis of elongation of the first at least partially enclosed space is substantially co-axial between the first and second chord members. Wherein the second partially enclosed space of the first and second chord members are displaced from each other with the axis of elongation of the second partially enclosed space of the first and second chord members being displaced, but substantially parallel to each other.

[0017] In yet another embodiment, the laterally displaced sections are positioned within the second section of the first and second chord members.

[0018] In another embodiment, further comprising a first and a second reinforcing J members that have elongate sections that are positioned adjacent the second section of the first and second chord members and hook sections that are positioned within the first partially enclosed space of the first and second chord members.

[0019] In another embodiment, the first and second reinforcing J members are clinch connected to the first and second chord members.

[0020] In one aspect, the shear panel for transferring force from an upper region of a building to anchors mounted within the foundation of the building, the shear panel comprising of a plurality of frame members defining the frame of the shear panel. A diaphragm member that is attached to the frame defined by the plurality of frame members so as to transfer uplift forces from one region o the shear panel frame to another. The diaphragm is contoured so as to define a plurality of lateral displacements out of the plane of the diaphragm member to thereby provide resistance to bending of the shear panel in a direction that is perpendicular to the plane of the diaphragm member. An anchor assembly, connected to the frame of the shear panel, so as to interconnect the shear panel to anchors mounted within the foundation of the building.

[0021] In yet another embodiment, the diaphragm member is corrugated so as to define the plurality of lateral displacements.

[0022] In another embodiment, the diaphragm member is corrugated so that the plurality of lateral displacements extends in a direction that is generally horizontal.

[0023] In another embodiment, the diaphragm member is corrugated so that the plurality of lateral displacements extends in a diagonal manner.

[0024] In yet another embodiment, the diaphragm member is comprised of a first and second corrugated member that are positioned and interconnected, so as to define a plurality of rectangular openings that have side walls extending in a direction laterally outward from the plane of the opening defined by the frame members.

[0025] In another embodiment, the first and second corrugated members are arranged so as to define a plurality of rectangular openings that extend generally horizontally across the openings defined by the frame member.

[0026] In another embodiment, the first and second corrugated members are contoured so that the plurality of rectangular members is separated by a plurality of interconnecting sections of the first and second corrugated members. These members are positioned immediately adjacent to each other and interconnected with each other.

[0027] In yet another embodiment, wherein the plurality of interconnecting sections is interconnected to each other via clinching.

[0028] In another embodiment, the diaphragm member comprises a plurality of diaphragm sections that are individually connected to the frame member, so as to be positioned throughout the opening defined by the frame member. Wherein the plurality of diaphragm sections are coupled to the frame so as to reduce the overall length of the diaphragm member to thereby reduce the tendency of the diaphragm member to be damaged as a result of transferring force to the anchor members.

[0029] In another embodiment, wherein the plurality of diaphragm sections comprise three independent sections of corrugated material that are mounted to the frame members.

[0030] In another aspect of the invention a shear panel assembly for transferring force from an upper portion of a building to a foundation. The assembly comprising of a plurality of frame members defining the frame of the shear panel. A diaphragm that is attached to the frame defined by the plurality of frame members so as to transfer uplift forces from one region of the shear panel frame to another. An anchor member embedded in the foundation having ends extending outward therefrom. An anchor attachment member comprised of a U-shaped strap that connects to the outer edges of the plurality of frame members to the anchor attachment member. Wherein the anchor attachment member defining holes that receive ends of an anchor member embedded in the foundation, wherein the openings are aligned with the frame members so that when the anchor attachment member is attached to the frame members, the frame members are substantially concentric with the ends of the anchor member.

[0031] In another embodiment, the attachment members define two vertical sections with a horizontal section interposed therebetween and wherein the openings are formed in the horizontal sections, and the vertical sections are attached to the outer edges of the vertical frame members defining the frame of the shear panel assembly.

[0032] In yet another embodiment, the horizontal section defines two recess that have the openings that receive the ends of the anchor member.

[0033] In another embodiment, the openings are configured to permit adjustment of the frame members in a direction that is perpendicular to the plane of the diaphragm member.

[0034] In yet another embodiment, further comprising slotted steel capture plates positioned within the two recesses that receive the ends of the anchor structure therethrough.

[0035] In another embodiment, wherein the anchor member is comprised of a U shaped member having a first and second end, and an interconnecting section wherein the interconnecting section is embedded on the foundation with the first and second ends extending outwardly therefrom so as to permit attachment to the anchor attachment member.

[0036] In one aspect of the invention, a shear panel assembly for transferring force from an upper portion of a building to a foundation. The assembly comprising of a shear panel having a first and second outer edges and a central portion interposed therebetween wherein the shear panel is attached to the upper portion of the wall. A hold-down assembly that interconnects the first and second outer edges to first anchor bolts positioned within the foundation such that the hold-down assembly resists uplift forces. An anchor assembly that interconnects the central portion of the shear panel to second anchor bolts positioned in the foundation so that the anchor assembly resists base shear forces inducing relative movement between the bottom of the shear panel and the foundation.

[0037] In one embodiment, wherein the hold-down assembly comprises a first and second attachment assembly wherein each of the first and second attachment assemblies comprises of a hold-down bolt sleeve which defines an opening that receives a hold-down bolt within the opening. Wherein the hold-down bolt sleeve is attached to the shear panel. An attachment plate that includes an opening wherein the attachment plate is positioned on the sleeve so as to allow the hold-down bolt to extend through the opening such that the end of the hold-down bolt can be coupled to the first anchor bolt so as to secure the hold-down bolt sleeve to the first anchor bolt.

[0038] In yet another embodiment, wherein the opening of the hold-down bolt sleeve is laterally extending so as to extend in a direction perpendicular to the plane of the shear panel so as to permit attachment between the first anchor bolts and the shear panel when the first anchor bolt is misaligned with the shear panel in a direction perpendicular to the plane of the shear panel.

[0039] In another embodiment, wherein the hold-down assembly further comprises an interconnection device that interconnects the hold-down bolt sleeve to the outer edge of the shear panel.

[0040] In yet another embodiment, the interconnection device comprises at least a pair of members attached to the hold-down bolt sleeve so as to define a space that receives the outer edge of the shear panel and at least one bolt that extends between the pair of members in the space so as to be interconnected to the shear panel.

[0041] In another embodiment, further comprising at least one reinforcing member mechanically coupled to the at least one bolt. Wherein the reinforcing member engages with the foundation so as to resist compressive forces being exerted on the hold-down assembly.

[0042] In another embodiment, wherein the reinforcing member extends in a direction parallel to the hold-down bolt and has a lip that engages with the foundation.

[0043] In yet another embodiment, the anchor assembly includes a base member that defines an opening such that the bottom edge of the shear panel can be positioned within the opening and secured thereto.

[0044] In another embodiment, wherein the base member includes at least one first opening that receives the first anchor bolt. Wherein the first opening extends in a direction perpendicular to the plane of the shear panel so as to accommodate misalignment between the shear panel and the first anchor bolt in a direction that is perpendicular to the plane of the shear panel.

[0045] In yet another embodiment, the base member defines at least one second opening that receives the second anchor bolt. Wherein the second opening extends in a direction perpendicular to the plane of the shear panel so as to accommodate misalignment between the shear panel and the second anchor bolt in a direction that is perpendicular to the plane of the shear panel.

[0046] In another embodiment, wherein the base member is sized to fit in a steel framing track of a lower portion of the wall.

[0047] In yet another embodiment, a shear panel assembly for transferring force from an upper portion of a building to a foundation, the assembly comprising of a shear panel defining a planar area, wherein a plurality of corrugations are formed in the planar area of the shear panel. An attachment assembly for attaching the shear panel to the upper portion of the wall. An anchor assembly that interconnects the shear panel to the foundation, wherein the plurality of corrugations provide ductility in the shear panel thereby allowing limited compression and expansion of the shear panel when under shear loading to reduce buckling of the shear panel during shear loading.

[0048] In another embodiment, wherein the planar area comprises a first side and a second side, wherein the corrugations comprise a ridge and a groove on the first and second sides of the planar area. The corrugation on the first side of the planar area is substantially symmetric to the corrugation on the second side about the plane of the planar area.

[0049] In yet another embodiment, wherein the groove on the first side of the planar area is engaged with the groove on the second side of the planar area.

[0050] In another embodiment, wherein the grooves on the first and second area are secured by a plurality of clinches.

[0051] In another embodiment, wherein the substantially symmetric ridges on the first and second sides of the planar area defines a cavity.

[0052] In yet another embodiment, wherein the cavity is a hexagonal shape in cross section.

