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

(11) **EP 3 527 737 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.08.2019 Bulletin 2019/34

(21) Application number: **18425007.4**

(22) Date of filing: **15.02.2018**

(51) Int Cl.:
E04B 1/344 *(2006.01)* ***E04B 1/348*** *(2006.01)*
E05D 3/02 *(2006.01)* *E04B 5/14* *(2006.01)*

(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:
MA MD TN

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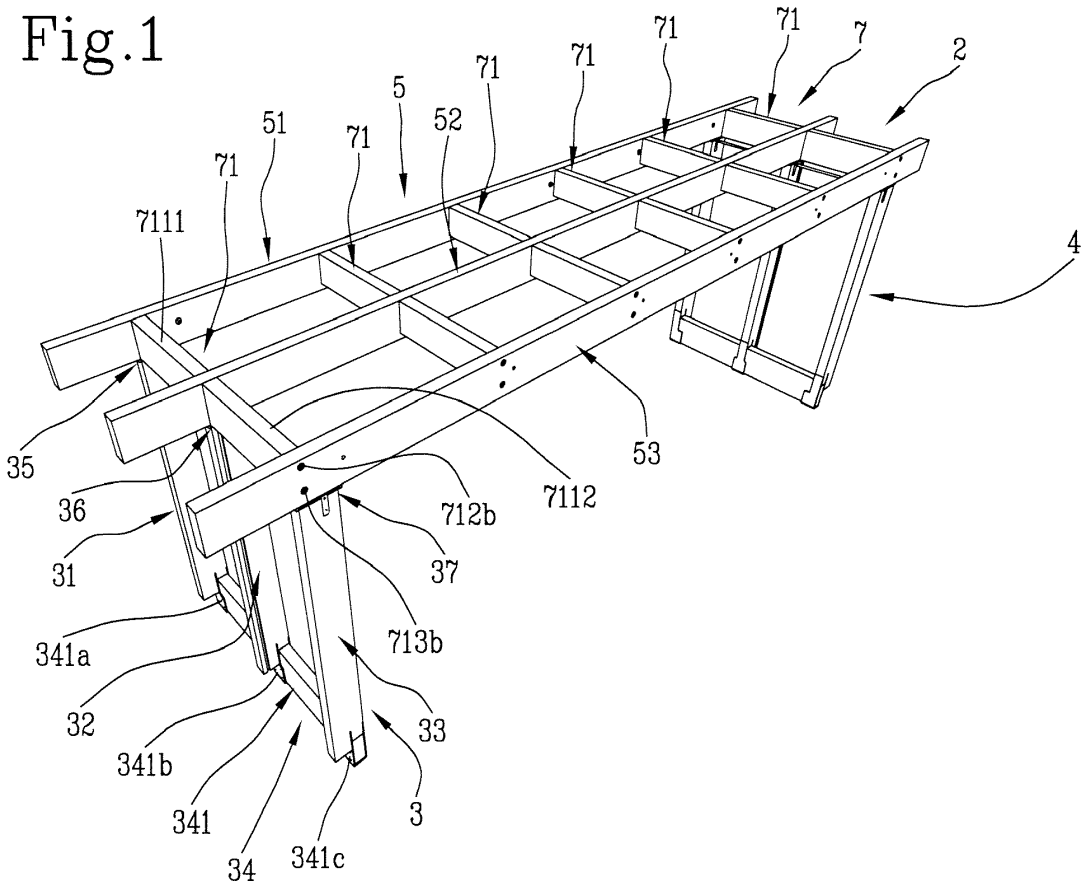
(54) **MODULAR BUILDING AND MODULE FOR CONSTRUCTING SUCH A BUILDING**

(57) This invention relates to a modular building (1) which allows improving the organization of work on the construction of the building (1) according to specific requirements, to a module (2) of such a building (1) and to a construction system (2, 6) for constructing such a building (2).

Fig.1



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Description

[0001] This invention relates to a modular building which allows improving the organization of work on the construction of the building according to specific requirements, to a module of such a building and to a construction system for constructing such a building.

[0002] Unless a building is very small, its construction must take place at a construction site and that is to say, at the place where the building will be used by the end users of that building. That sets constraints on the organization of the work for the construction of the building and on the final configuration of the building. In effect, the need for the work to be carried out at a construction site sets operating constraints on the execution mode and type of tasks to be carried out by construction workers and on the type and/or features of the components that will form part of the building, be they load-bearing, non-load bearing or accessory components.

[0003] This disclosure has for an aim to provide a building which allows at least a large part of the tasks for the construction of the building, irrespective of its size, hence also if the building is of large size, at a place other than that where the building will be used by end users, thereby facilitating such tasks and increasing the number of possible configurations of the building, in particular with regard to the nature and/or features of the components that will form part of the building when such tasks have been carried out. Another aim of this disclosure is to provide a module for a building according to this disclosure which allows such building to be made modular and transportable to an extent such that the whole building can be made transportable, even when the building is of large size.

[0004] In this sense, the modularity of the building and the transportability of each building module can, in combination, allow achieving the aforesaid aim of being able to allow a large part of the construction tasks to be carried out at a place other than that where the building will be used by end users.

[0005] A further aim of this disclosure is to provide a module of such building which, through configuration of the individual module, can facilitate transportation of the module itself and hence transportation of the whole building comprising a plurality of modules.

[0006] A further aim of this disclosure is to provide a construction system for the construction of such building to allow one module of the building to be coupled quickly and safely to another module of the building. For this purpose, the constructions system comprises a building module and a coupling system which allow coupling the module itself to another building module.

[0007] According to a first aspect of it, this disclosure relates to a modular building. According to a second aspect of it, this disclosure relates to a building module of the modular building according to the first aspect. According to a third aspect of it, this disclosure relates to a construction system for the construction of the modular building according to the first aspect. This construction system comprises a module according to the second aspect and a coupling system which allows coupling one module of such building quickly and safely to another module of such building.

[0008] A building according to the first aspect of this disclosure may be considered, for example, a dwelling. In this application, therefore, the word "building" may be substituted by the word "dwelling".

[0009] A module according to the second aspect of this disclosure may be considered, for example, a dwelling module for the construction of the above mentioned dwelling. In this application, therefore, the term "module" may be substituted by the term "dwelling module".

[0010] The above mentioned aims, with reference to the building according to the first aspect of this disclosure, are fully achieved by a building having the features arising from any one or more of the accompanying claims, or any combination thereof, intended to protect the building.

[0011] The above mentioned aims, with reference to the module according to the second aspect of this disclosure or to the construction system according to the third aspect of this disclosure, are fully achieved by a module having the features arising from any one or more of the accompanying claims, or any combination thereof, intended to protect the module or the construction system.

[0012] The features of a building according to the first aspect of this disclosure, of a module according to the second aspect of this disclosure and of a system according to the third aspect of this disclosure will become clearer from the following detailed description of respective embodiments of the building, module and construction system given by way of non-limiting examples of the concepts claimed.

[0013] The following detailed description refers to the accompanying drawings, in which:

- Figure 1 is a perspective view of the structure of a possible embodiment of a module according to the first aspect of this description, while such module adopts an operating condition whereby the module is positioned in such a way as to define a portion of a possible embodiment of a building according to this disclosure;
- Figure 2 is a perspective view of such module structure, while such module adopts a non-operating or transporting condition;
- Figure 3 is a side view of the module structure such as to show from another viewpoint the differences between the operating condition and the transporting condition;
- Figure 4 is a top view of the module structure such as to show a plan of the top of the structure;
- Figure 5 is an exploded perspective view of the top of the module structure;
- Figure 6 is a face view of one side of the module

structure;

- Figure 7 is an exploded perspective view of that side of the module structure;
- Figure 8 is a perspective view of the respective structures of two modules of the building and a coupling system which locks and/or couples such modules to each other;
- Figure 9 shows, in a perspective view, the respective structures of the modules of Figure 8 and, in an exploded view, the coupling system of Figure 8;
- Figure 10 shows the modules of Figure 7, coupled by the coupling system of Figures 7 and 8 and each of which is integrated with some components additional to the respective structure;
- Figures 11A and 11 B show an articulation belonging to the module of Figure 1 while the articulation adopts a first and a second position, respectively, corresponding to the non-operating condition and the operating condition of the module, respectively;
- Figures 12A, 12B and 12C schematically represent the possible embodiment of the building in a top view, a first side view and a second side view, respectively, where the building comprises a first number of modules;
- Figure 12D schematically represents the possible embodiment of the building in a top view, where the building comprises a second number of modules, different from the first number.

[0014] Figures 1-9 refer to a possible embodiment of a module according to this disclosure. The module referred to in Figures 1-9 is denoted by the numeral 2 in Figures 1-3 and 8-10. The module 2 comprises a first side frame 3. The module 2 comprises a second side frame 4. The module 2 comprises a middle frame 5. The second side frame 4 may have one or more of the features of the first side frame 3. Every module of a building according to this disclosure may have one or more of the features of the module 2.

[0015] Figures 8-9 refer to the above mentioned module 2 represented in Figures 1-7 and 10, as well as to another module 2' which may form part of a building according to this disclosure. Such other module 2' comprises another middle frame 5', another first side frame 3' and another second side frame 4'.

[0016] Each module of the building may comprise one or more components additional to those shown in Figures 1-9. These one or more additional components may comprise, for example, at least one additional side component. The additional side component may comprise, for example, at least one panel and/or at least one window and/or at least one installation and/or at least one fixture and/or at least one covering and/or at least one door.

[0017] By installation is meant, for example, a lighting installation and/or an air conditioning installation and/or a heating installation and/or a plumbing installation and/or an electrical installation and/or a gas supply installation.

[0018] Figure 10 shows, as possible additional components, at least one covering C and one covering C' forming part of the middle frame 5 of the module 2 and of the middle frame 5' of the other module 2', respectively. Figure 10 shows, as possible additional components, a panel P and a panel P' which form part of the first side frame 3 of the module 2 and of the first side frame 3' of the other module 2', respectively. Figure 10 shows, as possible additional components, a window F and another window F' which form part of the first side frame 3 of the module 2 and of the first side frame 3' of the other module 2', respectively.

[0019] A building according to this disclosure comprises a plurality of modules. Each of these modules of the building may have one or more of the features of the module labelled 2.

[0020] The numeral 1 in Figures 12A, 12B, 12C and 12D denotes a schematic representation of a possible embodiment of a building according to this disclosure. Figures 12A, 12B and 12C refer to a case where, by way of example, the building 1 comprises three modules. In the case of Figures 12A, 12B and 12C, a first module 2a, a second module 2b and a third module 2c can be identified. Figure 12D refers to a case where, by way of example, the building 1 comprises four modules. In the case of Figure 12D, therefore, a fourth module 2d can also be identified. Each of the modules 2a-2d of Figures 12A-12D may have one or more of the features of the module 2. For example, the first module 2a might be the module labelled 2 in Figures 1-10 and the second module 2b might be the module labelled 2' in Figures 8-10.

[0021] A building according to this disclosure may in any case comprise any number of modules, each having one or more of the features of the module 2.

[0022] In Figure 12A, the building 1 is shown from above. Figure 12B is a first side view of the building 1. Figure 12C is a second side view of the building. The second side view of Figure 12C is a view from a point opposite to that of the first side view of Figure 12B.

