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(72) Inventors:
• **PONTAROLO, Valerio**
33079 Sesto al Reghena (PN) (IT)
• **PONTAROLO, Luca**
33079 Sesto al Reghena (PN) (IT)
• **PONTAROLO, Valentina**
33079 Sesto al Reghena (PN) (IT)

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(74) Representative: **Frare, Paolo et al**
Barzanò & Zanardo Milano S.p.A.
Via Borgonuovo 10
20121 Milano (IT)

(71) Applicant: **Pontarolo Engineering S.p.a.**
33078 San Vito al Tagliamento (PN) (IT)

(54) **DISPOSABLE FORMWORK FOR INSULATED MASONRY, AND BUILDING MADE WITH A MASONRY INCLUDING SUCH FORMWORK**

(57) The present invention relates to a disposable formwork (1) for insulated masonry comprising a first panel (2), thermally and/or acoustically insulating, and a second panel (3), facing said first panel (2) and connected to the same by one or more crossbeams (4), wherein

the second panel (3) is made of a material having a density comprised between 150 and 2500 kilograms per cubic meter (kg/m^3) and a specific heat capacity comprised between 0.5 kJ/kgK and 2 kJ/kgK.

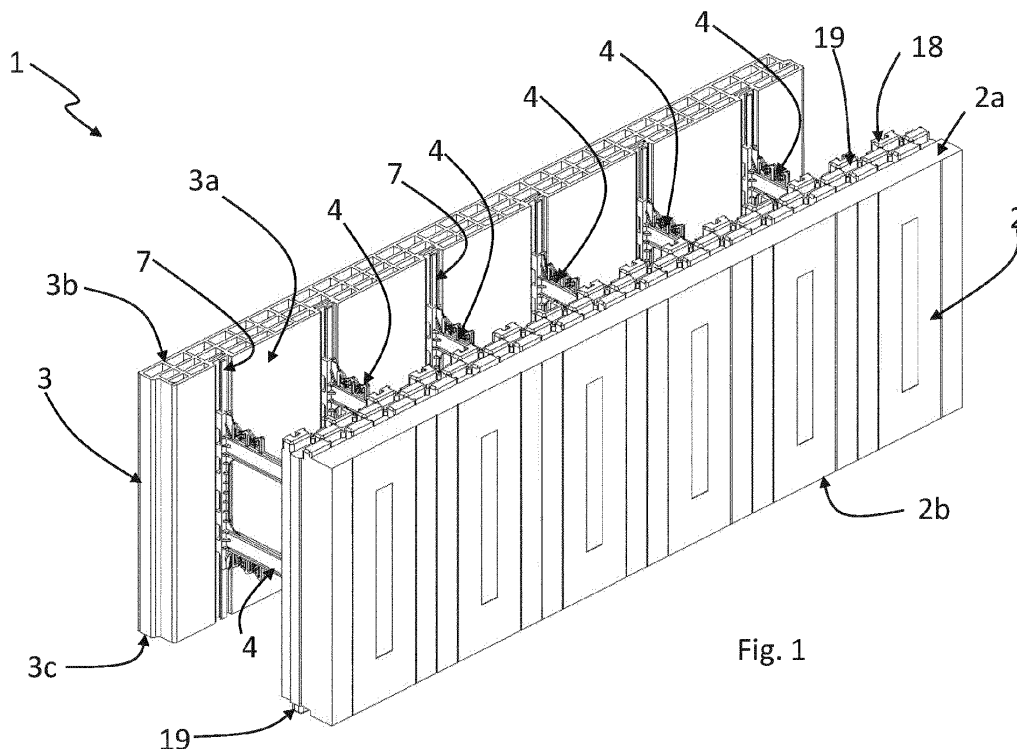


Fig. 1

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Description

[0001] The present invention relates to a disposable formwork for insulated masonry (i.e. with insulating characteristics), and to a building comprising at least one masonry structure (i.e. comprising elements superimposed with one another, with the interposition or not of cementing material) comprising such a formwork.

[0002] Disposable formworks are currently known for the realization of insulated masonry, comprising two panels of expanded polystyrene (hereinafter also EPS) facing one another and connected together by plastic or metal crossbeams.

[0003] It is specified that expanded polystyrene has very different characteristics from non-expanded polystyrene; in particular, expanded polystyrene has low thermal conductivity, and relatively low density. After positioning a plurality of formworks alongside and/or superimposed with one another, concrete in the liquid state is poured into the cavity defined between the mutually connected expanded polystyrene panels of the different formworks; as the concrete cures, it permanently grips the panels and the crossbeams of the formworks, so as to constitute, together with them, a wall or another architectural element.

[0004] The expanded polystyrene panels present on the two faces of the wall thus defined guarantee that it has high thermal insulation characteristics and, together with the large mass of concrete present in the masonry, also guarantee high acoustic insulation. At the same time an earthquake-resistant load-bearing structure can also be created.

[0005] Typical uses of such disposable formworks of the known type are for example the realization of masonry structures of buildings in the event of obtaining high thermal and/or acoustic insulation between the rooms separated by such walls, and between the inside and the outside of the building.

[0006] Disposable formworks of this type are known, for example, from US patent no. US 5,390,459.

[0007] Versions of such disposable formworks are also known in which the expanded polystyrene panels comprise, on their faces delimiting the thickness of the panel, a plurality of protuberances being variously distributed that define between one another the same number of seats into which similar protuberances of another panel of the same type are inserted, belonging to a similar formwork that must be coupled at the top or at the bottom thereto.

[0008] The coupling of the protuberances projecting from a panel into the seats of a panel on top of or below the same, guarantees that such panels remain perfectly coupled and coplanar to one another even if they are subjected to the hydrostatic thrust due to the mass of concrete while it is being poured between the panels. However, such solutions of the known type have some drawbacks; in particular the expanded polystyrene panels used for making such formworks of the known type hinder the passage of heat through them, but they are substantially ineffective in compensating for sudden and/or high ambient temperature changes and nonuniformity of temperatures within the environment delimited by them.

[0009] Such changes and lack of uniformity can arise for example if the heating inside the room is comprised of a high temperature heat source and a surface with relatively reduced emission such as, for example, a pellet burner, a fireplace, a radiator, etc.; in this case the temperature is very high in the immediate vicinity to the heat source and increasingly lower moving away from it which, on one hand, reduces the thermal comfort of the room and, on the other hand, could cause convective motions that cause the movement of dust in the environment.

[0010] Furthermore, in the case of walls of a building that subdivide the inside of it from the outside environment, there is the problem that, at the openings such as the passages for doors and windows, and at the floors that subdivide the various storeys, there are often thermal bridges that can locally generate hotter or colder areas than the rest of the wall, which can reduce the thermal comfort inside the building. Furthermore, such localized temperature nonuniformities can promote the formation, inside or outside the building, of condensation, with the consequent risk of mould being generated and/or any objects (such as furniture, doors, windows, etc.) in contact with the wall being damaged.

[0011] Another drawback of the walls made with such disposable formworks of the known type consists of the fact that, in the event of fixing a hanging accessory to the wall, such as a painting, a shelf, etc., the presence of the expanded polystyrene panel makes the fixing of such accessory a bit complicated. Such drawback is encountered both in the event of fixing the hanging accessory to the inside of the building and to the outside thereof.

[0012] The main task of the present invention is that of overcoming the drawbacks mentioned above, and in particular that of obtaining a disposable formwork that enables masonry structures to be realized, load-bearing or not, earthquake-resistant or not, able both to hinder the passage of heat and/or noise through them, and to reduce or however discourage thermal nonuniformities in an environment delimited by such masonry structures, and therefore to be able to obtain a building that, when using such a formwork, has one or more masonry structures whose temperature is particularly uniform, also in the presence of localized or particularly intense heat sources.

[0013] Another aim of the present invention is that of obtaining a disposable formwork, the installation of which is easy and quick.

[0014] Yet another aim is that of obtaining a disposable formwork that can be installed on top of or below another similar formwork, guaranteeing the perfect coplanarity of the outer surfaces of the masonry structures obtained after the solidification of the concrete cast in the superimposed formworks.

[0015] A further aim of the present invention is that of obtaining a disposable formwork that enables masonry structures

to be realized to which it is easy to fix hanging accessories, even heavy ones.

[0016] Another aim of the invention is that of obtaining a disposable formwork that allows masonry structures to be realized that are sufficiently resistant to fire. Another aim of the invention is that of realizing a building whose exterior walls have sufficient fire resistance, in particular both at openings, such as the passages for doors or windows, present on the exterior walls, and at any floors that subdivide the storeys. These and other aims according to the present invention are reached by realizing a disposable formwork for insulated masonry comprising a first panel, thermally and/or acoustically insulating, and a second panel, facing said first panel and connected to the same by one or more crossbeams, wherein the second panel is made of a material having a density comprised between 150 and 2500 kilograms per cubic meter (kg/m^3) and a specific heat capacity comprised between 0.5 kJ/kgK (kilojoule over kilogram degrees Kelvin) and 2 kJ/kgK (kilojoule over kilogram degrees Kelvin).

[0017] It is underlined that such density and specific heat capacity refer to the material that constitutes the second panel, and not to the second panel as a whole, which can have for example a honeycomb structure, and/or comprising cavities or openings that increase the volume thereof without changing the weight.

[0018] In preferred embodiments, the second panel can be advantageously made of one or more of the following materials, alone or in combination with each another, or with other materials: perforated brick, cellular brick, cellular brick obtained by wood flour, wood-cement, solid brick, bricks obtained from demolition scraps, concrete, reinforced concrete, autoclaved aerated concrete, high-temperature mineralized wood wool with magnesite, pressed wood fiber, pressed glass or rock wool, cellular glass, panels from polyurethane scraps, fiberglass or polymer, polypropylene, polyethylene, unexpanded polystyrene (PS), PVC.

[0019] In a preferred embodiment, the second panel is made of a material that has a reaction to fire in class A1 or A2 according to standard UNI EN 13501-1:2009(EU); Italian Ministerial Decree of 15 March 2005(IT).

[0020] The following Table 1 shows the density, specific heat capacity and reaction to fire values of some materials that can be advantageously used for making the second panel.

Table 1

MATERIAL	SPECIFIC HEAT CAPACITY		DENSITY	REACTION TO FIRE
	J/KgK	KJ/KgK	Kg/m^3	UNI EN 13501-1:2009(EU); D.M. 15 March 2005(IT);
SOLID BRICK	840	0,84	1500	A1
PERFORATED CELLULAR BRICK	1000	1	800	A1
PERFORATED BRICK	840	0,84	1200	A1
CONCRETE	880	0,88	1800-240	A1
CELLULAR CEMENT	1000	1	450	A1
WOOD-CEMENT	1810	1,81	350-550	A2
LIME AND CEMENT PLASTER	910	0,91	1800	A1
GYPSUM PLASTER	850	0,85	1500	A1
ROCKWOOL	1030	1,03	150	A1

[0021] It is underlined that expanded polystyrene cannot be used except in combination with other materials, for making a second panel according to the invention as, although it has a specific heat capacity (about 1.35 kJ/kgK) within the claimed range, its density is too low ($20\text{-}30 \text{ kg/m}^3$). The same can be said for expanded polyurethane.

[0022] Preferably, the second panel can have a thickness comprised between 35 mm and 250 mm, more preferably comprised between 50 mm and 200 mm.

[0023] Preferably, the first panel can have a thickness comprised between 45 mm and 300 mm, more preferably comprised between 52 mm and 250 mm.

[0024] Advantageously, on a first surface of the second panel facing the first panel there are means for fixing to the one or more crossbeams.

[0025] Preferably, such fixing means are mechanical fixing means (e.g. jointed); more preferably such fixing means do not comprise non-mechanical fixing means, such as gluing, welding, overmoulding.

[0026] In an advantageous embodiment, such fixing means comprise:

- one or more first seats formed in the first surface of the second panel, coupled or that can be coupled to at least partially counter-shaped first appendages projecting from a first end of the one or more crossbeams, and/or
- one or more second appendages projecting from the first surface of the second panel, coupled or that can be coupled to at least partially counter-shaped second seats obtained at a first end of the one or more crossbeams.

[0027] In a preferred embodiment, the first seats and/or the second appendages cover the entire height of the first surface of the second panel.

[0028] Advantageously, the second panel comprises constraining means for a similar second panel positioned on top of or below it.

[0029] In a preferred embodiment, such constraining means comprise one or more first male elements projecting respectively from an upper surface and/or from a lower surface of the second panel, and one or more first female elements, obtained respectively on the lower surface and/or on the upper surface of the second panel, such first male elements and first female elements of such second panel being positioned and configured so as to couple respectively with corresponding first female elements and first male elements of a further similar second panel located below or on top of such second panel.

[0030] In another advantageous embodiment, the constraining means comprise the one or more crossbeams and the fixing means, a first end of such one or more crossbeams simultaneously engaging with the fixing means of two second panels superimposed on each other, aligned vertically or staggered to one another. Advantageously, the second panel comprises centering means with a similar second panel placed side by side thereto.

[0031] In an advantageous embodiment, such centering means comprise:

a first rabbet defined in a first side wall of the second panel, and a corresponding second rabbet defined in a second side wall of the second panel, such first and second rabbet being shaped and positioned in such a way that, by placing side by side the second panels of two of such formworks to bring into engagement the first side wall of one of such second panels with the second side wall of the other second panel, the first rabbet of one of such second panels and the second rabbet of the other of such second panels mate with each other.

[0032] In a further advantageous embodiment, such centering means comprise:

a second female element defined in a first side wall of the second panel, and a corresponding second male element defined in a second side wall of the second panel, such second female element and second male element being shaped and positioned in such a way that, by placing side by side the second panels of two of such formworks to bring into engagement the first side wall of one of such second panels with the second side wall of the other second panel, the second female element of one of such second panels and the second male element of the other of such second panels join with each other.

[0033] In a preferred embodiment, the first panel and/or the second panel have a square, or substantially square, or rectangular, or substantially rectangular, shape.

[0034] A second aspect of the invention relates to a building comprising an insulated masonry element that separates the inside of such building from the outside environment, such insulated masonry element comprising one or more formworks according to the invention. It is underlined that the expression "masonry" means a masonry structure (e.g. an interior or exterior wall of a building) comprising elements superimposed with each other, with the interposition or not of cementing material.

[0035] In a preferred embodiment, in such building according to the invention the aforesaid insulated masonry structure comprises an opening adapted to place in communication the inside of the building with the outside environment; in this case one or more formworks according to the invention are positioned with the respective second panel turned towards the outside environment, at least partially defining the perimeter edge of the opening.

[0036] Preferably, one or more formworks according to the invention define the entire perimeter edge of the opening.

[0037] The positioning of the second panel of one or more formworks according to the invention towards the external environment, at least partially, preferably totally, defining the perimeter edge of the opening, guarantees, thanks to the "thermal flywheel" effect previously, described, that such area of the masonry has a substantially uniform temperature, even in the case, for example, of high exposure to the sun of such second panel. This reduces the formation of possible hot or cold areas both inside and outside the building, with the consequent increase in thermal comfort, and the reduction in the risk of formation of condensation and mould, both inside and outside the building. Furthermore, in the advantageous case in which the second panel is made of a material having reaction to fire in class A1 or A2 according to standard UNI EN 13501-1:2009(EU); Italian Ministerial Decree 15 March 2005(IT), such specific positioning of the second panel guarantees that any fire outside the building could not penetrate into it through the openings.

[0038] Advantageously, such opening may be a compartment of a door or a window.

