

Description

[0001] The present application relates to a multi-floor building section and a multi-floor building.

[0002] Typically, a building comprises at least one floor, several walls and a roof for providing living space or working space. Such buildings have to resist external forces, for example caused by wind load. Additionally, they also have to bear their own weight and the weight of persons and/or objects inside the building. Hence, considering said boundaries, two major concepts are used for the construction of buildings.

[0003] In one of said concepts the building loads of the building are transmitted via load-bearing walls, which thus have a double function. One function is to provide a closure for the living or working space and the second function is to provide a structural element for transmitting the load of the building to the ground on which the building is erected on. Such walls cannot be removed without a replacement which takes over the loads. Furthermore, such kind of load-bearing walls are often heavy and bulky. Such walls were used to be made of stone or brick.

[0004] Modern technology, in particular the use of reinforced concrete, has made it possible to replace this concept by a second concept.

[0005] The second concept is an alternative concept which separates these two functions. The load of a building is transmitted through a framed structure comprising pillars and beams. In its simplest form a framed building comprises one floor, four pillars and a roof arranged on said four pillars. At this stage, the building is completely open and does not yet provide an at least partially closed living or working space. For a minimal stability of the building, the pillars have to be relatively large. To provide an at least partially closed living or working space, walls have to be arranged in the empty space between said pillars. These walls only have to bear their own load and do not add any load-transmitting component to the building. Such walls can be replaced or removed without having to consider any load bearing or transmitting function for other components.

[0006] The use of concrete reinforced by steel has certain drawbacks. Typically concrete takes care of the compression forces, while steel takes care of the tension forces needed to hold a building. In the construction process, the steel prescribed to resist the tension forces needed is previously formed in temporary configurations that later get engulfed or submerged in concrete that is carefully poured in, or pumped, in a more or less liquid state into a mould. After approximately a couple of weeks the cement loses humidity gaining in resistance and achieves its final shape and stability. It is at this moment when the moulds that made its shape can be taken away. Sometimes these moulds or "formwork" can be recycled but sometimes that is not the case. In this logic, making a building involves a triple construction: first the armature of the steel has to be put in place, then the mould for the concrete, and then the concrete itself.

[0007] Following this process, a concrete building is typically built by putting the necessary elements one after each other in a procedure where the supporting elements first have to "set" (or solidify) and their moulds taken away before the next elements can be built besides or on top of them depending of the configuration desired.

[0008] This technology has at least the following negative effects. The process of solidification or "setting" and supporting produces a linear dependent chain of events that increases the construction duration of a building and thus its cost. The need to build a mould for each construction element adds to the time a structure needs for its fabrication. Most of the work needs to be done by hand. The structure tends to be heavy. The transport of the weight of the cement and formwork needed is costly, time consuming, and ecologically impactful. Today's increasing need for the insulation of buildings is in contrast to the reduced volume the structure according to the second concept provides. Once the life-cycle of a building is completed, the disassembly of the structure is consuming in terms of time, energy and environmental consequences. A rather considerable investment is then necessary to separate the steel from the concrete to be able to recycle the materials properly.

[0009] Some attempts have been made to avoid some of the drawbacks of the prior art and to take advantage of both concepts. These attempts have resulted in a hybrid structure, in particular a framework having a cladding. However, such structures are bulky and inflexible and cannot be manufactured individually since cladding and framework have to be well-matched to each other.

[0010] It is therefore an object of the invention to avoid at least some of the drawbacks of the prior art and to provide a multi-floor building section which is lightweight, flexible and can be used for different shapes of a building.

[0011] This object is accomplished by a multi-floor building section and/or a multi-floor building according to the independent claims. Further advantageous embodiments are described in the dependent claims.

[0012] The essence of the invention lies in the following: A multi-floor building section according to the invention comprises at least two floors and one or more walls connecting said at least floors. Said one or more walls are load-bearing walls and comprise a multi-layer space frame structure. The multi-layer space frame structure is made of a plurality of nodes and a plurality of struts connecting the nodes. The whole load transmitted by said one or more walls is transmitted through said multi-layer space frame structure.

[0013] Such a configuration provides a structure which takes the full load of a building without the need of additional elements or parts. In other words, the multi-layer space frame structure is self-supporting. The bearing load of a building can be transmitted to the ground or a foundation without additional load-transmitting components on the respective walls and independent of the strength of a cladding which might be added or arranged on the walls, the bearing load of the building can be trans-

mitted. Hence, design and appearance of a building can be chosen independently and without any impact on the structural strength of the building.