[0023] The building 1 comprises a first side wall 11 of the building 1. The first side wall 11 might define a first external side face of the building 1. The first side wall 11 is schematically represented in Figures 12A, 12B, 12C and 12D as if it were a surface. The building 1 comprises a second side wall 12 of the building 1. The second side wall 12 is opposite to the first side wall 11. The second side wall 12 might define a second external side face of the building, facing the opposite side with respect to the first face. The second side wall 12 is schematically represented in Figures 12A, 12B, 12C and 12D as if it were a surface. The building 1 comprises a floor 13 of the building 1. The floor 13 might define an external top face of the building 1. The floor 13 is schematically represented in Figures 12A, 12B, 12C and 12D as if it were a surface. The floor 13 might by a roof floor or an intermediate floor.

[0024] In Figures 12A and 12D, the surface which schematically represents the floor 13 is shown in plan view, the surface which schematically represents the first

side wall 11 is shown in profile view and the surface which schematically represents the second side wall 12 is shown in profile view. In Figure 12B, the surface which schematically represents the first side wall 11 is shown in plan view and the surface which schematically represents the floor 13 is shown in profile view. In Figure 12C, the surface which schematically represents the second side wall 12 is shown in plan view and the surface which schematically represents the floor 13 is shown in profile view.

[0025] The modules of the building 1 are disposed in a row. The row extends along an axis of extension. That means the modules of the building are distributed and/or disposed one after the other along the axis of extension. The row of modules defines the building 1.

[0026] In Figures 12A and 12D, this axis of extension is labelled X. The axis of extension X may be straight, curved or both.

[0027] The middle frame 5 comprises a plurality of beams. The beams of the middle frame 5 are placed side by side transversely to the respective axes.

[0028] The module 2 has a longitudinal extension which is labelled e1 in Figure 4. The longitudinal extension e1 is along a longitudinal direction defined by the module 2. The longitudinal direction is indicated by the first axis Y1 in Figure 4. The longitudinal direction coincides with the axis of extension X of the building 1.

[0029] The axis of each of the beams of the middle frame 5 is disposed transversely and preferably at right angles to the aforementioned longitudinal direction of the module 2.

[0030] The beams of the middle frame 5 are disposed in a row.

[0031] The row of beams extends along the longitudinal direction of the module 2. That means the beams in the row are distributed and/or disposed one after the other along the longitudinal direction of the module 2 and/or along the longitudinal extension e1 of the module 2. The row of beams extends from a first beam in the row to a last beam in the row.

[0032] The module 2 has a transverse extension which is labelled e2 in Figure 4. The transverse extension e2 is along a transverse direction defined by the module 2. The transverse direction of the module 2 must be considered transversely and preferably at right angles to the aforementioned longitudinal direction of the module 2. The transverse direction is a direction from the first side frame 3 to the second side frame 4. The transverse direction of the module 2 coincides with a transverse direction of the building 1. The transverse direction of the building 1 is a direction locally transverse to the axis of extension X of the building 1 and directed from one to the other of the first side wall 11 and second side wall 12. In this sense, the transverse direction of the building 1 coincides, for each point on the axis of extension X, with the normal to the axis of extension X and directed from one to the other of the first side wall 11 and second side wall 12. The transverse direction of the module 2 is indicated by the axis Y2 in Figure 4.

[0033] The beams of the middle frame 5 are disposed in such a way that the respective axis of each of the beams is disposed transversely to the longitudinal direction of the module and/or along the transverse direction of the module 2.

[0034] In the example shown in Figures 1-10, the middle frame 5 comprises a first beam 51, a second beam 52 and a third beam 53. The first beam 51 may be considered as the first beam in the row and the third beam 53 may be considered as the last beam in the row. It should be borne in mind, however, that the middle frame 5 may comprise any number of beams.

[0035] The middle frame 5 comprises a stiffening system 7. The stiffening system 7 stiffens the middle frame 5 transversely and preferably at right angles to the respective axes of the beams of the middle frame 5.

[0036] The stiffening system 7 comprises at least one stiffening structure 71. The stiffening structure 71 is disposed along and/or defines a stiffening axis. The stiffening axis is transverse and preferably at right angles to the respective axes of the beams of the middle frame 5. The stiffening axis is parallel to the longitudinal direction of the module 2 and/or transverse to the transverse direction of the module 2. In the example illustrated in the accompanying drawings, the stiffening axis is disposed at a certain distance along the transverse direction or extension of the module 2.

[0037] The stiffening structure 71 stiffens the middle frame 5 by applying a stiffening action on the beams of the middle frame 5. This stiffening action locks or contributes to locking the beams of the middle frame 5 to each other. The stiffening action is directed along the stiffening axis.

[0038] The stiffening structure 71 comprises a group of spacing elements.

[0039] The spacing elements of the group are each associated with a respective pair of consecutive beams along the row of beams, and interposed between the beams of the respective pair. Each of the spacing elements of the group keeps the beams of the pair associated with the spacing element itself spaced from each other transversely and preferably at right angles to the respective axes. Each of the spacing elements of the group keeps the beams of the pair associated with the spacing element itself spaced from each other along the longitudinal direction of the module 2.

[0040] The spacing elements of the group are alternated with the beams of the middle frame 5.

[0041] In the example shown in the accompanying drawings, the middle frame 5 comprises a first pair of consecutive beams along the row of beams. The first pair of consecutive beams comprises the first beam 51 and the second beam 52. In the example shown in the accompanying drawings, the middle frame 5 comprises a second pair of consecutive beams along the row of beams. The second pair of consecutive beams comprises the second beam 52 and the third beam 53.

[0042] In Figure 5, the group of spacing elements is labelled 711. In the example shown in the accompanying drawings, the group of spacing elements comprises a first spacing element 7111 and a second spacing element 7112, shown in Figures 1, 2, 4 and 5. It should be borne in mind, however, that the group of spacing elements may comprise any number of spacing elements.

[0043] The first spacing element 7111 is associated with the first, first beam 51-second beam 52 pair and is interposed between the first beam 51 and the second beam 52. That means the first spacing element 7111 keeps the first beam 51 and the second beam 52 of the middle frame 5 spaced from each other transversely to the respective axes of the first beam 51 and second beam 52 and/or spaced from each other along the longitudinal direction of the module 2.

[0044] The second spacing element 7112 is associated with the second, second beam 52-third beam 53 pair and is interposed between the second beam 52 and the third beam 53. That means the second spacing element 7112 keeps the second beam 52 and the third beam 53 of the middle frame 5 spaced from each other transversely to the respective axes of the second beam 52 and third beam 53 and/or spaced from each other along the longitudinal direction of the module 2.

[0045] The first spacing element 7111 and the second spacing element 7112 are thus alternated between the first beam, the second beam 52 and the third beam 53.

[0046] The stiffening structure 71 comprises at least one tie rod.

[0047] The stiffening structure 71 is configured for the tie rod to act in such a way that for each pair of consecutive beams along the row, the beams of the respective pair exchange a respective retaining action through the spacing element associated with the respective pair of beams and through the tie rod. The respective retaining action tightens or tends to tighten the beams of the respective pair to each other transversely to the respective axes of the beams of the self same pair of beams and in opposition to the spacing element associated with that pair of beams. The respective retaining action pushes or tends to push the beams of the respective pair towards the other transversely to the respective axes of the beams of the self same pair of beams and in opposition to the spacing element associated with that pair of beams. Through the tie rod, the beams of the respective pair remain pressed against the spacing element associated therewith and from respectively opposite sides of the spacing element itself. The respective retaining action is exchanged between the beams of the respective pair in opposition to the spacing element associated with the respective pair of beams. The tie rod is disposed along the stiffening axis in such a way that the respective retaining actions exchanged between the respective pairs of beams are directed along the stiffening axis. The aforementioned stiffening action applied by the stiffening structure is the result of combining at least these respective retaining actions.

[0048] The tie rod passes through the beams of the middle frame 5. The tie rod passes through the spacing elements of the group of spacing elements. The tie rod is fastened to a beam of the middle frame and to another beam of the middle frame by respective fastening elements. The beams the tie rod is fastened to could be the first beam in the row and the last beam in the row. The stiffening structure 71 comprises these fastening elements.

[0049] In the example shown in the accompanying drawings, the stiffening structure 71 comprises a first tie rod 712.

[0050] The first tie rod 712 acts in such a way that the beams of the first, first beam 51-second beam 52 pair exchange with each other a retaining action which may be defined as "first retaining action". The first retaining action tightens or tends to tighten the first beam 51 and the second beam 52 to each other transversely to their respective axes and in opposition to the first spacing element 7111. The first retaining action pushes or tends to push the first beam 51 and the second beam 52 towards each other transversely to their respective axes and in opposition to the first spacing element 7111. Through the first tie rod 712, the first beam 51 and the second beam 52 remain pressed against the first spacing element 7111 associated therewith and from respectively opposite sides of the first spacing element 7111. The first retaining action is exchanged between the first beam 51 and the second beam 52 in opposition to the first spacing element 7111. The first tie rod 712 is disposed along the stiffening axis in such a way that the first retaining action is exchanged between the first beam 51 and the second beam 52 along the stiffening axis.

[0051] The first tie rod 712 acts in such a way that the beams of the first pair second beam 52-third beam 52 exchange with each other a retaining action which may be defined as "second retaining action". The second retaining action tightens or tends to tighten the second beam 52 and the third beam 53 to each other transversely to their respective axes and in opposition to the second spacing element 7112. The second retaining action pushes or tends to push the second beam 52 and the third beam 53 towards each other transversely to their respective axes and in opposition to the second spacing element 7112. Through the first tie rod 712, the second beam 52 and the third beam 53 remain pressed against the second spacing element 7112 associated therewith and from respectively opposite sides of the second spacing element 7112. The second retaining action is exchanged between the second beam 52 and the third beam 53 in opposition to the second spacing element 7112. The second tie rod 712 is disposed along the stiffening axis in such a way that the second retaining action is exchanged between the second beam 52 and the third beam 53 along the stiffening axis.

[0052] The aforementioned stiffening action applied by the stiffening structure is the result of combining at least the first retaining action and the second retaining action.

[0053] The first tie rod 712 passes through the beams 51-53 of the middle frame 5. The first tie rod 712 passes through the first spacing element 7111 and the second spacing element 7112. The first tie rod 712 is fastened to the first beam 51 through a first fastening element 712a and to the third beam 53 through a second fastening element 712b. These fastening elements are identifiable at least in Figure 5. The stiffening structure 71 comprises the first fastening element 712a and the second fastening element 712b. In the example shown in the accompanying drawings, the stiffening structure 71 comprises a second tie rod 713. The second tie rod 713 may have the same structural and/or functional features as the first tie rod 712.

[0054] The second tie rod 713 is fastened to the first beam 51 through another first fastening element 713a and to the third beam 53 through another second fastening element 713b.

[0055] In the example shown in the accompanying drawings, the stiffening system 7 comprises a plurality of stiffening structures.

[0056] These stiffening structures are distributed and/or disposed one after the other along the transverse direction and/or along the transverse extension of the module 2. The stiffening structures are disposed along and/or define respective stiffening axes. In the example illustrated in the accompanying drawings, the stiffening axes are each disposed at a certain distance along the transverse direction or extension of the module 2.

[0057] Each of the stiffening structures may have one or more of the structural and/or functional features described above with reference to the stiffening structure 71 Thus, in Figures 1, 2, 4 and 5, each of these stiffening structures is also labelled 71.

