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(54) **WALL PANEL WITH CORNER CONNECTOR BLOCK**

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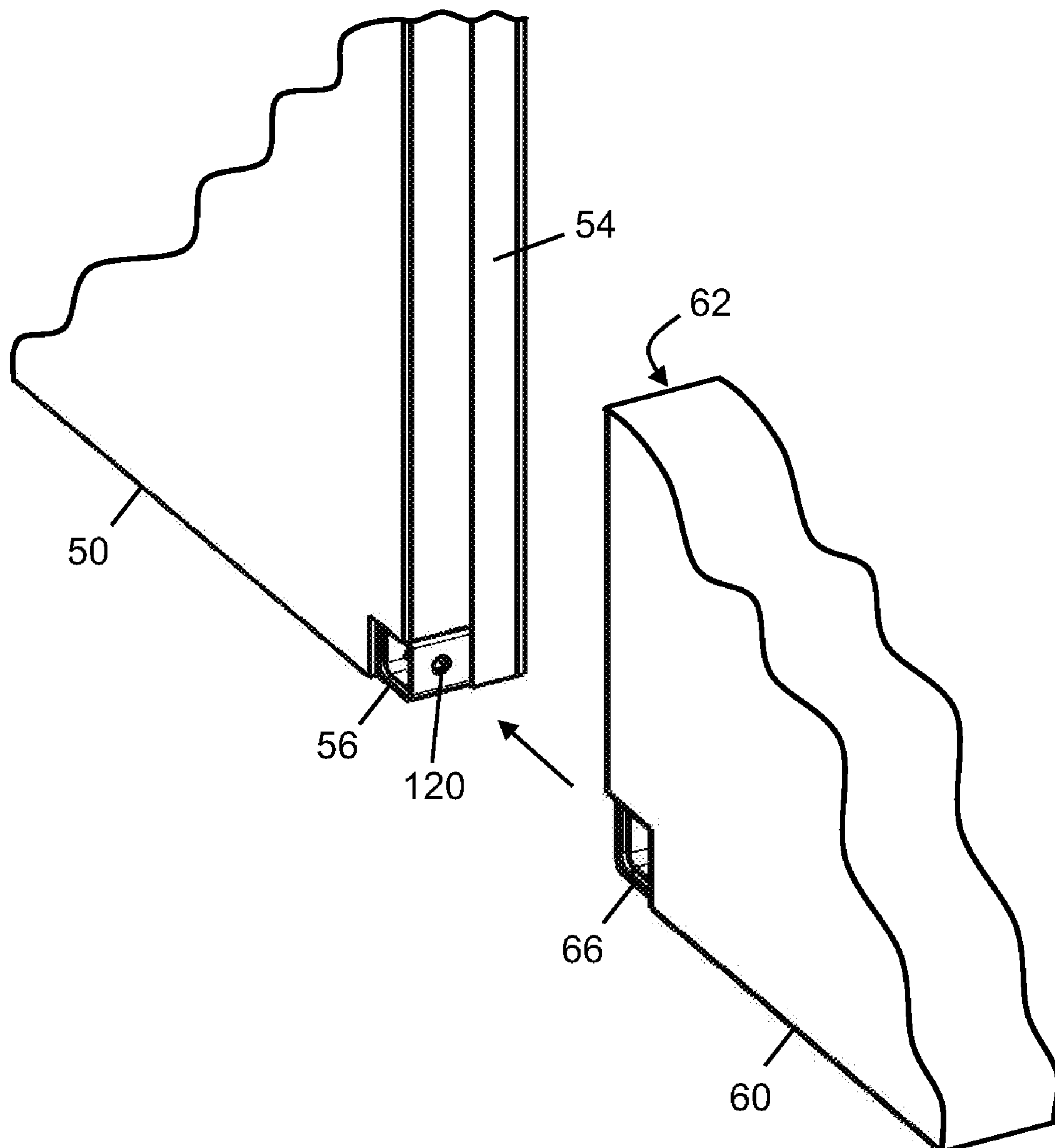
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(57) **ABSTRACT**

A wall panel includes hollow connector blocks in its lower corners, reinforced with anchor pins embedded in cementitious material of the