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(54) **Method for construction of a building and a building**

(57) In the method, a frame of the building is erected, which frame comprises interme-diate floors between the floors and load-bearing structural elements, such as load-bearing walls and/or pillars, supporting the intermediate floors. An opening is formed to at least one intermediate floor and the modular unit (50) is lowered through the opening to the floor under the intermediate floor. Openings can be formed to each intermediate floor of the frame and at least one modular unit can be lowered to each floor. The modular units are lowered to the floors from above so that the modular unit of the lowest floor is lowered in its place first. After this, the modular unit of the second lowest floor is lowered in its place, and this is continued until the modular units are lowered in their places to all floors. A roof cover-in is built substantially ready to the building before lowering the modular units to the floors. An opening (30a) is formed to the roof covering, which opening is in alignment with the openings of the intermediate floor, and the modular units are lowered to the floors through the opening of the roof covering and through the openings in the intermediate floor. The openings in the roof covering are covered immediately after all modular units have been transferred inside the building.

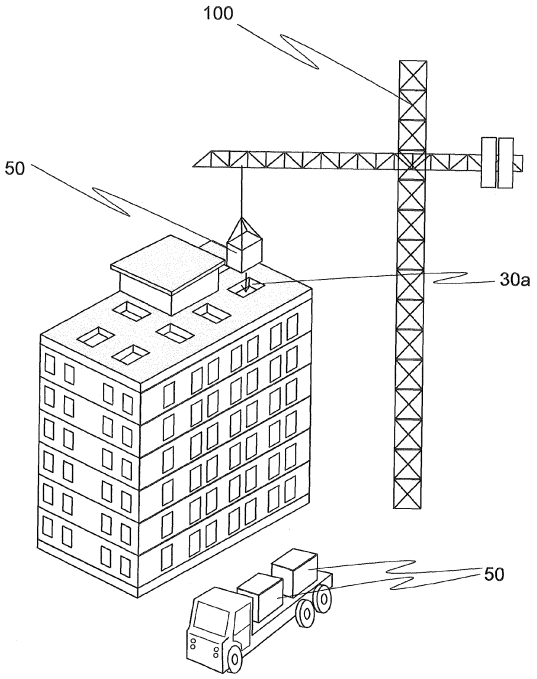

Fig. 1c

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Description

[0001] The invention relates to a method for constructing a building, which building has at least two floors, in which method a frame of the building is erected, which frame comprises at least one intermediate floor and load-bearing structural elements, such as load-bearing walls and/or pillars, supporting the intermediate floors, an opening is formed to at least one intermediate floor in connection with the construction of the intermediate floor and a modular unit is lowered to at least one floor under the intermediate floor through said opening. The invention also relates to a building constructed with the method.

[0002] The concentration of the population in cities and growth centres creates the demand to build new apartments, especially in blocks of flats. The constant price increase of new apartments has led to the situation, in which many of those in need of apartments can't afford their own apartment. The rise of the construction costs also inevitably leads to the rise of the rent level, which also makes it harder to get a rental apartment for a reasonable price. There is thus a clear need for solutions reducing the construction costs of blocks of flats.

[0003] One known way for reducing the construction costs is to increase the use of prefabricated structural elements, i.e. units. The prefabricated structural elements can be manufactured in plant conditions faster and more efficiently than on the construction site, whereby the construction time of a block of flats shortens bringing savings to the construction costs. The prefabricated structural elements typically used in the construction of blocks of flats are hollow-core slabs, partition elements and façade elements. Also prefabricated sanitary box elements, i.e. bathroom elements, are known, in which elements the entire bathroom is manufactured as one modular unit ready for installation. The finished modular units are typically installed in their places after the construction of the load-bearing frame of the building, i.e. after the construction of load-bearing vertical structures and intermediate floors. Transferring and installing of the modular units between the closed intermediate floors is hard and slow. Furthermore, the floor surface of the modular unit to be placed on the intermediate floor remains higher than the floor surface of the other spaces of the apartment, which makes the use of the space harder and weakens the aesthetic look of the apartment.

[0004] Publications FR 2025953 and US 2005/0108957 describe installation methods of modular units, in which methods the modular units are lowered in their places inside the frame of the building from above through the openings in the intermediate floors of the building. The modular units are installed in their places simultaneously with the progress of the construction work or immediately after the frame is finished. Publication WO 2007/085687 describes a repair method for sanitary cabins of a block of flats, in which method the old sanitary cabins and the parts of the intermediate floors of the building limited to them are demolished. New sanitary cabinet elements are lowered inside the building through openings formed in the intermediate floors in connection with the demolishing work.

[0005] The object of the invention is to provide a method for constructing a building, especially a block of flats, and a building constructed with the method, with which method and building the disadvantages relating to the prior art can be reduced.

[0006] The objects of the invention are obtained with a method and a building, which are characterized by what is presented in the independent claims. Some advantageous embodiments of the invention are presented in the dependent claims.