[0014] Such a configuration enables to omit the use of concrete and to provide a reliable replacement which takes over respectively replaces the characteristics of the concrete in the reinforced structures. The multi-layer space frame structure replaces the resistance of the concrete since its shape can resist tension and compression without the need of associating itself with another material.

[0015] Furthermore, it enables to assemble flexible structures out of prefabricated pieces that acquire their final volume on the building site but are transported in a fraction of their final size.

[0016] Additional moulds or formwork is no longer needed.

[0017] A multi-floor-building section can be build in a fraction of the time compared to the prior art.

[0018] The resistance of the multi-floor building structure is received by the geometry of the frame structure and not by a solid volume. Therefore, the structural weight of a building may be reduced what subsequently results in a reduction of foundations and earthworks needed for it.

[0019] Additionally, recycling is facilitated.

[0020] Preferably, the struts are relatively short compared with the overall dimensions of the walls, for example between 5 cm and 100 cm, preferably between 10 cm and 50 cm, more preferably between 12 cm and 30 cm. Walls have typically a length and a height and a thickness. The thickness is typically in a range which corresponds to a fraction of the length or height of a respective wall. The dimensions of the nodes and struts are in a comparable scale to the thickness. Preferably, the length of the struts is smaller than the thickness of a wall built with said multi-layer space frame structure. Such a configuration enables to build multi-floor building sections without the need of heavy equipment and enables a high versatility in the shape of multi-floor building sections. The respective multi-floor-building section can be built either by hand or through automated mechanisms.

[0021] A structural concrete wall can today be as thin as 15 cm, whereas the walls of the multi-layer space frame structure may be in the range of around 60 cm. Yet, since this multi-layer space frame structure has space in between its elements, installations and insulation materials can be easily housed within the structural elements, i.e. between the respective nodes and struts.

[0022] Advantageously, the multi-layer space frame structure extends substantially over a full extent of at least one of said one or more walls. "Substantially" as used herein does not exclude exactly. In the present case, "substantially over a full extent" encompasses in particular 90% - 100% of the full extent, including exactly 100%. Preferably, the multi-layer space frame structure extends over a full extent of each of said at least one or more walls.

[0023] In this way, a complete wall or even all walls

can be built of a multi-layer space frame structure. Additional elements such as a cladding can be arranged on the respective walls over a full extent of said walls.

[0024] At least one floor of said at least two floors may comprise a multi-layer space frame structure made of a plurality of nodes and a plurality of struts connecting the nodes, wherein the whole load transmitted by said at least one floor is transmitted through said multi-layer space frame structure. Advantageously, said multi-layer space frame structure extends through said at least one floor, preferably over a full extent of said at least one floor.

[0025] This enables to build floors and walls in a similar configuration and with the use of identical basic elements such as struts and nodes.

[0026] Advantageously, the multi-layer space frame structure of the walls and of the floors is similar or identical.

[0027] Preferably the multi-layer space frame structure has a first end layer and a second end layer.

[0028] In this way, two layers of a wall or floor are provided on which different elements can be attached.

[0029] Preferably, at least one of said floors and/or said one or more walls comprises a first face element attached to the first end layer and preferably a second face element attached to the second end layer.

[0030] This makes it possible to provide closed floors and/or walls, which may have a uniform thickness and a uniform design. Furthermore, it makes it possible to provide for example additional insulating elements between said first face element and said second face element and/or a piping for electrification of a building or for sanitary installation, which are finally hidden behind said first and second face elements.

[0031] Preferably, at least one of the first face element and the second face element comprises at least an insulation layer and a top layer.

[0032] Such a configuration enables, irrespective of the dimensions of the multi-layer space frame structure, to provide a desired configuration in relation to the insulation properties of the building.

[0033] As explained above, a multi-layer space frame structure comprises a plurality of nodes and a plurality of struts connecting the nodes. It is preferred that each strut of the multi-layer space frame structure connects two nodes of the plurality of nodes and has a longitudinal direction, two ends and a connector at each end. Advantageously, each node has a plurality of receivers for receiving connectors. Preferably, each receiver comprises a lateral insertion opening for inserting one of the connectors of one of the struts in an insertion direction substantially perpendicular to the longitudinal direction of the strut. In a preferred embodiment, a connector of a strut is connected to a receiver of a node by a snap-fit connection or by a friction connection.

[0034] Typically, a strut of a multi-layer space frame structure is of an elongate shape. The longitudinal direction is defined by an axis of the strut which extends through its ends, in particular by an axis which extends

through the connectors of the strut. The term "longitudinal direction" is not limited to one direction only, but has a bidirectional meaning.