panel. The connector blocks have holes for connecting adjacent wall panels together and for connecting the wall panels to the floor. Connectors are inserted via exposed apertures in the connector blocks that provide access to their hollow interiors. The apertures can be covered when the panels are fastened in place.



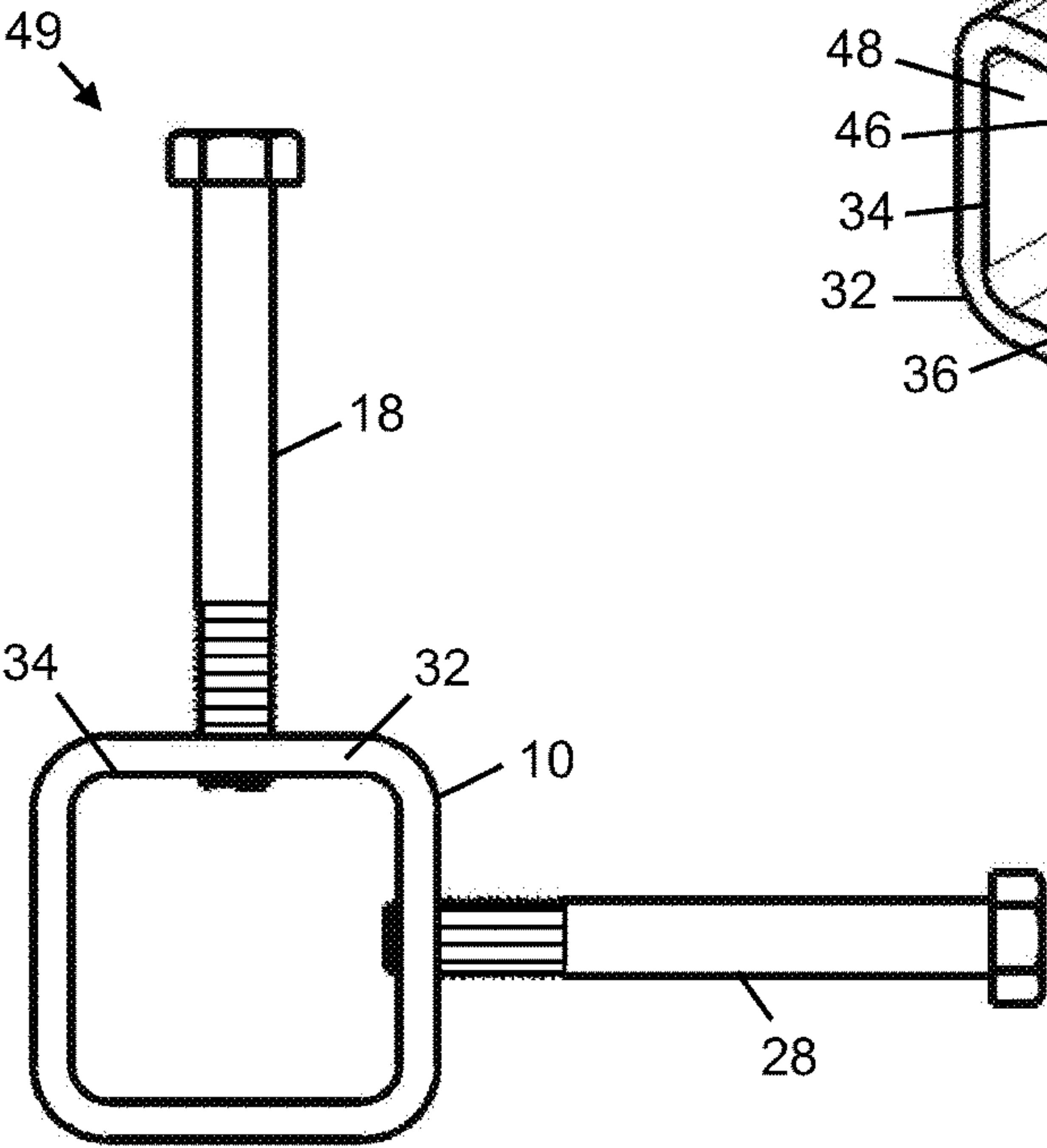
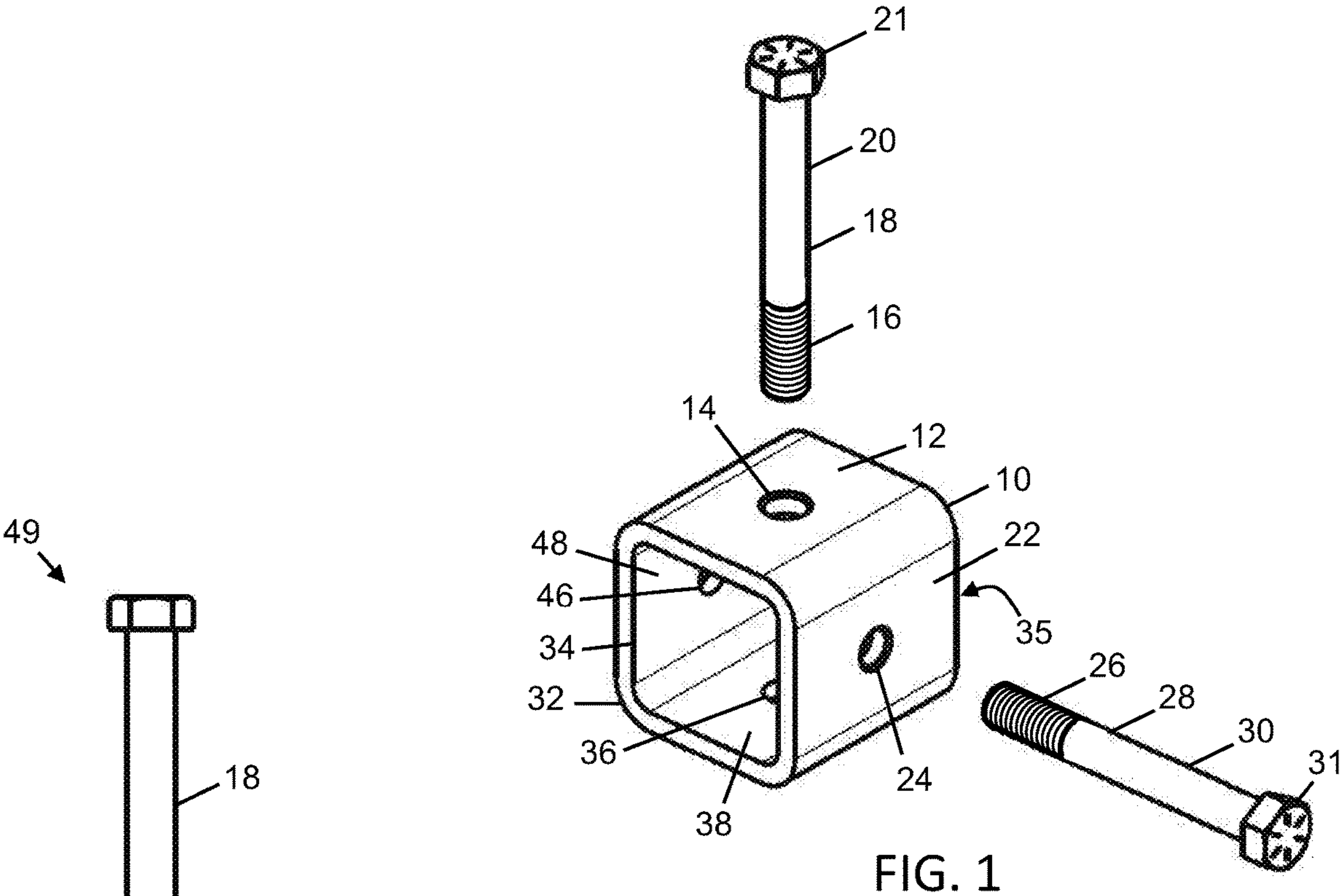


