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(71) Applicant: **Framework Design and Construction Limited**
Ringwood, Hampshire BH24 3PL (GB)

(72) Inventors:
- **BEVINGTON, Christopher Paul**
  Salisbury
  SP ND (GB)
- **BEVINGTON, Tim, Christopher**
  Verwood
  BH31 6TN (GB)
- **GIDDINGS, Brian, William**
  Verwood
  BH31 6HG (GB)

(74) Representative: **Atkinson & Company Intellectual Property Limited**
7 Moorgate Road
Rotherham S60 2BF (GB)

(54) METHOD OF CONSTRUCTING A BUILDING, AND A BUILDING WITH A FRAMEWORK

(57) In a wall of a building comprising structural insulated panels (SIPs) secured to a steel framework, SIPs **800**, **802** engage an I-section upright having a web **806** and flanges **808**, **810**. Adjacent ends of the SIPs **800**, **802** abut one another at a joint **812**, in line with the mid-section of the web **806**. Insulative cores **814**, **816** of the SIPs **800**, **802** and their structural facings **818**, **820** are cut away to form a recess **822** to accommodate the upright **804**. Steel plates **824** are secured to the SIPs **800**, **802** to close off the recess **822**, which is filled with insulative material **828** that bonds with the SIP cores **814**, **816**. The insulation of the steel upright combats cold bridging, and the recess makes construction of the building easier and cheaper by allowing the SIPs **800**, **802** to be moved into place from the side, rather than having to be slid down the height of the upright **804** from above.

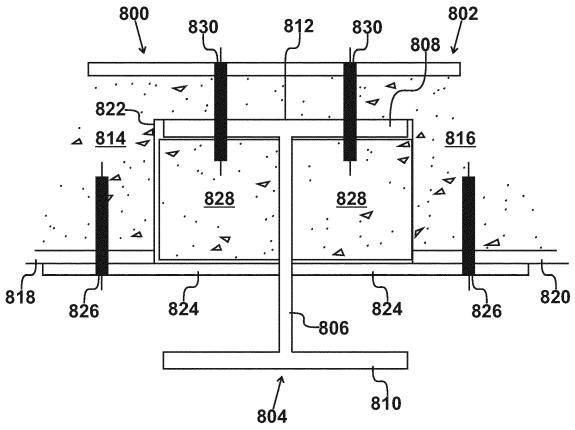

Fig. 17

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Description

[0001] This invention concerns buildings, particularly but not necessarily exclusively buildings for use as domestic dwellings.

[0002] As is well known, domestic dwellings are expensive, notwithstanding repeated calls by campaigners for so-called "affordable housing". Aside from the high cost of land, exacerbated in many places by a shortage of suitable building sites, one of the main reasons for the expense of domestic dwellings is that traditional building methods (especially the use of bricks and mortar) are slow, and dependent upon resources (materials and trade skills) that are themselves expensive and in short supply.

[0003] An alternative to traditional buildings is proposed in US2004/103595 (Glatfelter). This describes a building comprising wall panels, each comprising insulation sandwiched between exterior and interior skins, secured to a ferrous metal framework of I-section members.

[0004] It is an object of the present invention to enable domestic buildings to be constructed more quickly and at lower cost and to shorter build times than those currently conventional and with benefits over previously known framework-and-panels structures like that of Glatfelter. Thus according to a first aspect of the invention there is provided a method of constructing a building comprising the steps of:

(a) forming a foundation which defines a datum level for the building;
(b) constructing on the foundation and securing thereto a framework extending upwards of the datum level, which framework comprises a plurality of mutually spaced-apart framework elements each formed of steel and comprising two flanges interconnected by a web; and
(c) securing between parallel pairs of said framework elements structural insulated panels each having an insulative core sandwiched between structural facings, pairs of said structural insulated panels having adjacent ends abutting one another at a common framework element;

characterised in that said method further comprises configuring the mutually abutting ends of the structural insulated panels to completely cover at least one flange of said common framework element.

[0005] By completely covering at least one flange of the framework element, the steel flange is thermally insulated, and thereby cold bridging through the framework element is combated, as will be discussed in more detail hereinafter. By contrast, Glatfelter's prior art system fails to provide an insulative cover to combat coldbridging through the metal framework.

[0006] Structural insulated panels, commonly known as SIPs, are available from a variety of suppliers including SipsEcopanel of Glenrothes, Scotland. The insulative core typically comprises a foam - or possibly a slab - of styrene or polyurethane (PUR) or polyisocyanurate (PIR), and the structural facings between which the core is sandwiched are typically formed of oriented strand board (OSB) although they may otherwise be of sheet metal, plywood, cement or magnesium oxide board. SIPs are strong, with little or no tendency to shrink or move in use. Importantly, also, they meet national standards for sustainable building as set out for instance in the UK Code for Sustainable Homes and the USA Habitat for Humanity.

[0007] SIPs are available in various sizes up to 6000mm long or more, and can of course be cut to required dimensions, but in Europe at least a common size is 2400mm long by 1200mm (in USA, 8ft by 4ft) and these dimensions can be used as modular spacing for the framework elements of the present invention. It may be noted that around **170** bricks would be required to cover the same area as a 2400mmx1200mm SIP, even as only a single-skin wall, and could take a skilled bricklayer half a day to lay.

[0008] SIPs are also available in various thicknesses, mostly in the range from 100mm to 200mm, and it will be understood that the thickness is related to the profile of the framework elements - so that, for instance, the structural facings of the SIP overlay flanges of the frameworks elements between which it is secured. Commonly, SIPs have an overall thickness of 142mm (USA, 6in) but SIPs of other thickness may be used in the invention.

[0009] The construction of foundations for domestic dwellings is conventionally slow and expensive. Detailed plans have to be prepared in advance before groundwork can begin; and then the depth of excavation must be agreed on site with a building inspector, according to the perceived state of the ground. This can hold up the groundworks timetable, meaning that expensive plant and skilled operatives are used inefficiently and, often, neighbours of the site suffer inconvenience for longer than scheduled. For faster build times, the framework of the present invention - possibly with the SIPs already fitted - can be laid on a foundation of essentially conventional form, with trench/strip footings or concrete rafts/pads, or using screw piling.it is preferred to use screw piling.

[0010] In a second aspect the invention comprises a building comprising a framework formed of a plurality of mutually spaced apart framework elements each formed of steel and comprising two flanges interconnected by a web and, secured between parallel pairs of said framework elements, structural insulated panels each having an insulative core sandwiched between structural facings, pairs of said structural insulated panels having adjacent ends abutting one another at a common framework element; characterised in that, at the mutually abutting ends of the structural insulated panels, the insulative cores of the structural insulated panels are configured to fit closely between the flanges of the common framework

element and closely against the web thereof, and the structural facings of the structural insulative panels are configured to fit closely upon and cover at least one said flange of the common framework element.

[0011] Preferably the framework elements are of steel, which is strong and inexpensive. And the SIPs may be used for floors and ceilings, walls and the roof of the building.

[0012] In a third aspect the invention extends to a prefabricated kit of parts for constructing the building.

[0013] Other aspects of the invention will be apparent from the following description, which is made by way of example only with reference to the accompanying drawings which are purely schematic and in which -

Figure 1 is a simplified isometric view of the configuration of a single storey house embodying the invention, as seen from above and the front;

Figure 2 is a simplified isometric view of a screw piled foundation for the house of Figure 1;

Figure 3 is a simplified isometric view of a steel framework for the house of Figure1.

Figure 4 is an isometric view of a front part of the steel framework as at A in Figure 3, to an enlarged scale relative to Figure 2 and illustrating the way in which SIPs are applied to the framework;

Figure 5 is a plan view in cross-section of a corner of the steel framework as at B in Figure 3, to the same scale as Figure 3 and similarly illustrating the way in which SIPs are applied to the framework above a lower ring beam thereof;

Figure 6 is an isometric view corresponding to Figure 5;

Figure 7 is a perspective view illustrating the construction of an upper ring beam of the framework, as at C in Figure 3 and to an enlarged scale;

Figure 8 is an end elevation illustrating the construction of a ridge of the framework in cross-section;

Figure 9 shows an end elevation of framework elements for the roof;

Figures 10 and 11 are perspective views from opposite ends of the roofing framework;

Figures 12 and 13 are perspective views illustrating the construction of the roof;

Figures 14 and 15 are views, in cross-section and viewed from above, of a wall of a house embodying a form of the invention somewhat different from that shown in Figures 1 to 13, Figure 15 showing part of Figure 14 enlarged for clarity;

Figure 16 is a view, partly in cross-section and partly isometric, viewed from above, of a wall of a house embodying a further form of the invention;

Figure 17 is a view, in cross-section and viewed from above, of a wall of a house embodying a preferred form of the invention; and

Figure 18 is a view, in cross-section and viewed from one side, of a floor of a house adapted from the wall arrangement of Figure 17.

[0014] Referring first to Figure 1, the configuration of the house **100** shown therein is simplified in as much as doors, windows and other features are omitted for ease of illustration. The external walls **102** (which may be covered with appropriate cladding, not shown) comprise 2400mmx2400mm SIPs mounted on a steel framework to be described in more detail hereinafter. The internal walls (not shown) also comprise SIPS of smaller dimensions; and in fact, but not shown in Figure 1 for simplicity, the external walls may comprise SIPS 2400mm high by 1200mm wide. Like the walls, the roof comprises SIPs mounted on the steel framework.

[0015] For simplicity of description, the height H of the house **100** to its eaves is a nominal 2400mm, its length L is a nominal 9600mm and its depth D is a nominal 4800mm. Actual houses constructed by means of the invention are expected to be substantially larger than these nominal dimensions, and the house may have two or more storeys, and it does not have to have a simple rectangular footprint.

[0016] Turning to Figure 2, the house **100** has a foundation formed of screw piles **106** with heavy bearer plates driven into the ground at selected locations set using the Global Positioning System (GPS). As illustrated by Figure 2, the screw piles are located just within the planned footprint **108** of the house, spaced apart at 2400mm intervals. There may well be more screw piles than the nominal number shown purely for illustration in Figure 2 (generally they are spaced apart by an amount equal to three or four times the diameter of the pile helix) and they may be arranged differently from those shown in Figure 2, eg to support a house with a non-rectangular footprint.

[0017] The screw piles are driven into the ground by means of rotary hydraulic powerheads to a depth at which it is calculated (in relation to ground conditions) they will support the weight of the house **100**. They are then adjusted using a laser so that their tops lie in a common horizontal plane which defines a datum level for the building

[0018] The steel framework **110** of the house **100** comprises, as illustrated by Figure 3, the following framework elements: upright girders (ie columns) of the kind generally designated as universal columns (UC) each having two flanges interconnected by a web; horizontal girders (ie beams) of the kind generally designated as UB and each similarly having two flanges interconnected by a web; and inclined UB beams serving as rafters, ridge beams and other components of the roof. The framework elements are of I-section or C-section according to their function and location in the framework, but it should be understood that details of the sections are not shown in Figure 3, for simplicity of illustration. The framework is mostly bolted together, for strength and longevity, but as noted hereinafter welded connections are used in places.