[0035] It is self-evident that the longitudinal direction of a strut and the relation between this longitudinal direction and the insertion direction in a corresponding node are determined by the inserted state of the strut in the node.

[0036] "Substantially" as used herein does not exclude exactly. In the present case, "substantially perpendicular" encompasses all angles between 85° and 95°, including exactly 90°.

[0037] Snap-fit connections are connections which connect two parts after at least one part of the snap-fit connection has been temporarily deflected and brought into engagement with the other part or counterpart of the snap-fit connection. At least one part of the snap-fit connection thus provides a retention force which keeps the respective part of the snap-fit connection in engagement with its counterpart. After connecting of the two parts, the deflected portion can be completely unloaded or remain pretensioned. At least, a predetermined position of the deflected portion can be upheld.

[0038] Friction connections are connections which connect two parts and which are held together by friction between said two parts.

[0039] A snap-fit connection or a friction connection facilitates the connection of two parts, in particular facilitates the connection of a node and a strut in a space frame structure. Additional components for securing can be omitted and also tools for fastening or connecting said elements together, for example screwdrivers, wrenches or the like are not necessary. In other words, a tool-free installation is enabled.

[0040] Furthermore, for attaching a cladding to the multi-layer space frame structure struts which have only one connector can be used. Such struts can be attached to the nodes of the first end layer or the second end layer and can comprise additional elements for attaching a cladding to the struts, such as screw holes.

[0041] Preferably, the multi-layer space frame structure of the one or more walls and the multi-layer space frame structure of the at least one floor are connected to each other such as to build a continuous multi-layer space frame structure.

[0042] In this way, a uniformly built multi-layer space frame structure can be provided to which a cladding can be attached to provide a complete multi-floor building section having walls and floors, in particular closed walls and floors.

[0043] Another aspect of the invention relates to a multi-floor building comprising a multi-floor building section as herein described.

[0044] A complete building can be provided which has a structural strength determined by the multi-layer space frame structure without the need of additional load-transmitting or load-bearing elements on or in its walls and floors. The design and appearance can be chosen at a

later stage without an impact on the structural integrity or strength of the building.

[0045] In a preferred embodiment, the multi-floor building may comprise a multi-floor building section which comprises at least three floors vertically spaced apart and four walls connecting the four floors.

[0046] The construction system according to the invention makes it possible to provide a multi-floor building which is easily producible and which provides living room or working space for families and companies.

[0047] An exemplary embodiment of a multi-floor building according to the invention comprising a multi-layer space frame structure is explained with respect to the following figures in which:

Fig. 1 - shows perspective view of a multi-floor building;

Fig. 2 - shows a vertical section view of the building of Fig. 1;

Fig. 3 - shows a horizontal section view of the building of Fig. 1;

Fig. 4 - shows a partially cut perspective view of a part of the building of Fig. 1;

Fig. 5 - shows a cutout of a wall of the building of Fig. 1; and

Fig. 6 - shows two connections of struts to a node.

[0048] Fig. 1 shows a multi-floor building 100. The multi-floor building 100 is erected on a concrete foundation 102 which comprises a subterranean garage 103. The multi-floor building 100 comprises floors 110 and walls 120.

[0049] Fig. 2 shows a vertical section view of the multi-floor building 100 of Fig. 1. The section view is taken along a vertical plane through the multi-floor building 100. In this section view the foundation 102 comprising the subterranean garage 103 is visible. For the sake of convenience the ground on or in which the foundation 102 is arranged is not shown. As best seen in Fig. 2, the multi-floor building 100 comprises four floors 110 and one roof 130. The roof 130 may be seen as an additional floor. The walls 120, the floors 110 and the roof 130 of the multi-floor building 100 comprise a multi-layer space frame structure 1. The multi-layer space frame structure 1 is a continuous structure which extends throughout the walls 120, the floors 110 and the roof 130. The complete building load of the multi-floor building 100 is transmitted (transferred) via said multi-layer space frame structure 1 into the foundation 102.

[0050] Fig. 3 shows a horizontal section view of the multi-floor building 100 of Fig. 1. The section view of Fig. 3 is taken on a horizontal plane through the multi-floor building 100. The multi-floor building 100 has a substan-

tially square cross-section comprising four outer walls 120. These four outer walls 120 are load-bearing walls. The bearing load of the multi-floor building 100 is transmitted in the vertical direction of the building through the multi-layer space frame structure 1 of said four outer walls 120 only.