FIG. 2

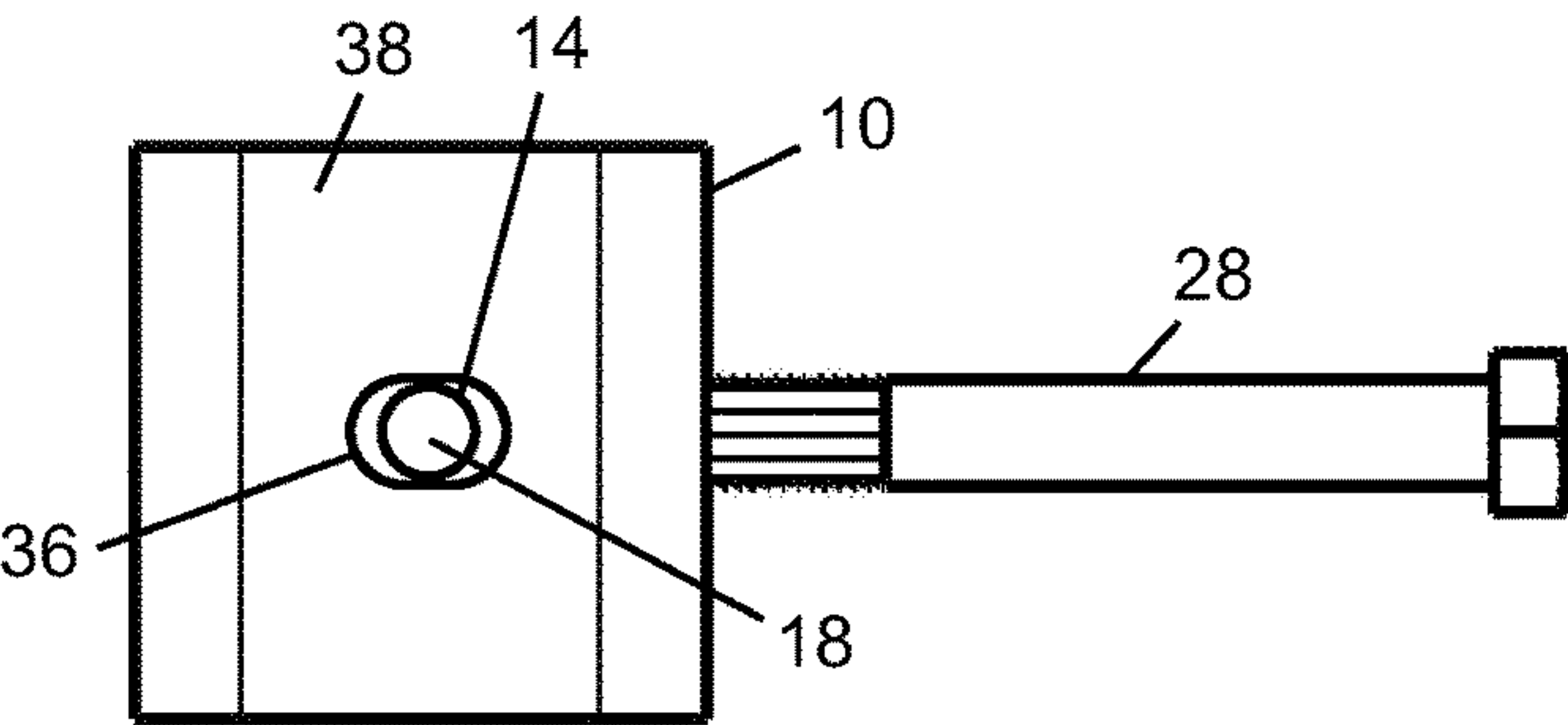


FIG. 3

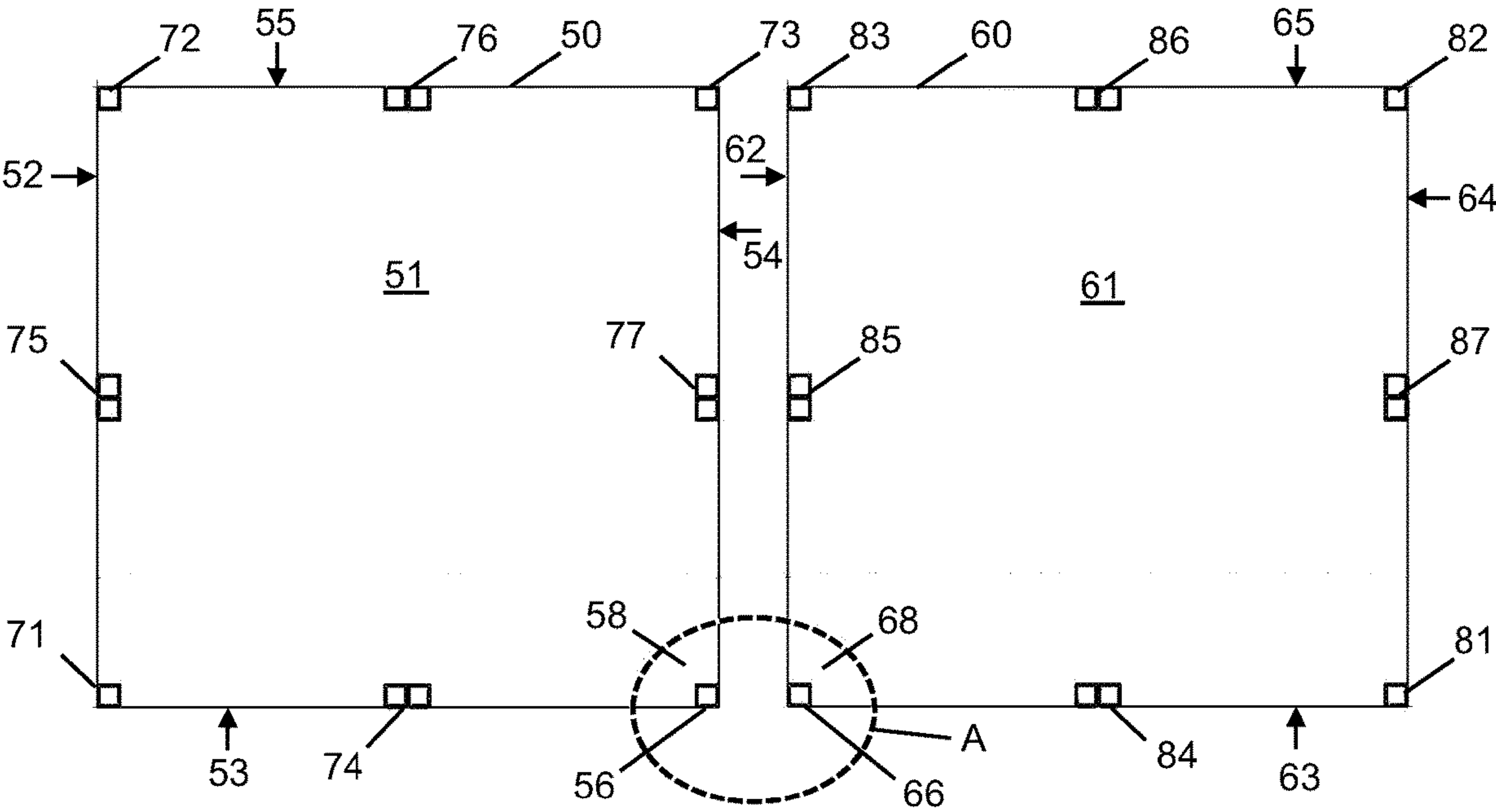


FIG. 4