[0058] Through the configuration of the stiffening structure 71 described, which acts through at least one tie rod passing through the beams and the spacing elements that keep the beams spaced from each other in opposition to the action of the tied rod, it is possible to reduce the stresses applied to the middle frame 5 when the module 2 is gripped in order to move it. In effect, if the module 2 is constructed at a factory and transported by a means of transport to the destination site where the building 1 will be built, the module 2 is gripped preferably by a handling system and loaded onto the means of transport which will transport it to the destination site. The handling system preferably applies respective gripping actions on the middle frame 5 and, in particular, on the first beam 51 and last beam 53. Such gripping actions could generate considerable stresses in the components of the middle frame 5 since these gripping actions are concentrated predominantly on opposite sides of the middle frame 5. This configuration of the stiffening structure 71 allows stiffening the middle frame 5 transversely to the beams thereof but reducing the state of stress generated in the components of the middle frame 5 while the module 2 is being handled and moved.

[0059] The beams of the middle frame 5 and the spacing elements could be made at least partly or entirely of wood.

[0060] The use of wood may be desirable to make the module 2, hence the entire building 1, more aesthetically pleasing.

[0061] The state of stress that could be generated as a result of the aforementioned gripping actions could, in particular, be very high if the beams of the middle frame 5 are made at least partly or entirely of wood. Reducing the state of stress as aforementioned is therefore all the more an advantage if the beams of the middle frame 5 are made at least partly or entirely of wood.

[0062] For each pair of consecutive modules along the row of modules, the building 1 comprises a respective coupling system associated with the respective pair of modules. The respective coupling system couples and/or locks the modules of the respective pair to each other. That way, the row of modules defines the building 1.

[0063] In Figures 8 and 9 any one of the coupling systems of the building 1 is labelled 6.

[0064] Identifiable in Figures 12A-12D are a first pair of consecutive modules, comprising the first module 2a and the second module 2b, and a second pair of consecutive modules, comprising the second module 2b and the third module 2c. In Figure 12D, a third pair of consecutive modules, comprising the third module 2c and the fourth module 2d, is also identifiable.

[0065] Identifiable in Figures 12A-12D are a first coupling system 6a, associated with the first pair of modules 2a-2b, and a second coupling system 6b, associated with the second pair of modules 2b-2c. In Figure 12D, a third coupling system 6c, associated with the third pair of modules 2c-2d, is also identifiable.

[0066] In Figures 12A-12D, each of the coupling systems 6a-6d is schematically represented by a line representing the coupling between the modules.

[0067] The coupling system 6 of Figures 8 and 9 might, for example, be the coupling system 6a shown in Figures 12A and 12D. In this case, the module 2 is the first module 2a and the module 2' is the second module 2b.

[0068] Each of the modules 2 defines a respective portion of the building 1. This respective portion of the building 1 corresponds to a respective sector of the building 1 along the axis of extension X.

[0069] The extension e1 of each module along its longitudinal direction coincides with the extension along the axis of extension X of the respective portion of the building defined by the module 2 itself. Varying the number of modules corresponds to varying the extension of the building along the axis of extension X.

[0070] In the example shown in the accompanying drawings, the extension e2 of each module 2 along its transverse direction coincides with the extension of the building 1 along the transverse direction of the building 1.

[0071] Each of the first side frames of the respective modules 2a-2d defines a respective portion of the first side wall 11 of the building 1. This respective portion of the first side wall 11 corresponds to a respective sector

of the first side wall 11 along the axis of extension X. In Figure 12C, the first side frames of the first module 2a, of the second module 2b and of the third module 2c are labelled 3a, 3b and 3c, respectively.

[0072] Each of the second side frames of the respective modules 2a-2d defines a respective portion of the second side wall 12 of the building 1. This respective portion of the second side wall 12 corresponds to a respective sector of the second side wall 12 along the axis of extension X. In Figure 12B, the second side frames of the first module 2a, of the second module 2b and of the third module 2c are labelled 4a, 4b and 4c, respectively. Each of the middle frames of the respective modules 2a-2c defines a respective portion of the floor 13 of the building 1. This respective portion of the floor 13 of the building 1 corresponds to a respective sector of the floor 13 of the building along the axis of extension X. In Figures12A and 12D, the middle frames of the first module 2a, of the second module 2b and of the third module 2c are labelled 5a, 5b and 5c, respectively. In

[0073] Figure 12D, the middle frame of the fourth module 2d is labelled 5d.

[0074] Each pair of consecutive modules along the row of modules can be considered as comprising a preceding module and a succeeding module of the respective pair. In Figures 12A-12C, the preceding modules of the first pair of modules 2a-2b and of the second pair of modules 2b-2c can be considered as the first module 2a and the second module 2b, respectively. In Figure 12D, the preceding module of the third pair of modules 2c-2d can be considered as the third module 2c.

[0075] In Figures 12A-12C, the succeeding modules of the first pair of modules 2a-2b and of the second pair of modules 2b-2c can be considered as the second module 2b and the third module 2c, respectively. In Figure 12D, the succeeding module of the third pair of modules 2c-2d can be considered as the fourth module 2d.

[0076] As stated above, the coupling system 6 of Figures 8-9 might, for example, be the coupling system 6a shown in Figures 12A-12D. In this case, the module 2 is the first module 2a and the module 2' is the second module 2b.

[0077] Thus, the coupling system labelled 6 in Figures 8-9 is associated with a pair of modules where the preceding module is the module labelled 2 and the succeeding module is the module labelled 2'.

[0078] In Figures 8 and 9, the middle frame of the preceding module 2 is labelled 5 and the middle frame of the succeeding module 2' is labelled 5'. In

[0079] Figure 8 the numeral 53 denotes the last beam of the middle frame 5 of the preceding module 2 and the numeral 51' denotes the first beam of the middle frame 5' of the succeeding module 2'. Also shown in Figure 8 are the first side frame 3' of the succeeding module 2' and the second side frame 4' of the succeeding module 2'. Also shown in Figure 9 are the second beam 52' and the third beam 53' of the succeeding module 2'.

[0080] The coupling system 6 for coupling and/or locking the preceding module 2 and the succeeding module 2' to each other couples and/or locks the middle frame 5 of the preceding module 2 and the middle frame 5' of the succeeding module 2' to each other. The coupling system 6 for coupling and/or locking the preceding module 2 and the succeeding module 2' to each other couples and/or locks at least the last beam 53 of the middle frame 5 of the preceding module 2 and the first beam 51' of the middle frame 5' of the succeeding module 2' to each other.

[0081] The coupling system 61 comprises at least one coupling structure 61. The coupling structure 61 is disposed along and/or defines a coupling axis. The coupling axis is transverse and preferably at right angles to the respective axes of the last beam 51 of the preceding module 2 and of the first beam 53' of the succeeding module 2'. The coupling axis is parallel to the axis of extension X of the building 1 and/or transverse to the aforementioned transverse direction of the building 1. In the example illustrated in the accompanying drawings, the coupling axis is disposed at a certain distance along the transverse direction or extension of the building 1.

[0082] The coupling structure 61 couples and/or locks the last beam 53 and the first beam 51' by applying a coupling action on the last beam 53 and on the first beam 51'. This coupling action locks or contributes to locking the middle frame 5 of the preceding module 2 and the middle frame 5' of the succeeding module 2' to each other. This coupling action locks or contributes to locking the last beam 53 and the first beam 51' to each other. The coupling action is directed along the coupling axis.

[0083] The coupling structure 61 comprises at least one spacing element 611.

[0084] The spacing element 611 of the coupling structure 61 keeps the last beam 53 and the first beam 51' spaced from each other transversely to their respective axes. The spacing element 611 of the coupling structure 61 keeps the last beam 53 and the first beam 51' spaced from each other along the axis of extension X of the building 1. The spacing element 611 of the coupling structure 61 is interposed between the last beam 53 and the first beam 51'.

[0085] The coupling structure 61 comprises at least one tie rod 612.

[0086] The coupling structure 6 is configured for the tie rod 612 to act in such a way that the last beam 53 and the first beam 51' exchange a retaining action through the tie rod 612. This retaining action tightens or tends to tighten the last beam 53 and the first beam 51' to each other transversely to their respective axes and in opposition to the spacing element 611. This retaining action pushes or tends to push the last beam 53 and the first beam 51' towards each other transversely to their respective axes and in opposition to the spacing element 611. Through the tie rod 612, the last beam 53 and the first beam 51' remain pressed against the spacing element 611 from respectively opposite sides of the spacing element 611. This retaining action is exchanged between

the last beam 53 and the first beam 51' in opposition to the spacing element 611. The tie rod 612 is disposed along the coupling axis in such a way that the retaining action is directed along the aforementioned coupling axis..

[0087] The aforementioned coupling action applied by the coupling structure 61 is the result at least of the aforementioned retaining action exchanged between the last beam 53 and the first beam 51'.

[0088] The tie rod 612 passes through the last beam 53 and the first beam 51'. The tie rod 612 is preferably situated externally of the spacing element 611. The tie rod 612 is fastened to the last beam 53 through a first fastening element 612a and to the first beam 51' through a second fastening element 612b. The coupling structure 61 comprises these fastening elements.

[0089] A coupling system as described above allows securely coupling and uncoupling the preceding module 2 and the succeeding module 2' of the building very quickly and safely.

[0090] In the example shown in the accompanying drawings, the coupling system 6 comprises a plurality of coupling structures.

[0091] These coupling structures are distributed and/or disposed one after the other along the transverse direction and/or along the transverse extension of the building 1 or of the module 2. These coupling structures are disposed along and/or define respective coupling axes. In the example illustrated in the accompanying drawings, the coupling axes are each disposed at a certain distance along the transverse extension or direction of the building 1 or of the module 2.

[0092] Each of the coupling structures 61 may have one or more of the structural and/or functional features described above with reference to the coupling structure 61. Thus, in Figures 8-9, each of these coupling structures is labelled 61.

[0093] It should be borne in mind that each module of the building may have one or more of the features - for example, structural and/or functional - of the module labelled 2.

[0094] A possible embodiment of a construction system according to this disclosure comprises the module 2 and the coupling system 6.

[0095] The module 2 is configured to be able to adopt an operating condition and a transporting condition. The transporting condition could be defined as a non-operating condition. When the module 2 defines a respective portion of the building 1, the module 2 adopts the operating condition. When the module 2 adopts the operating condition, the first side frame 3 is at a position away from the middle frame 5 and the second side frame 4 is at a position away from the middle frame 5. In Figures 1, 8, 9 and 10, the module 2 is in the operating condition. In Figure 3, the first side frame 3 and the second side frame 4, where drawn with the solid line, are the respective positions away from the middle frame 5.

[0096] When the module 2 adopts the transporting condition, the first side frame 3 is at a position juxtaposed with the middle frame 5 and the second side frame 4 is at a position juxtaposed with the middle frame 5. In Figure 2, the module 2 is in the transporting condition. In Figure 3, the first side frame 3 and the second side frame 4, where drawn with the dashed line, are each in the respective positions juxtaposed with the middle frame 5. Thus, Figure 3 shows the module 2 both in the operating condition and in the transporting condition.

[0097] When in the respective position juxtaposed with the middle frame 5, the first side frame 3 and the second side frame 4, are each practically folded towards the inside of the module 2 and/or of the middle frame 5.

[0098] The module 2 is configured to cause and/or perform a rotational movement of both the first side frame 3 and second side frame 4 between the respective position away from the middle frame 5 and the respective position juxtaposed with the middle frame 5. The rotational movement of the first side frame 3 is indicated by the double arrow R1 in Figure 3 and the rotational movement of the second side frame 4 is indicated by the double arrow R2 in Figure 3.

