(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 385 463 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.10.2018 Bulletin 2018/41

(51) Int Cl.:
E04B 1/348 *(2006.01)* ***E04B 1/94*** *(2006.01)*

(21) Application number: **18165445.0**

(22) Date of filing: **03.04.2018**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **05.04.2017 GB 201705498**

(71) Applicant: **Eronen, Leif**
20360 Turku (FI)

(72) Inventor: **Eronen, Leif**
20360 Turku (FI)

(74) Representative: **Becker Kurig Straus**
Patentanwälte
Bavariastrasse 7
80336 München (DE)

(54) OFF-SITE MANUFACTURED CONSTRUCTION MODULE, METHOD AND BUILDING SYSTEM

(57) An off-site manufactured construction module, comprising a floor element, a roof element, and a plurality of wall elements, wherein the elements are made of planar cross-laminated timber elements configured to form a cuboid compartment for a building, and the elements are connected to each other using wooden fastening elements; the cross-laminated timber elements of the cuboid compartment are processed with a fire prevention fluid; a wet area of the cuboid compartment is arranged by adding a moisture insulation layer to the wet area; pre-defined technical connections are arranged to extend through at least one planar cross-laminated timber element of the cuboid compartment; and interior equipment and surface layers are arranged to the cuboid compartment.

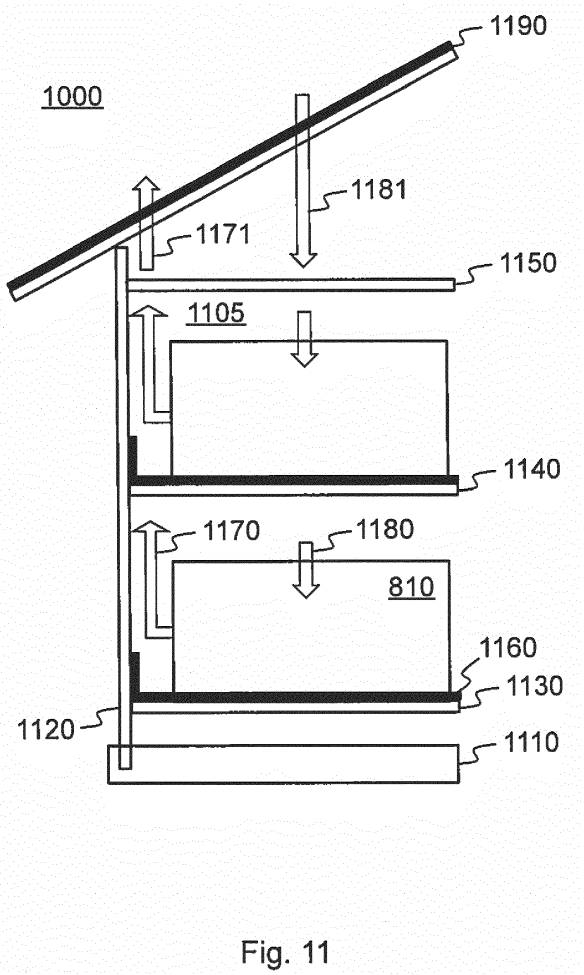

Fig. 11

EP 3 385 463 A1

Description

TECHNICAL FIELD

[0001] The invention relates to an arrangement for off-site manufactured construction module, method and building system.

BACKGROUND

[0002] This section illustrates useful background information without admission of any technique described herein being representative of the state of the art.

[0003] Prefabricated modules for use in buildings are known. The modules size and appearance may vary depending on its application. Within the area of the prefabricated modules it is known that such modules may accommodate wet areas, such as bathrooms or kitchens.

[0004] In current solutions, however, buildings are made according to the current construction methods and are built mainly from construction materials that are not good for health and further involve different kinds of incompatible technical solutions or the materials are incompatible with each other.

[0005] When using the current construction method systems the health of people is endangered both at home and at work without offering them a possibility to decide by themselves.

[0006] Current construction manufacturing methods create huge CO2 emissions, the modules are not seamless and comprise materials that are not human and environment friendly. Furthermore, updating a building system comprising current modules is extremely difficult, even impossible in most cases.

[0007] In view of the above-mentioned disclosures, there is a need for an improved solution for building systems based on prefabricated modules.

SUMMARY

[0008] Various aspects of examples of the invention are set out in the claims.

[0009] According to a first example aspect of the present invention, there is provided an off-site manufactured construction module, comprising

a floor element,

a roof element, and

a plurality of wall elements,

wherein the elements are made of planar cross-laminated timber elements configured to form a compartment for a building, and the elements are connected to each other using wooden fastening elements;

the cross-laminated timber elements of the module are processed with a fire prevention fluid;

a wet area of the compartment is arranged by adding a moisture insulation layer to the wet area;

pre-defined technical connections are arranged to extend through at least one planar cross-laminated timber element of the module; and

interior equipment and surface layers are arranged to the compartment.

[0010] In an embodiment, the module further comprises interior walls forming at least two compartments within the module.

[0011] In an embodiment, the module further comprises at least one duct configured to accommodate the pre-defined technical connections.

[0012] In an embodiment, the pre-defined technical connections comprise at least one of the following:

- electricity;
- audio/video (AV);
- telecommunication;
- surveillance system;
- sensor data;
- external data network data;
- ventilation;
- water supply;
- water sewage;
- water based heating;
- cooling system; and
- sprinkler system.

[0013] In an embodiment, the pre-defined technical connections are arranged disconnectable on an external surface of the module.

[0014] In an embodiment, the module further comprises attachment means on an external surface of the module configured to exchangably engage the module to a fixed framework of a building system.

[0015] In an embodiment, the wooden fastening elements comprises at least one the following: wooden pegs and wooden lamello fasteners.

[0016] In an embodiment, at least one of the floor element, the roof element, and the wall element comprises an opening.

[0017] In an embodiment, the off-site manufactured construction module is coated externally with an insulation layer.

[0018] In an embodiment, the insulation layer is seamless and comprises thermal insulation material having of thickness 200-300mm, and the planar cross-laminated timber (CLT) element having thickness of 60-125mm.

[0019] In an embodiment, the insulation layer covers seamlessly whole external surface of the off-site manufactured construction module.

[0020] According to a second example aspect of the present invention, there is provided a method for off-site manufacturing a construction module, the method comprising:

- arranging, by a crane device, first planar wall elements on a first longitudinal assembly line and on a second longitudinal assembly line respectively, the first and the second longitudinal assembly line arranged in parallel and movable in direction perpen-

dicular to the longitudinal parallel axis of the assembly lines, wherein the first and the second planar wall element are placed an end side wall against an upper surface of the respective longitudinal assembly line;
turning the first and the second planar wall element, by the corresponding longitudinal assembly line, so that the first and the second planar wall element are placed a side wall against the upper surface of the respective longitudinal assembly line;
assembling wooden fastening elements to at least of the end side walls of the first and the second planar wall element;
arranging, by the crane device, floor and roof elements on the first and the second longitudinal assembly line on opposite sides of the respective wall elements, wherein the floor and the roof elements are placed an end side wall against an upper surface of the respective longitudinal assembly line;
moving the roof and the floor elements towards each other, using at least one shifting assembly line between the first and the second longitudinal assembly line so that the wooden fastening elements of the respective planar wall element located on the respective longitudinal assembly line interlock with apertures arranged to the respective floor and the roof element to generate an U-shaped intermediate element on each respective first and second longitudinal assembly lines;
turning, by at least one of the corresponding longitudinal assembly line and the crane device, the U-shaped intermediate elements on the respective first and the second longitudinal assembly line so that the open end of each U-shaped intermediate element face each other;
moving the U-shaped intermediate elements towards each other, using at least one of the assembly lines so that a batten element arranged to an end wall of a first U-shaped intermediate element and a groove element arranged to an end wall of a second U-shaped intermediate element interlock with each other to generate an intermediate compartment element;
arranging, by the crane device, a second planar wall element, to each end of the intermediate compartment element so that a mechanized element arranged to an end wall of each open end of the intermediate compartment element interlocks with correspondingly mechanized respective second planar wall element to generate a compartment, wherein the elements are made of planar cross-laminated timber elements;
processing the cross-laminated timber elements of the module with a fire prevention fluid;
adding a moisture insulation layer to a wet area of the compartment;
arranging pre-defined electricity and ventilation connections to the module; and
arranging interior equipment and surface layers to the compartment.

[0021] According to a third example aspect of the present invention, there is provided a building system comprising:
a fixed framework comprising means for exchangably engaging an off-site manufactured cuboid construction module of the first aspect.

[0022] In an embodiment, the fixed framework comprises a plurality of vertical pillars and a plurality of horizontal pillars, the plurality of horizontal pillars are connected to the plurality of vertical pillars, and the off-site manufactured construction module received on top of a transport frame is arranged on at least two horizontal pillars and anchored thereon, the building system further comprises:

an elastic assembly bed arranged between the module and the transport frame or between the transport frame and the horizontal pillars; and
a seamless insulation layer arranged horizontally below and above the module.

[0023] In an embodiment, the building system further comprises:
fixed technical connections arranged to the fixed framework and configured to be disconnectably connected to the pre-defined technical connections of at least one module.

[0024] In an embodiment, when the modules are engaged to the fixed framework, free service space is arranged on at least one vertical and at least one horizontal external surface of the module.

[0025] In an embodiment, the building system further comprises:
a moisture insulation layer arranged within the framework as a horizontal plane between an upper and a lower module.

[0026] In an embodiment, the building system further comprises:
an external surface panel and a roof panel to cover the modules and the fixed framework.

[0027] Different non-binding example aspects and embodiments of the present invention have been illustrated in the foregoing. The embodiments in the foregoing are used merely to explain selected aspects or steps that may be utilized in implementations of the present invention. Some embodiments may be presented only with reference to certain example aspects of the invention. It should be appreciated that corresponding embodiments may apply to other example aspects as well.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] For a more complete understanding of example embodiments of the present invention, reference is now made to the following descriptions taken in connection with the accompanying drawings in which:

Fig. 1 shows a first schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 2 shows a second schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 3 shows a third schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 4a shows a schematic picture of a planar wall element configured to manufacture a module according to an example embodiment of the invention;
Fig. 4b shows a third schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 4c illustrates how mechanized elongated assembly grooves are arranged to engage with the open ends of the wall elements;
Fig. 5 shows a fifth schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 6 shows a sixth schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 7 shows a seventh schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 8 shows an eighth schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 9 shows a ninth schematic picture of a system configured to manufacture a module according to an example embodiment of the invention;
Fig. 10 shows a schematic picture of an on-site building configured to utilize the module according to an example embodiment of the invention;
Fig. 11 shows another schematic picture of an on-site building configured to utilize the module according to an example embodiment of the invention;
Fig. 12 shows a flow chart of a method for manufacturing a module according to an example embodiment of the invention;
Figs. 13a-b show schematic pictures of an insulated module according to an example embodiment of the invention;
Fig. 14 shows a schematic above view of a building system comprising an apartment house utilizing an off-site manufactured construction module according to an example embodiment of the invention;
Fig. 15 shows a schematic side view of a building system comprising an apartment house utilizing an off-site manufactured construction module according to an example embodiment of the invention;
Fig. 16 shows a schematic side view of a building system comprising a detached house, a row house, a sauna or such utilizing an off-site manufactured construction module according to an example embodiment of the invention;
Fig. 17 shows a schematic side view of a building system comprising a detached house, a row house, a sauna or such utilizing an off-site manufactured construction module according to an example embodiment of the invention; and
Fig. 18 shows another schematic picture of an on-site building system with a plurality of floors configured to utilize the module according to an example embodiment of the invention.

DETAILED DESCRIPTON OF THE DRAWINGS

[0029] The present invention and its potential advantages are understood by referring to the drawings. In this document, like reference signs denote like parts or steps.

[0030] Earlier construction philosophies could be categorized in high level to first and second generations.

[0031] The reasons for this new third generation construction philosophy carry far in history, at least from 18th century to 1960's, to call this period as the first generation of the construction philosophy. In this case, building materials forgave both design errors and construction errors.

[0032] The first generation used building materials having same characteristics because the materials used were mainly organic. Problems caused by moisture in this era was due to the ability of materials used in construction to deal with moisture that is why they were able to pass moisture and dry.

[0033] The first generation method of construction was very modest but there were no indoor air problems if the building was off the ground and the roof kept most of the moisture out. Water and moisture are therefore not a problem but the materials' inability to deal with them is.

[0034] The first generation buildings were typically built during dry periods, when the construction materials do not become wet when constructing. If the materials became wet however, they were allowed to dry. Usage of wet building materials and seal materials were not a problem because the carpentry reputation was at stake. Professional pride and reputation for high-quality construction were crucial to survive.

[0035] Safeguarding the health of building residents and the reasons to use natural resources is our handprint and legacy for future generations. By taking into account the process and lowering CO2 emissions generated during the whole process, the construction industry are taken to the new millennium that is essential for mankind. This means building with a responsible manner structurally and technically safe buildings that use renewable resources in those parts of the structures where possible.

[0036] During the second generation, that is, from the 1960's to the present day, building practices developed but so did the problems. Building solutions entered the markets the use of which we suffer today. The new materials were used to repair old buildings without realizing their properties and effects to the renovated buildings.

[0037] Unfortunately, these same mistakes are repeated and new materials and solutions are all the time

brought to the market that work in controlled laboratory environments but not in practice. In addition to the problems caused by the moisture is the use of various chemicals together, and their compatibility is unknown.

[0038] When choosing building materials it should always be understood to choose materials with similar characteristics, rather than, for example, use the moisture-impermeable and moisture permeable materials. When the moisture-permeable material gets wet, the moisture cannot evaporate because of impermeable material, and this results, inter alia, mildew. Different materials react with moisture, such as various glues, binders and coating materials. As a result, particles, toxins, and a variety of compounds may come off to the breathing air and are transferred from the lungs into the bloodstream. On the other hand the different chemical compounds cause skin and the respiratory tract problems.

[0039] When renovating old buildings without taking into account the old building's material features but to be corrected using the new materials, it is possible that the new materials do not work in the old building.