[0039] In a further advantageous embodiment, the building according to the invention comprises at least two storeys

subdivided by a floor, wherein the insulated masonry that comprises one or more formworks according to the invention separates such two storeys and in this case, one or more formworks according to the invention can be advantageously positioned in correspondence of the floor, and with the respective second panel turned towards the outside environment.

[0040] As in the advantageous case of the opening, also in this case the positioning of the second panel at the floor, turned towards the outside environment guarantees, thanks to the "thermal flywheel" effect previously described, that such area of the masonry has a substantially uniform temperature, also in the case, for example, of high exposure of the sun to such second panel. This reduces the formation of possible hot or cold areas both inside and outside the building, with the consequent increase in thermal comfort, and the consequent reduction in the risk of formation of condensation and mould, both inside and outside the building.

[0041] Furthermore, in the advantageous case in which the second panel is made of a material having reaction to fire in class A1 or A2 according to standard UNI EN 13501-1:2009(EU); Italian Ministerial Decree of 15 March 2005(IT), such specific positioning of the second panel guarantees that any fire outside the building could not penetrate from the outside of the building to the floor area. Furthermore, this particular advantageous embodiment guarantees that any fire present in the outer façade of the building does not propagate between the storeys subdivided by the floor, as the second panel prevents the propagation of fire between the regions of masonry positioned on top of and below such second panel.

[0042] Advantageously, in a building according to the invention, an insulated masonry structure can comprise a plurality of formworks according to the invention.

[0043] In an advantageous embodiment, in such building according to the invention such plurality of formworks can comprise two formworks according to the invention superimposed with each other, aligned vertically or staggered to each other, so that the first panel of the upper formwork is superimposed with the first panel of the lower formwork and the second panel of the upper formwork is superimposed with the second panel of the lower formwork.

[0044] In an advantageous embodiment, in such building according to the invention such plurality of formworks can comprise two formworks according to the invention superimposed with each other, aligned vertically or staggered to each other, so that the first panel of the upper formwork is superimposed with the second panel of the lower formwork and the second panel of the upper formwork is superimposed with the first panel of the lower formwork.

[0045] In a further advantageous embodiment, in such building according to the invention such plurality of formworks can comprise two formworks according to the invention placed side by side so that the first panel of one of such two formworks is placed side by side with the first panel of the other of such two formworks, and the second panel of one of such two formworks is placed side by side with the second panel of the other one of such two formworks.

[0046] In a further advantageous embodiment, in such building according to the invention such plurality of formworks can comprise two formworks according to the invention placed side by side to each other so that the first panel of one of such two formworks is placed side by side with the second panel of the other of such two formworks, and the second panel of one of such two formworks is placed side by side with the first panel of the other of such two formworks.

[0047] In an advantageous embodiment, in such building according to the invention the aforesaid insulated masonry can comprise one or more of such formworks according to the invention, and one or more traditional formworks comprising two panels made of thermally and/or acoustically insulating material connected to each other by one or more crossbeams; in such advantageous embodiment, a formwork according to the invention can be arranged on top of, or below, or side by side to a traditional formwork.

[0048] Preferably, in such advantageous embodiment, the traditional formwork comprises means adapted to be coupled with the means of the formwork according to the invention for the constraining thereof to a similar second panel placed on top of or below it.

[0049] Preferably, the traditional formwork comprises means adapted to be coupled with centering means of the second panel for the centering thereof with a similar second panel placed side by side thereto.

[0050] In an advantageous embodiment, in such building according to the invention the aforesaid insulated masonry can comprise one or more of such formworks according to the invention, and one or more traditional formworks comprising two panels made of thermally and/or acoustically insulating material connected to each other by one or more crossbeams; in such advantageous embodiment, a formwork according to the invention can be placed side by side to a traditional formwork.

[0051] Advantageously, the panels of the traditional formwork comprise means adapted to be coupled to the centering means of a formwork according to the invention. Further advantageous and/or preferable characteristics of the invention are reported in the dependent claims. The features and advantages of the present invention will be more apparent from the following description, which is to be understood as exemplifying and not limiting, with reference to the appended schematic drawings, wherein:

- Figure 1 is a perspective view of a first embodiment of a formwork according to the invention;
- Figure 2 is a plan view of the formwork appearing in Figure 1;
- Figure 3 is a detailed plan view of a further embodiment of formwork according to the invention;
- Figure 4 is a perspective view of six formworks of the type illustrated in Figures 1 and 2, placed side by side, two

by two and superimposed with each other;

- Figure 5 is a perspective view of a second embodiment of a formwork according to the invention;
- Figure 6 is a plan view of the formwork appearing in Figure 5;
- Figure 7 is an enlarged detail of Figure 6;
- Figure 8 is a perspective view of a further embodiment of six formworks according to the invention, placed side by side two by two and superimposed with each other;
- Figure 9 is a perspective view of a detail of a first embodiment of the second panel of a formwork according to the invention;
- Figure 10 is a front view of a detail of two second panels of the type of Figure 9 arranged one on top of the other;
- Figure 11 is a perspective view of a detail of two second panels, arranged one on top of the other, of two formworks according to a further embodiment of the invention;
- Figure 12 is a front view of a detail of the two panels of Figure 11;
- Figure 13 is a perspective view of a detail of two second panels, arranged one on top of the other, of two formworks according to a further embodiment of the invention;
- Figure 14 is a front view of a detail of the two panels of Figure 13;
- Figures 15 to 25 are plan views of different possible embodiments of the second panel of a formwork according to the invention;
- Figure 26 is a perspective view of part of two formworks according to the invention, superimposed and staggered to each other;
- Figure 27 is a schematic view of a building according to the invention;
- Figure 28 is a front view of part of a masonry structure of a building according to the invention, at the opening for a window;
- Figure 29 is a perspective view of part of the masonry structure of Figure 28;
- Figure 30 is a perspective view of part of a wall of a building according to the invention, at the opening for a door;
- Figure 31 is a front view of part of the masonry structure of figure 30;
- Figure 32 is a perspective view of part of a masonry structure of a building according to the invention, at a floor;
- Figure 33 is a schematic lateral section of part of the masonry structure and of the floor of Figure 32. Examples of disposable formworks for insulated masonry structures according to the invention are represented in the appended figures, and indicated overall with number 1.

[0052] The formwork 1 comprises a first panel 2, made of thermally and/or acoustically insulating material such as expanded polystyrene (which is only a thermal insulator), wood-cement, expanded polypropylene, expanded polyethylene, expanded polyurethane, etc.

[0053] The formwork 1 comprises a second panel 3, facing the first panel 2, and connected thereto by one or more crossbeams 4.

[0054] Preferably, the crossbeams 4 are made of plastic, or metal, or a combination of such materials.

[0055] The second panel 3 is made of a material having a density comprised between 150 and 2500 kilograms per cubic meter (kg/m^3) and a specific heat capacity comprised between 0.5 kJ/kgK and 2 kJ/kgK.

[0056] The specific heat capacity and the high density of the second panel 3 ensure that once the latter has reached a certain temperature, it tends to maintain it, therefore acting as a "thermal flywheel" which tends to keep the temperature of the environment delimited by such second panel 3 constant.

[0057] The second panel 3 contributes both to reducing sudden temperature changes in the environment delimited thereby, and to making the temperature in such environment uniform, also in the presence of localized heat sources.

[0058] The second panel 3 can be for example made of one or more of the following materials, alone or in combination with each other, or with other materials: perforated brick, cellular brick obtained by wood flour, wood-cement, solid brick, bricks obtained from demolition scraps, concrete, reinforced concrete, autoclaved aerated concrete, high-temperature mineralized wood wool with magnesite, pressed wood fiber, pressed glass or rock wool, cellular glass, panels from polyurethane scraps, fiberglass or polymer, polypropylene, polyethylene, unexpanded polystyrene (PS), PVC.

[0059] As well as having high thermal inertia, such materials also have high mechanical resistance and are therefore suitable for the easy fixing to the second panel 3 of a hanging accessory, such as an item of furniture, a painting, a shelf, for example through the fixing of anchors, nails, etc. to such panel 3.

[0060] The panels 3 illustrated in the embodiments of Figures 1-4, 9, 10, 15-20, 26 can for example be advantageously made of brick, brick-wood, cellular brick, unbaked clay, terracotta, cement, concrete; such second panels are preferably made with a geometry that provides empty spaces and that is commonly called "perforated".

[0061] The second panels 3 illustrated in the embodiments of Figures 5-8, 11-14, 21-25 are instead made of concrete or autoclaved aerated concrete, or wood-cement or wood or solid brick, solid brick-wood or solid cellular brick, or another solid material.

[0062] In a preferred embodiment, the second panel is made of a material that has a reaction to fire in class A1 or A2

according to standard UNI EN 13501-1:2009(EU); Italian Ministerial Decree of 15 March 2005(IT). Advantageously, the first panel 2 and/or the second panel 3 have, in a front view, a square, or substantially square, or rectangular, or substantially rectangular, shape.

[0063] It is underlined that in the present document, expressions such as "upper", "lower", "side", "front", "rear" and the like refer to a condition of the formwork 1 according to the invention installed to constitute a vertical, or substantially vertical, masonry structure and, therefore, with the first and the second panel positioned vertically, such as in the advantageous embodiments illustrated in Figures 1, 4, 5, 8.

[0064] Advantageously, the second panel 3 has a thickness comprised between 35 mm and 250 mm, preferably comprised between 50 mm and 200 mm.

[0065] Advantageously, the first panel 2 has a thickness comprised between 45 mm and 300 mm, preferably comprised between 52 mm and 250 mm. Advantageously, on a first surface 3a of the second panel 3, facing the first panel 2, there are means for fixing to one or more crossbeams 4 that connect the first and the second panel.

[0066] In an advantageous embodiment, such as the one illustrated in Figure 3, and those illustrated in Figures 18-20, 22 and 23, such fixing means comprise one or more first seats 5 obtained in a first surface 3a of the second panel 3; such first seats 5 are coupled or can be coupled to at least partially counter-shaped first appendages 6, projecting from a first end of one or more crossbeams 4.

[0067] Advantageously, the first seats 5 affect the entire height of the first surface 3a of the second panel 3, so that it is possible to longitudinally insert a first appendage 6 of a crossbeam 5 into the respective first seat 5 of a second panel 3 starting from the upper or lower end of such first seat 5.

[0068] Preferably, as for example in the embodiments represented in Figures 3, 19, 20 and 23, the first seats 5 have, in a plan view of the second panel 3 (still with reference to their installation to constitute a vertical masonry structure), a substantially T-shaped section, with a first leg 5a, placed at the first surface 3a of the second panel 3, which defines on such first surface 3a an access opening to the first seat 5, and a first head 5b, obtained in the body of the second panel 3.

[0069] In this case, the first appendages 6 of the crossbeams 4 preferably have a plan section which is also T-shaped, defining a second head 6b, advantageously at least partially counter-shaped to the first head 5b of the first seats 5, and that can be positioned inside such first head 5b, preferably by means of the longitudinal insertion into the seat 5 itself. Advantageously, in the case in which the first seats 5 have such T-shaped section, the first appendages 6 can advantageously comprise a second leg 6a, connected to the second head 6b and conformed and positioned so as to exit from the first leg 5a of a seat 5 with which such first appendage 6 is associated when the respective second head 6b is inserted into the head 5b of such first seat; advantageously, the second leg 6a is connected to the rest of the crossbeam 4, the latter therefore remaining constrained to the second panel 3 in the perpendicular direction to the second panel 3 itself, the second head 6b of the first appendage 6 not being able to exit through the first leg 5b of the opening 5.

[0070] Other possible shapes of the first seats 5 are however possible; for example, in the embodiments of Figures 18 and 22, the seats 5 have a plan with a section that we will define as "double T", which differs from a T-shaped section in that a further head 5c is associated with the leg 5a, parallel and distanced from the first head 5b.

[0071] In such embodiment, wherein the first seats 5 have such "double T" shaped section, the first appendages 6 can advantageously also have a "double T" shaped section, counter-shaped to that of the first seats 5, or even a T-shaped section, shaped so that the second head 6b of such appendage is positioned in the first head 5b or in the further head 5c of the respective first seat 5 (obtaining in the latter case the possibility to have two distances between the first and the second panel, corresponding to the second head 6b positioned in the first head 5b or in the further head 5c).

[0072] Other configurations of the first seats 5 (e.g. dovetail, Q or Ω shaped, etc.) and the respective, at least partially counter-shaped, ones, first appendages 6 are however possible.

[0073] In a further advantageous embodiment such as the one illustrated in Figure 7, and those illustrated in Figures 15-17, 24, 25 and 26, the fixing means advantageously comprise one or more second appendages 7 projecting from the first surface 3a of the second panel 3; such second appendages are coupled or can be coupled to at least partially counter-shaped second seats 8 obtained in a first end of the one or more crossbeams 4.

[0074] Advantageously, the second appendages 7 affect the entire height of the first surface 3a of the second panel 3, so that it is possible to longitudinally insert a second appendage 7 into a second seat 8 of a crossbeam 4 starting from the upper or lower end of such second appendage 7.

[0075] In further advantageous embodiments such as those illustrated in Figures 7, 17, 21 and 26, the second appendages 7 are made as a single part, in other words a single body, with the second panel 3.

[0076] In further advantageous embodiments such as the ones illustrated in Figures 15, 16, 24 and 25, the second appendages 7 are additional elements (i.e. not made as a single piece), fixed in turn to the second panel 3, for example, but not necessarily, in third seats 9 obtained in the first surface 3a thereof; such third seats 9 can be, for example, shaped similarly to the first seats 5 described above.

[0077] In the case in which the second appendages 7 are additional elements, they are preferably part of an insert 70, a first end 70a of which, at least partially counter-shaped to the third seats 9, is inserted and fixed into them; a second part of such insert 70, comprising the second appendage 7, instead projects from the third seat 9, and therefore from

the first surface 3a of the second panel 3.

[0078] Advantageously, the second appendages 7 can have a T-shaped section in the plan view, preferably, but not necessarily, similar to the section of the first appendages 6 described above; in this case the second seats 8 coupled or that can be coupled with such second appendages 7 can preferably have a T or "double T" plan shape preferably, but not necessarily, analogous to the section of the first seats 5 described above.

[0079] In any case, other possible shapes of the second appendages 7 and the respective, at least partially counter-shaped, second seats 8 are possible. Advantageously, also the first panel 2 comprises, on a second surface 2c thereof, facing the second panel 3, second fixing means 20 to one or more crossbeams 4 that connect the first and the second panel; preferably such second fixing means 20 can have an analogous shape to one of the advantageous embodiments described above of the fixing means of the second panel 3 to the crossbeams 4.

[0080] In a further embodiment, not represented, the crossbeams 4 can be fixed to the first panels through gluing, or can be incorporated with an end thereof into the body of the first panels 2 (e.g. during the production or moulding of the latter).

[0081] Advantageously, the second panel 3 comprises constraining means for a similar second panel 3 positioned on top of or below it.

[0082] In an advantageous embodiment, such constraining means comprise one or more first male elements projecting respectively from an upper surface 3b and/or from a lower surface 3c of the second panel 3, and one or more first female elements, obtained respectively on the lower surface 3c and/or on the upper surface 3b of the second panel 3; the first male elements and first female elements of a second panel 3 are positioned and configured so as to couple respectively with corresponding first female elements and first male elements of a further similar second panel 3 located below or on top of such second panel 3.