[0007] The invention relates to a method for constructing a building, which has at least two floors. In the method, a frame of the building is erected, which frame comprises at least one intermediate floor and structural elements, such as load-bearing walls and/or pillars, supporting the intermediate floors. The frame of the building can be constructed on the site or entirely or partly as prefabricated structure elements. In the method, an opening is formed to at least one intermediate floor in connection with the construction of the intermediate floor and a modular unit is lowered to at least one floor under the intermediate floor through said opening. Through the opening in the intermediate floor the modular unit can be lowered from above directly in its correct place in the floor, whereby it is not necessary to transfer the modular unit anymore in the floor level. In the method, a roof covering is substantially ready installed to the building before lowering the modular units to the floors. A substantially ready-made roof covering refers to the fact that the roof covering of the building prevents the rain water to get inside the building through the roof covering. A substantially ready-made roof covering thus comprises at least water-proof underlay and it can also comprise a surface layer of the actual roof covering. An opening is formed to the roof covering, which opening is in alignment with the openings of the intermediate floor, and the modular units are lowered to the floors through the opening of the roof covering. Before lowering the modular units in their places the opening formed in the roof covering can be covered by a temporary cover. After lowering the modular units in their places, the opening of the roof covering is constructed so as to be closed, i.e. covered with the roofing used in the roof covering, whereby the roof covering becomes entirely waterproof and uniform in its appearance.

[0008] In a preferred embodiment of the method according to the invention, a frame is erected, which frame has several intermediate floors, and at least one opening is formed to substantially each intermediate floor of the frame so that the openings are in alignment with the same vertical line and at least one modular unit is lowered through the openings to substantially each floor. In this embodiment the building to be constructed is thus clearly a block of flats, which has several floors on top of each other, which floors have one or several apartments. The

number of the floors is not limited in any way. In typical blocks of flats, the number of the floors can be from three to twelve, but the number of the floors can also be bigger than mentioned above. The number of the intermediate floors depends naturally on the number of the floors of the building. The number of the intermediate floors can be for example 2, 3, 4, 5, 6 or more than 6.

[0009] The blocks of flats are constructed so that the room spaces in different floors to be constructed from the modular units have substantially the same size and they set exactly on top of each other, i.e. they are in the same place of the intermediate floor in every floor. One floor can have several apartments, wherein each apartment has typically at least one room space to be constructed from the modular unit. The modular units are lowered to the floors from above through the openings of the intermediate floors and the roof covering so that the modular unit of the lowest floor is lowered in its place first. After this the modular unit of the second lowest floor is lowered in its place, and this is continued until the modular units are lowered in their places in all floors. Naturally, the modular unit of the uppermost floor does not need to be lowered through the intermediate floor between the floors.

[0010] In another preferred embodiment of the method according to the invention outer walls and roof are constructed to the building. A thermal insulation is installed to the outer walls and roof before lowering the modular units to the floors. In this way, a thermally insulated, weatherproof continuous outer coating is provided to the building. Due to the thermally insulated outer coating the inner temperature of the building can be increased with the heating devices to the level of the normal residential temperature, whereby the frame structures start to dry and the humidity and the temperature of the interiors can be kept substantially constant. At least a part of the outer walls of the building can be built substantially ready before lowering the modular units to the floors. This means that the construction of the cladding of the outer walls can be started immediately after installing the thermal insulation layer of the outer walls.

[0011] In yet another preferred embodiment of the method of the invention the modular units have a floor slab and they are supported from the floor slab to the edges of the opening of the intermediate floor so as to bear the vertical loads after they have been lowered in their places to the right floor inside the block of flats. The dead weight of the modular units and the loads of the modular unit during their use, such as person loads, are transferred through the edges of the floor slab to the edges of the opening of the intermediate floor, wherefrom they transfer through the load-bearing frame of the building to the ground. Vertical loads are thus not at least remarkably transferred from the modular unit located higher in the building to the modular unit underneath it. The openings of the intermediate floors are dimensioned so that they are only slightly bigger in their size than the floor slabs of the modular unit, so that only a clearance which is as small as possible and enables the through passage of the modular units remains between the edges of the floor slab and the edges of the opening. In this case, the floor slab is easy to attach from its edges to the edges of the opening without big supporting elements. Preferably the modular units are supported in their places so that the upper surface of the floor slab and the upper surface of the intermediate floor set to a substantially same level. In the apartments of the building all floor surfaces of the room spaces are thus substantially on the same level, whereby they fulfil the requirements of unrestricted living.

[0012] In yet another preferred embodiment of the method according to the invention, a modular unit comprising a floor slab, ceiling and walls, is lowered to the floor with the method. The walls have a first surface and a second surface, and the first surfaces of the walls define a bathroom inside them. The bathroom has fixed equipment and/or furniture for use in the bathroom. At least a WC seat, hand basin with accessories, shower wall or curtain, shower faucet, bathroom cabinet, lamp, heat distribution system, floor drain and washing machine connections belong typically to the equipment of such modular unit.

