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

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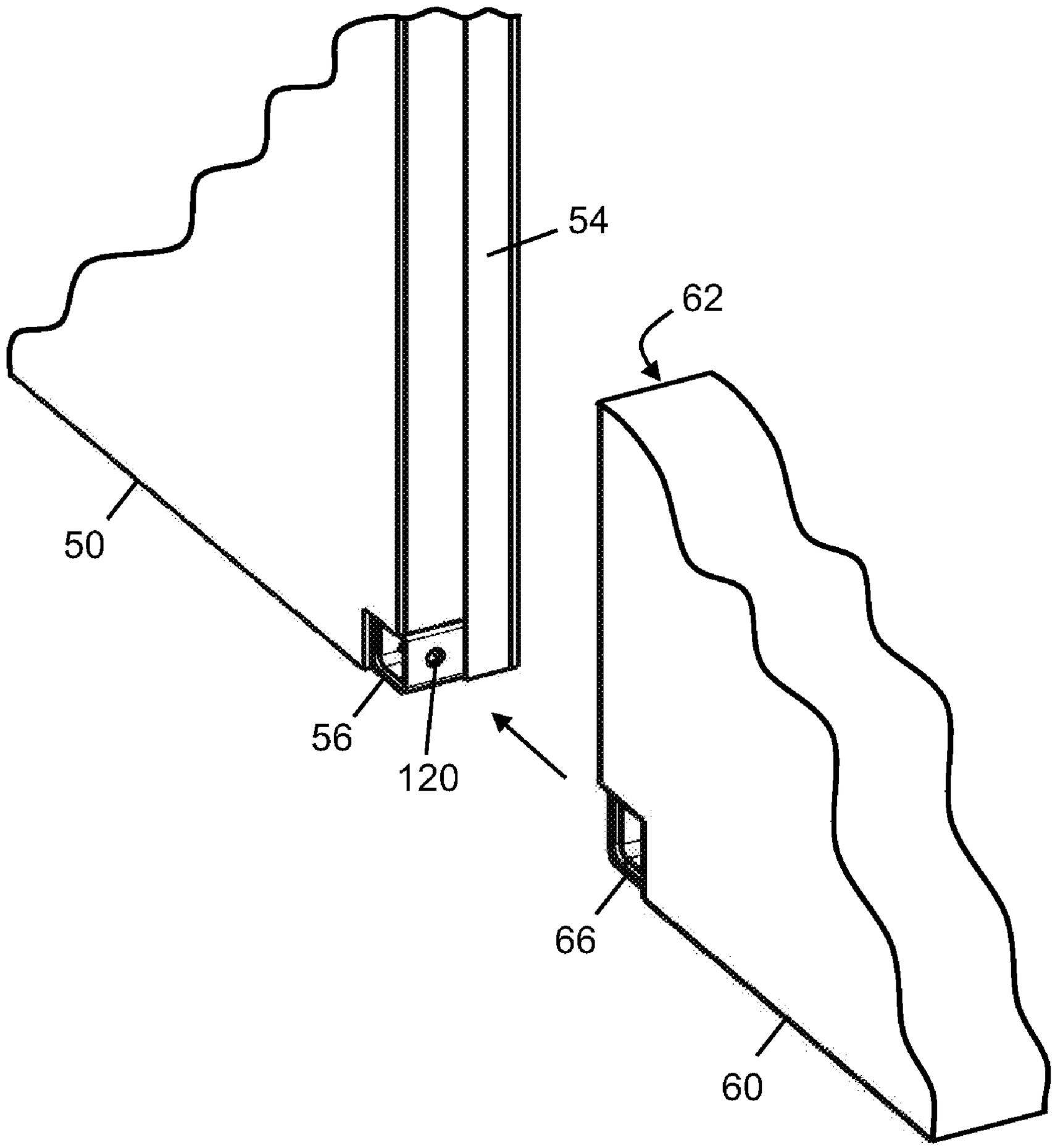
(57) **ABSTRACT**

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.



