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GB 1358863 A **EP 1865118 A**

(58) Field of Search:
INT CL **E04B**
Other: **WPI, EPODOC, SEARCH-PATENT**

(54) Title of the Invention: **A construction arrangement and a method of connecting panels**
Abstract Title: **Panel connection with connecting brace joining panel face channels**

(57) A construction arrangement having two or more panels 102, 103 wherein each panel has a retaining means 115a, 115b arranged on a major surface of the panel, and wherein the arrangement further involves a connecting means 107 for connecting at least two panels together. The connecting means 107 engages retaining means of first and second panels to connect them. The connecting means can engage with the retaining means in more than one location on the retaining means, and the retaining means is elongate. The construction arrangement allows for adjustability of the connection means prior to fixing the panels, and therefore tolerates misalignments between the panels. The retaining means may be a channel extending close to one panel edge and between a pair if other panel edges. The connecting arrangement may include connecting means received in each channel and a brace or bracket 108 secured to each retaining means. The panels may be connected at right angles and the brace may have two legs perpendicular to each other and a reinforcing plate 120a. The connecting means may comprise a head 111a, 111b retained in the channel and a shaft 109a, 109b extending therefrom to pass through a slotted hole in the brace and receive a nut 110a, 110b to secure the brace. One of the panels may have a rebated edge 121 to receive the edge 123 of the other panel.

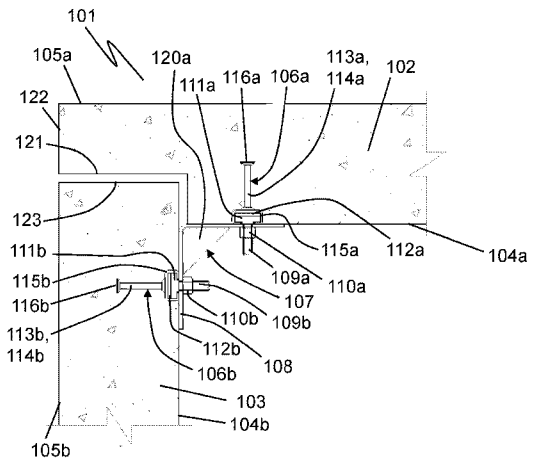
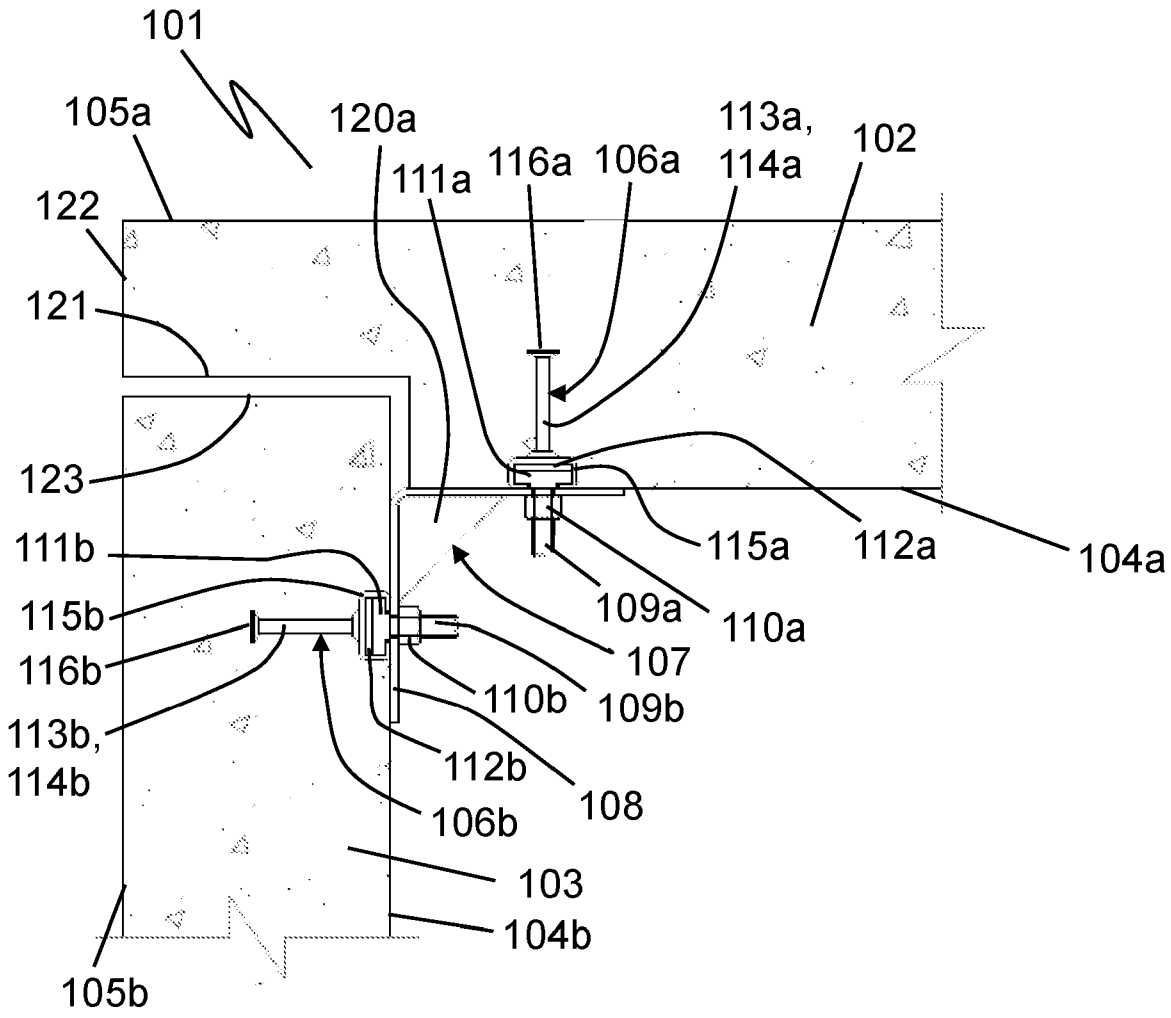


Figure 1

GB 2617299 A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116a
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102
122
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123
111b
115b
116b
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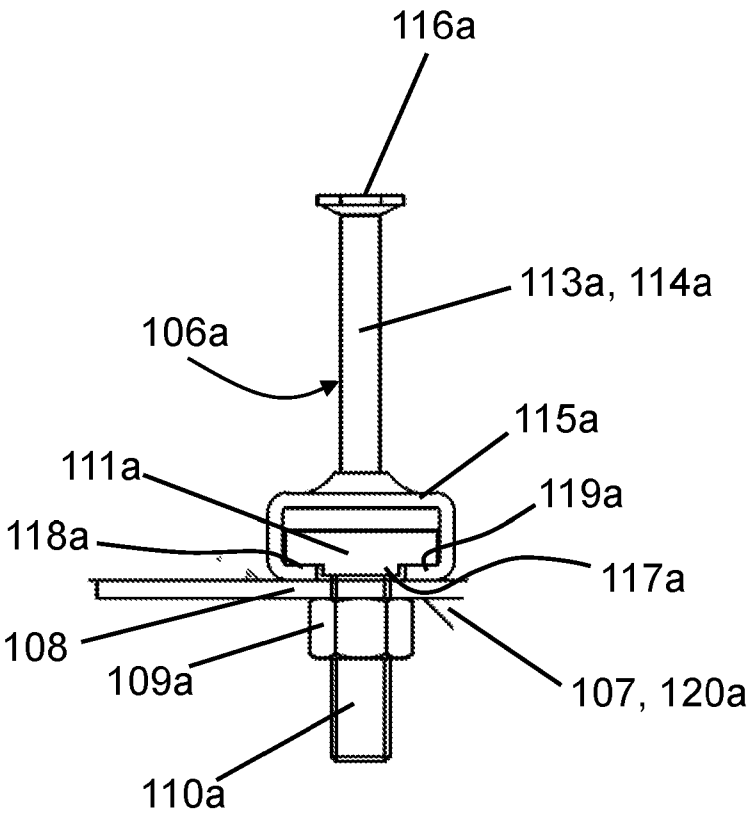
110a
107
110b
109b
112b
108
106b
103
104b

Figure 1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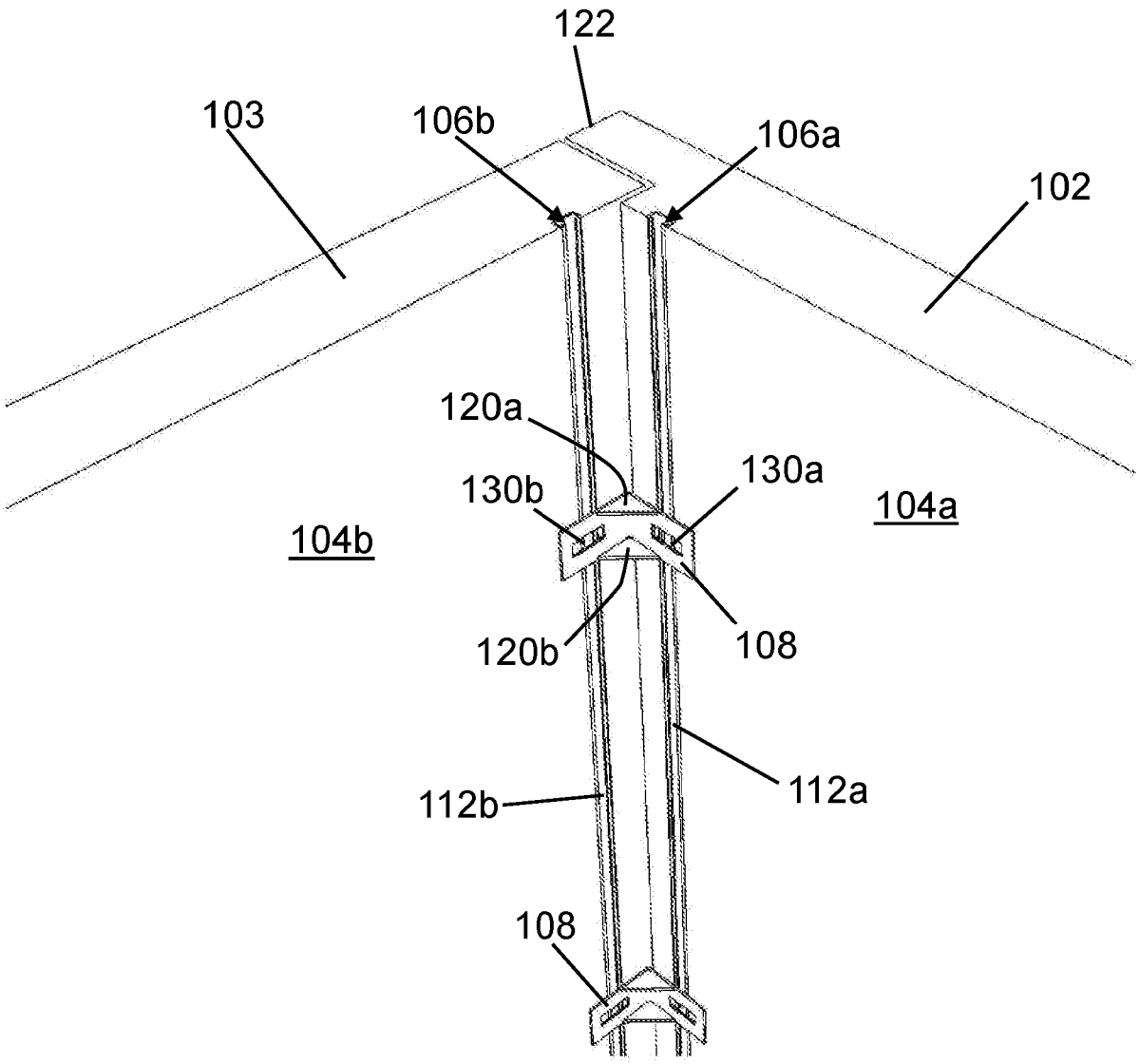
113a, 114a
106a
115a
111a
119a
118a
117a
108
109a
107, 120a
110a