[0013] In yet another preferred embodiment of the method according to the invention, a modular unit, in which a part of said floor slab extends along the length of at least one wall outside the area defined by the second surfaces of said walls, is lowered to the floor with the method. This part of the floor slab and/or the second surface of said at least one wall have second fixed equipment and/or furniture for use in the second room space. The essential fact in this embodiment of the invention is thus, that there are first fixed equipment and/or furniture inside of it, which equipment and/or furniture are designed for use in the bathroom inside the modular unit, and that there are second fixed equipment outside the modular unit, which equipment are designed for use in the space outside the modular unit. The second room space outside the modular unit can be a kitchen, whereby the above-mentioned second equipment and/or furniture are fixed kitchen equipment and/or furniture. Such equipment that typically belong to every kitchen are among others kitchen cupboards, kitchen sink with accessories as well as connections for installing dish washer, stove and refrigeration equipment. The second equipment and/or furniture can also be fixed hall equipment and/or furniture, such as closets.

[0014] A building according to the invention has at least two floors, a frame comprising at least one intermediate floor and load-bearing structural elements, such as load-bearing walls and/or pillars, supporting the intermediate floors. The building comprises further at least one modular unit in the floor under at least one intermediate floor. The modular unit has been lowered through the opening in the intermediate floor formed in connection with the construction of the intermediate floor. The building is characterized by having a roof covering, which is sub-

stantially ready built before lowering the modular units to the floors. An opening which is in alignment with the openings of the intermediate floor is formed to the roof covering, and the modular units have been lowered to the floors through the opening in the roof covering. A preferred embodiment of the building according to the invention has outer walls and a roof, to which a thermal insulation has been installed before lowering the modular units to the floors.

[0015] In yet another preferred embodiment of the building according to the invention the modular units comprise a floor slab and the modular units are supported from the floor slab to the edges of the opening of the intermediate floor in a manner so as to bear the vertical loads.

[0016] An advantage of the method according to the invention is that it enables a remarkable increase of the prefabrication degree in the construction of block of flats, what shortens the construction time and brings savings to the construction costs.

[0017] Further, an advantage of the invention is that it accelerates the installation of the modular units to the building. Before installing the modular units in their places, the openings in the intermediate floors formed for the modular units serve as "channels", which make it easier and faster to heat and dry the building during the construction work. The invention thus shortens the construction time also in this way. Further, an advantage of the invention is that it improves the construction quality, since the major part of the construction-technically demanding construction works is transferred from the construction site to be made in plant conditions.

[0018] In the following, the invention will be described in detail. In the description, reference is made to the enclosed drawings, in which

Figs. 1a to 1d show by way of an example a construction method of a building according to the invention with the aid of a series of pictures and

Figure 2 shows a cross-sectional view of the modular unit in a building constructed with the method.

Figures 1a-1d show by way of an example a construction method of a building according to the invention with the aid of a series of pictures.

[0019] The building to be constructed with the method presented in Figures 1a-1d is a six-storey block of flats. In the method, the foundation 28 is constructed first, on which foundation the frame 10 of the block of flats is erected (Fig. 1 a). The foundation can be a footing foundation or a pile foundation or any other known foundation. The block of flats has several floors 26 on top of each other, which floors can have one or more apartments. The block of flats presented in Figures 1a-1d has six floors, but it can also have another number of floors. Between each floor there is an intermediate floor 12, which forms the ceiling of the lower floor and the floor of the upper floor. The upper surface of the uppermost floor has a roof 14, which has a substantially same structure as the intermediate floors. The lower surface of the lowest floor has a base floor 16, which in Figure 1a is a ground slab. Between the intermediate floors 12 and the uppermost intermediate floor and the roof 14 there are vertical load-bearing walls 20 and pillars 22, which bear the loads of the roofs and intermediate floors and transfer them into the foundation. The frame of the block of flats is constructed from reinforced concrete, i.e. its load-bearing structures are reinforced concrete structures. The frame can be constructed on the site or entirely or partly as prefabricated structure elements. The construction of the frame of the block of flats is conventional known construction technique, which is not described in more detail in this connection.

[0020] In the method, openings 30 are formed in each intermediate floor 12 so that the openings in the superimposed intermediate floors have substantially the same size and form and they are in alignment with the same vertical line. Openings 30 corresponding to the openings in the intermediate floors are formed to the roof 14. The openings are formed so many, that there is one opening in the place of an apartment to be built in each floor. The openings are dimensioned so that their outer dimensions are slightly bigger than the outer dimensions of the modular unit to be placed in the opening.

[0021] The thermal insulation layer of the roof 14 and the roof covering 18 as well as the outer walls 24 of the building are constructed after the frame of the building has been finished. The roof covering is constructed to a degree of readiness, where the roof covering becomes rain water proof. This means that at least waterproof underlay is installed to the roof covering. The roof covering can also be substantially ready built in its entirety, i.e. also a final surface layer of the roof covering can be installed therein. Lead-through openings 30a are left in the roof covering in the places of the openings in the roof. The openings of the roof covering are covered by opening covers (the covers are not presented in the Figures), so that the roof covering becomes waterproof.

[0022] The outer walls can be constructed on site or as prefabricated structure elements. The outer walls are constructed at least to a degree of readiness, where they have a finished thermal insulation and an external wind shield layer covering the thermal insulation from weather. After the construction of the outer walls and roof covering the interiors of the building are protected from the weather and the outer covering of the building is thermally insulated. After this the inner temperature of the building is increased to normal residential temperature with the heating devices, whereby the structures begin to dry. The drying of the structures can be accelerated with separate dryers. Decoration works of the building are made simultaneously with the drying of the structures.