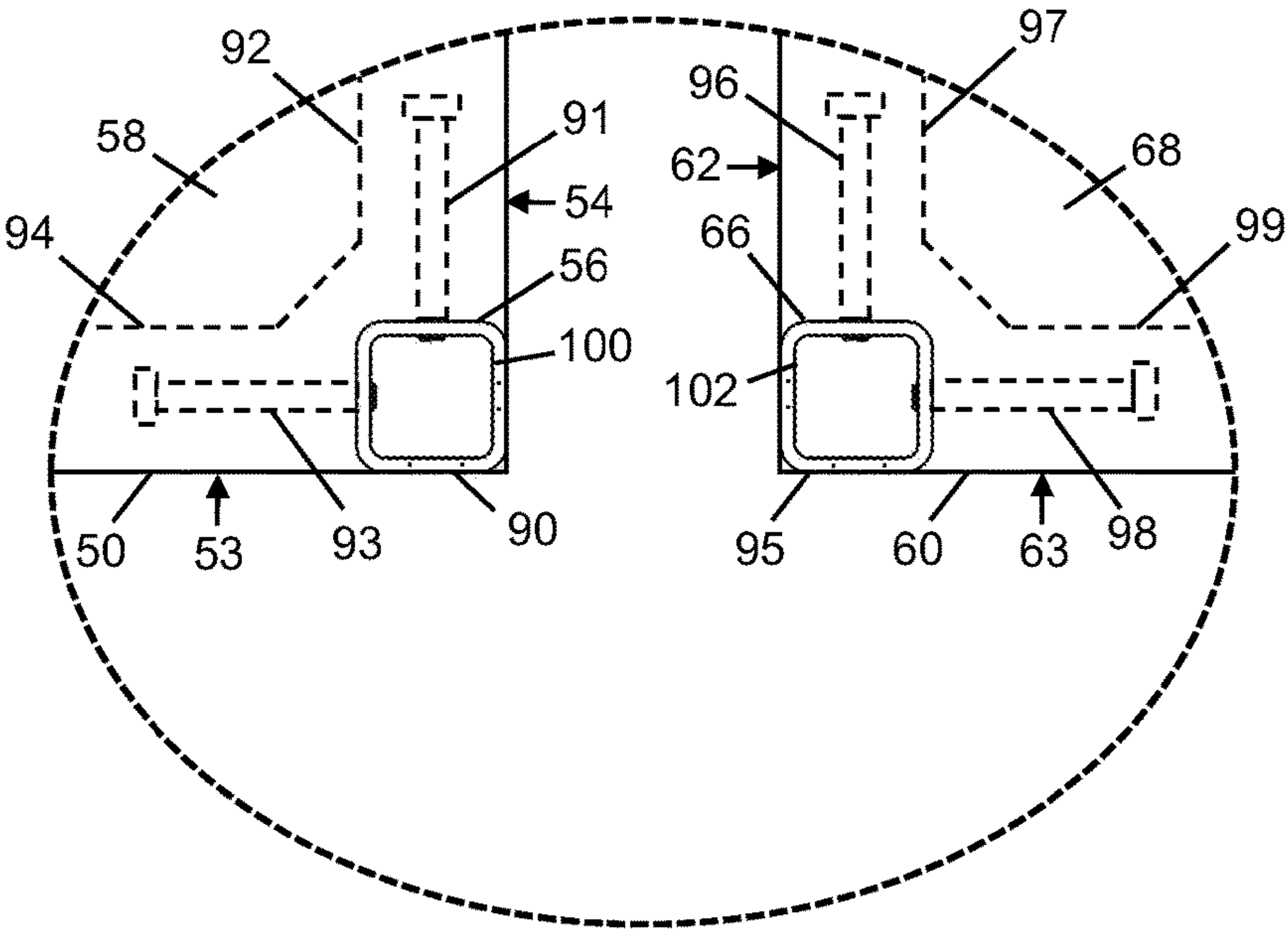
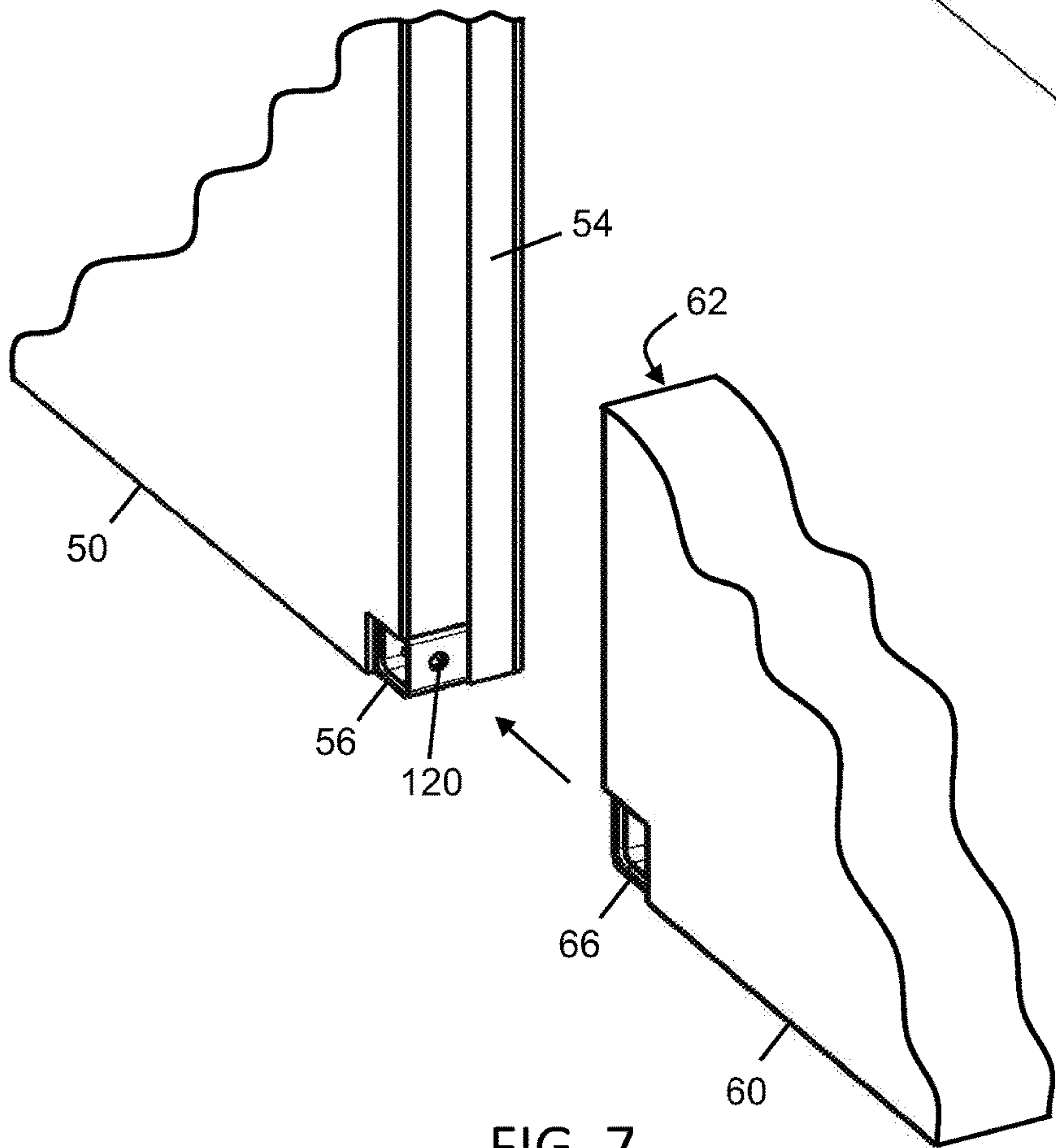
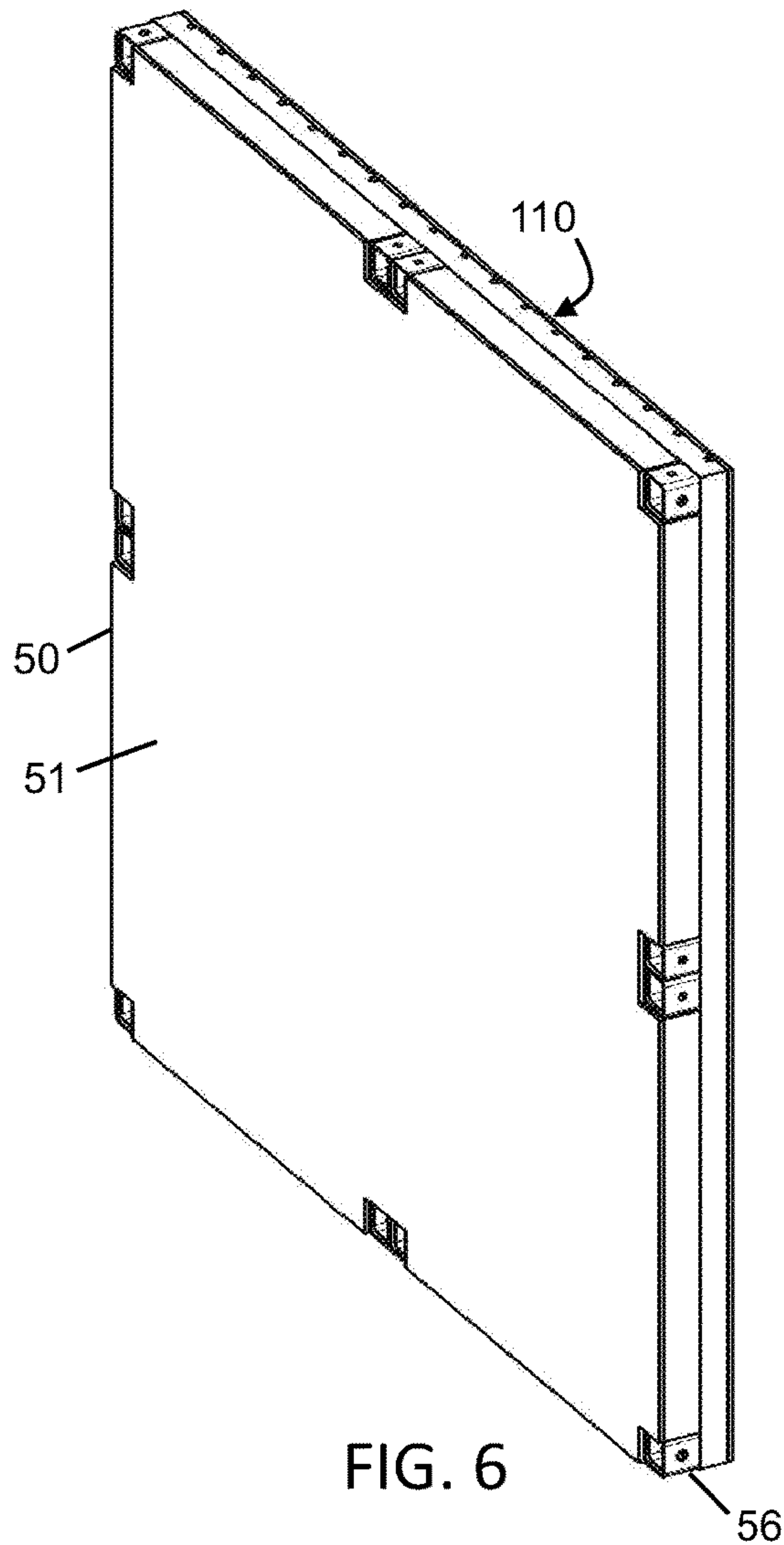