[0083] Advantageously, for example in the case in which the second panel 3 is constituted of or comprises a perforated brick, such as in the advantageous embodiment of Figures 9 and 10, the first male elements can comprise one or more anchors 10, partially inserted into openings 11, obtained in the upper surface 3b and/or lower surface 3c of the second panel 3 and preferably affecting the entire height thereof, thus constituting through openings that connect the lower surface 3c and upper surface 3b of the second panel 3; advantageously the anchors 10 exit with a first end 10a thereof perpendicularly from the upper surface 3b (and/or from the lower surface 3c) of the second panel 3, so as to be inserted into openings 11 of a further second panel 3 on top (or below) of a further similar formwork 1 associated at the top or at the bottom with the formwork 1 to which such plug 10 belongs.

[0084] One or more of the anchors 10 therefore connect the two superimposed panels 3 to each other, guaranteeing that they remain perfectly coupled and coplanar even if they are subjected to the hydrostatic thrust due to the mass of the concrete inside the formworks 1.

[0085] In a further advantageous embodiment, e.g. the one represented in Figures 11 and 12 and 13 and 14, the constraining means can comprise constraining appendages 12 projecting from the upper surface 3b and/or from the lower surface 3c of the second panel 3, which can be inserted into at least partially counter-shaped constraining seats 13 obtained correspondingly, respectively on the lower surface 3c and/or upper surface 3b of a similar second panel 3 placed on top of or below it.

[0086] Such constraining appendages 12 and constraining seats 13 can have different shapes and arrangements.

[0087] For example, in the advantageous embodiment illustrated in Figures 11 and 12, the constraining appendages 12 project from the upper surface 3b of the second panels 3, and the constraining seats 13 are obtained in the lower surface 3c of the second panels 3, preferably aligned with the constraining appendages 12.

[0088] In the embodiment of Figures 13 and 14, the constraining appendages 12, defining rabbets, project instead both from the upper surface 3b and from the lower surface 3c of the second panels 3 and, correspondingly, the constraining seats 13 are obtained both on such upper surface 3b and on the lower surface 3c.

[0089] In a further advantageous embodiment, an example of which is represented in Figure 26, the constraining means for a similar second panel 3 placed on top of or below a second panel 3 can comprise the crossbeams 4 and the fixing means of the first surface 3a thereto, e.g. the fixing means previously described.

[0090] In this case, a first end of a crossbeam 4 can be fixed both to the first surface 3a of a second panel 3, and to the first surface 3a of a similar second panel 3, on top of or below it, possibly arranged staggered, as in Figure 26 (or the two superimposed second panels 3 can be advantageously aligned vertically with each other); the crossbeam 4 therefore keeps the two superimposed second panels 3 constrained to each other, guaranteeing that they remain perfectly coupled and coplanar even if they are subjected to the hydrostatic thrust due to the mass of the concrete during the casting thereof. Advantageously, the second panel 3 may comprise centering means of a similar second panel 3 placed side by side thereto.

[0091] Advantageously, as in the examples of Figures 6, 9, 15-19, 21-25, such centering means can comprise a first rabbet 14 defined in a first side wall 3d of the second panel 3, and a corresponding second rabbet 15, defined in a second side wall 3e of the second panel 3; such first and second rabbet are conformed and positioned so that, by placing the second panels 3 of two formworks 1 side by side to bring into engagement the first side wall 3d of one of such second

panels 3 with the second side wall of the other second panel 3, the first rabbet 14 of one of such second panels 3 and the second rabbet 15 of the other second panel 3 are coupled to each other.

[0092] In a further advantageous embodiment, represented for example in Figure 20, the centering means can comprise a second female element 16 defined in the first side wall 3d of the second panel 3, and a corresponding second male element 17, defined in the second side wall 3e of the second panel 3; such second female element 16 and second male element 17 are advantageously conformed and positioned so that, by placing the second panels 3 of two formworks 1 side by side according to the invention to bring the first side wall 3d of one of such second panels 3 in engagement with the second side wall of the other second panel 3, the second female element 16 of one of such second panels 3 and the second male element 17 of the other of said second panels 3 mate with each other.

[0093] Advantageously, the first panel 2 comprises, in an upper face 2a and in a lower face 2b, delimiting the thickness of the first panel 2 itself, portions provided with a plurality of protuberances 18, variously distributed, which define between them the same number of seats 19 into which similar protuberances 18 of another similar first panel 2 of another formwork 1 of the same type are inserted, which must be coupled on top of or below it.

[0094] Preferably, such protuberances 18 and seats 19 are distributed on the entire surface of such faces 2a, 2b. Furthermore, the protuberances 18 and the seats 19 defined can have in plan view a regular shape, e.g. square, round, triangular, trapezoidal, hexagonal, octagonal, etc., or irregular, e.g. comma, V, U or C shaped, or other complex shapes.

[0095] A second aspect of the invention relates to a building, represented schematically in Figure 27 and indicated by number 50, comprising an insulated masonry structure 51 that separates the inside 52 of such building 50 from the outside environment 53.

[0096] Such insulated masonry structure 51 comprises one or more formworks 1 according to the invention.

[0097] In a preferred embodiment such as the one illustrated in Figures 27 to 31, in such building 50 the aforesaid insulated masonry structure 51 comprises an opening 54 adapted to place the inside 52 of the building 50 in communication with the outside environment 53; in the advantageous example of Figure 27, the building 1 is a house, and the insulated masonry structure 51 is a perimeter wall of such building 1, in which five openings 54 are made, and in particular four openings for windows and an opening for a door.

[0098] Advantageously, in the masonry structure 51, one or more formworks 1 according to the invention are positioned with their second panel 3, turned towards the outside environment 53, at least partially defining a perimeter edge 54a of such opening 54.

[0099] In an advantageous embodiment such as those illustrated in Figures 27, 28 and 29, the masonry structure 51 comprises a plurality of formworks 1 according to the invention, which define the entire perimeter edge 54a of the opening 5a; for example, the opening 54 can be advantageously substantially rectangular or square, and the formworks 1 according to the invention can define the four sides of the perimeter edge 54a of such opening 54. Other shapes for the opening 54 (e.g. circular) are however possible.

[0100] Advantageously, an opening 54, e.g. the passage of a door or a window, can be defined by the joining of a plurality of second panels 3 which delimit, for example with an edge thereof, an edge of such opening 54; in a further advantageous embodiment, an opening 54 can be defined within a single second panel 3.

[0101] The positioning of the second panel 3 of one or more formworks 1 according to the invention towards the external environment, at least partially, preferably totally, defining the perimeter edge 54a of the opening 54, guarantees, thanks to the "thermal flywheel" effect previously described, that such area of the masonry 51 has a substantially uniform temperature, even in the case, for example, of high exposure to the sun of such second panel 3.

[0102] In the advantageous case in which the second panel is made of a material having reaction to fire in class A1 or A2 according to standard UNI EN 13501-1:2009(EU); Italian Ministerial Decree of 15 March 2005(IT), such specific positioning of the second panel 3 guarantees that any fire outside the building 50 could not penetrate into it through the opening 54.

[0103] In a further advantageous embodiment, the building 50 comprises at least two storeys 55a, 55b subdivided by a floor 56.

[0104] In this advantageous case, the insulated masonry that comprises the one or more formworks 1 according to the invention separates such two storeys 55a, 55b and such floor 56 from the outside environment 53.

[0105] In this advantageous case, one or more formworks 1 according to the invention can be advantageously positioned at the floor 56, and with the second panel 3 turned towards the outside environment.

[0106] In this case, the first panel 2 of such formwork 1 can advantageously have an opening or groove 20a, adapted to allow the entry of an end of the floor 56 into the gap between such first panel 2 and the second panel 3, so as to allow such end to be incorporated into the concrete when it is cast into the formwork 1.

[0107] Also in this advantageous case, the positioning of the second panel 3 at the floor 56, turned towards the outside environment guarantees, thanks to the "thermal flywheel" effect previously described, that such area of the masonry structure 50 has a substantially uniform temperature, also in the event, for example, of high exposure to the sun of such second panel 3. Furthermore, in the advantageous case in which the second panel 3 is made of a material having reaction to fire in class A1 or A2 according to standard UNI EN 13501-1:2009(EU); Italian Ministerial Decree of 15 March

2005(IT), such specific positioning of the second panel 3 guarantees that any fire outside the building 50 could not penetrate from the outside of the building 50 to the floor area. Furthermore, this particular advantageous embodiment guarantees that any fire present in the outer façade of the building 50 does not propagate between the storeys subdivided by the floor 56, as the second panel 3 prevents the propagation of fire between the regions of masonry 51 positioned on top of and below such second panel 3.

[0108] Advantageously, in a building 50 according to the invention, an insulated masonry structure 51 can comprise a plurality of formworks 1 according to the invention.

[0109] In an advantageous embodiment, in such building 50 such plurality of formworks 1 can comprise two formworks 1 superimposed with each other, aligned vertically or staggered to each other, so that the first panel 2 of the upper formwork 1 is superimposed with the first panel 2 of the lower formwork 1 and the second panel 3 of the upper formwork 1 is superimposed with the second panel 3 of the lower formwork 1.

[0110] In an advantageous embodiment, in such building 50 according to the invention such plurality of formworks 1 can comprise two formworks 1 according to the invention superimposed with each other, aligned vertically or staggered to each other, so that the first panel 2 of the upper formwork 1 is superimposed with the second panel 3 of the lower formwork 1 and the second panel 3 of the upper formwork 1 is superimposed with the first panel 2 of the lower formwork 1.

[0111] In a further advantageous embodiment, in such building 50 according to the invention such plurality of formworks 1 can comprise two formworks 1 according to the invention placed side by side so that the first panel 2 of one of such two formworks 1 is placed side by side with the first panel 2 of the other of such two formworks 1, and the second panel 3 of one of such two formworks 1 is placed side by side with the second panel 3 of the other one of such two formworks 1.

[0112] In a further advantageous embodiment, in such building 50 according to the invention such plurality of formworks 1 can comprise two formworks 1 according to the invention placed side by side to each other so that the first panel 2 of one of such two formworks is placed side by side with the second panel 3 of the other of such two formworks 1, and the second panel 3 of one of such two formworks is placed side by side with the first panel 1 of the other of such two formworks 1.

[0113] In an advantageous embodiment, in such building 50 according to the invention the aforesaid insulated masonry can comprise one or more of such formworks 1 according to the invention, and one or more traditional formworks 60 comprising two panels 61a, 61b made of thermally and/or acoustically insulating material connected to each other by one or more crossbeams 62; in such advantageous embodiment, a formwork 1 according to the invention can be arranged on top of, or below, or side by side, with a traditional formwork 60. Preferably, in an advantageous embodiment, the traditional formwork 60 comprises means adapted to be coupled with the means of the formwork 1 for the constraining thereof to a similar second panel placed on top of or below it; in a preferred embodiment, such means adapted to be coupled with the constraining means comprise one or more male elements, not illustrated, projecting respectively by an upper surface and/or a lower surface of the panels 61a, 61b, and one or more female elements, not illustrated, obtained respectively on the lower surface and/or on the upper surface of the panels 61a, 61b; such male and female elements are positioned and configured so as to be coupled respectively with corresponding first female and first male elements of a first panel 2 or second panel 3 of a formwork 1 according to the invention placed below or on top of such traditional formwork 60.

[0114] In a further advantageous embodiment, a formwork 1 according to the invention can for example be coupled with a traditional formwork 60 arranged on top of or below it, using one or more crossbeams which, in this case, are engaged both with the formwork 1 and with the traditional formwork 60 placed on top of or below it. In an advantageous embodiment, in the building 50 according to the invention, the insulated masonry 51 can comprise one or more of such formworks 1 according to the invention, and one or more traditional formworks 60 placed side by side to each other or to a formwork 1 according to the invention.

[0115] Advantageously, the panels 61a, 61b of the traditional formwork 60 comprise means adapted to be coupled to the centering means of a formwork according to the invention.

[0116] The functioning of the formwork 1 according to the invention is described below; two or more formworks 1 according to the invention can be installed side by side and/or superimposed with each other (vertically aligned and/or staggered) such as in the examples of Figures 4 and 8, and/or in one or more traditional formworks 60 (such as in the advantageous embodiments represented in Figures 28-33) defining overall one or more masonry elements, or masonry structures, such as an interior or exterior wall of a building 50.

[0117] The first panels 2 of the formworks 1 are for example installed turned towards the outside of the environment(s) circumscribed by such masonry structures, while the second panels 3 are turned towards the inside of such environments. Alternatively, for example at openings 54, such as passages for windows or doors, or floors 56, the formworks 1 may be installed with the second panels 3 turned towards the outside environment 53.

[0118] Once the desired shape of such masonry structures has been obtained, concrete in the liquid state is cast to fill the gap between the first and the second panel of the various formworks 1; the constraining means of the second panels 3 guarantee that the mutually superimposed second panels 3 remain perfectly coupled and coplanar even if they are subject to the hydrostatic thrust due to the mass of the concrete during the casting thereof.

[0119] In the same way, the coupling of the protuberances 18 projecting from the first panels 2 into the seats 19 of the first panels 2 below, guarantees that such first panels 2 remain perfectly coupled and coplanar even if they are subjected to the hydrostatic thrust due to the mass of concrete during the casting thereof.

[0120] As it solidifies, the concrete firmly grips the first and second panel, and the crossbeams 4 that connect them, constituting together with such components the masonry structure.

[0121] Such masonry structure is thermally and/or acoustically insulated thanks to the first panels 2 of the formworks 1, turned for example towards the outside of the environment delimited by the masonry structure, or towards the outside environment 53.

[0122] The second panels 3, turned instead for example towards the inside of the environment delimited by the masonry structure, or towards the outside environment 53, for example at the openings 54 or floors 56, thanks to their high thermal inertia and density, act as a thermal flywheel for such environment, compensating for any sudden temperature changes due, for example, to the presence of high temperature punctiform heat sources, such as fireplaces, pellet burners, the sun shining, etc.

[0123] Furthermore, the second panels 3, having a high density, are adapted to the easy and stable fixing thereto, and therefore to the masonry structure, of hanging accessories, such as shelves, paintings, etc., e.g. with anchors, nails, etc.

[0124] Again, being made of material that has reaction to fire in class A1 or A2 according to standard UNI EN 13501-1:2009(EU), of Ministerial Decree of 15 March 2005(IT), the second panels 3 effectively protect the masonry structure made by them from fire.

[0125] Finally, it is clear that the formwork and the building according to the present invention are susceptible to numerous modifications and variants, all falling within the scope of the invention; furthermore, all the details may be replaced with other technically equivalent elements. In practice, the materials used, as well as the dimensions thereof, can be of any type according to the technical requirements.

Claims

1. Disposable formwork (1) for insulated masonry comprising a first panel (2), thermally and/or acoustically insulating, and a second panel (3), facing said first panel (2) and connected to the same by one or more crossbeams (4), **characterized in that** said second panel (3) is made of a material having a density comprised between 150 and 2500 kilograms per cubic meter (kg/m^3) and a specific heat capacity comprised between 0.5 kJ/kgK and 2 kJ/kgK.
2. Formwork (1), as in claim 1, **characterized in that** said second panel (3) is made of one or more of the following materials, alone or in combination with each other, or with other materials: perforated brick, cellular brick obtained by wood flour, wood-cement, solid brick, bricks obtained from demolition scraps, concrete, reinforced concrete, autoclaved aerated concrete, high-temperature mineralized wood wool with magnesite, pressed wood fiber, pressed glass or rock wool, cellular glass, panels from polyurethane scraps, fiberglass or polymer, polypropylene, polyethylene, unexpanded polystyrene (PS), PVC.
3. Formwork (1), according to one or more of the preceding claims, **characterized in that** said second panel (3) is made of a material having a reaction to fire in class A1 or A2 according to UNI EN 13501-1:2009 (EU), of Italian Ministerial Decree of 15 March 2005 (IT) .
4. Formwork (1) according to one or more of the preceding claims, **characterized in that** on a first surface (3a) of said second panel (3) facing said first panel (2) there are means (5, 7) for fixing to said one or more crossbeams (4).
5. Formwork (1), as in claim 4, **characterized in that** said fixing means comprise:
 - one or more first seats (5) formed in said first surface (3a) of said second panel (3), coupled or that can be coupled to at least partially counter-shaped first appendages (6) projecting from a first end of said one or more crossbeams (4),
 - and/or
 - one or more second appendages (7) projecting from said first surface (3a) of said second panel (3), coupled or that can be coupled to at least partially counter-shaped second seats (8) obtained at a first end of said one or more crossbeams (4).
6. Formwork (1), as in claim 5, **characterized in that** said first seats (5) and/or said second appendages (7) cover the entire height of said first surface (3a) of said second panel (3).