Figure 2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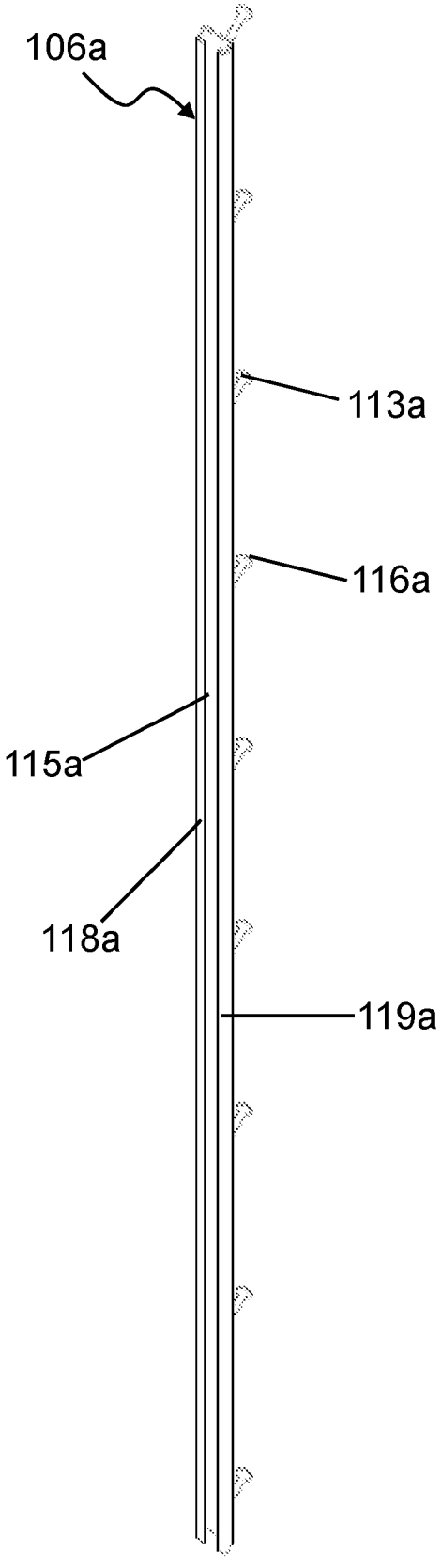
103
106b
106a
102
120a
130a
130b
104a
104b
120b
108
112a
112b
108

Figure 3



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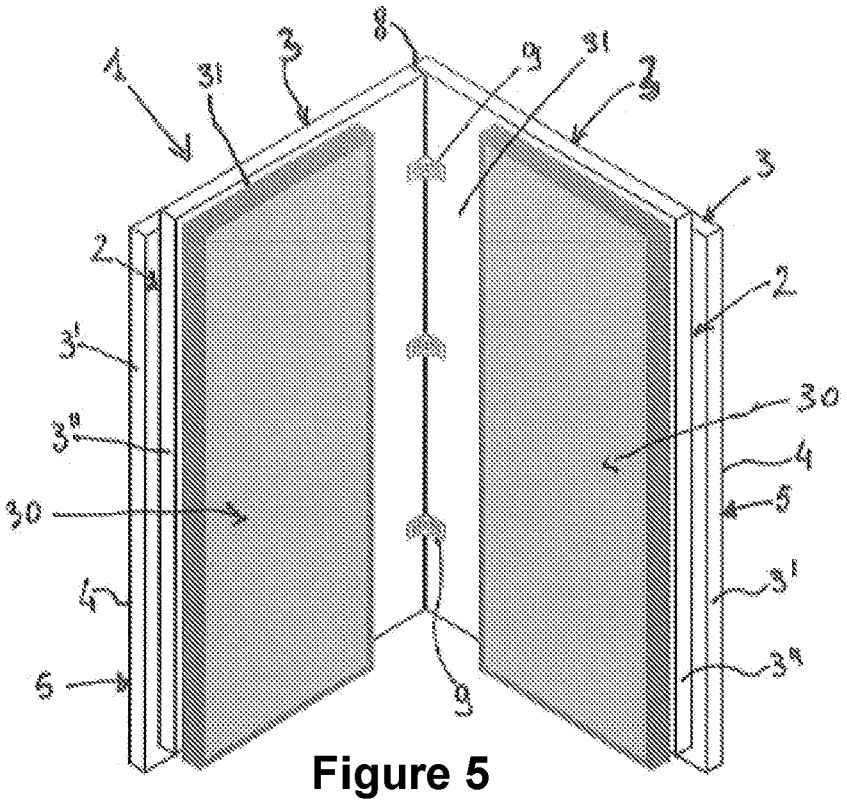

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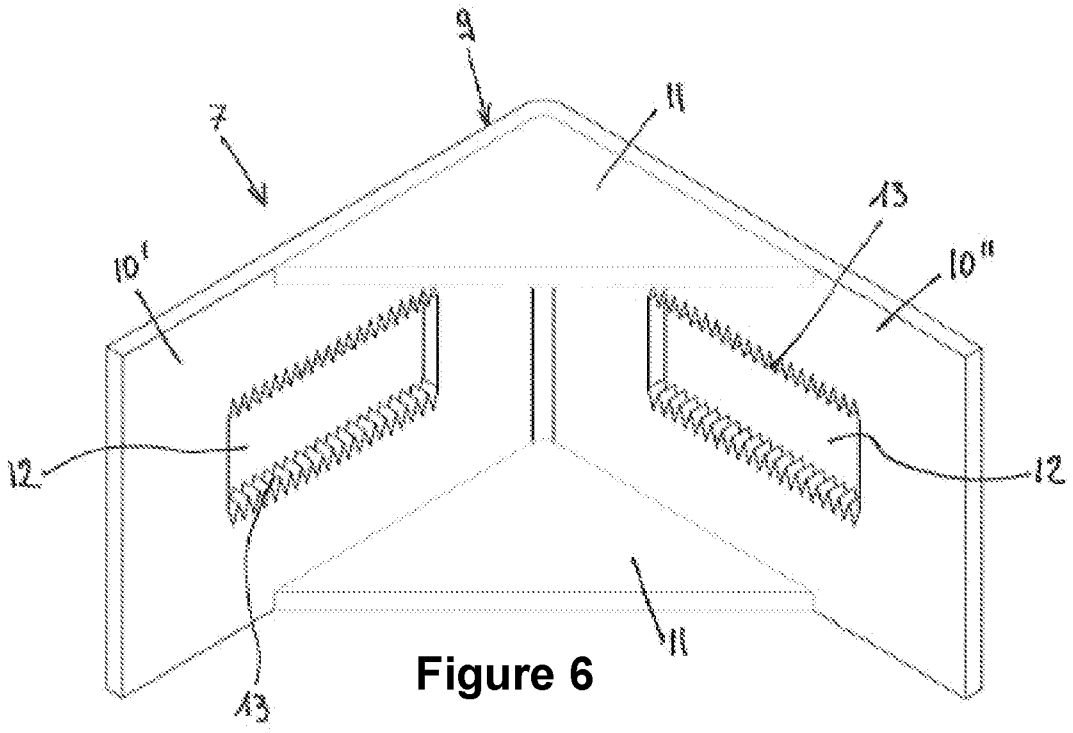

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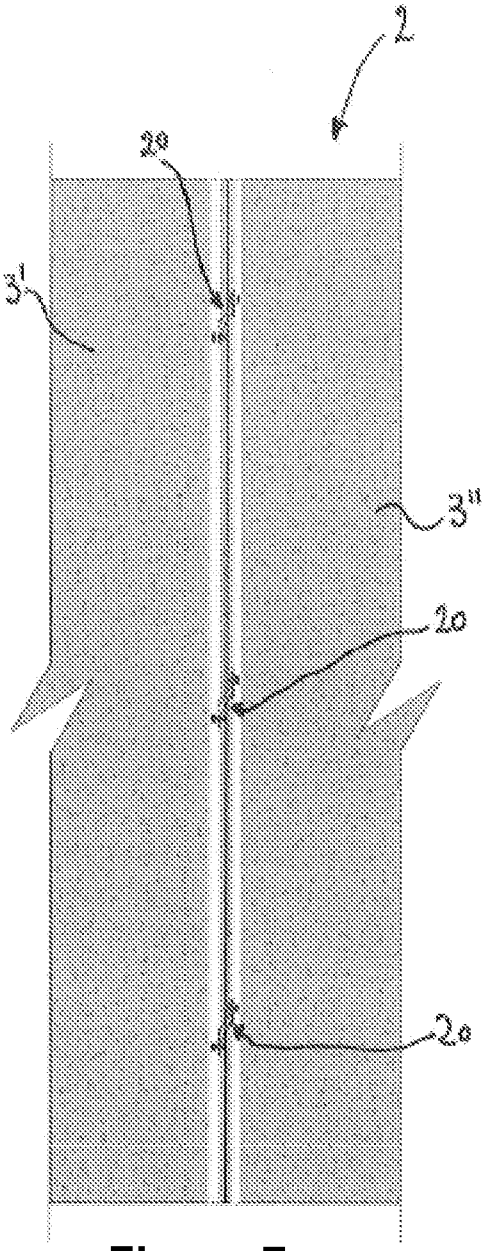

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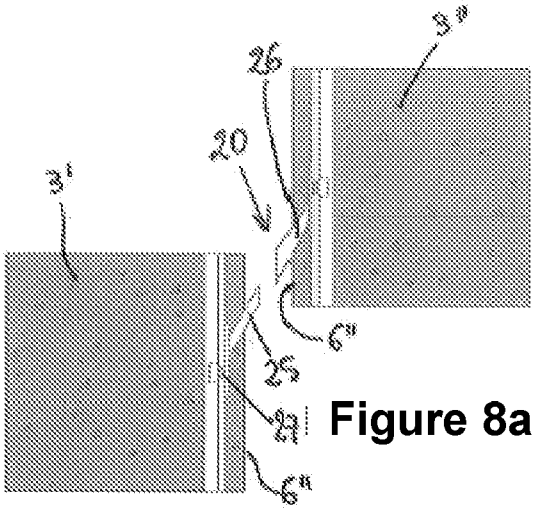