FIG. 5



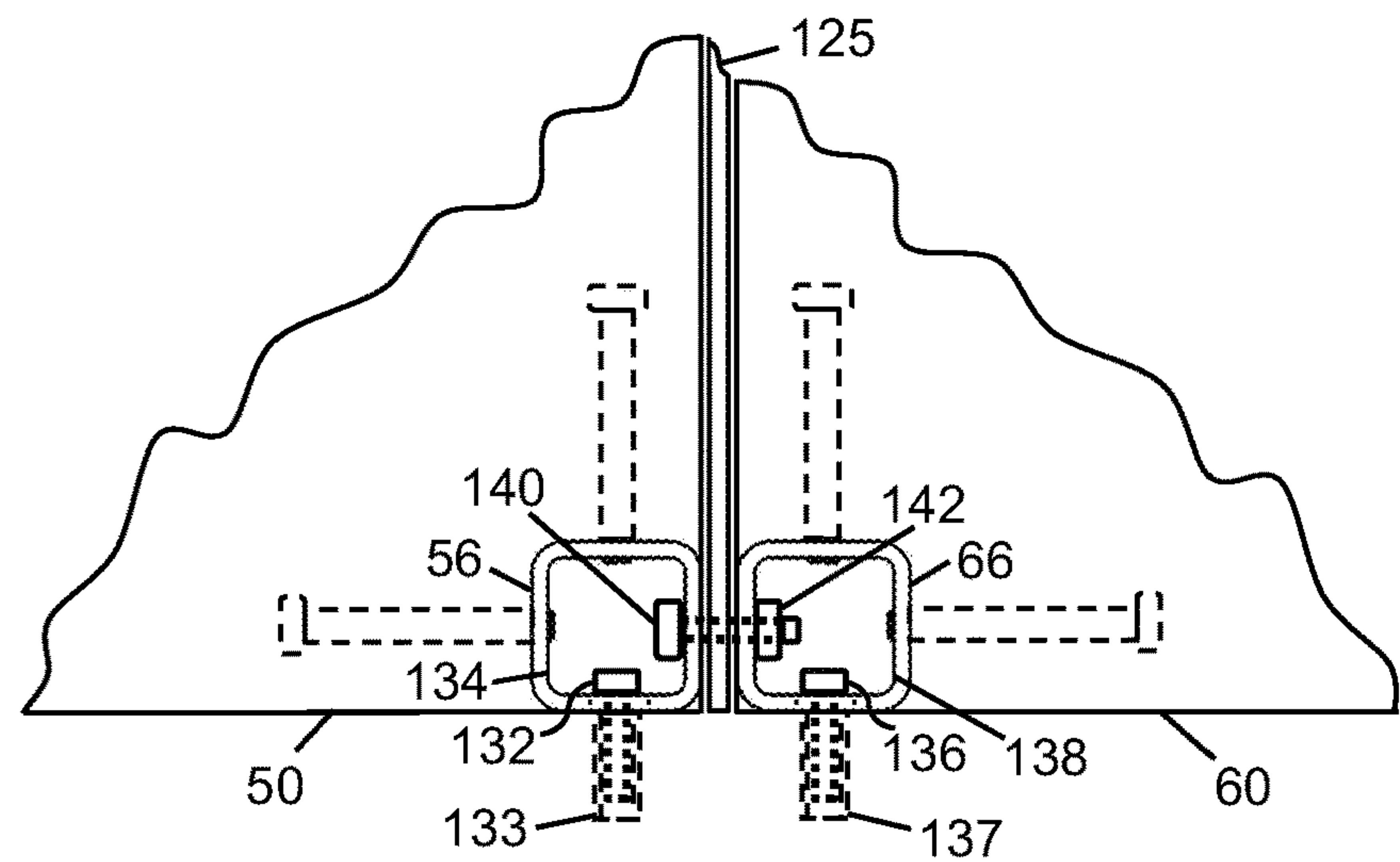


FIG. 8

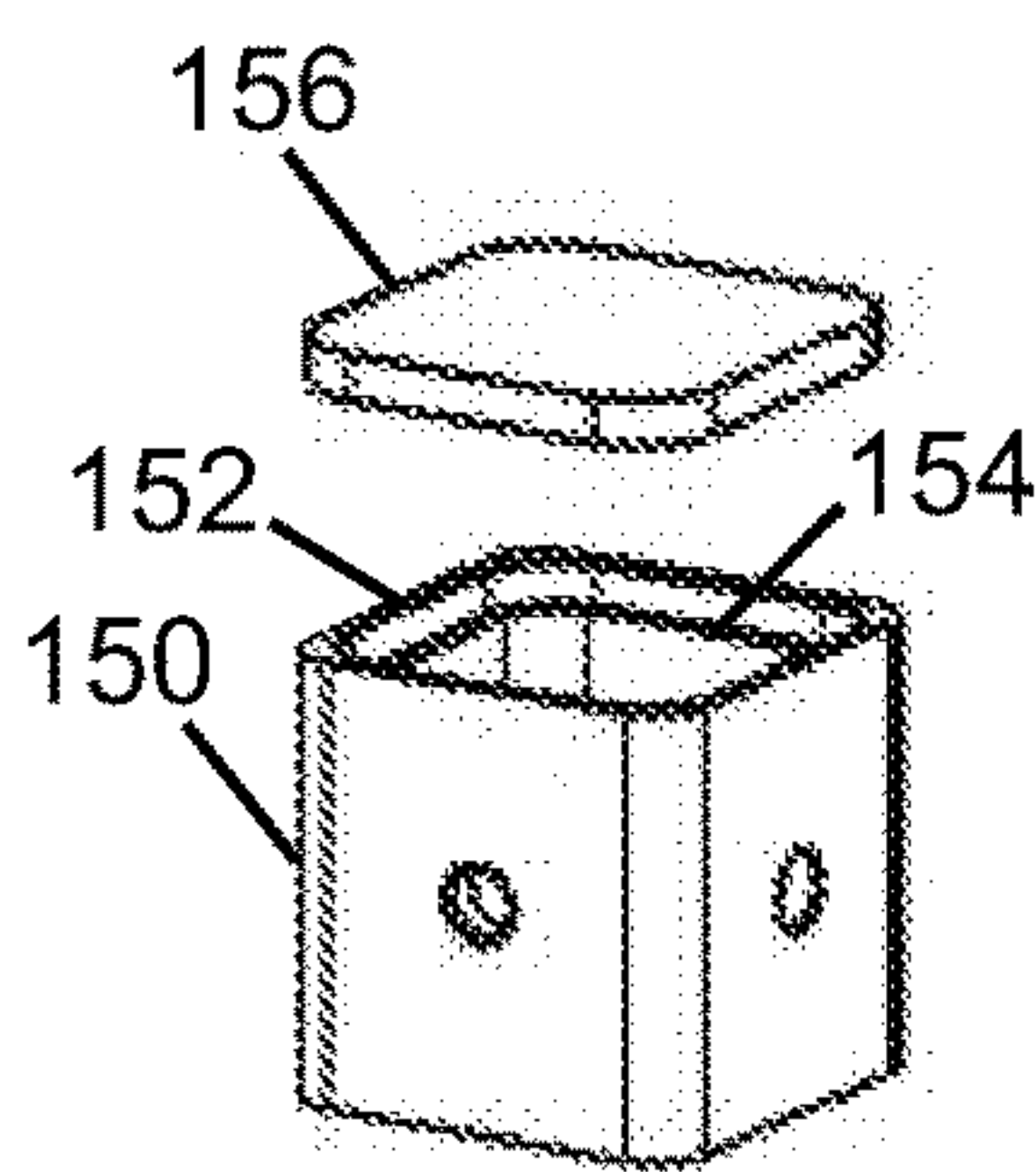


FIG. 9

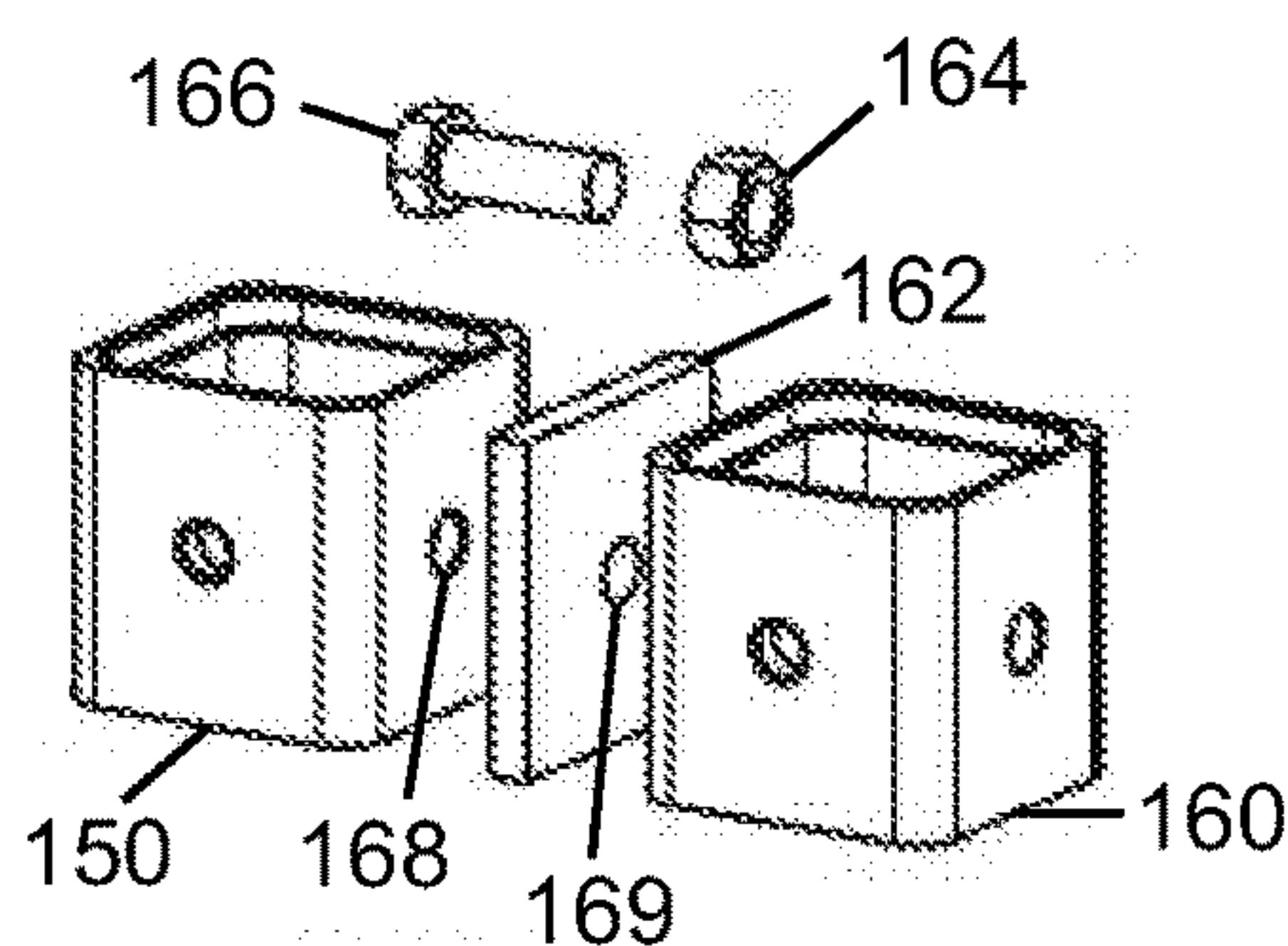


FIG. 10

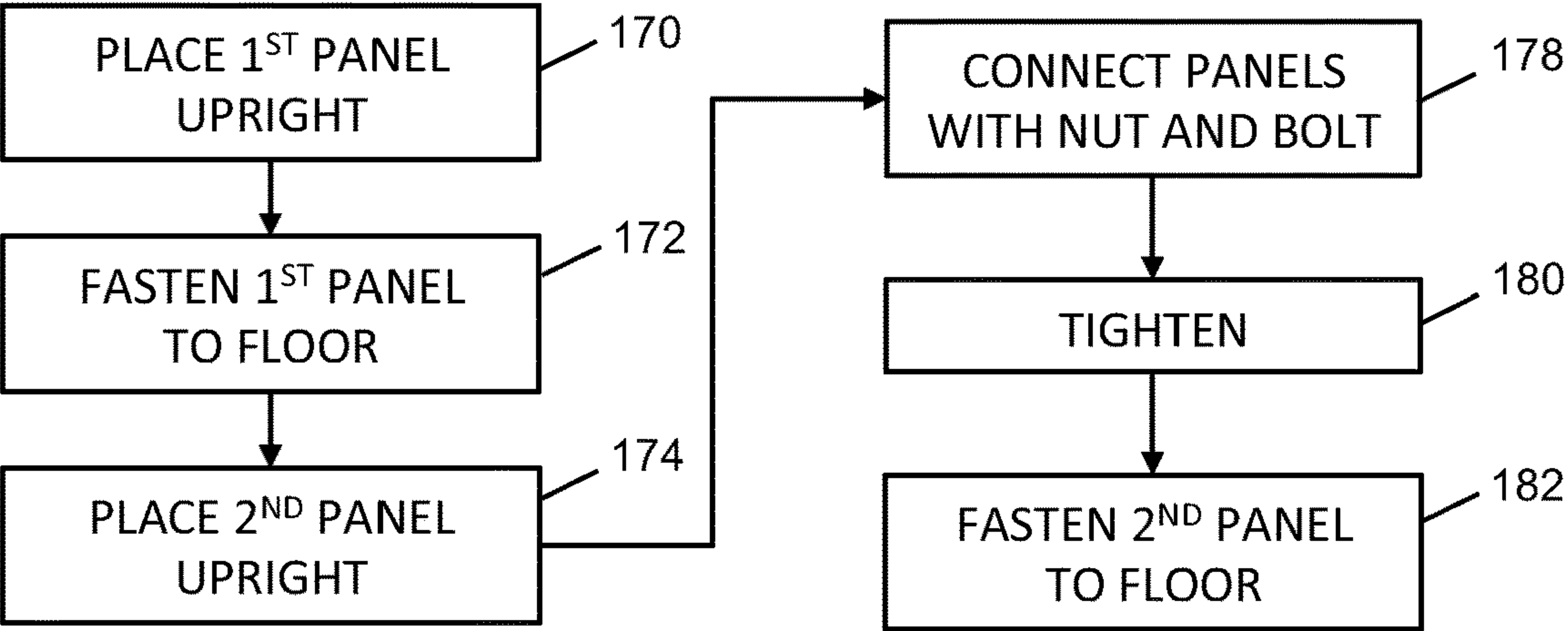


FIG. 11

WALL PANEL WITH CORNER CONNECTOR BLOCK

TECHNICAL FIELD

[0001] The present invention is related to a structural wall panel. More specifically, it relates to a wall panel with an embedded corner block that permits connection of the wall panel to the floor and to an adjacent similar wall panel.

BACKGROUND

[0002] The prefabrication of wall panels is a major improvement in the construction field. Wall panels are usually prepared and fabricated off-site. Typically, industry-standard pre-cast or tilt-up wall panels do not require high dimensional tolerances for assembly into a wall.

[0003] One type of wall panel may be a structural insulated panel (SIP), which is usually made of several components, among them a central insulation core or block core made of expanded polystyrene foam (EPS), extruded polystyrene foam, polyisocyanurate foam, polyurethane foam or composite honeycomb and two layers of structural skin or structural board that can be made of sheet metal, plywood, cement, magnesium oxide board or oriented strand board.

[0004] Fabricating the wall panels in a factory instead of on-site minimizes the cost of their production. In the meantime, quality control of each wall panel is improved because the influence of external parameters, such as the construction site, the weather and the construction workers, is minimized.

[0005] This background is not intended, nor should be construed, to constitute prior art against the present invention.

SUMMARY OF INVENTION

[0006] The present invention is related to a wall panel that has features for connecting it to adjacent wall panels and the floor, in order to construct a modular wall. The wall panel has corner connectors placed at each corner, integrated in the panel. The corner connectors also act as a point of fixation where a hook can be mounted in order to lift the wall panel. The corner connectors may also facilitate the alignment of the wall panels in the wall. Depending on the embodiment, the wall panels disclosed herein provide at least one of the advantages described in relation thereto.

[0007] Disclosed herein is a wall panel defined, when oriented as a section of a wall, by a proximal face and a distal face that are connected to two side edges, a top edge and a bottom edge, the wall panel comprising: a volume of cementitious material proximal to one of the side edges; a volume of cementitious material proximal to the bottom edge; a hollow connector block in a corner defined by said one of the side edges, the bottom edge and the proximal face, wherein walls of the connector block at said one of the side edges and bottom edge each define a hole, and an open face of the connector block defines an aperture in the proximal face of the wall panel; and two anchor pins each connected to and projecting from another different wall of the connector block into a different one of the volumes of cementitious material.

[0008] Also disclosed is a method of erecting a wall comprising providing two wall panels, each defined, when oriented as a section of a wall, by a proximal face and a distal face that are connected to two side edges, a top edge and a bottom edge, each wall panel comprising a volume of cementitious material proximal to one of the side edges; a

