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(54) Titre : **Modular prefabricated panel for buildings, in particular for houses.**

(57) **Abrégé :**

The modular prefabricated panel (10) comprises : a first coating layer (20); a second coating layer (22); and a frame (25), which is arranged between said first and second coating layers (20, 22) and comprises a plurality of beams (30), which are rigidly constrained to one another, each beam (30) being arranged in correspondence to a respective outer edge of said panel (10). The beam (30) is shaped so as to have at least one between a projection (33) and a recess (34) designed to be interlocked, in a removable manner, with at least one respective recess/projection (34, 33) of a respective beam (30) belonging to an adjacent panel (10).

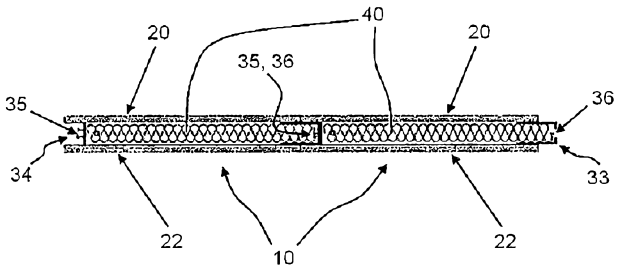

Fig. 6a

TITLE: "Modular prefabricated panel for buildings, in particular houses"

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DESCRIPTION

Technical field

The present invention relates to a modular prefabricated panel for buildings, in particular houses.

More in detail, the present invention relates to a panel according to the preamble of appended claim 1.

Technological background

In the field of civil engineering, in particular in the field of building and construction, prefabricated elements are commonly used to build structures designed for different types of use, such as for example living units.

The use of prefabricated elements is advantageous because it is cheaper, quicker and easier compared to conventional building methods.

In the prior art, prefabricated panels are known, which are made of concrete and have structural functions.

A drawback of these panels, besides the significant weight, lies in fact that they do not have sufficient thermal and acoustic insulating properties that can be compatible with the needs of the building and construction market. Furthermore, the outer surfaces of the concrete panels do not look very good and, therefore, need to be refined both on the outer face and on the inner face of the building or associated with other structures featuring better thermal and/or acoustic insulating properties.

Hence, in order to obtain a finished building, different procedures have to be carried out, such as for example: installation of the panels, laying and anchoring of the insulating material, and application of plaster to

the inner and outer faces.

Furthermore, prefabricated panels are known, which consist of a plurality of layers of wood, which, in order to be highly resistant to the loads stressing the structure, turn out to be very thick and generally very expensive.

A further drawback of the existing prefabricated panels lies in the means used to connect the different panels, which often comprise numerous elements to be assembled, thus leading to longer assembly times, which increase costs and make operations more difficult. Furthermore, some connections are not able to ensure sufficient resistance and stability, namely enough to resist the loads coming from the structure, whose resistance is entrusted to said prefabricated panels.

In general, structures consisting of modular elements cannot be easily disassembles and reused, as some particularly critical parts of the structure, such as the joints between the panels, are manufactured using ordinary building materials, such as cement, concrete or glue.

WO 2010/106224 A1 relates to a wall element comprising: a first plate, a second plate and an insulation material layer arranged between the first and the second plates, and a rabbet arranged on the edge of the wall element. In order to provide a wall element that is easy to use there is arranged a rabbet on all edges of the wall element and in order to provide a wall element that bears at least itself said rabbet is provided from the first plate and the second plate to a separate support frame consisting of one or more parts, which are placed on all edges of the wall element.

FR 2769649 A1 discloses a panel comprising two separate and parallel polymer sheets, attached by a sealing adhesive to uprights and cross members of a polymer or from a resin and fiber composition material, produced by pultrusion. The uprights and cross-members can be of U, H, I or square cross-section, and the adhesive used to seal the sheets to them contains a co-solvent of both components.

US 2011/173925 A1 discloses a structural insulated panel system includes a frame having a first and second vertical frame members and top and bottom frame members. First and second siding members are attached to opposite sides of the frame, the frame and the first and second siding members forming a cavity, with an insulation material within the cavity. The first vertical frame member includes recesses having a first depth and the second vertical frame member includes projections having a second depth. A first compressible seal is disposed within the recesses and is compressed by the projections of an adjacent panel upon assembly. A second compressible seal is disposed adjacent to each outside edge of the first or second vertical frame member and is compressed by the other frame member upon assembly. A plurality of voids are formed in at least one of the frame members and filled with the insulation fill material.

JP H0430050 A discloses a plate core material and a frame member forming a panel to be used for a thermostatic chamber or the like are made of non-combustible material mainly composed of calcium silicate. Multiple channels are provided in the surface of the core material, and primer processing is performed to it, and the core material is

made of the low density non-combustible material. An engaging recessed part and an engaging projecting part to be engaged with adjacent panels are provided in the frame material, and the frame material is made of the high density non-combustible material. Next, the non-combustible material is covered with surface shell plates made of metal, and they are subjected to pressure-connection through adhesive.

Summary of the invention

An object of the present invention is to provide a panel, which is able to solve this and other drawbacks of the prior art and which, at the same time, can be produced in a simple and economic fashion.

A further object of the present invention is to provide a load-bearing panel having a series of functional features, such as for example: thermal insulation, superficial finishing, easy assembly procedures, and ability to be disassembled and then reused.

According to the present invention, this and other objects are reached by means of a panel according to appended claim 1.

The appended claims are an integral part of the technical teaches provided in the following detailed description concerning the present invention.

Brief description of the drawings

Further features and advantages of the present invention will be best understood upon perusal of the following detailed description, which is provided by way of example and is not limiting, with reference to the accompanying drawings, which specifically show what follows:

- figure 1 is a front view of a building where panels

according to the present invention are installed;

- figure 1a is a front view of further variant of a building where panels according to the present invention are installed;
- figure 2 is a front view of a panel according to a first embodiment of the present invention;
- figure 3 is a front view of a panel according to a second embodiment of the present invention;
- figure 4 is a cross section along line IV-IV of a variant of the panel shown in figure 2;
- figure 5 is a cross section along line IV-IV of a further variant of the panel shown in figure 2;
- figures 6 and 6a are cross sections of two panels connected to one another according to two embodiments;
- figure 7 is a cross section of a panel connected to the ground;
- figures 8 and 8a are cross sections showing two panels connected to one another in correspondence to a corner;
- figure 8b shows the detail indicated with VIII in figure 8a;
- figure 9 shows different manufacturing details of the panel according to the present invention;
- figure 10 is a perspective view of a panel with a corner shape;
- figure 11 is a cross section showing an embodiment of a panel;
- figure 12 shows different construction details of an anchoring system;
- figure 13 shows an example of joined panels, in particular vertical and horizontal panels;
- figure 14 shows a variant of joined panels and of the relative connection to the ground;

- figure 15 is a front view of a variant of a panel;
- figures 16a, 16b, 16c show a further variant of a panel, in particular in a front view, in a plan view, and in a cross section along line XVI, respectively;
- figure 17 shows a front view of a further variant of a panel.

Detailed description of the invention

Figure 1 shows a building 1 comprising a series of lateral walls including a plurality of panels 10, a floor 4 and a roof 3. Furthermore, there are different openings A, in particular a window and a door, which are obtained by using special variants of panel 10 described below.

Figure 1 is shown by mere way of example; as a matter of fact, roof 3 can be built with a dedicated load-bearing structure covered with a covering layer (for example profiled sheet metal). Furthermore, as explained more in detail below, the panels can be used to build a floor or a ceiling. A particular embodiment is shown in figure 13 (described below).

Roof 3 is built by arranging panels 10 along the horizontal or inclined plane, or a combination thereof, according to the needs.

According to a different embodiment, roof 3 can be not built by means of panels 10, but it creates an independent body that is coupled to rest of the structure of the building.

In the embodiment shown, building 1 is a single-storey building, but one can also build multiple-storey buildings.

In case of multiple-storey buildings, one needs horizontal planes acting as floor 4 for each storey; said floor 4, according to an advantageous embodiment, is built by using and assembling one or more panels 10 according to

the present invention.

Even with single-storey buildings, floor 4 can be built by using one or more panels 10 according to the present invention.

Furthermore, these panels 10 can also be simply used as curtain walls for a load-bearing structure, such as for example a skeleton consisting of a framework made of reinforced concrete or steel, etc..

A person skilled in the art can clearly understand that the shape, the extension, the dimensions, and the interior partition of the building can largely vary, without for this reason going beyond the scope of protection of the present invention.

With reference to the figures mentioned above, a panel 10 according to the present invention is shown, which comprises:

- at least one first coating layer 20;
- at least one second coating layer 22;
- at least one frame 25, which is arranged between said first and second coating layers 20, 22 and comprises a plurality of beams 30, which are rigidly constrained to one another.

In the first embodiment shown in figure 2, each beam 30 is arranged in correspondence to a respective outer edge of said panel 10. In particular, panel 10, which conveniently has a rectangular shape, preferably has four beams 30, which are rigidly constrained to one another and are arranged so as to create frame 25 having the shape of a "picture frame", wherein each beam 30 is close to a respective edge in a position that is substantially parallel thereto; this means that beam 30 can be slightly reentrant, protruding (at the most of a few of cm) or

aligned relative to the outer edge of at least one of the two coating layers 20, 22.