Figure 8a

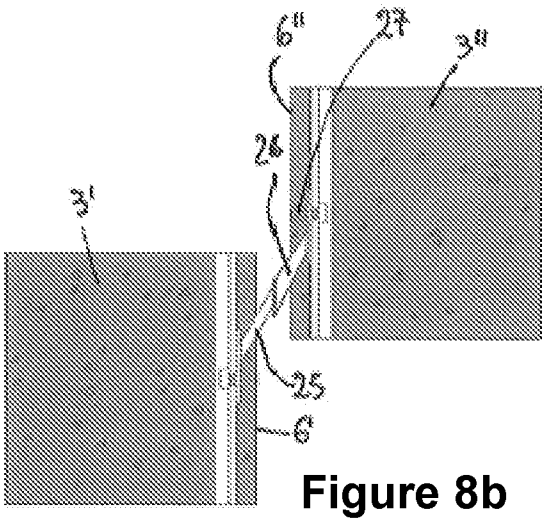


Figure 8b

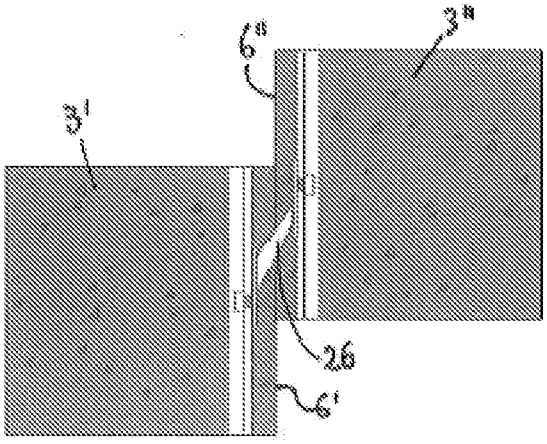
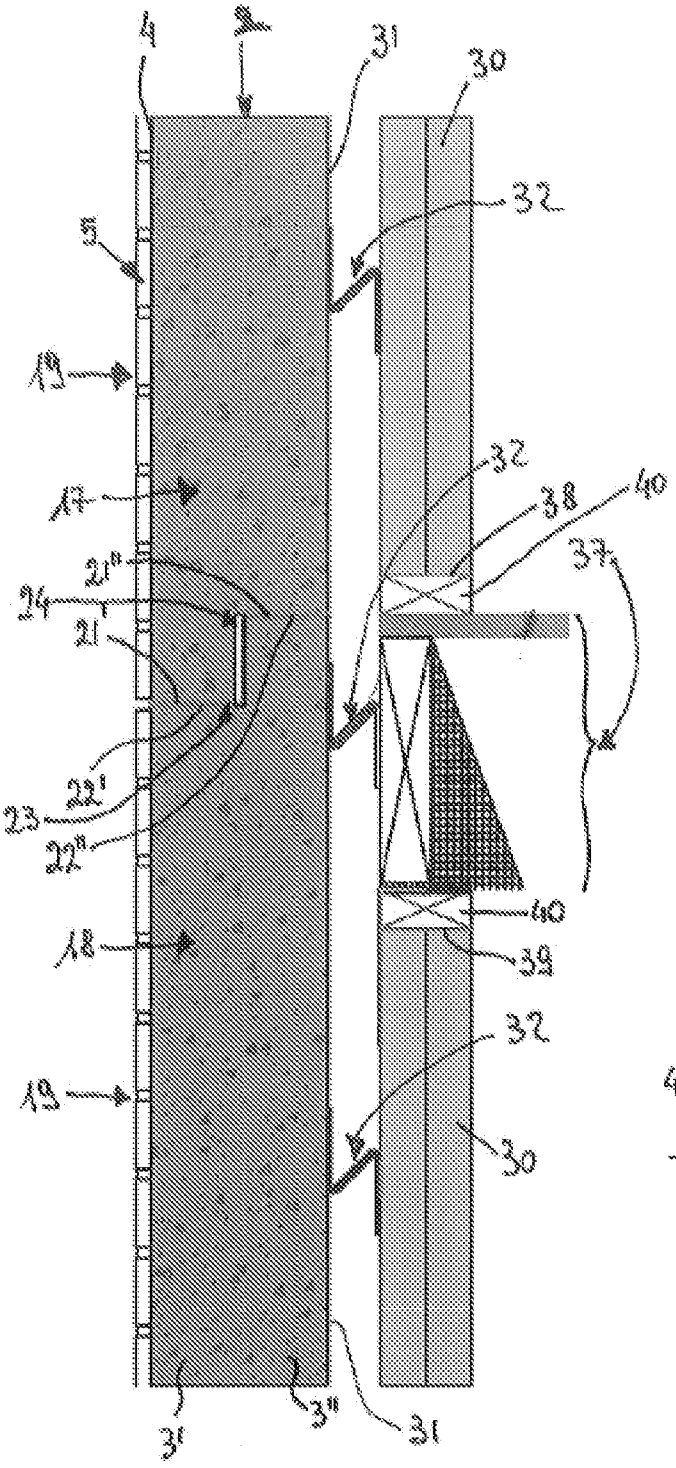


Figure 8c



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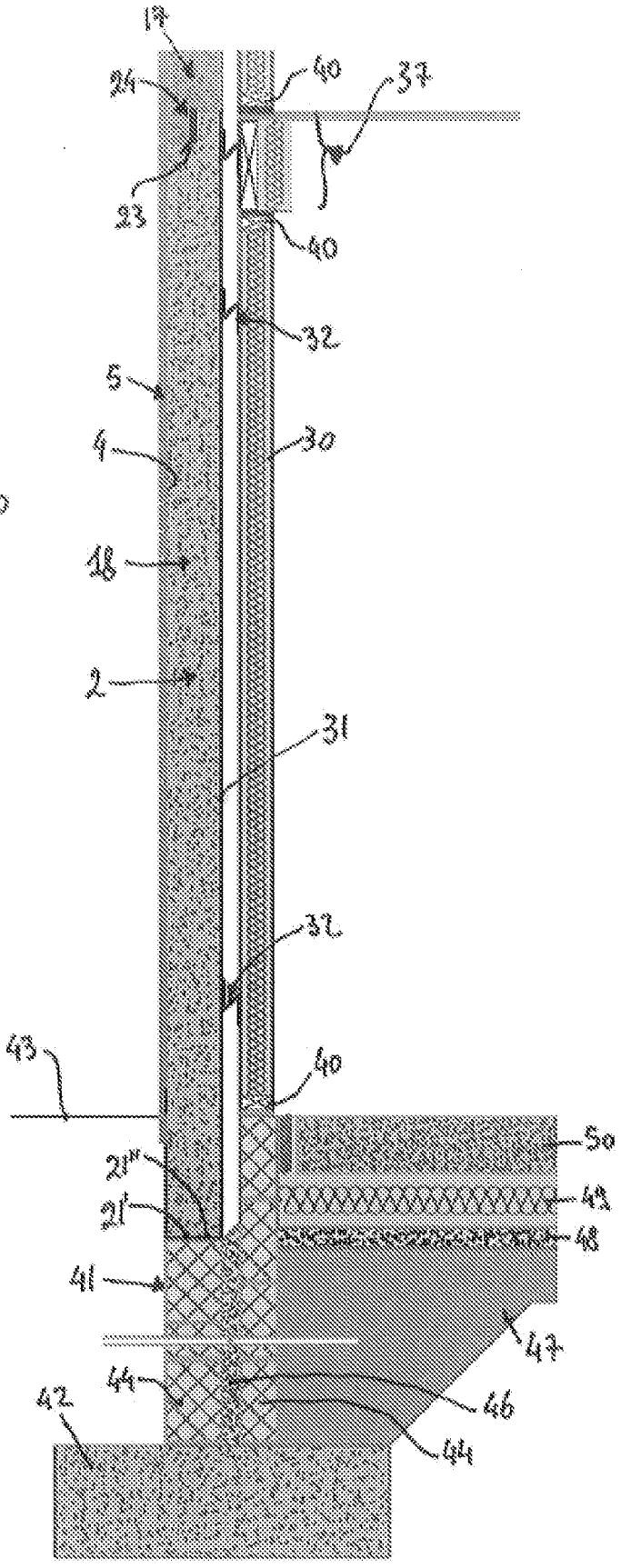

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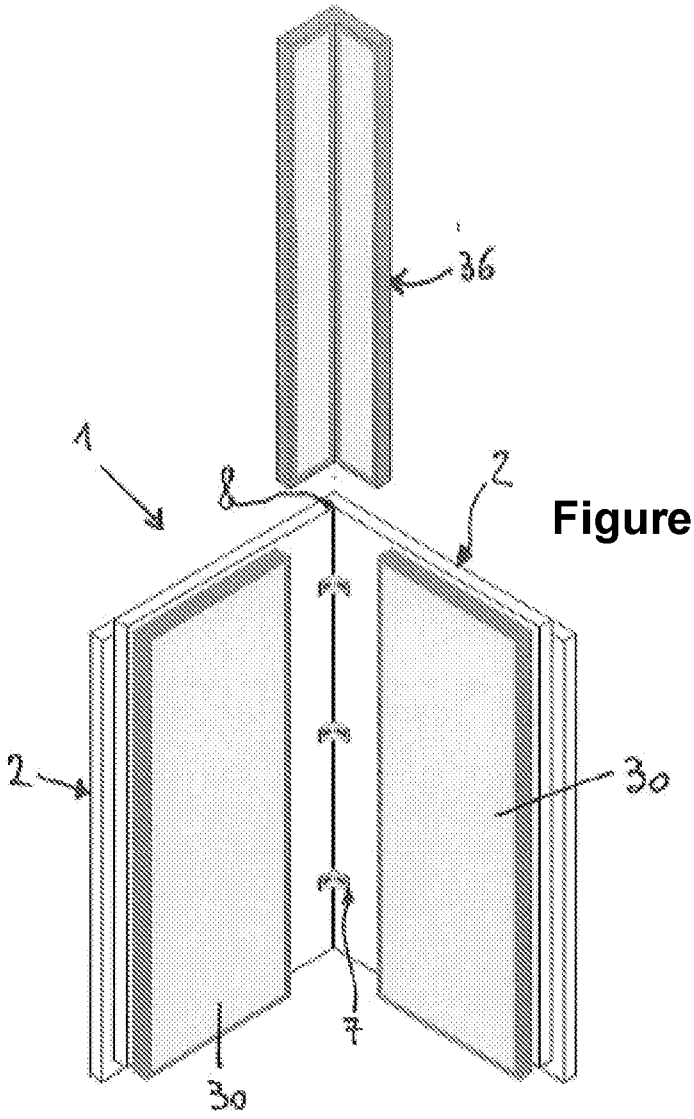