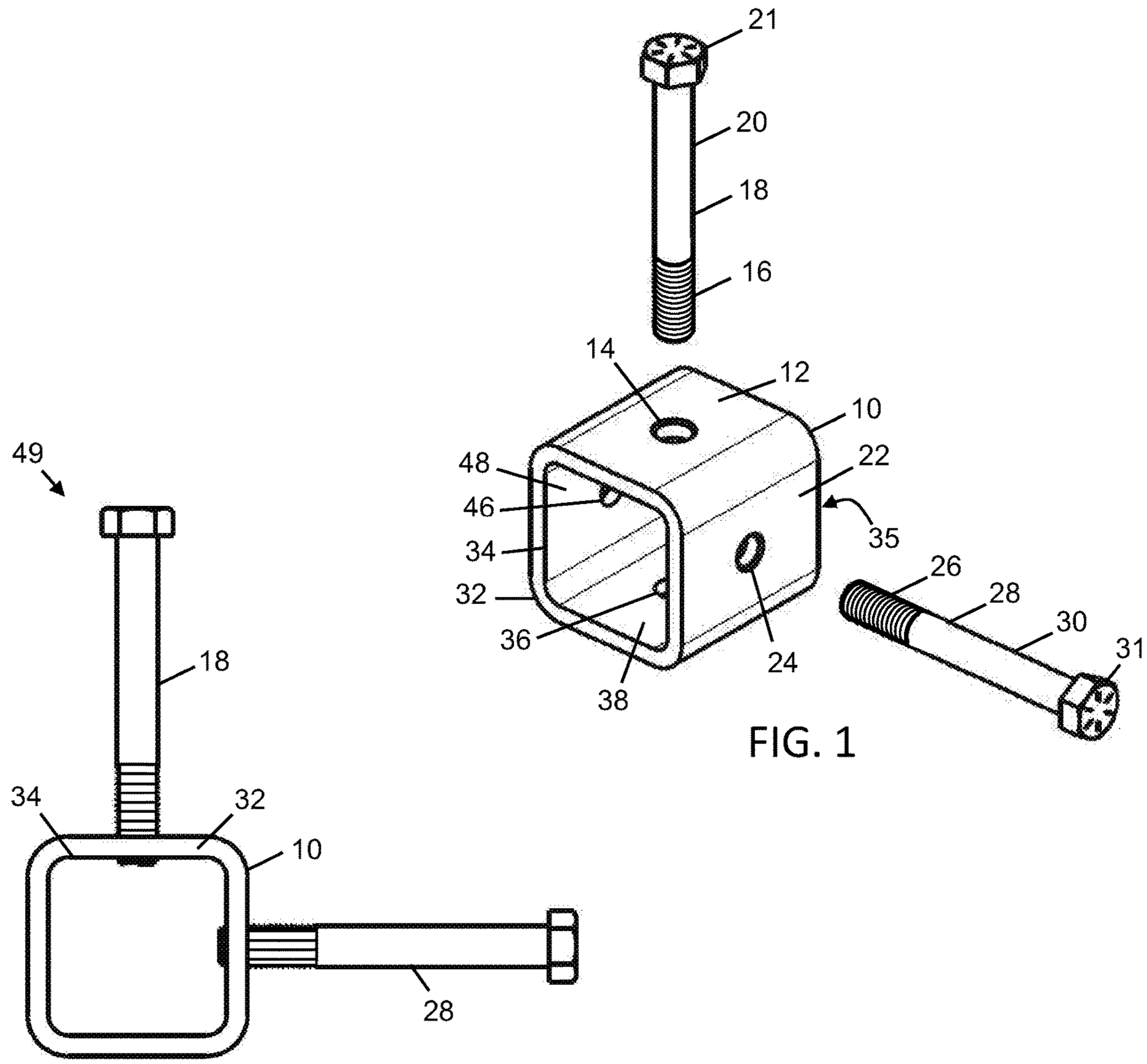


FIG. 1

FIG. 2

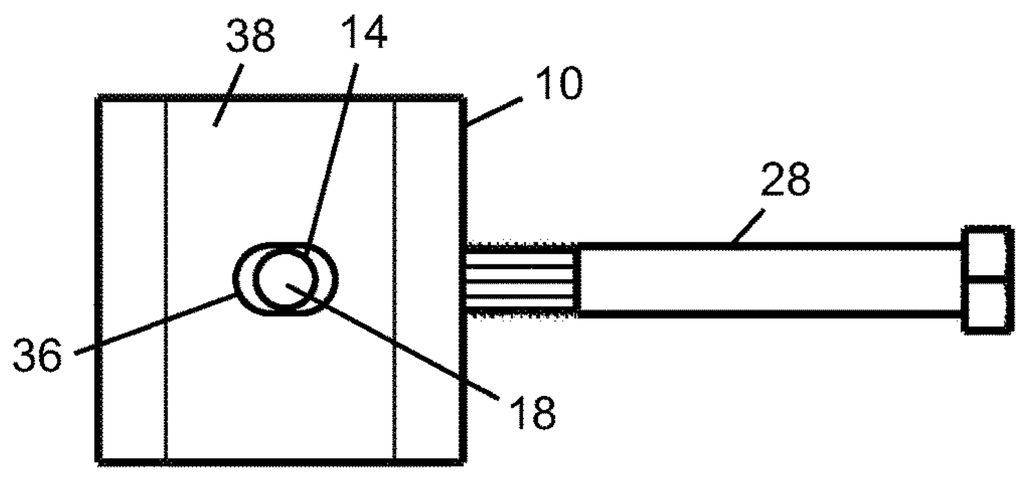