[0051] A rectangular structure of additional walls 120 is arranged inside the multi-floor building 100. Said additional walls 120 provide a stairwell. These additional walls 120 are, with respect to the stairwell, load-bearing walls and transmit the load of the stairwell to the foundation 102 (see Fig. 2). The load of the stairwell is transmitted in the vertical direction through the multi-layer space frame structure 1 of said four walls 120 only. The arrangement of the stairwell inside of the multi-floor building 100 has therefore no influence on the structural integrity of the multi-floor building 100.

[0052] Fig. 4 shows a perspective view of a part of the multi-floor building of Fig. 1, in particular a multi-floor building section 101 in which, for the sake of convenience, only one floor 110 is shown. The multi-floor building section 101 is taken from a corner of the multi-floor building 100 (see Fig. 1). The multi-floor building section 101 comprises a first floor 110 and a second floor (not shown) vertically spaced apart from said first floor 110. Said two floors 110 are connected via a first wall 120 and a second wall 120. Both of the first and second walls are load-bearing walls 120 and comprise a multi-layer space frame structure 1, the multi-layer space frame structure 1 extending over a full extent of the first wall 120. Furthermore, the same multi-layer space frame structure 1 extends into the floor 110 and, in the shown embodiment, extends over a full extent of the floor 110 as well as over a full extent of the second floor (not shown). Moreover, the same multi-layer space frame structure 1 extends into the second wall 120. The complete bearing load of the building is transmitted through said multi-layer space frame structure 1. The walls 120 comprise a first face element 4 and a second face element 5. The first face element 4 is attached to a first end layer 2 of the multi-layer space frame structure 1. The second face element 5 is attached to a second end layer 3 of the multi-layer space frame structure 1. The first face element 4 comprises an insulation layer as explained with respect to the following Fig. 5.

[0053] Fig. 5 shows a detail of a part of a wall 120 of the multi-floor building of Fig. 5 with a multi-layer space frame structure 1 in a perspective view. The multi-layer space frame structure 1 comprises a plurality of nodes 10 and a plurality of struts 20. For the sake of simplicity, only one node and only one strut are provided with a reference number. The space frame structure 1 according to Fig. 5 is a multi-layer space frame structure, which comprises several layers of nodes 10, which are connected with struts 20. The space frame structure also comprises a first face element 4 and a second face element 5. The first face element 4 and the second face element 5 are each made of a plurality of layers, such as

insulating layers and top layers, which are not referenced separately. The first face element 4 is attached to a first end layer 2 of the multi-layer space frame structure 1 and the second face element 5 is attached to a second end layer 3. A layer of a multi-layer space frame structure, and therefore an end layer, too, is defined by a plurality of nodes 10 which are arranged in a common plane. The common plane may be planar (flat) or curved and is in the present case planar. The space frame structure 1 of Fig. 5 thus comprises five layers, namely a first end layer 2, a second end layer 3 and three layers between said first end layer 2 and said second end layer 3. The first and second face elements 4 and 5 do not transmit bearing loads of the building and can therefore be freely selected.

[0054] Fig. 6 shows the connection of two struts 20 and a node 10 of Fig. 5. One strut 20 has already been inserted into a receiver 11 of the node 10 and a second strut 20 has been brought into contact with the node 10, or more precisely with an insertion opening of the node 11. Said second strut 20 has been placed next to the insertion opening and will be moved in the insertion direction A into the receiver 11 for connecting the strut 20 with the node 10. For this reason, a connector 21 of the strut 20 will be inserted into a chamber 13 of the receiver 11. This connection of the strut 20 and the node 10 can be for example a snap-fit connection between the node 10 and the strut 20 as shown or alternatively also a friction connection.

Claims

1. Multi-floor building section (101) comprising at least two floors (110) and one or more walls (120) connecting said at least two floors (110), wherein said one or more walls (120) are load-bearing walls and comprise a multi-layer space frame structure (1) made of a plurality of nodes (10) and a plurality of struts (20) connecting the nodes (10), wherein the whole load transmitted by said one or more walls (120) is transmitted through said multi-layer space frame structure (1).
2. Multi-floor building section (101) according to claim 1, wherein the multi-layer space frame structure (1) extends substantially over a full extent of at least one of said one or more walls (120), preferably over a full extent of each of said at least one or more walls (120).
3. Multi-floor building section (101) according to claim 1 or 2, wherein at least one floor (110) of said at least two floors (110) comprises a multi-layer space frame structure (1) made of a plurality of nodes (10) and a plurality of struts (20) connecting the nodes (10), wherein the whole load transmitted by said at least one floor (110) is transmitted through said multi-layer

space frame structure (1).