[0040] Concerning new buildings again, there are used incompatible materials, and designers and builders do not necessarily understand the properties of individual materials, in particular their functional entity. There are further emerging problems, when allowing the construction materials to get wet, and not allowing them to air dry or dry materials exchanged due to cost-effectiveness.

[0041] Currently, both of these forms of building construction methods consciously endanger users and their health. Cost-efficiency and profit maximization cause the uncontrolled use of sub-contracted labour force, which is often unprofessional and lacking the responsibility and/or interest to the work. Own mistake patching will be cheaper than doing work properly right from the beginning and it seems to be unfortunately part of a common strategy on the market. This is supported by the fact that the volume of construction and renovation of complaints increases.

[0042] Typical construction defects include leaky tin roofs, bathroom flooring and pipe fittings.

[0043] The poor performance of the construction and the problems caused by poor materials are touching all because it is estimated that each year 958 000 persons only in Finland (2012) are exposed to problems caused by moisture and mildew problems. Health costs in Finland caused only by indoor air problems amount to an annual cost estimated at 1.5-3.0 billion Euros but the reality may be even worse.

[0044] The second generation of construction will be costly for both the state and the individual human being. The construction industry estimates that the Finnish repair debt (in 2014) was estimated to be about 54-80 billion Euros that is around the same amount that the government expenditure was in 2014. The repair debt corresponds to the sum that would have had to be invested to the buildings in order to keep them in order. No matter only Finnish construction problems are referred, similar problems exist also elsewhere and one can only guess what it is elsewhere in the EU, Asia and the USA.

[0045] Solution for the existing problems is the new third generation method referred as K3CS™ method. The system is defined to create new and healthy homes, public buildings, as well as renovating the old ones. All the materials, techniques and technologies used must be justified, and they use really new materials (not recycling / hazardous wastes which are dangerous to people and buildings) that are among the best in the market.

[0046] Due to its unique processes K3CS™ is able to meet the construction and renovation needs of both the Finnish and global systems. K3CS™ process is capable of producing tens of thousands of houses, inter alia, to developing countries, if desired. When designing for the developing countries, the houses can make use of local labour and local materials.

[0047] The new, powerful, and industrial building model makes it possible to use serial production with a high standard so that the implementation of every detail to customer's specification is easier and faster.

[0048] The new concept is possible to produce healthy, safe and environmental stewardship of houses / buildings, which are user-friendly, such as the updating of the emerging technologies for buildings, as well as energy consumption and the exchange of surfaces.

[0049] The industrial process is able to produce large quantities even at a short time frame thanks to the production model. The production model reduces human errors to almost zero.

[0050] K3CS™ building is safe, fit for purpose, and long-lasting. It is also updateable. The system comprises capability for quick and easy updating of the technical parts and modules of the building as a standard feature.

[0051] In an embodiment, the method comprises off-site manufacturing a construction module, the module being used for assembling an apartment of a building. Each module, and in case an apartment comprises several modules, each apartment is configured to be independently air-conditioned and excess pressurized in controlled manner.

[0052] In an embodiment, pre-defined electricity and ventilation connections are arranged to a (e.g. cuboid) compartment of the module. The pre-defined electricity and ventilation connections are arranged on the external surface of the module to enable easy service and exchange of equipment or modules.

[0053] Fig. 1 shows a first schematic picture of a system 100 configured to manufacture a module according to an example embodiment of the invention.

[0054] In an embodiment, a method for off-site manufacturing a construction module comprises arranging, by a crane device 110, a first planar wall element 120 on a first longitudinal assembly line 130 and a second planar wall element 121 on a second longitudinal assembly line 140 respectively. The first 130 and the second longitudinal assembly line 140 are arranged in parallel and movable in direction 135 perpendicular to the longitudinal par-

allel axis of the assembly lines 130,140. The planar wall element 120,121 comprises a planar cross-laminated timber (CLT) element that may be pre-machined, notched and/or treated before receiving at the assembly lines. Treatments such as insulation, water/moisture resistance and/or fire resistance may be performed.

[0055] In an embodiment, each element 120 received at the assembly lines may comprise unique identifier that may enable machine readability/user readability within the assembly lines. Technical coupling components (such as wooden pegs) for the element 120 may be attached to a surface of the element 120 with adhesive mass to improve and speed up the assembly.

[0056] In an embodiment, between the first 130 and the second longitudinal assembly line 140 is arranged a transfer line 150 configured to move elements in direction 155 parallel to the longitudinal parallel axis of the assembly lines 130,140.

[0057] In an embodiment, module assembly may take place on a dedicated assembly table with assistance of an overhead crane or an elevator. One corner of the dedicated assembly table may comprise 90° predefined support structure so that vertical support is provided for the module assembly on two perpendicular sides for perpendicular wall elements, for example. Thus, free assembly space may be provided below the module, 360° around the module and above the module.

[0058] Fig. 2 shows a second schematic picture of a system 100 configured to manufacture a module according to an example embodiment of the invention.

[0059] In an embodiment, the first 120 and the second planar wall elements (only first planar element shown in Fig. 2) are placed an end sidewall against an upper surface of the respective longitudinal assembly line 130. Before lifting the planar element 120 on the upper surface of the line 130, assembly support elements 210 may be placed between the upper surface of the line 130 and the end sidewall of the planar element 120.

[0060] In an embodiment, the planar wall element 120 is pre-manufactured with defined measures, such as length, width, thickness and desired openings (windows, doors etc.) and apertures (for interlocking elements, for example).

[0061] In an embodiment, the assembly lines 130, 140 further comprise a pivoting device 220 that is configured to support the planar wall element 120 when lifted on the upper surface of the line 130. The planar wall element 120 may be fastened to the pivoting device 220 or the planar wall element 120 may be lifted on the upper surface of the line 130 so that the planar wall element 120 inclines and rests against the pivoting device 220 without any fastening.

[0062] The pivoting device 220 is arranged to turn between a first position when being perpendicular to the surface of the line 130 (as shown in Fig. 2) and a second position when being parallel to the surface of the line 130.

[0063] Turning of the pivoting device 220, as well as movements of the assembly lines 130,140,150 and the crane device 110 may be motorized and controlled by a computer program and associated computer apparatus to provide automated assembly system. Also intelligent reading of the unique identifiers attached to the wall elements 120,121 may be computerized.

[0064] After turning the pivoting device 220 to place a wall element 120,121 in planar position on the assembly line, the pivoting device 220 may be moved farther away from the wall element 120,121 to provide space for further wall elements and/or working with the coupling items of the wall elements.

[0065] Fig. 3 shows a third schematic picture of a system 100 configured to manufacture a module according to an example embodiment of the invention.

[0066] The first 120 and the second planar wall element 121 are turned, by the corresponding longitudinal assembly line 130,140 and associate pivoting devices 220, so that the first 120 and the second planar wall element 121 are placed a side wall against the upper surface of the respective longitudinal assembly line 130,140. At this phase the assembly support elements 210 (See Fig. 2) assembled earlier between the upper surface of the line 130 and the end sidewall of the planar element 120 may be removed.

[0067] Fig. 4a shows a schematic picture of a planar wafl element 120 configured to manufacture a module according to an example embodiment of the invention.

[0068] After the planar wall element 120 is turned down as explained regarding Fig. 3 and the assembly support elements 210 (See Fig. 2) are removed the planar wall element 120 is shown in Fig. 4a. In at least two ends 401,402 of the planar wall element 120 there are a plurality of mechanized interlocking apertures 410,420,430. In sidewalls of the planar wall element 120 there are mechanized peg apertures 440. Furthermore, also within the mechanized interlocking apertures 410,420,430 there may be mechanized peg apertures 450 arranged.

[0069] As shown in Fig. 4a, there may also be mechanized peg apertures 460 arranged on the surface of the wall element 120 between the ends 410,402. Such peg apertures may be configured to fasten a dividing wall in later phase of the assembly.

[0070] Fig. 4b shows a fourth schematic picture of a system 100 configured to manufacture a module according to an example embodiment of the invention.

[0071] Wooden fastening elements, such as pegs 441 are arranged to at least to the sidewalls of the planar wall element 120. The pegs interconnect with the mechanized peg apertures 440 of Fig. 4a. Furthermore, wooden fastening elements, such as pegs may be arranged also to the mechanized interlocking apertures 410,420,430 of Fig. 4a for the mechanized peg apertures 450 as shown in Fig. 4a. Further wooden pegs may be arranged to the mechanized peg apertures 460 of Fig. 4a on the surface of the wall element 120.

[0072] Fig. 4b illustrates how further wall elements 122,123 are lifted and arranged on the assembly line 130.

[0073] In an embodiment, a planar floor element 123

and a planar roof element 122 are arranged by the crane device on the first (and the second) longitudinal assembly line 130 on opposite sides of the respective wall element 120, wherein the floor 123 and the roof element 122 are placed an end side wall against an upper surface of the respective longitudinal assembly line 130.

[0074] Additionally, a dividing wall element 124 may be arranged by the crane device on the first (and the second) longitudinal assembly line 130 on top of the wall element 120 and between the floor 123 and the roof element 122.

[0075] Furthermore, mechanized elongated assembly grooves 442 are arranged to the open ends of the wall elements 122,123,124.

[0076] The roof 122 and the floor elements 123 are moved by the assembly line 130 and associated pivoting devices 220 (see e.g. Fig. 2) towards each other, using at least one shifting assembly line between the first and the second longitudinal assembly line or associated pivoting devices 220 so that the wooden pegs 441 of the respective planar wall element 120 located on the respective longitudinal assembly line 130 interlock with apertures arranged to the respective floor 123 and the roof element 122 to generate an U-shaped intermediate element 510 on each respective first 130 and second longitudinal assembly lines.

[0077] Fig. 4c illustrates how mechanized elongated assembly grooves 442 are arranged to engage with the open ends of the wall elements 122,123,124.

[0078] In Fig. 4c, as an example, the roof element 122 is shown, wherein the roof element 122 comprises an elongated assembly groove 442 on the open sidewall of the element 122. The elongated assembly groove 442 fits with the elongated batten element 443. The batten element 443 then again fits with another element 125, such as corresponding roof element form the second assembly line (see second assembly line 140 of Fig. 1).

[0079] Fig. 5 shows a fifth schematic picture of a system 100 configured to manufacture a module according to an example embodiment of the invention.

[0080] The roof and the floor elements are moved by each assembly line 130,140 and associated pivoting devices (see e.g. Fig. 2) towards each other, using at least one shifting assembly line 150 between the first and the second longitudinal assembly line 130,140 or associated pivoting devices so that the wooden pegs of the respective planar wall elements located on the respective longitudinal assembly line 130,140 interlock with apertures arranged to the respective floor and the roof element to generate U-shaped intermediate elements 510,520 on each respective first 130 and second longitudinal assembly line 140. Inside each U-shaped intermediate element 510,520 there may be temporary support frames arranged to support the roof element before turning the U-shaped intermediate element 510,520 (e.g. 90 degrees clockwise or counterclockwise).

[0081] Fig. 6 shows a sixth schematic picture of a system 100 configured to manufacture a module according to an example embodiment of the invention.

[0082] In an embodiment, each U-shaped intermediate element 510,520 are turned by the corresponding longitudinal assembly line 130,140 and the crane device so that the open end of each U-shaped intermediate element 510,520 face each other. Inside each U-shaped intermediate element 510,520 there may be temporary support frames 610 arranged to support the roof element when the U-shaped intermediate element 510,520 is turned. The support frames 610 may be removed later in the module manufacturing process without damaging the module or any of its wall elements.

[0083] Fig. 7 shows a seventh schematic picture of a system 100 configured to manufacture a module according to an example embodiment of the invention.

[0084] In an embodiment, the U-shaped intermediate elements are moved towards each other, using at least one of the assembly lines so that a batten element (see Fig. 4c) arranged to an end wall of a first U-shaped intermediate element and a groove element arranged to an end wall of a second U-shaped intermediate element interlock with each other to generate a intermediate compartment element 710. The batten element guides the two U-shaped intermediate elements towards each other in correct position.

[0085] Fig. 8 shows an eighth schematic picture of a system 100 configured to manufacture a module according to an example embodiment of the invention.

[0086] In an embodiment, an additional planar wall element 805 is arranged, by the crane device, to each end of the intermediate compartment element so that a mechanized element 820,830 arranged to an end wall of the element 805 of each open end of the intermediate compartment element 710 interlocks with correspondingly mechanized respective second planar wall element to generate a compartment 810, wherein the wall, roof and floor elements are made of planar cross-laminated timber (CLT) elements. The end wall element 805 may be pushed by the crane device or at least one assembly line towards the intermediate compartment element 710 from the open end direction towards the intermediate compartment element 710 to interlock with correspondingly mechanized open end of the intermediate compartment element 710.

[0087] In an embodiment, the intermediate compartment element 710 and the module are cuboid.

[0088] In an embodiment, the intermediate compartment element and the module are spherical.

[0089] As shown in Fig. 4a, in at least two ends of the planar wall element there are a plurality of mechanized interlocking apertures. In sidewalls of the planar wall element there are mechanized peg apertures. Furthermore, also within the mechanized interlocking apertures there may be mechanized peg apertures arranged.

[0090] As shown in Fig. 4a, there may also be mechanized peg apertures arranged on the surface of the wall element between the ends. Such peg apertures may be configured to fasten a dividing wall.

[0091] In an embodiment, wooden fastening elements, such as pegs or lamellos, may be arranged both in vertical (e.g. through the roof element in Fig. 8) and horizontal (e.g. through the end wall 805 in Fig. 8) direction in addition to a mechanized element 820,830 arranged to an end wall 805 of each open end of the cuboid intermediate element 710.

[0092] In an embodiment, the compartment 810 may be lifted by the crane device and a transport frame (see Fig. 10) is arranged under the compartment 810. The transfer line 150 is configured to move the compartment 810 arranged on the transport frame in direction parallel to the longitudinal parallel axis of the assembly lines for further processing of the compartment 810. The compartment 810 may be cuboid or spherical, for example.