According to the second embodiment shown in figure 3, beams 30 of frame 25 are arranged only in correspondence to some of the outer edges of panel 10 (in this case, three of them). In this case frame 25 has a "U" shape. In other words, frame 25 has an interruption in correspondence to a side of panel 10, thus not developing in a continuous manner along the perimeter thereof.

As a person skilled in the art can clearly understand, the expression "beams rigidly constrained to one another" means that frame 25 can be built as a single piece, in which each beam 30, which preferably but not exclusively has a straight axis, builds a relative segment; or the single beams 30 can be caused to be integral to one another, so as to build frame 25, by means of known joining systems, such as welding or bolting, etc..

Further embodiments comprise a frame that is similar to the ones shown in figure 2 and 3, in which, though, further beams are provided, which are not arranged in correspondence to the peripheral edges of panel 10. These "additional" beams can be inserted between the two coating layers and can be parallel or inclined relative to the axis of the outer edges of panel 10.

According to a further embodiment (not shown), in case there are beams 30 that extend through panel 10, at least one of said first and second coating layers 20, 22 can be made up of different parts, so that one or more beams 30 can be accessed from the outside and, hence, can be interlocked, in a removable manner, with a respective beam 30 belonging to an adjacent panel 10; for example, so as to form a "T" joint between two panels.

As far as the outer shape of panel 10 is concerned, there are different possible solutions, besides the rectangular shape. For example, some shapes are possible, which are described hereinafter in a non-limiting manner: L, T, V, irregular, polygonal with at least one curved side, polygonal with at least one angle that is not a right angle, etc..

In particular, when one needs to create openings A in the structure, which, for example, are useful for the later installation of a door or a window, one has to use panels 10 with a shape that is similar to the ones mentioned above, or a combination thereof, so as to generate, in the structure, an opening A having a desired shape and size.

According to a further embodiment shown, in a non-limiting manner, in figure 1, panel 10 can have an opening A. In the embodiment of figure 1, opening A is a window with a rectangular shape; however, the shape and the size of this opening A can change significantly. The figure also shows (on the left side) an opening A for the installation of a door, which is built by using to two adjacent panels 10 having a shape that is such as to create an opening, in particular with a rectangular shape.

Alternatively, figure 1a schematically shows a building that is similar to the one of figure 1, in which opening A housing the door is built by means of a single panel 10 having a shape that allows said door to be housed therein. Optionally, panel 10 is already provided with a door associated with the respective opening A.

Figure 4 shows a cross section of a variant of panel 10, in which one can see: beams 30 making up the frame 25; the first coating layer 20; the second coating layer 22.

Between said first and second coating layers there is

interposed a layer of insulating material 40, which has the function of ensuring the thermal and/or acoustic insulation of the building. This solution turns out to be particularly advantageous in case panel 10 is positioned on the outer face of the building.

Prefabricated elements for buildings generally do not have insulating properties that are able to fulfill the requirements currently provided for by law and ensure the thermal comfort of the people using them. Therefore, constructors normally have to subsequently apply layers of insulating material that need to be positioned and fixed. This situation generates a series of drawbacks, such as for example longer installation times, increase in costs, and probability of an insufficient result.

The use of insulating material ensures high performances in terms of transmittance, thus decreasing the quantity of energy needed to heat up/cool down the building, hence reducing managing costs.

The layer of insulating material 40 is made of a known material, such as for example polyurethane foam, or a sound-proofing material, preferably in the form of panels, such as mineral wool.

The first coating layer 20, preferably facing outwards with respect to the building 1, generally comprises a panel 41 made of fibre cement or concrete or plaster.

The second coating layer 22, preferably facing inwards with respect to the building 1, comprises a wood panel 42 and a plasterboard panel 43.

The wood making up panel 42 is known and can be selected among different types of wood, such as for example natural wood, plywood, chipboard and, more advantageously, OSB (Oriented Strand Board).

The panels making up said coating layers 20, 22 are fixed to frame 25 by means of known fixing means (nor shown).

For example, with reference to the variant shown in figure 4, said frame 25 is caused to be integral, by means of the direct polyurethane injection building system, to the fibre cement panel 41 and to a wood panel 42, which is fixed to a plasterboard panel 43 by means of known mechanical or chemical fixing means.

An especially advantageous example of panel 10 mentioned above can be described as follows:

- fibre cement panel, thickness ranging from 5 to 20 mm;
- OSB panel, thickness ranging from 5 to 30 mm;
- plasterboard panel, thickness ranging from 5 to 20 mm.

Figure 5 shows a variant of panel 10 that is similar to the one of figure 4, but does not feature the layer of insulating material and, therefore, is preferably used to build dividing walls on the inside of a building, where an acoustic insulation is not provided.

Layers 20, 22 comprised in the variant shown in figure 5 are slightly different from the ones of the variant of figure 4.

The variant shown in figure 5 includes a first coating layer 20 comprising plasterboard panel 43. The second coating layer 22 comprises wood panel 42 and plasterboard panel 43.

According to a further embodiment, panel 10 comprises, on at least one between said first and second coating layers 20, 22, a finishing layer, which is used to make the structure look good. Furthermore, this finishing layer helps reduce costs for the final user, as no further procedures are needed to finish panels 10.

The finishing layer, which is known in itself, can be made up of stucco, plaster, paint, wallpaper, etc..

Furthermore, further embodiments (not shown) are possible, in which at least one between said first and second coating layers 20, 22 comprises at least one fibre cement panel 41 or wood panel 42 or plasterboard panel 43 or a combination thereof.

It has to be intended that, the examples mentioned above and concerning the layers 20, 22 are non-limiting embodiments of the present invention and, therefore, can be varied in terms of material and number of the layers, thickness, and sequence of the layers.

According to a particularly advantageous embodiment, frame 25 is made of a metal material, such as steel, galvanized steel, aluminum, due to the high mechanical performances.

Furthermore, frame 25 made of a metal material can be coated with a layer of paint, so as to protect it from corrosion.

According to further embodiments, said frame 25 is made of wood, plastic, concrete, reinforced concrete. Furthermore, frame 25 can possibly comprise different beams made of different materials.

A non-limiting example of the present invention, which turns out to be particularly advantageous, comprises a frame 25 made of galvanized steel with a thickness of the flanges of beams 30 ranging from 1 to 5 mm.

Figure 6 shows two panels 10 according to the present invention joined to one another; in particular, the figure shows two flat panels 10.

Each panel 10 comprises a beam 30, which is shaped so as to have at least one between a projection 33 and a

recess 34, which is designed to be interlocked, in a removable manner, with at least one respective recess/projection 34, 33 of a respective beam 30 belonging to an adjacent panel 10. These projections 33 and recesses 34 are designed to create a mechanical male-female coupling.

In the embodiment of figure 6, beams 30 belonging to frame 25 have, in their cross section, a "C"-shaped profile. However, for the profile of the beams, further shapes are possible, such as for example a V shape, an L shape, a dovetail shape, and other more complex shapes.

This shape of beams 30 allows the different panels 10 to be joined to one another is a very quick manner, without using special tools, thus decreasing the chance for mistakes during the procedure.

A further advantage resulting from this type of mechanical coupling lies in the fact that building 1 can be completely disassembled and the parts making it up can be reused to built, at a later stage, other buildings. Hence, the panels of the structure can be disassembled and reused for an infinite number of times.

Figure 7 shows how a panel 10 belonging to a vertical wall is joined to a horizontal surface 2.

In order to obtain this coupling, said surface 2 is associated with at least one beam 30a, which is shaped so as to have at least one between a projection 33 and a recess 34, which is designed to be interlocked, in a removable manner, with at least one respective recess/projection 34, 33 of a respective beam 30 belonging to panel 10 according to any of the variants of the present invention.

In the case shown in figure 7, in a non-limiting way,

surface 2 coincides with floor 4 at the base of the building 1, to which the different panels used to build the whole structure are fixed.

Surface 2 can be made of different known materials.

Beam 30a is fixed to surface 2 by means of suitable known fixing means, such as nails, screws, bolts, rivets, welding, interlocking systems, bayonet systems, gluing, etc., or a combination thereof.

According to an embodiment, surface 2 is made of concrete and beam 30a is partially embedded in it.

Figure 8 shows two panels 10 joined to one another in correspondence to a corner by means of a profile 32, which is designed to be interlocked, in a removable manner, with beams 30 of the two panels 10 converging towards the corner.

Profile 32 is shaped so as to have at least one between a projection 33 and a recess 34, which is designed to be interlocked, in a removable manner, with at least one respective recess/projection 34, 33 of a respective beam 30 belonging to adjacent panel 10. Projections 33 and recesses 34 are designed to create a mechanical male-female coupling, similar to the one created between single panels 10.

In the example shown, the angle between panels 10 is a 90° angle, but one can also use a profile 32 that is able to join panels 10 so that they form an acute or obtuse angle.

According to a further embodiment, the profile is designed to connect more than two panels 10; for example, in case outer walls and inner walls converge.