Figure 11

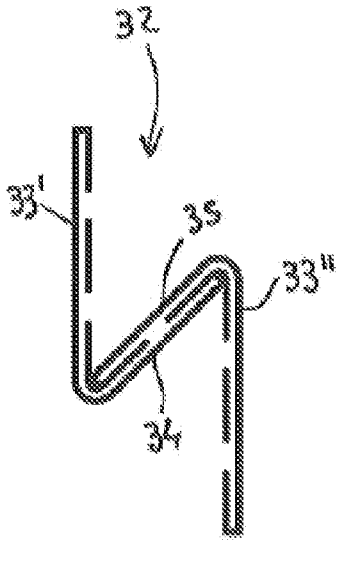

Figure 12a

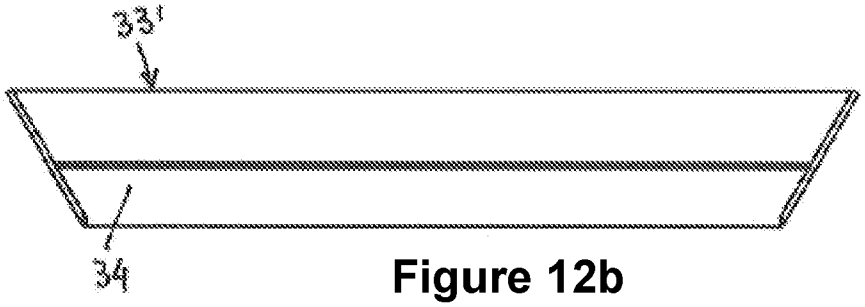

Figure 12b

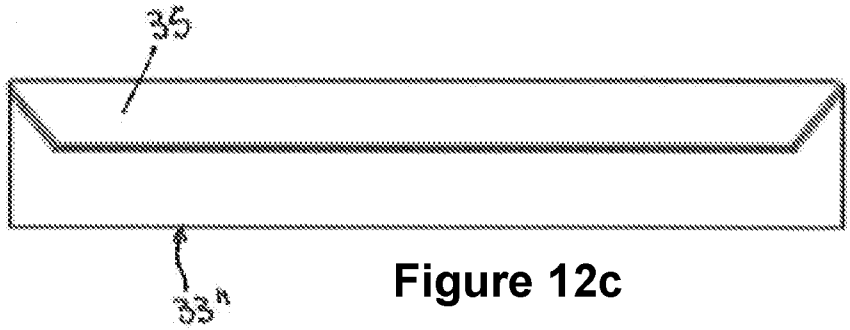

Figure 12c

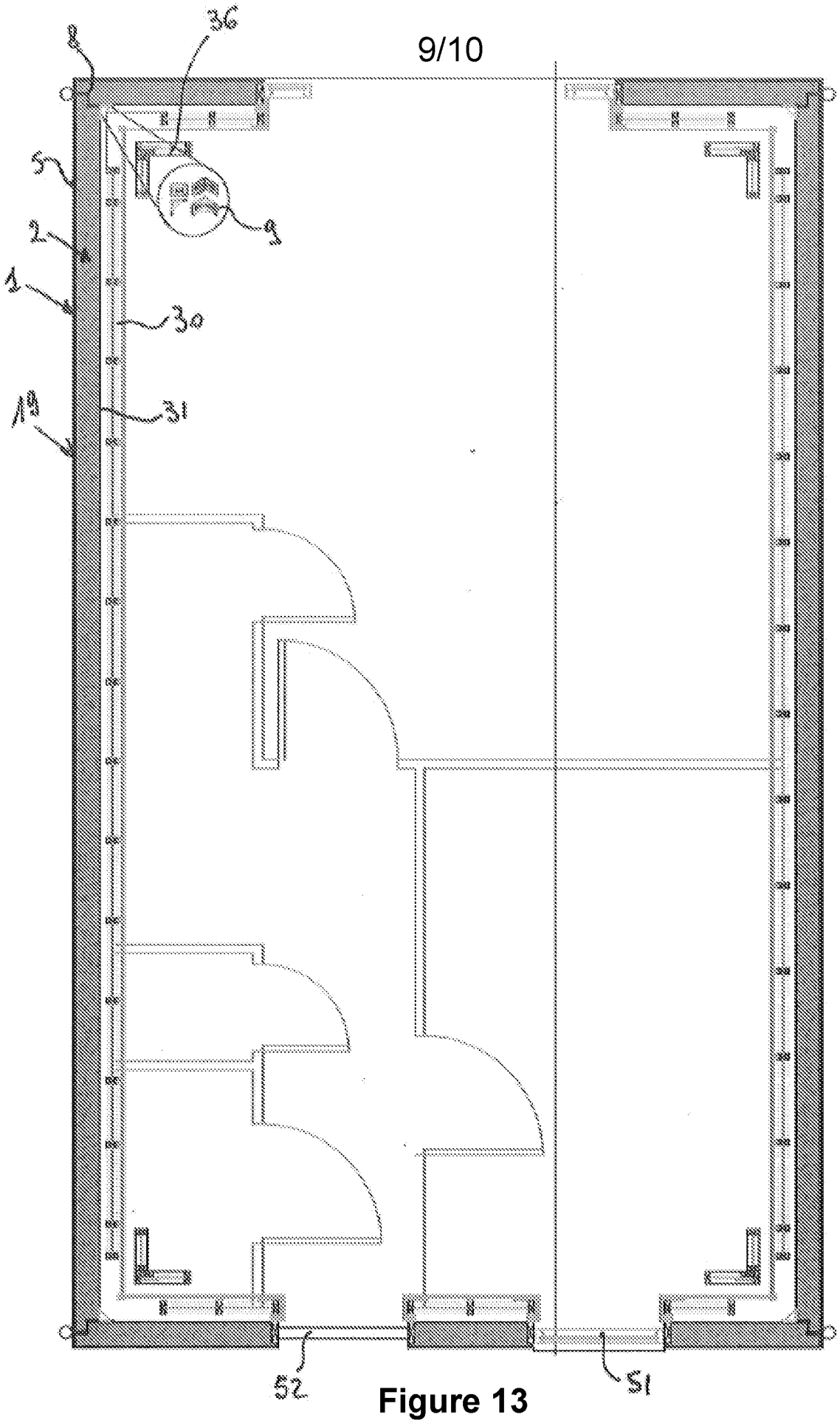

Figure 13

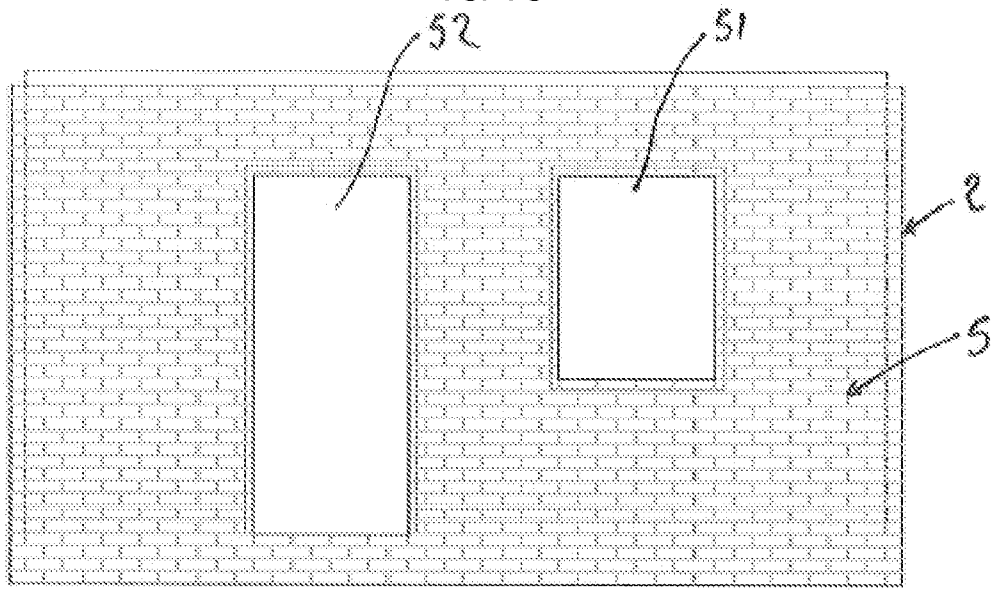

Figure 14a

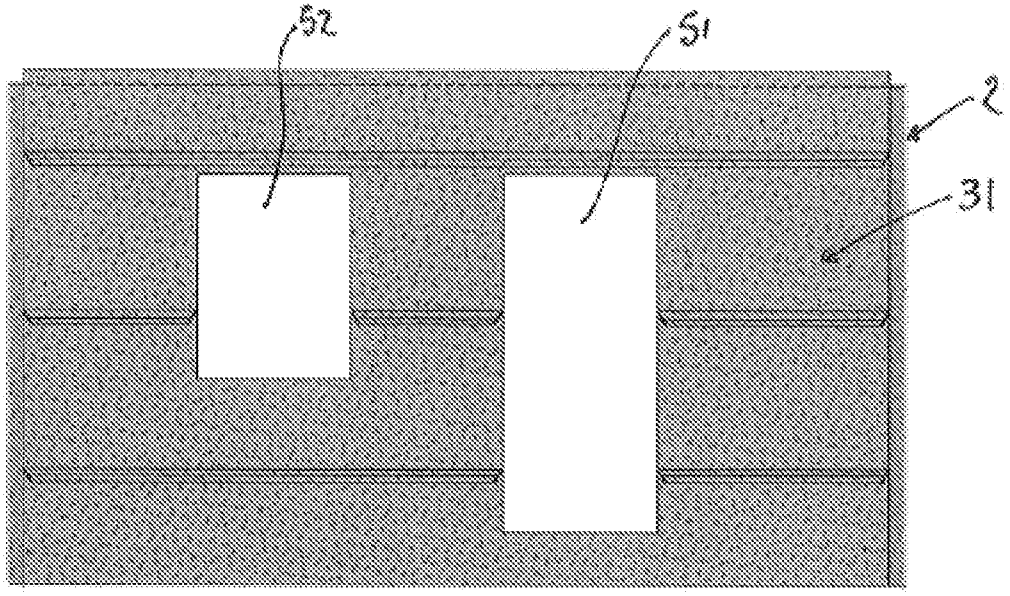

Figure 14b

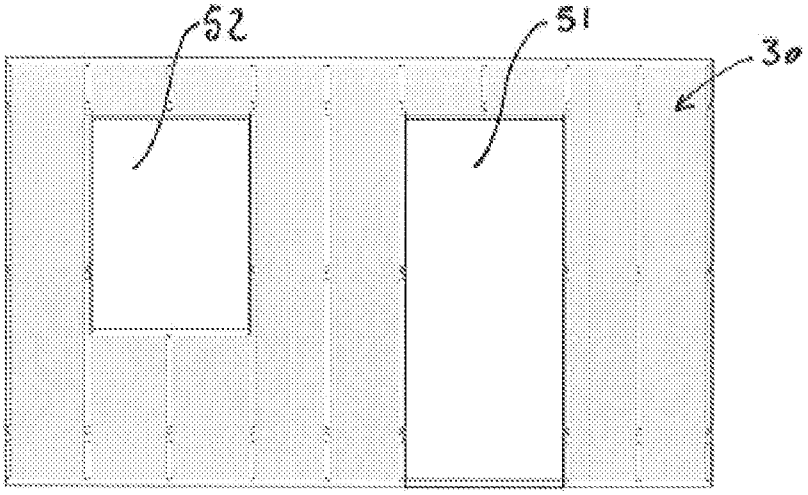

Figure 14c

A CONSTRUCTION ARRANGEMENT AND A METHOD OF CONNECTING PANELS

The present invention relates to an arrangement for constructing a partition or wall. In particular, the invention relates to an arrangement for connecting two or more panels together and a method of use thereof.

Recently, there has been an increasing demand for prefabricated building structures. Most of the components of such structures, including the walls and in some instances the roofs, are produced in a factory and are transported to a building site in their finished state, where the building is then assembled. The on-site construction time for such buildings is drastically reduced when compared to traditional methods of construction, where the construction of the walls and roofs is conducted *de novo* on site. There are multiple benefits to the prefabrication of buildings. For example, there are reduced costs of labour resulting from the drastic reduction in building time, the level of skill required for on-site construction is minimized, and the number of possible setbacks and mistakes are reduced. The overall result is a less costly structure which can be provided quickly and on schedule, with little or no reduction in the quality of the finished building.

Many prefabricated buildings utilise construction panels either externally, internally or both externally and internally. This mitigates the need for brickwork or the construction of timber frames or panels on site. Panels are typically arranged together and connected to produce a partition or wall. There are numerous ways of connecting two panels together to construct a partition or wall. One method involves the use of an adhesive such as glue or mortar to adhere two adjacent panels together. This arrangement requires time for the adhesive to set and the adhesive will weaken over time and so, whilst adhesives are suitable in situations where time is not important and/or it is not required for the construct to be particularly sturdy, or where the construct is only intended to be used for a short time period, adhesives are generally not suitable for connecting panels for the construction of walls of a building.

Mechanical means can also be used to connect two or more panels together. Such means may be used in addition to or instead of adhesives and generally result in a stronger and more permanent construct than panels that are adhered together by adhesives alone. Where the panels are constructed from wood, it is possible to position two panels beside one another, place a nail plate extending from one panel to the adjacent panel and hammer it into the panels to connect them. Variations of this method are known, such as placing a bracket across two panels and screwing the bracket onto the panels, or even using a series of staples to brace the two panels.

In each of these prior art arrangements the panels are irreversibly modified when they are connected. If the connection is done incorrectly as a result of human error, for example if the panels are spaced too close together such that insulation or sealant cannot be placed between them (if desired), or too far apart such that there is an undesirably large gap between the panels, then the panels often must be discarded due to the irreversible modification that occurred during

the connecting of the panels. There is a requirement therefore for an arrangement for connecting panels that does not require irreversible and/or extensive *in situ* modification of the panels to connect them.

To mechanically connect concrete panels, for example, for the formation of walls, it is required to form the panel or modify the panel such that it can receive brackets or bolts or other connecting means to connect adjacent panels. One method of connecting two concrete panels at right angles to form a corner involves prefabricating apertures in the panels at predetermined points along the periphery of each panel. The panels are then set beside each other on site such that the apertures are in alignment, and an angle bracket can be placed traversing the apertures. Bolts are then inserted through the brackets and apertures, and nuts can be tightened onto the bolts to fix the brackets in place, thereby connecting the panels. A problem with this method is that it can often be difficult or impossible to align the apertures of the adjacent panels. Where this occurs, the only solution is to change the panel completely. This can result in panels being discarded, leading to unnecessary waste of building materials, and time wasted in attempting to connect panels which have misaligned apertures. There is therefore a requirement for an arrangement for connecting panels that provides on-site adjustability of the position of connecting means such as brackets.