7. Formwork (1), according to one or more of the preceding claims, **characterized in that** said second panel (3) comprises constraining means for a similar second panel (3) positioned on top of or below it.

8. Formwork (1), according to claim 7, wherein said constraining means comprise one or more first male elements (10, 12) projecting respectively from an upper surface (3b) and/or from a lower surface (3c) of said second panel (3), and one or more first female elements (11, 13), obtained respectively on the lower surface (3c) and/or on the upper surface (3b) of said second panel (3), said first male elements (10, 12) and first female elements (11, 13) of said second panel (3) being positioned and configured so as to couple respectively with corresponding first female elements (11, 13) and first male elements (10, 12) of a further similar second panel (3) located below or on top of said second panel (3).

9. Formwork (1), as in claim 7 when it depends on claim 4 or on a claim dependent on claim 4, wherein said constraining means comprise said one or more crossbeams (4) and said fixing means, a first end of said one or more crossbeams (4) simultaneously engaging with the fixing means of two second panels (3) superimposed on each other, aligned vertically or staggered one another.

10. Formwork (1) according to one or more of the preceding claims, **characterized in that** said second panel (3) comprises centering means with a similar second panel (3) placed side by side thereto.

11. Formwork (1), as in claim 10, **characterized in that** said centering means comprise:

a first rabbet (14) defined in a first side wall (3d) of said second panel (3), and a corresponding second rabbet (15) defined in a second side wall (3e) of said second panel (3), said first (14) and second rabbet (15) being shaped and positioned in such a way that, by placing side by side the second panels (3) of two of said formworks (1) to bring into engagement the first side wall (3d) of one of said second panels (3) with the second side wall of the other second panel (3), the first rabbet (14) of one of said second panels (3) and the second rabbet (15) of the other of said second panels (3) mate with each other and/or

a second female element (16), defined in a first side wall (3d) of said second panel (3), and a corresponding second male element (17), defined in a second side wall (3e) of said second panel (3), said second female element (16) and second male element (17) being shaped and positioned in such a way that, by placing side by side the second panels (3) of two of said formworks (1) to bring the first side wall of one of said second panels (3) in engagement (3d) with the second side wall of the other second panel (3), the second female element (16) of one of said second panels (3) and the second male element (17) of the other of said second panels (3) mate with each other.

12. Formwork (1) according to one or more of the preceding claims, **characterized in that** said first panel (2) and/or said second panel (3) have a square, or substantially square, or rectangular, or substantially rectangular shape.

13. Building (50) comprising an insulated masonry structure (51) that separates the inside (52) of said building (1) from the outside environment (53), said insulated masonry structure (51) comprising one or more formworks (1) according to one or more of the previous claims.

14. Building (50) according to claim 13, which is **characterized in that** said insulated masonry structure (51) comprises an opening (54) adapted to place in communication the inside (52) of said building (1) with the outside environment (53), which is **characterized in that** said one or more formworks (1) are positioned with the respective said second panel (3) turned towards the outside environment (53) at least partially defining the perimeter edge (54a) of said opening (54).

15. Building (50) according to claim 13 or 14, comprising at least two storeys (55a, 55b) subdivided by a floor (56), wherein said insulated masonry structure (51) separates said two storeys (55a, 55b) and said floor (56) from the outside environment (53), which is **characterized in that** said one or more formworks (1) are positioned at said floor (56) and with the respective said second panel (3) turned towards the outside environment (53).

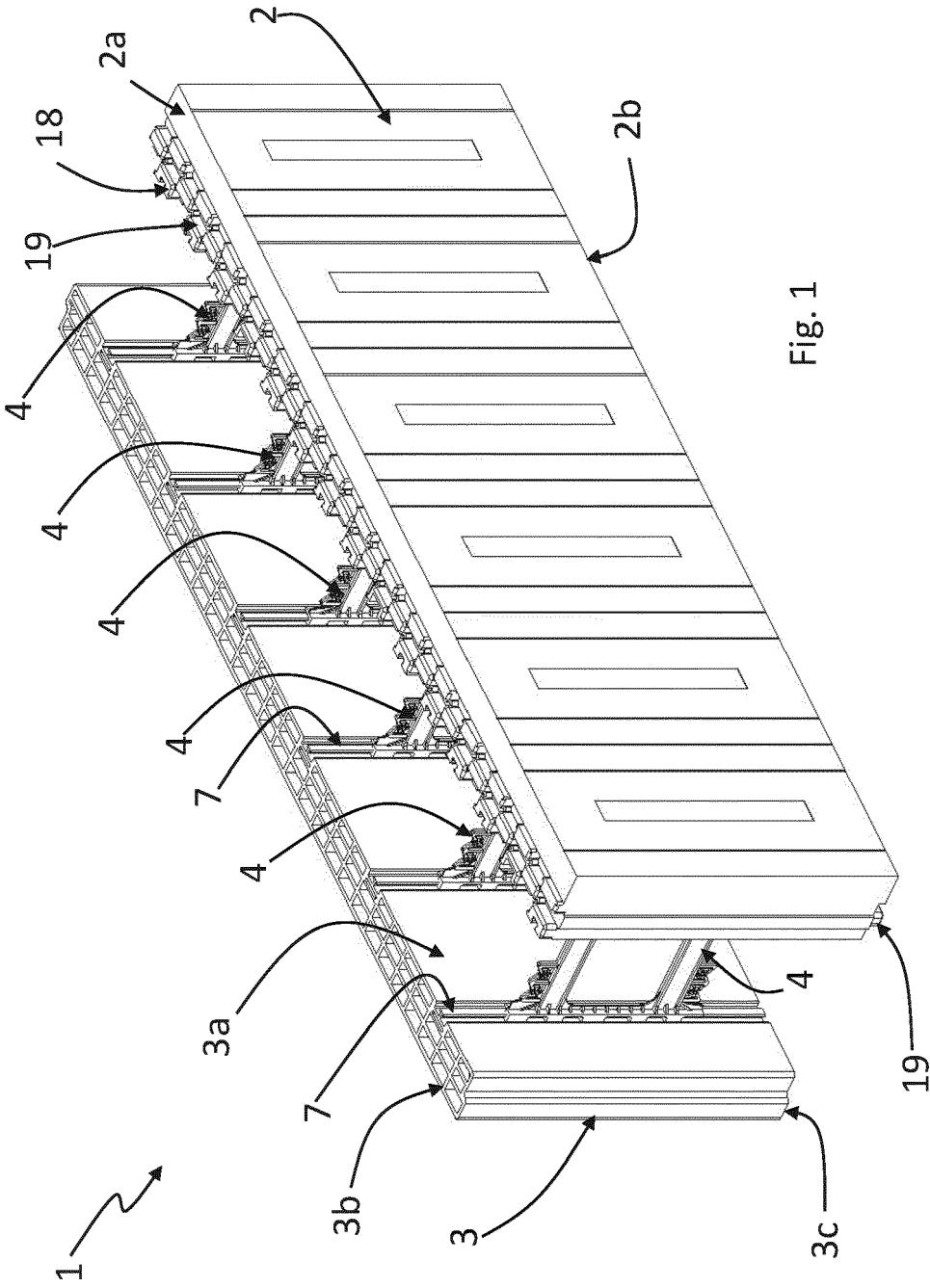
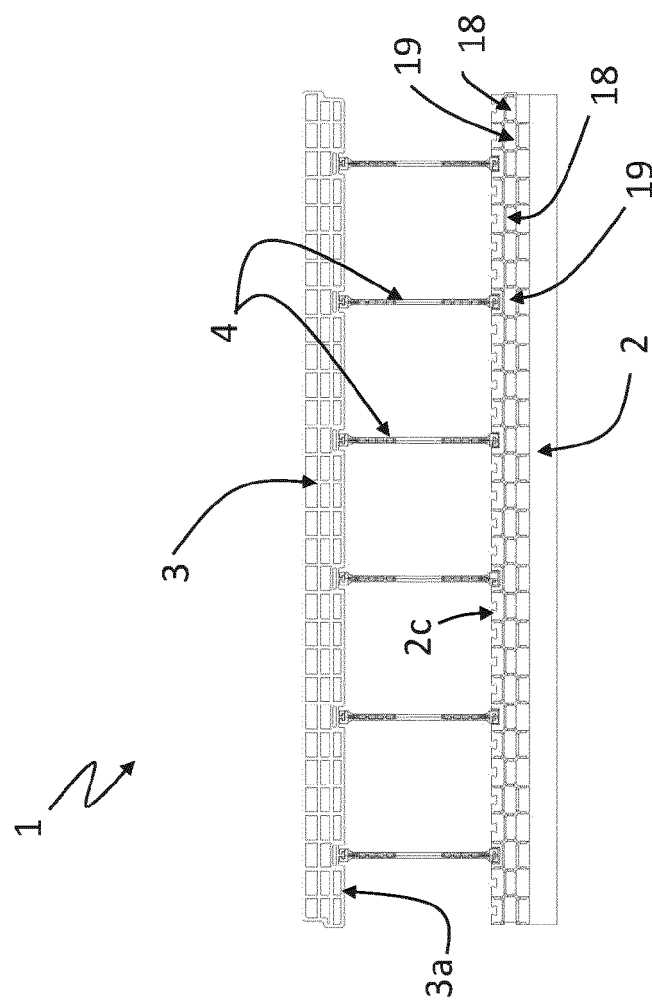
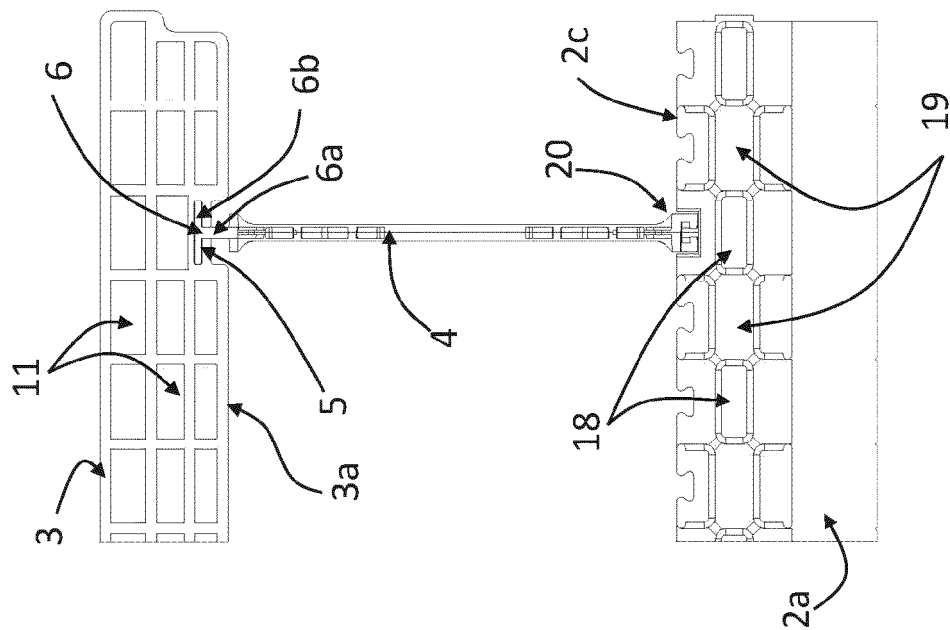