A non-limiting example of the present invention, which turns out to be particularly advantageous, comprises a

profile 32 made of galvanized steel with a thickness of the wing of profile 32 ranging from 1 to 5 mm.

Furthermore, as shown in figure 8, profile 32 comprises a layer of insulating material 40a, which is similar to the one described with reference to figure 4, so as to ensure the thermal insulation thereof and avoid the so-called "thermal bridge", which is an area with a high thermal conductivity that is able to mitigate the positive effects resulting from the insulation of the rest of the structure.

According to a further embodiment (not shown), this profile 32 is not provided with a layer of insulating material 40a, for example in case of a connection between inner dividing walls, provided that there is no need for a thermal or acoustic insulation.

According to a further embodiment, profile 32 at least partially comprises a coating layer made of fibre cement, plasterboard or wood or a combination thereof. Furthermore, as already mentioned with reference to the panels, a finishing layer can be applied on the outside of the profile.

Figure 9 shows some non-limiting examples of some details represented in a cross section view: a beam 30; a beam 30a designed to be fixed to the surface; a profile 32. Figure 12 shows a variant of beam 30a of the preferred embodiment.

Furthermore, it is possible for each beam 30, 30a to be shaped so as to have at least a plurality of projections 33 and recesses 34, which are designed to be interlocked, in a removable manner, with respective recesses 34 and projections 33 of a respective beam 30, 30a belonging to adjacent panel 10.

Figure 10 shows an embodiment of panel 10 having a corner shape.

Panel 10 comprises a plurality of beams 30, whose axes are arranged in a three dimensional manner and, unlike the axes of the previous examples, do not belong to a single plane.

Panel 10 shown in figure 10 consists of two parts 90, 91, which are arranged so as to be substantially perpendicular and can be identified as the planes on which panel 10 at least partially extends; each part 90, 91 comprises at least one beam 30 as well as the first and second coating layers 20a, 20b, 22a, 22b.

Since panel 10 is not flat, frame 25 is arranged between said first coating layers 20a, 20b and said second coating layers 22a, 22b, which are joined to one another so as to avoid the presence of openings through panel 10.

According to a further embodiment, at least one among said first coating layers 20a, 20b and said second coating layers 22a, 22b does not entirely cover beam 30 of frame 25 arranged in correspondence to the corner, so that said beam 30 can be interlocked, in a removable manner, with a respective beam 30 belonging to an adjacent panel 10.

Clearly, further more complex shapes of corner panel 10 are possible. For example, corner panel 10 comprises more than two parts, each belonging to a respective plane. Furthermore, the angle between the faces can be acute or obtuse.

One can also provide a panel that at least partially extends on a curved surface.

For the corner panel one can use, when possible, all the embodiments described above for the flat panel, which, for the sake of brevity, are not repeated below.

According to a further embodiment, on at least one pair of beams 30 and/or 30a designed to be associated with one another there is provided a fixing system, which is used to keep said beams in position when they are coupled to one another, thus preventing the cooperating panels 10 from accidentally moving apart and create stability problems to the building. This fixing system can comprise, for example, a snap system, a quick release system, screw joints, bolt joints, etc., which are all known to skilled person.

For example, the fixing system can be advantageously applied to beams 30, 30a in the shape of further projections and recesses, which are able to engage one another and provide a suitable holding force after a slight elastic deformation of the pair of beams 30 and/or 30a during the coupling of the respective panels 10.

The variant shown in figure 11 shows a panel 10, wherein at least one beam 30 comprises at least one between a pin 35 and a slot 36 or hole, which is designed to be mechanically engaged, in a removable manner, with a respective slot/pin 36, 35 belonging to an adjacent panel 10. In particular, beam 30 having a recess 34 facing outwards ("female" beam) comprises a pin 35, which is designed to be inserted into a slot 36, which is obtained on projection 33 of a beam 30 ("male" beam) belonging to an adjacent panel 10.

Preferably, pin 35 has the shape of a cone or a truncated cone, so that it can be inserted into the respective slot 36 by slightly lifting one of the two panels 10 and, once it is in, the shape of a cone or truncated cone can prevent the two cooperating panels 10 from being decoupled due to force that substantially act

parallel to the plane of panels 10.

Figure 6a shows the coupling between two panels of the type described above.

Consequently, profiles 32, as well, can comprise at least one between a pin 35 and a slot 36, which is designed to be mechanically engaged, in a removable manner, with a respective slot/pin 36, 35 belonging to an adjacent panel 10 or to a complementary profile 32, as shown in figure 8a and 8b. In particular, there is a pair of profiles 32, which have pins and slots 35, 36 that are designed to join said profiles 32 and, furthermore, are designed to be mechanically engaged with respective adjacent panels 10.

Furthermore, some fixing systems and building details are provided, which are such as to ensure a greater resistance and a smaller deformability of the building, in particular when dealing with vertical and horizontal actions.

Figure 12 shows an anchoring system 6, which is designed to constrain a panel 10, for example a vertical one, to a beam 30a associated with a surface 2, for example a horizontal one, such as a concrete slab or a floor 4. System 6 comprises:

- a lower plate 60, which has a shape that is such as to be at least partially housed preferably in beam 30a associated with the surface 2 or in the beam 30;
- an upper plate 61, which has a shape that is able to at least partially cover beam 30a, preferably the one associated with surface 2;
- a third profile 62, which is designed to create a mechanical coupling, preferably a removable one or one that is able to be disassembled, among lower plate 60, upper plate 61, beam 30a and panel 10.

In the detail shown in the figure, lower plate 60 has a threaded recess 600, which is manufactured by welding a bolt 601 in correspondence to a hole 602 (alternatively, the threaded recess 600 can also be manufactured by inserting a threaded rivet); upper plate 61 has a hole 612, as well. The third profile 62 has an angular shape, in this case an "L" shape, in which on one side there is provided a hole 622 and on the other side there is provided a pin 35, which is designed to be mechanically engaged with slot 36 of a panel 10, similarly to what described above. Finally, a threaded screw 605 creates a mechanical coupling, in particular a bolted coupling, between panel 10 and beam 30, 30a by extending through holes 602, 612, 622 available on the third profile and on the upper plate and by being screwed into the thread of the lower plate.

In this embodiment, beam 30a associated with base surface 2 does not have a simple "C" shape, but has a shape that is such as to allow panels 10 to be inserted by means of the sliding of the relative beams 30 along the longitudinal extension of adjacent beam 30a; in particular, it has a "C" shape with two additional ends or wings, which face and, in particular, converge towards the concave (namely inward) part of the cross section of beam 30a, so as to create the above-mentioned anchoring system 6. Furthermore, this arrangement prevents panel 10 from being decoupled from base beam 30a (in this case when it is lifted) and, furthermore, allows the anchoring system described above to be mounted.

More in general, building 1 can comprise an anchoring system 6 that is designed to preferably constrain a beam 30a associated with the surface 2 to a respective beam 30 belonging to an adjacent panel 10, so as to avoid relative

movements between panel 10 and beam 30a.

Figure 9 shows a further fixing system comprising a plate 160, which is designed to join two adjacent and aligned panels 10 by means of known fixing means; in this case plate 160 has holes, which are designed to house a screw that is screwed into each panel 10 to be joined. Thanks to this system adjacent panels 10 are prevented from sliding relative to one another, thus making the whole building 1 more resistant and safer.

Similarly, element 161 is a further variant consisting of a plate with an angular shape that is used to join two panels 10 arranged close to a corner of building 1.

The building, according to a further embodiment, can comprise an edge beam 38, whose cross section is shown in figure 9, which represents a non-limiting embodiment thereof.

Edge beam 38 is shaped so as to have at least one between a projection 33 and a recess 34, which is designed to be interlocked, in a removable manner, with at least one respective recess/projection 34, 33 of a respective beam 30 belonging to an adjacent panel 10.

In particular, edge beam 38 is shaped so as to receive at least one panel 10, preferably arranged in a horizontal fashion, and mechanically connect it to a panel 10 that is preferably arranged in a vertical manner; this happens, for example, when one needs to create a mutual constrain between an outer vertical wall, built by means of panels 10, and a horizontal floor 4 arranged between two storeys of a building 1.

As a person skilled in the art can clearly understand, the shape and the size of edge beam 38 (as well as those of all the other beams and connection elements) can largely

vary based on the type of panels 10 to be connected and on the performances in terms of bearing resistance requested to counter the vertical and horizontal loads to which a building 1 is subject, such as for example crowd load, snow, wind, earthquake, etc..

Pitch beams 38 can be advantageously arranged along the horizontal perimeter of building 1 in correspondence to the different storeys, so as to create a sort of "belt", which is useful to ensure a greater solidity of the whole, thus constraining panels 10 lying both on the same plane and on different planes, such as for example the horizontal and the vertical ones.

Figure 13 shows a non-limiting example of a coupling between a vertical and a horizontal panel 10, in which one can clearly see a roof structure 3 built by means of a strut-and-tie system, which has a substantially triangular shape and comprises two elements acting as struts 70 (only one of them is shown), which are connected by a tie 72 at the base; in case of a metal structure, the connection between the tie 72 and the strut 70 can be built by means of a gusset plate 74, which is welded to the beam/strut 70 that is connected to a cable or chain acting as tie 72.