[0023] After having obtained a sufficiently low relative air humidity concerning the durability of the surface ma-

terials the modular units 50 (Figure 1 c) are transferred inside the building. The modular units are prefabricated structural elements, which have a floor slab, walls and a ceiling. The structure of the modular units is disclosed in more detail in the description of Figure 2. The modular units are ready built and equipped at the element factory and delivered to the construction site as parts ready to be installed. In order to transfer the modular units, the openings 30a in the roof covering are opened and the modular units are lowered by a crane 100 through the openings in the roof covering 18, roof 14 and in the intermediate floors 12 to the floors 26. The openings of the roof covering, roof and intermediate floors are dimensioned so that the side dimensions of the openings are slightly bigger than the outer dimensions of the modular unit. The side dimensions of the opening can be for example in both directions 50 mm bigger than the side dimensions of the modular unit. Thus, a sufficient clearance, which enables a lead-through, remains between the outer surfaces of the walls of the modular unit and the edges of the opening.

[0024] The installation of modular units is started from the lowest floor, i.e. the modular unit of the lowest floor is lowered first in its place on the base floor 16. The base floor has a cavity 17 (Figure 1a) in the lowering point of the modular unit, the outer dimensions of which cavity are the same as the dimensions of the openings in the intermediate floors 12. The depth of the cavity is dimensioned so that the upper surface of the floor slab and the upper surface of the base floor 16 of the modular unit placed in the cavity set substantially on the same level. The modular unit of the lowest floor is attached to the base floor by grouting.

[0025] Next, the modular unit 50 of the second lowest floor is lowered in its place. The modular unit is lowered down in the manner described above by a crane 100 through the openings in the roof covering 18, roof 14 and the intermediate floors 12. The modular unit is attached from the edges of the floor slab to the edges of the opening 30 of the intermediate floor 12 by appropriate fixing elements so that the dead weight and person loads are transferred through the fixing elements to the edges of the opening of the intermediate floor. The fixing elements can be for example steel fixing plates generally used in concrete elements, which fixing plates are cast with the rod-like attachment parts so as to fix to the edges of the opening 30 of the intermediate floor and to the edges of the floor slab of the modular unit. Steel fixing plates can be attached to each other by welding with the aid of a connector. The gap between the floor slab of the modular unit and the edges of the opening of the intermediate floor is filled with grouting.

[0026] Modular units are installed in a respective manner to all floors and all apartments of a floor of the block of flats. After the modular units of the uppermost floor have been lowered and fixed in their places, the openings 30a in the roof 14 and roof covering 18 are covered (Figure 1d). After the covering of the openings the roof is entirely thermally insulated and the roof covering is waterproof.

[0027] Figure 2 shows by way of an example a cross-sectional view of a modular unit 50 in a building constructed with the method. The modular unit is a closed "room-like" space, which has a floor slab 52, walls 54 and a ceiling 56. One wall has an opening door 58 for getting in to the modular unit. The walls 54 of the modular unit are in their structure normal walls having skeleton construction and being coated with lining plates on both sides. The ceiling has horizontal supporting beams, on the under surface of which there is an interior lining plate. The floor slab of the modular unit is dimensioned so that it bears the loads coming from its dead weight as well as the service loads when supported from its edges. The floor slab is manufactured from reinforced concrete. The floor slab is attached from its edges to the edges of the opening 30 of the intermediate floor 12 so that the upper surface of the floor slab and the upper surface of the intermediate floor are substantially set to the same level. For fixing the modular unit, there are steel fixing plates 60 on the edge surfaces of the floor slab and on the edge surface of the opening 30, which fixing plates are cast by rod-like attachment parts so as to fix to the edges of the opening of the intermediate floor and to the edges of the floor slab. The steel fixing plates are welded together with the aid of connectors 68. The gap between the floor slab of the modular unit and the edges of the opening of the intermediate floor is filled with grouting 62.

[0028] Inside the modular unit, there are fixed equipment and/or furniture for use in the bathroom (furniture and equipment are not shown in the Figure). At least a WC seat, hand basin with accessories, shower wall or curtain, shower faucet, bathroom cabinet, lamp, heat distribution system, floor drain and washing machine connections belong typically to the equipment of a bathroom modular unit. The modular unit has in one corner a vertical channel 66, a so-called duct, defined by the walls, the first end of which channel opens through the opening in the floor slab 52 under the floor slab and the second end opens through the opening in the ceiling 56 over the ceiling. The channel is designed for placing the pipes and wires of the heating, plumbing, ventilation and electrical installation systems of the block of flats. Such pipes and wires to be placed in the channel are among others drain pipes, air pipes, pipes for cold and warm service water, pipes for the water circulating heating system, pipes for sprinkler system and electric cables. The channel can have all above-mentioned pipes and wires ready-fitted, wherein the pipes and wires of the superimposed modular units are connected to each other when installing the modular units. The floor height of a block of flats is according to the building regulations at least 3 meters, wherein the clearance between the upper intermediate floor and the lower intermediate floor of the story is about 2700 mm, The modular unit is dimensioned so that the distance between the upper surface of the floor slab and the upper surface of the ceiling is about 2400 mm, i.e.

clearly smaller than 2700 mm. Between the two superimposed modular units installed in their places, i.e. between the upper surface of the ceiling of the lower modular unit and the lower surface of the floor slab of the upper modular unit remains thus an assembly space 64, in which pipes and wires passing in the channels 66 of the modular units can be connected.