[0053] In another embodiment, wherein the planar area comprises a first layer and a second layer. Wherein each of the first and second layers comprise a plurality of ridges and grooves. The first and second layers are secured together such that the ridges and grooves are substantially symmetric in cross section about the plane parallel to and between the first and second layers.

[0054] In yet another embodiment, wherein each of the first and second layers comprises segmented sections. Wherein the segmented sections are joined together to form the first and second layers.

[0055] In another embodiment, wherein the segmented sections are joined by gusset straps to form butt joints.

[0056] In another aspect of the invention, a shear panel assembly for transferring force from an upper portion of a building to a foundation. The assembly comprising of a shear panel having a first and a second outer edges and a central portion interposed therebetween wherein the shear panel is attached to the upper portion of the wall. An anchor assembly that comprises at least one anchor bolt having a first leg and a second leg extending out of the foundation with an interconnecting section interposed therebetween. Wherein the interconnection section is embedded in the foundation to provide greater resistance to uplift forces.

[0057] In another embodiment, wherein the anchor assembly comprises two separate anchor bolts. Wherein the first anchor bolt is adapted to resist uplift forces and the second anchor bolt is adapted to resist shear forces.

[0058] In yet another embodiment, each of the first and second anchor bolts is an U-shaped bolt.

[0059] In yet another aspect of the invention, a wall assembly interconnection an upper portion of a building to a foundation. The assembly comprising of a plurality of vertical studs distributed along the wall assembly. A shear panel positioned between two adjacent vertical studs at least one location. The panel has a first and second outer edges and a central portion interposed therebetween wherein the shear panel is attached to the foundation. An attachment assembly for attaching the shear panel to the upper portion of the wall assembly. The attachment assembly comprises a top track that has more than two vertical components in cross section. The additional vertical components provide the wall assembly with greater resistance to shear and uplift forces acting on the building.

[0060] In yet another embodiment, the cross section of the top track comprises a first section and a second section with an interconnecting section interposed therebetween. Wherein the first and second sections are substantially parallel, wherein the interconnection section comprises at least one bend such that the cross section of the top track in M-shaped when the first and second sections are positioned vertically.

BRIEF DESCRIPTION OF THE DRAWINGS

[0061] FIG. **1** illustrates two adjoining wall frames with shear panels in one embodiment of the invention installed;

[0062] FIG. **2**A is a side elevation view of the shear panel;

[0063] FIG. **2**B is an end elevation view of the shear panel;

[0064] FIG. **2**C is a plan sectional view of the shear panel;

[0065] FIG. **3**A illustrates formation of corrugated panels from top, middle, and bottom panel sections;

[0066] FIG. **3**B illustrates attachment of the corrugated panels to sub-frames;

[0067] FIG. **3**C illustrates joining of two halves of corrugated panels framed by sub-frames to form the shear panel;

[0068] FIG. **3**D illustrates installation of vertical tracks on vertical sections of the shear panel;

[0069] FIG. **3**E illustrates the shear panel being secured to a foundation by an anchor and a hold-down strap;

[0070] FIG. **4**A is a top end side elevation view of the shear panel;

[0071] FIG. **4**B is a bottom end side elevation view of the shear panel;

[0072] FIG. **5**A is a cross-sectional view of the top portion of the shear panel, illustrating a cross-section of a pair of chords joined together;

[0073] FIG. **5**B is a cross-sectional view of the bottom portion of the shear panel;

[0074] FIG. **5**C is a cross-sectional view of the vertical section of the shear panel, illustrating positioning of J-plates used to reinforce the shear panel;

[0075] FIG. **5**D is a cross-sectional view of the vertical section of the shear panel, illustrating how the shear panel is secured to the anchor;

[0076] FIG. **6** illustrates a cross-sectional view of the chord;

[0077] FIG. **7**A is a side elevation view of another embodiment of the corrugated diaphragm shear panel;

[0078] FIG. **7**B illustrates a base plate of the shear panel of FIG. **7**A;

[0079] FIG. **8** is an end elevation view of top portion of the shear panel of FIG. **7**A, illustrating manner of attachment of the shear panel to a top track that is part of top portion of a wall;

[0080] FIG. **9** is a cross sectional view of a vertical section, illustrating a cross sectional view of a pair of chord members in relation to the corrugated diaphragm;

[0081] FIG. **10** is an end elevation view of bottom portion of the shear panel of FIG. **7**A, illustrating manner of attachment of the shear panel to a foundation to resist shear forces;

[0082] FIG. **11**A is an isometric view of a bottom assembly that secures the shear panel to the foundation;

[0083] FIG. **11**B is a side elevation view of lower bottom portion of the shear panel, illustrating manner of attachment of the shear panel to the foundation to resist uplifting forces;

[0084] FIG. **11**C is a cross sectional top view of lower bottom portion of the shear panel;

[0085] FIG. **11**D is an end elevation view of bottom portion of the shear panel, illustrating manner of attachment of the shear panel to the foundation to resist the uplifting forces;

[0086] FIG. **12**A is an end view of a first hold-down bracket; and

[0087] FIG. **12**B is a side view of the first hold-down bracket.

[0088] FIG. **13**A is a front elevation view of embodiments of shear panel and hold-down systems;

[0089] FIG. **13**B is a side section view generally along a vertical centerline of the systems of FIG. **13**A;

[0090] FIG. **13**C is a side elevation view of the systems of FIG. **13**A;

[0091] FIG. **13**D is front elevation view of one embodiment of a shear panel of the systems of FIG. **13**A;

[0092] FIG. **14**A is a detail of FIG. **13**B;

[0093] FIG. **14**B is a detail of FIG. **13**D;

[0094] FIG. **15** is a plan view of one embodiment of a shear transfer plate;

[0095] FIG. **16** is a front elevation of one embodiment of a shear transfer plate;

[0096] FIG. **17** is a detail front elevation of FIG. **13**A;

[0097] FIG. **18** is a detail plan view at D-D of FIG. **13**A;

[0098] FIG. **19** is a detail plan view at A-A of FIG. **13**A;

[0099] FIG. **20** is a detail plan view at B-B of FIG. **13**A;

[0100] FIG. **21**A is a detail front elevation of FIG. **13**A;

[0101] FIG. **21**B is a detail side elevation of FIG. **13**A with a hold-down assembly installed with an anchor interconnect;

[0102] FIG. **21**C is a detail side elevation of FIG. **13**A with a hold-down assembly installed without an anchor interconnect;

[0103] FIGS. **22**A and **22**B are detail plan section views at generally at C-C of FIG. **13**A;

[0104] FIGS. **23**A and **23**B are detail plan section views at generally at B-B of FIG. **13**A;

[0105] FIGS. **24**A and **24**B are detail plan section views at generally at C-C of an alternative embodiment of FIG. **13**A;

[0106] FIGS. **25**A and **25**B are detail plan section views at generally at B-B of an alternative embodiment of FIG. **13**A;

[0107] FIGS. **26**A-**26**D are front, rear, side elevation and a plan view respectively of one embodiment of a hold-down bracket;

[0108] FIGS. **27**A and **27**B are front and side elevation views respectively of one embodiment of a slotted support plate;

[0109] FIGS. **28**A and **28**B are plan and side elevation views respectively of one embodiment of a compression plate;

[0110] FIG. **29** is a side view of one embodiment of fastener;

[0111] FIG. **30** is a side view of one embodiment of hold-down interconnect fastener;

[0112] FIGS. **31**A and **31**B are plan and side elevation views respectively of one embodiment of a compression fastener;

[0113] FIGS. **32**A and **32**B are plan and side elevation views respectively of one embodiment of a hold-down interconnect coupler;

[0114] FIG. **33** is an elevation view of one embodiment of an assembled hold-down assembly;

[0115] FIG. **34** is a plan view generally at A-A of FIG. **33**;

[0116] FIG. **35** is a section plan view generally at B-B of FIG. **33**;

[0117] FIG. **36** is a plan view of another embodiment of a hold-down bracket;

[0118] FIG. **37** is a plan view of yet another embodiment of a hold-down bracket;

[0119] FIG. **38** is a plan view of another embodiment of compression plate; and

[0120] FIG. **39** is a plan view of another embodiment of hold-down assembly in an assembled state.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0121] Reference will now be made to the drawings wherein like numerals refer to like parts throughout. FIGS. **1** through **6** relate to embodiments of the invention that use one design of a chord that forms various structures described below. FIGS. **7** through **12** relate to embodiments of the invention that use another design of the chord. It will be appreciated that the chords of different designs both afford advantages in a substantially similar manner that is described below.