[0099] The module 2 is thus configured to perform and/or cause a movement of the module 2 between the operating condition and the transporting condition.

[0100] As already stated, it should be remembered that the second side frame 4 may have one or more of the structural and/or functional features of the first side frame 3. Thus, all the features described below with reference to the first side frame 3 could also apply to the second side frame 4.

[0101] The first side frame 3 comprises a plurality of beams.

[0102] The beams of the side frame 3 could be made at least partly or entirely of wood so as to improve the aesthetic appearance of the module 2.

[0103] The first side frame 3 comprises a plurality of beams 31, 32, 33. The beams 31, 32, 33 are placed side by side transversely and preferably at right angles to their respective axes.

[0104] The first side frame 3 comprises a plurality of articulations 35, 36, 37. Through the articulations of the first side frame 3, the module 2 is configured so that each beam of the first side frame 3 is associated with a respective beam of the middle frame 5.

[0105] The beams of the first side frame 3 are each connected by one of these articulations to the beam associated therewith of the middle frame 5. Thus, each of these articulations may be considered associated with a respective beam of the first side frame 3 and with a respective beam of the middle frame 5.

[0106] The first articulation 35, the second articulation 36 and the third articulation 37 are associated with the first beam 31-first beam 51 pair, with the second beam 32-second beam 52 pair and with the third beam 33-third beam 53 pair, respectively.

[0107] For each of these articulations 35-37 associated with a beam of the first side frame 3 and with a beam

of the middle frame 5, the module 2 is configured in such a way that the articulation can cause and/or perform a respective rotational movement between the beam of the first side frame 3 and the beam of the middle frame 5. By this rotational movement, the beam of the first side frame 3 moves between a position away from the beam of the middle frame 5 and a position juxtaposed with the beam of the middle frame 5.

[0108] The position of the first side frame 3 away from the middle frame 5, hence the operating condition of the module 2, corresponds to the position where all the beams of the first side frame 3 are away from the respective beams of the middle frame 5.

[0109] The position of the first side frame 3 juxtaposed with the middle frame 5, hence the transporting condition of the module 2, corresponds to the position where all the beams of the first side frame 3 are juxtaposed with the respective beams of the middle frame 5.

[0110] Figures 11A and 11B show the articulation labelled 35. The articulations of the first side frame 3 may each have one or more of the structural and/or functional features of the articulation 35 shown in Figures 11A and 11B.

[0111] The articulation 35 comprises a first member 351 and a second member 352. The articulation 35 comprises a hinge 353. The articulation 35 is configured in such a way that the first member 351 and the second member 352 can move by mutual rotation caused by the hinge 353. between a mutually apart position and a mutually juxtaposed position. In Figure 11A, the first member 351 and the second member 352 are in the mutually apart position. In Figure 11B, the first member 351 and the second member 352 are in the mutually juxtaposed position.

[0112] The articulation 35 comprises a locking system 354 which allows defining a locked condition of the articulation 35 where the first member 351 and the second member 352 are in the mutually juxtaposed position. The locking system comprises at least a first locking portion 3541 integral with the first member 351 and a second locking portion 3542 integral with the second member 352. The locking system comprises a pin 3543. In the locked condition, the pin 3543 is inserted through the first locking portion 3541 and second locking portion 3542 in order to prevent the rotation which could be caused by the hinge 353.

[0113] The first member 351 of the articulation 35 is connected to the beam associated therewith of the middle frame 5. The second member 352 of the articulation 35 is connected to the beam associated therewith of the first side frame 3.

[0114] For each of the articulations associated with a beam of the first side frame 3 and with a beam of the middle frame 5, the module 2 is configured in such a way that the position of the beam of the first side frame 3 away from the beam of the middle frame 5 corresponds to the mutually juxtaposed position of the first and second members of the articulation.

[0115] For each of the articulations associated with a beam of the first side frame 3 and with a beam of the middle frame 5, the module 2 is configured in such a way that the position of the beam of the first side frame 3 juxtaposed with the beam of the middle frame 5 corresponds to the mutually apart position of the first and second members 351 and 352 of the articulation.

[0116] Both the first side frame 3 and the second side frame 4 are therefore connected to the middle frame 5 by a respective plurality of articulations allowing the respective side frame to move between the respective position juxtaposed with the middle frame 5 and the respective position away from the middle frame 5. In the building 1 the middle frame 5 is supported at least by the first side frame 3 and by the second side frame 4. Thus, the middle frame 5 could be considered as a floor or an intermediate floor of the single module 2 and the first side frame 3 and second side frame 4 as a first side wall and a second side wall, opposite to the first side wall, of the single module 2, respectively.

[0117] The first side frame 3 comprises a connecting system 34. The connecting system locks the beams of the first side frame 3 to each other.

[0118] The connecting system 34 comprises at least one connecting element 341.

[0119] The connecting element 341 applies a locking action on the beams of the first side frame 3. This locking action is such that the respective beams of the first side frame perform as one the respective rotational movements relative to the respective beams of the middle frame 5.

[0120] The connecting element 341 is fastened to the beams of the first side frame by a plurality of fastening elements 341 a, 341 b and 341 c.

[0121] That way, the aforementioned rotational movement of the first side frame 3 relative to the middle frame 5 comprises the rotational movements of the respective beams of the first side frame 3 relative to the respective beams of the middle frame 5.

[0122] That way, when at least one of, or preferably each of, the articulations 35-37 is in the locked condition, the first side frame 3 is locked in the position away from the middle frame 5.

[0123] With reference to the fact that the second side frame 4 may have one or more of the features - functional and/or structural, for example - of the first side frame 3, when the first side frame and the second side frame 4 are locked in the respective positions away from the middle frame, the module 2 can be considered locked in the operating condition.

[0124] The connecting element may be, for example, a beam which is disposed transversely, and preferably at right angles, to the respective axes of the other beams of the first side frame 3.

[0125] The module 2 allows constructing a building whose size can be easily varied according to requirements.

[0126] The module 2 is also configured to adopt a more

compact condition - that is, the transporting condition - whereby the module 2 can be easily transported from the place where the module 2 is constructed and/or stored to the place where the building comprising the module will be used by the end users. That way, the module 2 can be constructed in a factory, at more ease and with greater freedom of module construction operations and choice of components of the module 2. Moreover, the module 2 can also be constructed beforehand, even if there is no specific request for it to be used for a specific building. This reduces building construction times because the modules can be made available immediately when the need to construct the building 1 arises.

Claims

1. A modular building (1) comprising a plurality of modules (2), each of which comprises:

   - a respective first side frame (3);
   - a respective second side frame (4);
   - a respective middle frame (5);

   wherein the modules are disposed along a row which extends along an axis of extension (X) of the building (1) and the building (1) comprises, for each pair of consecutive modules along the row, at least one respective coupling system (6) associated with the respective pair, to lock the modules of the respective pair to each other in such a way that the row of modules defines the building (1);.
   wherein, for each module:

   - the module (2) defines a respective portion of the building (1) corresponding to a respective sector of the building (1) along the axis of extension (X), the respective sector of the building (1) comprising a respective sector of a floor (13) of the building (1), a respective sector of a first side wall (11) of the building and a respective sector of a second side wall (12) of the building (1);
   - the first side frame (3) of the module (2) defines the respective sector of the first side wall (11);
   - the second side frame (4) of the module (2) defines the respective sector of the second side wall (12);
   - the middle frame (5) of the module (2) defines the respective sector of the floor (13);
   - the middle frame (5) comprises a plurality of beams (51-53) and a stiffening system (7), the beams being placed side by side transversely to their respective axes and the stiffening system (7) comprising at least one stiffening structure (71) which acts transversely to the respective axes of the beams to stiffen the middle frame (5);
   wherein
   - the stiffening structure (71) comprises at least one spacing element (7111) and at least one tie rod (712), the spacing element (7111) keeping at least two beams (51, 53) of the middle frame (5) spaced from each other transversely to their respective axes and the tie rod (712) tightening the at least two beams (51, 53) to each other transversely to their respective axes and in opposition to the spacing element (7111).

2. The modular building (1) according to claim 1, wherein the respective tie rod (712) passes through the at least two beams (51, 53) transversely to the respective axes of the at least two beams (51, 53) and through the respective spacing element (7111).

3. The modular building according to claim 1 or 2, wherein the beams (51, 52, 53) of the middle frame (5) in each module (2) are disposed in a row.

4. The modular building according to claim 3, wherein, in the stiffening system (7) of the middle frame (5) of each module (2):

   - the stiffening structure (71) comprises a group (711) of spacing elements which includes the at least one spacing element (7111); wherein:
   - each spacing element (7111; 7112) of the group (711) is associated with a respective pair of consecutive beams (51-52; 52-53) along the row and keeps the beams of the respective pair spaced from each other transversely to their respective axes;
   - for each pair of consecutive beams along the row, the at least one tie rod (712) tightens the beams of the pair of beams to each other, in opposition respectively to the spacing element (7111, 7112) associated with the self same pair of beams (51-52; 52-53).

5. The modular building (1) according to claim 4, wherein the tie rod (712) passes through the beams (51-53) of the middle frame (5) transversely to the respective axes of the beams and through the spacing elements (7111, 7112) of the respective group (711) of spacing elements.

6. The modular building (1) according to one or more of the preceding claims wherein, in each module (2):

   - the module (2) has a longitudinal extension (e1) along a longitudinal direction (Y1) defined by the module (2) and a transverse direction (e2) along a transverse direction (Y2) defined by the module (2), the transverse direction (Y2) being transverse to the longitudinal direction (Y1) and the longitudinal direction (Y1) coinciding with the axis of extension (X) of the building (1);
   - each beam of the middle frame (5) is disposed

with its respective axis disposed along the transverse extension (e2);
- the stiffening system (7) of the middle frame (5) comprises a plurality of stiffening structure (71) distributed one after the other along the transverse extension (e2) of the module (2), the stiffening structures (71) each acting transversely to the respective axes of the beams to stiffen the middle frame (5).

7. The modular building (1) according to claims 3 and 6, wherein the row of beams extends along the longitudinal direction (Y1) of the module (2), from a first beam (51) to a last beam (53), and the transverse direction of the module is a direction from the first side frame (3) to the second side frame (4).

8. The modular building (1) according to one or more of the preceding claims, wherein, for each coupling system (6) associated with a pair of consecutive modules along the row, where the pair of modules comprises a preceding module (2) and a succeeding module (2'), the coupling system (6) couples the middle frame (5) of the preceding module (2) and the middle frame (5') of the succeeding module (2') to each other.

9. The modular building (1) according to claims 7 and 8, wherein the coupling system (6) comprises at least one coupling structure (61), wherein the coupling structure (61) comprises at least one tie rod (612) and a spacing element (611), the spacing element (611) keeping at least the last beam (53) of the middle frame (5) of the preceding module (2) and the first beam (51') of the middle frame (5') of the succeeding module (2') spaced from each other transversely to their respective axes and the tie rod (612) tightening the last beam (53) and the first beam (51') to each other transversely to their respective axes and in opposition to the spacing element (611).

10. The modular building according to one or more of the preceding claims, wherein, in each module (2), the module (2) is configured to adopt an operating condition of the module (2), where the first side frame (3) and the second side frame (4) of the module (2) are each in a respective position away from the middle frame (5), and a transporting condition of the module (2), where the first side frame (3) and the second side frame (4) of the module are in a respective position juxtaposed with the middle frame (5);
the module (2) being configured to cause a rotational movement of both the first side frame (3) and second side frame (4) between the respective position away from the middle frame (5) and the respective position juxtaposed with the middle frame (5).