The mainly vertical loads coming from floor panels 4 and, possibly, also from roof 3 are transmitted to vertical panels 10 mainly through edge beams 38, which are also used to distribute loads along the outer perimeter of building 1.

Furthermore, edge beam 38 can be associated with at least one stiffening element 76, so as to improve the mechanical fixing of panels 10 of floor 4 to vertical panels 10, for example by means of fixing means, such as welding , bolting, screws, rivets, etc..

Stiffening element 76 can also be useful to prevent local instability phenomena that can especially occur in metal elements, such as beams 30, 38.

In particular, vertical panel 10, horizontal panel 10 and edge beam 38 are also designed so as to be mechanically joined by means of a screw system, in which at least one beam 30 of frame 25 (in this case the upper one) has a thread, for example manufactured by means of threaded rivets, which is suited to receive a screw extending through beam 30 of panel 10 of floor 4 and edge beam 38, thus ensuring a solid coupling once the screws have been tightened.

Furthermore, one can use fixing means to join vertical panel 10 to stiffening element 76, so as to improve the degree of constraint between the vertical walls and floor 4.

Like profiles 32, edge beam 38, too, can comprise a layer of insulating material 40a.

Figure 14 shows a detail of a joint between a vertical wall, a floor 4 and a foundation element, which is designed to create a geo-mechanical constraint with the ground on which building 1 at least partially stands.

The vertical wall comprises a panel 10, which is connected to floor 4, which is also made of panels 10, preferably those on which people can walk. In this case, the connection between vertical panel 10 and floor 4 is built by means of an anchoring system 6 described above; this system 6 connects a beam 30 of vertical panel 10 to a beam 30a associated with surface 2, which, in this case, consists of a floor 4 made up of panels 10.

In particular, beam 30a is associated with floor 4 thanks to a peripheral beam 314, which, in this case, has a

"C" shape obtained by means of a UPE steel profile, said peripheral beam 314 being associated to beams 30 of panels 10 of floor 4 by means of known fixing means.

A foundation element 140 is fixed to the peripheral beam 314 or, if necessary, to the floor beam by means of known fixing means. In particular foundation element 140 is a Krinner screw, which is suited to be screwed into the foundation ground.

An advantage of this solution mainly lies in the possibility to disassemble the structure, in a short time and in a simple and economic fashion, after its use has ended, in order to use it for other purposes.

In this way, the foundations of the building are removable, as well, and have all the advantages that this specif feature involves, namely a very small impact on the environment, as the entire building can be disassembled and removed at the end of its useful life, in order to reuse all its part to build a new structure; furthermore, one can create an air gap between floor 4 and the ground, so as to create a ventilated crawl space.

It should be pointed out that the fixing means described above do not limit the scope of protection of the present invention to these embodiments. Generally speaking, building 1 can comprise fixing means to constrain, preferably in a reversible manner, at least one beam 30 of a panel 10 to at least one among: a beam 30 belonging to an adjacent panel 10, a beam 30a, a profile 32, an edge beam 38, a stiffening element 76.

As already mentioned above, a further embodiment, shown in figure 15, is provided, which comprises a first group of beams 30 arranged in correspondence to the rectangular edge and further beams 30 arranged not in

correspondence to the outer edges of panel 10, the latter being arranged, in particular, parallel to the longest side of rectangle; these inner beams 30 are mainly used to ensure high performances in therm of bearing resistance when panel 10 is stressed and bended by forces acting outside of their plane. As a matter of fact, if panel 10 is used to build a floor 4, which is generally arranged in a substantially horizontal position, it is subject to forces that are substantially orthogonal to panel 10 itself and, therefore, cause significant bending moments.

Without these "additional" beams 30, floor 4 would not be able to bear the loads for which it designed.

A person skilled in the art can clearly understand that, by varying some parameters, such as the distance, the arrangement, the degree of constraint, the material, the profile (IPE, HEA, HEB, UPE, UPN, etc.), of the beams 30 making up frame 25, one can obtain different resistance values based on the needs and on the actual use. For example, one can obtain a panel 10 or floor 4 that is able to resist a distributed load equal to 50, 200, 400 kg/m2, or even more.

Therefore, as you can understand from the description above, the panel is a load bearing panel and can be advantageously used to build outer walls, inner walls and floors.

In a building different services are needed, such as water, electricity, gas, air vents, heating and air conditioning systems, etc.. For this reason, some panels are advantageously provided with systems to allow these services to be accessible to the user, without brick wall structures or the like, thus reducing building times and costs.

With reference to a first embodiment, panel 10, between the first and the second coating layers 20, 22, is designed to at least partially house utility systems 50, such as pipes, wires, conduits, devices, etc..

In order to house and hold the different utility systems in a safer and more effective manner, the panel can also comprise one or more auxiliary elements, such as raceways, wirings, coatings, brackets, etc..

According to a further variant, on at least one among said first and second coating layers 20, 22 and said frame 25, there is provided at least one hole 52 to at least partially connect the utility systems 50 to the outside of panel 10. Hole 52 is used, for example, in case a pipe needs to be connected to a home appliance, such as for example the water pipes to be connected to a washing machine.

Figure 16a, 16b, 16c show an example of a panel 10 provided with water systems 50 comprising supply pipes and draining pipes to supply water to and drain it from utilities such as sanitary fixtures and home appliances.

According to a further variant, panel 10 can comprise electric systems 50 and elements such as electric cables, connector blocks, power sockets, "plug and play" wirings, etc..

Figure 17 shows a panel 10 comprising a conductor element 54 to supply power and a connector block 55 that can be inspected by a user. Furthermore, the panel is designed so as to receive a light fixture 56, which, for example, can be associated to an electric bulb.

Advantageously, conductor element 54 is made up of electric cables, which are preferably bundled, for example, in a sheath or pipe.

The panel comprises, furthermore, a block with a switch 57 and a power socket 58.

As already mentioned above, connector block 55, switch 57 and power socket 58 can be accessed by the user by means of suitable holes (without reference numbers), which are able to display these elements towards the outer part of the panel, so that the user can use them.

According to a further embodiment, systems 50 - or parts thereof - projecting from a panel are housed in cavities that are either provided between beams 30 of frame 25 or are especially made to hide systems 50 from the users standing on the inside of building 1. Therefore, entire building 1 can be provided with utilities by positioning relative systems 50 on the inside of panels 10 and by connecting systems 50 of the different panels 10, thus creating an actual system network for each utility, without systems 50 and pipes being visible from the outside when building 1 is finished and without requiring accessory brick walls.

It should be pointed out that terms such as "vertical" and "horizontal" were used for greater clarity and easiness of comprehension, with particular reference to the examples described and discussed above, without limiting the inventive concept of the present invention to these space arrangements and to these executive details.

Naturally, the principle of the present invention being set forth, embodiments and implementation details can be widely changed relative to what described above and shown in the drawings as a mere way of non-limiting example, without in this way going beyond the scope of protection provided by the accompanying claims.

CLAIMS

1. Building (1) comprising: lateral walls made by a plurality of panels (10) comprising:

- at least one first coating layer (20);
- at least one second coating layer (22);
- at least one frame (25) made of metal, which is arranged between said first and second coating layers (20, 22) and comprising a plurality of beams (30), which are rigidly constrained to one another, each beam (30) being arranged in correspondence to a respective outer edge of said panel (10), and being shaped so as to have at least one between a projection (33) and a recess (34), for being interlocked, in a removable manner, with at least one respective recess/projection (34, 33) of a respective beam (30) belonging to an adjacent panel (10);

the building (1) being characterized in comprising:

- a horizontal surface (4), such as a floor or a ceiling or a roof, built by using one or more of said panels (10);
- an edge beam (38), which is shaped so as to have at least one between a projection (33) and a recess (34), for being interlocked, in a removable manner, with at least one respective recess/projection (34, 33) of a respective beam (30) belonging to said panel (10); said edge beam (38) creating a mechanical connection between at least a horizontal panel (10) belonging to said horizontal surface (4) and at least a vertical panel (10) belonging to said lateral walls.

2. Building (1) according to claim 1, wherein edge beams (38) are arranged along the horizontal perimeter of building (1) in correspondence to the different storeys, constraining panels (10) lying both on the same plane and on different planes.

3. Building (1) according to claim 1 or 2, comprising a horizontal surface (2), to which is associated at least a beam (30a), which is shaped so as to have at least one between a projection (33) and a recess (34), for being interlocked, in a removable manner, with at least one respective recess/projection (34, 33) of a respective beam (30) belonging to said panel (10).

4. Building (1) according to any of the previous claims, comprising a profile (32), said profile (32) being shaped so as to have at least one between a projection (33) and a recess (34), for being interlocked, in a removable manner, with at least one respective recess/projection (34, 33) of a respective beam (30) belonging to said panel (10).

5. Building (1) according to any of the previous claims, comprising an anchoring system, for constraining said beam (30a) to a respective beam (30) belonging to said panel (10).

6. Building (1) according to any of the previous claims, comprising fixing means to constrain, preferably in a reversible manner, at least one beam (30) of said panel (10) to at least one among: a beam (30) belonging to an adjacent panel (10), a beam (30a), a profile (32), an edge beam (38), a stiffening element (76).