[0093] In an embodiment, stiffness, bearing capability and sealing of the module structure may be improved by attaching connection joint using screws or head bolts. Angles for the screws or bolts may vary depending on the connection joint.

[0094] In an embodiment, on external surfaces of the module/compartment 810 lift fittings may be arranged. The lift fittings may also be used for guide elements for the next module/compartment 810 to be assembled later on next to the previous module.

[0095] Fig. 9 shows a ninth schematic picture of a system configured to manufacture a module according to an example embodiment of the invention.

[0096] The transfer line 150 of Fig. 8 may transfer the compartment 810 automatically to further processing of the compartment 810.

[0097] In an embodiment, different process phases are defined as shown in Fig. 9. The order of the phases may vary. Before entering process phases of Fig. 9, a transport frame is installed under the compartment/module (see e.g. transport frame 1020 in Fig. 10).

[0098] First, in phase 910, the cross-laminated timber (CLT) elements of the compartment 810 are processed with a fire prevention fluid. The fire prevention fluid may be sprayed or pressurized to the CLT elements automatically, for example. Pressurized fire prevention process surprisingly provides protection also against termites.

[0099] Second, in phase 920, the fire prevention processed cuboid compartment 810 is dried.

[0100] Third, in phase 930, interior of the compartment 810 is processed with a thermal insulation material. The thermal insulation material may be sprayed automatically, for example.

[0101] Fourth, in phase 940, the wet area of the interior of the compartment 810 is processed with a moisture insulation layer. The moisture insulation layer may be sprayed automatically, for example.

[0102] Fifth, in phase 950, pre-defined electricity and ventilation connections, as well as equipment, to the cuboid compartment 810 of the module are arranged. Surface layer, such as tiling, may be arranged in this phase. In addition, remaining pre-defined technical connections, interior equipment and surface layers to the cuboid compartment are arranged. Furthermore, remaining interior elements, such as floors, doors and windows are assembled before the cuboid compartment 810 of the module is ready for transporting to on-site. If the compartment 810 requires no further processing, it may be transmitted for on-site transportation without steps 910-950.

[0103] In an embodiment, if the compartment 810 is manufactured for a detached house, a row house, a villa or a sauna, for example, then a pre-manufactured CLT-bed is received under the compartment 810. The CLT-bed comprises, for example, necessary thermal insulation elements.

[0104] In an embodiment, the pre-defined technical connections comprise at least one of the following: electricity; audio/video (AV); telecommunication; surveillance system; sensor data; external data network data; ventilation; water supply; water sewage; water based heating; a cooling system; and a sprinkler system.

[0105] Fig. 10 shows a schematic picture of an on-site building configured to utilize the off-site manufactured construction module 810 according to an example embodiment of the invention.

[0106] In an embodiment, the construction module 810 may be transported from off-site manufacturing place to on-site covered and protected using a truck, for example.

[0107] A building system 1000 comprises a fixed framework 1010 comprising means for exchangably engaging an off-site manufactured construction module 810 to the building system 1000. The transport frame 1020 discussed in Fig. 8 is also shown. An on-site crane device may be used to lift the construction module 810 on desired place within the fixed framework 1010.

[0108] In an embodiment, the off-site manufactured construction module 810 may be attached to the fixed framework 1010 for example by rounding the module 810 by a band and attaching the band to the horizontal pillar/bar of the fixed framework 1010. Such band would improve tolerance of the building system for earthquakes or other unstable movements of the foundation.

[0109] In an embodiment, at least one of the floor element, the roof element, and the wall element of the module 810 comprises an opening.

[0110] In an embodiment, the off-site manufactured construction module 810 does not comprise at least one wall element so that a wall portion of the compartment is left open.

[0111] Fig. 11 shows another schematic picture of an on-site building system 1000 configured to utilize the module 810 according to an example embodiment of the invention. Arrangement illustrated in Fig. 11 may be applied for renovating buildings or constructing new buildings.

[0112] In an embodiment, a concrete foundation 1110 may be provided. On top of the concrete foundation 1110 there may be a CLT-layer and through the CLT-layer there are vertical CLT-frame elements 1120 of the fixed framework fastened. The vertical CLT-frame elements

1120 are anchored to the concrete foundation 1110.

[0113] Furthermore, horizontal CLT-frame elements 1130,1140,1150 of the fixed framework are fastened to the vertical CLT-frame elements 1120. For clarity reasons only one vertical CLT-frame element 1120 is shown and the right hand side vertical CLT-frame element are not shown.

[0114] Between each module 810 and corresponding horizontal and vertical CLT-frame elements 1120,1130 there are waterproofing layers 1160 arranged. The waterproofing layers 1160 are arranged so that the waterproofing layers 1160 extend over the horizontal size of the module 810 and also partially the vertical direction as shown in Fig. 11.

[0115] Each module 810 is lifted to its desired position within the system 1000. The pre-defined technical connections of each module are arranged disconnectable on an external surface of the module. The module 810 further comprises engaging means on an external surface of the module configured to exchangably engage the module to a fixed framework 1120-1150 of the building system 1000.

[0116] The building system 1000 further comprises fixed technical connections 1170-1171,1180-1181 arranged to the fixed framework and configured to be disconnectably connected to the pre-defined technical connections of at least one module 810. The building system further comprises at least one duct configured to accommodate the fixed technical connections.

[0117] In an embodiment, the fixed technical connections 1170-1171,1180-1181 of the building system 1000 comprise at least one of the following: electricity; audio/video (AV); ventilation; water supply; water sewage; water based heating; a cooling system; and a sprinkler system.

[0118] As an example, in Fig. 11, fixed technical connection 1170-1171 illustrates exhaust air ventilation and fixed technical connection 1180-1181 illustrates fresh air ventilation.

[0119] As shown, the building system 1000 is arranged so that when the modules 810 are engaged to the fixed framework 1120-1150, free service space 1105 is arranged on at least one vertical and at least one horizontal external surface of the module 810. All technical connections 1170-1171,1180-1181 are arranged within the free service space 1105. This enables easy service of the connections, exchange of the connections and related equipment and exchangeability of the whole module 810. The humidity and temperature of the free service space 1105 may be kept in desired level automatically by technical equipment controlled by a computer device, for example.

[0120] The building system 1000 may further comprise an external vertical surface wall panel (façade), such as CLT panel, external to the vertical frame element 1120 and a waterproof roof panel 1190 to cover the modules 810 and the fixed framework 1120-1150. The roof panel 1190 may also comprise solar panels for producing electricity for the building and/or the grid.

[0121] In an embodiment, the building system 1000 may comprise fixed framework 1120-1150 but other elements, such as modules 810, facade element, roof panel 1190 and even foundation 1110 may be dynamically selected by the customer or builder when installing the building system 1000. Renovating and exchanging the dynamic elements is also possible after the installation.

[0122] In an embodiment, a weather protective visor element may be arranged on upper part of the module to cover external surface of a side wall element of the module. Width of the visor may depend on the needed external insulation layer needed.

[0123] Fig. 12 shows a flow chart of a method for manufacturing a module according to an example embodiment of the invention.

[0124] In step 1200, a method for off-site manufacturing a construction module is started.

[0125] In step 1205, first planar wall elements are arranged, by a crane device, on a first longitudinal assembly line and a second planar wall element on a second longitudinal assembly line respectively, the first and the second longitudinal assembly line arranged in parallel and movable in direction perpendicular to the longitudinal parallel axis of the assembly lines, wherein the first and the second planar wall element are placed an end side wall against an upper surface of the respective longitudinal assembly line.

[0126] In step 1210, the first and the second planar wall element are turned, by the corresponding longitudinal assembly line, so that the first and the second planar wall element are placed a side wall against the upper surface of the respective longitudinal assembly line.

[0127] In step 1215, wooden fastening elements, such as wooden pegs or lamellos, are assembled to at least of the end side walls of the first and the second planar wall element.

[0128] In step 1220, floor and roof elements are arranged by the crane device, on the first and the second longitudinal assembly line on opposite sides of the respective wall elements, wherein the floor and the roof elements are placed an end side wall against an upper surface of the respective longitudinal assembly line.

[0129] In step 1225, the roof and the floor elements are moved towards each other, using at least one shifting assembly line between the first and the second longitudinal assembly line so that the wooden fastening elements, such as wooden pegs or lamellos of the respective planar wall element located on the respective longitudinal assembly line interlock with apertures arranged to the respective floor and the roof element to generate an U-shaped intermediate element on each respective first and second longitudinal assembly lines.

[0130] In step 1230, the U-shaped intermediate elements are turned by at least one of the corresponding longitudinal assembly line and the crane device, on the respective first and the second longitudinal assembly line so that the open end of each U-shaped intermediate el-

ement face each other.

[0131] In step 1235, the U-shaped intermediate elements are moved towards each other, using at least one of the assembly lines so that a batten element arranged to an end wall of a first U-shaped intermediate element and a groove element arranged to an end wall of a second U-shaped intermediate element interlock with each other to generate a intermediate compartment element.

[0132] In step 1240, a second planar wall element is arranged, by the crane device, to each end of the intermediate compartment element so that a mechanized element arranged to an end wall of each open end of the intermediate compartment element interlocks with correspondingly mechanized respective second planar wall element to generate a compartment, wherein the elements are made of planar cross-laminated timber (CLT) elements.

[0133] In step 1245, the cross-laminated timber elements of the module are processed with a fire prevention fluid.

[0134] In step 1250, a moisture insulation layer is added to a wet area of the compartment.

[0135] In step 1255, pre-defined electricity and ventilation connections are arranged to the module.

[0136] In step 1260, interior equipment and surface layers are arranged to the compartment to provide the off-site manufactured construction module.

[0137] The method ends in step 1265.

[0138] Figs. 13a-b show schematic pictures of an insulated module 1300 according to an example embodiment of the invention.

[0139] In an embodiment, the off-site manufactured construction module is coated externally with an insulation layer 1310.

[0140] In an embodiment, the insulation layer 1310 may have different thicknesses on different parts of the insulated module 1300.

[0141] In an embodiment, the insulation layer 1310 comprises thermal insulation material has thickness of 200-300mm, and the planar cross-laminated timber (CLT) element 1320 has thickness of 60-125mm.

[0142] Sidewall layer 1312 and bottom layer 1313 of the insulation layer 1310 may have thickness of 200mm whereas the top layer 1311 of the insulation layer 1310 may have thickness of 300mm, for example. Top, sidewall and bottom layers 1321-1323 of the planar cross-laminated timber (CLT) element 1320 have thickness of 100mm, for example. Furthermore a planar cross-laminated timber (CLT) element 1330 configured to provide basement may have thickness of 100mm, for example.

[0143] On top of the module 1300, a roof truss (not shown) may be arranged, and external to the insulation layer 1310 (e.g. left side in Fig. 13a) a facade may be arranged, for example.

[0144] In an embodiment, the insulation layer 1310 covers seamlessly whole external surface of the insulated off-site manufactured construction module 1300. The insulation layer 1310 contacts directly with the whole external surface of the off-site manufactured construction module. The insulation layer 1310 may be assembled on-site or off-site as indicated by the arrow in Fig. 13b.

[0145] Fig. 14 shows a schematic above view of a building system 1400 comprising an apartment house utilizing an off-site manufactured construction module according to an example embodiment of the invention.

[0146] A view of a single floor with four apartments 1401-1404 is shown. Each apartment 1401-1404 comprises an off-site manufactured construction module as explained by embodiments of the invention. The building system 1400 may further comprise a lobby 1410, a technical room space 1420-1421, an elevator E and stairs S, for example. Ventilation/exhaust pipes 1431, apartment water/sewer pipes 1434, inter-floor water/sewer pipes 1433, apartment electricity equipment 1432, and air conditioning equipment 1430 are installed within the technical room space 1420, 1421 or within the apartment modules 1401-1404. Only necessary equipment, such as air conditioning equipment 1430 is installed within the apartment module and other equipment are placed to the technical room space for easy service and maintenance, as well as to minimize risks caused by malfunctions, leaks and fire, for example. Pipes and connections from the technical room space 1420-1421 may be fed through the adjacent CLT wall element of the module 1401-1404 or externally outside the module to a position (e.g. exhaust ventilation for a room) of the module and fed through e.g. a CLT roof element of that module position. Water pipes and sewer pipes may be fed external and beneath the module to appropriate location before extending through a CLT floor element, for example.

[0147] Fig. 15 shows a schematic side view of a building system 1500 comprising an apartment house utilizing an off-site manufactured construction module according to an example embodiment of the invention.

[0148] First, a foundation 1510 is generated. The foundation 1510 may comprise concrete and steel with strengthened apertures for pillar bases 1511. Above the foundation 1510 a 2K water resistant compound layer is arranged. Next a CLT element bed 1512 is arranged over the 2K water resistant compound layer. The CLT element bed 1512 may be machined or notched and connected/insulated with adjacent elements using adhesive mass, for example.

[0149] Next, the pillar bases 1511 are added and anchored to the foundation 1510. Vertical pillars 1520 (framework) are then assembled and anchored to the pillar bases 1511. Pillar bases and frontend bases may also be assembled for all floors and external surfaces of the system 1500.

[0150] Next, horizontal pillars 1521 (framework) are assembled and anchored to the respective floor pillar bases. The pillars 1520-1521 may be of glued laminated timber, for example. Furthermore, insulation layer (e.g. Expanded polystyrene insulation EPS) above the CLT element bed 1512 is installed, and connection frame 1530 and façade CLT elements 1531 may be installed

and anchored. The connection frame element 1530 may comprise, for example, a metal reinforced two-compound mold element.

[0151] Then, a first floor module 1501 arranged on top of transport frame(s) 1540 (see also transport frame 1020 in Fig. 10) is assembled on the horizontal pillars 1521 and anchored there. An elastic assembly bed 1541 may be arranged between the module 1501 and the transport frame 1540 or between the transport frame 1540 and the horizontal pillar 1521. The elastic assembly bed 1541 enables elasticity of the system 1500 in view of earthquakes or foundation movements, for example. Furthermore, noise cancellation of the system 1500 is improved.

[0152] Next, first floor's technical room space and lobby 1550 floor elements 1551, wall elements 1552 and ceiling elements 1553 are installed and anchored. The elements 1551-1553 may be CLT elements.