11. The modular building according to claim 10, wherein, for each side frame (3; 4) of each module (2):

- the side frame comprises a plurality of beams (31-33) placed side by side transversely to their respective axes;
- the side frame comprises a plurality of articulations (35, 36, 37);
- through these articulations, the module (2) is configured in such a way that the beams (31; 32; 33) of the side frame are each associated with a respective beam (51; 52; 53) of the middle frame (5);
- the beams (31; 32; 33) of the side frame are each connected to the beam associated therewith of the middle frame (5) through a respective articulation (35; 36; 37) in such a way that each of the articulations (35; 36; 37) may be considered associated with a respective beam (31; 32; 33) of the side frame and with a respective beam (51; 52; 53) of the middle frame (5);
- for each of these articulations (35-37) associated with a beam (31; 32; 33) of the side frame and with a beam (51; 52; 53) of the middle frame, the module (2) is configured in such a way that the articulation can cause a respective rotational movement between the beam (31; 32; 33) of the side frame and the beam (51; 52; 53) of the middle frame (5), so that the beam of the side frame can move between a position away from the beam of the middle frame (5) and a position juxtaposed with the beam of the middle frame (5).

the position of the side frame away from the middle frame (5) corresponding to the position where all the beams (31, 32, 33) of the side frame are away from the respective beams (51, 52, 53) of the middle frame;
the position of the side frame juxtaposed with the middle frame corresponding to the position where all the beams (31, 32, 33) of the side frame are juxtaposed with the respective beams (51, 52, 53) of the middle frame.

12. The modular building (1) according to claim 11, wherein for each articulation (35; 36; 37):

- the articulation (35) comprises a first member (351), a second member (352) and a hinge (353), the articulation (35) being configured in such a way that the first member (351) and the second member (352) can move by mutual rotation caused by the hinge (353), between a mutually apart position and a mutually juxtaposed position;
- the articulation (35) comprises a locking system (354) which allows defining a locked condition of the articulation (35, 36, 37) where the first member (351) and the second member (352)

are in the mutually juxtaposed position.
- for each articulation (35; 36; 37) associated with a beam (31; 32; 33) of the side frame and with a beam (51; 52; 53) of the middle frame (5), the first member (351) of the articulation is connected to the beam of the middle frame and the second member is connected to the beam (51; 52; 53) of the side frame;

the module (2) being configured in such a way that, for each articulation (35; 36; 37) associated with a beam of the side frame and with a beam (51; 52; 53) of the middle frame (5):

- the position of the beam (31; 32; 33) of the side frame away from the beam (51; 52; 53) of the middle frame (5) corresponds to the mutually juxtaposed position of the first and second members of the articulation;
- the position of the beam (31; 32; 33) of the side frame juxtaposed with the beam (51; 52; 53) of the middle frame (5) corresponds to the mutually apart position of the first member (351) and second member (352) of the articulation (35; 36; 37).

13. The modular building according to claim 12, wherein, for each side frame of each module (2):

- the side frame comprises a connecting system (34) which acts transversely to the respective axes of the beams in order to lock the beams to each other in such a way that the respective beams of the side frame perform as one the respective rotational movements relative to the respective beams of the middle frame;
the module being configured in such a way that the rotational movement of the side frame relative to the middle frame (5) comprises the rotational movements of the respective beams of the side frame relative to the respective beams of the middle frame (5), so that when at least one or each of the articulations (35-37) is in the locked condition, the side frame is locked in the position away from the middle frame (5).

14. The modular building according to claim 12 or 13, wherein the locking system of the articulation comprises at least a first locking portion (3541) integral with the first member (351) and a second locking portion (3542) integral with the second member (352), the locking system comprising a pin (3543) which, in the locked condition of the articulation, is inserted through the first locking portion (3541) and second locking portion (3542).

15. A module for constructing a modular building according to one or more of the preceding claims, comprising:

- a first side frame (3);
- a second side frame (4);
- a middle frame (5) comprising a plurality of beams (51-53) and a stiffening system (7), the beams being placed side by side transversely to their respective axes and the stiffening system (7) comprising at least one stiffening structure (71) which acts transversely to the respective axes of the beams to stiffen the middle frame (5);

wherein the stiffening structure (71) comprises at least one spacing element (7111) and at least one tie rod (712), the spacing element (7111) keeping at least two beams (51, 53) of the middle frame (5) spaced from each other transversely to their respective axes and the tie rod (712) tightening the at least two beams (51, 53) to each other transversely to their respective axes and in opposition to the spacing element (7111).

16. A construction system for constructing a modular building according to one or more of claims 1 to 14, comprising a module according to claim 15 and a coupling system for coupling the module to another module (2') of the building (1);
wherein:

- the coupling system (6) comprises at least one coupling structure (61);
- the coupling structure (61) comprises at least one tie rod (612) and one spacing element (611);
- the coupling structure is configured in such a way that the spacing element (611) can keep at least one beam (53) of the middle frame (5) of the module (2) and at least one beam (51') of a middle frame (5') of the other module (2') spaced from each other transversely to their respective axes and the tie rod (612) can tighten the last beam (53) and the first beam (51') to each other transversely to their respective axes and in opposition to the spacing element (611).

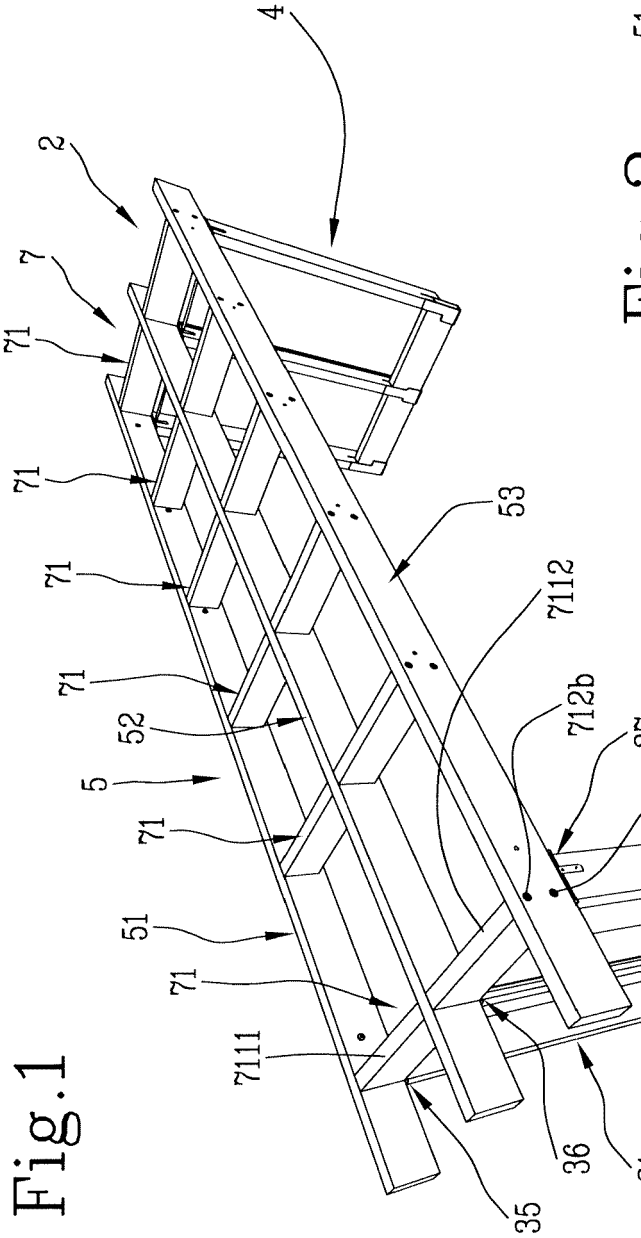

2
4
7
71
71
71
71
52
5
71
51
71
7111
35
36
31
341a
32
341b
341
34
341c
3
33
37
713b
712b
7112
53