FIG. 3

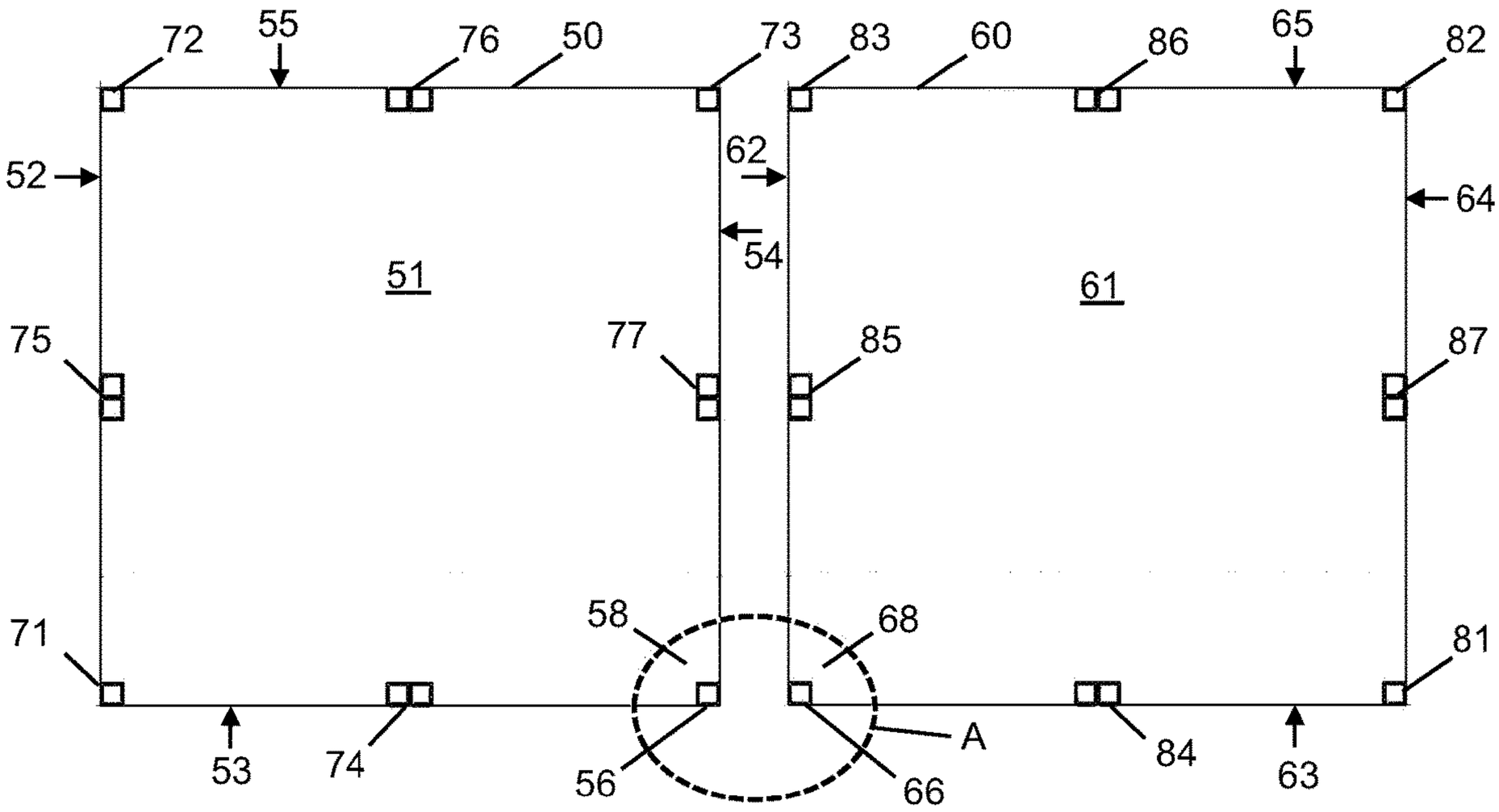

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FIG. 4