[0153] Next, further insulation layer 1560 (e.g. Expanded polystyrene insulation EPS), vertical pillars, horizontal pillars, pillar bases etc. are installed to assemble the building system 1500 with a plurality of floors.

[0154] In an embodiment, insulator layers 1560 are seamless throughout the floor of the system 1500.

[0155] Eventually, an elevator and elevator equipment are installed, CLT roof base elements are installed and anchored, rainwater systems, windows, balconies and doors as well, if not assembled already during module manufacturing process. The elevator engine room may be arranged above the CLT roof base element.

[0156] Next, insulation layer (e.g. Expanded polystyrene insulation EPS) for the façade and the CLT roof base elements may be installed and the CLT façade layer 1531 may be arranged. Finally external water resistant cover layer (e.g. two component resistive compound) is installed over the CLT roof base elements.

[0157] Then, for each module 1501, a water/sewer lead through element may be installed underneath the module 1501. The lead through element comprises overflow protection.

[0158] Next, for each module 1501, a water/sewer lead through element may be installed external to the module 1501 on the floor element of the technical room space, The lead through element comprises overflow protection.

[0159] Furthermore, air ventilation (in/out) main pipes are installed and all modules 1501 are connected to the main ventilation system. Each apartment may comprise dedicated filter systems.

[0160] A sprinkler system may be installed to all modules 1501 and inner spaces, such as lobbies and technical room spaces.

[0161] Furthermore, sewer main pipes are installed and all modules 1501 are connected to the main sewer pipes system.

[0162] Furthermore, cold and warm water pipes are installed and all modules 1501 are connected to the main water pipe system.

[0163] Furthermore, a circular air heating system is installed to heat the air within the building system 1500 external to the modules 1501.

[0164] Eventually remaining equipment, such as electricity and surface elements are installed.

[0165] Fig. 16 shows a schematic side view of a building system 1600 comprising a detached house, a row house, a sauna or such utilizing an off-site manufactured construction module according to an example embodiment of the invention.

[0166] First, a foundation 1610 is generated. The foundation 1610 may comprise a pillar ingot or bar, concrete base, steel pipe base or a screw pillar, for example. On top of the foundation 1610 absorbing elements are installed. The absorbing elements may comprise elastic material, for example. Among or below the foundation a technical room space may be arranged to comprise sewer pipes, water pipes, electricity equipment, data communication equipment and such. On top of the absorbing elements a CLT bed 1621 (framework) may be installed. Between the CLT bed 1621 and the floor element of the off-site manufactured CLT construction module 1601 an insulation layer 1620 (e.g. Expanded polystyrene insulation EPS) is installed.

[0167] Next, above the module 1601, intermediate room space 1602 is arranged and supported by horizontal 1630 and vertical 1631 bars (framework) made of CLT.

[0168] Above the intermediate room space 1602, roof structure elements 1640 are installed and finally a waterproof layer 1641 is installed.

[0169] Within the intermediate room space 1602, technical room space may be installed, such as electricity equipment, ventilation equipment, sprinkler equipment and such. Further insulation layer (e.g. EPS) may be installed between the module 1601 roof and the intermediate space 1602 and/or between the intermediate space 1602 and the roof structure elements 1640.

[0170] Eventually remaining equipment, such as electricity and surface elements are installed.

[0171] Fig. 17 shows a schematic side view of a building system 1700 comprising a detached house, a row house, a sauna or such utilizing an off-site manufactured construction module according to an example embodiment of the invention.

[0172] First, a foundation 1610 is generated. The foundation 1610 may comprise a pillar ingot or bar, concrete base, steel pipe base or a screw pillar, for example. The pillars may extend over the ground level as shown. On top of the foundation 1610 absorbing elements are installed. The absorbing elements may comprise elastic material, for example. A technical room space 1701 may be arranged below the module(s) 1601 even partially within ground level 1750 to comprise sewer and water pipes 1730, electricity equipment and electricity lines 1740, data communication equipment and such. On top of the absorbing elements a CLT bed 1621 may be installed. Between the CLT bed 1621 and the floor element of the off-site manufactured CLT construction module 1601 an insulation layer 1620 (e.g. Expanded polystyrene insulation EPS) is installed.

[0173] In an embodiment, space under the CLT bed 1621 may be ventilated.

[0174] Next, above the module 1610, intermediate room space 1602 is arranged and supported by horizontal 1630 and vertical 1631 bars made of CLT.

[0175] Above the intermediate room space 1602, roof structure elements (not shown) are installed and finally a waterproof layer (not shown) is installed.

[0176] A water/sewer lead through element 1720 may be installed to the module 1601. The water/sewer lead through element 1720 may be arranged within a manger 1710 that is waterproof and is overflow protected, that is that even if there is any leaks the manger 1710 and the overflow protective system makes sure the leaking fluid is controllable handled.

[0177] Eventually remaining equipment, such as electricity and surface elements are installed.

[0178] Fig. 18 shows another schematic picture of an on-site building system 1800 configured to utilize the module 810 according to an example embodiment of the invention. Arrangement illustrated in Fig. 18 may be applied to renovating buildings or constructing new buildings.

[0179] In an embodiment, a concrete foundation may be provided (see e.g. figures 11 or 15-17). On top of the concrete foundation there may be a CLT-layer and through the CLT-layer there are vertical CLT-frame elements 1820 of the fixed framework fastened. The vertical CLT-frame elements 1810 are anchored to the concrete foundation.

[0180] Furthermore, horizontal CLT-frame elements 1820 of the fixed framework are fastened to the vertical CLT-frame elements 1810. For clarity reasons the foundation and CLT bed over the foundation are not shown.

[0181] Between each module 810 and corresponding horizontal and vertical CLT-frame elements 1810,1820 there are air cavities 1830 arranged. The air cavities 1830 are arranged so that the airflow 1835 may flow and circulate around the modules 810. The airflow 1835 may be heated by a heating system (not shown).

[0182] Each module 810 is lifted to its desired position within the system 1800.

[0183] The pre-defined technical connections of each module 810 are arranged disconnectable on an external surface of the module 810. The module 810 further comprises engaging means on an external surface of the module 810 configured to exchangably engage the module 810 to a fixed framework 1810-1820 of the building system 1800.

[0184] The building system 1800 further comprises fixed technical connections arranged to the fixed framework and configured to be disconnectably connected to the pre-defined technical connections of at least one module 810. The building system further comprises at least one duct configured to accommodate the fixed technical connections.

[0185] In an embodiment, the fixed technical connections of the building system 1800 comprise at least one of the following: electricity; audio/video (AV); data; ventilation; water supply; water sewage; water based heating; vertical interconnections, horizontal interconnections, a cooling system; and a sprinkler system.

[0186] As an example, in Fig. 18, fixed technical connections illustrate exhaust air ventilation 1840, fresh air ventilation 1845 (may comprise air conditioning as well), water supply and sewage interconnection 1850 and pipeline 1855. The vertical interconnection 1850 may comprise a manger (e.g. steel manger coated with two-compound water-resistant mass) to provide overflow protection. Horizontal interconnection 1860 is configured to provide, for example, a duct from the apartment of the module 810 to a lobby of the building system 1800. A CLT façade plate 1870 and a CLT roof plate 1880 are also illustrated.

[0187] As shown, the building system 1800 is arranged so that when the modules 810 are engaged to the fixed framework 1810-1820, free service and air space 1830,1831 is arranged on at least one vertical and at least one horizontal external surface of the module 810. All technical connections are arranged within the free service space 1830,1831. This enables easy service of the connections, exchange of the connections and related equipment and exchangeability of the whole module 810. The humidity and temperature of the airflow 1835 of the free service space 1830 may be kept in desired level automatically by technical equipment controlled by a computer device, for example.

[0188] The building system 1800 may further comprise an external vertical surface wall panel (façade) 1870, such as CLT panel, external to the vertical frame element 1810 and a waterproof roof panel 1880 to cover the modules 810 and the fixed framework 1810-1820. The roof panel 1880 may also comprise solar panels for producing electricity for the building and/or the grid.

[0189] In an embodiment, the building system 1800 may comprise fixed framework but elements, such as modules 810, facade element 1870, roof panel 1880 and even foundation may be dynamically selected by the customer or builder when installing the building system 1800. Renovating and exchanging the dynamic elements is also possible after the installation.

[0190] In an embodiment, a free space 1831 air between the façade element 1870 and the module 810 is heated, dampness is removed and an ultraviolet (UV) light system may be installed within the free space 1831. The UV light kills viruses and bacteria to improve the building system 1800 healthiness. The UV light system may be part of the technical connections and may be switched off when service personnel are working within the space 1830, 1831

[0191] In an embodiment, any CLT element may comprise thickness of 60 mm - 180 mm, width of 1000 mm - 3200 mm and length of 1500 mm up to 18 000 mm and layered in 3 - 5 layers, for example. Instead of CLT, ecologic element plates may also be used.

[0192] In an embodiment, instead of CLT element, any

organic material element is used.

[0193] In an embodiment, materials used for the off-site manufactured construction module have similar characteristics.

[0194] Without in any way limiting the scope, interpretation, or application of the claims appearing below, a technical effect of one or more of the example embodiments disclosed herein is an improved solution for providing a modular assembly of a building system. Further technical effect is the time of the building process is reduced. Another technical effect is that environmentally problematic material usage is reduced. Another technical effect is that off-site amount of construction work is increased.

[0195] Although various aspects of the invention are set out in the independent claims, other aspects of the invention comprise other combinations of features from the described embodiments and/or the dependent claims with the features of the independent claims, and not solely the combinations explicitly set out in the claims.

[0196] It is also noted herein that while the foregoing describes example embodiments of the invention, these descriptions should not be viewed in a limiting sense. Rather, there are several variations and modifications, which may be made without departing from the scope of the present invention as defined in the appended claims.

[0197] The invention has been explained above with reference to the aforementioned embodiments, and several advantages of the invention have been demonstrated. It is clear that the invention is not only restricted to these embodiments, but comprises all possible embodiments within the spirit and scope of the inventive thought and the following patent claims.

Claims

1. An off-site manufactured construction module, comprising
a floor element,
a roof element, and
a plurality of wall elements,
wherein the elements are made of planar cross-laminated timber (CLT) elements configured to form a compartment for a building, and the elements are connected to each other using wooden fastening elements;
the cross-laminated timber elements of the construction module are processed with a fire prevention fluid;
a wet area of the compartment is arranged by adding a moisture insulation layer to the wet area;
pre-defined technical connections are arranged to extend through at least one planar cross-laminated timber element of the module; and
interior equipment and surface layers are arranged to the compartment.

2. The module of claim 1, further comprising interior walls forming at least two compartments within the module.

3. The module of claim 1 or 2, further comprising at least one duct configured to accommodate the pre-defined technical connections, the pre-defined technical connections are arranged disconnectable on an external surface of the module and comprise at least one of the following:

electricity;
audio/video (AV);
telecommunication;
surveillance system;
sensor data;
external data network data;
ventilation;
water supply;
water sewage;
water based heating;
a cooling system; and
a sprinkler system.

4. The module of any of claims 1 to 3, further comprising engaging means on an external surface of the module configured to exchangably engage the module to a fixed framework of a building system.

5. The module of any of claims 1 to 4, wherein the wooden fastening elements comprises at least one the following: wooden pegs and wooden lamello fasteners.

6. The module of any of claims 1 to 5, wherein at least one of the floor element, the roof element, and the wall element comprises an opening.

7. The module of any of claims 1 to 6, wherein the off-site manufactured construction module is coated externally with an insulation layer.

8. The module of claim 7, wherein the insulation layer covers seamlessly external surface of the off-site manufactured construction module and comprises thermal insulation material having of thickness 200-300mm, and the planar cross-laminated timber (CLT) element having thickness of 60-125mm.

9. A method for off-site manufacturing a construction module, the method comprising:

arranging, by a crane device, a first planar wall element on a first longitudinal assembly line and a second planar wall element on a second longitudinal assembly line respectively, the first and the second longitudinal assembly line arranged in parallel and movable in direction perpendic-

ular to the longitudinal parallel axis of the assembly lines, wherein the first and the second planar wall element are placed an end side wall against an upper surface of the respective longitudinal assembly line;
turning the first and the second planar wall element, by the corresponding longitudinal assembly line, so that the first and the second planar wall element are placed a side wall against the upper surface of the respective longitudinal assembly line;
assembling wooden fastening elements to at least of the end side walls of the first and the second planar wall element;
arranging, by the crane device, floor and roof elements on the first and the second longitudinal assembly line on opposite sides of the respective wall elements, wherein the floor and the roof elements are placed an end side wall against an upper surface of the respective longitudinal assembly line;
moving the roof and the floor elements towards each other, using at least one shifting assembly line between the first and the second longitudinal assembly line so that the wooden fastening elements of the respective planar wall element located on the respective longitudinal assembly line interlock with apertures arranged to the respective floor and the roof element to generate an U-shaped intermediate element on each respective first and second longitudinal assembly lines;
turning, by at least one of the corresponding longitudinal assembly line and the crane device, the U-shaped intermediate elements on the respective first and the second longitudinal assembly line so that the open end of each U-shaped intermediate element face each other;
moving the U-shaped intermediate elements towards each other, using at least one of the assembly lines so that a batten element arranged to an end wall of a first U-shaped intermediate element and a groove element arranged to an end wall of a second U-shaped intermediate element interlock with each other to generate an intermediate compartment element;
arranging, by the crane device, a second planar wall element, to each end of the intermediate compartment element so that a mechanized element arranged to an end wall of each open end of the intermediate compartment element interlocks with correspondingly mechanized respective second planar wall element to generate a compartment, wherein the elements are made of planar cross-laminated timber (CLT) elements;
processing the cross-laminated timber elements of the module with a fire prevention fluid;
adding a moisture insulation layer to a wet area of the compartment;
arranging pre-defined electricity and ventilation connections to the module; and
arranging interior equipment and surface layers to the compartment.

10. A building system comprising:

a fixed framework comprising means for exchangably engaging an off-site manufactured construction module of any of claims 1 to 8.