[0029] Some advantageous embodiments of the method and building according to the invention have been described above. The invention is not limited to the solutions described above, but the inventive idea can be applied in different ways within the scope of the claims.

Claims

1. A method for constructing a building, which building has at least two floors (26), in which method a frame (10) of the building is erected, which frame comprises at least one intermediate floor (12) and load-bearing structural parts, such as load-bearing walls (20) and/or pillars (22), supporting the intermediate floors, an opening (30) is formed in at least one intermediate floor (12) in connection with the construction of the intermediate floor and a modular unit (50) is lowered to at least one floor (26) under the intermediate floor through said opening, **characterized in that** a roof covering (18) is built substantially ready to the building before lowering the modular units (50) to the floors (26), an opening (30a) is formed to the roof covering (18), which opening is in alignment with the openings (30) of the intermediate floor (12), and the modular units (50) are lowered to the floors through the opening (30a) of the roof covering (18).

2. The method according to claim 1, **characterized In that** a frame (10), which has several intermediate floors (12), is erected and at least one opening (30) is formed to substantially each intermediate floor (12) of the frame (12) in connection with the construction of the intermediate floors so that the openings (30) are in alignment with the same vertical line and at least one modular unit (50) is lowered to substantially each floor (26) through the openings (30).

3. The method according to claim 1 or 2, **characterized in that** outer walls (24) and a roof (14) are constructed to the building, to which outer walls and roof a thermal insulation is installed before lowering the modular units (50) to the floors (26).

4. The method according to any of the claims 1-3, **characterized in that at** least a part of the outer walls (24) of the building is built substantially ready before lowering the modular units (50) to the floors (26).

5. The method according to any of the claims 1-4, **characterized in that** the modular units (50) have a floor slab (52) and the modular units are supported from the floor slab to the edges of the opening (30) of the intermediate floor (12) in a manner so as to bear the vertical loads.

6. The method according to any of the claims 1-5, **characterized in that** with the method, a modular unit (50) is lowered to the floor (26), which modular unit comprises a floor slab (52), a ceiling (56) and walls (54), which walls (54) have a first surface and a second surface, the first surfaces of which walls define a bathroom, which bathroom has fixed equipment and/or furniture for use in the bathroom.

7. The method according to claim 6, **characterized in that** with the method, a modular unit (50) is lowered to the floor (26), in which modular unit a part of said floor slab (52) extends along the length of at least one wall (54) outside the area defined by the second surfaces of said walls and said part of the floor slab (52) and/or the second surface of at least one wall have second fixed equipment and/or furniture for use in the second room space.

8. A building comprising at least two floors (26), a frame (10), which comprises at least one intermediate floor (12) and load-bearing structural elements, such as load-bearing walls (20) and/or pillars (22), supporting the intermediate floors, and at least one modular unit (50) in the floor (26) under at least one intermediate floor (12), which modular unit (50) has been lowered to the floor (26) through the opening (30) formed to the intermediate floor (12) in connection with the construction of the intermediate floor, **characterized in that** the building has a roof covering (18), which is built substantially ready before lowering the modular units (50) to the floors (26), and an opening (30a) is formed to the roof covering (18) in alignment with the openings (30) of the intermediate floor (12) and the modular units (50) have been lowered to the floors through the opening (30a) of the roof covering (18).

9. The building according to claim 8, **characterized in that** the building has outer walls (24) and a roof (14), to which outer walls and roof a thermal insulation has been installed before lowering the modular units (50) to the floors (26).

10. The building according to claim 8 or 9, **characterized in that** the modular units (50) have a floor slab (52) and the modular units are supported from the floor slab to the edges of the opening (30) of the intermediate floor (12) in a manner so as to bear the vertical loads.