4. Multi-floor building section (101) according any one of claims 1 to 3, wherein the multi-layer space frame structure (1) has a first end layer (2) and a second end layer (3). 5
5. Multi-floor building section (101) according to claim 4, wherein at least one of said at least two floors (110) and/or said one or more walls (120) comprises a first face element (4) attached to the first end layer (2) and preferably a second face element (5) attached to the second end layer (3). 10
6. Multi-floor building section (101) according to claim 5, wherein at least one of the first face element (4) and the second face element (5) comprises at least an insulation layer and a top layer. 15
7. Multi-floor building section (101) according to any one of claims 1 to 6, wherein each strut (20) of the multi-layer space frame structure (1) connects two nodes (10) of the plurality of nodes (10) and has a longitudinal direction (B), two ends and a connector (21) at each end, and wherein each node (10) has a plurality of receivers (11) for receiving connectors (21). 20 25
8. Multi-floor building section (101) according to claim 7, wherein each receiver (11) comprises a lateral insertion opening for inserting one of the connectors (21) of one of the struts (10) in an insertion direction (A) substantially perpendicular to the longitudinal direction (B) of the strut (20), wherein a connector (21) of a strut (20) is connected to a receiver (11) of a node (10) by a snap-fit connection or by a friction connection. 30 35
9. Multi-floor building section (101) according to any one of claims 3 to 8, wherein the multi-layer space frame structure (1) of the one or more walls (120) and the multi-layer space frame structure (1) of the at least one floor (110) are connected to each other such as to form a continuous multi-layer space frame structure (1). 40 45
10. Multi-floor building (100) comprising a multi-floor building section (101) according to any one of claims 1 to 9. 50
11. Multi-floor building (100) according to claim 10, wherein the multi-floor building section (101) comprises at least three floors (110) vertically spaced apart and four walls (120) connecting the four floors (110). 55