[0122] FIG. **1** is a perspective view of two adjoining wall frames **101** joined at a corner. The wall frame **101** comprises a plurality of vertical chords **102** that are secured at the top by a horizontal chord comprising an M-track **104**, and at the bottom by a bottom track **106**. In this embodiment, the chords **102**, **104** are steel; however, a person of ordinary skill in the art will appreciate that they can be made of a number of different materials, including wood, without departing from the spirit of the invention. The wall frame **101** is assembled and secured to a foundation **110** in a manner known in the art. Secured to at least one location of each wall frame **101** is a shear panel **100** of one embodiment of the invention. The shear panel **100** is secured to the M-track

104 and the bottom track **106** in a manner described below. Additionally, the shear panel **100** is secured to the foundation **110** by a hold-down strap **114** and an anchor **112** in a manner described below. It will be appreciated that the shear panel **100**, when secured to the wall frame **101** and the foundation **110**, provides the wall frame **101** with structural integrity to substantially resist shear forces and uplifting forces applied to the wall frame **101**.

[**0123**] FIG. **2**A illustrates a side elevation view of the shear panel **100** comprising a corrugated diaphragm **120** framed by vertical chord sections **122**, a top horizontal section **124**, and a bottom horizontal chord section **126**. FIG. **2**B illustrates an end elevation view of the shear panel **100**, showing that the profile of the shear panel **100** is such that when installed in the wall frame **101**, the shear panel **100** fits substantially flush with the wall frame **101** and does not protrude out. FIG. **2**C illustrates a plan sectional view of the shear panel **100**. A cross-section of the vertical section **122** shows that the vertical section **122** is comprised of shaped chord members joined together. As will be described below in greater detail, the chord members of the vertical sections **122**, as well as the top chord section **124** and the bottom chord section **126**, increase the structural integrity of the shear panel substantially.

[**0124**] FIGS. **3**A to **3**E illustrate a sequence of assembly of one embodiment of the shear panel **100**. In FIG. **3**A, the corrugated diaphragm **120** comprises top panel sections **131***a*, **131***b*, middle panel sections **132***a*, **132***b*, and bottom panel sections **133***a*, **133***b*. The top panel section **131***b* is substantially same as the top panel section **131***a*, and is oriented such that it forms a mirror image of the top panel section **131***a* with respect to a plane that is in between and substantially parallel to the planes defined by the top panel sections **131***a*, **131***b*. Similarly, the middle panel sections **132***a*, **132***b* and the bottom panel sections **133***a*, **133***b* form symmetric structures.

[**0125**] In one embodiment, the top panel section **131***a* is attached to the middle panel section **132***a* by a butt joint **138** facilitated by a flat gusset strap **134**. The gusset strap **134** is clinched to each of the panel sections **131***a*, **132***a* so as to form the joint **138**. Similarly, the bottom panel section **133***a* is attached to the middle panel section **132***a* via gusset strap **134** so as to form a corrugated panel **130***a*. A corrugated panel **136***b* is formed in a similar manner.

[**0126**] Each of the two corrugated panels **130***a* and **130***b* comprises a plurality of corrugations **137** that run generally horizontally. In one embodiment, the sectional profile of the corrugation **137** resembles a square wave pattern. The corrugation **137** comprises a recessed flute **135** and an external flute **136**, wherein the recessed flute **135** defines a recess in the corrugated diaphragm **120** when viewed from either side of the corrugated diaphragm **120**. The external flute **136** and the recessed flute **135** are interconnected by a interconnecting section **310***a*(*b*). The external flutes **136** and the recessed flutes **135** are parallel to the plane of the corrugated panels **130***a*, **130***b*, and the interconnecting sections **310***a*, **310***b* are diagonal to the direction of the external and recessed flutes **136**, **135**. The interconnecting sections **310***a*, **310***b* are oriented diagonally such that the vertical distance between the closest edges of the adjacent external flutes **136** is larger than the vertical dimension of the recessed flute **135**. The degree of diagonality of the interconnecting sections **310***a*, **310***b* varies, but the mechanical advantage provided remains substantially similar.

[**0127**] The corrugation comprises the recessed flute **135** attached to the interconnecting section **310***b*, which in turn is attached to the external flute **136**. The external flute **136** is attached to the interconnecting section **310***a*. This structure is repeated so as to form the corrugated panels **130***a*, **130***b*.

[**0128**] The two corrugated panels **130***a* and **130***b* are secured together at contact points along the back sides of the recessed flutes **135** in a manner described below to form the corrugated diaphragm **120**. It will be understood that the recessed flute **135** and the external flute **136** are also referred to hereinafter as a groove and a ridge, respectively.

[**0129**] FIG. **3**B illustrates the corrugated panels **130***a*, **130***b* being attached to sub-frames **140***a*, **140***b*. The sub-frame **140***a* comprises chords **141***a*, **142***a*, and **143***a*. The sub-frame **140***b* forms a substantial mirror image of the sub-frame **140***a*. The corrugated panel **130***a* is attached to the sub-frame **140***a* in a manner described below to form a sub-panel **144***a*, and similarly, a sub-panel **144***b* comprises the corrugated panel **130***b* attached to the sub-frame **140***b*.

[**0130**] FIG. **3**C illustrates the sub-panels **144***a* and **144***b* being conjoined together. The two sub-panels **144***a*, **144***b* are secured to each other in a manner described below. The chords **141***a* and **141***b*, when secured together, become the top section **124**, as illustrated in FIG. **3**D. Similarly, the chords **143***a* and **143***b* become the bottom section **126**. As illustrated in FIG. **3**D, the chords **142***a* and **142***b* are secured together, and vertical tracks **123** are attached so as to form the vertical sections **122**.

[**0131**] FIG. **3**E illustrates the fully assembled shear frame **100** being secured to the foundation **110**. In one embodiment, the hold-down strap **114** comprises a U-shaped member with a first section **115***a* and a second section **115***b* attached by a base section **115***c* therebetween so as to define a recess **113**. The recess **113** is sized to receive the shear panel **100** such that the vertical sections **122** can be secured to the inside surfaces of the first and second sections **115***a*, **115***b* in a manner described below. The hold-down strap **114** further comprises openings (not shown) at the base, the openings spaced to match the protrusions of the anchor **112**. The base of the hold-down strap **114** is secured to the foundation **110** by an anchor nut **116**.

[**0132**] Parts that make up the shear frame **100**, as described above in reference to FIGS. **1**-**3**, are now described in greater detail. In particular, various geometries and methods of attachments that contribute to the strength of the shear frame **100** are described. FIGS. **4**A and **4**B illustrate top and bottom end side elevation views of the shear frame **100**, respectively, showing a plurality of attachment points. The corrugated diaphragm **120** is framed by the top section **124** at the top, the vertical sections **122** at the sides, and the bottom section **126** at the bottom. As described above, the corrugated diaphragm **120** comprises two corrugated panels **130***a* and **130***b* conjoined together. Furthermore, the top section **124**, the vertical sections **122**, and the bottom section **126** each comprises two chords joined in a substantially symmetrical manner. The attachment points illustrated in FIGS. **4**A and **4**B only show one side of attachment of the corrugated diaphragm **120** to the sub-frame **140**_a_(_b_). It will be understood that the manner of attachments on the other side of the corrugated diaphragm **120** is substantially similar.

[**0133**] The description of attachment hereinafter follows the sequence of assembly of the shear panel **100** described above. In reference to FIG. **3**A, FIGS. **4**A and **4**B illustrate a plurality of clinches **151** at the butt joint **138** that secure the panel sections **131**_a_(_b_), **132**_a_(_b_), **133**_a_(_b_) so as to form the corrugated section **130**_a_(_b_). The formed butt joint becomes one of the external flutes **136** of the corrugated diaphragm **120**.

[**0134**] In reference to FIG. **3**B, wherein the corrugated section **130**_a_(_b_) is being attached to the sub-frame **140**_a_(_b_), FIGS. **4**A and **4**B illustrate a plurality of clinches **152** along the top section **124**, a plurality of clinches **153** along the vertical sections **122**, and a plurality of clinches **154** along the bottom section **126**. The vertical dimensions and the corrugation spacing are selected to permit the exterior flutes **136** to coincide with the top and bottom sections **124** and **126** so as to allow the clinches **152** and **154** to secure the corrugated diaphragm **120** to the top and bottom sections **124** and **126**. Furthermore, the corrugated diaphragm **120** is sized in horizontal direction such that the clinches **153** are situated at the lateral ends of the exterior flutes **136**.