volume of cementitious material proximal to the bottom edge; a hollow connector block in a corner defined by said one of the side edges, the bottom edge and the proximal face, wherein walls of the connector block at said one of the side edges and the bottom edge define a side hole and a bottom hole respectively, and an open face of the connector block defines an aperture in the proximal face; and two anchor pins each connected to and projecting from another different wall of the connector block into a different one of said volumes of cementitious material; wherein, in one of the wall panels said one of the side edges is a right edge and in the other of the wall panels said one of the side edges is a left edge. The method comprises: attaching a first of the wall panels to a floor using a connector that passes through the bottom hole in the first wall panel; placing the second wall panel on the floor so that the side edges with the connector blocks face each other and a second connector can be passed through the side holes; tightening the second connector to draw the second wall panel to the first wall panel; and attaching the second wall panel to the floor using a third connector that passes through the bottom hole in the second wall panel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The following drawings illustrate embodiments of the invention, which should not be construed as restricting the scope of the invention in any way.

[0010] FIG. 1 is an exploded isometric view of a connector block, according to an embodiment of the present invention.

[0011] FIG. 2 is a side view of a connector block, according to an embodiment of the present invention.

[0012] FIG. 3 is a bottom view of a connector block, according to an embodiment of the present invention.

[0013] FIG. 4 is a side view of two adjacent wall panels prior to their connection, according to an embodiment of the present invention.

[0014] FIG. 5 is a close-up view of the area A of FIG. 4.

[0015] FIG. 6 is an isometric view of a wall panel, according to an embodiment of the present invention.

[0016] FIG. 7 is an isometric view of two wall panels to be connected, according to an embodiment of the present invention.

[0017] FIG. 8 is a broken side view of two connected wall panels, according to an embodiment of the present invention.

[0018] FIG. 9 is an exploded isometric view of a connector block with a cover, according to an embodiment of the present invention.

[0019] FIG. 10 is an exploded isometric view of two connector blocks, a seal portion and a connector, according to an embodiment of the present invention.

[0020] FIG. 11 is a flowchart for erecting a modular wall using wall panels, according to an embodiment of the present invention.

DESCRIPTION

A. Exemplary Apparatus

[0021] Referring to FIG. 1, there is shown a connector block 10, made from a length of rounded-corner hollow section steel (HSS) such that its overall shape approximates a cube. In an upper wall 12 of the connector block 10 there is a threaded hole 14 that matches the thread 16 on anchor pin 18. The anchor pin 18 is, for example, a hex bolt, with

shank 20 and hexagonal head 21. In a right side wall 22 of the connector block 10 there is a threaded hole 24 that matches the thread 26 on anchor pin 28. The anchor pin 28 is, for example, a hex bolt, with shank 30 and hexagonal head 31.

[0022] In use, the anchor pins 18, 28 are screwed into the connector block 10, and the assembly is cast in place in cementitious material used in the fabrication of a wall panel

[0023] The front, or proximal face 32 of the connector block 10 is open, defining an aperture 34 that is exposed when the connector block is in place in the wall panel, providing access to the hollow interior of the HSS. The hollow interior of the connector block 10 extends to the rear, or distal face 35 of the connector block.