[0019] The steel framework **110** is coated with zinc phosphate primer.

[0020] As illustrated first of all now by Figure 4, which relates to the part of the framework indicated at A in Fig-

ure 3, a SIP **200** (along with other SIPs) is secured in the steel framework, which comprises at its lower end a lower ring beam **202** made from 254x146 UB 37 girder of I-section with a 152x152 U-section column **204** bolted to it by way of a welded end plate **206**.

[0021] The SIP **200** comprises an insulative styrene core **208** 160mm thick sandwiched between opposed structural facings **210** formed of OSB and each 11mm thick. As indicated at **212**, the core **208** is routed or otherwise recessed to lie snugly between the flanges of the column **204** (that is, the flanges extending leftwards as seen in Figure 4). The flanges are spaced apart by an amount (ie 160mm) such that they lie snugly between the overlaying structural facings **210** of the SIP **200**, to prevent cold spots and thermal transmission through the assembly. It will be understood that another SIP not shown in Figure 4 is similarly engaged with the flanges of the column **204** that extend rightwards as seen in Figure 4.

[0022] Figure 4 does not show the framework elements of the SIP completely. In practice, both the SIP **200** and the column **204** extend upwards from the ring beam by 2400mm, and the SIP **200**, preformed as indicated above, is slid down between two parallel columns with their webs spaced apart so that the SIP fits snugly between them widthwise. The SIP is then secured in position.

[0023] Sections of 254x148 UB girders such as the framework element **202** are joined together around the periphery of the framework **110** to form a complete lower ringbeam **114** as shown in Figure 3. The lower ringbeam **112** is configured and arranged to sit on and be secured to the tops of the screw piles **106** (Figure 2) to support the house **100**. SIPs are slid horizontally between lower crossbeams **114** of the framework **110** (Figure 3) - conveniently, while the ringbeam is being constructed - to form a floor for the house **100**.

[0024] Figure 5 relates to a corner of the framework **110** as indicated at B in Figure 3. It shows, in cross-section as viewed from above, two SIPs **300** and **302** disposed at right angles to form the corner and engaged respectively with a 152x152 UC 23 I-section corner column **304** and a 150x90x24 PFC C-section column **306** welded to it using 150mm hit 300mm miss stitch welding. Each of the SIPs **300** and **302** has an insulative core **308** of styrene foam sandwiched between OSB structural facings **310**.

[0025] The insulative cores **308** are recessed as hereinbefore described to fit snugly between the flanges of their respective steel columns **304** and **306**, which flanges are overlaid by the OSB structural facings **310**. The space between the flanges of the I-section corner column **304** that does not receive the recessed portion of the SIP core **308** is filled with insulative material **312** similar to that of the cores **308** and the OSB facing is extended as indicated at **314** to cover the material **312** and provide a continuous OSB cover around the steel framework, to counter cold spots and thermal transmission through the structure. Joints, at corners and elsewhere in the OSB can be secured and sealed with an MS-polymer adhesive, which is also used for securing the insulative filling **312** in place.

[0026] For additional clarity, Figure 6 shows the corner at B in perspective, with reference numerals the same as those of Figure 5. It should be noted that the lower ringbeam, which carries the columns **304** and **306**, is not shown in Figure 6.

[0027] Figure 7 illustrates the framework **110** as at C in Figure 3. An upper ringbeam **116** (Figure 3) is constructed from sections of 178x102 UB girder **400** secured by M16 8.8 bolts **402** to a plate **404** fillet welded to the top of a column **406**, and similarly to other columns of the framework **110**. Trusses **118** (Figure 3) interconnect the front and rear parts of the upper ringbeam **116** and are secured to the columns by welding and bolting to provide a moment connection., and whilst the upper ringbeam/truss assembly is being constructed SIPs with their insulative cores recessed as aforedescribed are slid between the flanges thereof to form a ceiling for the house.

[0028] A ridge for the house **100** is constructed as shown in Figure 8. A 178x102 UB 19 ridge beam **500** is secured to the top of a 152x152 UC column **502** having its top end cut and capped with an end plate **504** at an angle to the horizontal, which thereby defines the inclination of the ridge beam **500**. SIPs are fitted, in the manner previously described herein, between mutually parallel ridge beams **500**, and each such SIP has a solid timber insert at its outer edge to provide or receive a fascia.

[0029] Figure 9 shows framework elements for the roof in end elevation. Front and rear ridge beams in the form of rafters **500f** and **500r** are each set at a defined inclination and joined together at their apex. At the apex, each ridge beam has a 100mm x 170mm x 8mm end plate **506** secured to it (at an angle to the respective ridge beam so that the end plates are vertically disposed in use) by 6mm fillet welding, and the end plates are then bolted together by way of M18 holes through both the rafters **500f** and **500r** and press braked. 300mm x 8mm press braked plates form an angled section and are bolted back to form the roof ridge.

[0030] Figure 10 and 11 show other details of the roof structure. At opposite ends of the 4800mm long section shown are pairs of 178x102 UB rafters **500** arranged as in Figures 8 and 9. The apex of the roof is formed of two 2400mm long girders **508** joined together at their proximal ends by way of two 150x150x8 rolled steel angles (RSA) **510** welded together back to back.

[0031] Referring now to Figures 12 and 13, these use the same reference numerals as Figures 10 and 11. SIPs **200** (of which only one is shown in Figures 12 and 13) like those used to form the floor, ceiling and walls of the house **100** are also used to form the roof. They are located between the flanges of the rafters **500**, where they are held in place by the vertical webs of the RSA framework elements **510**, and they rest on the lateral webs of

the RSA framework elements. The assembled roof is covered by cladding such as the Colorcoat Urban (Registered Trade Mark) system supplied by Tata Steel Europe Limited, headquartered in London.

[0032] As described hereinbefore with reference to and as shown in Figure 5, the OSB facing of the SIPs extends to provide a continuous OSB cover around the steel framework, to counter cold spots and thermal transmission through the structure. The arrangement is shown in more detail in Figures 14 and 15, Figure 15 being a relatively enlarged view of the region R of Figure 14. Mutually proximal ends of two SIPs **600** and **602** are engaged with a common framework element in the form of an I-section steel upright having a web **604** and flanges **606** at opposite ends thereof. The insulative cores **608** and **610** of the SIPs **600** and **602** fit snugly against opposite sides of the web **604** and are rebated to receive the flanges **606**. The SIPs **600** and **602** have OSB facings **612** and **614** respectively which abut (and may be glued together and/or sealed) on the midline **616** of the web **604**. Thus the flanges are completely covered by the OSB and there is no gap whereby cold may reach the common steel upright and be transmitted therethrough.

[0033] Figure 16 illustrates another form of the invention particularly designed to combat cold bridging - which is a matter of great concern to both builders and occupants of buildings.

[0034] The wall shown in Figure 16 includes two SIPs **700** and **702** engaged with a common framework element comprising an I-section steel upright **704** having a web **706** and flanges **708**, **710** at opposite ends thereof. Adjacent ends of the SIPs **700** and **702** abut one another at a joint **712**, in line with the mid-section of the web **706** of the common steel upright **704**. Towards one side of the wall (which is to say, its interior side) both of the insulative cores **714**, **716** of the SIPs **700**. **702** and their interior OSB facings **718**, **720** are cut away to form a recess **722** to accommodate the common steel upright **704**. Combining the amount by which each SIP **700, 702** is cut away, the recess **722** has a lateral extent equal to the width of the flange **708**, so that the common steel upright **704** is a snug fit therein.

[0035] On the interior side of the wall, the common steel upright **704** extends beyond the thickness of the SIPs **700**, **702**, and battens **726** having a thickness equal to the inward extension of the steel upright **704** are glued and/or screwed adjacent it, tightly against and level with the flange **710**. The battens **724** and similar battens spaced laterally along the SIPs **700, 702** provide support for an inner cladding of plasterboard or the like (not detailed in Figure 16, for simplicity of illustration) with a space behind it for wiring and piping etc.

[0036] Foam material **726** the same as that forming the insulative cores **714**, **716** of the SIPs **700, 702** (eg polyurethane) fills the recess **722** and unites with the cores **714**, **716** in a cohesive structure. This is done by injecting the filling material from the top of the common steel upright **704**; and to make sure the recess **722** is completely filled, the web **706** of the common steel upright **704** may be formed with holes (not shown in Figure 16) allowing for passage of the foam material **726** while it is being injected.

[0037] On the weather side of the wall, the common steel upright **704** is secured in place by fasteners **728** shot-fired through the SIPs **700**, **702** and into the flange **708**, and the joint **712** is sealed and taped before battens (not shown in Figure 16) are secured to the weather side of the wall to support exterior cladding

[0038] It will be noted that the insulative material of the cores **714**, **716** and the filling **726** completely covers at least the flange **708** on the weather side of the common steel upright **704**, and thereby combats cold bridging through the wall.

[0039] The arrangement of Figure 16 has another important advantage during construction of a building embodying the invention. This is that the SIPs **700**, **702** can be moved orthogonally of the common steel upright **704** to locate the recess **722** on and around the common steel upright **704**. Thus the SIPs can be put into place from one side of the wall being constructed, rather than having to be slid down from above, which is awkward and time-consuming. Thus the arrangement of Figure 16 is an improvement upon that described hereinbefore with reference to Figures 1 to 15. And construction in this way is easier and therefore cheaper than prior art arrangements like that of US2004/0103595 which require SIPs to be slid into position down the height of a column.

[0040] Figure 17 is a view similar to that of Figure 16, shown a preferred wall arrangement.

[0041] The wall shown in Figure 17 includes two SIPs **800** and **802** engaged with a common framework element comprising an I-section steel upright **804** having a web **806** and flanges **808**, **810** at opposite ends thereof. Adjacent ends of the SIPs **800** and **802** abut one another at a joint **812**, in line with the mid-section of the web **806** of the common steel upright **804**. Towards one side of the wall (which is to say, its interior side) both of the insulative cores **814**, **816** of the SIPs **800**. **802** and their interior OSB facings **818**, **820** are cut away to form a recess **822** to accommodate the common steel upright **804**. Combining the amount by which each SIP **800**, **802** is cut away, the recess **822** has a lateral extent equal to the width of the flange **808**, so that the common steel upright **804** is a snug fit therein.