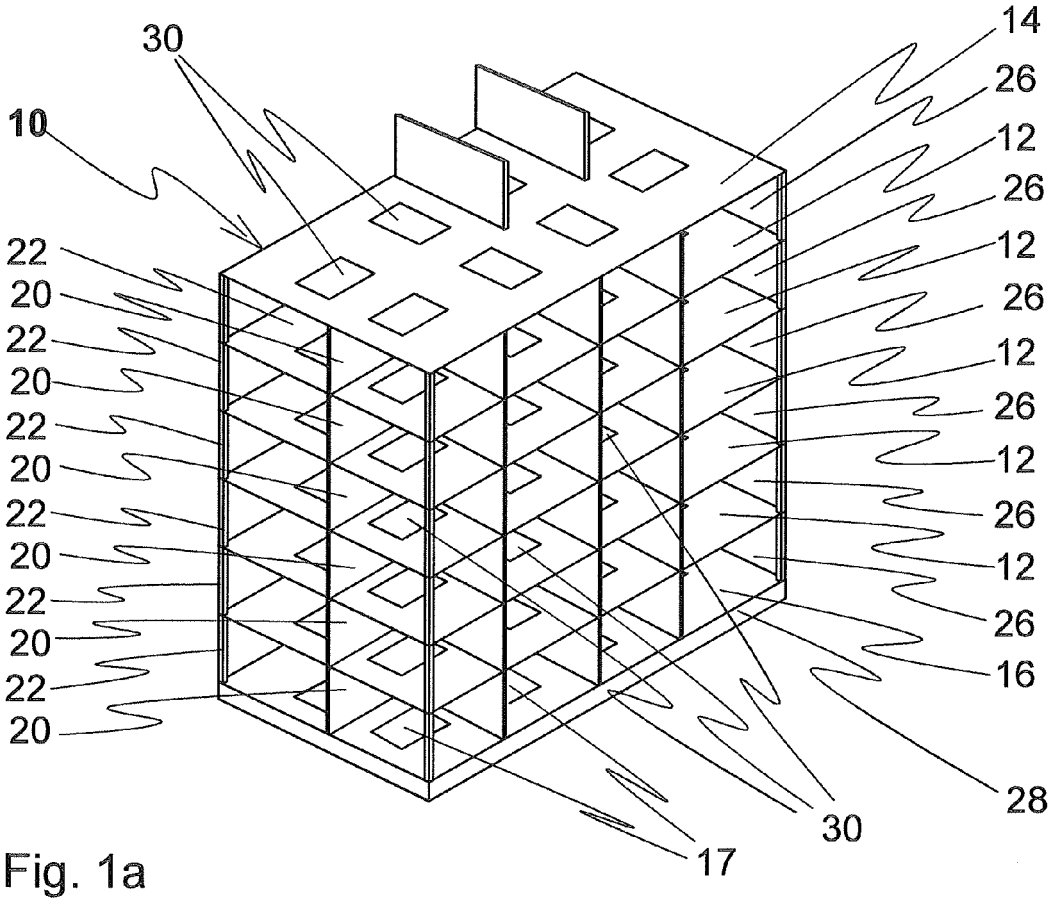
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Fig. 1a

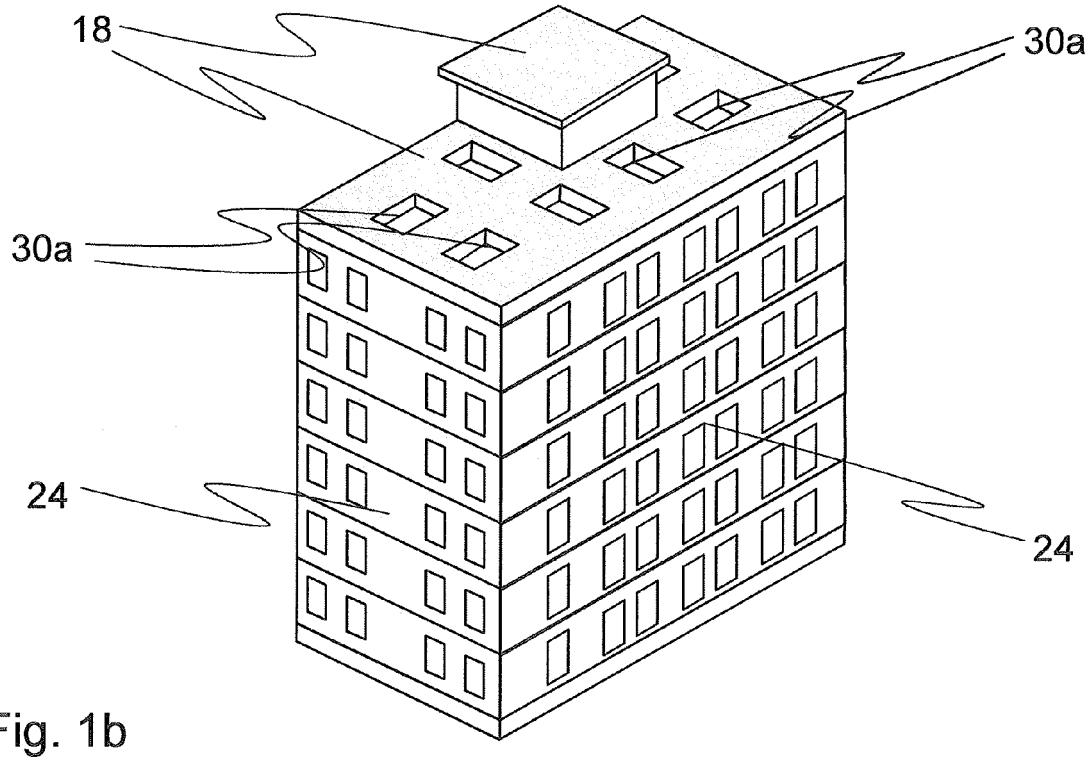
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Fig. 1b