It is an object of the invention to obviate or mitigate the above problems regarding connecting two or more panels to provide a partition or wall.

It is a further object of the invention to obviate or mitigate the problem of *in situ* modification of panels during the connection of two panels together.

It is a further object of the invention to obviate or mitigate the problem of on-site adjustability of the relative position of connecting means such as brackets.

According to a first aspect of the invention there is provided a construction arrangement comprising two or more panels, each panel comprising a retaining means arranged at or about one or more surfaces of the panel, the arrangement further comprising a connecting means for connecting at least two panels together, the connecting means being operably engageable with the retaining means such that when the connecting means is operably engaged with the retaining means of a first panel and the retaining means of a second panel, the first and second panels are thereby connected, and wherein the retaining means is adapted such that the connecting means can engage with the retaining means in more than one location on the retaining means.

Advantageously, the presence of the retaining means obviates the requirement for any further modification of the panels to connect them. The connecting means can be directly connected to each retaining means of two panels to join them together. Further advantageously, the retaining means can be formed and/or fitted in a factory before transporting the panels to a building site. This eliminates human error during assembly and connection of the panels and

improves the speed of assembly of the partition/wall on site. Yet further advantageously, the panel is not modified when the connecting means is used, therefore the connecting means can be removed from the panel and the panel is undamaged, enabling adjustment without modification/damage as required, for example, if the panels are incorrectly aligned after connection. If the panels are used in a temporary structure, the structure can be deconstructed, and the panels can be reused, as the panels are undamaged during each construction cycle. Advantageously again, the installer can adjust the location of the connecting means on the first and/or second panel, thereby tolerating initial misalignments between the panels and enabling alignment corrections to be made on-site.

Preferably, the connecting means is moveable, most preferably slidably moveable, between engagement locations on the retaining means.

Ideally, the retaining means is integrally formed with and/or is embedded in the panels.

Preferably, the final location of the connecting means relative to the retaining means is determinable on-site when connecting the panels and is not predetermined during formation of the panels and/or connecting means.

Preferably, the connecting means is an adjustable connecting means such that the connecting means can be attached to the panel(s) in more than one position.

Advantageously, this provides further adjustability, increasing the range of tolerable misalignments between the panels during installation.

Preferably, in use, the location of the connecting means relative to the first and/or second panels is adjustable prior to fixing to the panels.

Ideally, the location of the connecting means is vertically and/or laterally adjustable relative to the first and/or second panel prior to fixing to the panels, most preferably, the location of the connecting means is vertically and/or laterally adjustable relative to the retaining means of the first and/or second panel(s).

Ideally, the location of the connecting means on the panels when the connecting means is fixed to and is connecting the panels is adjustable vertically and/or laterally by moving the connecting means relative to the retaining means before fixing the connecting means to the retaining means.

Ideally, the panels are formed by casting a material, such as concrete, in a mould.

Preferably, the panels are formed from concrete.

In one embodiment, the retaining means is cast into the panel during formation of the panel.

Advantageously, no further modification of the panel is required after the concrete is poured in order to connect two or more panels together. The connecting means can be applied to the panels to connect them without requiring drilling/hammering into the panels or any interference with the integrity of the panel.

Ideally, the connecting means comprises one or more connecting elements, and the retaining means is operable to engage with and retain a connecting element of the connecting means on/within the panel.

Advantageously, connecting elements can be arranged in the retaining means to connect the panels together.

Ideally, the retaining means is shaped to engage with and retain one or more connecting elements via an interference fit.

Preferably, the connecting element is retained in the retaining means such that the connecting element cannot be moved away from the panel in at least one direction.

Ideally, each panel comprises two main planar surfaces with a perimeter surface extending between the two main planar surfaces.

Preferably, the retaining means is located at or about a main planar surface of the/each panel.

In one embodiment, the retaining means comprises one or more bores or apertures into or through the panel.

In another embodiment, the retaining means is elongate.

Ideally, the retaining means extends parallel to one or more perimeter surfaces of the panel.

Advantageously, the connecting means is operable to connect two panels together about their main planar surfaces via the retaining means.

Ideally, the retaining means is a continuous retaining means.

Alternatively, the retaining means is a discontinuous retaining means.

Ideally, the retaining means extends along a portion of the/each panel, most preferably along a portion of a main planar surface.

Ideally, the location of the connecting means relative to the panel can be altered by altering the location of the connecting means relative to the retaining means.

Advantageously, in this embodiment where the retaining means is elongate, the connecting means can be fitted at any point along the retaining means. This provides additional adjustability over prior art panels that utilise precise, predetermined fixing points, which can lead to problems on site where the fixing points of adjacent panels do not align.

Preferably, the retaining means is sized such that a plurality of connecting means may be engaged with the retaining means to connect one or more panels together.

Ideally, the retaining means extends at least partially between perimeter surfaces of the or each panel.

Preferably, the retaining means extends from at or about one perimeter surface of the/each panel to at or about one other perimeter surface of the same panel.

Advantageously, the connecting means can be engaged with the retaining means at any location on the retaining means. A larger retaining means increases the options for points of

connection as well as the overall strength of the connection if a plurality of connecting means, or a larger connecting means, are used.

Ideally, the retaining means is located towards one edge of the main planar surface of the/each panel.

Advantageously, the connecting means can be used to connect two panels together such that the main planar surfaces are coplanar, or at a right-angle to provide a corner, or alternative angles as desired.

In one embodiment, the retaining means comprises at least one retaining anchor embedded in the panel.

Ideally, the retaining means is/are cast into the panel during formation of the panel.

Preferably, the retaining anchor(s) is/are cast into the panel during formation of the panel.

Preferably, the retaining anchor comprises an anchoring portion extending into the panel.

Ideally, the retaining means comprises a retaining portion for engaging with the connecting means or, preferably, a connecting element of the connecting means

In one embodiment, the retaining portion comprises one or more teeth arranged to engage with a part of the connecting means.

Advantageously, the teeth can hold the connecting means in place whilst it is being fixed to the retaining means such that the location of the connecting means relative to the retaining means does not slip during fixing.

Ideally, the connecting means comprises a brace, the brace being operable to extend from one retaining means on one panel to another retaining means on another panel.

Preferably, the brace comprises means for engaging with the retaining means.

Ideally, the brace is co-operable with one or more connecting elements to connect the brace to the retaining means.

In one embodiment, the brace is planar.

Advantageously, a planar brace can be used to connect two panels in a coplanar relationship.

In an alternative embodiment, the brace is a right-angled brace comprising two planar portions connected at a right angle to one another.

Advantageously, a right-angled brace can be used to connect two panels together at a right-angle providing a corner.

Alternative shaped braces are also within the scope of the invention to connect two panels together at any desired angle between 0º where panels are coplanar and 180º where the panels are parallel and the main planar surfaces are mutually opposing.

Ideally, the brace having a portion connectable to one panel and portion connectable to a second panel, wherein the angle between said portions is between 0º and 180º.

In one embodiment, the brace is an elongate brace which extends along the surface of the panels in use.

Advantageously, multiple connecting elements can be used along with the elongate brace to strengthen the connection between the two panels. Alternatively or additionally, multiple braces can be used.

Ideally, the brace is a bracket such as an angle bracket.

Ideally, the connecting means, most preferably the brace comprises one or more reinforcements.

Advantageously, this strengthens the connection between panels in use.

In one embodiment, one or more panels comprise a recess to accommodate another panel and improve the fitting therebetween.

Ideally, at least one panel comprises a recess at or about its edge, the recess being sized to accommodate a perimeter surface of another panel.

Ideally, at least one panel comprises a recess at or about its edge, the recess being sized to accommodate an edge of another panel.

Ideally, the recess extending depth-wise into the panel from a main planar surface of the panel.

Preferably, the recess having a width equal to or larger than the width of a second panel.

Ideally, the perimeter surface or edge of the second panel can be inserted into the recess.

Ideally, when the second panel is inserted into the recess, an outer main planar surface of the second panel is coplanar with the perimeter surface of the panel having the recess.

Advantageously, when the panels are arranged in a right-angled/corner configuration, the edge of one panel is located within the recess of another panel. This improves the strength of the connection between the two panels when the connection means is engaged with the retaining means of each panel.

Preferably, the retaining means, most preferably the retaining portion, comprises an opening, channel or groove having a lip, shoulder or dovetail cross-section or other such formation such that a connecting element having a wide portion and a narrow elongate portion is retained in the opening, channel or groove, whereby the wide portion is retained and the narrow portion extends from the opening, channel or groove.

Ideally, the connecting element has a head and shaft, the head being sized to fit within the retaining means, most preferably, within the retaining portion of the retaining means, with the shaft extending therefrom.

Ideally, the connecting element is a bolt having a head and shaft, the head of the bolt being sized to fit within the retaining means, most preferably, within the retaining portion of the retaining means, with the shaft extending therefrom.

In one embodiment, the head of the connecting element has one or more teeth arranged protruding from the shaft side of the head, the tooth or teeth corresponding to teeth on the retaining portion of the retaining means.

Ideally, the brace comprises an opening or aperture sized to accommodate the connecting element, most preferably, the shaft of the connecting element.

Preferably, the opening or aperture is an elongate slot.

Advantageously, the location of the connecting element relative to the brace can be adjusted by moving the brace about the connecting element via the elongate slot. This provides further adjustability of the connecting means relative to the retaining means.

Ideally, the aperture of the brace is delimited at least partially by teeth.

Advantageously, the aperture can receive a correspondingly toothed lock washer that is fixed by engagement of the teeth when inserted into the aperture, but wherein its relative position in the aperture can be changed by moving the lock washer such that the teeth of the lock washer engage a different set of teeth in the aperture.

Preferably, the connecting means comprises one or more nuts or other fixing means engageable with the connecting element to hold the brace against the retaining means.

According to a second aspect of the invention there is provided a method of connecting two panels together wherein each panel comprises a retaining means, the method comprising the steps of arranging the panels proximal to one another then arranging a connecting means in operable engagement with the retaining means of each panel to connect the panels together.

Ideally, the method comprising the step of inserting a connecting element into the retaining means of a first panel and a connecting element into the retaining means of a second panel.

Preferably, the method comprising moving, most preferably slidably moving, the connecting element along the retaining portion of the retaining means to a desired location.

Advantageously, the connecting element can be located at any location along the retaining means and is not limited to being located at a predetermined aperture on the panel.

Ideally, the method comprising the step of arranging a brace on a connecting element, the connecting element extending through an opening or slot of the brace.

Preferably, the method comprising adjusting the location the brace relative to the connecting element(s) by moving the brace about the connecting element thereby adjusting the location of the connecting element in the opening or slot.

Preferably, the method comprising the step of arranging a brace extending between the connecting elements of each panel.

Ideally, the method comprising fitting a fixing means such as a nut onto the connecting element to attach the brace to the panels thereby joining the panels.

In one embodiment, the method comprising the step of arranging two panels together about their edges at right-angles thereby providing a corner, and using a right-angled brace to connect the panels about their retaining means.

According to a third aspect of the invention there is provided a panel comprising a retaining means arranged at or about one or more surfaces of the panel, the retaining means being capable of slidably receiving at least part of a connecting means.

Ideally, the retaining means is operably engageable with a connecting means to fix the panel to another panel about their edges to form a corner.

In another embodiment, the retaining means is elongate.

Ideally, the retaining means is located towards one edge of the main planar surface of the panel.

Ideally, the panel comprises two main planar surfaces with a perimeter surface extending between the two main planar surfaces.

Preferably, the retaining means is sized such that a plurality of connecting means may be engaged with the retaining means to connect one or more panels together.

Ideally, the retaining means extends at least partially between perimeter surfaces of the panel.

Preferably, the retaining means extends from at or about one perimeter surface of the panel to at or about one other perimeter surface of the same panel.

Ideally, the retaining means extends parallel to one or more perimeter surfaces of the panel.

In one embodiment, the panels comprises a recess to accommodate another panel and improve the fitting therebetween.