[0024] A hole 36 in the bottom wall 38 of the connector block 10 allows a connector (e.g. bolt) to be used to connect the wall panel, in which the connector block is embedded, to a floor. To do this, the connector is inserted through the aperture 34 and into the hole 36, to be screwed into a socket in the floor. There is generous clearance between the connector and the hole 36 so that small adjustments to the position of the wall panel may be made before the connector is tightened to fasten the wall panel to the floor. For example, the hole 36 is 19 mm ($\frac{3}{4}$ ") wide slotted hole, and the diameter of the shank of the connector that goes through the hole is 16 mm ($\frac{5}{8}$ ").

[0025] A hole 46 in the left wall 48 of the connector block 10 allows another connector (e.g. nut and bolt) to be used to connect the wall panel in which the connector block is embedded to an adjacent wall panel with a similar connector block. To do this, one part of the connector (e.g. bolt) is inserted through one of the apertures 34 and into the hole 46, and another part of the connector (e.g. nut) is inserted through the other aperture 34 and onto the first part of the connector. The connector may be other than a nut and bolt in other embodiments. There is generous clearance between the connector and the hole 46 so that small adjustments to the position of the second wall panel may be made before the connector is tightened to fasten the two wall panels together. For example, the diameter of the hole 46 is 19 mm ($\frac{3}{4}$ ") and the diameter of the shank of the connector that goes through the hole is 16 mm ($\frac{5}{8}$ ").

[0026] FIG. 2 is a side view of the connector block assembly 49, showing proximal face 32 and aperture 34 of the connector block 10. The extent to which the anchor pins 18, 28 are screwed into the threaded holes 14, 24 respectively is shown to be only just through the walls of the connector block. This so as not to restrict the inner volume of the connector block, which would make it more difficult to insert the connectors.

[0027] Optionally, the anchor pins 18, 28 are welded to the connector block 10. Note that in other embodiments, the holes 14, 24 may not be threaded and the anchor pins 18, 28 may have a different physical format. For example, the anchor pins may be Nelson™ studs. In other embodiments, the anchor pins are lengths of threaded bar, or lengths of rebar. In some embodiments, the anchor pins extend more than half way along the side of the panel in which they are embedded. In other embodiments the anchor pins extend as far as practicable along the full length of the panel. In some embodiments, the anchor pins extend from one connector block, embedded along the side of the panel to another connector block in the wall panel. The main function of the anchor pins 18, 28 is to provide a mechanical anchor when

they are embedded in a cured, cementitious material, and as such, the anchor pins may adopt any physical shape, size and/or surface profile that achieve this function.

[0028] FIG. 3 is a bottom view of the connector block 10, showing a bottom view of the anchor pin 28. The underside of the end of the anchor pin 18, located in hole 14, is visible through slotted hole 36 in the bottom wall 38 of the connector block 10.

[0029] Note that while the anchor pins 18, 28 have been shown attached centrally to the solid faces 12, 22 of the connector block 10, it is possible in other embodiments to attach the anchor pins off-center.

[0030] FIG. 4 is a side view of two adjacent wall panels 50, 60 located in a position with respect to one another that they would be in prior to their connection to form a modular wall. Proximal faces 51, 61 of the wall panels 50, 60 are visible to the observer. Wall panel 50 has a left side edge 52, a bottom edge 53, a right side edge 54 and a top edge 55. Wall panel 60 has a left side edge 62, a bottom edge 63, a right side edge 64 and a top edge 65. The distal faces of the wall panels 50, 60 are not visible.

[0031] Wall panel 50 has a connector block 56 in its lower, right corner area 58 defined by right side edge 54, bottom edge 53 and proximal face 51. Wall panel 60 has connector block 66 in its lower, left corner area 68 defined by left side edge 62, bottom edge 63 and proximal face 61. Connector blocks 56, 66 are identical or similar to connector block 10, except that they are oriented as mirror images to each other in the wall panels 50, 60.

[0032] Depending on the embodiment, wall panel 50 may have further corner connector blocks 71, 72, 73 and wall panel 60 may have further corner connector blocks 81, 82, 83. Connector block 71 may be identical to connector block 66, and connector block 81 may be identical to connector block 56.

[0033] Furthermore, the wall panels 50, 60 may have side connector blocks 74-77 and 84-87 respectively, which may be used to provide additional connection points between adjacent wall panels or between a wall panel and the floor or ceiling.

[0034] Connector block 56 and connector block 66 are connected together when the wall panels 50, 60 are joined. Optionally, an intervening compressible seal, e.g. made of foam, is positioned between the wall panels 50, 60 before they are fully connected to each other. The seal makes the wall joint water and airtight.

[0035] If threaded bar is used as the anchor pins, connector block 56 is, in some embodiments, connected to side connector block 77 and side connector block 74 with the threaded bar. Likewise, in these embodiments, the connector blocks at the other corners are connected to their neighboring side connector blocks.

[0036] FIG. 5 is a close-up of area A in FIG. 4, encompassing the corner area 58 of wall panel 50 and corner area 68 of wall panel 60. Connector block assembly 90 is shown with its connector block 56 and anchor pins 91, 93. Anchor pin 91 is embedded in a volume of cementitious material 92 proximal to the right side edge 54 of the wall panel 50. Anchor pin 93 is embedded in a volume of cementitious material 94 proximal to the bottom edge 53 of the wall panel 50. The two volumes of cementitious material 92, 94 are contiguous, and contact the top wall and left wall respectively of the connector block 56.

[0037] Connector block assembly 95 is shown with its connector block 66 and anchor pins 96, 98. Anchor pin 96 is embedded in a volume of cementitious material 97 proximal to the left side edge 62 of the wall panel 60. Anchor pin 98 is embedded in a volume of cementitious material 99 proximal to the bottom edge 63 of the wall panel 60. The two volumes of cementitious material 97, 99 are contiguous, and contact the top wall and right wall respectively of the connector block 66.

[0038] Connector block 56 defines an aperture 100 in its proximal face, which is exposed and therefore also an aperture in the proximal face 51 of wall panel 50. Connector block 66 defines an aperture 102 in its proximal face, which is exposed, and therefore also an aperture in the proximal face 61 of wall panel 60. The distal faces of the connector blocks 56, 66 are inside or embedded in the volume of the wall panels 50, 60 respectively.

[0039] FIG. 6 is a view of wall panel 50, which has an overall rectangular cuboid shape or envelope. The connector block 56 is underflush with the proximal face 51 of the wall panel, as are all the other connector blocks. This is so that, after the wall panel 50 has been installed in its final position and the various connectors have been tightened, the aperture that the connector block 56 defines can be filled or covered to the same level as the proximal face 51 of the wall panel in preparation for finishing, such as painting. The connector block 56 extends from underflush with the proximal face 51 of the wall panel 50 part of the way to the distal face 110 of the wall panel. This wall panel 50 is an example of an SIP in which the structural strength is provided largely by a reinforced cementitious frame within the inner, proximal half of the wall panel. The wall panel 50 has, for example, an insulating core of EPS. As an example only, the wall panel 50 may measure 2.4 m×2.4 m×0.2 m (8'×8'×8").

[0040] The dimensions of the connector blocks (e.g. 56) and the positions and orientations of the connector blocks in the wall panel 50 should be defined with a tight enough tolerance for the wall panel to be placed and fastened with sufficient accuracy in its intended location. For example, during fabrication of the wall panel 50, and particularly during casting of the cementitious material, the connector blocks (e.g. 56) are screwed to the forms used for casting the wall panel, the forms holding the connector blocks in place during the casting.

[0041] FIG. 7 shows the two wall panels 50, 60 aligned ready to be connected to each other. Assume to start with that wall panel 50 has been fastened in place on the floor. Wall panel 60, with its left side edge 62 facing the right side edge 54 of wall panel 50, is then positioned so that the hole in the bottom wall of the connector block 66 is close to or over a socket in the floor, or passes over an anchor stud in the floor. A connector is then used to connect the wall panels 50, 60 together via hole 120 in connector block 56 in the wall panel 50 and a similar hole in the left wall of the connector block 66 in wall panel 60. As the connector is tightened, wall panel 60 is drawn closer to wall panel 50. When tightened, wall panel 60 is then fastened to the floor using a bolt screwed into the in-floor socket, or by a nut, for example, tightened onto an anchor stud projecting from the floor into connector block 66.

[0042] FIG. 8 is a side view of the two connected wall panels 50, 60, with seal 125 between them. Wall panel 50 is connected to the floor (not shown) by a bolt 132, which is fastened into a threaded socket 133 in the floor, for example.