[0042] On the interior side of the wall, the steel upright **804** extends beyond the thickness of the SIPs **800**, **802**, and steel plates **824** disposed laterally of the inwardly extending portion of the web **806** are secured to the SIPs **800**, **802** by glued and shot-fired fasteners **826**. Thus the plates **824** close off the recess **822**, which is then filled with insulative material **828** (eg polyurethane) like and bonding with that of the SIP cores **814**, **816**, by injecting this from above.

[0043] On the weather side of the wall, the common steel upright **804** is secured in place by fasteners **830** shot-fired through the SIPs **800**, **802** and into the flange

808, and the joint **812** is sealed and taped.

[0044] As with the arrangement of Figure 16, battens (not shown in Figure 17) are secured to both sides of the wall to support cladding. And like the arrangement of Figure 16, that of Figure 17 provides benefits in (a) combatting cold bridging, because the common steel upright **804** is covered with insulation on at least its weather side and (b) making construction easier and cheaper by allowing the SIPs **800**, **802** to be moved orthogonally into place from the side, rather than having to be slid down the height of the common steel upright **804** from above.

[0045] The arrangement of Figure 18 is an adaptation of that shown in Figure 17, designed particularly for the floor of a building embodying the invention.

[0046] The floor shown in Figure 18 includes two SIPs **900** and **902** engaged with a common horizontal framework element comprising an I-section steel joist **904** having a web **906** and flanges **908**, **910** respectively at the top and the bottom of the web **906**. Adjacent ends of the SIPs **900** and **902** are cut away to form a recess **912** to accommodate the common steel joist **904**, the recess **912** having a lateral extent equal to the width of the top flange **908**, so that the common steel joist **904** is a snug fit therein.

[0047] On the underside of the floor, the common steel joist **904** extends below the thickness of the SIPs **900**, **902**, and steel plates **914** disposed laterally of the downwardly extending portion of the web **906** are secured to the SIPs **900**, **902** by glued and shot-fired fasteners **916**. Thus the plates **914** close off the recess **912**, which is then filled with insulative material **918** (eg polyurethane) like and bonding with that of the SIP cores **920**, **922**. Rolled steel angles **924** are located on the underside of the plates **914** and against the web **906** of the web **904**, and the assembly secured in place by fasteners **926** shot-fired into the SIPs **900**, **902**.

[0048] It will be noted that the recess **912** allows the SIPs **900**. **902** to be conveniently dropped vertically down into place on the horizontal common steel joist **904** to form a floor, rather than having to be slid along the length of the joist **904**. On the upper side of the floor, the common steel joist **904** is secured in place by fasteners **928** shot-fired through the SIPs **900**, **902** and into the upper flange **908**.

[0049] The arrangement of Figure 18 may be adapted to form a ceiling or a roof.

[0050] In the present invention, an arrangement in which the SIPs are formed with recesses to receive the framework members (widthways, not just the flanges of the framework members, as in the embodiments of Figures 16, 17 and 18) is recommended. As well as providing improved protection against cold bridging through an external wall, the recessed configuration is of benefit in internal walls because it is cheaper and more convenient in that it allows the SIPs to be moved sideways into position on the framework (which will be assembled at least in part before the SIPs are installed) rather than having to be slid along the length of a framewrork element, between its flanges. It should also be understood that, whilst Figures 16, 17 and 18 show connections between SIPs and a framework element in a straight section of walling or flooring, the recessed configurations shown therein can be adapted to corner connections (see eg Figures 5 and 6) in which two SIPs at right angles to one another meet at a common framework element, or similarly in roof structures where the SIPs are at an angle to one another rather than being in a straight line.

[0051] Those skilled in the art will now appreciate that the main features of the invention are as follows.

[0052] Floor cross-beams are welded to an array of GPS-positioned screw-bored piles with heavy bearer plates. Each pile is designed and installed to support a load of 10,000kgf, and the building including framework plus SIPs and building fittings weighs about 15,000kgf.

[0053] Deep, heavy-duty I-section girders are used to construct a peripheral ring beam. SIPS having a 160mm thick insulative core of foam (preferably polyurethane but possibly another material such as styrene) sandwiched between two 11mm OSB structural facings are installed between the webs of the cross-beams to form a floor. The floor is covered with particleboard flooring such as the CaberDek (Registered Trade Mark) flooring available from Norbord Europe Limited of South Molton, UK, which flooring has a wear-restant, water-resistant and slip-resistant coating.

[0054] An upper ringbeam is constructed to complete a box-like structure for the steel framework.

[0055] Walls of the building are formed of SIPs 2400mm high and either 1200mm or 2400mm wide, with made-to-measure or cut-to-size end panels. The SIPs completely cover the girders, at least on the weather side, to prevent cold spots, and are themselves enclosed by 25mm cavities and membranes, within inner and outer finishing cladding. The inner cladding may be skimmed plasterboard or, like the outer cladding, to choice. Double-cladding to a total thickness of about 240mm offers U-values better than 0.17W/m2K, exceeding current targets such as the norm of 0.21W/m2K adopted by the European Mineral Wool Manufacturers Association (EURIMA). It also provides good results in airtightness, for passive housing.

[0056] According to customer choice, windows and doors may be sealed double- or triple-glazed units.

[0057] A key aim of the invention is to offer, at an extremely competitive price, a house with a build time of only three to five weeks which is especially suitable for DIY completion. The house as delivered would include basis first-fix facilities for water, sewage and electricity. And it would be ready for purchasers to choose and fit out their own kitchens, bathrooms, and utility areas with appliances. (This has a particular advantage in the self-build market. The house as delivered is adequate for a purchaser to move into it - not into a caravan or tent on site - and complete the house within their own timescale and budget).

[0058] However, whilst the invention is particularly suit-

able for self-build customers, who can complete it to their own particular requirements and to their own timescale, the "plain vanilla" structure it delivers is likely to be attractive also to developers, local authorities and housing associations

[0059] The invention allows a wide variety in design, even within the modular configurations using standard 2400mmx1200mm SIPS. Beyond that, SIPs of longer length can be used, with no need for jointing; and SIPs can be cut to a required length.

[0060] The building may have a single-pane flat roof or a pitched roof which may be covered by cladding such as the Colorcoat Urban (Registered Trade Mark) system supplied by Tata Steel Europe.

[0061] Finally it will be noted that the formation of recesses in ends of the SIPs facilitates construction by enabling the SIPs to be conveniently put into place from one side (or, in the case of a floor, from above) rather than having to be slid along the length of a framework element as in prior art arrangements.

Claims

1. A method of constructing a building (**100**) comprising the steps of:

(a) forming a foundation (**106**) which defines a datum level for the building (**100**);
(b) constructing on the foundation (**106**) and securing thereto a framework (**110**) extending upwards of the datum level, which framework comprises a plurality of mutually spaced-apart framework elements each formed of steel and comprising two flanges (**606**) interconnected by a web (**604**); and
(c) securing between parallel pairs of said framework elements structural insulated panels (**600**, **602**) each having an insulative core (**608**, **610**) sandwiched between structural facings (**612**, **614**), pairs of said structural insulated panels **(600, 602)** having adjacent ends abutting one another at a common framework element;

characterised in that said method further comprises configuring the mutually abutting ends of the structural insulated panels (**600**, **602**) to completely cover at least one flange (**606**) of said common framework element.

2. A method of constructing a building as claimed in Claim 1 **characterised in that** said method comprises, at the mutually abutting ends of the structural insulated panels (**600**, **602**), configuring the insulative cores (**608**, **610**) of the structural insulated panels (**600**, **602**) to fit closely between the flanges (**606**) of the common framework element and closely against the web (**604**) thereof, and configuring the structural facings (**612**, **614**) of the structural insulative panels (**600**, **602**) to fit closely upon and over said one flange (**606**) to cover it.

3. A method of constructing a building as claimed in Claim 2 **characterised in that** said method comprises mutually spacing the framework elements by a modular distance defined by the length and breadth of the structural insulated panels.

4. A method of constructing a building as claimed in any preceding claim **characterised in that** said method comprises forming said foundation by driving into the ground a plurality of screw piles **106** to a depth at which their tops lie in a common horizontal plane determined by laser levelling.

5. A method of constructing a building as claimed in any preceding claim **characterised in that** said method comprises the steps of:

a) securing some of the structural insulative panels between said parallel pairs of framework elements vertically disposed so as to form walls of the building;
b) securing some of the structural insulated panels between said parallel pairs of framework elements horizontally disposed so as to form a floor and a ceiling of the building; and
c) securing some of the structural insulated panels between said parallel pairs of framework elements inclined to the horizontal so as to form a roof of the building.

6. A method of constructing a building as claimed in Claim 1 including constructing a wall with an exterior side and an interior side, **characterised in that** said method comprises the steps of:

a) cutting away adjacent ends of a said pair of structural insulated panels (**700**, **702**) to form a recess (**722**) configured and arranged to receive said common framework element;
b) moving the structural insulated panels (**700**, **702**) of said pair orthogonally of the common framework element to locate said recess (**722**) on the exterior flange (**606**) of the common framework element to cover its exterior side; and
c) filling said recess (**722**), on the interior side of said exterior flange (**606**), with insulative material (**726**) which bonds with the insulative cores (**608**, **610**) of the structural insulated panels (**600**, **602**).

7. A method of constructing a building as claimed in Claim 6 **characterised in that** said method further comprises securing steel plates (**824**) to both structural insulated panels (**800**, **802**) of said pair on the

interior side of the wall, to close off said recess (**822**) on the interior side of the wall before it is filled with said insulative material (**828**).

8. A method of constructing a building as claimed in Claim 1 including constructing a floor of the building with an upper side and a lower side, **characterised in that** said method comprises the steps of:

a) cutting away adjacent ends of a said pair of structural insulated panels (**900**, **902**) to form a recess (**912**) configured and arranged to receive said common framework element (**904**) horizontally disposed;
b) moving the structural insulated panels (**900**, **902**) of said pair vertically downwards onto the common framework element (**904**) to locate said recess on the upper flange (**908**) of the common framework element (**904**) to cover its upper side;
c) filling said recess (**912**), on the lower side of said upper flange (**908**), with insulative material (**918**) which bonds with the insulative cores (**920**, **922**) of the structural insulated panels (**900**, **902**); and
d) securing steel plates (**924**) to both structural insulated panels (**600**, **602**) of said pair on the lower side of the floor, to close off said recess (**912**) on the lower side of the floor before it is filled with said insulative material (**918**).

9. A building comprising a framework formed of a plurality of mutually spaced apart framework elements each formed of steel and comprising two flanges interconnected by a web and, secured between parallel pairs of said framework elements, structural insulated panels each having an insulative core sandwiched between structural facings, pairs of said structural insulated panels (**600**, **602**) having adjacent ends abutting one another at a common framework element; **characterised in that**, at the mutually abutting ends of the structural insulated panels (**600**, **602**), the insulative cores **608**, **610**) of the structural insulated panels (**600**, **602**) are configured to fit closely between the flanges (**606**) of the common framework element and closely against the web (**604**) thereof, and the structural facings (**612**, **614**) of the structural insulative panels (**600**, **602**) are configured to fit closely upon and cover at least one said flange (**606**) of the common framework element.