Ideally, the panel comprises a recess at or about its edge, the recess being sized to accommodate an edge of another panel.

Ideally, the recess extending depth-wise into the panel from a main planar surface of the panel.

Preferably, the recess having a width equal to or larger than the width of a second panel.

Ideally, the edge of the second panel can be inserted into the recess.

According to a fourth aspect of the invention there is provided a panel comprising a connecting element arranged at or about one or more surfaces of the panel and protruding therefrom, the connecting element being operable to engage with a brace to connect two or more panels together.

Ideally, the connecting element protrudes from a surface of the panel, most preferably from a main planar surface.

Preferably, the connecting element protrudes substantially perpendicularly from the plane of the main planar surface.

According to a fifth aspect of the invention there is provided a method of constructing a panel having a retaining means, the method comprising integrally forming the panel with a

retaining means at or about one or more surfaces of the panel, and/or embedding a retaining means at or about one or more surfaces of the panel.

Ideally, the method comprising forming a mould for the panel.

Preferably, the method comprising forming a mould having a protrusion shaped to form a retaining means in a panel created by the mould.

In one embodiment, the method comprising arranging retaining anchors in the mould.

Preferably, the method comprising pouring concrete or other suitable casting material in the mould and allowing time to set.

Ideally, the method comprising removing the panel from the mould.

Advantageously, no further modification of the panel is required to connect it to another panel via a connecting means.

According to a sixth aspect of the invention there is provided a kit of parts, the kit comprising at least two panels wherein each panel has a retaining means and/or a connecting element, the kit further comprising a connecting means for connecting the panels about their retaining means.

Ideally, the kit comprising one or more connecting elements.

Preferably, the kit comprising one or more braces.

Ideally, the kit comprising one or more bolts and/or other fixing means.

According to a seventh aspect of the invention there is provided a prefabricated cavity wall panel assembly comprising an external leaf, an internal leaf appendable from the external leaf so as to define a cavity therebetween, and wherein at least one of the leaves is formed at least partially from two or more panels, each panel comprising a retaining means arranged at or about one or more surfaces of the panels, the assembly further comprising a connecting means for connecting at least two panels together, the connecting means being operably engageable with the retaining means such that when the connecting means is operably engaged with the retaining means of a first panel and the retaining means of a second panel, the first and second panels are thereby connected.

Ideally, the cavity wall panel assembly is prefabricated in a factory environment.

Advantageously, this reduces the problems with poor workmanship and *ad hoc* modifications taking place on the construction site.

Ideally, the/each panel is a precast water-resistant concrete panel.

Preferably, the external leaf is formed as a prefabricated concrete or steel frame panel.

In one embodiment, the internal leaf is formed as a prefabricated timber or steel frame panel.

Preferably, the load bearing structural external leaf is a precast concrete panel having a precast/prefabricated brick slip external finish.

Ideally, the load bearing structural external leaf is a panel having a prefabricated brick slip external finish.

Preferably, the internal leaf is a timber frame wall panel.

Ideally, the gaps of the timber frame wall panel are filled with an insulation material.

Ideally, the insulation material are prefabricated insulation panels designed to optimize the insulation properties of the internal wall panel.

Ideally, the cavity is set at a distance in a range of 30 mm to 70 mm, most preferably 40 mm to 60 mm and ideally 50 mm.

Preferably, a mechanical coupling arrangement is disposed along the mutually opposing upright jointing surfaces of adjacent external wall panels.

Ideally, the mechanical coupling arrangement comprises means for interlocking adjacent external wall panels together as one panel is lowered into a final jointed position beside an adjacent external wall panel, already mounted on the ground or ground floor external wall panel.

Preferably, the mechanical coupling arrangement comprises a means for pulling adjacent external wall panels towards each other to interlock the two panels together so that the mutually opposing upright jointing surfaces are in an abutting relationship along their length.

Advantageously, the mechanical coupling arrangement allows two adjacent panels to be mechanically interlocked while simultaneously pulling the two panels together into a final assembled position where no gaps exist between the mutually opposing upright jointing surfaces.

Preferably, a mechanical coupling arrangement is disposed along the mutually opposing horizontal jointing surfaces of stacked external wall panels.

Preferably, a mechanical coupling arrangement is disposed along the mutually opposing horizontal jointing surfaces of stacked load bearing structural external wall panels.

Ideally, the mechanical coupling arrangement comprises means for interlocking stacked external wall panels together as one panel is lowered on top of a lower external wall panel into a final jointed position on top of an external wall panel already mounted on the ground or ground floor external wall panel.

Ideally, the cavity wall panel assembly is assembled into a quadrangular structure where the external load bearing wall panels are provided with structural stability directly or indirectly with the floor cassette.

Preferably, the cavity wall panel assembly is sufficiently robust to carry the floor load.

In one non-limiting embodiment, the cavity wall panel assembly is designed to carry 7-13 kn/m, most preferably 10kn/m.

Ideally, the internal leaf has means for sealing the gap between the bottom and/or top of the internal leaf and the floor and/or ceiling.

Preferably, the internal leaf has means for compressibly sealing the gap between the bottom/top of the internal leaf and the floor/ceiling.

Ideally, a compressible foam seal extends along all or part of the uppermost/lowermost portion of the internal leaf/wall panel so that when the cavity wall panel assembly is lowered into a final position the gap between the lowermost portion of the internal leaf and the floor is compressibly sealed.

Preferably, a compressible foam seal extends along all or part of the uppermost/lowermost portion of the internal leaf/wall panel so that when the cavity wall panel assembly is in a final position and the ceiling is set on the cavity wall panel the gap between the uppermost portion of the internal leaf and the ceiling is compressibly sealed.

Ideally, additional structural support means are provided at the corner joints of the wall panel assembly.

Ideally, the additional structural support means are provided by at least one gusset.

Advantageously, the fastening means for joining the outer and inner panels together comprise a male member fixed to a surface of a panel and a female member fixed to the facing surface of the other panel.

Preferably, the fastening means for joining the outer and inner panels together comprise a male member fastened to the inner surface of the outer panel and a female member fastened to the external surface of the inner panel, or vice versa. Conveniently, the male and female members are fastened to the corresponding surfaces of the panels by means of fixing means, preferably by fixing screws and/or by gluing.

Preferably, the male member is a rod while the female member is a socket.

Advantageously, the outer and inner panels can have the same dimension in terms of width (i.e. horizontal development) and/or height (i.e. vertical development), thus in terms of their area.

Advantageously, the inner and outer panels can have different dimensions in terms of width (i.e. horizontal development) and/or height (i.e. vertical development), thus in terms of their area.

Preferably, the outer panel is larger/wider than the inner panel.

Preferably, the outer panel is higher than the inner panel.

Preferably, the outer and inner panels have the same thickness. Alternatively, the outer and inner panels have different thicknesses.

Preferably, two adjacent cavity wall panel assemblies are joined together at a corner by connecting means.

Preferably, two adjacent cavity wall panel assemblies are joined together by connecting means acting on the outer panels.

Ideally, the connecting means comprises at least one angle bracket.

Preferably, the outer panels of two adjacent cavity wall panel assemblies are connected together in correspondence of a corner by means of at least one brace, most preferably by at least one angle bracket.

Preferably, a plurality of braces or angle brackets are associated to the outer panels and are suitably spaced from each other along the vertical development of the panel.

Preferably, the brace, most preferably the angle bracket, comprises two parts that define an angle between them.

Preferably, the brace comprises reinforcing wings at the junction of the two parts.

Preferably, the two parts of the angle bracket are provided with apertures for attaching each part to a corresponding panel.

Ideally, the cavity wall assembly comprising an insulated element.

Advantageously, the insulated element is associated removably to the cavity wall panel assembly by means of attaching means.

Preferably, the insulated element is shaped as a panel.

Advantageously, the attaching means are configured to support the insulated element.

Advantageously, the attaching means comprise supporting brackets that are associated respectively to the internal surface of the cavity wall panel assembly and to the insulated element. Conveniently, the supporting brackets are fitted in the factory during the manufacturing of the cavity wall panel assembly.

Preferably, the supporting brackets comprise a first rail and a second rail, wherein the first rail is fixed to the cavity wall panel assembly and is provided with a wing that engages/hooks to a corresponding wing of the second rail that is fixed to the insulated element.

Advantageously, the means for attaching the insulated element to the cavity wall panel assembly are configured so that the insulated element is hung on the cavity wall panel assembly.

Preferably, the means for attaching the insulated element to the cavity wall panel assembly are configured so that the upper edge and/or lower edge are internally spaced from the corresponding upper edge and/or lower edge of the cavity wall panel assembly.

Conveniently, an insulated element shaped as a corner panel is inserted in correspondence of the corner joint between two cavity wall panel assemblies.

Advantageously, the insulated panel may be associated to the cavity wall panel assembly side by side with or without empty spaces between them.

Advantageously, the internal services or fittings can be pre-installed/fitted on the cavity wall panel assembly.

Preferably, the internal services or fittings are installed/fitted in the factory.

Alternatively, the internal services or fittings can be fitted and/or installed at the wall building site.

Advantageously, the windows and/or doors can be pre-defined and fitted on the cavity wall panel assembly.

Preferably, the windows and/or doors are installed/fitted at the factory. Alternatively, the windows and/or doors can be fitted and/or installed at the wall building site. Advantageously, the windows and/or doors can be pre-defined and fitted on the external wall panel in the factory.

According to an eighth aspect of the invention there is provided a building formed at least partially from a construction arrangement as outlined above.

It will be appreciated that optional features applicable to one aspect of the invention can be used in any combination, and in any number. Moreover, they can also be used with any of the other aspects of the invention in any combination and in any number. This includes, but is not limited to, the dependent claims from any claim being used as dependent claims for any other claim in the claims of this application.

The invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional plan view of a construction arrangement according to the invention,

Figure 2 is an expanded view of a construction arrangement according to invention,

Figure 3 is a perspective view of a construction arrangement according to the invention,

Figure 4 is a perspective view of a retaining arrangement according to the invention,

Figure 5 is a perspective view of the prefabricated cavity wall panel assembly according to the invention,

Figure 6 is a perspective view of the angle bracket used for connecting two external leaves in correspondence of a corner of the prefabricated cavity wall panel assembly,

Figure 7 is a vertical cross section view of the connection of two panels of Fig. 5,

Figures 8a-c show in sequence a detail of the connection of Fig. 7,

Figure 9 is a vertical cross section of the detail of the junction of two storeys of the prefabricated cavity wall panel assembly, according to the invention showing an upper and lower floor,

Figure 10 is a vertical cross section of the detail of the junction of the prefabricated cavity wall panel assembly with the ground floor according to the invention,

Figure 11 shows the prefabricated cavity wall panel assembly of Fig. 5 and in an exploded view the insulation corner panel to be inserted,

Figure 12a is a vertical cross section of the connection between the two brackets for coupling the internal panel to the external panel,

Figures 12b,12c are respectively the front views of the upper and lower brackets of Figure 12a,

Figure 13 is a plan view of a floor built with the prefabricated cavity wall panel assembly according to the invention,

Figure 14a is a front view of the exposed external surface of the prefabricated cavity wall panel assembly according to the invention,

Figure 14b is a front view of the internal surface of the external panel of the prefabricated cavity wall panel assembly of fig. 14a,

Figure 14c is a front view of the internal panel connected to the internal surface of the external panel of fig. 14b.