The bolt 132 is placed through the aperture 134 of the connector block 56 and screwed into the socket 133.

[0043] A bolt 140 is passed into the aperture 134 of the connector block 56, through a hole in the right side wall of the connector block 56, a hole in the seal 125, and a hole in the left side wall of the connector block 66. A nut 142 is placed through the aperture 138 in the connector block 66 and onto the thread of the bolt 140, and it is then tightened to bring the wall panels 50, 60 together.

[0044] In some embodiments, a length of threaded bar with two nuts is used as the connector that connects the two connector blocks 56, 66, instead of nut 142 and bolt 140.

[0045] Wall panel 60 is connected to the floor by a bolt 136 screwed into a threaded socket 137. The bolt 136 is placed through the aperture 138 of the connector block 66 and screwed into the socket 137.

[0046] FIG. 9 is a connector block 150 in which the upper region 152 of the walls, adjacent the proximal face, has been thinned to form a ledge 154 a short distance below the proximal face of the connector block. A cover or plate 156 is dimensioned to fit within the thinned portion of the walls of the connector block and sit on the ledge 154. The fit may be, for example, a push fit or a snap fit, or the cover may be glued into the connector block 150. The cover 156 is put into the connector block 150 after the wall panel in which it is embedded is fastened into place, to close the aperture. Finishing materials are then applied to the cover to make the proximal face of the wall panel uniform. The distal open face of the connector block 150 does not need a cover as it is inside the volume of the wall panel, and therefore hidden when the cover 156 is in place.

[0047] FIG. 10 shows connector block 150 and a similar connector block 160, with intervening portion of seal 162. The connector blocks 150, 160 are connected together with nut 164 and bolt 166, which passes through holes 168, 169 and another hole (not visible) in the left wall of connector block 160.

B. Exemplary Method

[0048] FIG. 11 shows a method for erecting a modular wall using wall panels. In step 170, a first wall panel 50 is provided and placed upright in position in the wall. The position is such that the hole in the bottom wall of the connector block in the wall panel passes over a correspondingly threaded socket embedded in the floor.

[0049] In step 172, the first wall panel 50 is fastened to the floor, by placing a bolt through the aperture in the connector block, through the slotted hole in the bottom wall of the connector block and into the socket, and then screwing the bolt into the socket.

[0050] In step 174, a second wall panel 60 is provided and placed upright close to the first wall panel. The position is such that the hole in the bottom wall of the connector block in the wall panel 60 is approximately over another threaded socket embedded in the floor. The second wall panel may be up to 2.5 cm (1") away from the first panel, for example.

[0051] In step 178, the two wall panels are connected with a connector, such as a nut and bolt, through the holes in the exposed side walls of the connector blocks. The nut and bolt are below flush with the proximal faces of the wall panels through which the holes in the side walls of the connector blocks are accessed. In step 180, the nut and bolt are tightened to bring the second wall panel closer to the first wall panel and fasten the two panels together.

[0052] In step 182, the second wall panel is then fastened to the floor in the same way that the first panel was fastened to the floor.

C. Variations

[0053] The reference to, for example, the side edges as left and right and the surfaces as proximal or distal is non-limiting and simply for convenient reference, as the wall panel can be oriented in a variety of ways depending on how it is used in the construction of a building.

[0054] It is worth noting that the actual rectangular shape, the proportions and the dimensions shown are simply an embodiment of the present invention and can be subjected to modification.

[0055] The connector blocks may be positioned or oriented differently than shown is the exemplary embodiments.

[0056] The edges of the wall panel may be covered with a protective or sealant layer, for example. As such the cementitious material in some embodiments is proximal to the edges of the wall panel without extending to the outer surface of the edge.

[0057] The connector blocks may also be used in stem walls (grade beams), floor panels and roof panels.

[0058] In wall panels that are set on a base plate or anchoring pile there is a nut welded inside the connector block with a bolt that is use to raise or lower that corner of the wall panel.

[0059] Connector blocks embedded in the floor may be used to connect the wall panels to the floor.

[0060] In general, unless otherwise indicated, singular elements may be in the plural and vice versa with no loss of generality.

[0061] Throughout the description, specific details have been set forth in order to provide a more thorough understanding of the invention. However, the invention may be practiced without these particulars. In other instances, well known elements have not been shown or described in detail and repetitions of steps and features have been omitted to avoid unnecessarily obscuring the invention. Accordingly, the specification is to be regarded in an illustrative, rather than a restrictive, sense.

[0062] It will be clear to one having skill in the art that further variations to the specific details disclosed herein can be made, resulting in other embodiments that are within the scope of the invention disclosed. Steps in the flowchart may be performed in a different order, other steps may be added, or one or more may be removed without altering the main function of the invention. All parameters, dimensions, materials, and configurations described herein are examples only and actual ones of such depend on the specific embodiment. Accordingly, the scope of the invention is to be construed in accordance with the substance defined by the following claims.

1. A wall panel defined, when oriented as a section of a wall, by a proximal face and a distal face that are connected to two side edges, a top edge and a bottom edge, the wall panel comprising:

- a volume of cementitious material proximal to one of the side edges;
- a volume of cementitious material proximal to the bottom edge;
- a hollow connector block in a corner defined by said one of the side edges, the bottom edge and the proximal face, wherein walls of the connector block at said one

of the side edges and the bottom edge each define a hole, and an open face of the connector block defines an aperture in the proximal face of the wall panel; and two anchor pins each connected to and projecting from another different wall of the connector block into a different one of the volumes of cementitious material.

2. The wall panel of claim 1, wherein each anchor pin has a head with a diameter that is larger than a diameter of a shank of the anchor pin, each head being distal from the connector block.

3. The wall panel of claim 1, wherein the anchor pins are hex bolts that are screwed into further, threaded holes in the connector block.

4. The wall panel of claim 1, wherein the anchor pins are threaded bars that are screwed into further, threaded holes in the connector block.

5. The wall panel of claim 1, wherein the anchor pins are welded to the connector block.

6. The wall panel of claim 1, wherein a further open face of the connector block is inside the wall panel.

7. The wall panel of claim 1, wherein the connector block is a length of hollow structural steel with a rounded-corner square cross-section.

8. The wall panel of claim 7, wherein the length of the hollow structural steel is equal to a side of the square cross-section.

9. The wall panel of claim 1, wherein the connector block and anchor pins are cast in place in the volumes of cementitious material.

10. The wall panel of claim 1, wherein the volumes of cementitious material are contiguous.

11. The wall panel of claim 1, wherein the hole in the wall of the connector block at the bottom edge is slotted.

12. The wall panel of claim 1, wherein the connector block comprises a ledge on an interior wall of the connector block.

13. The wall panel of claim 12, comprising a plate that is dimensioned to sit on the ledge and fill the aperture.

14. The wall panel of claim 1, comprising:
another volume of cementitious material proximal to the other side edge;

another hollow connector block in a corner defined by the other side edge, the bottom edge and the proximal face, wherein walls of the other connector block at the other side edge and the bottom edge each define another hole, and an open face of the other connector block defines another aperture in the proximal face of the wall panel; and

two further anchor pins each connected to and projecting from another different wall of the other connector block into a different one of the volumes of cementitious material proximal to the bottom edge and the other side edge.

15. A method of erecting a wall comprising:
providing two wall panels, each defined, when oriented as a section of a wall, by a proximal face and a distal face that are connected to two side edges, a top edge and a bottom edge, each wall panel comprising:
a volume of cementitious material proximal to one of the side edges;
a volume of cementitious material proximal to the bottom edge;
a hollow connector block in a corner defined by said one of the side edges, the bottom edge and the

proximal face, wherein walls of the connector block at said one of the side edges and the bottom edge define a side hole and a bottom hole respectively, and an open face of the connector block defines an aperture in the proximal face; and
two anchor pins each connected to and projecting from another different wall of the connector block into a different one of said volumes of cementitious material;
wherein, in one of the wall panels said one of the side edges is a right edge and in the other of the wall panels said one of the side edges is a left edge;
attaching a first of the wall panels to a floor using a connector that passes through the bottom hole in the first wall panel;
placing the second wall panel on the floor so that the side edges with the connector blocks face each other and a second connector can be passed through the side holes;
tightening the second connector to draw the second wall panel to the first wall panel; and
attaching the second wall panel to the floor using a third connector that passes through the bottom hole in the second wall panel.

16. The method of claim **15** comprising:
placing a seal between the wall panels before tightening the second connector.

17. The method of claim **15** comprising:
covering the apertures in the connector blocks with plates.

* * * * *