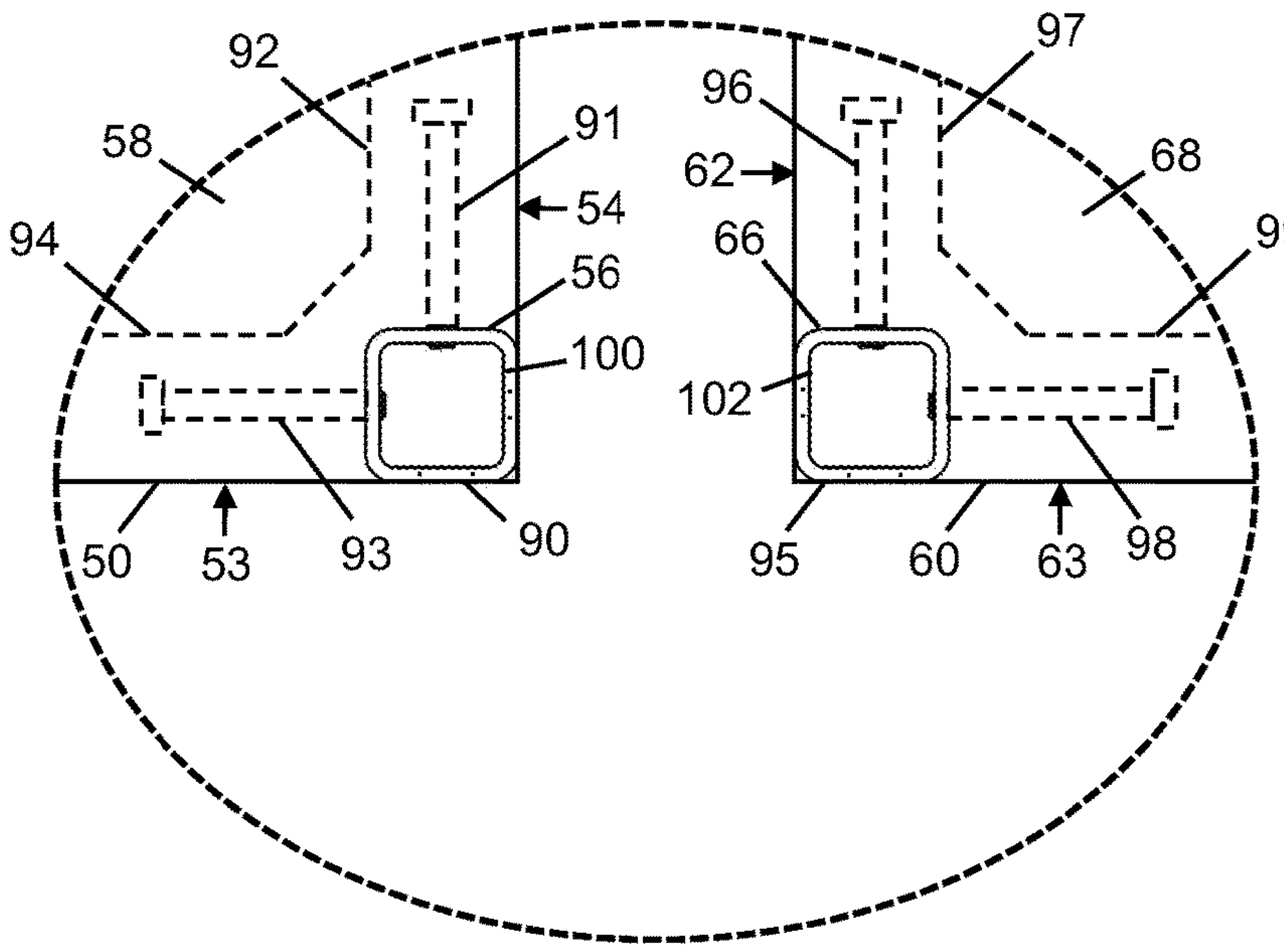
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FIG. 5