10. A building as claimed in Claim 9 **characterised in that** insulative cores (**608**, **610**) of the structural insulated panels (**600**, **602**) are recessed to receive flanges (**606**) of the framework elements, with the cores (**608**, **610**) fitting snugly between the flanges (**606**) and the structural facings (**612**, **614**) overlaying at least one flange (**606**).

11. A building as claimed in Claim 9 **characterised in that** adjacent ends of a said pair of structural insulated panels (**700**, **702**) are formed to provide together a recess (**722**) configured and arranged to receive said common framework element (**704**) with an exterior flange (**708**) thereof against one side of the recess (**722**), and **in that** the recess is filled, on the interior side of said exterior flange (**708**), with insulative material (**726**) bonded with the insulative cores (**714**, **716**) of the structural insulated panels (**600**, **602**).

12. A method of constructing a building as claimed in Claim 11 **characterised in that** said building further comprises steel plates (**824**) secured to both structural insulated panels (**800**, **802**) of said pair on the interior side of the wall and closing off the interior side of said recess (**822**).

13. A building as claimed in Claim 9 **characterised in that** said building includes a floor wherein:

a) adjacent ends of a said pair of structural insulated panels are cut away to form together a recess (**912**) configured and arranged to receive said common framework element (**904**) horizontally disposed;
b) the structural insulated panels (**900**, **902**) of said pair are located on an upper flange (**908**) of the common framework element (**904**) and cover its upper side;
c) said recess (**912**) is filled, on the lower side of said upper flange (**908**), with insulative material (**918**) which bonds with the insulative cores (**920**, **922**) of the structural insulated panels (**900**, **902**); and
d) steel plates (**924**) are secured to both structural insulated panels (**900**, **902**) of said pair on the lower side of the floor, to close off said recess (**912**) on the lower side of the floor before it is filled with said insulative material (**918**).

14. A prefabricated kit of parts for a building as claimed in any of Claims 19 to 13, which kit comprises a plurality of said framework elements configured to form a said framework accommodating a plurality of said structural insulated panels securable to the framework elements to form a floor, interior and exterior walls, a ceiling and a roof of the building.