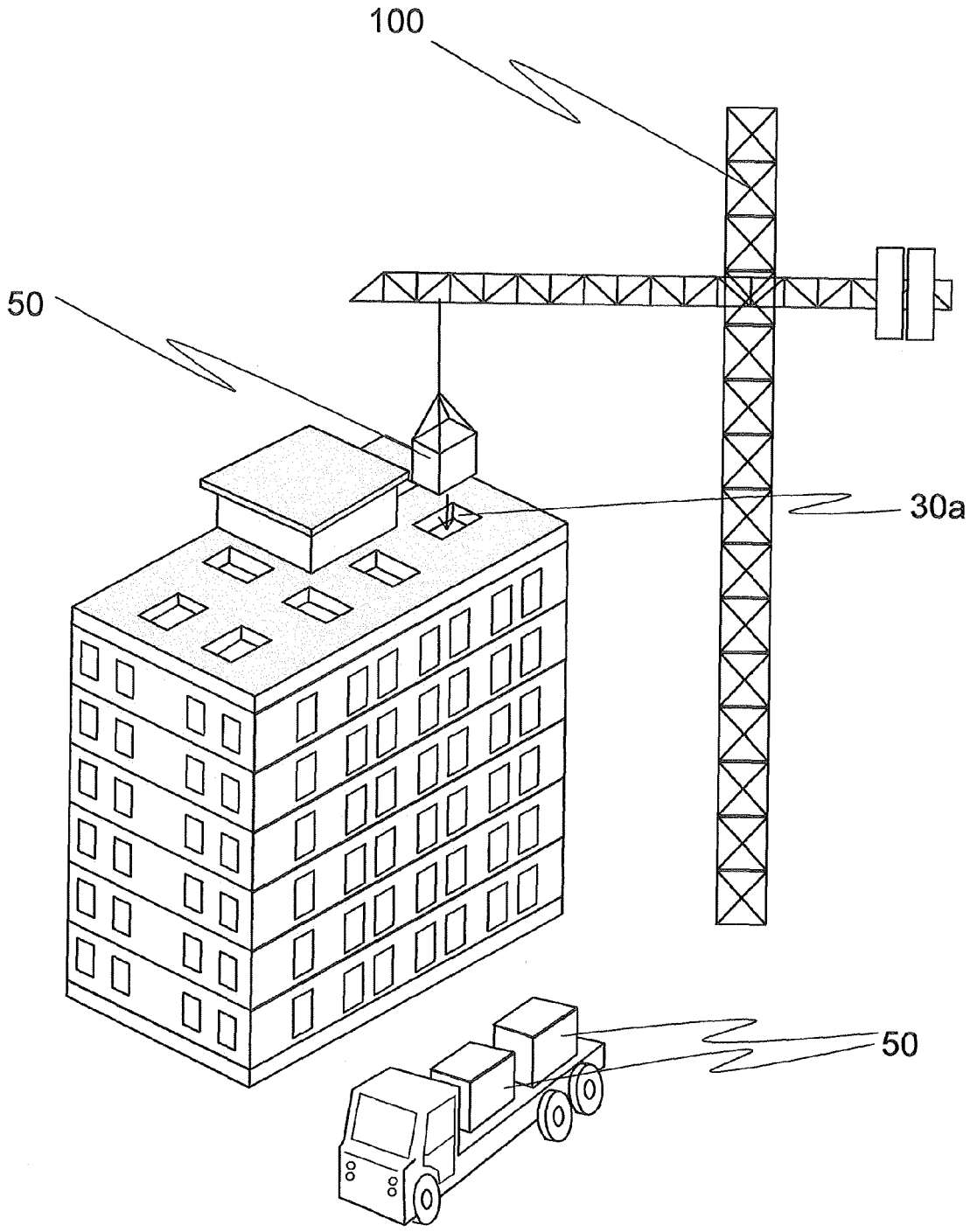

Fig. 1c

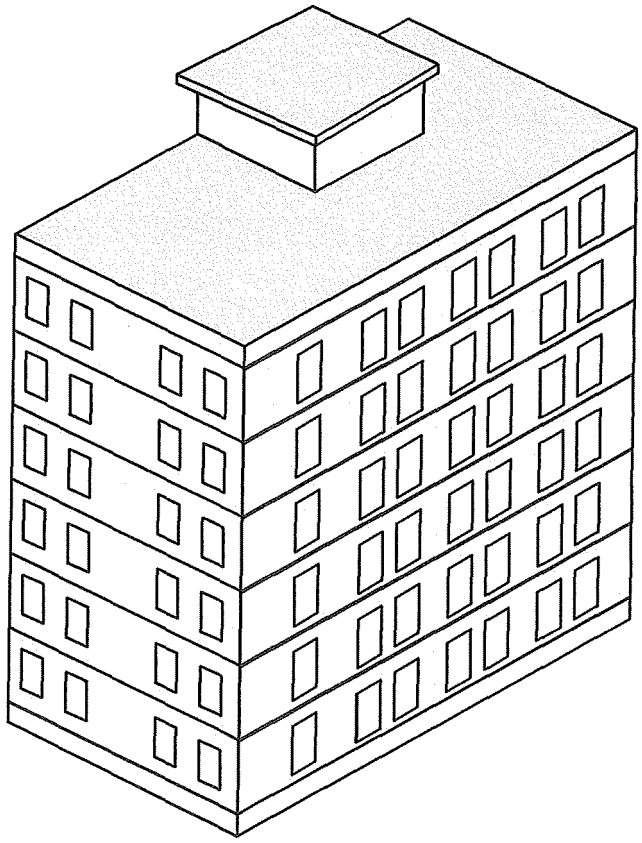

Fig. 1d

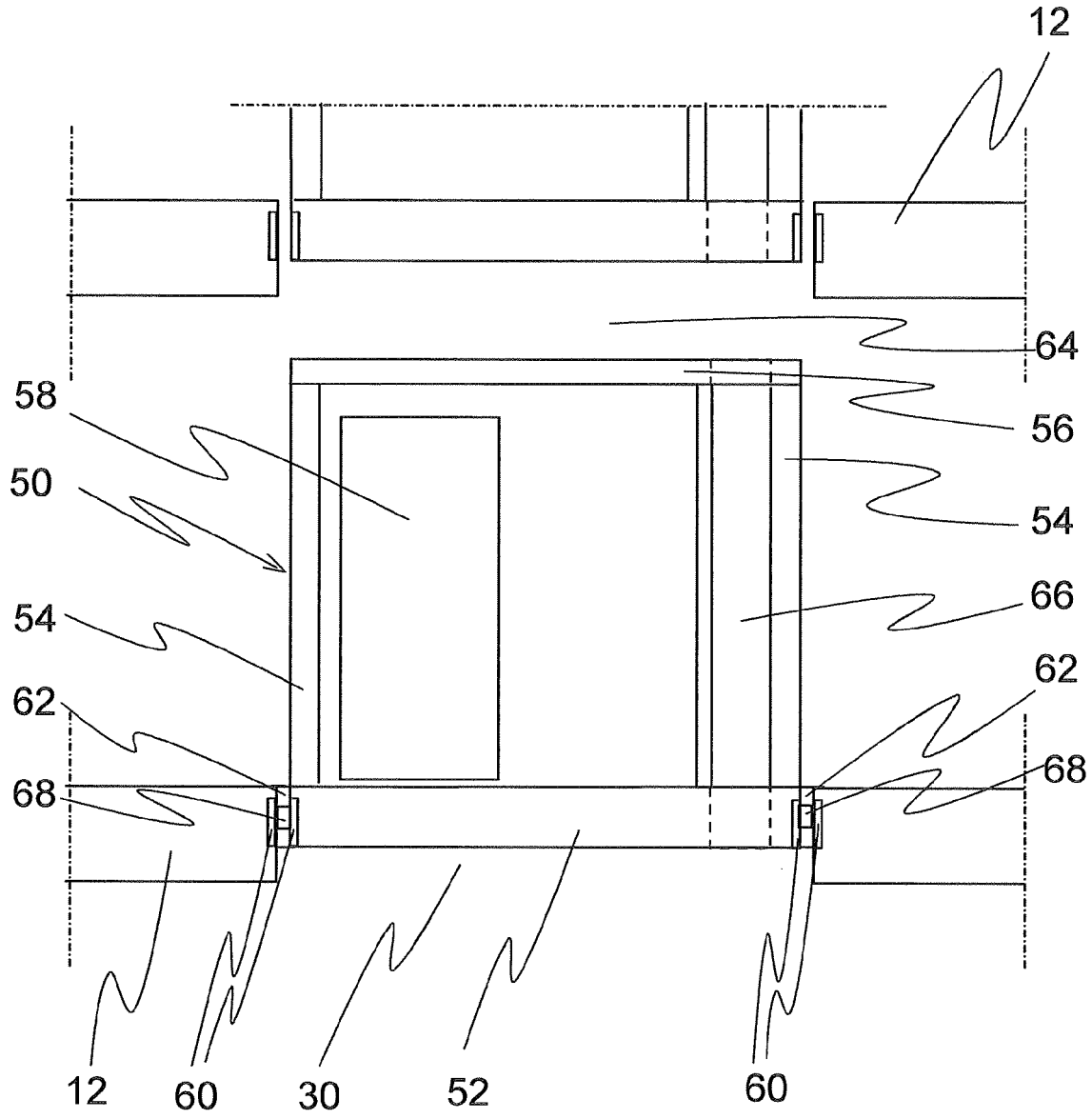

Fig. 2

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 14 39 7515

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	WO 2007/085687 A1 (T T TYOEMAATULOS OY [FI]; PITKAENEN HARRI [FI]) 2 August 2007 (2007-08-02)	8-10	INV. E04B1/348
A	* abstract * * page 2, line 36 - page 3, line 36 * * figures *	1-7	
X	FR 2 944 301 A1 (NEW CONCEPT [FR]) 15 October 2010 (2010-10-15) * page 4, line 1 - line 12 * * figure 1 *	8,9	
A,D	FR 2 025 953 A1 (RAMM BLOC SYSTEMS GMBH) 11 September 1970 (1970-09-11) * page 3, line 10 - line 19 * * figures *	1,8,10	
A,D	US 2005/108957 A1 (QUESADA JORGE D [US]) 26 May 2005 (2005-05-26) * paragraph [0058] - paragraph [0061] * * figures 1,10-12,16b *	1	
A	FR 1 556 987 A (RENÉ VILLENEUVE) 14 February 1969 (1969-02-14) * claim 1 * * figures 4,5 *	1	TECHNICAL FIELDS SEARCHED (IPC) E04B E04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 August 2014	López-García, G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

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