Fig.1

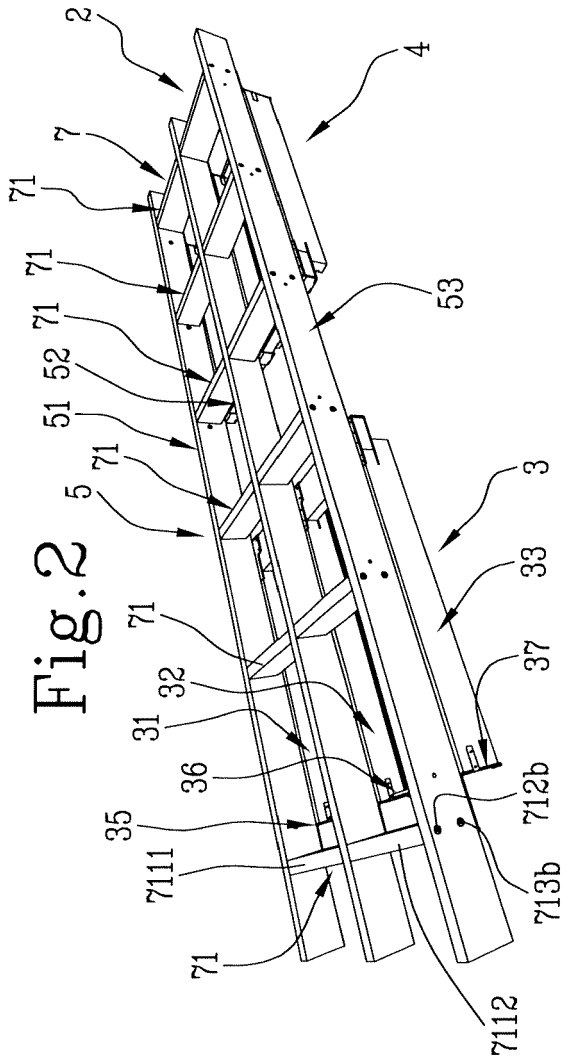

2
4
7
71
71
71
51
52
5
71
53
3
33
37
712b
713b
7112
71
7111
35
36
31
32
71

Fig.2

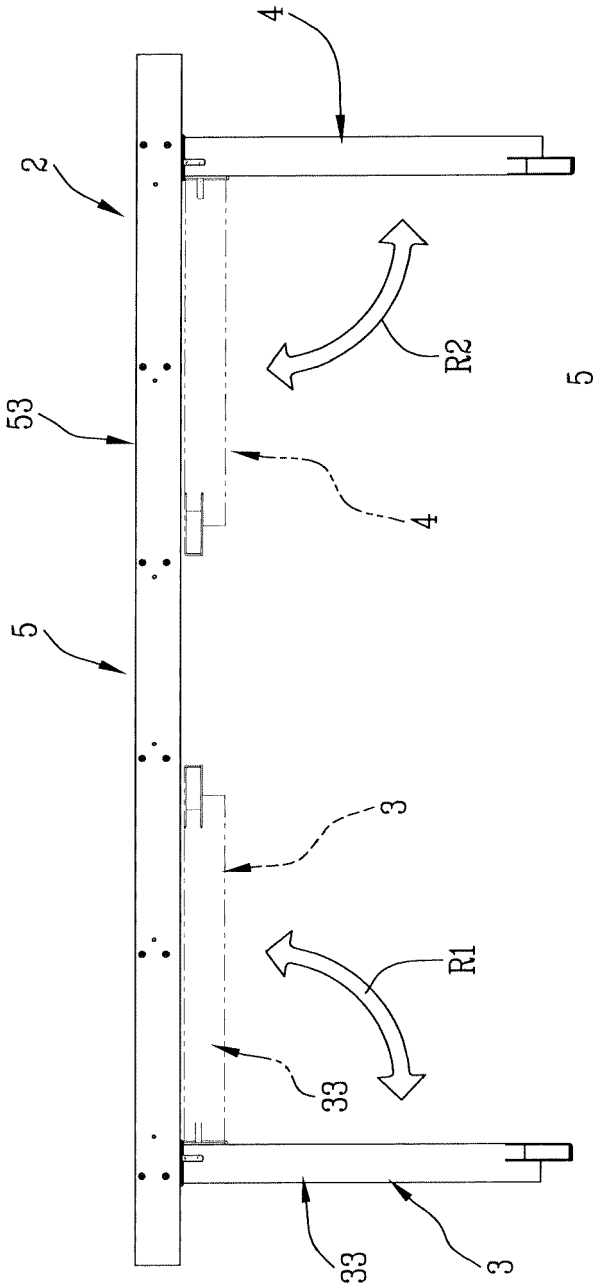

2
4
53
R2
4
5
3
R1
33
33
3

Fig.3

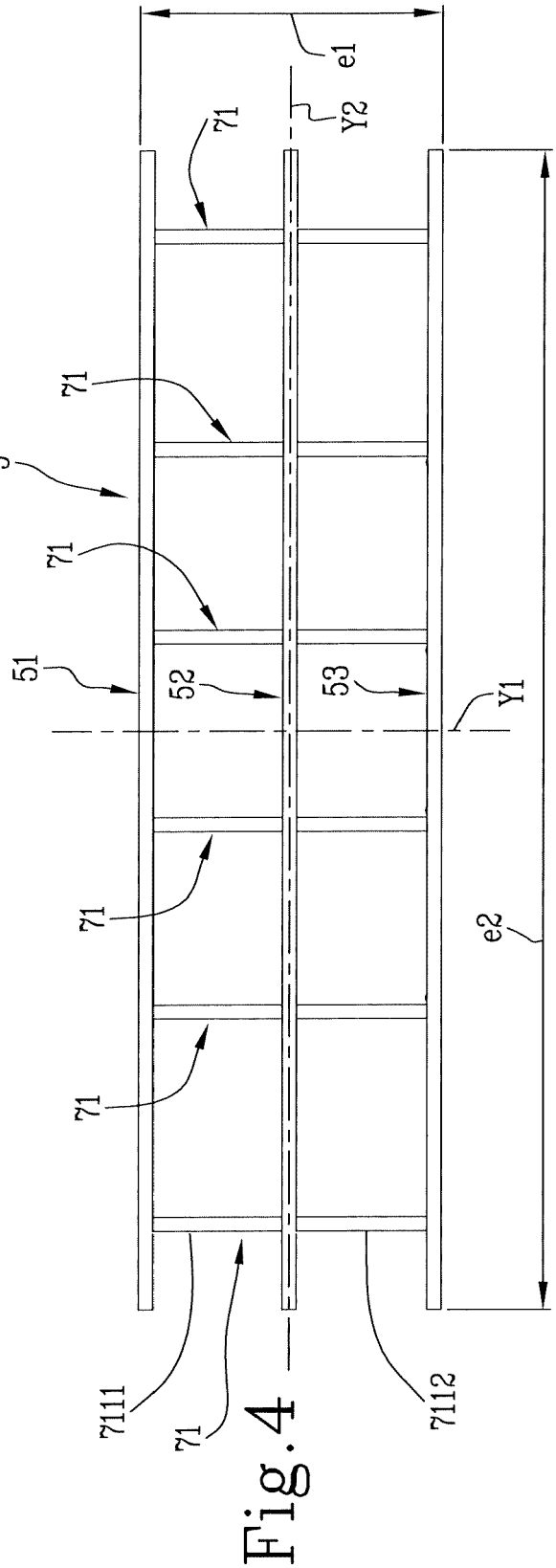

e1
Y2
71
71
5
71
51
52
53
Y1
71
71
e2
7111
71
7112

Fig.4