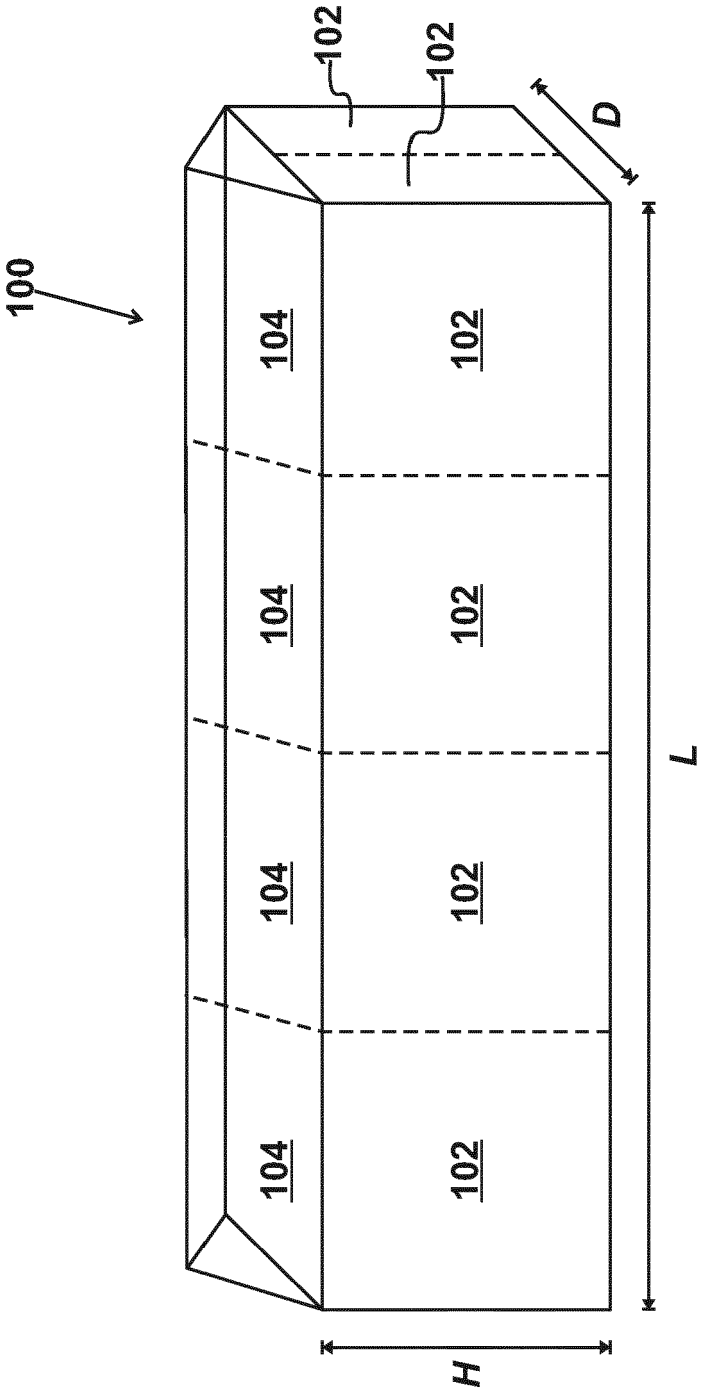


Fig. 1

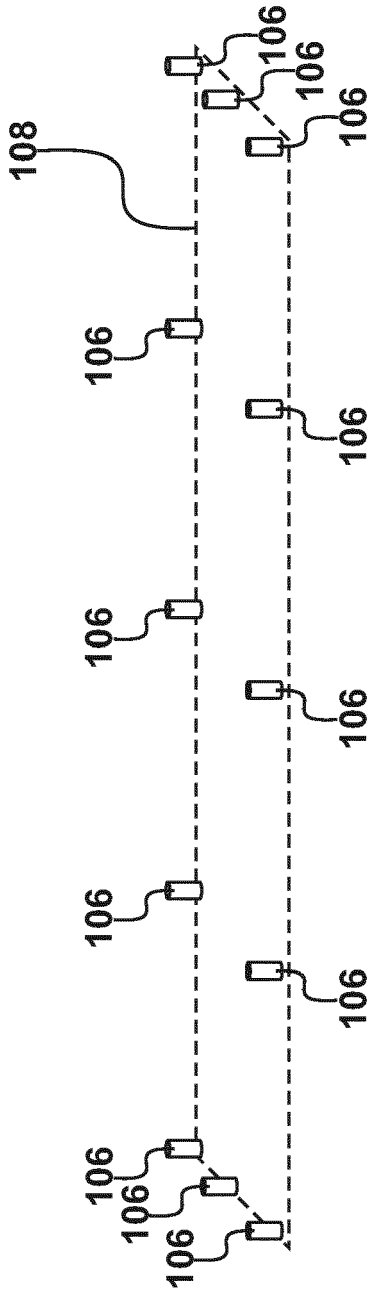


Fig. 2

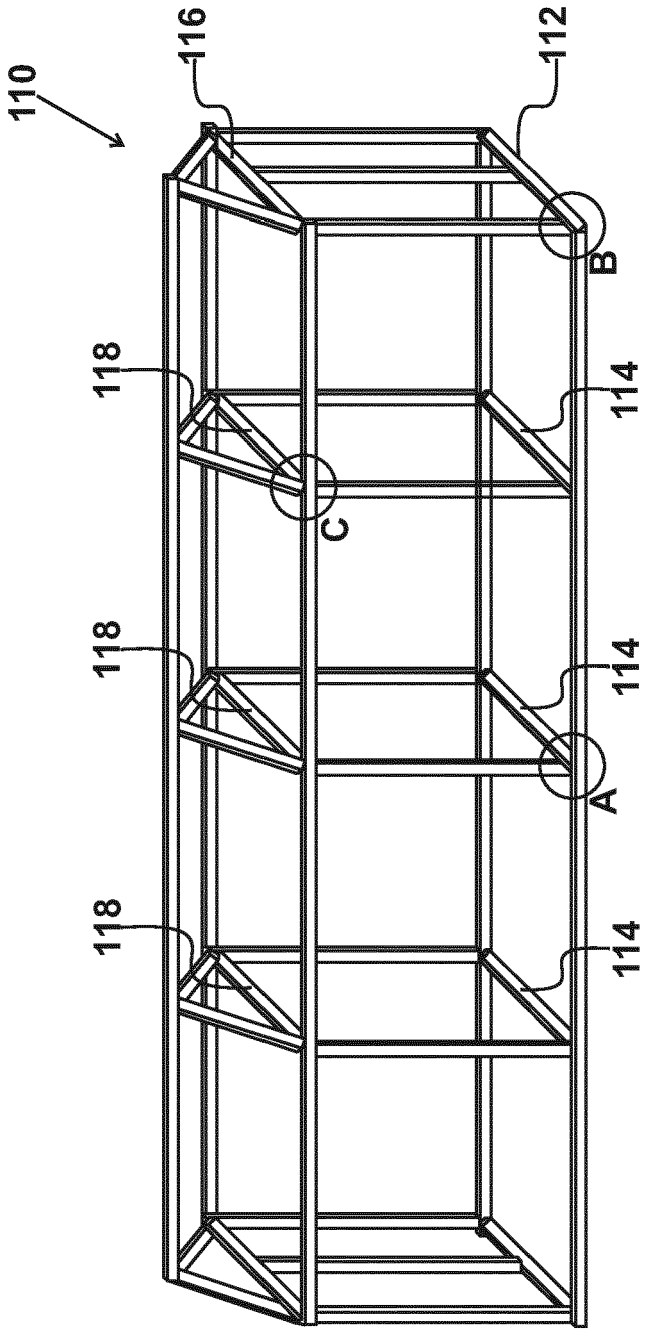


Fig. 3

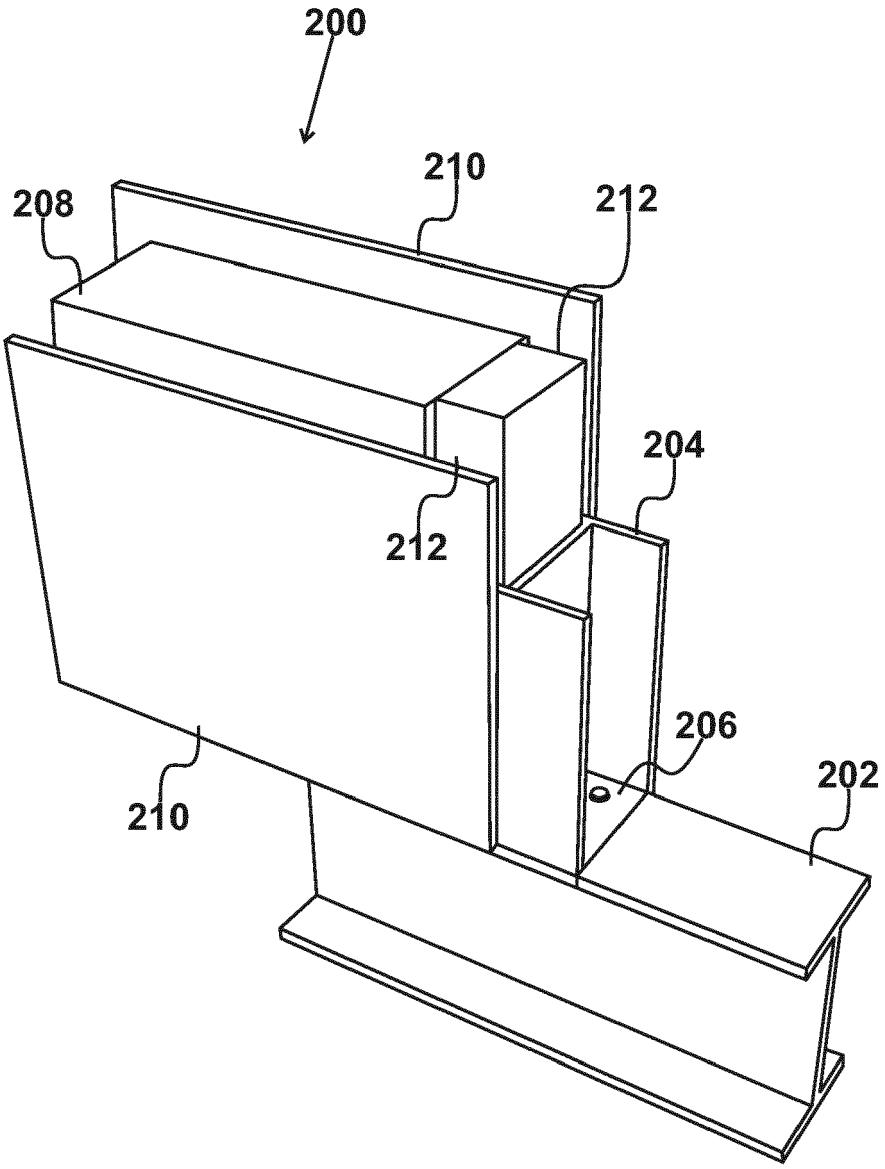
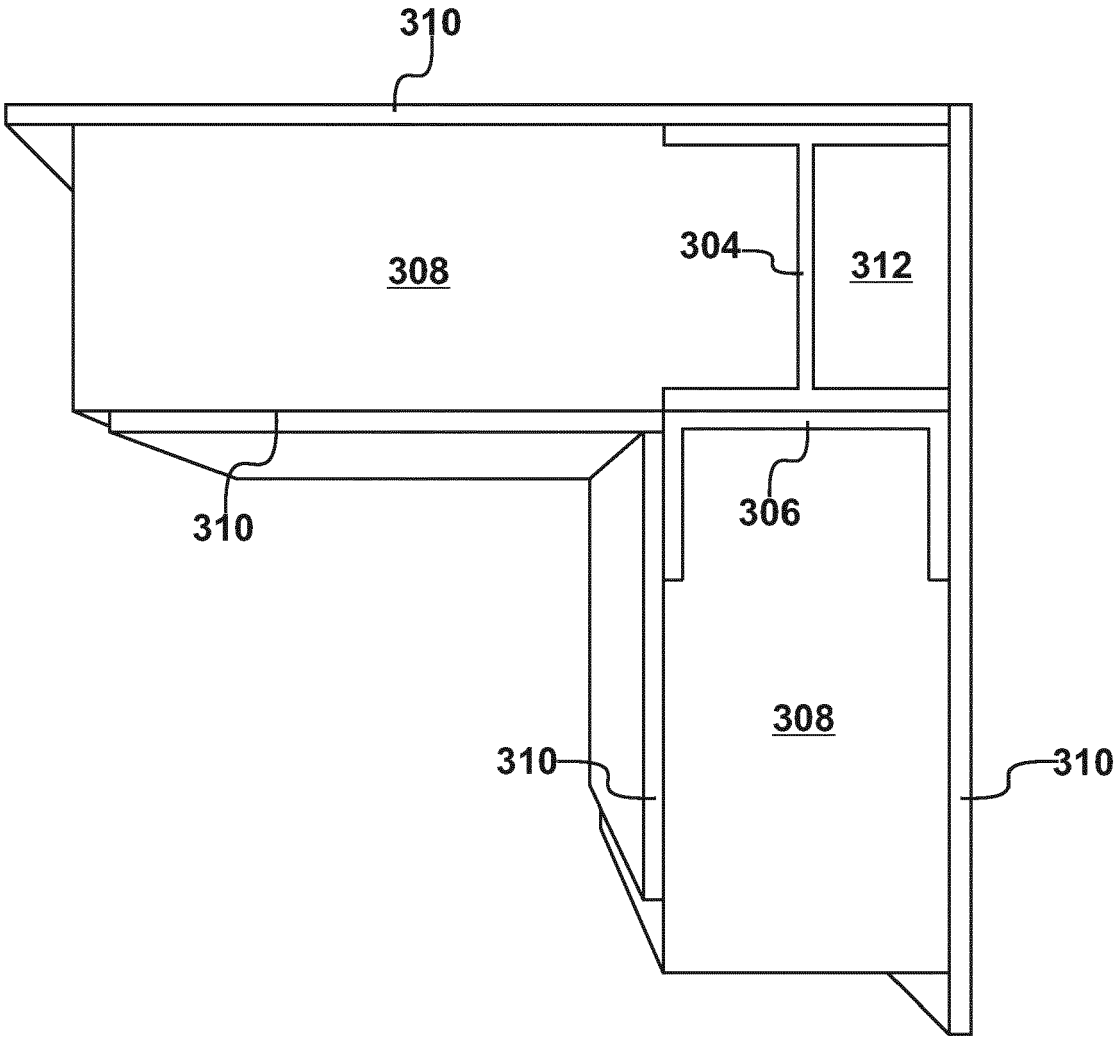


Fig. 4



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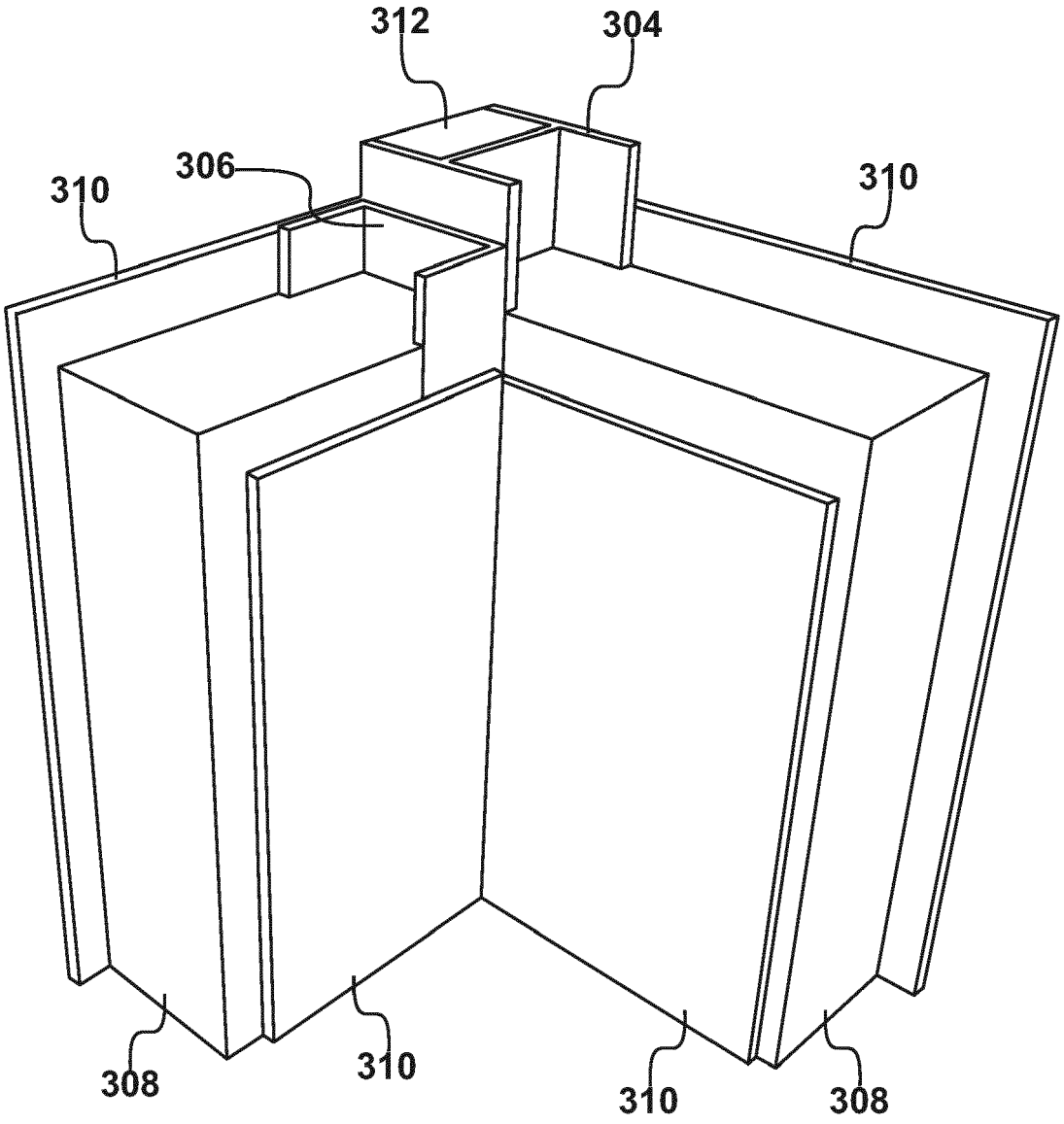