[**0135**] In reference to FIG. **3**C, wherein the sub-panels **144**_a_ and **144**_b_ are being assembled together, FIGS. **4**A and **4**B illustrate a plurality of clinches **150** distributed throughout the recessed flutes **135**. When the sub panels **144**_a_ and **144**_b_ are mated, the back sides of the recessed flutes **135** come into contact so as to allow the clinches **150** to be made. The combination of clinching of the corrugated panel **130**_a_(_b_) to the sub-frame **140**_a_(_b_) and clinching the corrugated panels **130**_a_ and **130**_b_ together contributes to the rigidity of the resulting shear panel **100**.

[**0136**] The structural integrity of the wall frame **101** is improved by a manner in which chords are shaped and assembled into sections that form the frame of the shear panel **100**, and by a manner in which the shear panel **100** is attached to the wall frame **101** and the anchor **112**. FIG. **5**A illustrates an enlarged cross-sectional view of the top portion of the shear panel **100**. The top section **124** comprises the chords **141**_a_ and **141**_b_, described in greater detail below, arranged in a substantially symmetric manner. Each of the two chords **141**_a_, **141**_b_ is secured to the external flute **136** by the top clinches **152** as described above. In one embodiment, the top section **124** is secured to the M-track **104** that defines the top of the wall frame **101**, by a plurality of field installed shear transfer screws **156**. A plurality of such attachments are performed along the M-track **104** that coincides with the top section **124**.

[**0137**] As illustrated in FIG. **5**A, the M-track **104** is an elongated member that extends along the top portion of the wall, and has a cross section that comprises a first section **301** and a second section **302** with an interconnecting section **303** interposed therebetween. The first and second sections **301**, **302** extend vertically, and the ends of the interconnecting section **303** are attached to the top of the first and second sections **301**, **302**. The interconnecting section **303** comprises a plurality of folds such that the section **303** includes additional vertical sections **305** interposed between horizontal sections **304**. The M-track **104**, illustrated in FIG. **5**A, further comprises an inverted U-shaped fold **307** near the middle of the interconnecting section **303**, such that the M-track **104** contains a total of 6 vertical extensions and 5 horizontal extension in its cross section. The plurality of folds that form the plurality of vertical and horizontal extensions provide greater strength to resist forces directed along vertical and horizontal directions.

[**0138**] The horizontal sections **304** on either sides of the U-shaped fold **307** are secured to the chords **141**_a_, **141**_b_ by the screws **156**. Furthermore, the first and second sections **301**, **302** are secured to another portion of the chords **141**_a_, **141**_b_ by the screws **156**.

[**0139**] FIG. **5**B illustrates an enlarged cross-sectional view of the bottom portion of the shear panel **100**. The bottom section **126** comprises the chords **143**_a_ and **143**_b_ arranged in a substantially symmetric manner. Each of the two chords **143**_a_, **143**_b_ is secured to the external flute **136** by the clinches **152** as described above. As shown in FIG. **4**B, the shear panel **100** is secured to the hold-down strap **114** by a plurality of hold-down screws **162** and a plurality of bolts or cap screws **160**. The hold-down strap **114** is in turn secured to the anchor **112** by a plurality of slotted steel capture plates **117** and the anchor nuts **116**. As shown in FIG. **5**B; the shear frame **100** and hold-down strap **114** assembly is positioned within the recess **107** defined by the bottom track **106**.

[**0140**] The bottom track **106** is a U-shaped member that has a cross section with a first leg **321** and a second leg **322** that is connected to the first leg **321** by a base section **323**. The recess defined by the first and second legs **321**, **322**, and the base section **323** is sized to receive the bottom of the shear panel **100** such that the shear panel **100** is substantially aligned with the wall.

[**0141**] Positioning the assembly at substantially center of the bottom track is facilitated by a slot **118** defined by the slotted capture plate **117**. FIG. **5**D illustrates the slot **118** that allows the assembly to be shifted with respect to the fixed anchor **112** so as to permit the assembly to be substantially centered within the bottom track **106**.

[**0142**] FIGS. **5**C and **5**D illustrate cross-sectional views of the vertical section **122** at two different heights. The vertical section **122** comprises the chords **142**_a_ and **142**_b_ arranged in a substantially symmetric manner. Each of the two vertical chords **142**_a_, **142**_b_ is secured to the external flute **136** by the clinches **153** as described above. The vertical section **122** further comprises the vertical track **123**.

[**0143**] The vertical track **123** extends vertically along the edges of the shear panel **100**, and has a U-shaped cross section comprising a first leg **331** and a second leg **332** interconnected by a base section **333** so as to define a recess that partially encloses the pair of chords **142**_a_, **142**_b_ within its recess. The chords **142**_a_, **142**_b_ are secured to the vertical track **123** by a plurality of screws **164** extending through the base section **333**. At the lower portion of the shear panel **100**, as illustrated in FIG. **5**D, additional screws extend through the first and second legs **331**, **332** and secure the vertical track **123** to the chords **142**_a_, **142**_b_. Additionally, the portion of the vertical section **122** that overlaps with the hold-down strap **114** is secured with a plurality of screws **162** that extend through the hold-down strap **114**, the vertical track **123**, and the chord **142**_a_(_b_).

[**0144**] The lower portion of the vertical section **122** is further reinforce by a pair of J-plates **145**_a_, **145**_b_, as illustrated in FIGS. **5**B and **5**C. Situated in the recessed flute **135** area, the J-plate **145**$a(b)$ is secured to its respective chord **142**$a(b)$ by clinches **153**. Additionally, the clinches **153** that join the J-plate **145**$a(b)$ to the chord **142**$a(b)$ extend to secure a hex nut **161** adjacent the J-plate **145**$a(b)$. The hex nut **161** receives a bolt or cap screw **160** that extends through the hold-down strap **114**, the vertical track **123**, and the chord **142**$a(b)$ so as to further secure the J-plate **145**$a(b)$ for reinforcement.

[**0145**] As described above, the sections that make up the frame of the shear panel **100** each comprise of a pair of chords. In one embodiment of the invention described above, the cross-sectional shape of the chord is available as a Deitrich design. In another embodiment of the invention, as described below, the cross-sectional shape of the chord may comprise a different shape without departing from the spirit of the invention.

[**0146**] FIG. **6** illustrates the cross sectional shape of the Deitrich chord **146** referred to above in relation to the shear panel frame. As shown in FIG. **6**, the cross section of the chord **146** comprises a plurality of folds, comprising a first segment **341** extending in a first direction. A second segment extends in a second direction from the first segment **341**, wherein the second direction is perpendicular to the first direction. A third segment **343** extends in a third direction from the second segment **342**, wherein the third direction is perpendicular to the second direction and opposite the first direction. The length of the third segment **343** is longer than that of the first segment **341**. A fourth segment **344** extends in a fourth direction from the third segment **343**, wherein the fourth direction is perpendicular to the third direction and opposite the second direction. The fourth segment **344** is shorter than the second segment **342**. A fifth segment **345** extends in the third direction from the fourth segment **345**. A U-shaped fold **349** is interposed between the fifth segment **345** and a sixth segment **346** that is collinear with the fifth segment **345**. The U-shaped fold **349** is positioned such that two ends at the top of the "U" joins the fifth and sixth segments **345**, **346**. A seventh segment **347** extends in the second direction from the sixth segment **346**. An eighth segment **348** extends in the first direction from the seventh segment **347**.

[**0147**] The first, second, and third segments **341**, **342**, **343** define a partially enclosed space **350**, and the fourth, fifth, sixth, seventh, and eighth segments **344**, **345**, **346**, **347**, and **348** define a partially enclosed space **351**. The chord **146** has a total of five segments extending in first and third directions, and three segments extending in second and fourth directions. Additionally, the U-shaped fold **349** is positioned between the fifth and sixth segments **345**, **346** that together are longer than any other single segment. The fold **349** permits the fifth and sixth segments **345**, **346** to maintain rigidity. It will be appreciated that the plurality of folds as described above permit the chord **146** to resist buckling in two lateral dimensions.

[**0148**] As is known in the art, a flat sheet offers substantial resistance to buckling along the direction parallel to the plane of the sheet, but offers little strength in the direction perpendicular to the plane. If the sheet is folded at a right angle, strength is provided in both lateral directions against buckling. In practice, sheets of metal are folded in a variety of manner to provide strength against buckling. Folded structures also offer an additional advantage over a solid structure of similar size by substantially reducing the weight.

[**0149**] The third and eighth segments **343**, **348** are substantially coplanar so as to permit another chord to be joined at locations along those segments to yield a composite structure. Similarly, two chords can be joined at the first segments **341** to form another composite structure such as the various sections of the shear frame **100** described above.

[**0150**] It will be appreciated that the plurality of folds in the chord **146** afford high strength with relatively low weight. Furthermore, the shape of the cross section of the chord **146** permits two or more chords **146** to be joined together, in manners described above, to yield stronger structures. The light weight and high compressive strength make the chord **146**a highly suitable material for construction applications such as frame sections and wall columns, due to structural advantages described above.