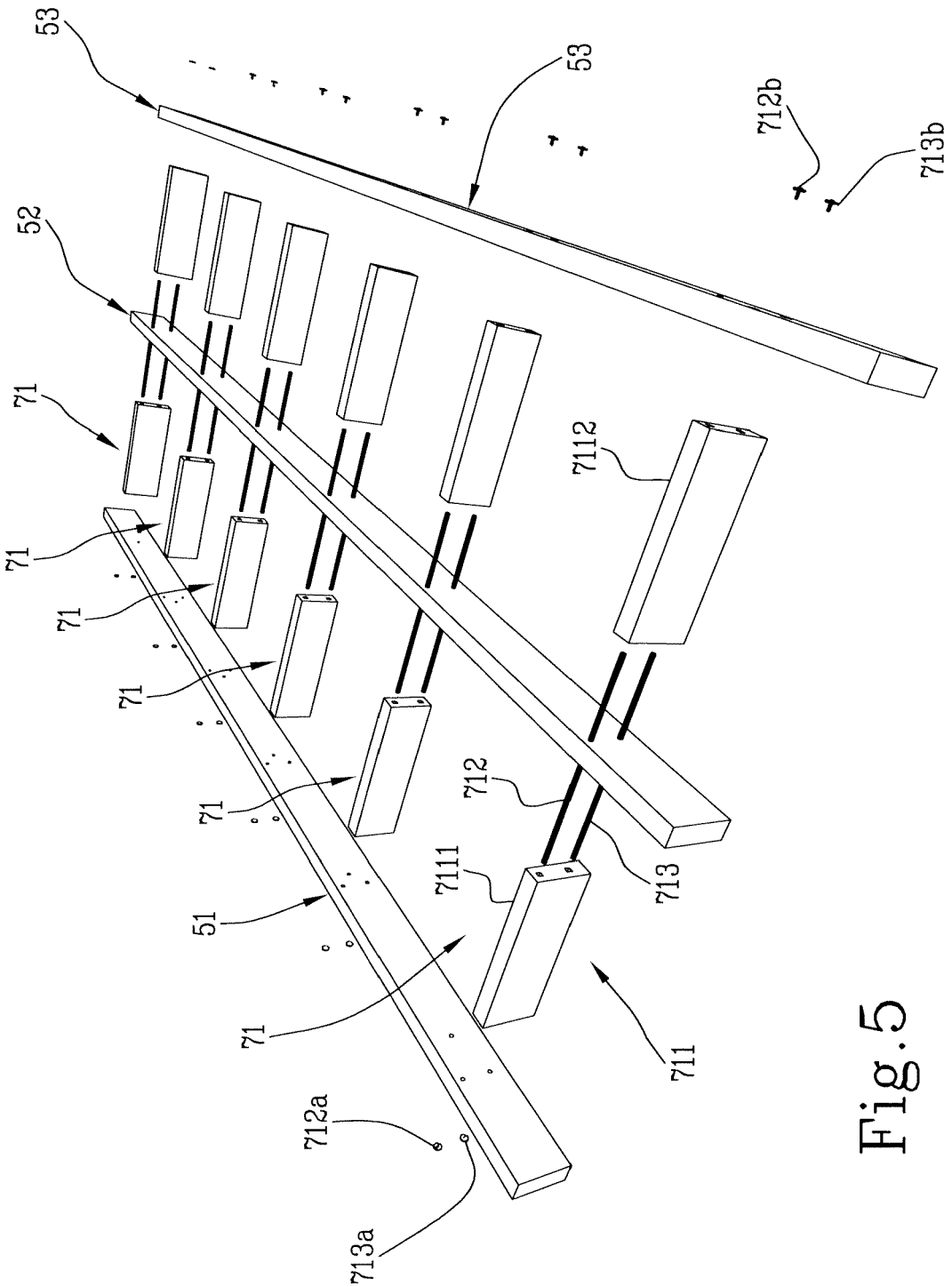

53
53
7112b
7113b
52
71
7112
71
71
71
712
71
7111
713
51
71
711
712a
713a

Fig.5

Fig.7

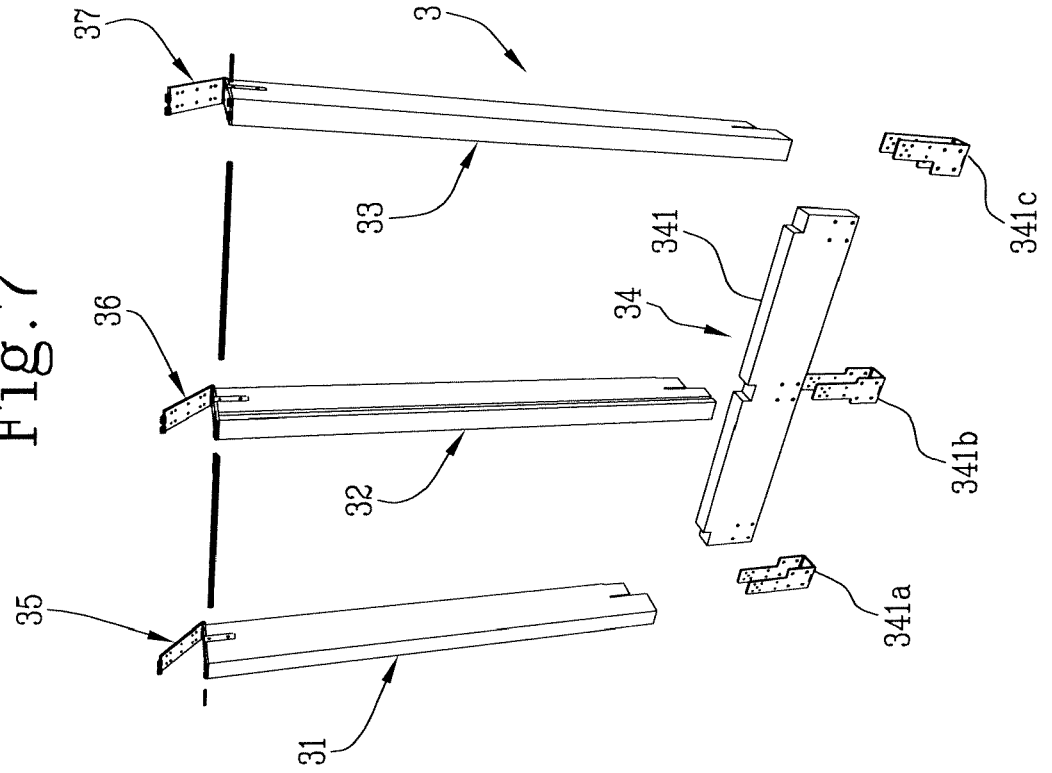

37
3
33
341c
341
34
36
341b
32
35
341a
31

Fig.6

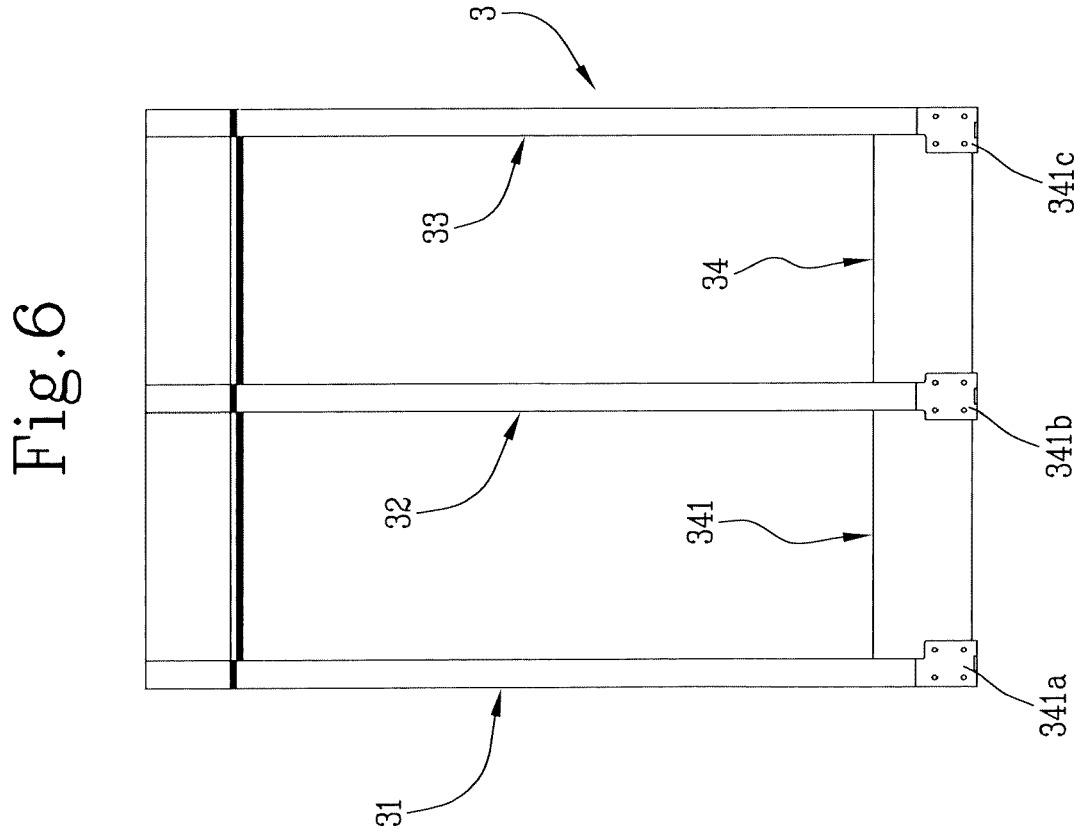
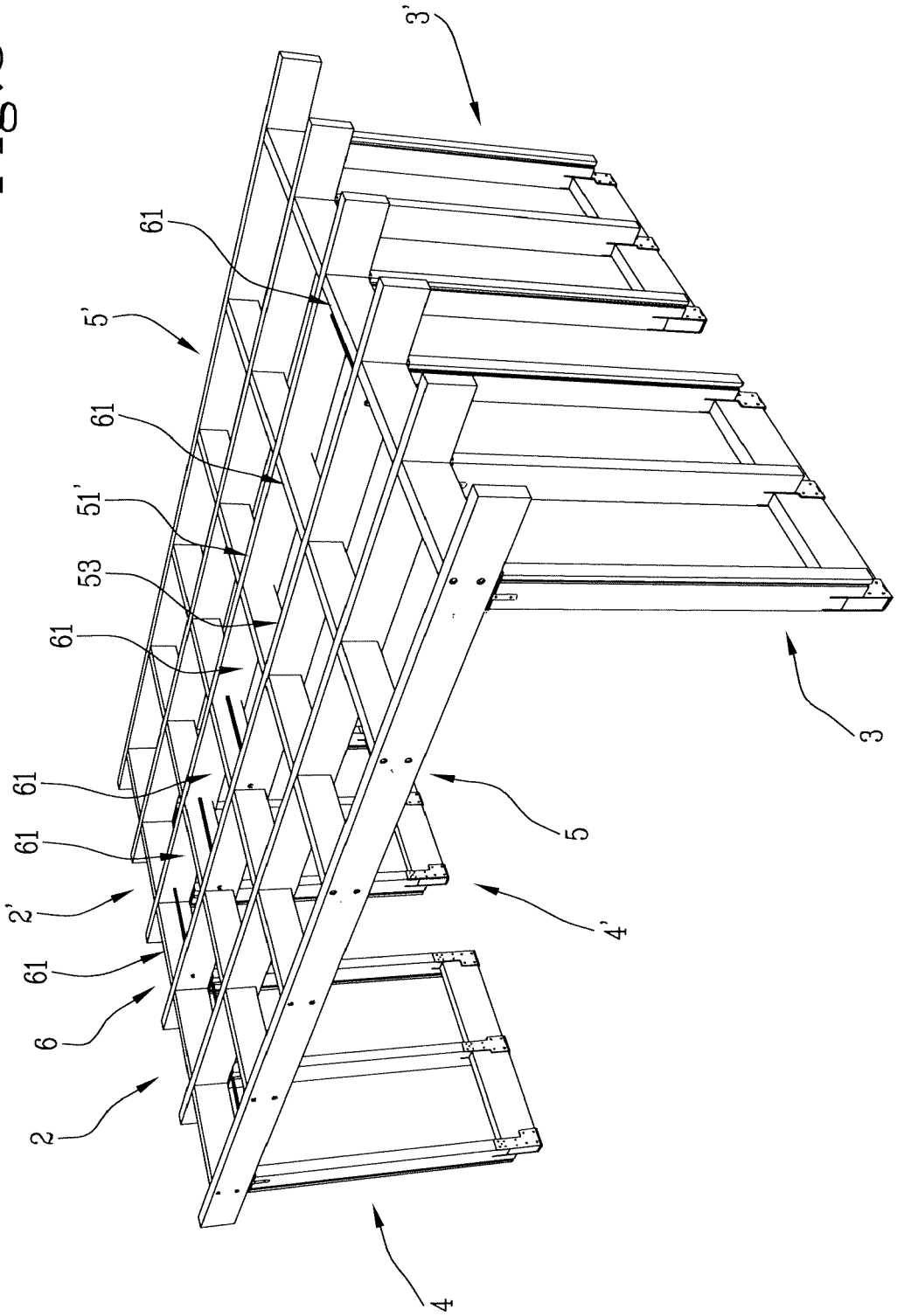