7. Building (1) according to any of the previous claims, wherein at least one of said panels (10) has a frame (25) consisting of said plurality of beams (30), which are rigidly constrained to one another, each beam (30) being arranged in correspondence to a respective outer edge of said panel (10).

8. Building (1) according to any of the previous claims, wherein at least one of said panels (10) has a beam (30) arranged in correspondence to each outer edge of the panel

(10).

9. Building (1) according to any of the previous claims, wherein at least one of said panels (10) has a layer of insulating material (40) interposed between said first and second coating layers (20, 22).

10. Building (1) according to any of the previous claims, wherein, in at least one of said panels (10), at least one between said first and second coating layers (20, 22) comprises a fibre cement panel (41).

11. Building (1) according to any of the previous claims, wherein, in at least one of said panels (10), at least one between said first and second coating layers (20, 22) comprises a wooden panel (42).

12. Building (1) according to any of the previous claims, wherein, in at least one of said panels (10), at least one between said first and second coating layers (20, 22) comprises a plasterboard panel (43).

13. Building (1) according to any of the previous claims, wherein, in at least one of said panels (10), at least one between said first and second coating layers (20, 22) comprises:

- fibre cement panel, thickness ranging from 5 to 20 mm;
- OSB panel, thickness ranging from 5 to 30 mm;
- plasterboard panel, thickness ranging from 5 to 20 mm.

14. Building (1) according to any of the previous claims, wherein in at least one of said panels (10) an opening (A) is provided.

15. Building (1) according to any of the previous claims, wherein at least one of said panels (10) at least partially houses service systems (50), between said first and second coating layers (20, 22).

16. Building (1) according to claim 15, wherein on the

frame (25) of at least one of said panels (10) there is provided a hole (52) to at least partially connect the utility systems (50) to the outside of panel (10).

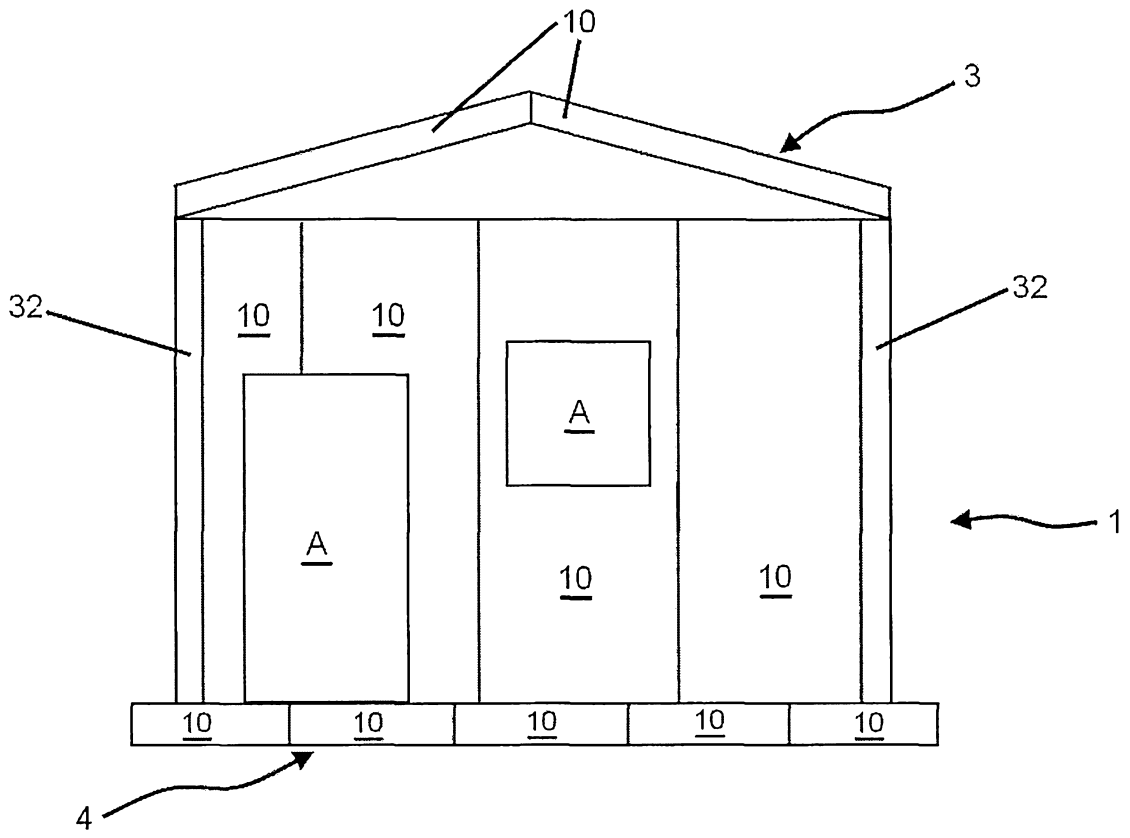
17. Building (1) according to claim 15 or 16, wherein at least one of said panels (10) comprises:

- a conductor element (54) to supply power;
- a connector block (55) that can be inspected by a user;
- a block with a switch (57); and
- a power socket (58).

18. Building (1) according to claim 15 or 16, wherein, at least one of said panels (10) is provided with water systems comprising supply pipes and draining pipes to supply water to and drain it from utilities.

19. Building (1) according to any of the previous claims, wherein, in at least one of said panels (10), at least one beam (30) comprises at least one between a pin (35) and a slot (36), for engaging, in a removable manner, with a respective slot/pin (36, 35) belonging to an adjacent panel (10) or profile (32).

20. Building (1) according to claim 19, wherein the beam (30) having the recess (34) facing outwards comprises the pin (35) which is designed to be inserted into the slot (36) which is obtained on projection (33) of a beam (30) belonging to an adjacent panel (10).


10
3
32
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32
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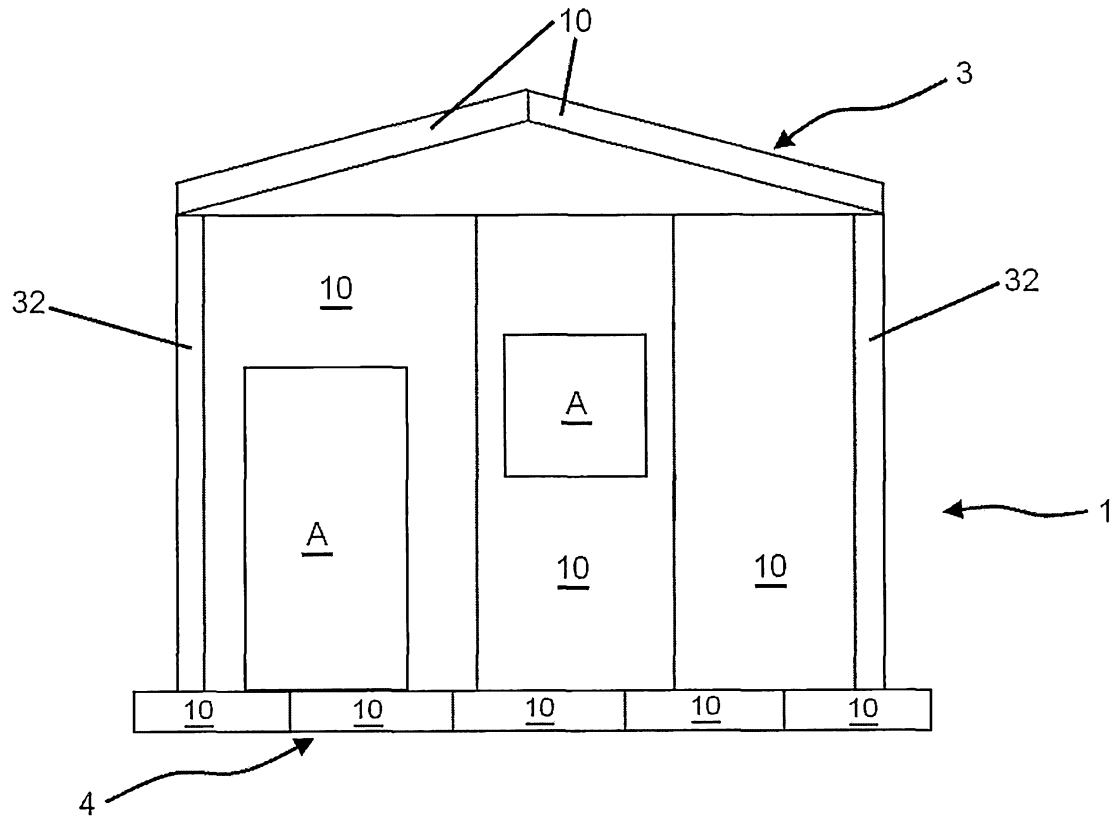
10
10
4

Fig. 1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A
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10
10
10
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10
10
4