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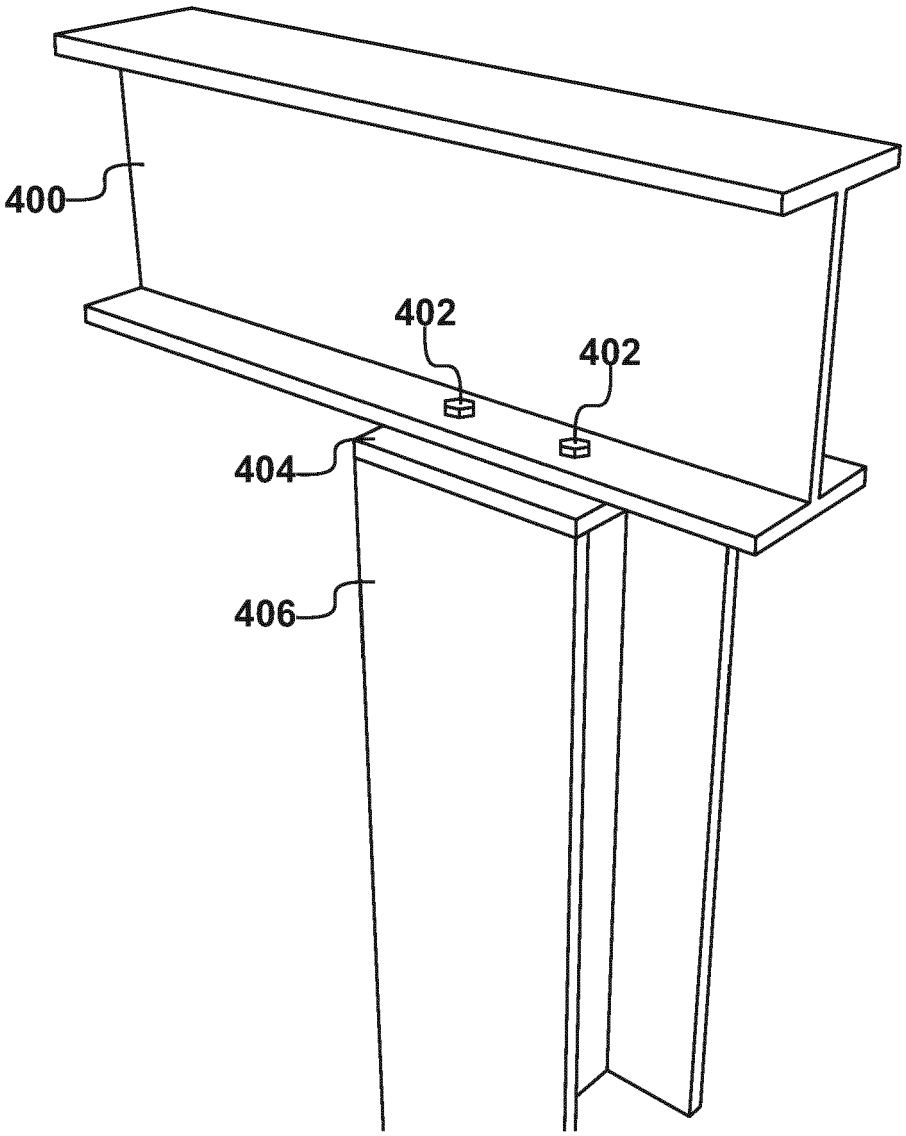