11. The building system of claim 10, wherein the fixed framework comprises a plurality of vertical pillars and a plurality of horizontal pillars, the plurality of horizontal pillars are connected to the plurality of vertical pillars, and the off-site manufactured construction module received on top of a transport frame is arranged on at least two horizontal pillars and anchored thereon, the building system further comprising:

an elastic assembly bed arranged between the module and the transport frame or between the transport frame and the horizontal pillars; and
a seamless insulation layer arranged horizontally below and above the module.

12. The building system of claim 10 or 11, further comprising:

fixed technical connections arranged to the fixed framework and configured to be disconnectably connected to the pre-defined technical connections of at least one module.

13. The building system of any of claims 10 to 12, wherein when the modules are engaged to the fixed framework, free service space is arranged on at least one vertical and at least one horizontal external surface of the module.

14. The building system of any of claims 10 to 13, further comprising a moisture insulation layer arranged within the framework as a horizontal plane between an upper and a lower module.

15. The building system of any of claims 10 to 14, further comprising an external surface panel and a roof panel to cover the modules and the fixed framework.

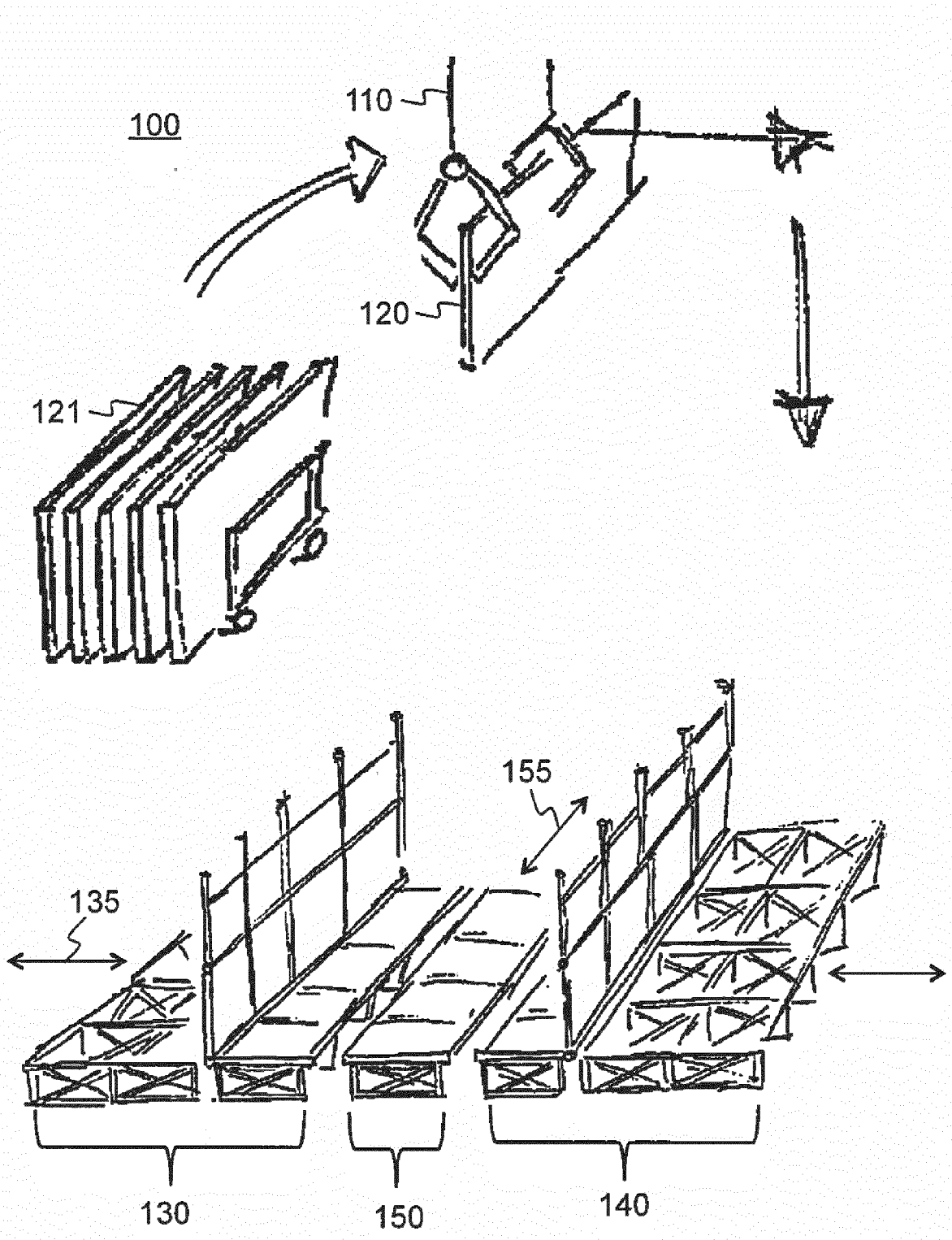

Fig. 1

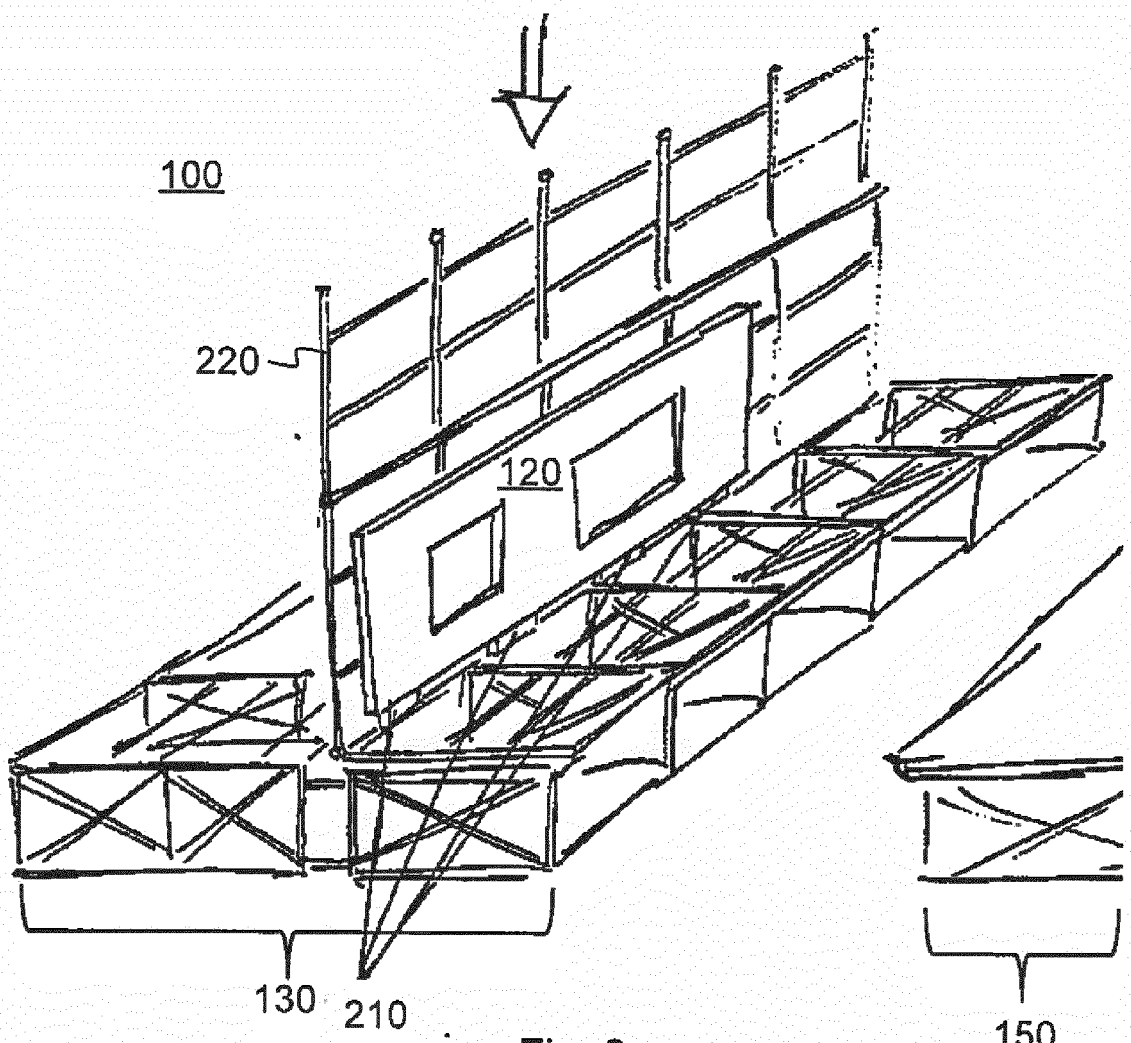

Fig. 2

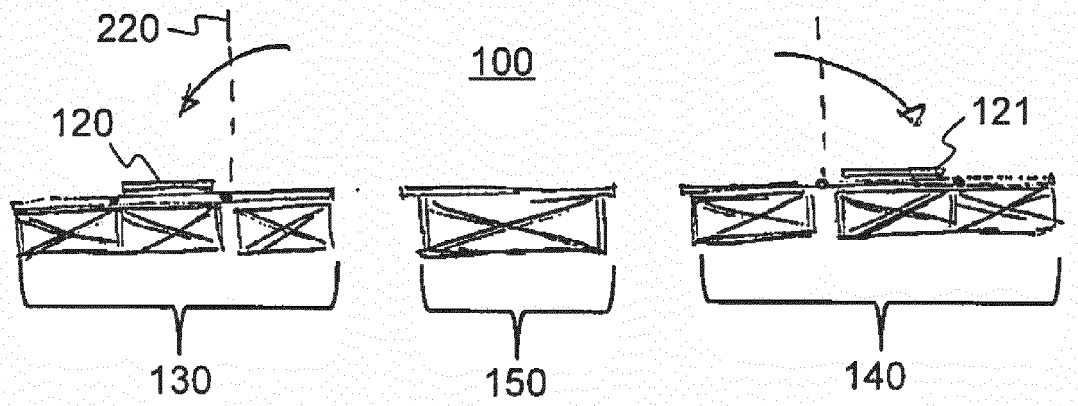

Fig. 3

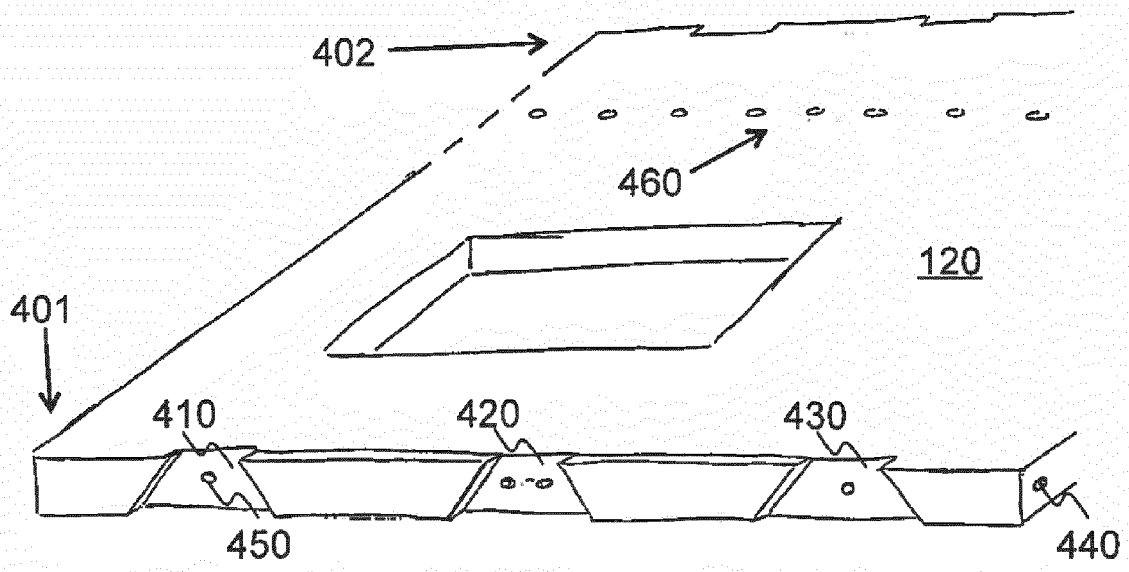
402
460
120
401
410
420
430
450
440

Fig. 4a

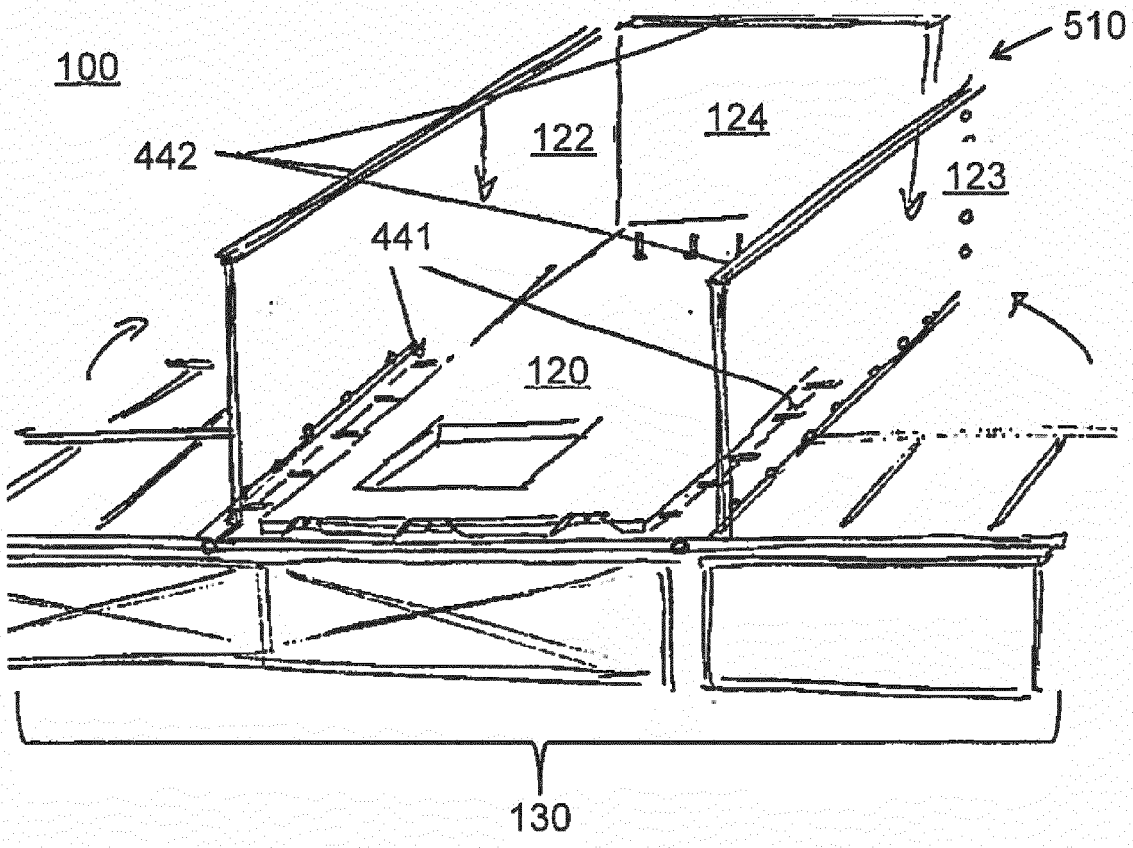
100
510
442
122
124
123
441
120
130

Fig. 4b

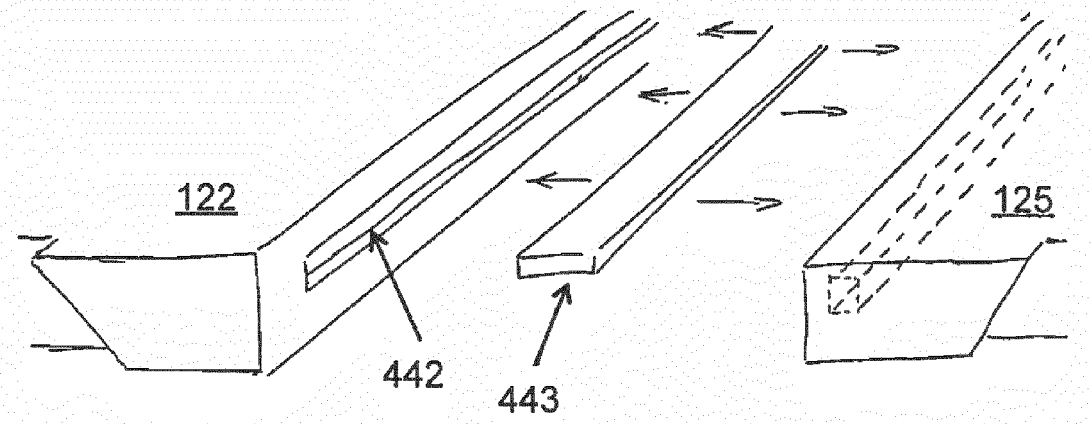

Fig. 4c

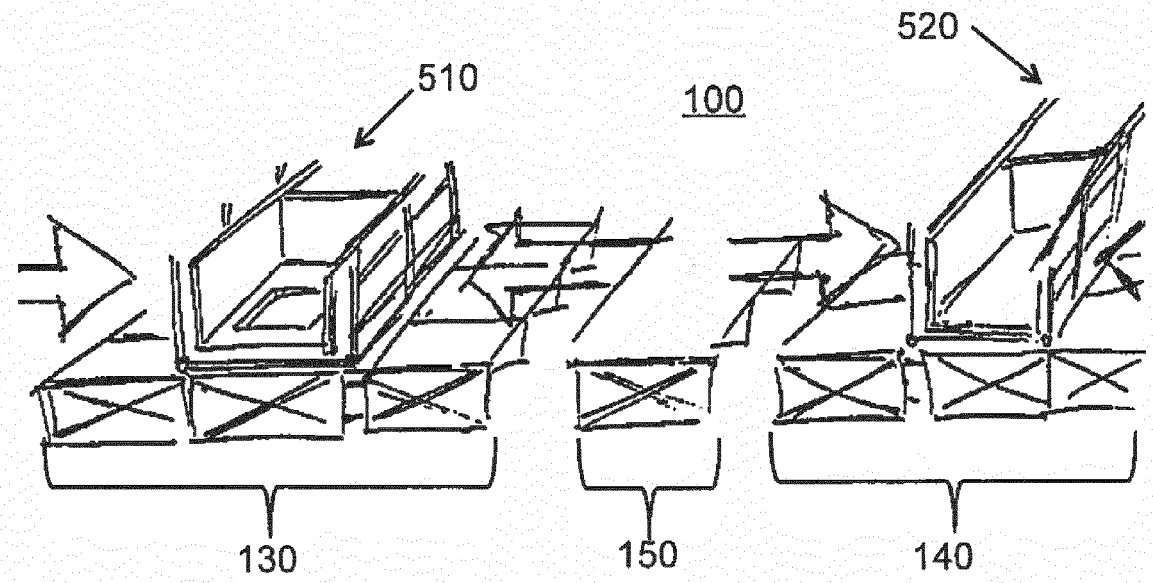

Fig. 5

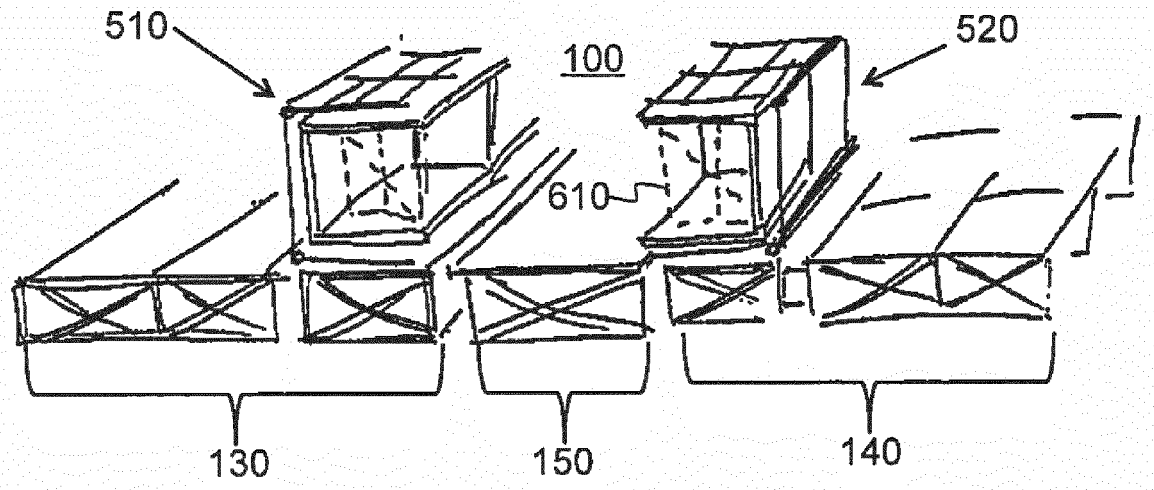

Fig. 6

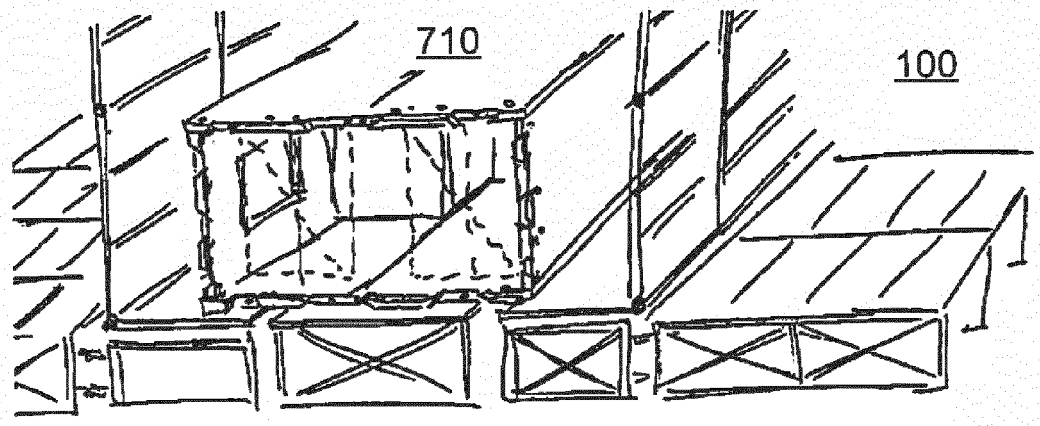

Fig. 7

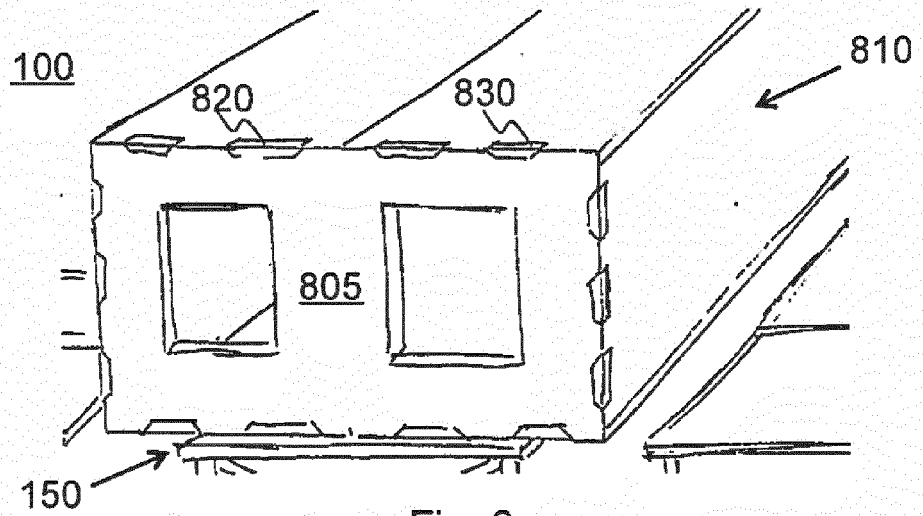

Fig. 8

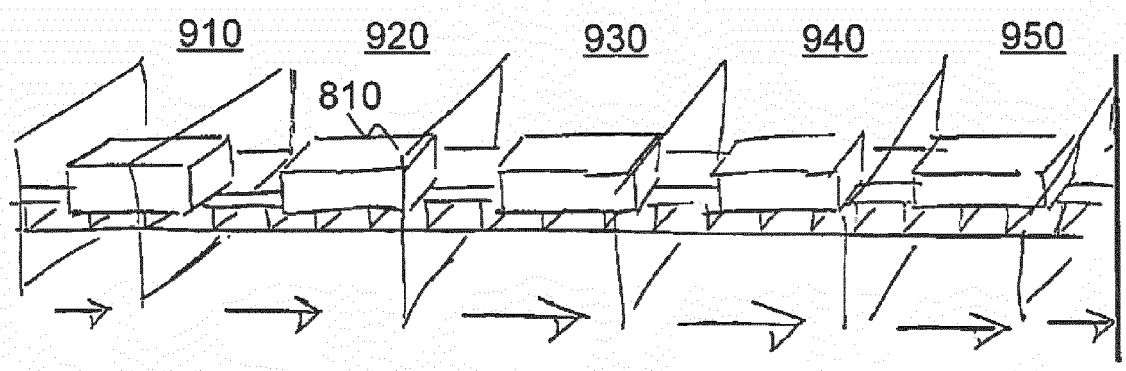

Fig. 9