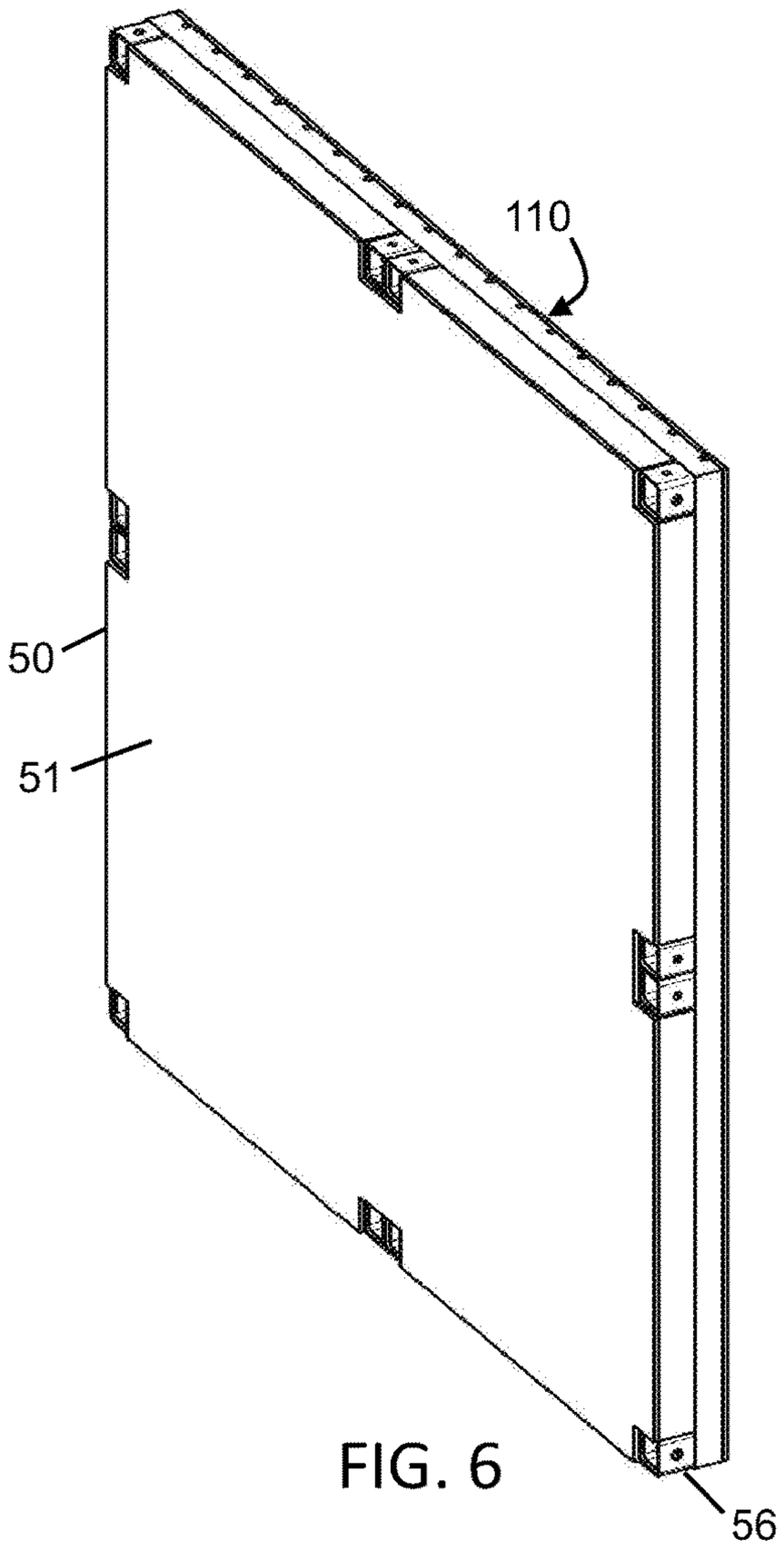

FIG. 6

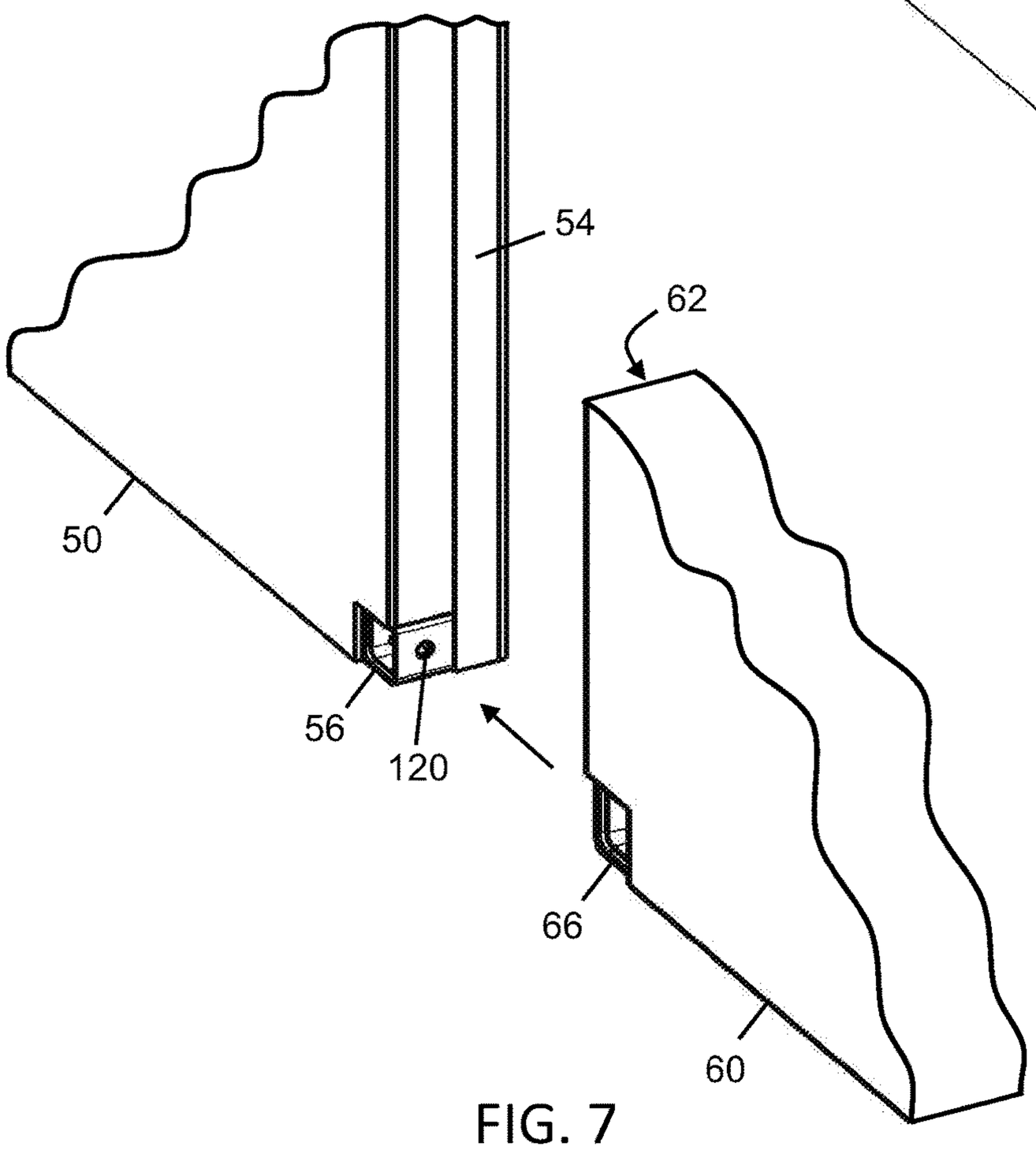

FIG. 7

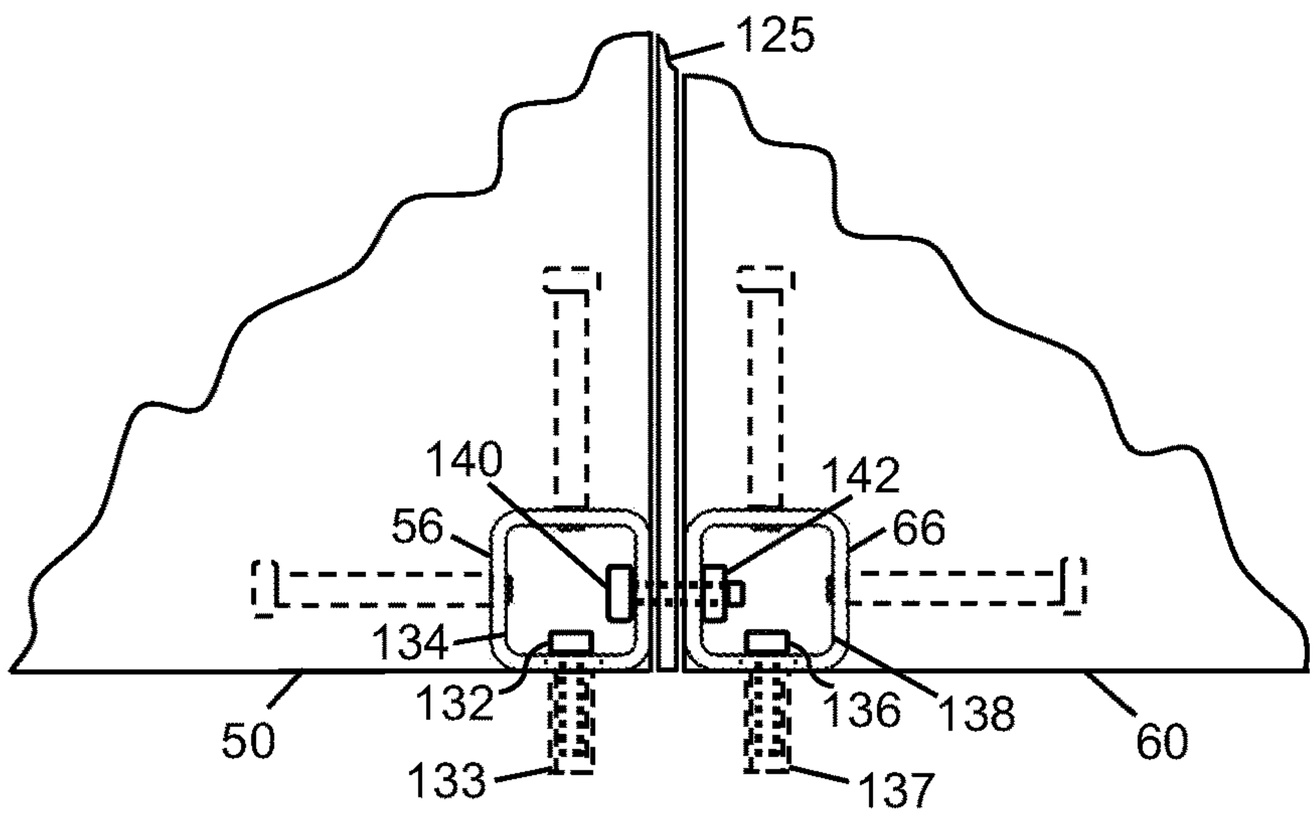

FIG. 8

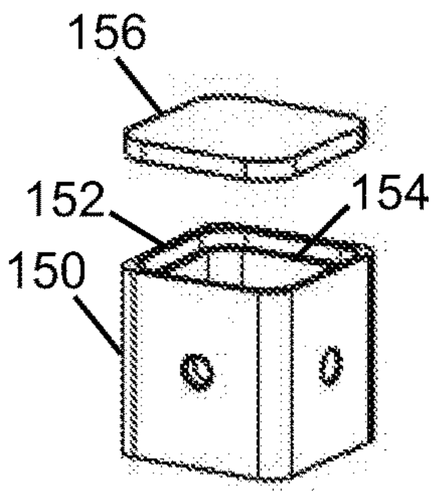

FIG. 9