Fig. 1



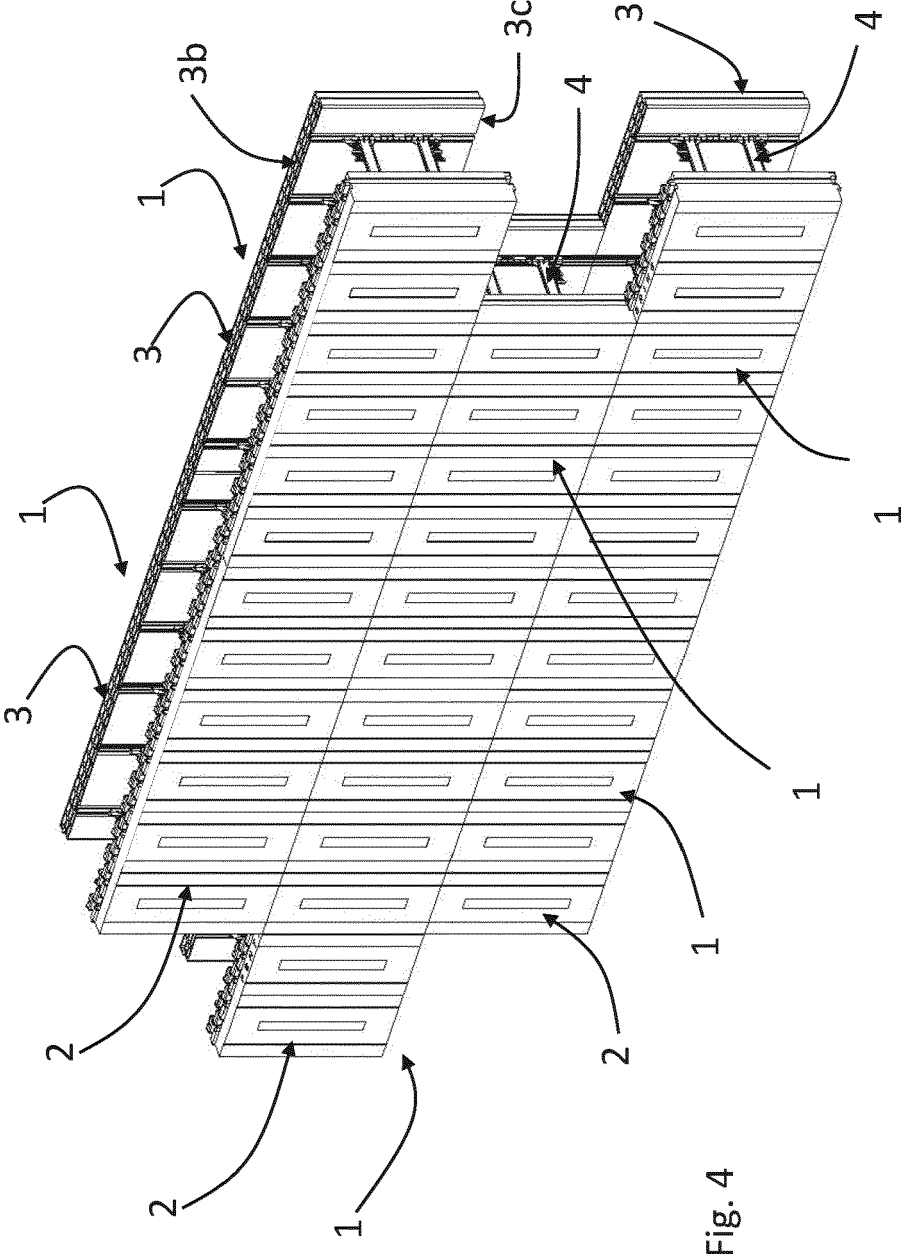
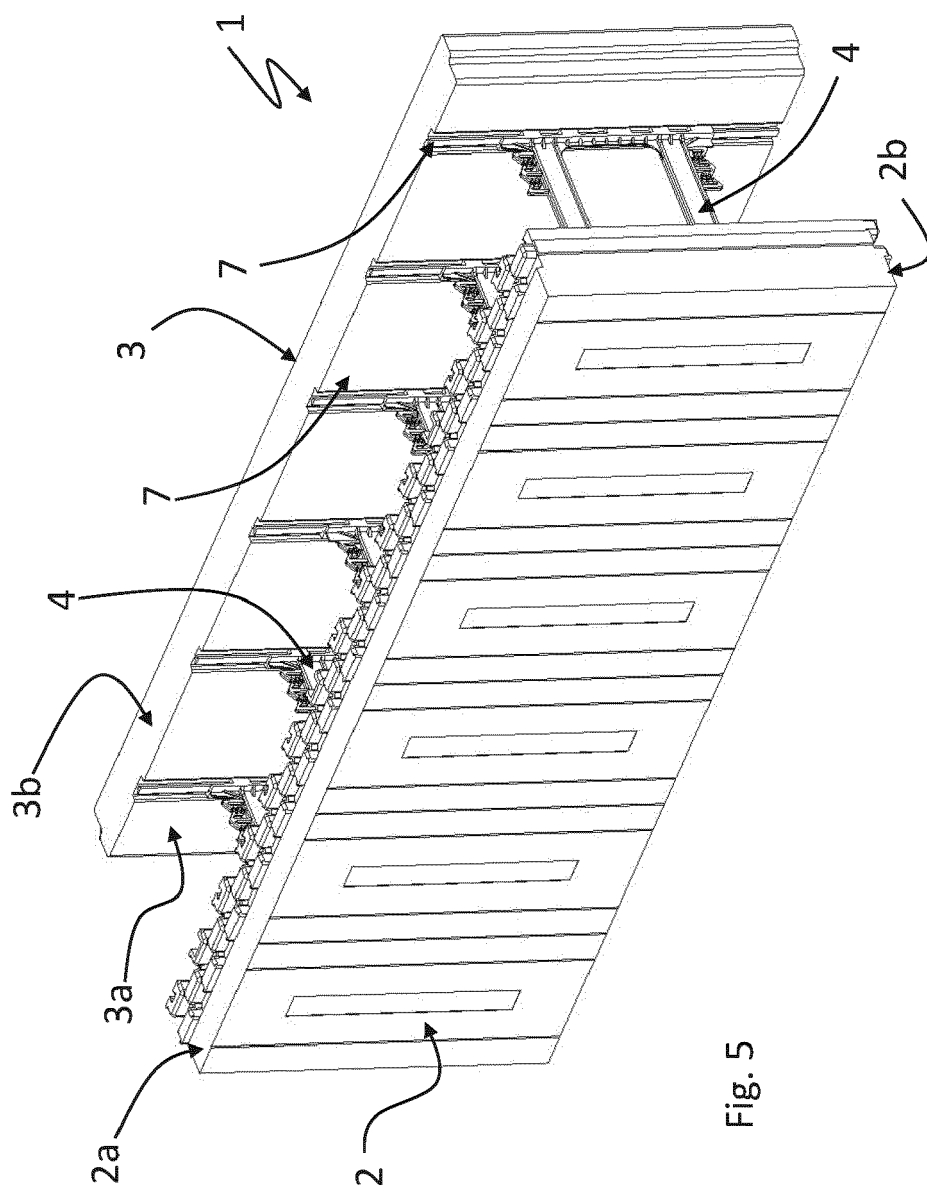
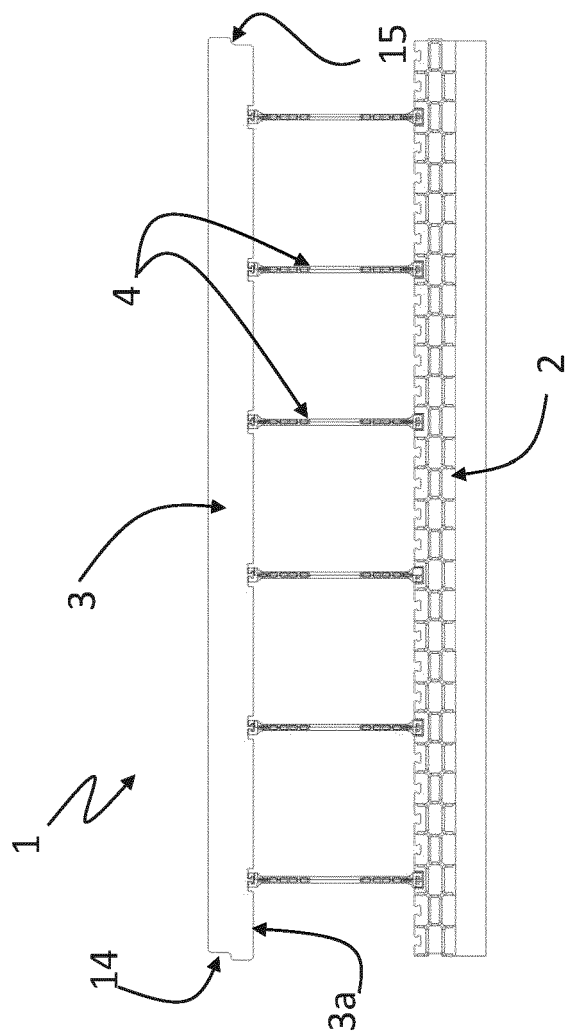
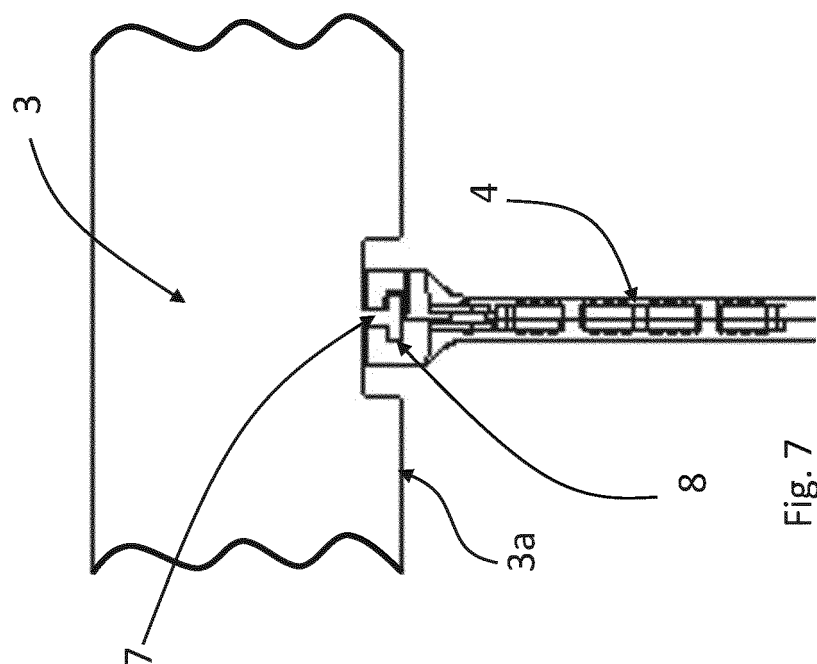
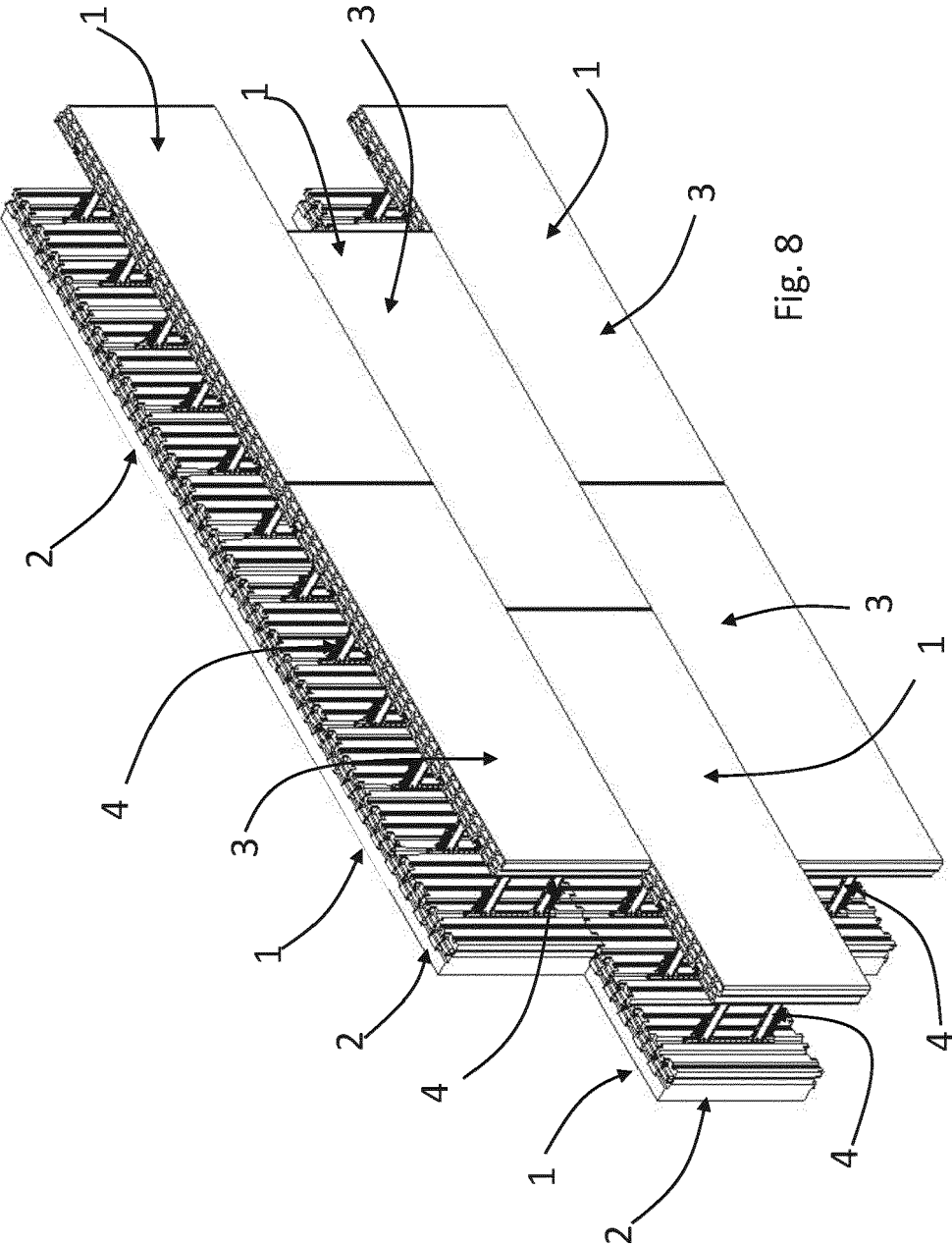