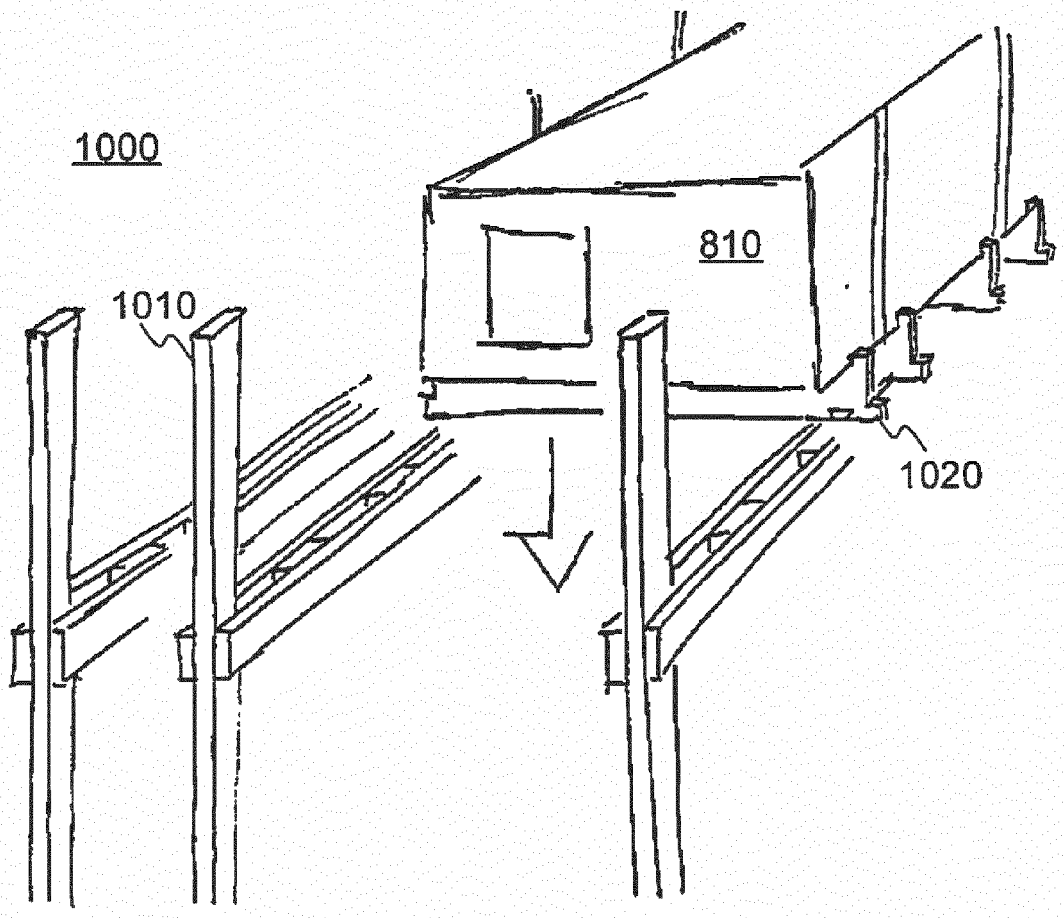

Fig. 10

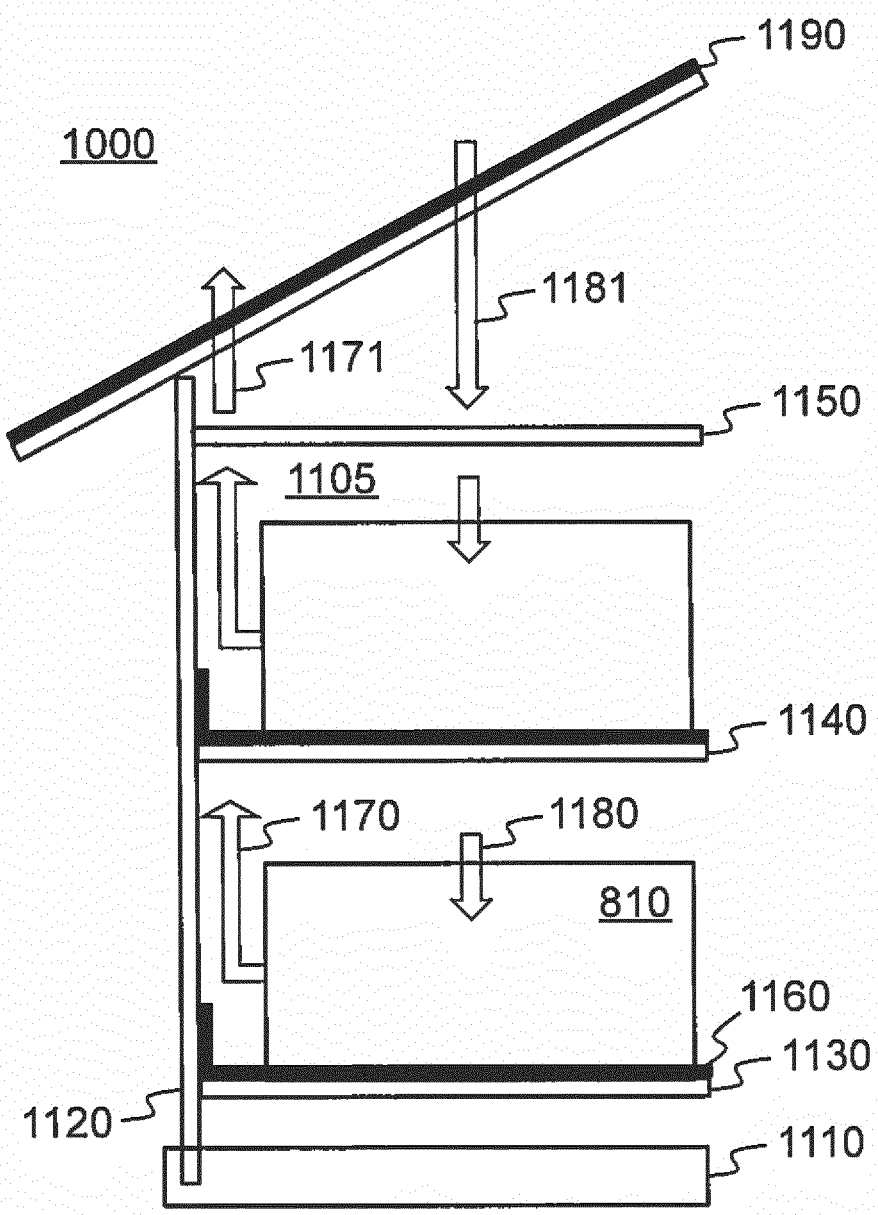
1190
1000
1181
1171
1150
1105
1140
1170
1180
810
1160
1130
1120
1110

Fig. 11

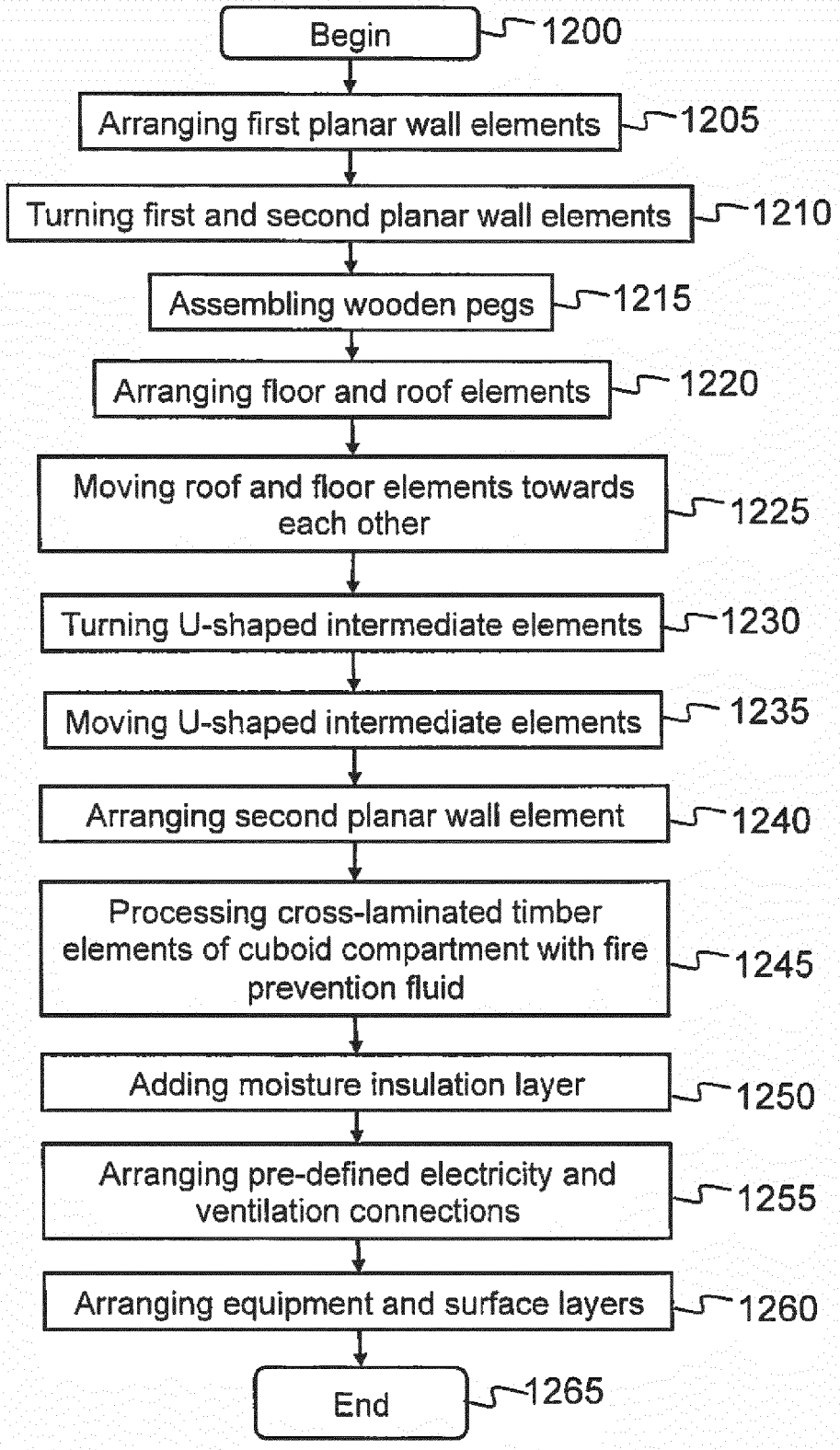
Begin
1200
Arranging first planar wall elements
1205
Turning first and second planar wall elements
1210
Assembling wooden pegs
1215
Arranging floor and roof elements
1220
Moving roof and floor elements towards each other
1225
Turning U-shaped intermediate elements
1230
Moving U-shaped intermediate elements
1235
Arranging second planar wall element
1240
Processing cross-laminated timber elements of cuboid compartment with fire prevention fluid
1245
Adding moisture insulation layer
1250
Arranging pre-defined electricity and ventilation connections
1255
Arranging equipment and surface layers
1260
End
1265

Fig. 12

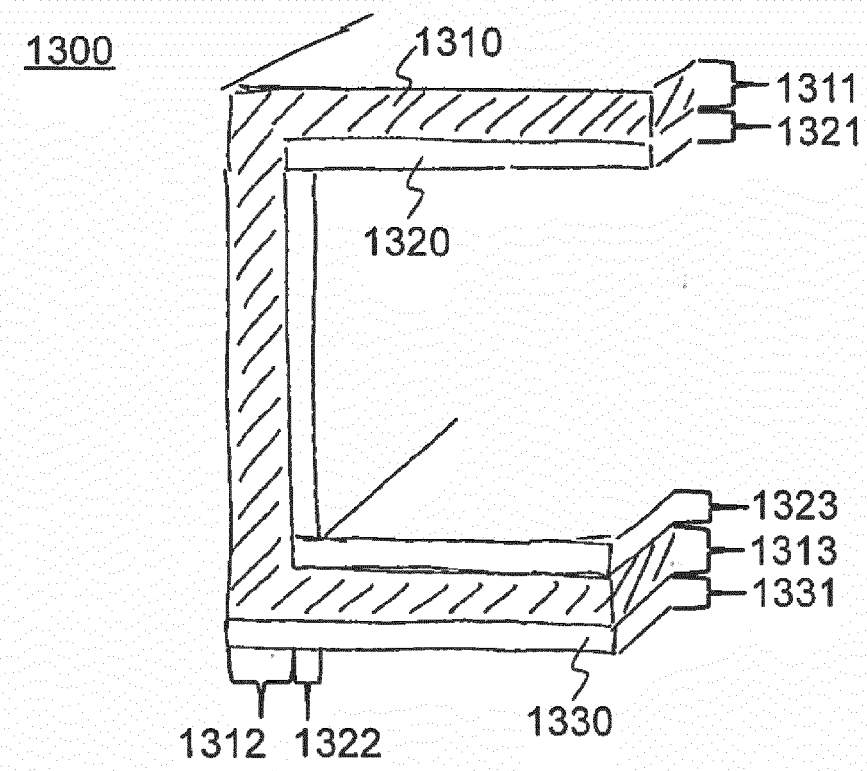

Fig. 13a

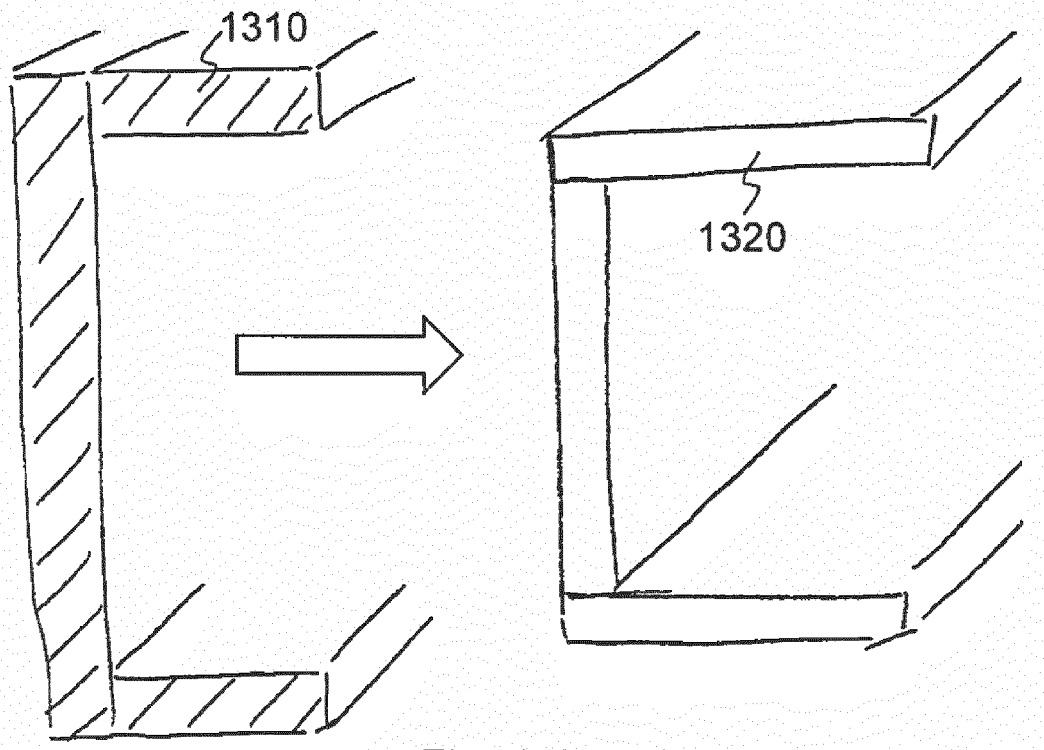

Fig. 13b

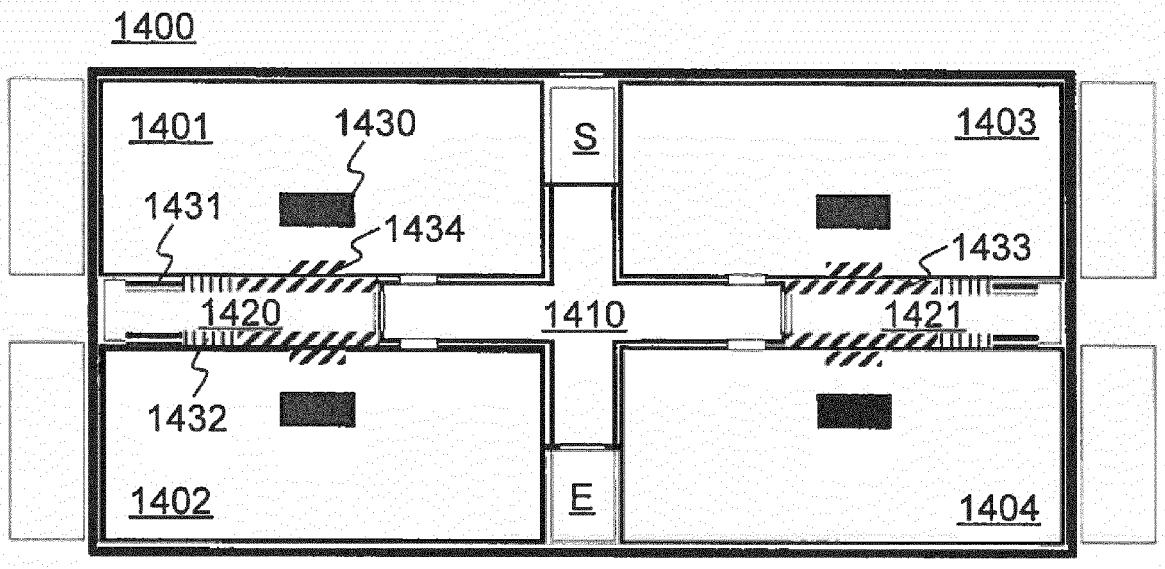
1400
1401
1430
S
1403
1431
1434
1433
1420
1410
1421
1432
1402
E
1404