Fig. 7

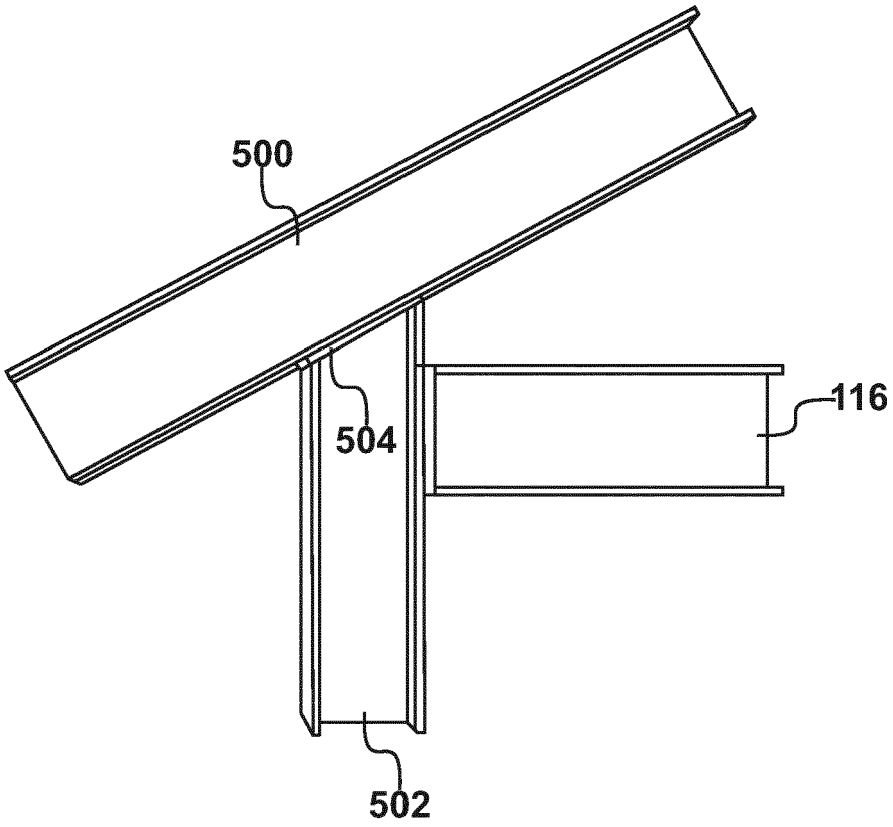

Fig. 8

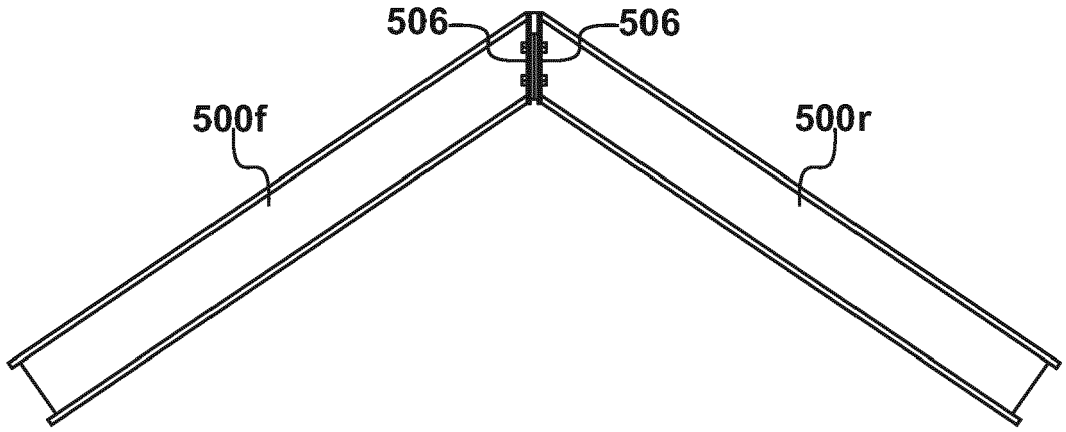

Fig. 9

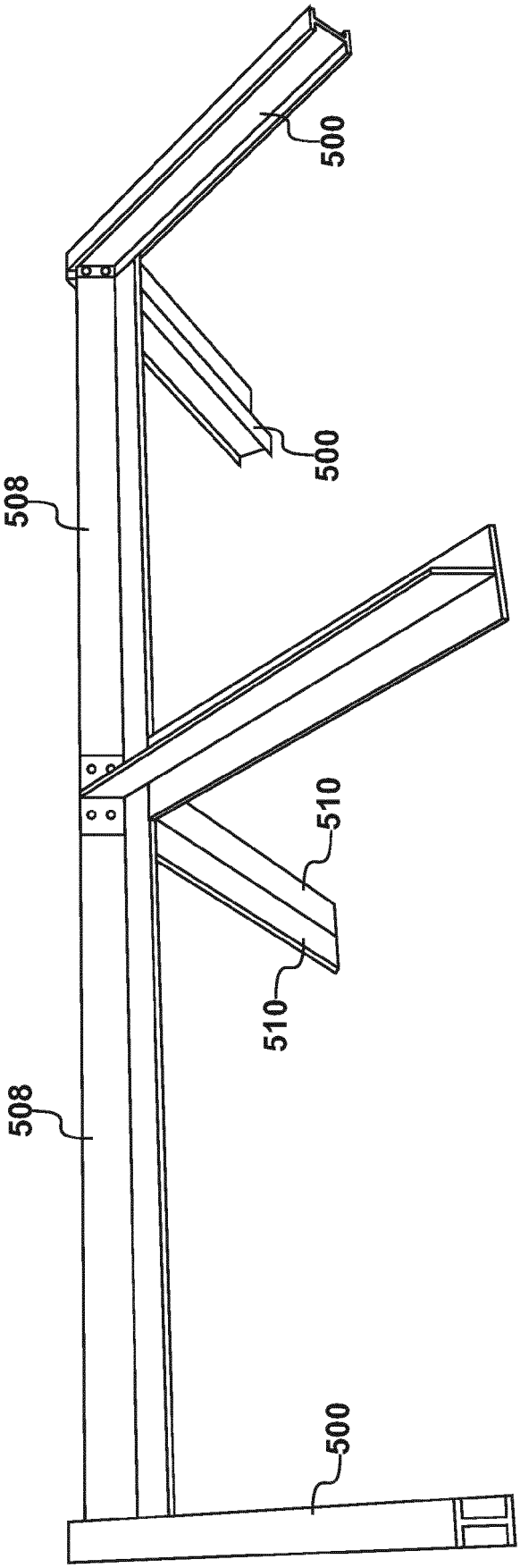

Fig. 10

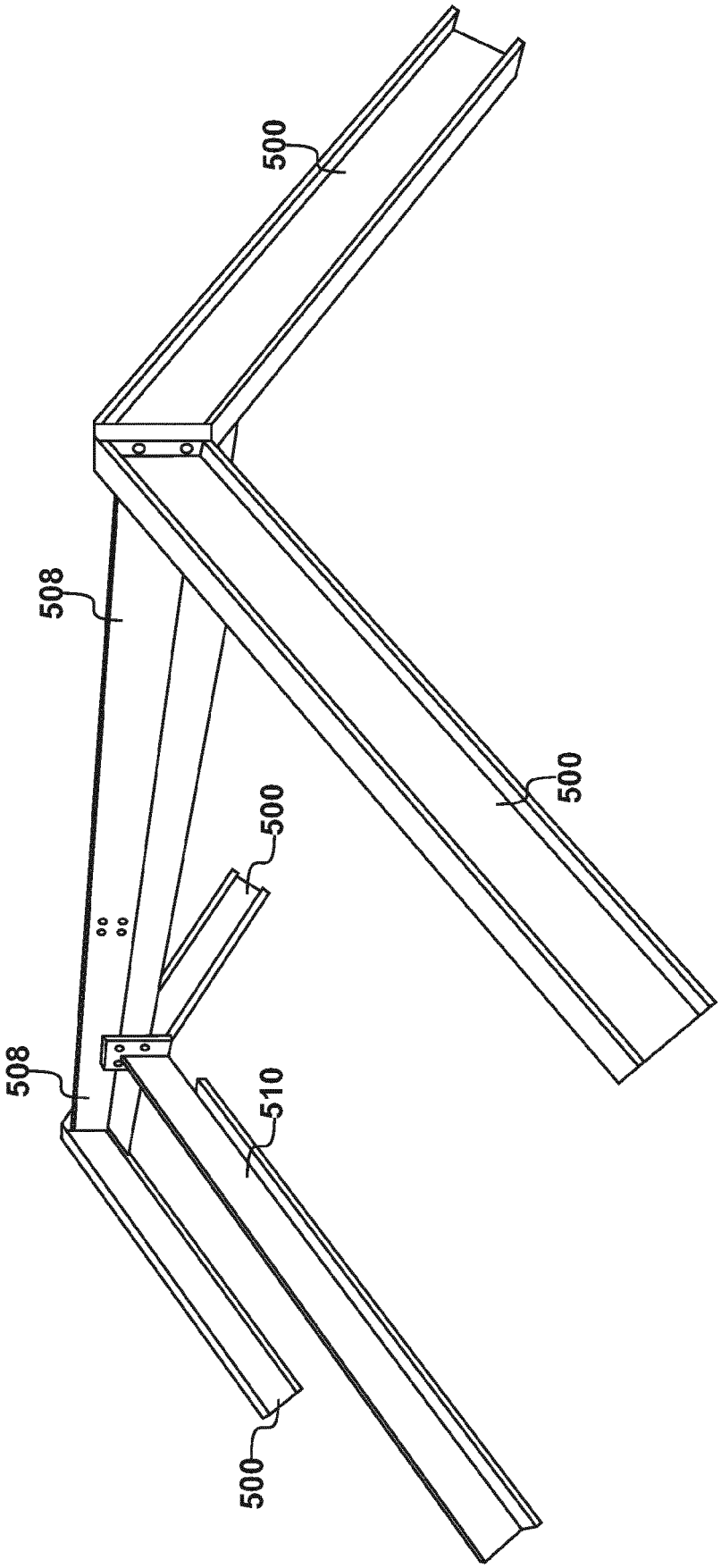

Fig. 11

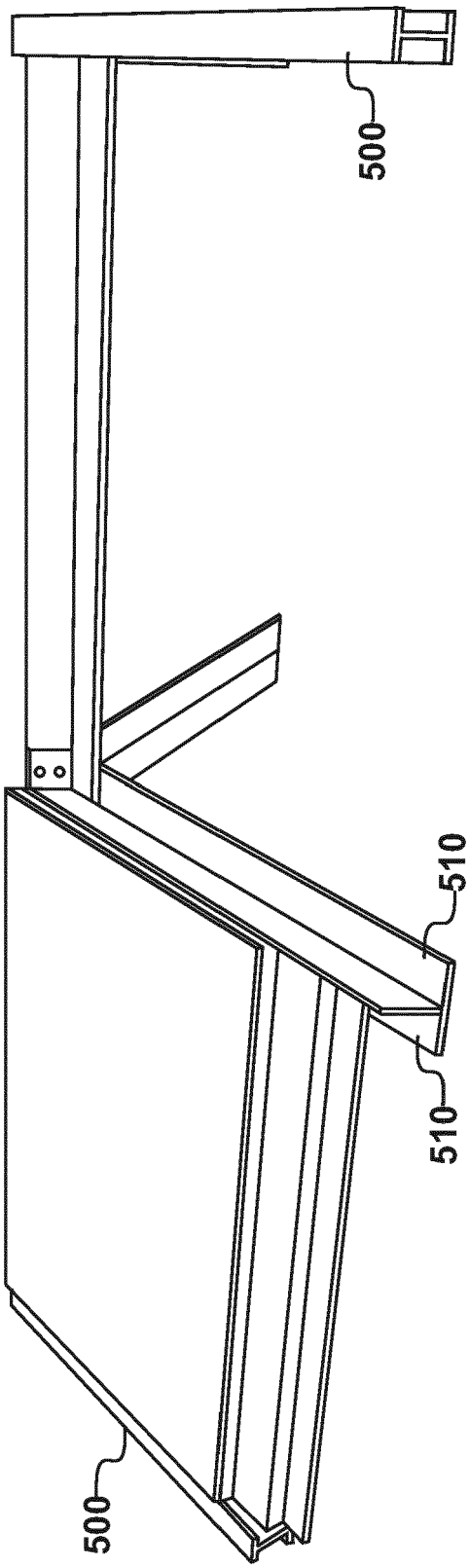

Fig. 12

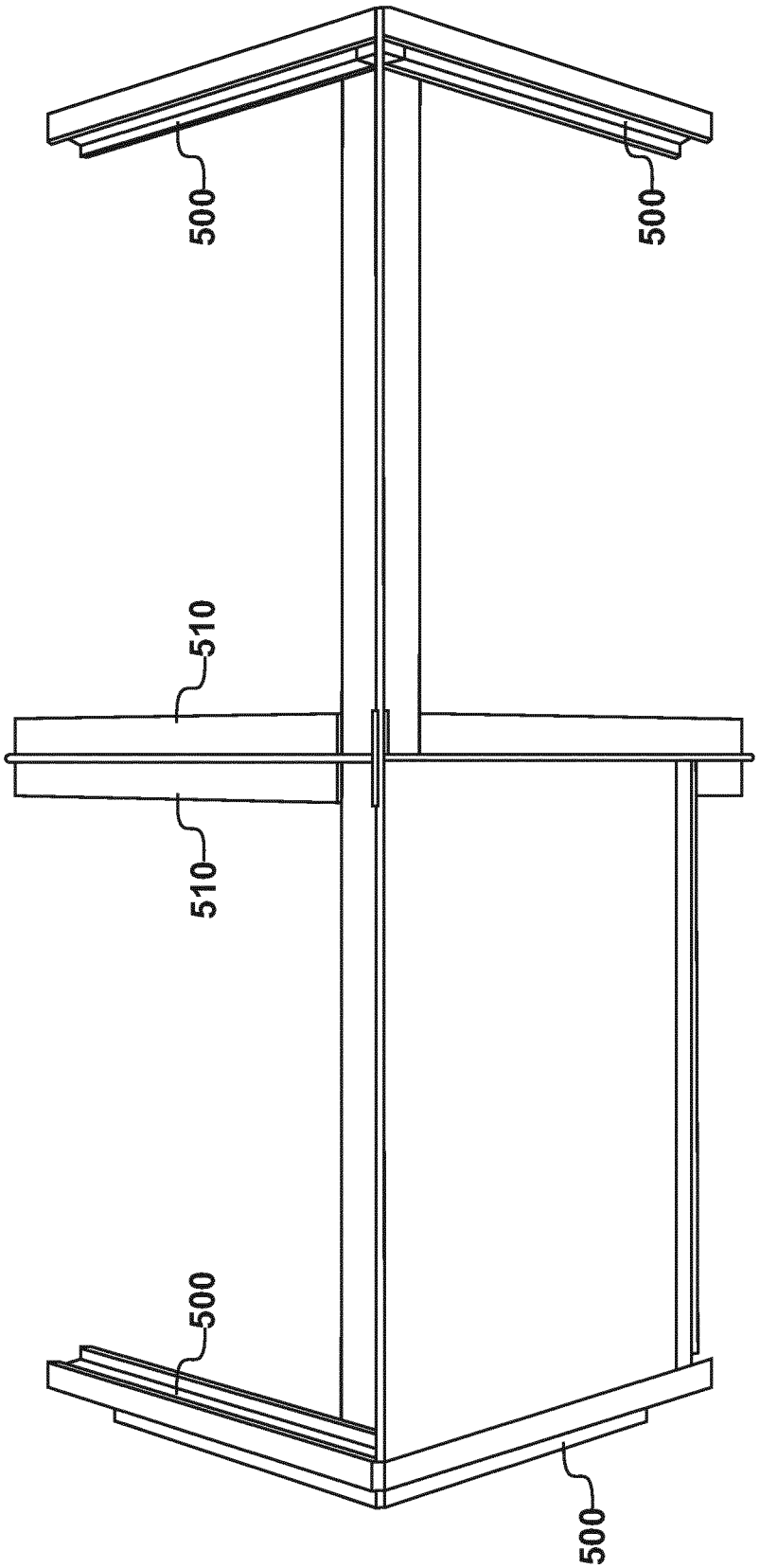

Fig. 13

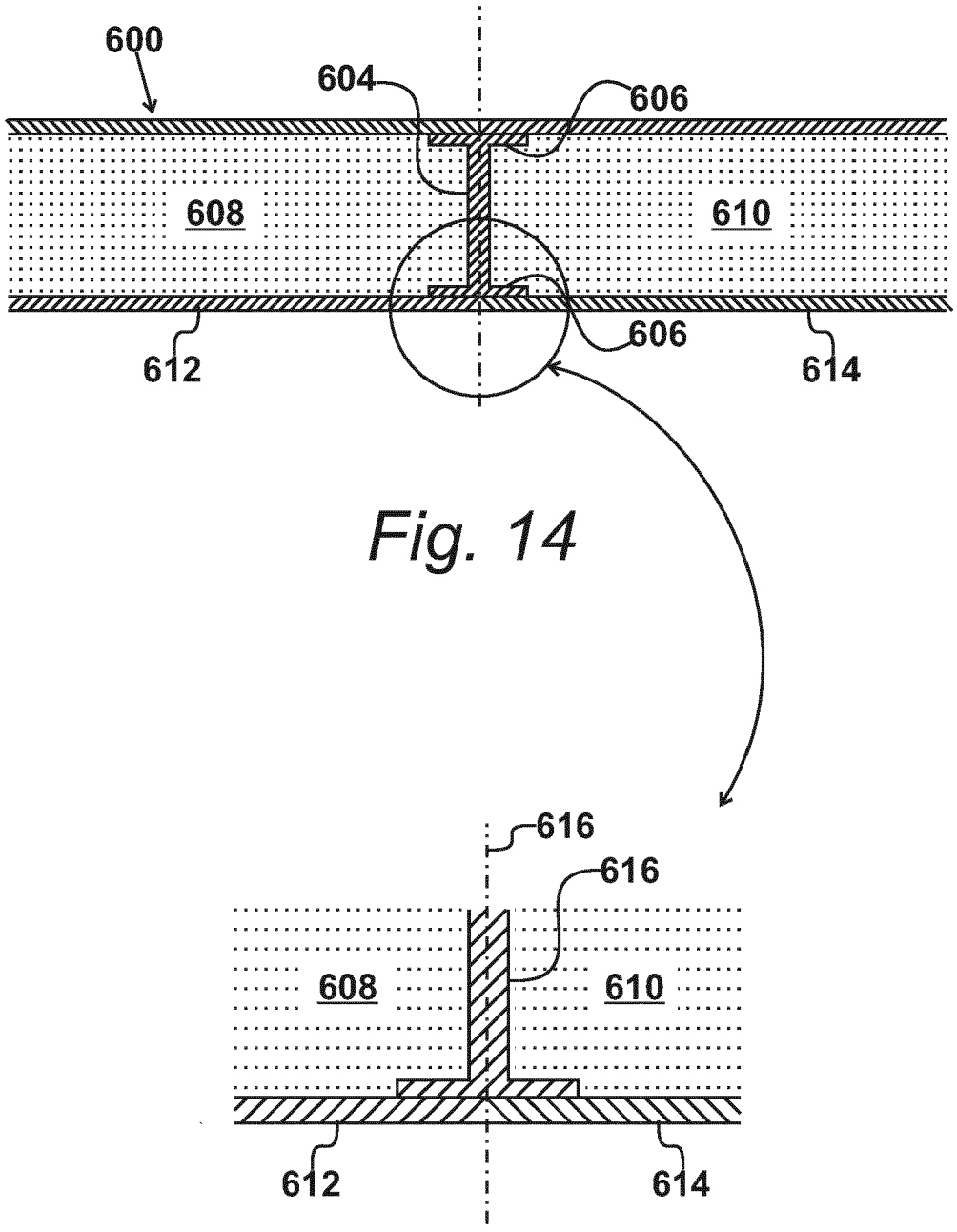

Fig. 14

Fig. 15

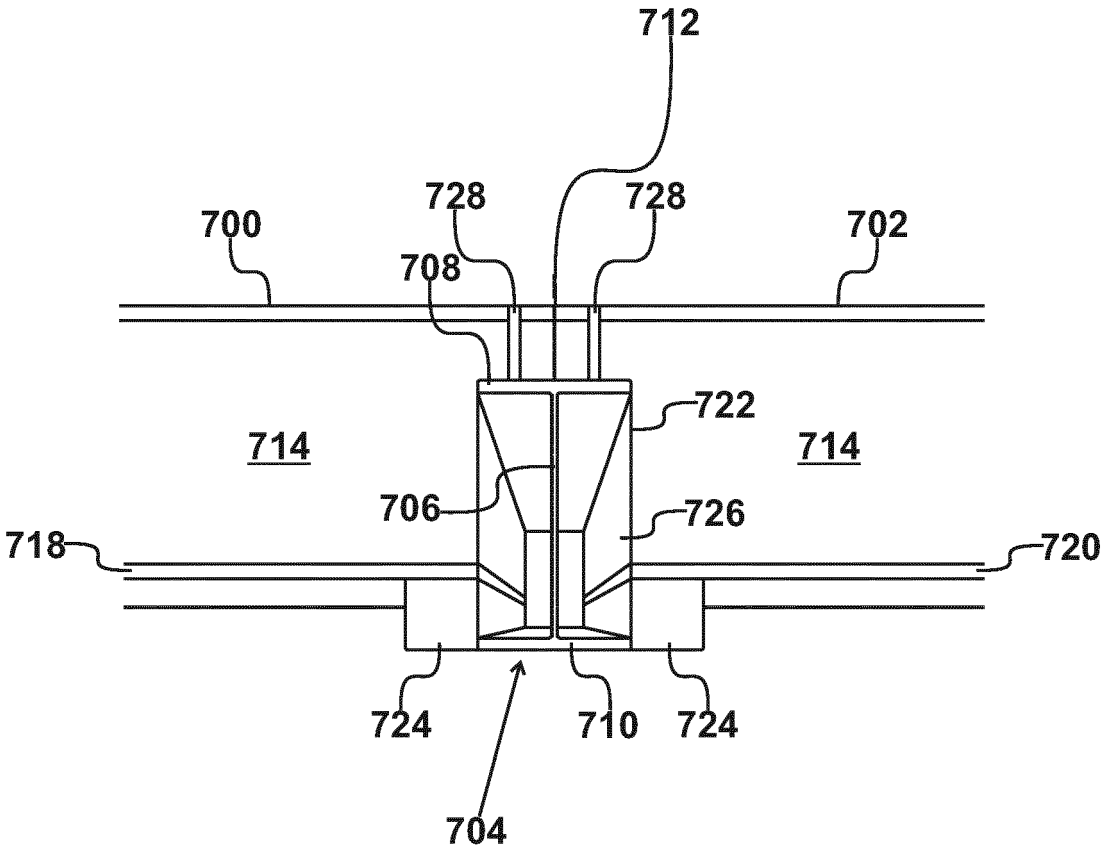
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Fig. 16