[**0151**] Another component that contributes to the overall strength of the shear panel **100** is the corrugated diaphragm **120**. In particular, the generally horizontal corrugation comprising alternating recessed and exterior flutes with interconnecting sections contribute to the strength of the shear frame **100**. The exterior flutes on both sides of the corrugated diaphragm **120** define an enclosed space, essentially making the geometry of the diaphragm resulting from the conjoining of the two separate diaphragm panels a series of connected horizontal tubular beams. In one embodiment, the cross section of such a beam is hexagonal in shape. Since the corrugations are generally horizontal, the corrugated diaphragm **120** has high compressive and tensile strength along the horizontal direction, which is also the primary directional component of a typical shear force, for which the panel is designed.

[**0152**] A lateral load shear force acting on a building is transmitted to the wall at the top or bottom, and if unmitigated with some form of bracing or strengthening, the rectangular geometry of the wall does not offer sufficient resistance against lateral movement of the top or bottom of the wall. Thus, the rectangular structure may become a parallelogram shaped structure due to the shear force. For example, an earthquake often shakes a building in a lateral motion, and the resulting shear forces act on the bottom of the wall. In another example, a strong wind blowing at the side of the building causes shear forces at the top of the wall. A shear force at the top of the wall not only tends to distort the rectangular shape of the wall, but also tends to apply an uplifting force at certain locations along the bottom of the wall. If the wall is not secured sufficiently to the foundation, the wall may detach from the foundation.

[**0153**] The shear panel **100** described herein mitigates the forces that tend to make the wall's top or bottom move relative to other parts of the building. The shear panel **100** described above is a substantially rigid structure, particularly against horizontal forces parallel to the plane of the shear panel **100**. The shear panel **100** is secured to the wall at the top and bottom of the wall in a manner described above, such that the plane of the shear panel **100** is substantially coplanar with the plane of the wall. Thus, shear forces acting on the wall are mitigated and dissipated by the rigid yet ductile shear panel **100** to inhibit the rectangular structure of the wall from being distorted to a parallelogram shape. A shear force acting on the top of the wall gets transferred to the lower part of the building through the shear panel **100**, and is thus dissipated. A shear force acting on the bottom of the wall is transmitted to the upper part of the building through the shear panel **100**, thus causing the upper part of the wall to move in unison with the lower part. In either case, the shear panel **100** helps maintain the rectangular geometry of the wall, and thus its structural integrity.

[**0154**] The employment of corrugated sheet diaphragms introduces a new variation in the concept of sheet diaphragm assemblies in that the three-dimensional geometry of a corrugated diaphragm provides an inherent degree of ductility to the diaphragm component of a shear-resisting assembly. Consequently the third dimension of the corrugated diaphragm provides a physical structure which can partially collapse or compress under certain conditions of force or strain without being destroyed. The term "destroyed", as applied to the discussion of corrugated sheet diaphragms, is defined as meaning the condition wherein relatively thin sheet metal which has deformed beyond tensile yield strength limits of the material. It is believed that the tendency to buckle at the compression members of the vertical chords is reduced when a corrugated diaphragm is employed which, by virtue of its internal compression capabilities, provides controlled ductility in the shear panel.

[**0155**] FIGS. **7** through **12** illustrate another embodiment of the invention, wherein a shear panel **200** comprises chord members **222** of unique design, and attachment assemblies adapted to attach the shear panel to top and bottom of the wall. The design of the chord **222** is described below in reference to FIG. **9**.

[**0156**] FIG. 7A illustrates the shear panel **200** comprising a corrugated diaphragm **210** is interposed between two vertical sections **220**. The shear panel **200** further comprises a top assembly **230** that secures the shear panel **200** to the top portion of the wall in a manner described below, and a bottom assembly **240** that secures the shear panel **200** to a foundation **243** in a manner described below.

[**0157**] The shear panel **200** is secured to the foundation **243** via anchor bolts **241** and **242** that are pre-installed in the foundation **243**. It is noted, however, that anchor bolts which are retrofitted into the foundation may also apply to the utilization of the invention herein described. Preferably, the anchor bolts **241** are ⅝" diameter steel U-bolts. The anchor bolt **241** and its associated attachment parts are adapted to resist horizontal base shear forces acting on the shear panel **200**. The hold-down anchor bolts **242** are preferably ¾" diameter steel u-bolts and their associated attachment parts are adapted to resist uplifting forces acting on the shear panel **200**.

[**0158**] FIG. 7B illustrates a base plate **250** that facilitates securing of the shear panel **200** to the foundation **243** through the connection of the horizontal base shear bolts **241**. The base plate **250** comprises a flat portion **253** and vertical portions **254** that are illustrated as folded out dashed lines in FIG. 7B. The flat portion **253** defines holes **251** sized to receive the anchor bolt **241**. The flat portion **253** further defines holes **252** sized to receive the anchor bolt **242**. The holes **252** are adapted to allow limited range of positioning of the anchor bolt **242** so as to allow the shear panel **200** to be positioned properly with respect to the wall and the foundation **243**. The vertical portions **254** attach to the corrugated diaphragm **210** in a manner described below. The base plate **250** is preferably formed from a minimum thickness of 14 gauge steel. The base plate **250** is illustrated in relation to the bottom track **246**. The bottom track **246** is described in greater detail below.

[**0159**] FIG. **8** illustrates attachment of the shear panel **200** to the top of the wall via the top assembly **230**. The top assembly **230** comprises a top track **231** that is attached to the top portion of the wall (not shown), and a hat channel **232** that secures the top track **231** to the corrugated diaphragm **210**.

[**0160**] The top track **231** comprises a U-shaped cross section having a first leg **401** and a second leg **402** with a base section **403** interposed therebetween so as to define a recess sized to receive the top portion of the shear panel **200**. The hat channel **232** comprises a cross section having a U-shaped portion with a first leg **411** and a second leg **412** with a base section **413** interposed therebetween. The hat channel **232** further comprises a first extension **415** extending from the first leg **411** on the opposite side from the base section **413**, and a second extension **416** extending from the second leg **412** on the opposite side from the base section **413**. The first and second extensions **415**, **416** are substantially coplanar to each other, and both are substantially parallel to the base section **403** of the top track **231** so as to allow attachment using screw and/or clinch **234**.

[**0161**] The first and second legs **411**, **412** of the hat channel **232** are substantially parallel, and are spaced to fit within a hemmed external flute **238** that forms the uppermost external flute in the shear panel **200**. As is illustrated in FIG. **8**, the hemmed flute **238** comprises the end section of the corrugated panels **210**. Specifically, the hemmed flute **238** comprises folding the metal sheet at the top of the corrugated panels **210** to form a double layer of metal so as to increase the strength of the hemmed flute **238** for attachment to the first and second legs **411**, **412** of the hat channel **232** via screws **233**. Thus, the hat channel **232** interconnects the corrugated diaphragm **210** to the top track **231**.

[**0162**] FIG. **8** also illustrates the cross section of the corrugated diaphragm **210** interposed between two chords **222**. The diaphragm **210** comprises a plurality of recessed flutes **236** and external flutes **235** arranged in an alternating manner. The recessed and external flutes **236**, **235** are connected by an interconnecting section **420** so as to form the corrugated structure described above. The diaphragm **210** is made by conjoining two corrugated panels together in a substantially symmetric manner, as described above in reference to FIGS. **3**A-C, by a plurality of clinches **237**.

[**0163**] FIG. **9** illustrates a cross sectional view of the vertical section **220**, comprising two chords **222** and a vertical track **221**. Also shown is a portion of the hold-down assembly **229** that is described in detail below. The chord **222** has a cross section that comprises a first section **431** extending in a first direction, connected to a second section **432** that extends in a second direction, wherein the second direction is perpendicular to the first direction. A third section **433** is attached to the second section **432** and extends in a third direction, wherein the third direction is perpendicular to the second direction and opposite the first direction. A fourth section **434** is connected to the third section **433** and extends in a fourth direction, wherein the fourth direction is perpendicular to the third direction and opposite the second direction. A fifth section **435** is connected to the fourth section **434** and extends in the third direction. A sixth section **436** is connected to the fifth section **435** and extends in the second direction. A seventh section **437** is connected to the sixth section **436** and extends in the third direction. An eighth section **438** is connected to the seventh section **437** and extends in the fourth direction. A ninth section **439** is connected to the eighth section **438** and extends in the first direction. The first, fifth, and ninth sections **431**, **435**, **439** are substantially coplanar. The third and seventh sections **433**, **437** are substantial coplanar. The second, fourth, sixth, and eighth sections **432**, **434**, **436**, **438** are substantially parallel. In total, the chord **222** has 5 sections that extend in the first or third directions, and 4 sections that extend in the second or fourth directions, so as to provide strength as described above in reference to the chord **146**.