3
33
341c
34
341b
32
341
341a
31

Fig.8



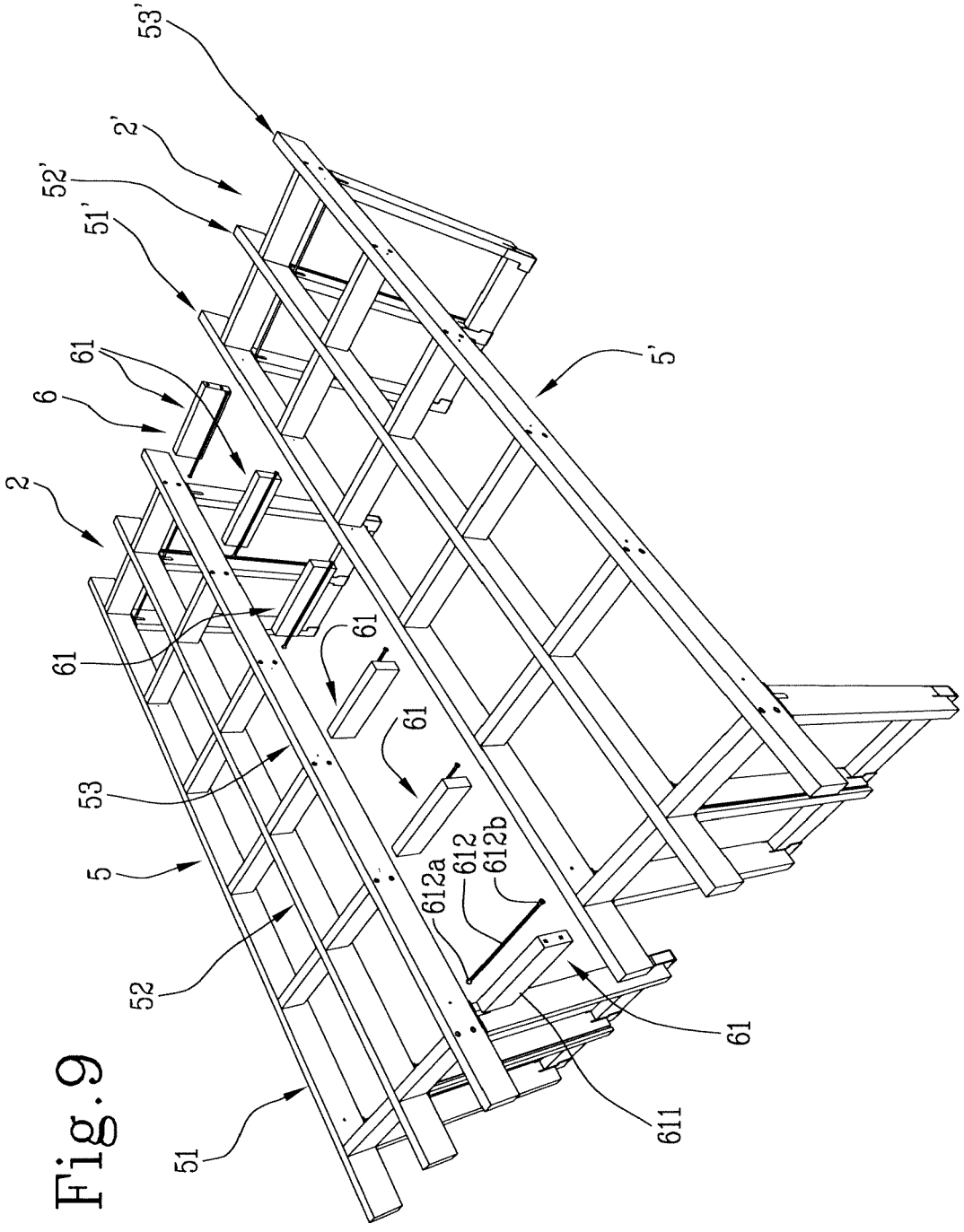


Fig.9

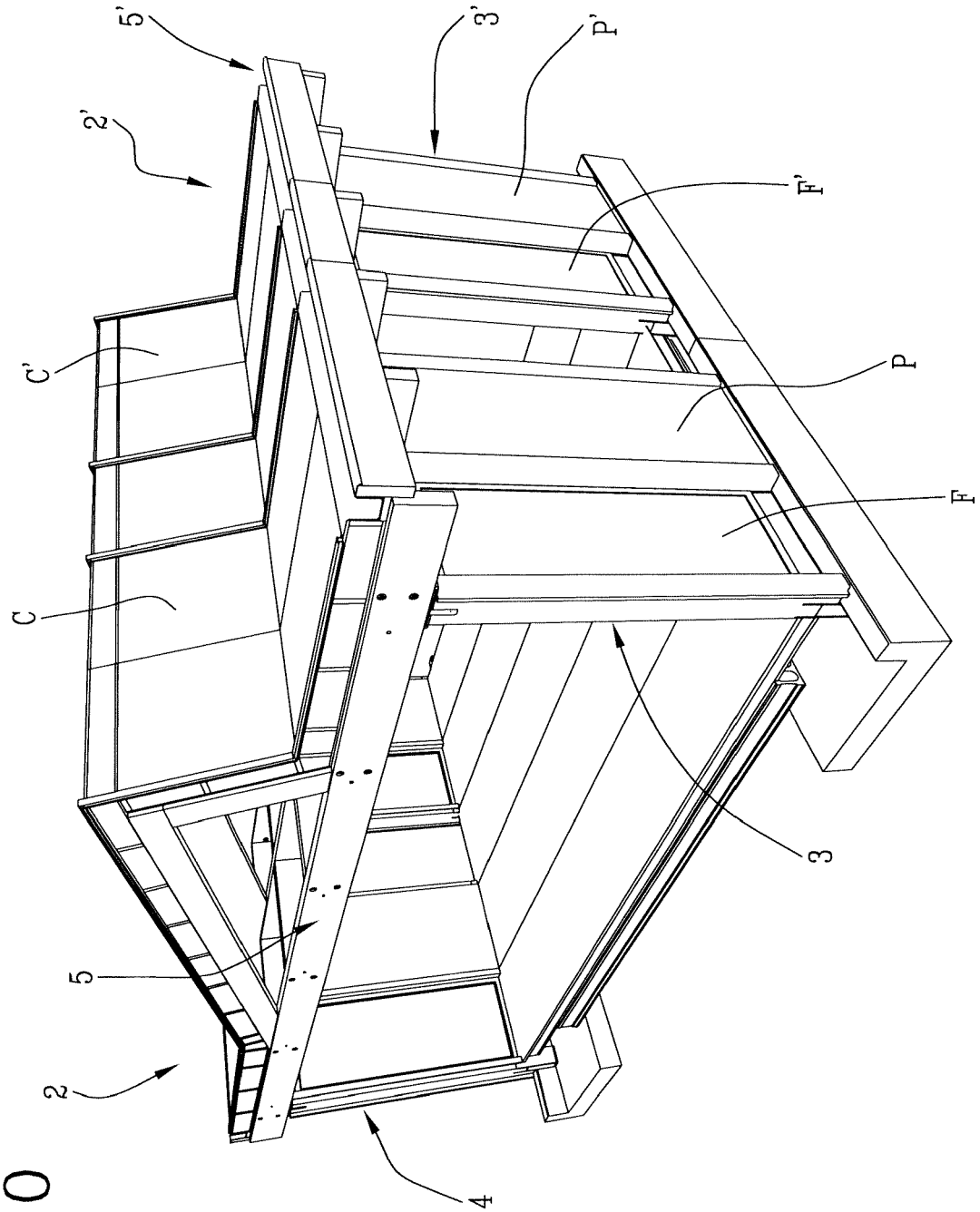


Fig.10

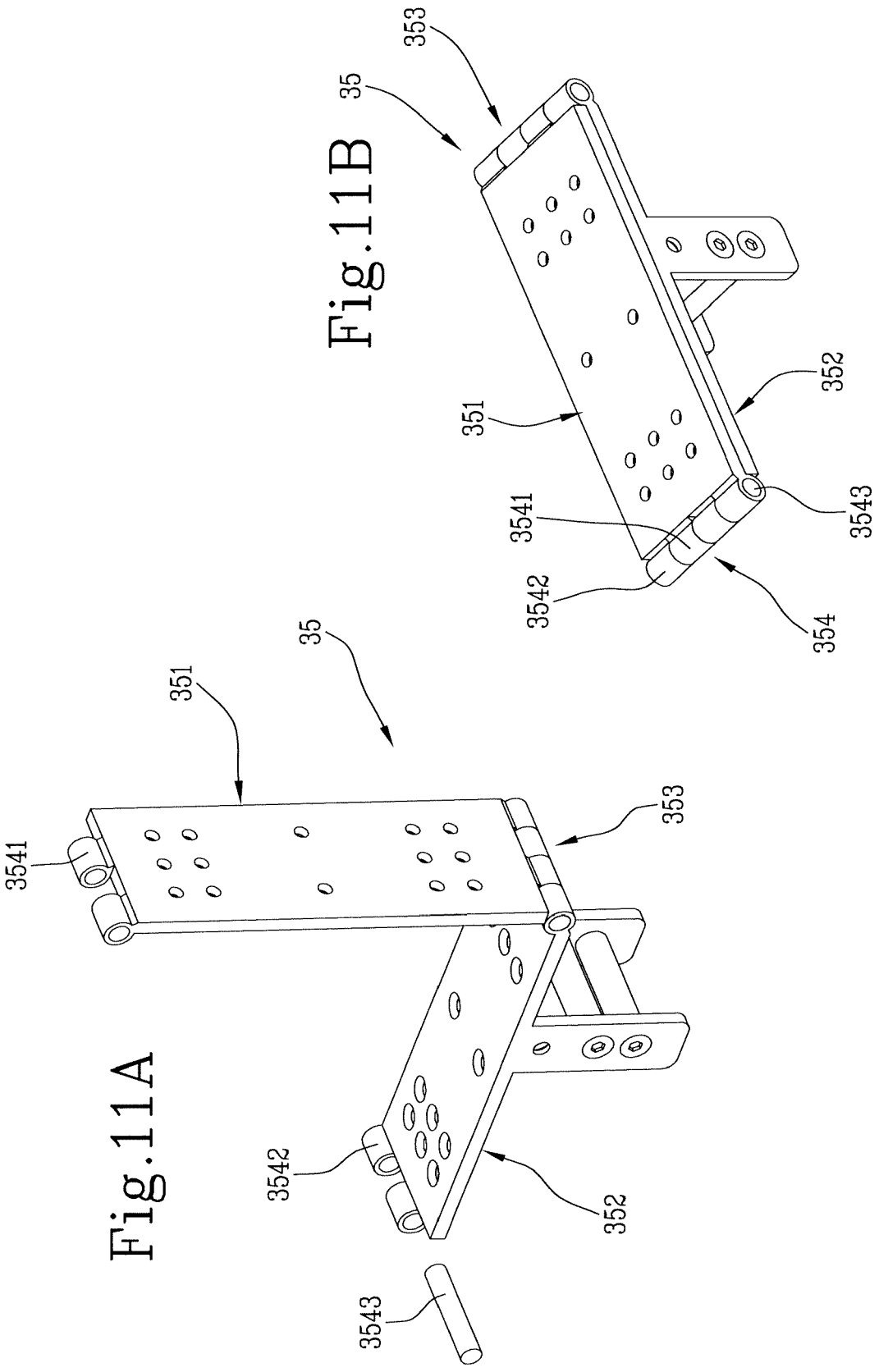


Fig.11B

Fig.11A

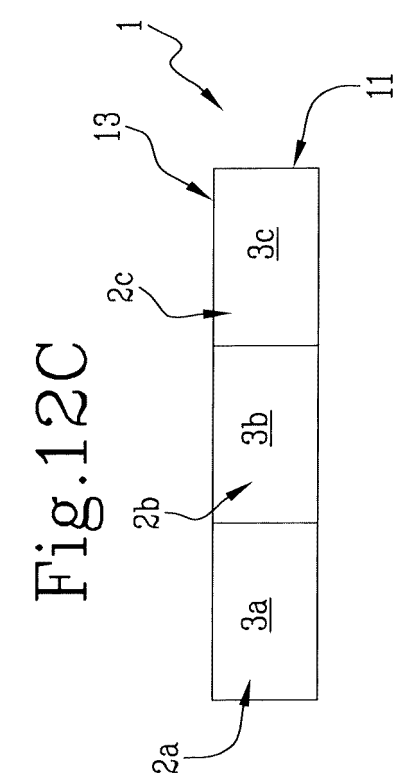


Fig.12C

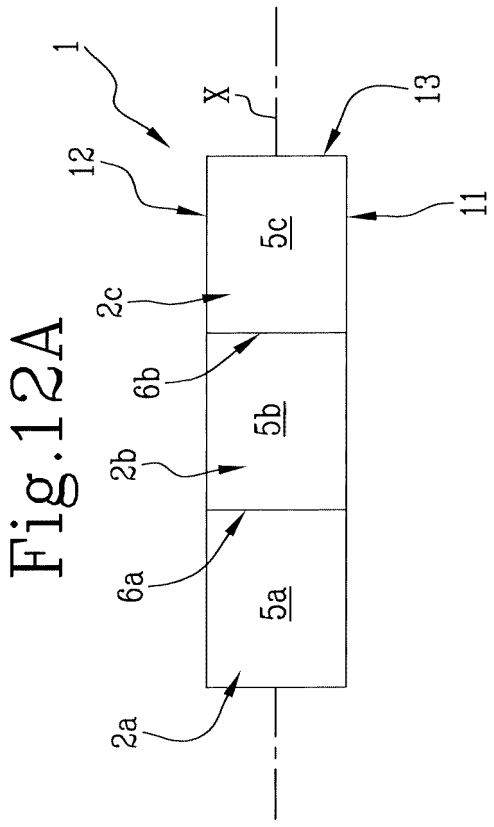


Fig.12A

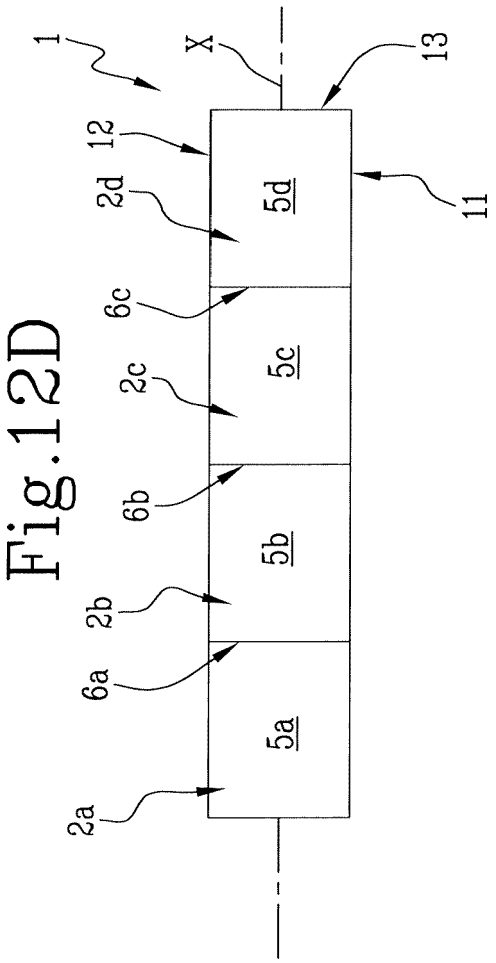


Fig.12D

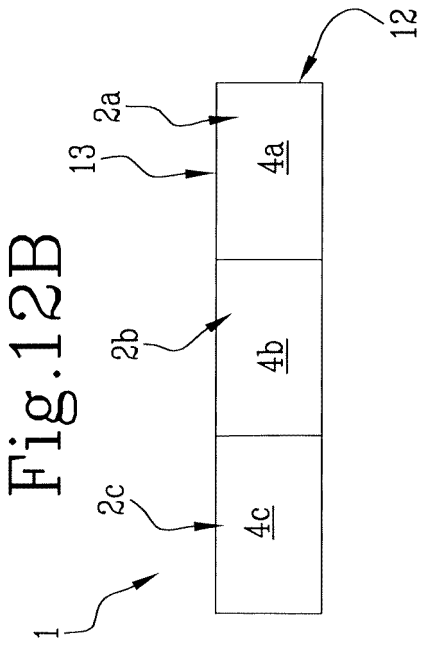


Fig.12B

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EUROPEAN SEARCH REPORT

Application Number
EP 18 42 5007

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

E04B
E05D
E04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 August 2018	Dieterle, Sibille

CATEGORY OF CITED DOCUMENTS

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