In the drawings there is a shown a construction arrangement indicated generally by reference numeral 101. The construction arrangement 101 has two rectangular, cast-concrete panels 102, 103. Both panels 102, 103 consist of an internal main planar surface 104a, 104b, an external main planar surface 105a, 105b and a perimeter surface extending between the internal 104a, 104b and external 105a, 105b main planar surfaces. Each panel 102, 103 has a retaining arrangement 106a, 106b arranged at the internal main planar surface 104a, 104b. The construction arrangement 101 further has a connecting arrangement 107 which is operably engaged with the retaining arrangements 106a, 106b of each panel 102, 103, thereby connecting the panels 102, 103 together. The retaining arrangements 106a, 106b are engageable with the connecting arrangement 107 without requiring any further modification to the panels 102, 103. The connecting arrangement 107 consists of a metal angle bracket 108 with two apertures 130a, 130b, each sized to receive a connecting element, two connecting elements (bolts 109a, 109b), and two nuts 110a, 110b screwed onto the bolts 109a, 109b to fix the bracket to the panels 102, 103. The apertures 130a, 130b are elongate slots which provides further adjustability as the connecting elements 109a, 109b can be moved within the apertures 130a, 130b before fixing the connecting elements 109a, 109b to the bracket 108. The head 111a of one bolt 109a is arranged in the retaining arrangement 106a of one panel 102 whereas the head 111b of the other bolt 109b is arranged in the retaining arrangement 106b of the other panel 103. The bolts 109a, 109b can slidably move along the retaining arrangements 106a, 106b respectively. The angle bracket 108 comprises two reinforcing plates 120a, 120b, each plate extending from the location of one bolt 109a on one panel 103 to the second bolt 109b on the second panel 103.

The panels 102, 103 are connected by the connecting arrangement 107, with the internal main planar surfaces 104a, 104b of each panel 102, 103 extending at right angles to one another such that they create a corner. The retaining arrangements 106a, 106b of each panel 102, 103 include an elongate groove 112a, 112b which extends vertically along the panel 102, 103 when stood upright as used in a partition or wall. The grooves 112a, 112b extend along the entirety of the internal main planar surfaces 104a, 104b of each panel 102, 103 respectively, from one perimeter surface to the opposing surface. The grooves 112a, 112b are arranged proximal to, and run parallel to, an upstanding perimeter edge of each panel 102, 103 as orientated in use.

The retaining arrangements 106a, 106b of each panel 102, 103 each have a plurality of retaining anchors 113a, 113b which are embedded in the panels 102, 103 and are cast into the

panels 102, 103 during formation of the panels 102, 103. Each anchor has an anchoring portion 114a, 114b and a retaining portion 115a, 115b. The anchoring portion 114a, 114b of each retaining anchor 113a, 113b is an elongate rod which extends into the panels 102, 103 in a direction perpendicular to the plane of the internal main planar surfaces 104a, 104b. The anchoring portion 114a, 114b extends from the retaining portion 115a, 115b and terminates in a foot 116a, 116b which is wider than the width of the shaft of the anchoring portion 114a, 114b. The foot 116a, 116b increases the strength of the anchoring of the retaining anchor 113a, 113b within the panel 102, 103 by preventing the retaining anchor 113a, 113b from easily being pulled out of the panel 102, 103.

Referring now to Figure 2, the retaining portion 115a includes an opening 117a having a rectangular cross-section and being sized to receive a part of the connecting elements, in particular the head portion of the bolts 109a, 109b. The opening 117a is partially closed over by two flanges 118a, 119a which extend over the opening 117a in an orientation parallel with the internal main planar surface 104a of the panel 102. The head 111a of the bolt 110a can therefore be inserted into the opening 117a in one orientation, i.e., vertically down into opening 117a, but once in the opening 117a, the head 111a of the bolt 110a cannot be moved substantially horizontally in any direction. Movement horizontally away from the panel 102 results in the head 111a abutting the flanges 118a, 119a. The bolt 110a is thereby retained by the retaining arrangement 106a.

Referring again to Figure 1, the first panel 102 has a recess 121 shaped to accommodate the second panel 103. The recess 121 is formed at the internal main planar surface 104a of the panel 102 at the edge 122 of the panel 102 and has a width slightly wider than that of the width of the perimeter surface 123 of the second panel 103. The second panel 103 can therefore slot into the recess 121 and external main planar face 105b of the second panel 103 is coplanar with the edge 122 of the first panel 102, when the panels 102, 103 are connected.

In use, the panels 102, 103 are stood upright and the second panel 103 is arranged within the recess 121 of the first panel 102 creating a corner. The bolts 109a, 109b are slidably inserted the openings of each retaining arrangement 106a, 106b respectively such that the head 111a, 111b of each bolt 109a, 109b is retained within the arrangements 106a, 106b and the shaft of the bolts 109a, 109b protrudes out perpendicularly from the internal main planar surfaces 104a, 104b of the panels 102, 103. The bolts 109a, 109b can be slidably moved within the retaining arrangements 106a, 106b to alter the final position of the connecting arrangement 107 and it is not required to perfectly vertically align the panels as with prior art assemblies. Once the desired final position is located, as defined by the location of the bolts 109a, 109b, the angle bracket 108 is inserted onto the bolts 109a, 109b such that the bolts pass through the apertures 130a, 130b of the bracket 108 and the corner of the bracket 108 sits neatly in against the corner of the panels 102, 103. To connect the panels 102, 103, the nuts 110a, 110b are tightened onto the bolts 109a, 109b against the bracket 108, securing the bracket 108 against the panels 102, 103 and

releasably locking the panels 102, 103 together. As noted, no modification of the panels 102, 103 is required to connect the panels 102, 103 together.

Various modifications will be apparent to those skilled in the art. For example, the retaining arrangements 106a, 106b need not have a retaining anchor 113a, 113b and could be formed as a dovetail groove, or other suitable shape or aperture, in the internal main planar surfaces 104a, 104b of the panels 102, 103. The bracket 108 is not limited to a right-angled bracket 108 but could be any suitable brace extending between the retaining arrangements 106a, 106b of the panels 102, 103, such as a planar bracket, thereby connecting the panels 102, 103 such that the internal main planar faces 104a, 104b are coplanar, or angled at any angle up to 180º, to alter the angle of the corner formed between the panels 102, 103. Multiple brackets 108 may be used to connect the panels 102, 103, or a single elongate bracket 108, extending along the joint, with a plurality of apertures for accommodating a plurality of connecting elements, or a combination of different sized brackets 108 may be used. The elongate groove 112a, 112b of the retaining arrangement 106a, 106b may be of any suitable shape provided it is operable to retain a connecting element. The connecting elements may be any suitable device capable of mechanically engaging with the retaining arrangement 106a, 106b and fixing to the bracket 108 without requiring further modification of the panels 102, 103 to connect the panels 102, 103. In an alternative arrangement, the connecting-element/bolt is cast into the panel 102, 103 such that it is permanently anchored into and protruding from the panel 102, 103. A bracket 108 can then be placed over the connecting element and fixed in position and repeated on an adjacent panel to connect the panels 102, 103. Again, this arrangement requires no further modification of the panel 102, 103 after fabrication of the panel 102, 103 to fix the panels 102, 103 together.

Also within the scope of the invention is a method of manufacturing a panel 102, 103 as shown in the drawings. The method involves casting a panel from concrete or other castable material. First, a mould is created for the panel, the mould having a projection or ridge which will form at least part of the retaining arrangement 106a, 106b after the mould is poured. Additionally or alternatively, one or more retaining anchors 113a, 113b are arranged within the mould so that when the concrete or other material is poured and sets, the anchors 113a, 113b are embedded in the resulting panel 102, 103. Yet a further alternative involves casting the connecting element in the panel 102, 103 and projecting therefrom such that fixing a bracket 108 across two similar panels 102, 103 joins the panels 102, 103. The panel 102, 103 is connectable to another similar panel via a connecting arrangement 107 immediately after manufacture without further modification of the panel 102, 103 being required.

Turning now to Figures 5 to 14 there is shown a prefabricated cavity wall panel assembly 1 according to the invention and it comprises at least two external leaves 2, but it is intended that the assembly 1 preferably comprises a plurality of external leaves 2 that are placed side by side. In particular, each external leaf 2 comprises at least one panel 3 configured to support building load and/or to transfer building load to the foundations of the same building.

The external surface 4 of the external leaf 2 is suitably finished as it is intended to be exposed. More in detail, the external surface 4 comprises an exposed finished face 5 (see Figure 14a) that can be brickwork, blockwork, or can be clad with weatherboard or brick slip. Conveniently, the exposed finished face 5 is prepared off-site, preferably in the factory, during the manufacturing of the panel. More in detail, the exposed finished surface 5 is suitably pre-fitted on the external surface 4 of the external leaf 2, and in particular of the external panel 3.

In particular, it is pointed out that in this document the "external" surface of the external leaf 2, or of the panel 3, is the one that is directed toward the exterior of the building intended to be made by the prefabricated cavity wall panel assembly 1, while the "internal" surface of the external leaf 2, or of the panel 3, is the one opposite to the external one and directed toward the inside of the same building.

Advantageously, each panel 3 is made of concrete, preferably of water resistant concrete. In particular, each panel is a precast water resistant concrete panel.

Conveniently, the external leaf 2 has a front panel part 3' and rear panel part 3'' where the rear panel part 3'' protrudes above the front panel part 3' at an upper end thereof to provide an interlocking key for jointing with vertically stacked external leaves 2. Furthermore, the front panel part 3' protrudes below the rear panel part 3'' at a lower end thereof to provide an interlocking key for jointing with vertically stacked external leaves 2. The panel parts can have the same or different dimensions in terms of width (i.e. horizontal development) and height (i.e. vertical development), thus in terms of area. Preferably, the front panel part 3' is larger/wider than the rear panel part 3''. Conveniently, the front panel part 3' and rear panel part 3'' can have the same or even different thickness.

Advantageously, two adjacent external leaves 2 are joined at a corner together by connecting arrangements 7. The panels 3 of two adjacent external leaves 2 are connected together in correspondence of a corner 8 by means of at least one angle bracket 9. More in detail, a plurality of angle brackets 9 are provided and they are suitably spaced from each other along the vertical development of the panels 3. In this way, two adjacent external leaves 2 are joined together at the corner so as to define a suitable angle, which can be of 90° as shown in Figure 5 but it can also be greater or smaller than that. The angle brackets 9 are spaced apart vertically along the included corner angle between the two panels 3. While not shown in the drawings, it will be apparent to the skilled person that the panels 3 may be arranged having a retaining arrangement according to the invention and as described above, and that the connecting arrangements 7 are adjustable along the length of the retaining arrangement.

Advantageously, the angle bracket 9 comprises two parts 10', 10'' that define an angle between them. Conveniently, the angle bracket 9 comprises reinforcing wings 11 at the junction of the two parts 10', 10''. Moreover, the two parts 10, 10'' are provided with apertures 12 for attaching each part to the corresponding panel. Conveniently, the aperture 12 is delimited at least in part by a toothed profile 13.

Advantageously, said at least two adjacent outer panels 3 forming each modular structure 2 are joined together by mechanical coupling arrangement 20.

A mechanical coupling arrangement 20 comprises an arrangement for pulling adjacent external wall panels 3 towards each other to interlock the two panels 3 together so that the mutually opposing upright jointing surfaces are in an abutting relationship along their length. Advantageously, the mechanical coupling arrangement 20 allows two adjacent panels 3 to be mechanically interlocked while simultaneously pulling the two panels 3 together into a final assembled position where no gaps exist between the mutually opposing upright jointing surfaces.

Conveniently, in case of external leaves 2 defining a wall 19 at the ground level 18 as shown in Figure 9, the front panel part 3' and rear panel part 3'' panels have different height and, in particular, the rear panel part 3'' is higher than the front panel 3' at the upper end thereof. Preferably, in this case, the mechanical coupling arrangement 20 for joining two adjacent panels together are configured so as that, when the corresponding facing surfaces 6', 6'' are in contact, the lower surfaces 21 of both panel parts 3', 3'' are substantially coplanar while the upper surface 22'' of the rear panel part 3'' protrudes upwards, thus defining a kind of upper step 23.