[**0164**] The chord **222** further defines first, second, and third at least partially enclosed spaces **281**, **282**, **283**, wherein the second space **282** is interposed between the first and third spaces **281**, **283**. The opening of the first space **281** faces in the same direction as the opening of the third space **283**. The opening of the second space **282** faces the opposite direction as that of first and third spaces **281**, **283**, such that the adjacent openings face alternating directions. The first space **281** includes a lip **284**, and the third space **283** includes a lip **285**.

[**0165**] The chord **222** is preferably roll formed from a 16 gauge steel. A plurality of bends in the cross sectional shape of the chord **222** makes the chord **222** highly resistant to lateral buckling when the chord **222** is subjected to a compressive force directed along its longitudinal axis of elongation.

[**0166**] The vertical section **220** comprises two chords **222** arranged such that the openings of the first and third spaces **281**, **283** of the two chords **222** face each other. As such, the chords **222** are secured to the corrugated diaphragm **210** by a plurality of clinches **223** at portions of the chords **222** that define the second spaces **282**. The portions of the two chords **222** that define the first spaces **281** are secured to the vertical track **221** in a manner described below in reference to FIG. **11**B.

[**0167**] FIG. **10** illustrates attachment of the shear panel **200** to the foundation **243** at the anchor bolt **241**, the attachment adapted to resist horizontal shear forces. A bottom track **246** is positioned on top of the foundation **243** such that a plurality of holes (not shown) permit the anchor bolts **241**, **242** to extend therethrough. The bottom track **246** has a U-shaped cross section having a first leg **461** and a second leg **462** with a base section **463** interposed therebetween. The spacing between the first and second legs **461**, **462** is selected to receive the bottom portion of the shear panel **200**.

[**0168**] The bottom track **246** is sized to receive the flat portion of the base plate **253** that defines the holes **251** (in FIG. **7**B), through which the anchor bolt **241** extends through. The anchor bolt **241** is secured by a nut **244** and a washer **245**. The corrugated diaphragm **210** is secured to the vertical portion of the base plate **254** by a plurality of screws **233** that extends through the vertical portion **254** and the hemmed external flute **238**. The chords **222** are secured to the base track **246** by a plurality of nails **247**.

[**0169**] FIGS. **11**A-D illustrate attachment of the shear panel **200** to the foundation **243**. FIG. **11**A illustrates the bottom assembly **240** isolated from the diaphragm **210** and the vertical sections **220**. The bottom assembly **240** comprises a hold-down assembly **500** and an anchor assembly **600**. The hold-down assembly **500** is adapted to resist uplift forces, and the anchor assembly **600** is adapted to resist base shear forces that induce relative movement between the bottom of the shear panel and the foundation.

[**0170**] The isometric view of the bottom assembly in FIG. **11**A illustrates the major components that are described in greater detail below. First and second hold-down brackets **263**, **264** are shown in relation to a hold-down bolt **261** that couples with the anchor bolt **242**. A plurality of bolts **265** and washer plates **266** secure the hold-down brackets **263**, **264** to the diaphragm **210** (not shown in FIG. **11**A).

[**0171**] FIG. **11**B illustrates securing of the chord **222** to the foundation **243** via the first and second hold-down brackets **263**, **264** and the hold-down bolt **261** coupled to the anchor bolt **242**. The anchor bolt **242** is coupled to the hold-down bolt **261** by a coupling nut **260**. The hold-down bolt **261** extends through an opening defined between the first and second hold-down brackets **263**, **264**. The hold-down brackets **263**, **264** are secured to the chord **222** by a plurality of bolts **265** and a washer plate **266** in a manner described below. The hold-down bolt **261** secures the chord **222** to the foundation **243** by tightening the hold-down bolt **261** with a washer **267** and a compression plate **262** interposed between the head of the hold-down bolt **261** and portions of the top edges of the hold-down brackets **263**, **264**.

[**0172**] FIG. **11**C illustrates a top cross sectional view of the hold-down assembly. In particular, positioning of the hold-down bolt **261** and the compression plate **262** relative to the first and second hold-down brackets **263**, **264** are shown. The opening **268** on the compression plate **262** is sized to allow limited range of position adjustment of the hold-down bolt **261** so as to permit proper positioning of the shear frame **200** with respect to the foundation **243**.

[**0173**] FIG. **11**C further illustrates the hold-down bolt **261** positioned within the space defined by the first and second hold-down brackets **263**, **264**. Each of the first and second hold-down brackets **263**, **264**, is U-shaped when viewed from the top as in FIG. **11**C, and are sized such that the second hold-down bracket **264** fits within a portion of a recess defined by the first hold-down bracket **263**. When tops of the "U" on the first and second hold-down brackets **263**, **264** are substantially aligned to each other, the bottoms of the "U" on the first and second hold-down brackets **263**, **264** are spaced apart to form the space through which the hold-down bolt **261** extends through.

[**0174**] The first hold-down bracket **263** is interposed between the two chords **222**, and is secured to the two chords **222** by the bolts **265** coupled by a nut coupler **271**. The nut coupler **271** extends through holes defined by the corrugated diaphragm **210**, the first and second hold-down brackets **263**, **264**, and the chords **222**, and butts against recesses on the washer plates **266**. The washer plate **266** is sized to fit within the partially enclosed space **282** (FIG. **9**), such that when the two bolts **265** are tightened, the two chords **222** are compressed together.

[**0175**] The first and second hold-down brackets **263**, **264**, and the diaphragm **210** between the chords **210** are inhibited from being collapsed by the nut coupler **271** acting as a spacer, and also by a formed compression filler **272**. The compression filler **272** is preferably made from rubber or plastic.

[**0176**] FIG. **11**D illustrates a side elevation view of attachment of the two chords **222** to the hold-down brackets **263**, **264**, and the diaphragm **210** interposed therebetween. The sectional views of the hold-down brackets **263**, **264** show their position in the recessed flute portion of the diaphragm **210**. The external flute portion of the diaphragm **210** is thus positioned in a cutout **273** in the hold-down brackets, as illustrated in FIG. **12**B.

[**0177**] FIGS. **12**A and **12**B illustrate end and side views of the first hold-down bracket **263**. The cutout **273** is sized to receive the external flute of the diaphragm **210** such that the hold-down bracket **263** can be positioned substantially flush with the chords **222**. The second hold-down bracket **264** is shaped similar to the first hold-down bracket illustrated in FIGS. **12**A, **12**B.

[**0178**] Aside from the structural advantages, the shear panel **200** provides an advantage of being able to be substantially prefabricated. In use, field installation of the shear panel **200** to the wall comprises several simple steps. First, the base plate **250** is secured to the foundation **243** by placing the base plate **250** within the bottom wall track **246** , and securing the anchor bolts **241**, **242** in manners described above in reference to FIGS. **9-11**. The shear panel is then inserted within the vertical legs **254** of the base plate **250**. The hold-down bolts **261** are inserted through the washer plates **267** and **262** and then placed through the vertical enclosed space of the hold-down brackets **263** and **264**. The hold-down bolt **261** is then threaded into the top opening of coupling nut **260** which has been threaded and tightly secured to the anchor bolt **242**. The hold-down bolt **261** is then tightened down firmly securing the shear panel to the embedded anchor bolts **242**. The field installed screws **233** are then installed through the prepunched holes in the vertical legs **254** of the base plate **250** and further into the hemmed bottom flutes **238** of the corrugated diaphragm. The shear panel **200** is then secured to the top wall track by the clinches and/or screws **234** as illustrated in FIG. **8**. The vertical track **221** is attached to the vertical chords **222** by a plurality of screws **270**, as illustrated in FIG. **11**B, to complete the installation process.

[**0179**] FIGS. **13**A, **13**B, **13**C provide front, side section, and side elevation views, respectively, of embodiments of a shear panel and hold-down system **1100**. The system **1100** is configured to more efficiently transfer shear forces incident on a building, such as from high wind loading and/or seismic forces, to an underlying building foundation. In this embodiment, the system **1100** comprises a shear panel assembly **1102** which is attached to a hold-down assembly **1104**. The hold-down assembly **1104** is interconnected to one or more structures of a building foundation and the shear panel **1102** is interconnected at an upper end thereof to other structure of the building **1200** such that lateral or uplift forces, particularly those applied at upper extents of the building are resisted by the physical strength of the shear panel assembly **1102** and its interconnection via the hold-down assembly **1104** to the building foundation. In certain embodiments, the system **1100** also comprises a shear transfer plate **1106** which is also interconnected to the shear panel assembly **1102**, as well as the underlying building foundation so as to provide additional resistance against uplift and lateral shifting of the system **1100** and attached building under shear or seismic forces.