Fig. 4







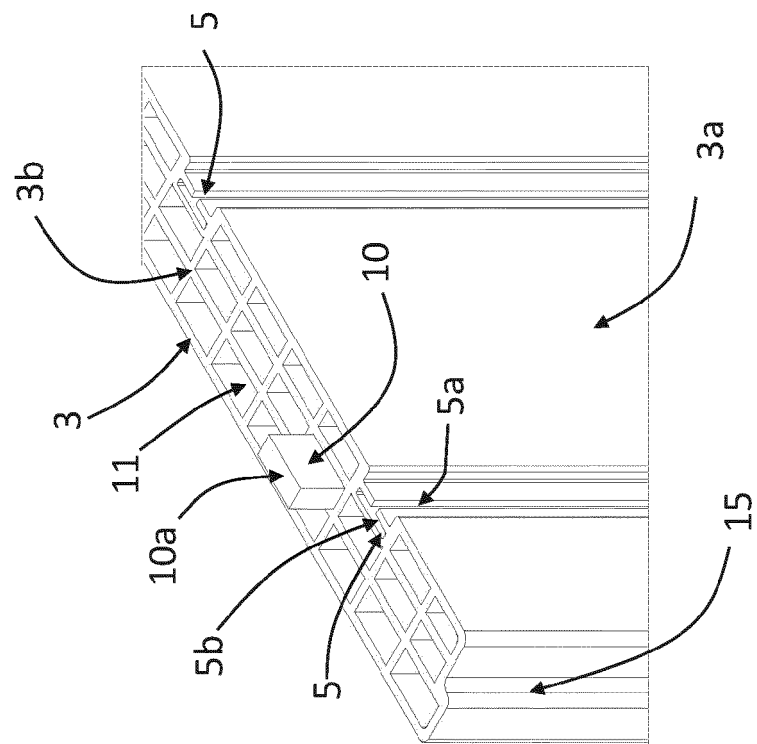


Fig. 9

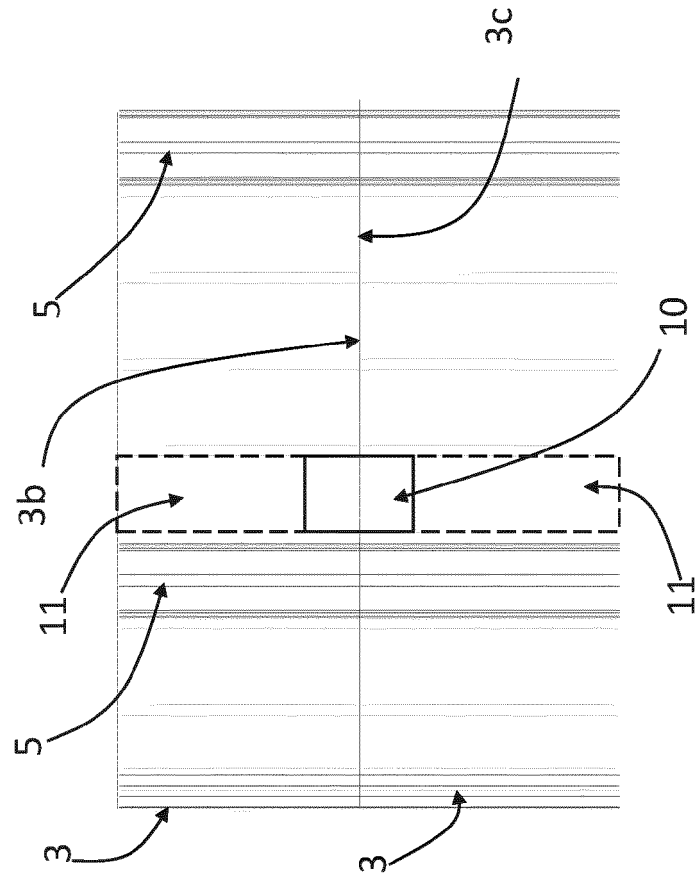


Fig. 10

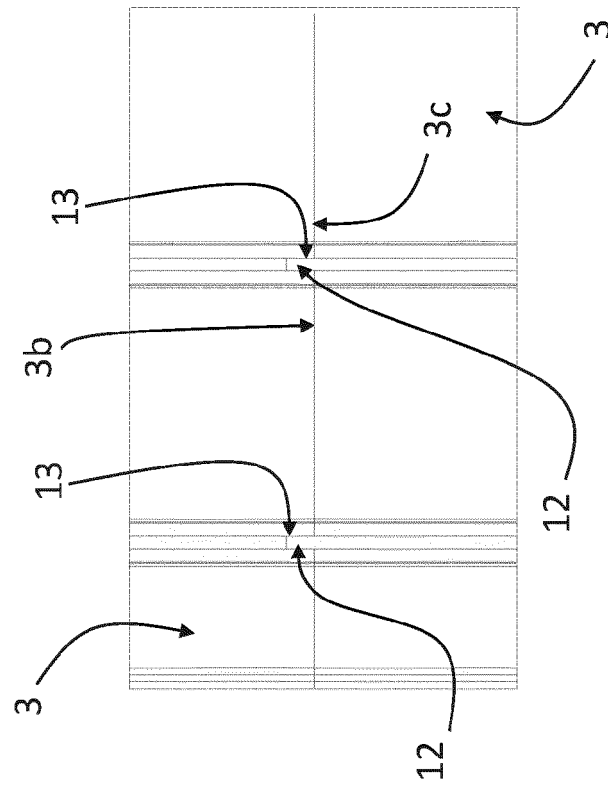


Fig. 11

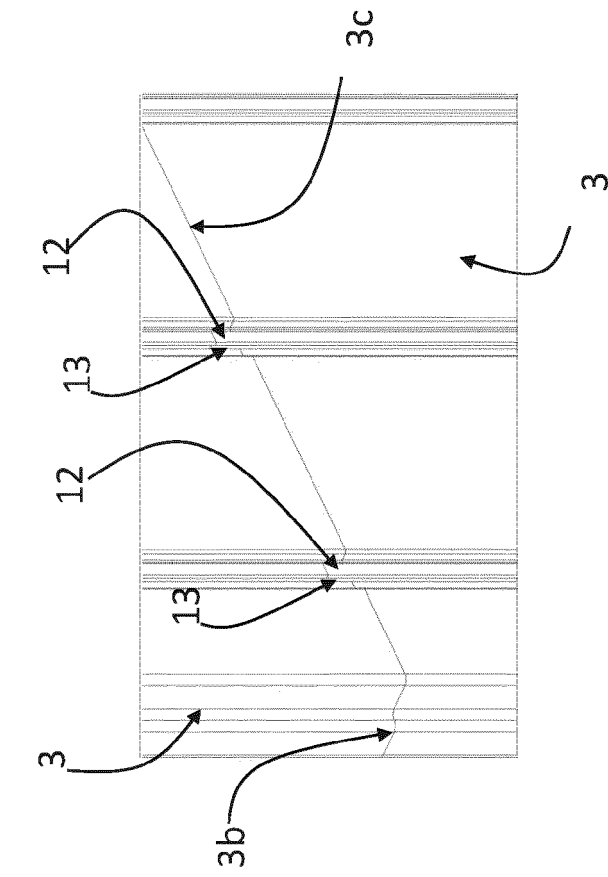


Fig. 12

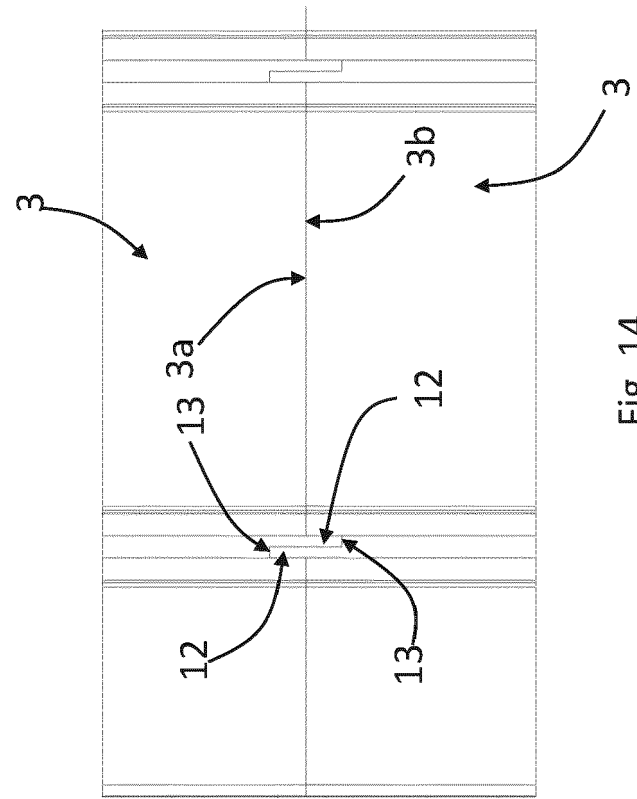


Fig. 13

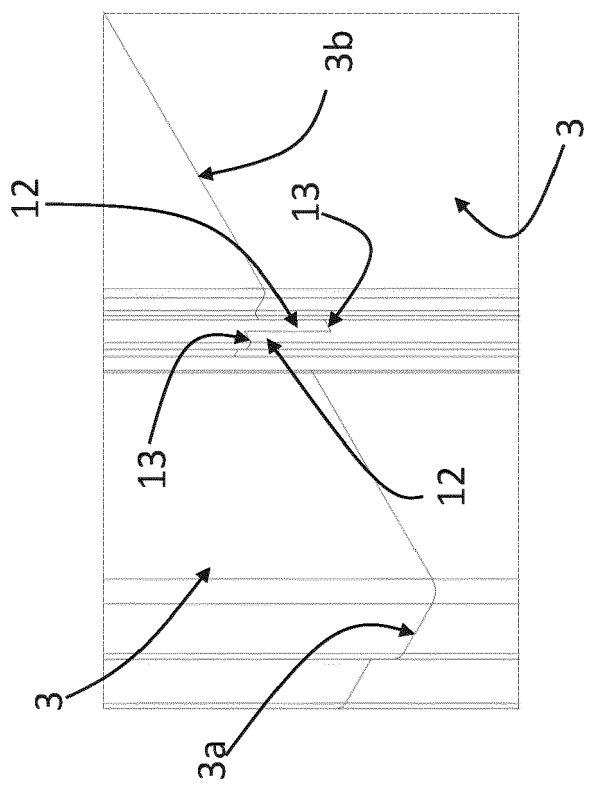


Fig. 14

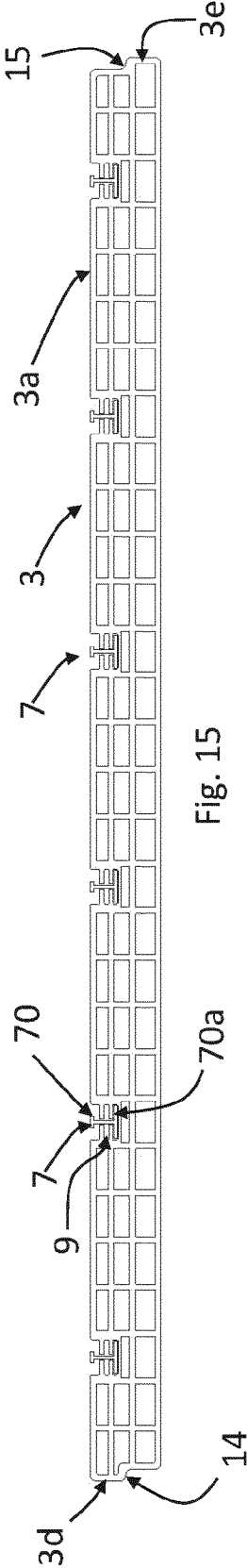


Fig. 15

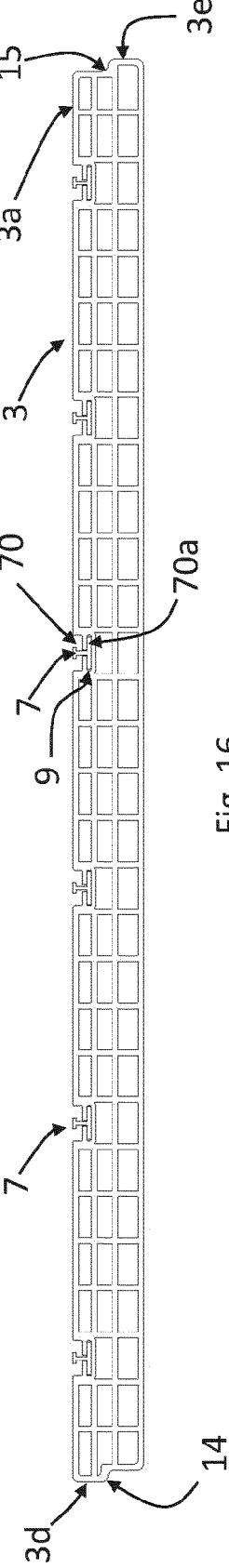
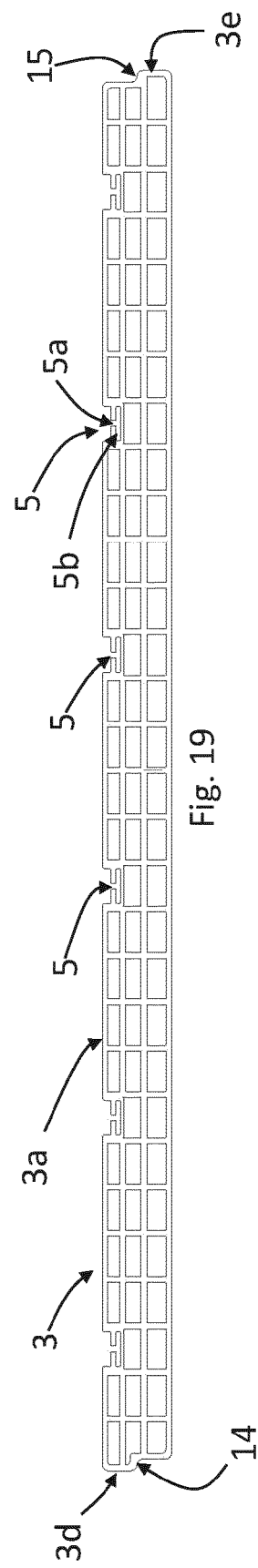
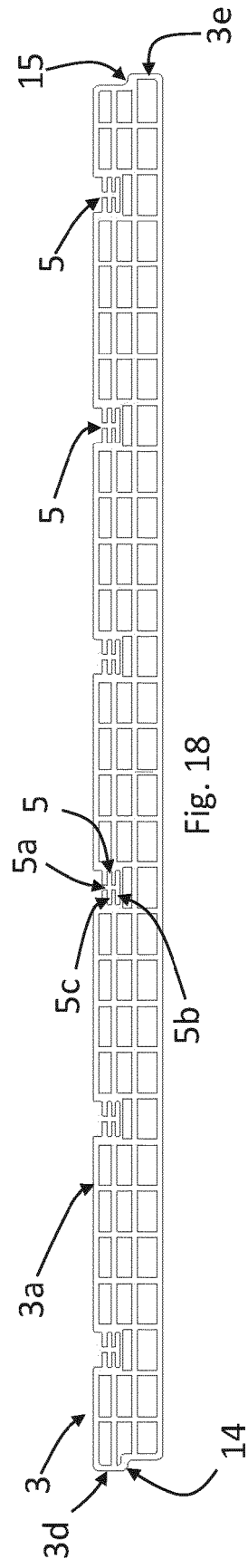
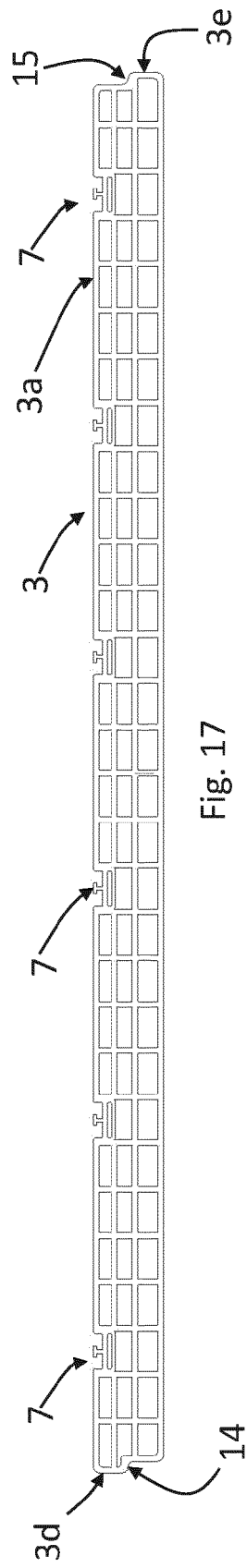
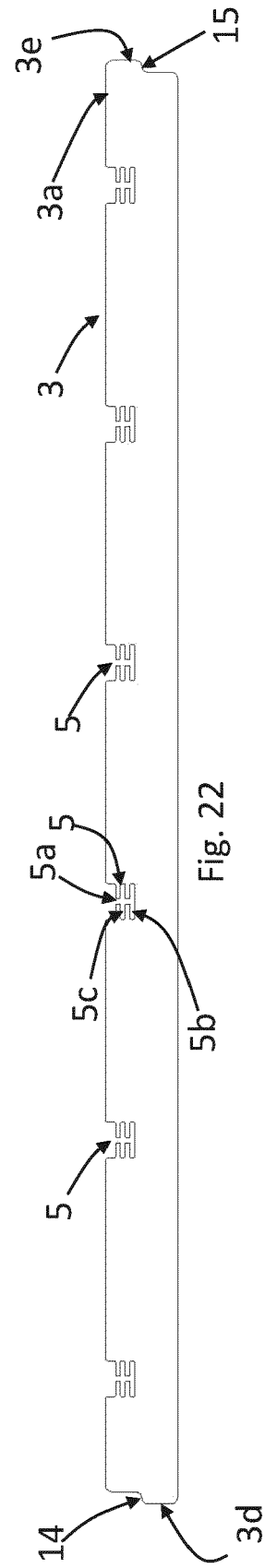
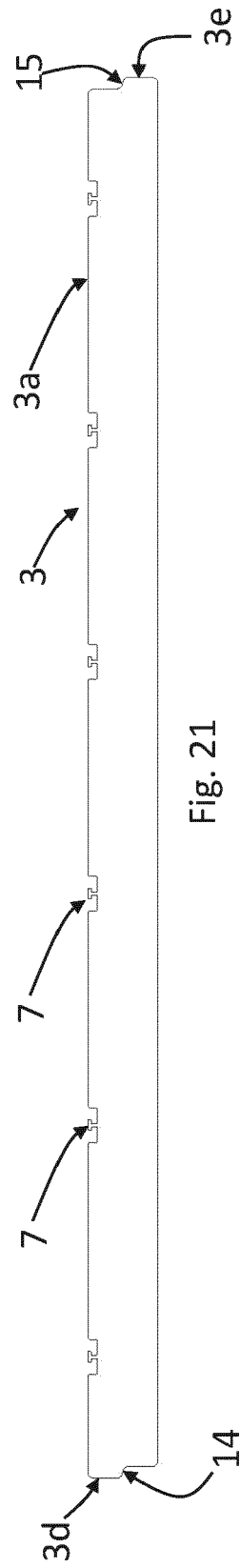
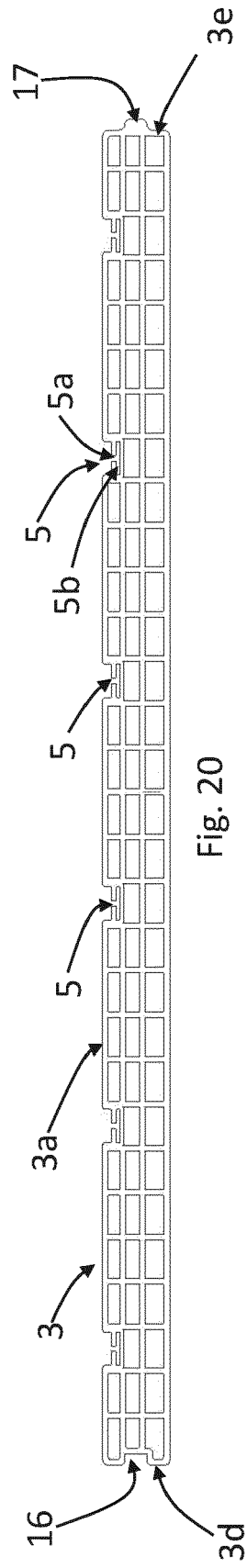
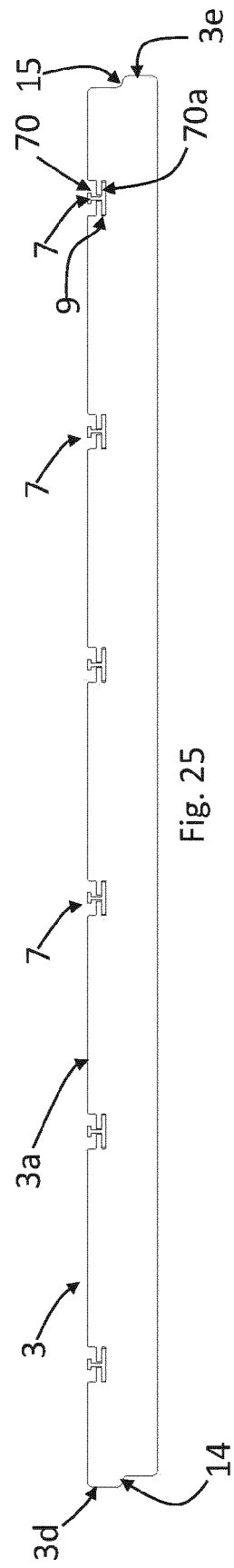
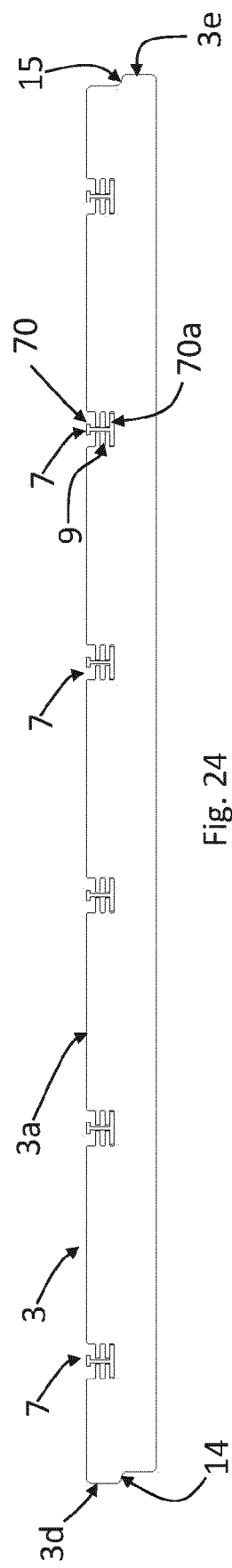
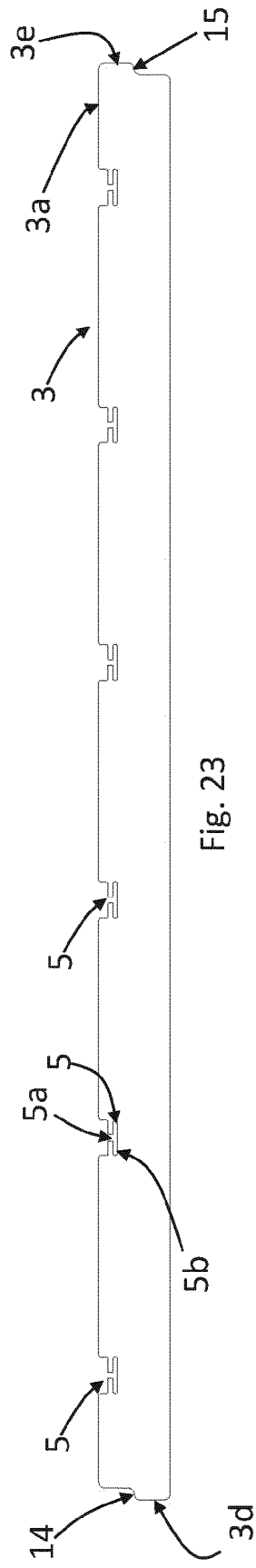