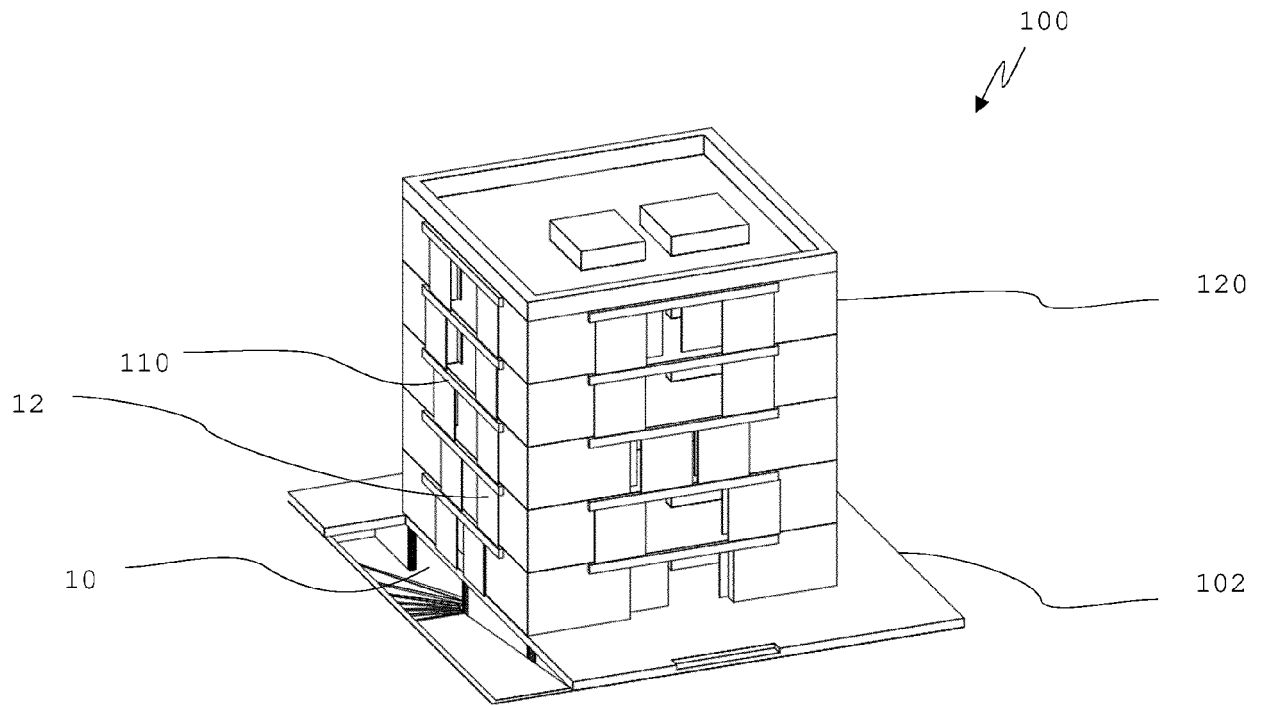


Fig. 1

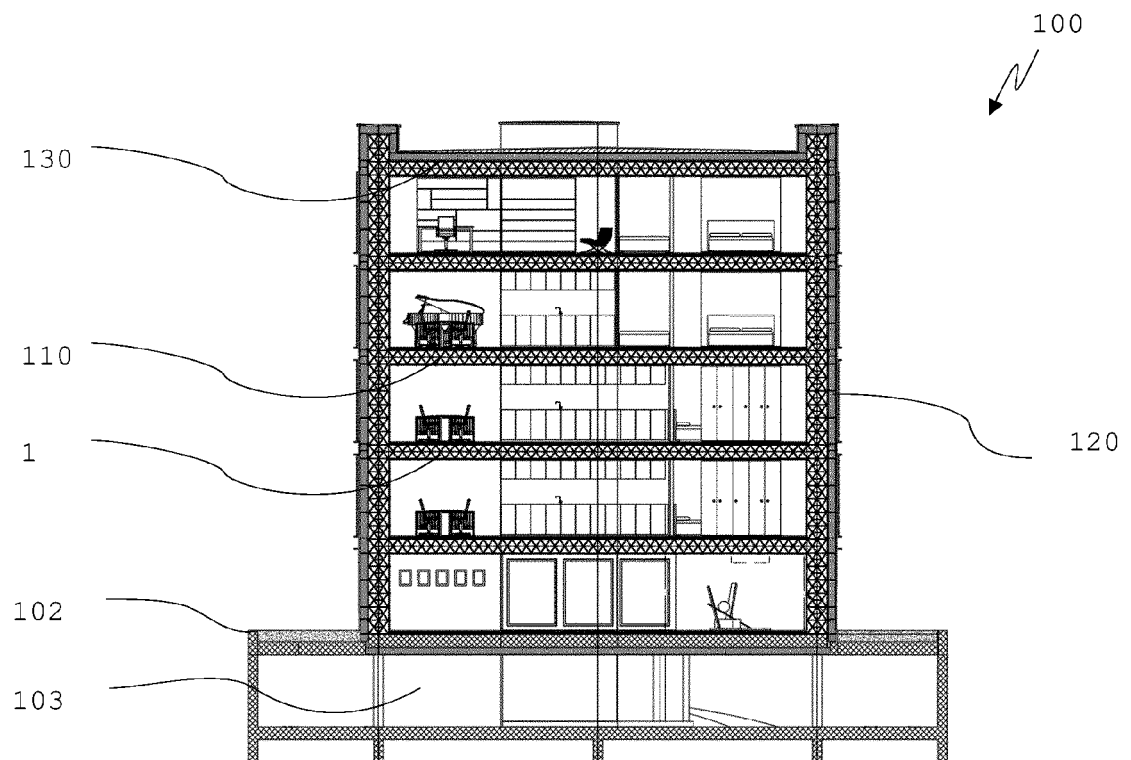


Fig. 2

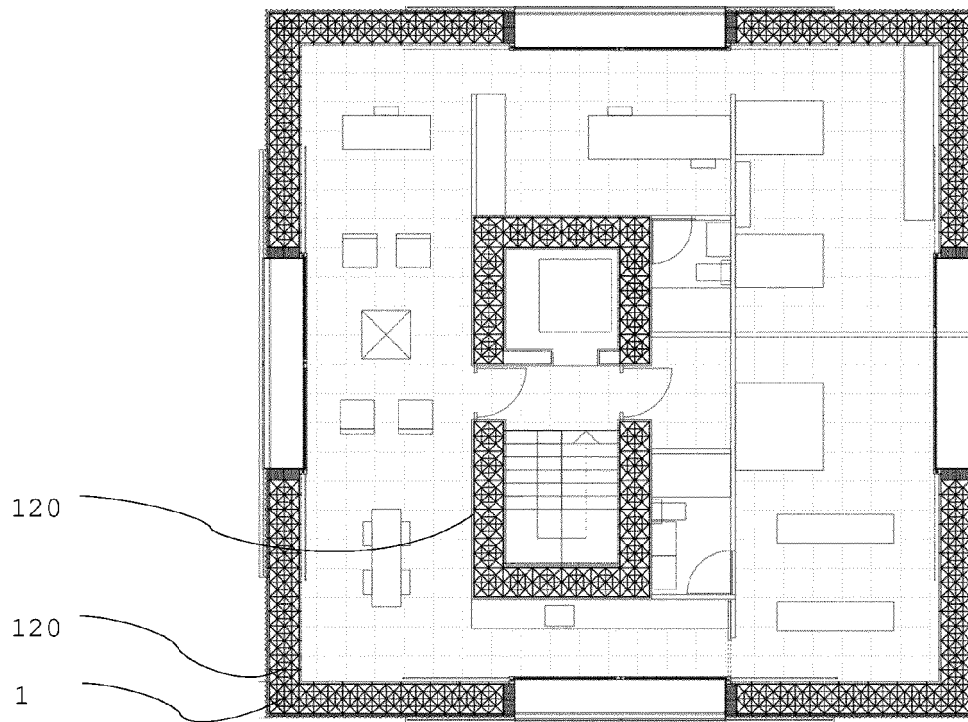


Fig. 3

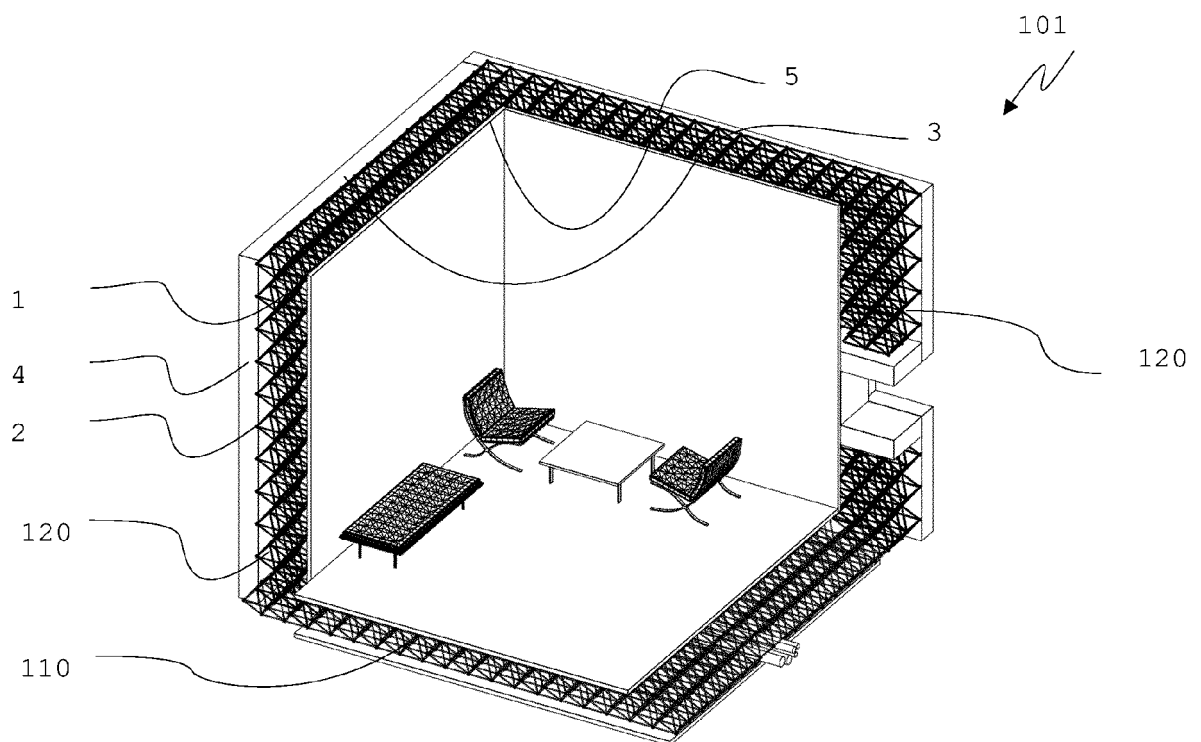
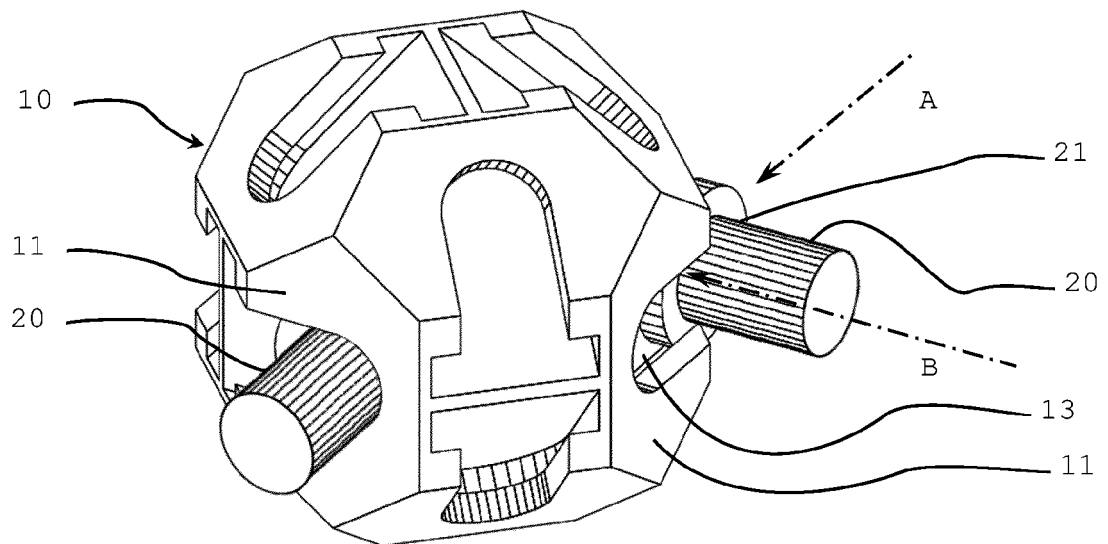