Fig. 1a

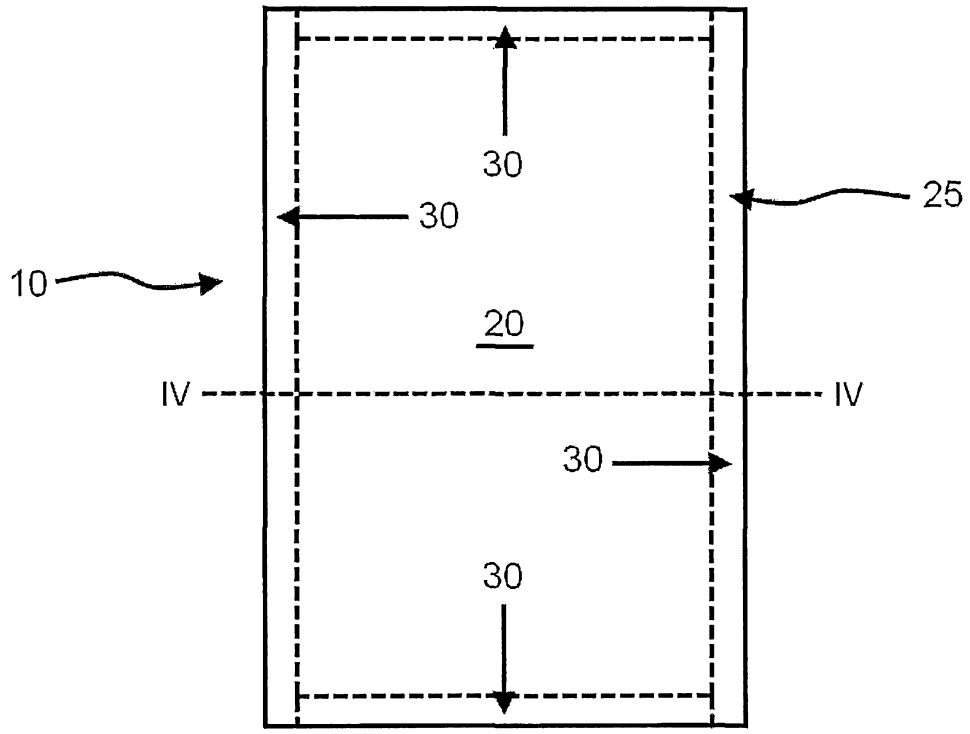

Fig. 2

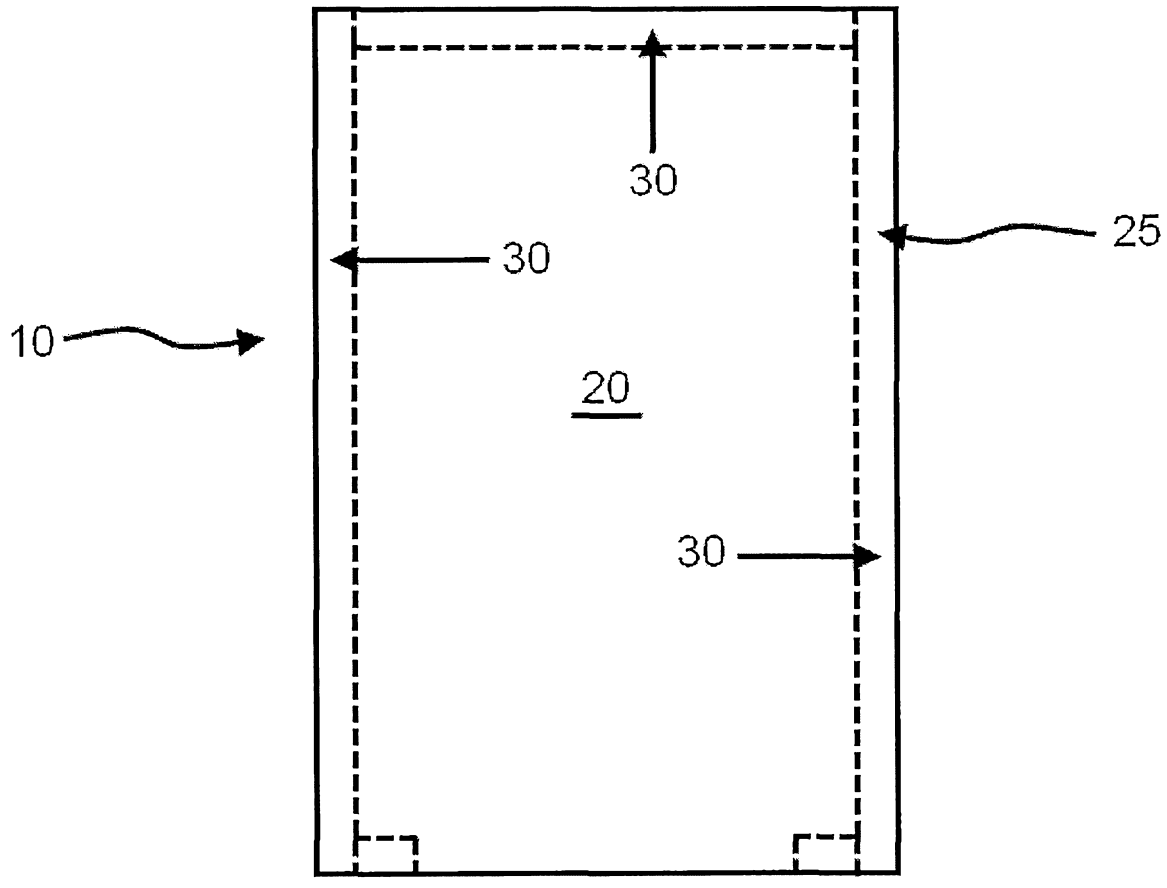

Fig. 3

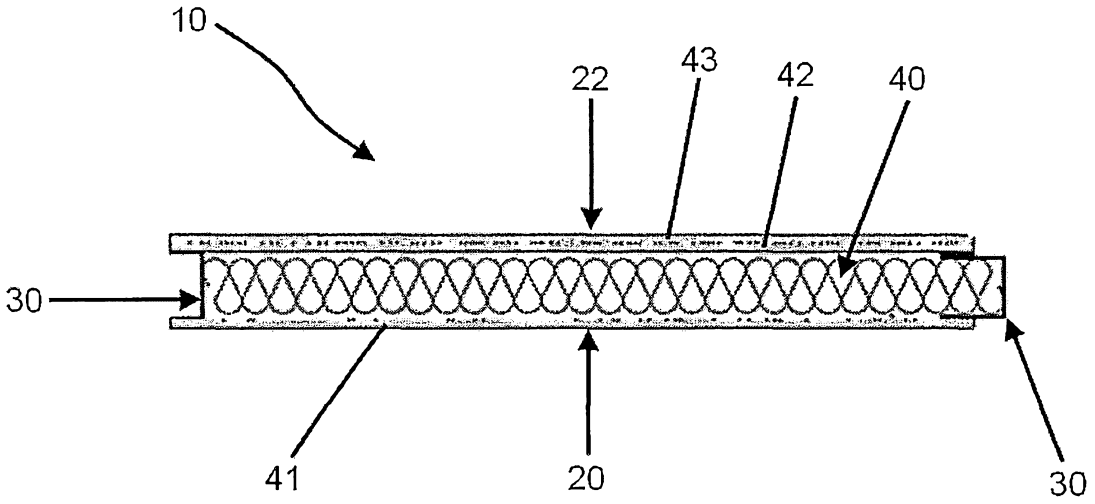

Fig. 4

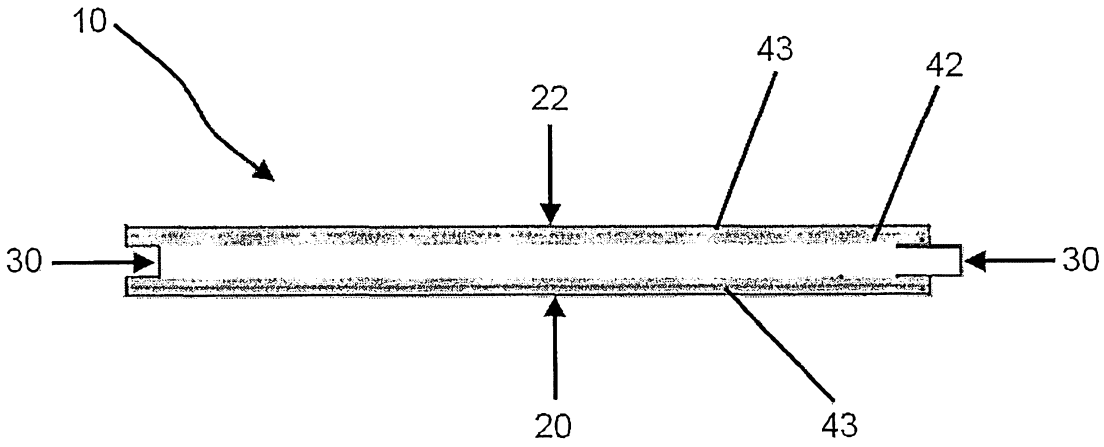

Fig. 5

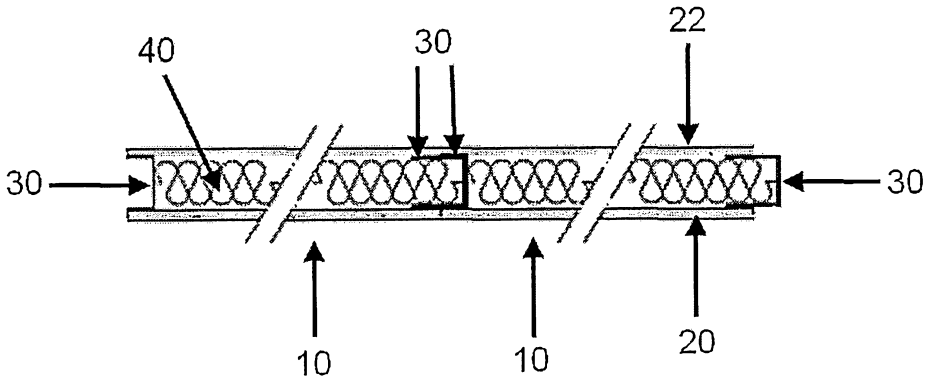