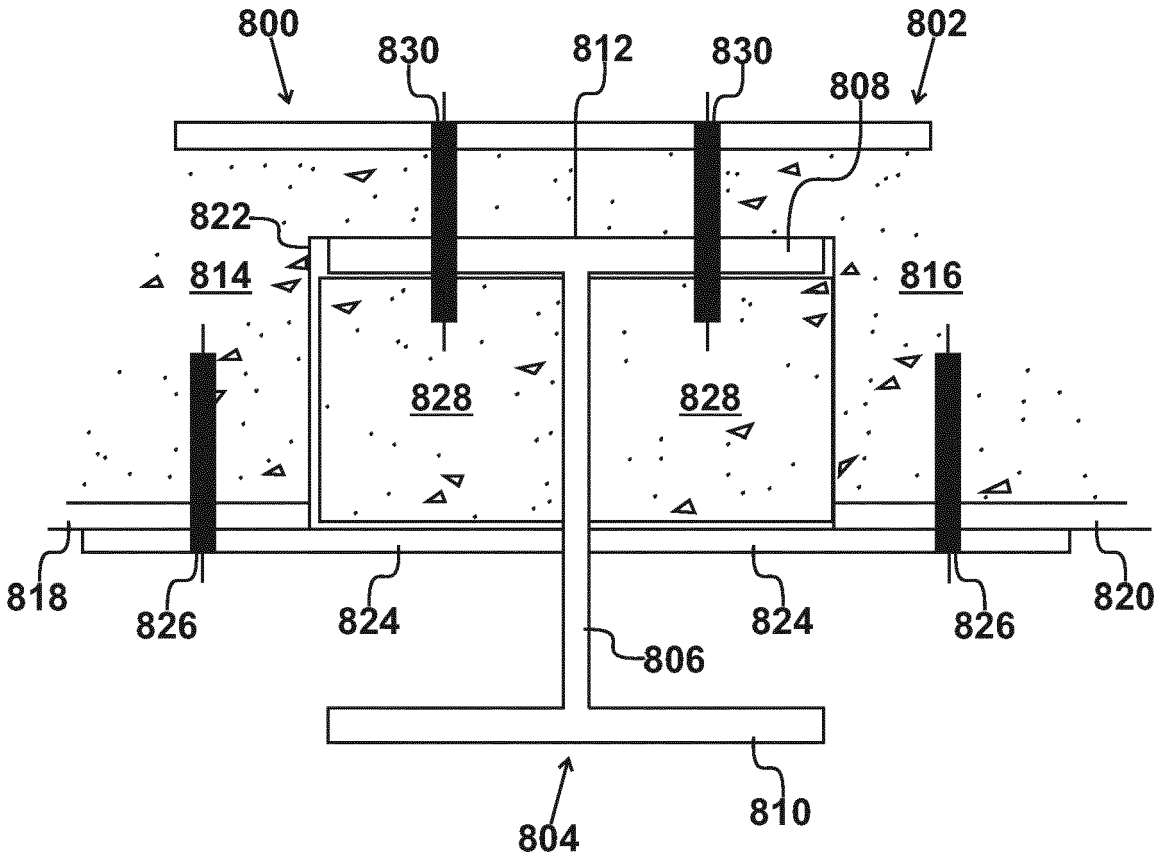
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Fig. 17

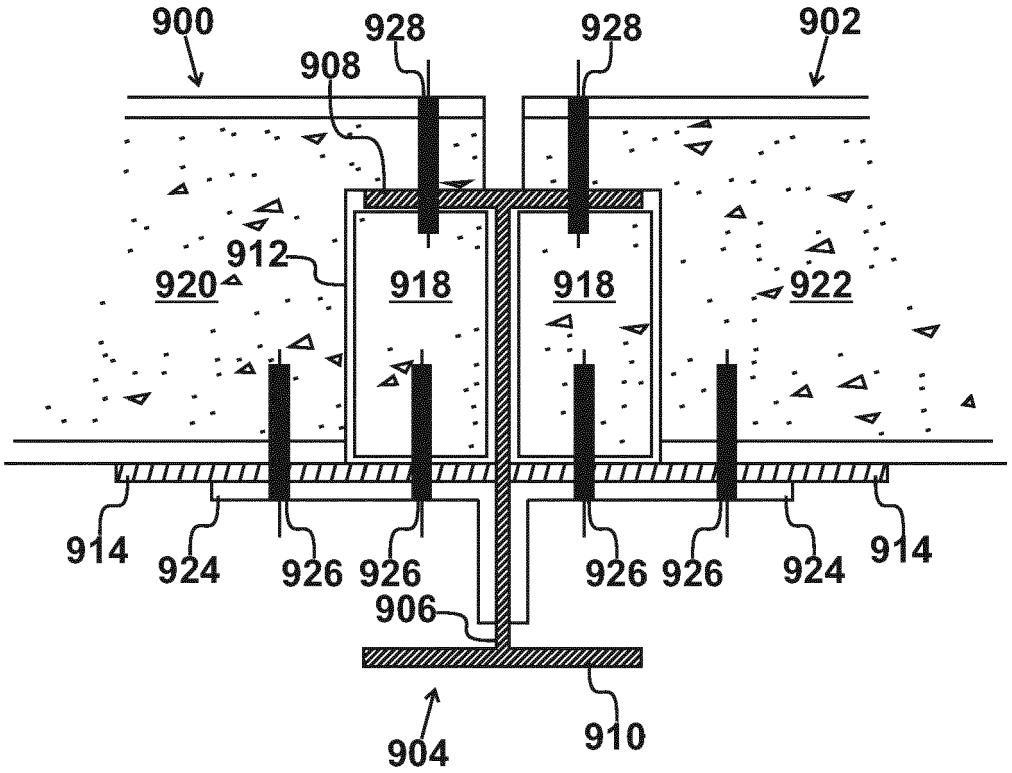
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Fig. 18

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EUROPEAN SEARCH REPORT

Application Number
EP 19 17 1773

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 September 2019	López-García, G

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