Fig. 16







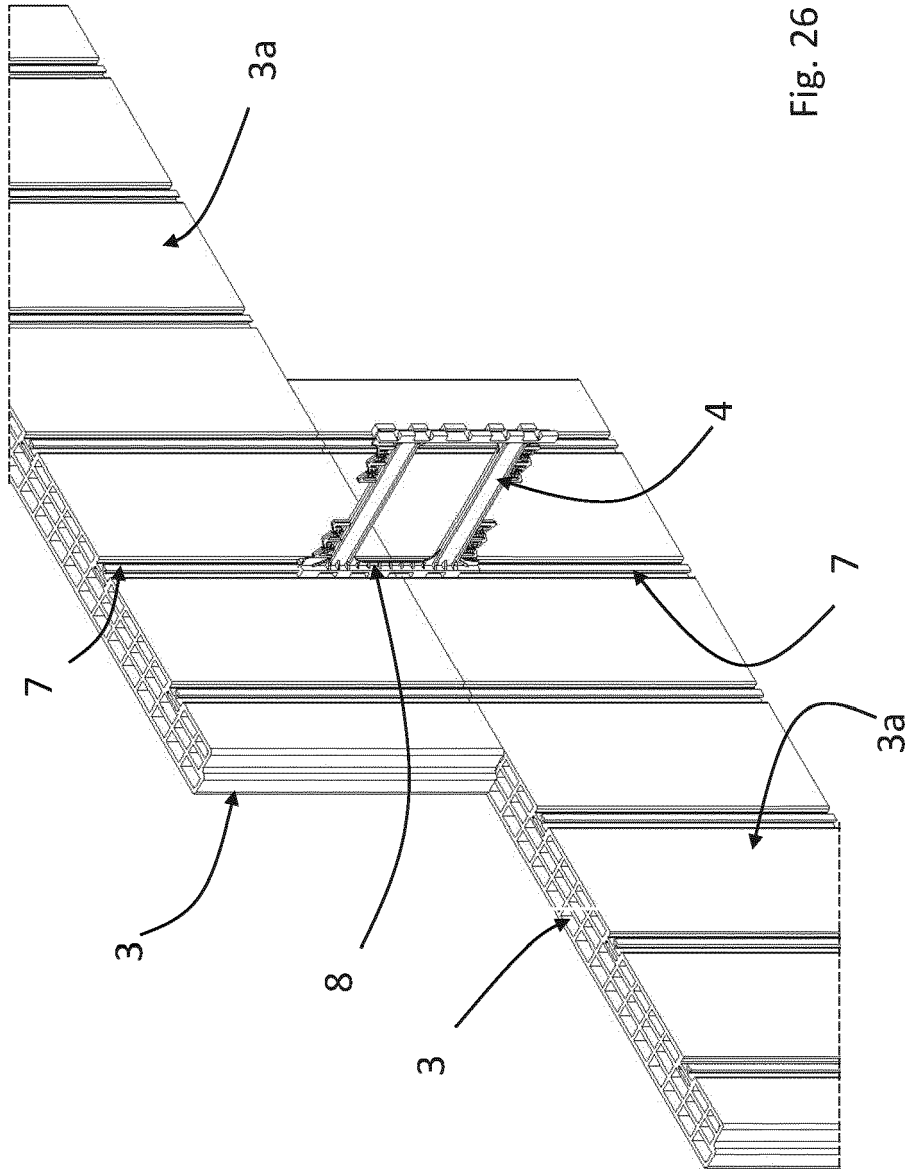


Fig. 26

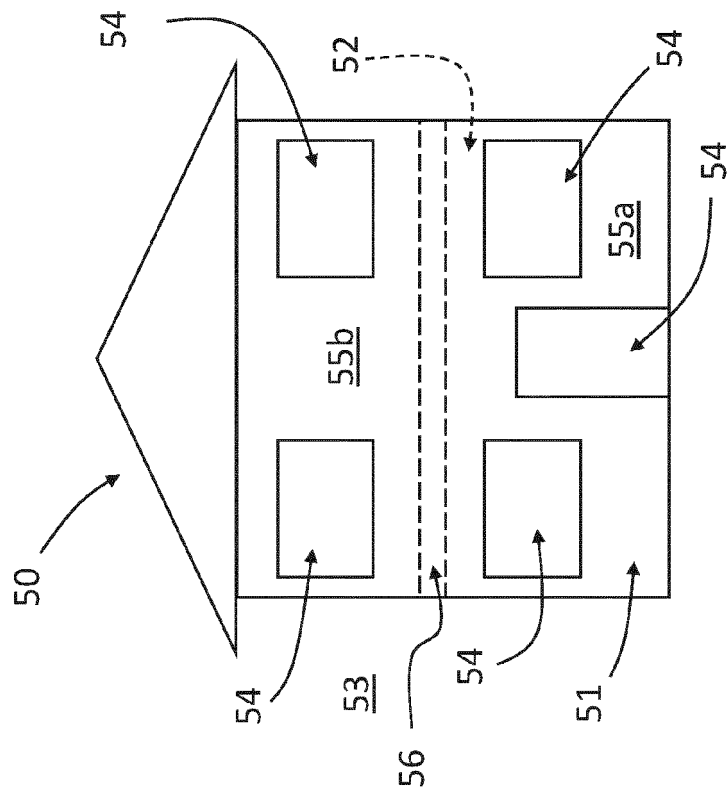


Fig. 27

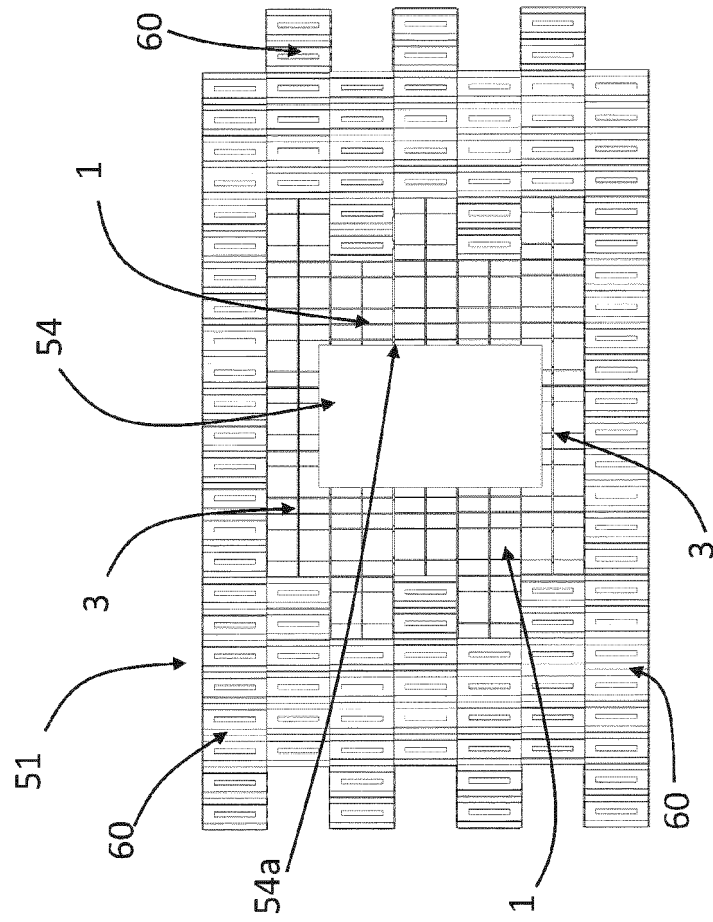


Fig. 28

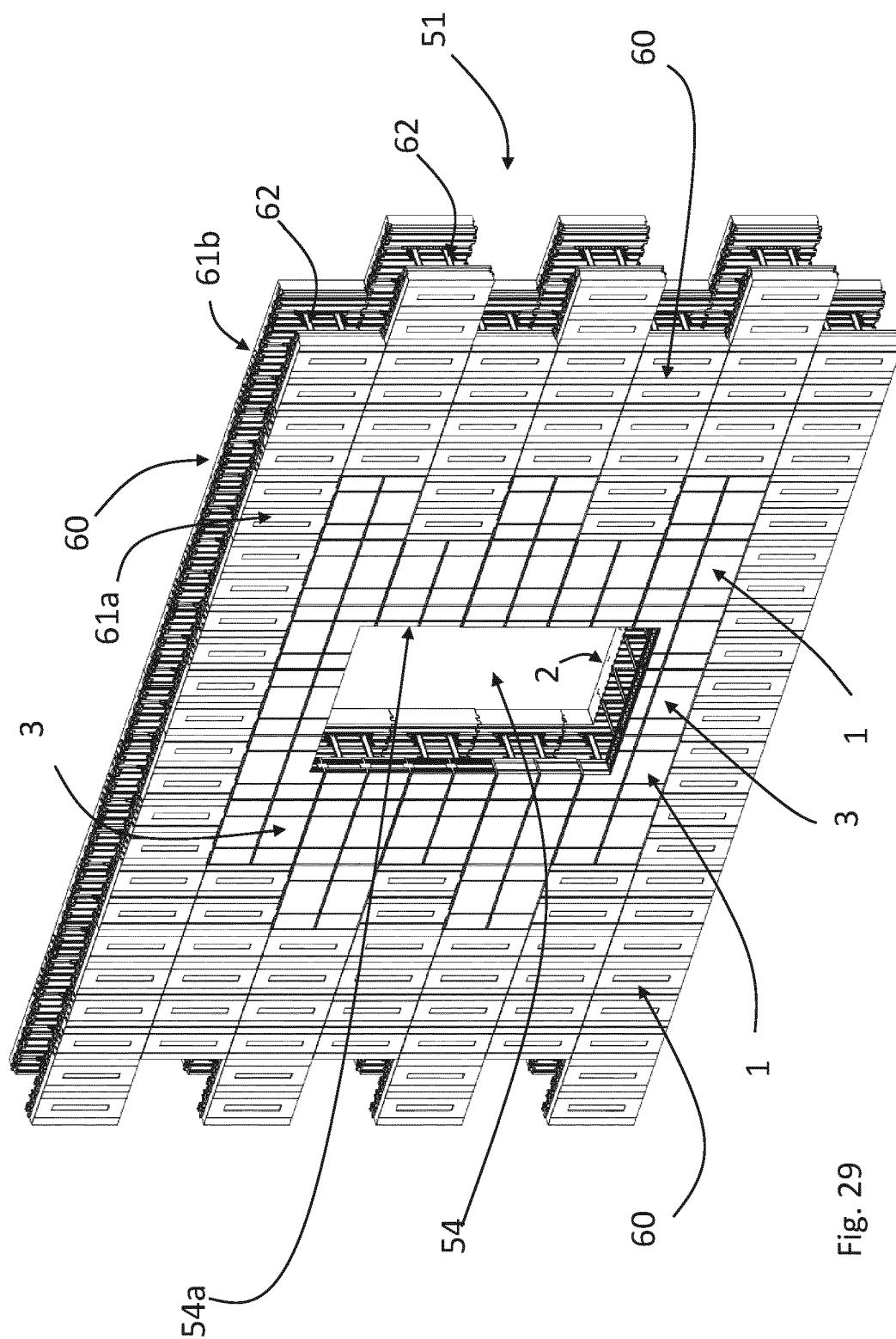


Fig. 29

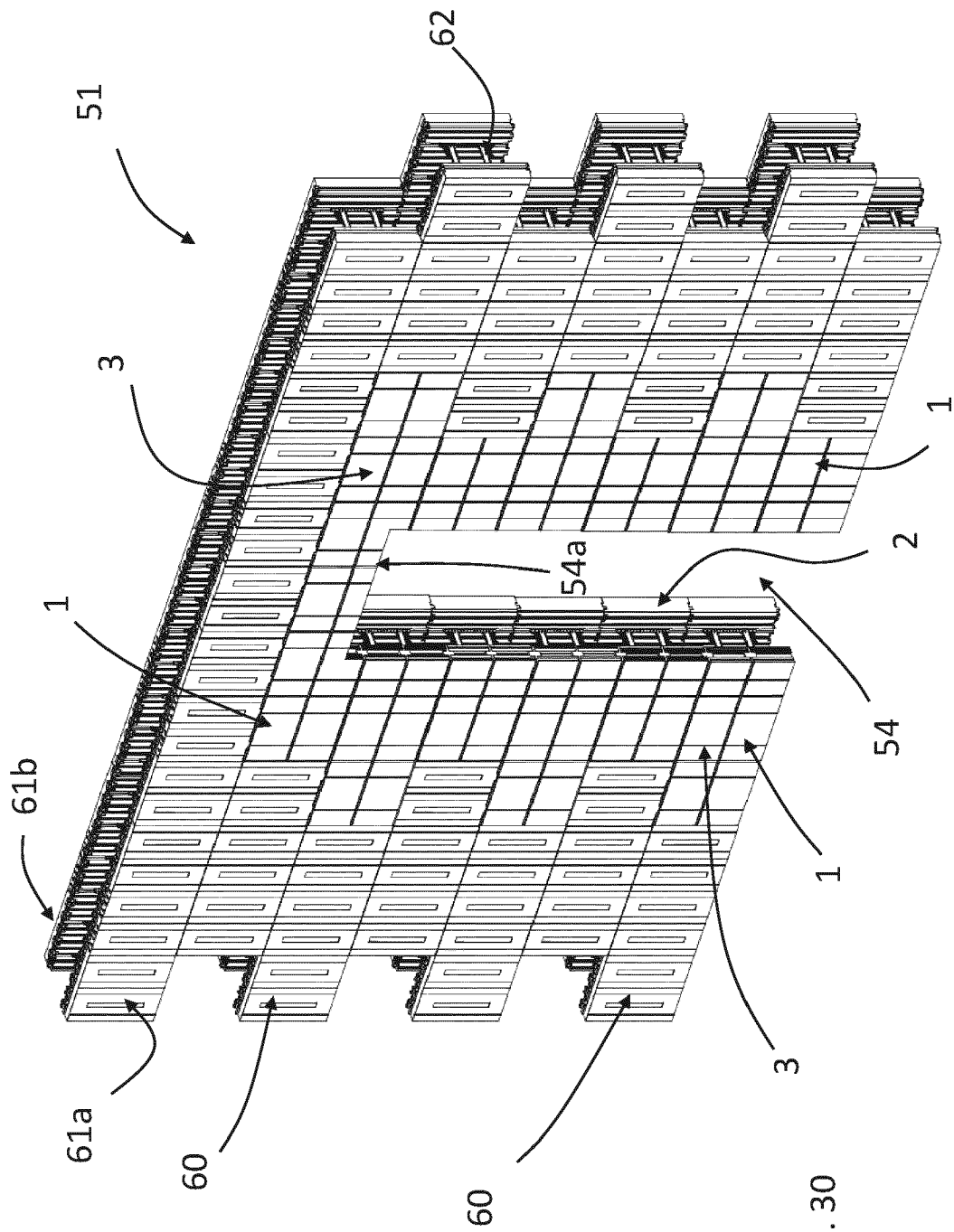


Fig. 30

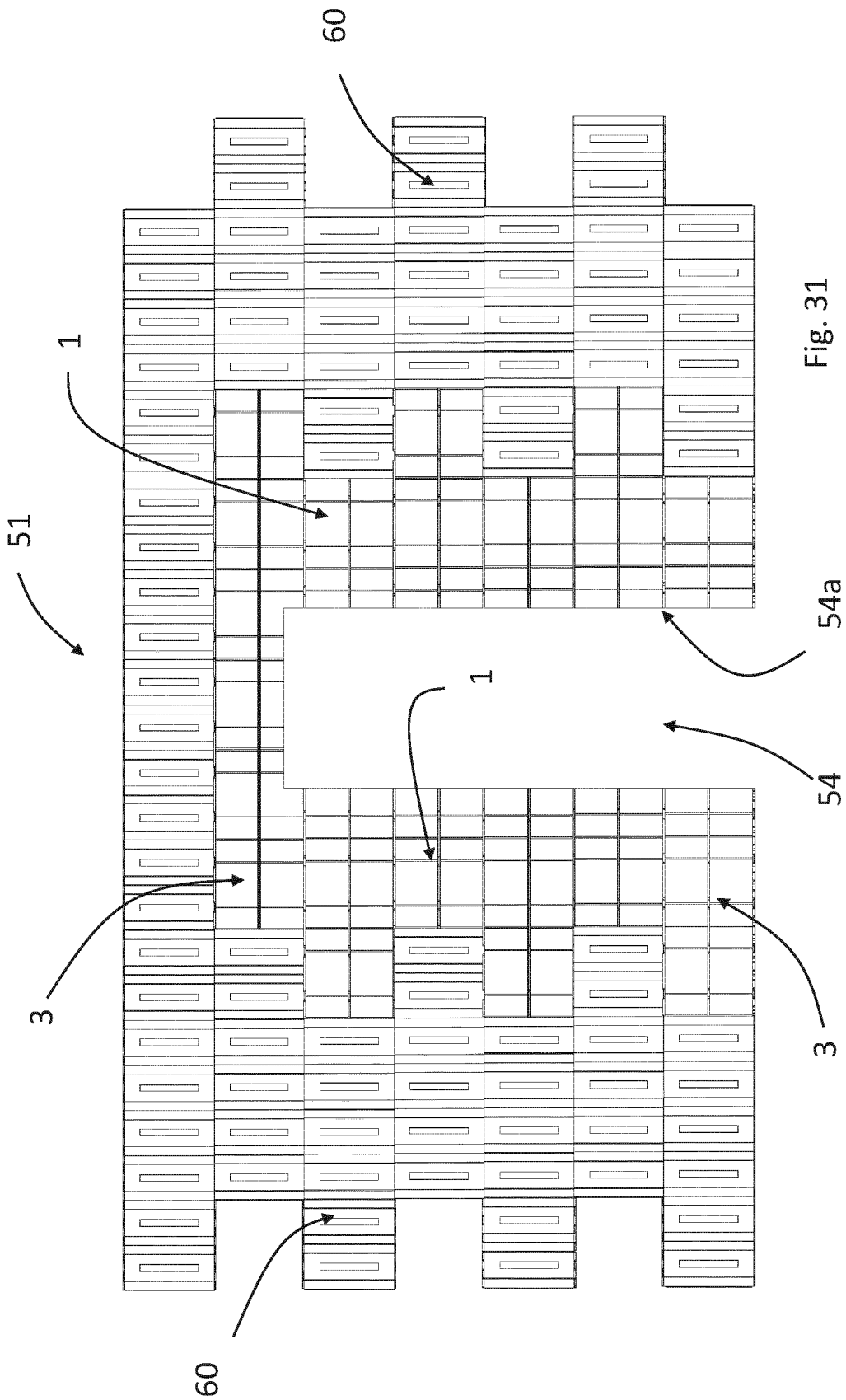


Fig. 31

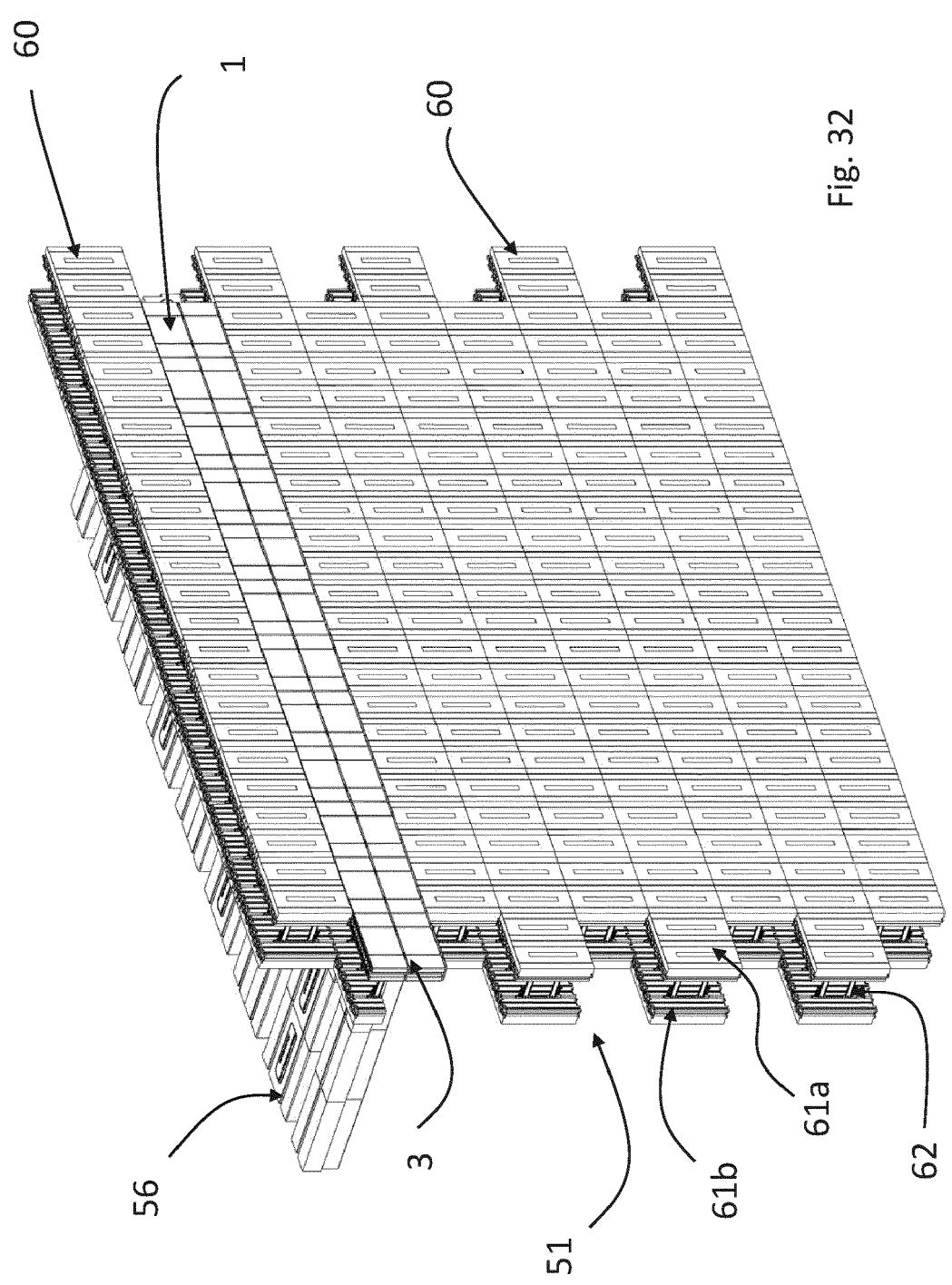