Fig. 14

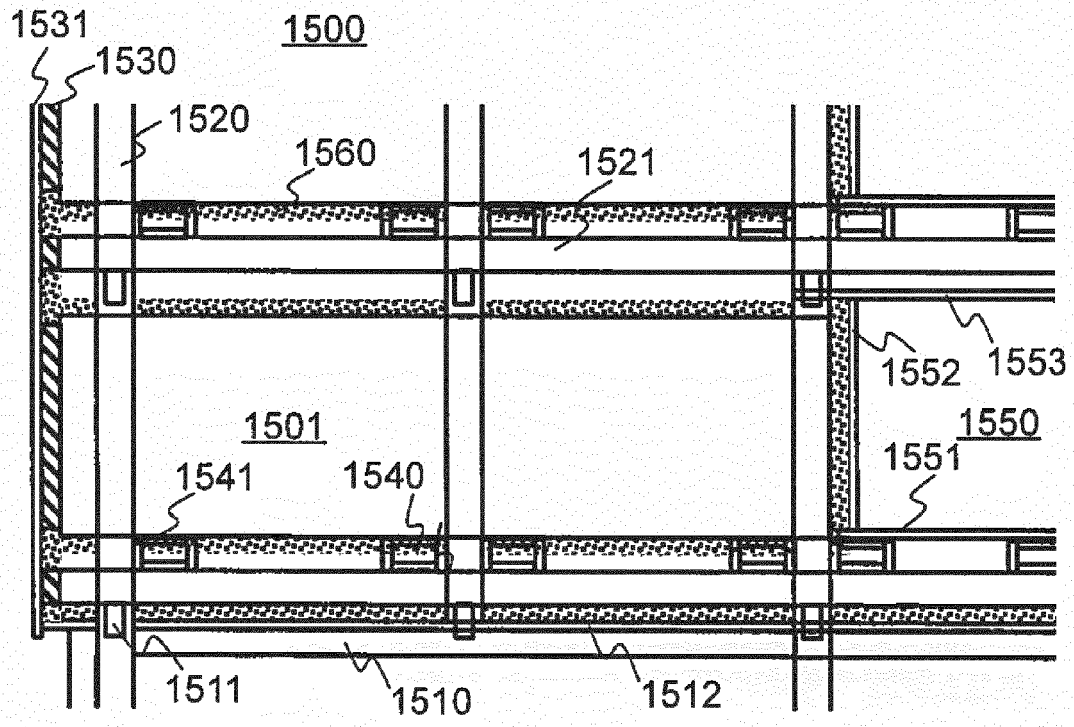
1531
1500
1530
1520
1560
1521
1552
1553
1501
1550
1541
1540
1551
1511
1510
1512

Fig. 15

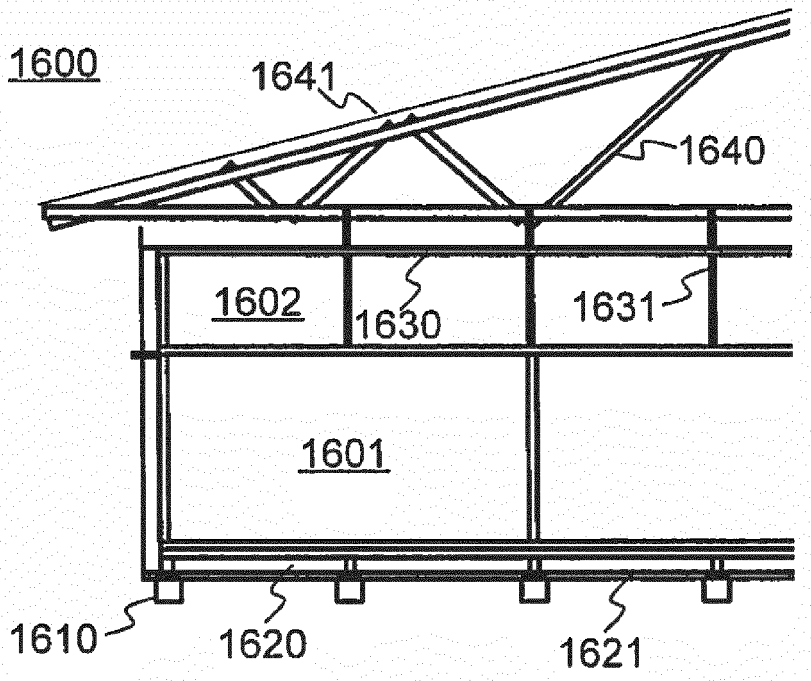
1600
1641
1640
1602
1630
1631
1601
1610
1620
1621

Fig. 16

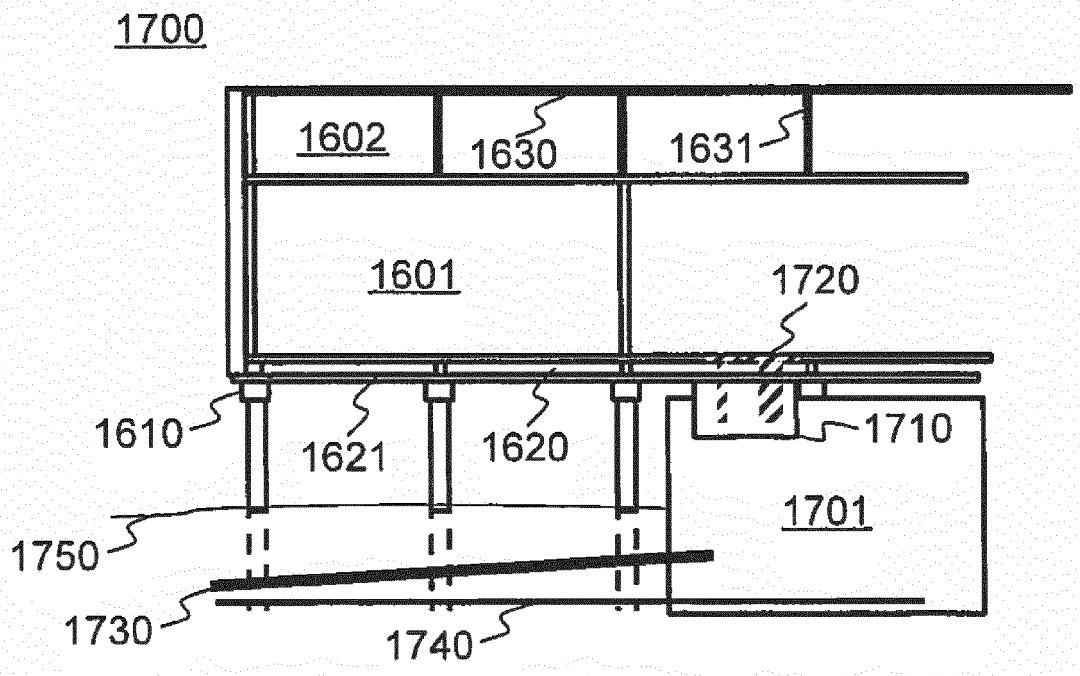
1700
1602
1630
1631
1601
1720
1610
1621
1620
1710
1701
1750
1730
1740

Fig. 17

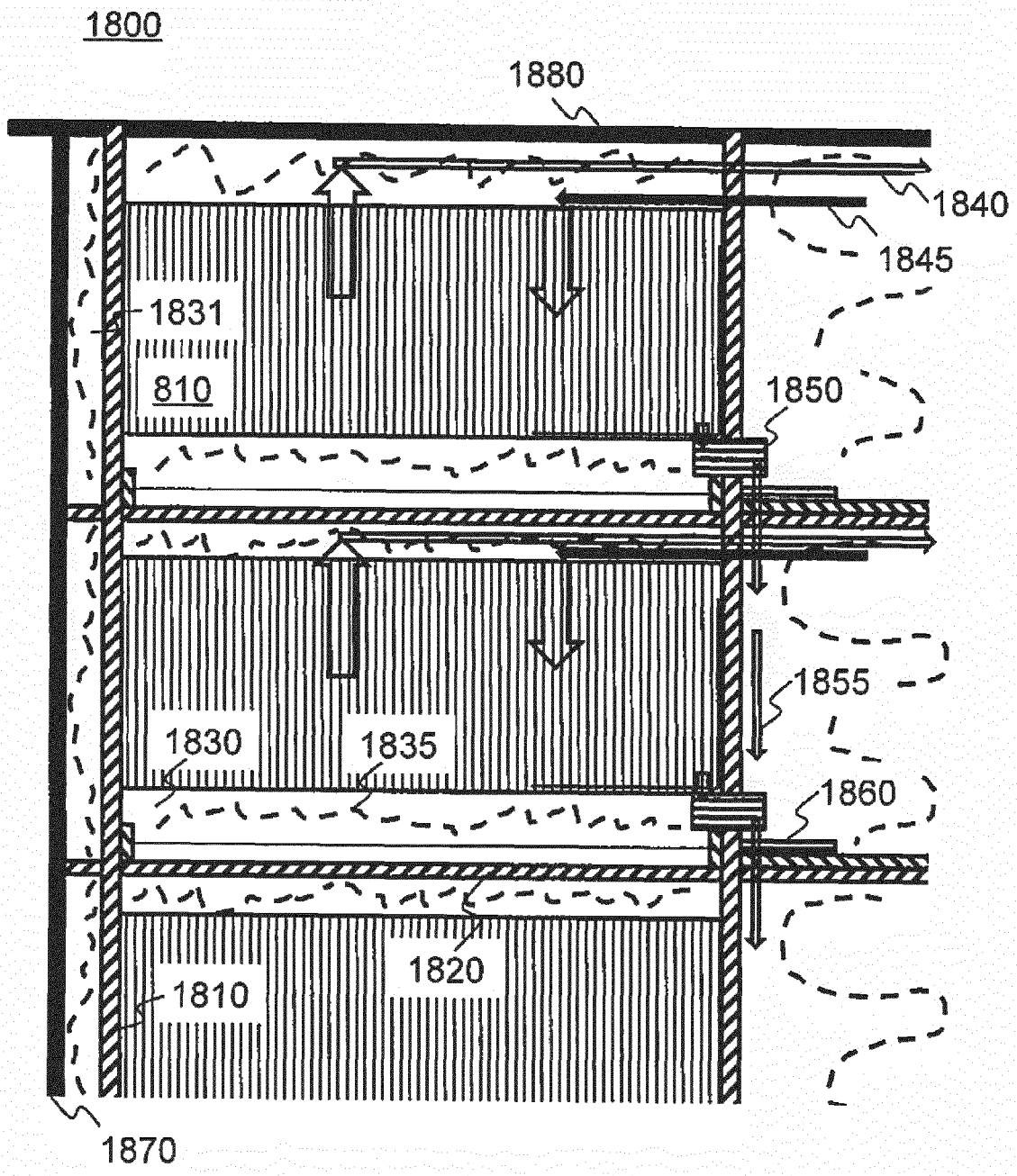
1800
1880
1840
1845
1831
810
1850
1855
1830
1835
1860
1820
1810
1870

Fig. 18

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 18 16 5445

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 617 912 A1 (INTER HOSPITALITY HOLDING B V [NL]) 24 July 2013 (2013-07-24) * abstract * * paragraph [0033] - paragraph [0061]; claims 1-10; figures 16-26 * -----	1-15	INV. E04B1/348 E04B1/94
A	DE 22 04 731 A1 (FURRER JOSEF) 17 August 1972 (1972-08-17) * the whole document * -----	1,5,9	

TECHNICAL FIELDS SEARCHED (IPC)

E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 August 2018	Galanti, Flavio

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 18 16 5445

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-08-2018

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2617912 A1	24-07-2013	CA 2862083 A1	01-08-2013
		CN 104204373 A	10-12-2014
		CY 1117658 T1	17-05-2017
		DK 2617912 T3	01-08-2016
		EP 2617912 A1	24-07-2013
		EP 3098359 A1	30-11-2016
		ES 2578786 T3	01-08-2016
		HR P20160611 T1	26-08-2016
		HU E029156 T2	28-02-2017
		PL 2617912 T3	30-11-2016
		PT 2617912 T	08-07-2016
		RU 2014134179 A	20-03-2016
		UA 115775 C2	26-12-2017
		US 2015240475 A1	27-08-2015
		WO 2013110617 A1	01-08-2013
DE 2204731 A1	17-08-1972	AT 320236 B	27-01-1975
		CA 979618 A	16-12-1975
		CH 538027 A	15-06-1973
		DE 2204731 A1	17-08-1972
		FI 51629 B	01-11-1976
		NO 131765 B	14-04-1975
		SE 392311 B	21-03-1977
		YU 26572 A	31-10-1978

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82