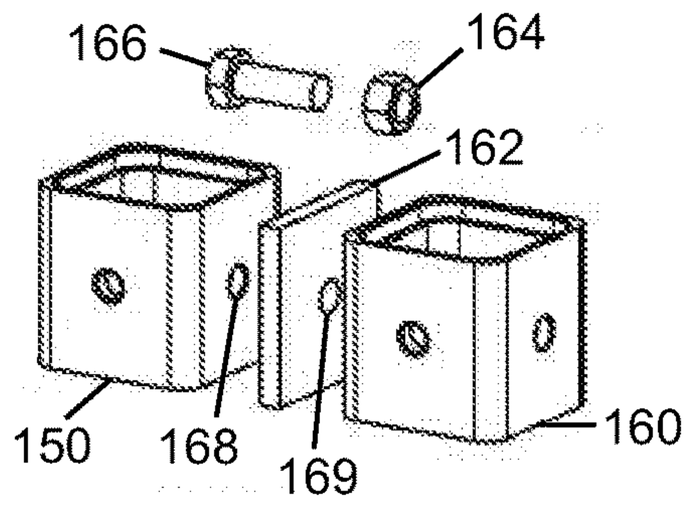

FIG. 10

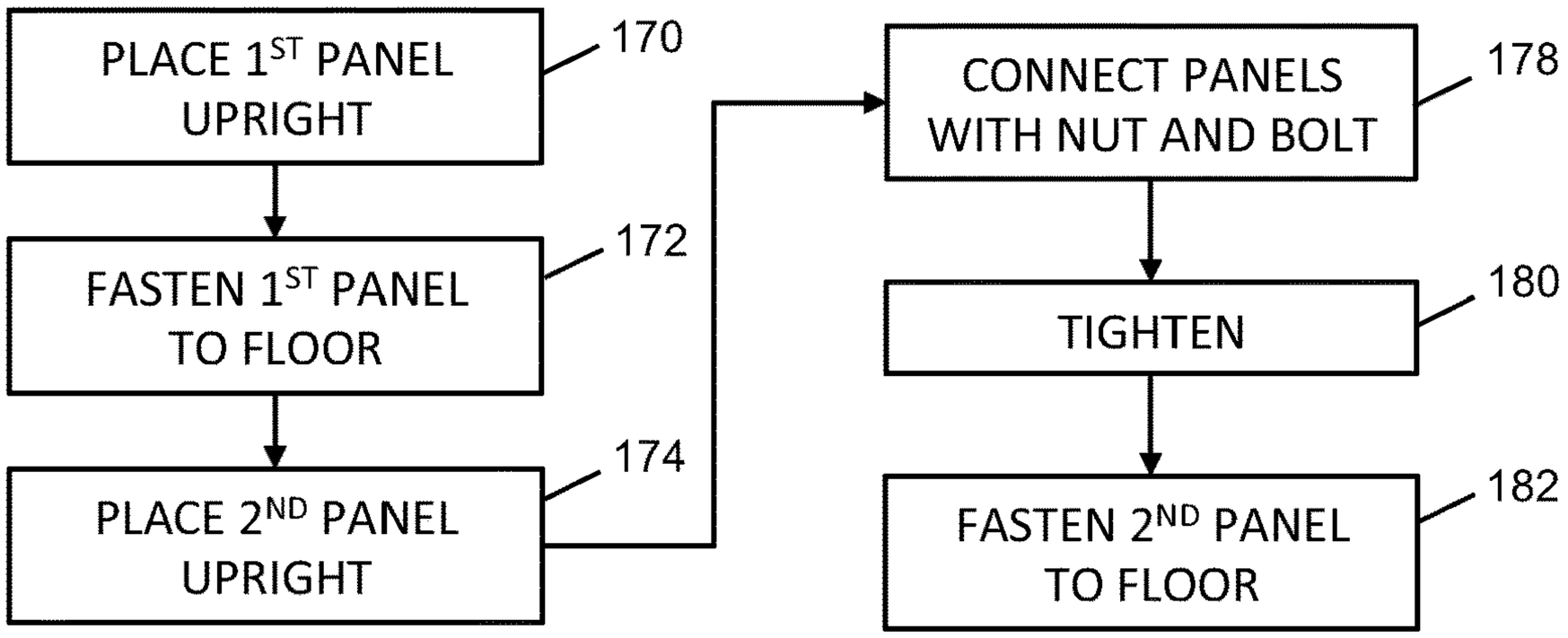

FIG. 11

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 (¾") wide slotted hole, and the diameter of the shank of the connector that goes through the hole is 16 mm (⅝").

[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 by 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 (¾") and the diameter of the shank of the connector that goes through the hole is 16 mm (⅝").

[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.

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