Fig. 32

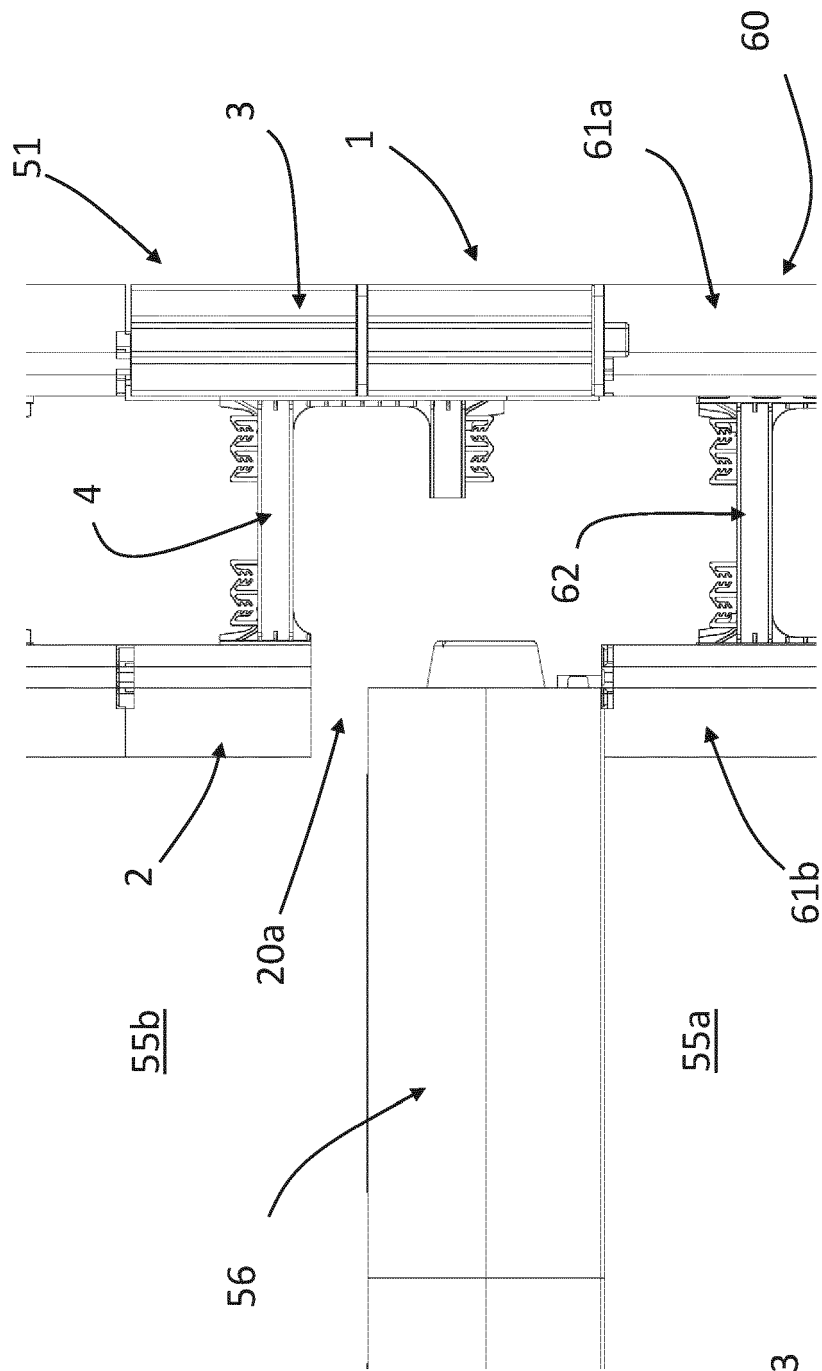


Fig. 33



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			TECHNICAL FIELDS SEARCHED (IPC)
			E04B
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Place of search The Hague		Date of completion of the search 10 July 2020	Examiner López-García, G
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