Fig. 6

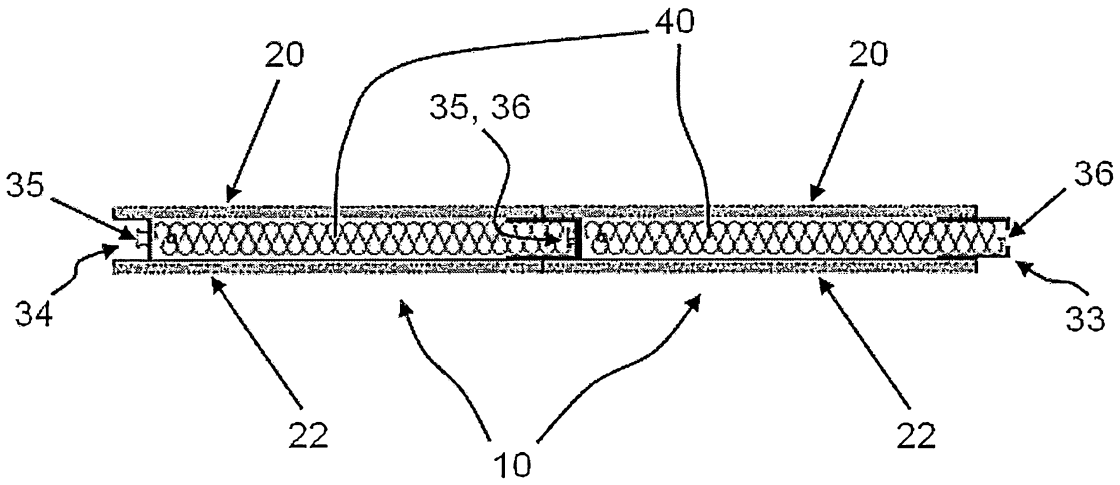

Fig. 6a

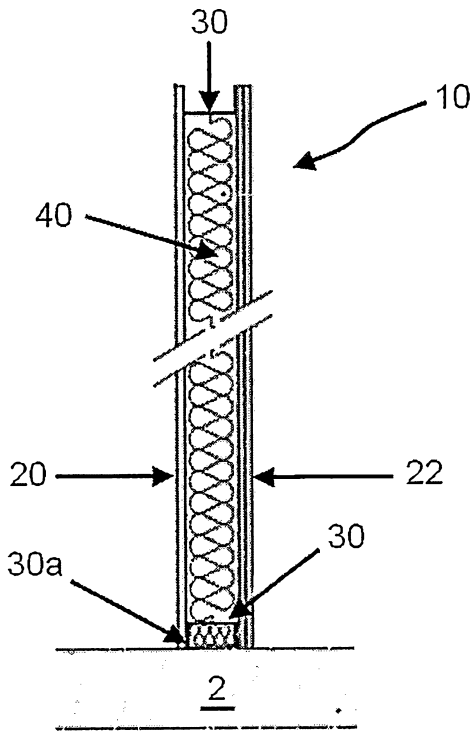

Fig. 7

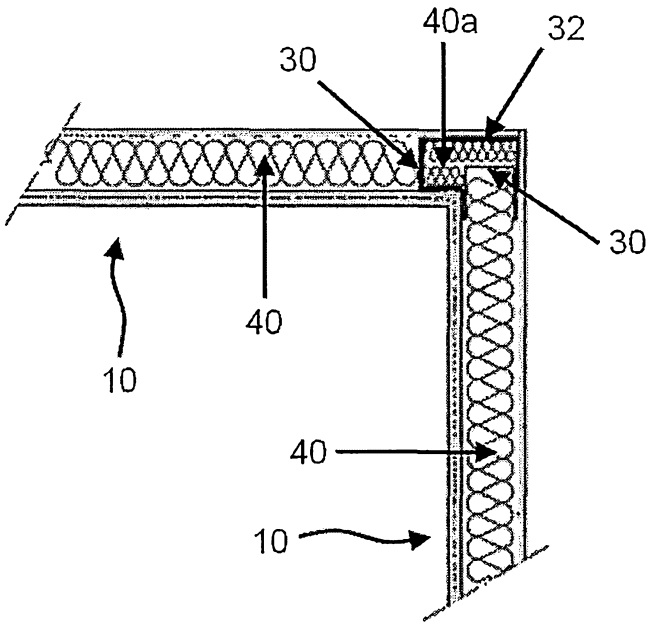

Fig. 8

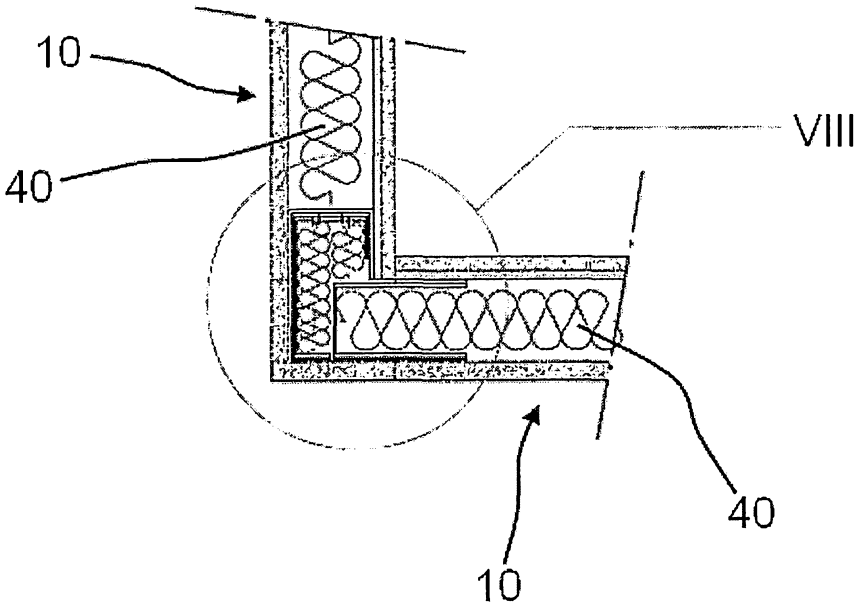

Fig. 8a