Conveniently, in case of modular structures defining a wall 19 at the upper level 17 as shown in figure 9, the front panel part 3' and rear panel part 3'' have the same height. Preferably, in this case, the mechanical coupling arrangement 20 for joining two adjacent panels together are configured so as that, when the corresponding facing surfaces 6', 6'' are in contact, the lower edge 21' of the front panel part 3' protrudes downwards (thus defining a kind of lower step 24) while the upper edge 22'' of the rear panel part 3'' protrudes upwards. Therefore, in order to define the wall 19 of the upper level 17 over the wall 19 of the ground level 18 (or in general of a lower level), the lower step 24 of the upper external leaf 2 matches the upper step 23 of the lower external leaf 2 and this enables a stable positioning and also facilitates their installation.

More in detail, the mechanical coupling arrangement 20 for joining two adjacent panels together comprises a male member 25 (fig. 8a) fixed to the vertical surface 6' of the one panel 3' and a female member 26 fixed to the vertical surface 6'' of the adjacent panel 3'', or vice versa. Conveniently, the male 25 and female members 16 (as shown in figures 8a-8c) are fixed to the corresponding vertical surfaces of the two adjacent panels by means of traditional fixing means, for example by fixing screws 27 but even by gluing or embedding.

Preferably, the male member 25 is a rod while the female member 26 is a socket. Advantageously, the male member 25 is tilted upward while the female member 26 is tilted downward, or vice versa.

The joining of the one panel 3' to the adjacent panel 3'' is shown in the sequence of figures 8a-8c. In particular, once the panel 3' is in position, the adjacent panel 3'' is lowered into position by lining up the respectively male 25 and female members 26 (see fig. 8a). Then, once the male 25 and female members 26 have been aligned and engaged, by lowering the adjacent panel 3'' the vertical facing surfaces 6', 6'' of the two panels are caused to enter in contact, thus

sealing the vertical joint between the panels (see fig. 8b). More in detail, when the adjacent panel 3'' is fully lowered, the vertical joint, which is defined by the contact of the facing vertical surfaces 6', 6'' of the two panels, is fully sealed.

An internal leaf 30, preferably shaped as a panel, is associated with the internal face 31 of the outer leaf 2. Advantageously, the internal leaf 30 is removably associated to the outer leaf 2 by means of attaching arrangement 32. Preferably, the attaching arrangement 32 are configured to support the insulated internal leaf 30. In particular, the attaching arrangement 32 comprise two supporting brackets 33', 33'' (fig. 12a) that engage with each other. The supporting brackets 33', 33'' preferably consisting of supporting rails that are associated respectively to the internal face 31 of the external leaf 2 and to the insulated internal panel 30. Conveniently, the supporting brackets 33', 33'' are fitted in the factory during the manufacturing of the prefabricated cavity wall panel assembly 1.

More in detail, the supporting brackets comprising a first rail 33', that is associated to the internal face 31 of the external leaf 2 and is provided with a lower wing 34 folded upwards, and a second rail 33'' that is associated to the insulated internal panel 30 and is provided with an upper wing 35 folded downward. Conveniently, as shown in figure 12a, the upper wing 35 of the second rail 33'' engages/hooks removably to the lower wing 34 of the first rail 33'.

Conveniently, as shown in figure 11, a further insulated internal element shaped as a corner panel 36 is inserted in correspondence of the corner joint 8 between two external leaves 2. Therefore, the insulated internal panel 30 may be substantially flat or may have any suitable shape.

The insulated internal panel 30 may be associated to the external leaf 2 face to face, with or even without empty spaces between them (see figure 14c).

Preferably, the insulated element 30 has smaller dimensions in terms of width and/or height (and therefore in terms of area) than the panels parts 3', 3'' forming the external leaf 2. Advantageously, the arrangement 32 for attaching the insulated internal panel 30 to the external leaf 2 are configured so that the insulated internal panel 30 is hung on the external leaf 2. More in detail, the lower 38 and upper edges 39 of the insulated internal panel 30, when hung on the external leaf 2, are spaced from the corresponding lower 21 and upper edges 22 of the external leaf 2. Therefore, in correspondence of the floor 37- both in case of an upper floor (see figure 9) and of a ground floor (see figure 10) - there are zones, defined between the lower edges 38 or upper edges 39 of the insulated internal panel 30 and the same floor 37, that are without insulated material. Conveniently, during the manufacture of the building assembly 1, these zones are filled with a suitable seal 40, preferably by a compressible sealing strip.

Furthermore, as shown in Figure 10, at the ground floor, the external leaf 2 is inserted so as to be below the external ground level 43 and to be in contact directly, or by means of a suitable concrete substructure 41, with the building foundations 42. Advantageously, in this way, the external leaf 2 transfers the building loads directly to the building foundation 42.

More in detail, the concrete substructure 41 can be made of blockwork 44 with an inner cavity filled with concrete or suitable cement aggregate mix 46. The ground floor 37 is defined in a traditional way, for example by defining, over the hardcore material 47, a lower concrete layer 48, an insulation layer 49 (that preferably comprises a damp-proof membrane) and a further upper concrete layer 50.

Advantageously, the internal services or fittings can be pre-installed/fitted on the assembly 1. Preferably, the internal services or fittings are installed/fitted in the factory, i.e. during the manufacturing of the prefabricated cavity wall panel assembly 1. Alternatively, the internal services or fittings can be fitted and/or installed at the building site, during the installation of the prefabricated cavity wall panel assembly 1. By internal services we mean at least electrical conduits/wiring and/or fittings, plumbing conduits and/or fittings and any and all telecommunications services conduits and/or fittings.

Advantageously, the windows 52 and/or doors 51 can be pre-defined and fitted on the prefabricated cavity wall panel assembly 1. Preferably, the windows 52 and/or doors 51 are installed/fitted in the factory, i.e. during the manufacturing of the prefabricated cavity wall panel assembly. Alternatively, the windows 52 and/or doors 51 can be fitted and/or installed at the building site, during the installation of the prefabricated cavity wall panel assembly 1.

In the preceding discussion of the invention, unless stated to the contrary, the disclosure of alternative values for the upper or lower limit of the permitted range of a parameter, coupled with an indication that one of the values is more highly preferred than the other, is to be construed as an implied statement that each intermediate value of the parameter, lying between the more preferred and the less preferred of the alternatives, is itself preferred to the less preferred value and also to each value lying between the less preferred value and the intermediate value.

The features disclosed in the foregoing description or the following drawings, expressed in their specific forms or in terms of a means for performing a disclosed function, or a method or a process of attaining the disclosed result, as appropriate, may separately, or in any combination of such features be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A construction arrangement comprising two or more panels, each panel comprising a retaining means arranged at or about one or more surfaces of the panel, the arrangement further comprising a connecting means for connecting at least two panels together, the connecting means being operably engageable with the retaining means such that when the connecting means is operably engaged with the retaining means of a first panel and the retaining means of a second panel, the first and second panels are thereby connected, and wherein the retaining means is adapted such that the connecting means can engage with the retaining means in more than one location on the retaining means, and wherein the retaining means is elongate.
2. A construction arrangement as claimed in claim 1 wherein the connecting means is slidably moveable between engagement locations on the retaining means.
3. A construction arrangement as claimed in claim 1 or claim 2 wherein the location of the connecting means is vertically and/or laterally adjustable relative to the retaining means of the first and/or second panel(s).
4. A construction arrangement as claimed in any preceding claim wherein the connecting means comprises one or more connecting elements, and the retaining means is operable to engage with and retain a connecting element of the connecting means on/within the panel.
5. A construction arrangement as claimed in claim 4 wherein the connecting element is retained in the retaining means such that the connecting element cannot be moved away from the panel in at least one direction.
6. A construction arrangement as claimed in any preceding claim wherein each panel comprises two main planar surfaces with a perimeter surface extending between the two main planar surfaces, and wherein the retaining means extends at least partially between perimeter surfaces of the or each panel.
7. A construction arrangement as claimed in claim 6 wherein the retaining means extends from at or about one perimeter surface of the/each panel to at or about one other perimeter surface of the same panel.
8. A construction arrangement as claimed in claim 6 wherein the retaining means is located towards one edge of the main planar surface of the/each panel.
9. A construction arrangement as claimed in any preceding claim wherein the retaining means comprises a retaining portion for engaging with the connecting means.
10. A construction arrangement as claimed in any preceding claim wherein the connecting means comprises a brace, the brace being operable to extend from one retaining means on one panel to another retaining means on another panel.

11. A construction arrangement as claimed in claim 10 when dependent on claim 4 wherein the brace is co-operable with one or more connecting elements to connect the brace to the retaining means.
12. A construction arrangement as claimed in claim 10 or 11 wherein the brace is a right-angled brace comprising two planar portions connected at a right angle to one another.
13. A construction arrangement as claimed in any one of claims 10 to 12 wherein the brace comprises one or more reinforcements.
14. A construction arrangement as claimed in claim 10 when dependent on claim 4 wherein the brace comprises an opening or aperture sized to accommodate the connecting element.
15. A construction arrangement as claimed in claim 14 wherein the opening or aperture is an elongate slot.
16. A construction arrangement as claimed in claim 14 or claim 15 wherein the connecting means comprises one or more nuts or other fixing means engageable with the connecting element to hold the brace against the retaining means.
17. A construction arrangement as claimed in claim 6 wherein one or more panels comprise a recess to accommodate another panel and improve the fitting therebetween, the recess being located at or about the edge of the panel and being sized to accommodate the perimeter surface of another panel, and wherein the recess extends depth-wise into the panel from a main planar surface of the panel.
18. A construction arrangement as claimed in claim 17 wherein the recess has a width equal to or larger than the width of a second panel, and wherein the perimeter surface of the second panel can be inserted into the recess so that when the second panel is inserted into the recess, an outer main planar surface of the second panel is coplanar with the perimeter surface of the panel having the recess.
19. A construction arrangement as claimed in claim 4 wherein the retaining means comprises an opening, channel or groove having a lip, shoulder or dovetail cross-section or other such formation such that a connecting element having a wide portion and a narrow elongate portion is retained in the opening, channel or groove, whereby the wide portion is retained and the narrow portion extends from the opening, channel or groove.
20. A construction arrangement as claimed in claim 19 wherein the connecting element has a head and a shaft, the head being sized to fit within the retaining means with the shaft extending therefrom.
21. A construction arrangement as claimed in any preceding claim wherein the panels are formed by casting a material, such as concrete, in a mould, and wherein the retaining means is cast into the panel during formation of the panel.
22. A method of connecting two panels together wherein each panel comprises a retaining means, the method comprising the steps of arranging the panels proximal to one another

then arranging a connecting means in operable engagement with the retaining means of each panel to connect the panels together, inserting a connecting element into the retaining means of a first panel and a connecting element into the retaining means of a second panel, slidably moving the connecting element along the retaining portion of the retaining means to a desired location, arranging a brace extending between the connecting elements of each panel and fitting a fixing means onto the connecting element to attach the brace to the panels thereby joining the panels.

23. A method as claimed in claim 22 further comprising the step of arranging the brace on a connecting element so that the connecting element extends through an opening or slot of the brace and adjusting the location the brace relative to the connecting element(s) by moving the brace about the connecting element thereby adjusting the location of the connecting element in the opening or slot prior to joining the panels.

24. A method as claimed in claim 22 or claim 23 comprising the step of arranging two panels together about their edges at right-angles thereby providing a corner, and using a right-angled brace to connect the panels about their retaining means.

25. A panel comprising a retaining means arranged at or about one or more surfaces of the panel, the retaining means being capable of slidably receiving at least part of a connecting means, and wherein the retaining means is adapted such that the connecting means can engage with the retaining means in more than one location on the retaining means, wherein the retaining means is elongate.

Intellectual Property Office

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Claims searched:	1-25	**Date of search:**	24 July 2023

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-6, 8-11, 13, 14, 16, 19-23, 25	EP1865118 A (ITW CONSTRUCTION PRODUCTS); see esp. figures
X	1-10, 12, 19-21, 25	GB1358863 A (ALUMINIUM SYSTEMS); see esp. figures

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

E04B

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC, SEARCH-PATENT

International Classification:

Subclass	Subgroup	Valid From
E04B	0001/61	01/01/2006
E04B	0001/41	01/01/2006