[**0180**] In these embodiments, the system **1100** also comprises a top track **1120** and a bottom track **1122** which provide additional structure for interconnection of the system **100** to the building and underline building foundation, respectively.

[**0181**] In this embodiment, the shear panel assembly **1102** comprises a plurality of corrugated panels **1110** such that the shear panel assembly **1102** comprises a corrugated shear panel assembly. In one embodiment, the corrugated panels **1110** comprise light-gauge sheet steel, which is rolled or stamped into a generally angular corrugated pattern. Thus, in this embodiment, the corrugated panels **1110** define outward flutes **1111** and inward flutes **1113** which are alternating and interconnected by a corresponding plurality of webs **1115**. In one particular embodiment, the corrugated panels **1110** are formed such that the outward flutes **1111** and inward flutes **1113** join adjacent webs **1115** at an angle α. The angle α can be selected for improved ease of manufacture and/or for improved mechanical properties of the system **1100**. In certain embodiments, an angle α of approximately 120° provides a preferred combination of fabrication ease and mechanical properties.

[**0182**] In this embodiment, two corrugated panels **1110** are arranged with each other such that the inward flutes **1113** abut and are substantially aligned with each other vertically, as well as laterally. The abutting corrugated panels **1110** are then joined to each other indicated by the attachment **1124**. In various embodiments, the attachment **1124** can comprise clinching, welding, adhesives, threaded fasteners, rivets, or other methods or materials for joining materials. In one preferred embodiment, clinching is at least partially employed as the attachment **1124** as clinching provides a relatively rapid and cost-effective manner of joining materials, particularly those embodiments in which the corrugated panels **1110** comprise light-gauge stamped or rolled steel.

[**0183**] The interconnected corrugated panels **1110** also define a plurality of elongate box structures **1114**. In this embodiment, the elongate box structures **1114** are generally contoured as hexagonal prisms defined by a pair of outward flutes **1111** and the adjoining webs **1115** on either side of the two interconnected corrugated panels **11110**. As the outlying inward flutes **1113** of the two opposed and interconnected corrugated panels **1110** are joined by the attachment **1124**, and are materially continuous with the webs **1115** and outward flutes **1111**, the elongate box structure **1114** defines a structurally strong member. The elongate box structure **1114** is resistant to both compressive and tensile loads, as well as torsional loads. Thus any shear forces, indicated in FIG. **13**A by the opposed arrows **1101**, particularly those acting generally in the plane of the shear panel assembly **102** are strongly resisted by the elongate box structures **1114**. In this particular embodiment, the elongate box structures **114** are arranged in a generally horizontal orientation. Shear forces **1101**, particularly those acting generally in the plane of the shear panel assembly **1102**, would tend to buckle, bend, twist, and/or parallelogram convention panels. However, as the shear panel assembly **1102** of these embodiments defines a three-dimensional structurally strong member defined by a plurality of strong interconnected elongate box structures **1114**, the interconnect corrugated panels **1110** of the shear panel assembly **1102** are by themselves strongly resistant to any twisting or parallelogramming. This aspect of the shear panel assembly **1102** is improved by the generally horizontal arrangement of the elongate box structures **1114** as shear forces **1101** acting generally in the plane of the shear panel assembly **1102** would otherwise tend to distort a panel along the horizontal direction.

[**0184**] FIGS. **15** and **16** illustrate in plan and front elevational view respectively, one embodiment of a shear transfer plate **1106**. The shear transfer plate is configured for attachment both to other components of the shear panel assembly **1102** as well as to an underlying building foundation. In this embodiment, the shear transfer plate **1106** comprises one or more openings **1126** dimensioned to receive and attach to anchor structures **1130** attached to an underlying building foundation. In this embodiment, the shear transfer plate **1106** also comprises a pair of vertically extending opposed webs **1132** having a plurality of attachment locations **1134** for connection of the shear transfer plate **1106** to other components of the shear panel assembly **1102**, such as via a plurality of attachments **1124**.

[**0185**] In one embodiment, the system **1100** further comprises one or more anchor fasteners **1136** configured to engage with a respective anchor member **1130** to secure the system **1100** to a building foundation via engagement with the shear transfer plate **1106**. As the openings **1126** are preferably dimensioned to closely conform to the dimensions and contours of the anchor members **1130**, when attached with respective anchor fasteners **1136** the shear transfer plate **1106** and thereby the shear panel assembly **1102** is restrained against movement with respect to the anchor members **1130** and thereby further with the underlying building foundation. (See FIGS. **17** and **19**).

[**0186**] FIGS. **18**, **20**, and **22**A and **22**B illustrate additional aspects of certain embodiments of a shear panel and hold-down system **1100**. In this embodiment, the system **1100** defines a pair of opposed and generally vertically extending box columns **1116**. In one embodiment, the box columns **1116** comprise a first elongate C channel **1142** and a second elongate C channel **1150**. In this embodiment, the first C channel **1140** comprises a web portion **1142** attached along opposite edges to flange portions **1144** and which are attached at opposite edge portions to lip portions **1142**. Thus, together the lip portions **1146**, the flange portion **1144**, and the web portion **1142** together define a generally C-shaped rectangular section. In one embodiment, the first and second C channel members **1140**, **1150** are row formed from sheet steel. In this embodiment, the second C channel **1150** similarly comprises a web portion **1152** attached along opposite edges to flange portions **1154** which are further attached at opposite edge to lip portions **1156**.

[**0187**] In this embodiment, the system **1100** further comprises a third C channel elongate member **1160**. The third C channel member **1160** is attached to both the first C channel member **1140** and second C channel member **1150** via a plurality of attachments **1158**, such as formed via welding, clinching, fasteners, adhesives, etc. The plurality of attachments **1158** further attach the third elongate C channel member **1160** to both opposed sides of the corrugated panels **1110** of the system **1100**. Together the interconnected first, second, and third elongate C channel members **1140**, **1150**, and **1160** define elongate and generally vertically extending box structures **1162**. The box structures **1162** are bounded by the interconnected first, second, and third C channel members to define a continuous and generally rectangular cross-section three-dimensional structure.

[**0188**] It will be understood that the box columns **1116** including in this embodiment the first, second, and third C channel members **1140**, **1150**, and **1160** as mutually interconnected and as connected to the corrugated panels **110** define a structure extending three dimensionally and internally cross-braced to provide significant resistance to bending or deformation when subject to compression, tensile, and twisting forces. These aspects significantly improve the capacity of the system **1100** to resist shear forces which might otherwise tend to distort or bend the system **1100** and any attached building structure. A further advantage of the system **1100** is that it is dimensioned and configured to readily integrate with existing standard framing dimensions. The system **1100** provides improved strength and durability arising from the combination of contours, materials, and interconnection of the various components of the system **1100** however avoids inconvenient dimensions or protrusions which might require expensive modification of existing designs for incorporation of the system **1100**.

[**0189**] FIGS. **24**A and **24**B illustrate another embodiment of a system **1100** including box columns **116**. This embodiment is substantially similar to the previously described embodiment including the box columns **116** and box structure **1162**. This embodiment differs however in lacking the second C channel elongate member **1150**. Rather, in this embodiment the first C channel member **1140** is attached to a third C channel member **1160** which is attached to corrugated panels **1110**, such as via a plurality of attachments **1158**. A further difference is that rather than the closed box structure **1162**, this embodiment defines an open box structure **1163**. The open box structure **1163** comprises multiple independent members interconnected so as to extend three-dimensionally in space. The open box structure **1163** likewise offers significant resistance to bending or deformation under tension, compression, and twisting loads. However, rather than defining an enclosed space as in the closed box structure **1162**, this embodiment **1163** maintains an open configuration, e.g., between the opposed lip portions **1146** to provide access to the interior of the open box structure **1163**, for example to facilitate manipulation of one or more attachments **1158**.

[**0190**] FIGS. **21**A-**21**C, **23**A and **23**B, **25**A and **25**B, **26**A-**26**D, **27**-**35** illustrate embodiments of a hold-down assembly **1104** of the system **1100**. The hold-down assembly **1104** is configured to interconnect the shear panel assembly **1102** to an underlying building foundation to restrain lift-off, downward forces, as well as lateral translation to assist securing an attached building to the underlying foundation. In one embodiment, the hold-down assembly **1104** comprises a hold-down bracket **1170** having slots **1172** formed therein (see FIGS. **26**A-**26**D). In this embodiment, the hold-down bracket **1170** describes a generally hat-shaped cross-section and is formed from stamped or rolled sheet steel.