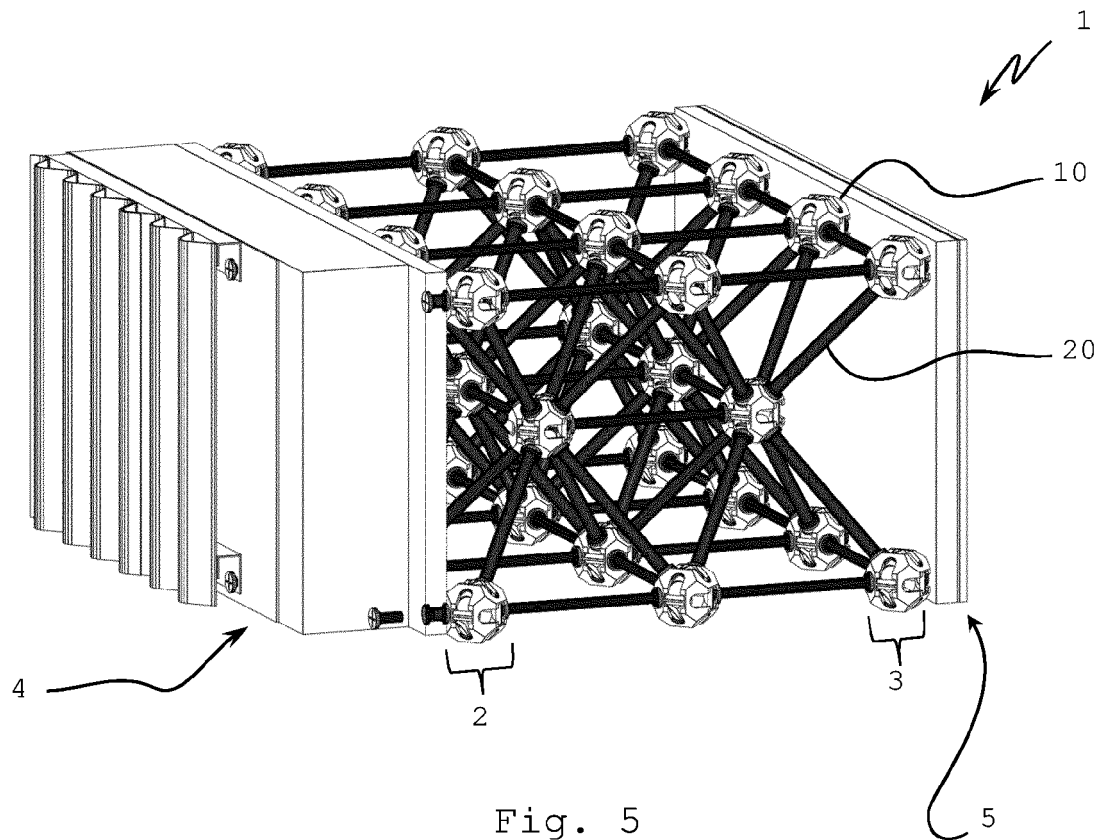


Fig. 4





EUROPEAN SEARCH REPORT

Application Number
EP 20 15 6428

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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A	FR 1 294 500 A (M. GASTON) 26 May 1962 (1962-05-26) * figures *	8	TECHNICAL FIELDS SEARCHED (IPC) E04B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 4 August 2020	Examiner Demeester, Jan
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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