[**0191**] In this embodiment, the hold-down assembly **1104** also comprises slotted plates **1174** also having slots **1176** which are configured to mate with and engage the slots **1172** of the hold-down bracket **1170**. The slotted plates **1174** engage in the hold-down brackets **1170** to further box in or interconnect in three dimensions the hold-down bracket **1170** such that the hold-down assembly **1104** has greater structurally resistance to bending and deformation under compression, tension, and twisting forces.

[**0192**] In this embodiment, the hold-down assembly **1104** also comprises a pair of compression plates **1180** dimensioned to be positioned at upper and lower ends of the hold-down bracket **1170**. In this embodiment, the hold-down assembly **1104** also comprises an elongate screw **1186** and the compression plates **1180** each define an opening **1182** dimensioned to closely receive the screw **1186**. Thus, in this embodiment, the screw **1186** passes through a compression plate **1180** arranged in an upper end of the hold-down bracket **1170** as well as a second compression plate **1180** arranged at a lower end of the hold-down bracket **1170**. In this embodiment, the hold-down assembly **1104** further comprises a compression nut **1190** which is manipulated to compress the compression plates **1180** into firm contact with the hold-down bracket **1170** positioned therebetween.

[**0193**] In this embodiment, the hold-down assembly **1104** further comprises a coupler **1192** which is dimensioned to threadably engage with a lower end of the screw **1186** and further configured to threadedly engage with the upper end of a respective anchor member **1130**. The screw **1186**, the compression **1190**, and the coupler **1192** are manipulated to bring the hold-down assembly **1104** into a desired position with respect to the underlying building foundation. In many applications, the location and/or vertical protrusion of the anchor members **1130** are subject to variation. In the desired orientation, the hold-down assembly **1104** is restrained from both upward and downward vertical movement with respect to the corresponding anchor member **1130** and thereby with respect to the underlying building foundation. The coupler **1192** facilitates vertical adjustment of the system **1100**. Thus, the system **1100** is adapted to connect at a desired height even with differing protrusion distances of the anchor members **1130** facilitated by the adjustability provided by the coupler **1192** and its engagement with a respective anchor member **1130**. The hold-down assembly **1104** is further restrained against lateral translation and bending due to the rigid nature of the materials forming the hold-down assembly **1104**.

[**0194**] Thus, the hold-down assembly **1104** as attached to a corresponding anchor member **1170** provides a rigid secure structure for interconnection of an associated shear panel assembly **1102**. In this embodiment, the hold-down assembly **1104** comprises a plurality of screws **1184** which are configured for attachment to an associated shear panel assembly **1102**. In this embodiment, the screws **1184** are configured for engagement with the sheet metal forming the shear panel assembly **1102**, however in other embodiments, the attachment provided by the screws **1184** can be supplemented or replaced by other methods of attachment, for example including welding, clinching, and/or adhesives.

[**0195**] FIG. **36** illustrates a plan view of another embodiment of hold-down bracket **1170**. In this embodiment, the hold-down bracket **1170** comprises an outer bracket configured for attachment to and engagement with an inner bracket **1194**. In this embodiment, both the outer hold-down bracket **1170** and inner hold-down bracket **1194** describe a generally hat-shaped cross-section with the inner bracket **1170** having a larger height or depth such that the connected inner and outer brackets **1170**, **1194** define an internal passage to accommodate the screw **1186**.

[**0196**] FIG. **37** illustrates yet another embodiment of hold-down bracket and in this embodiment an inner hold-down bracket **1170** is dimensioned to attach to and engage with an inner hold-down bracket **1194**. This embodiment is substantially similar to that embodiment previously described with FIG. **36**, however in this embodiment, the inner bracket **1194** defines a trapezoidal hat-shaped section rather than the rectangular hat shaped section of the embodiment illustrated and described with respect to FIG. **36**.

[**0197**] FIG. **38** illustrates one embodiment of a slotted compression plate **1194**. In this embodiment, the slotted compression plate **1194** comprises an elongate opening **1196** which is generally oval in shape. As can be seen in FIG. **39**, the elongate opening **1196** provides lateral clearance for the screw **1186**. This aspect facilitates accommodation of lateral mismatch between the system **1100** and one or more anchor members **1130**. Thus, the system **1100** provides lateral adjustability to accommodate limited horizontal mispositioning of one or more anchor members **1130** without requiring the expense and time consumption of removal and reinstallation of an anchor member **1130** in an appropriate position. FIG. **39** also illustrates that in this embodiment, the system **1100** comprises a first and a second elongate box members **1198*a*** and **1198*b***. These are attached with a first C channel member **1140** and a third C channel member **1160** together define box structure **1162** of the box column **1116**.

[**0198**] Thus, various embodiments provide a shear panel and hold-down system **1100** which is significantly resistant to uplift, compression, and lateral movement forces, such as rising from extreme weather conditions or seismic events to inhibit undesired movement of a building structure with respect to an underlying building foundation. The components of the system **1100** can be formed from well understood rolling and stamping formations to facilitate economical use of high strength materials resistant to environmental degradation, including sheet steel. Fabrication of the system **1100** as well as attachment to other building components is provided with well known, durable, and economical methods and materials for joining components, including use of threaded fasteners, clinching, and/or welding. The system **1100** provides for both vertical and lateral adjustability in the attachment of the system **1100** to an underlying building foundation, such as via the anchor members **1130**.

[**0199**] Although the various embodiments of the invention have shown, described and pointed out the fundamental novel features of the invention, it will be understood that various omissions, substitutions and changes in the form of the detail of the device illustrated may be made by those skilled in the art without departing from the spirit of the invention. Consequently, the scope of the invention should not be limited to the foregoing description, but should be defined by the appending claims.

What is claimed is:

1. A system for inhibiting unwanted movement between a building and an underlying foundation, the system comprising:

at least one shear panel assembly including corrugated portions and configured to resist bending and twisting distortion and

at least one hold-down assembly configured to attach to the at least one shear panel assembly and to attach to at least one anchor member rigidly engaged with an underlying building foundation so as to resist uplift, downward movement, and lateral movement of the at least one attached shear panel assembly, the at least one hold-down assembly configured to provide a range of vertical attachment adjustment to accommodate a range of extended length of the at least one anchor member.

2. The system of claim 1, wherein the at least one shear panel assembly is further configured for attachment to other building structure to provide resistance to bending and twisting distortion of attached other building structure.

3. The system of claim 1, wherein the at least one shear panel assembly comprises at least one corrugated panel defining opposed flutes.

4. The system of claim 3, wherein the at least one shear panel assembly comprises two connected corrugated panels, each corrugated panel defining inner and outer flutes with webs interposed between the inner and outer flutes.

5. The system of claim 4, wherein the inner and outer flutes connect with the webs at an angle selected to increase at least one of ease of fabrication of the corrugated panels and the structural properties of the at least one shear panel assembly.

6. The system of claim 5, wherein the angle is selected to be approximately 120°.

7. The system of claim 3, wherein the at least one shear panel assembly comprises two connected corrugated panels which together define a plurality of elongate box structures.

8. The system of claim 7, wherein the elongate box structures are configured to extend in a generally horizontal direction in an installed condition of the system.

9. The system of claim 7, wherein the elongate box structures define a generally hexagonal cross-section.

10. The system of claim 1, wherein the hold-down assembly is further configured to provide a range of horizontal adjustability.

11. The system of claim 10, wherein the hold-down assembly comprises a compression plate having an elongate opening dimensioned to receive the anchor member over the range of horizontal adjustability.

12. The system of claim 11, wherein the hold-down assembly comprises a screw and a coupler dimensioned to engage with the screw and with the anchor member such that the coupler can be manipulated to provide the vertical adjustment of the system.

13. The system of claim 12, wherein the hold-down assembly comprises a hold-down bracket configured such that the screw extends through the hold-down bracket and wherein the hold-down assembly defines a three-dimensionally extending box structure for increased resistance to bending and torsional distortion.

14. The system of claim 13, wherein the hold-down bracket comprises slots and the hold-down assembly further comprising slotted plates dimensioned to engage with the slots of the hold-down bracket to thereby in combination define the three-dimensionally extending box structure.

15. The system of claim 13, wherein the hold-down bracket comprises an inner bracket and an outer bracket.

16. The system of claim 13, further comprising compression plates dimensioned to engage at an upper end and a lower end of the hold-down bracket and to engage with the screw such that upwards and downwards forces imparted to the system are transferred to the respective anchor member.

17. The system of claim 1, wherein the system is at least partially formed of steel components and wherein the system is adapted to engage with steel framed buildings.

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