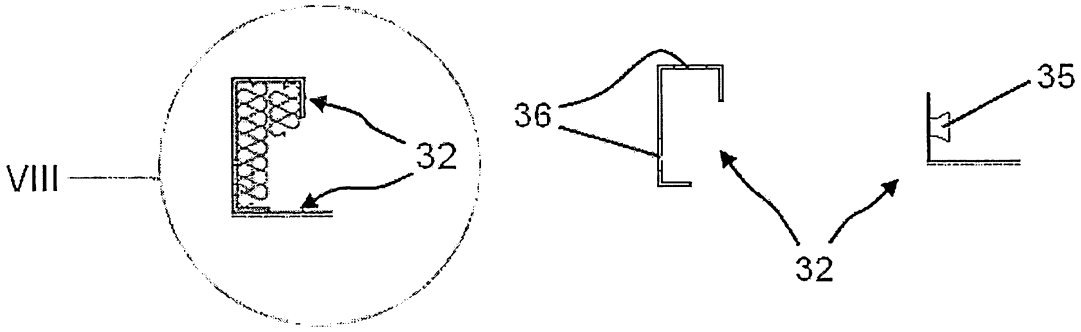

Fig. 8b

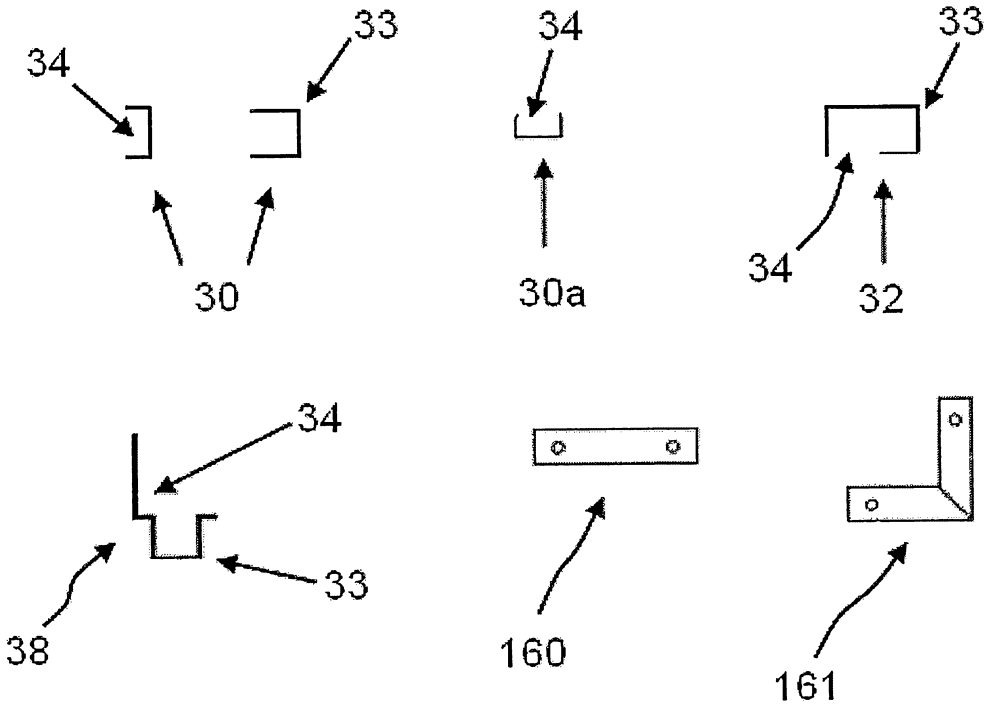

Fig. 9

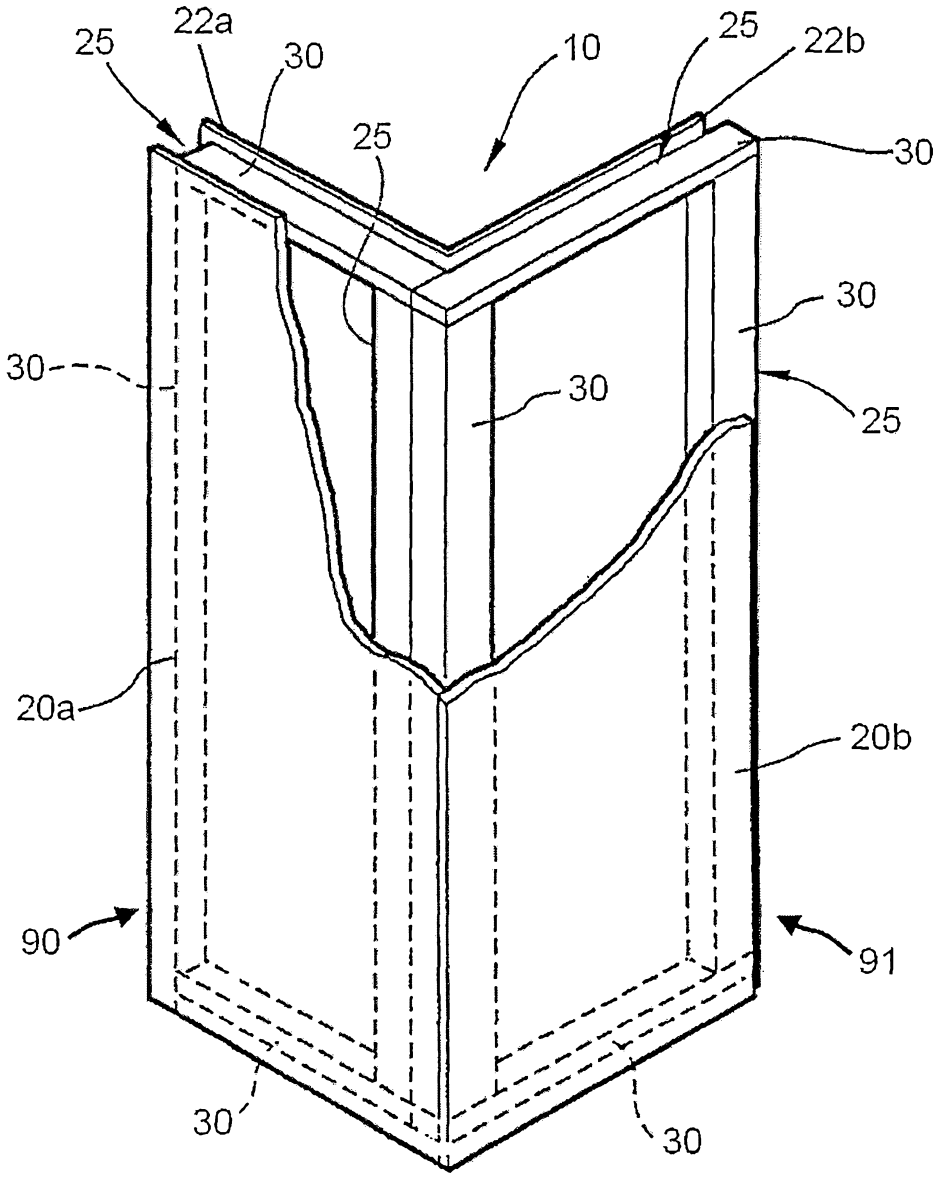

Fig. 10

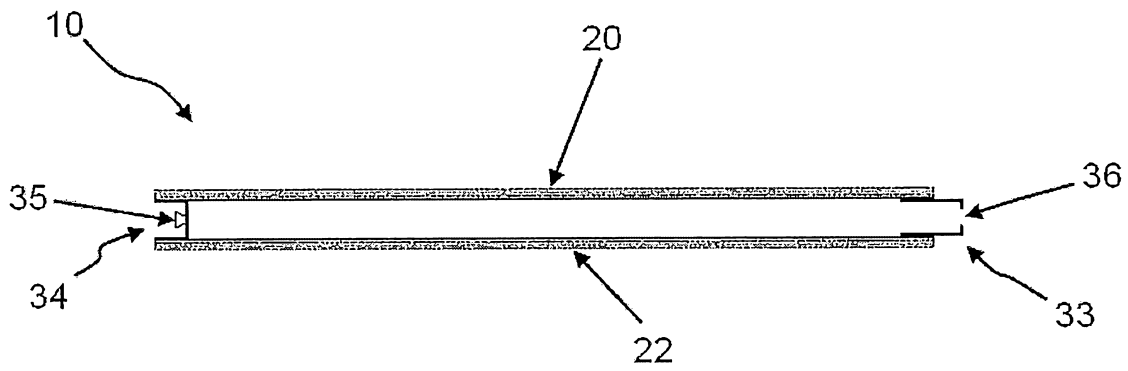

Fig. 11

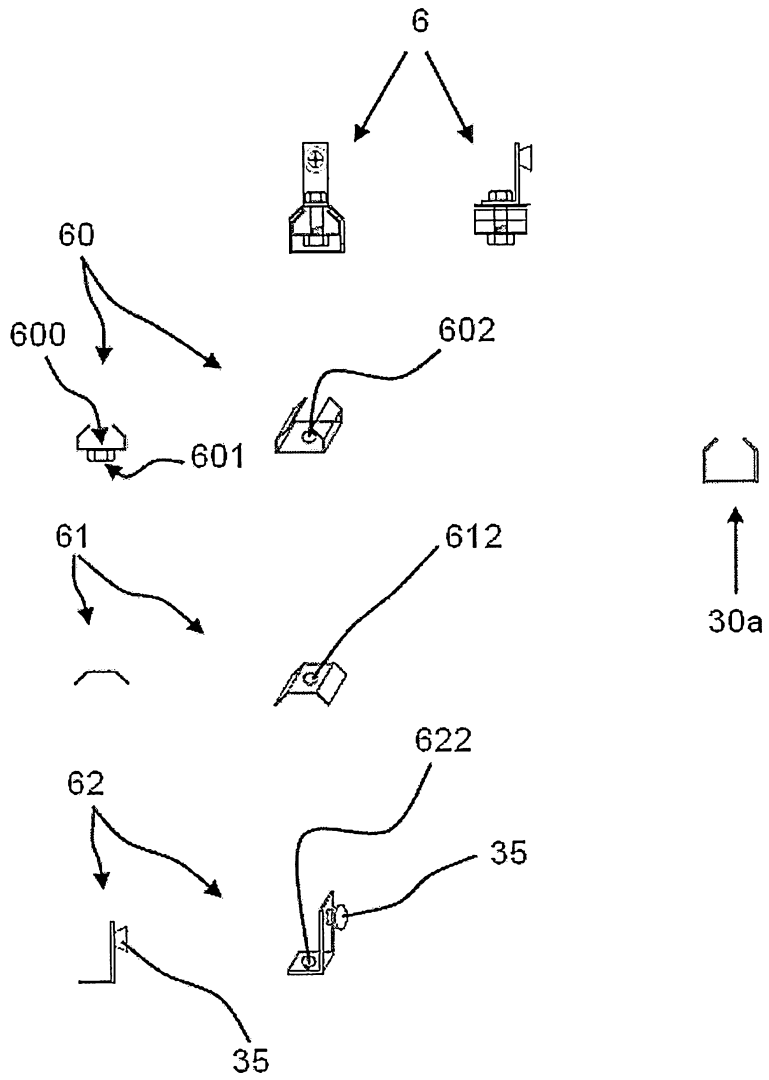

Fig. 12

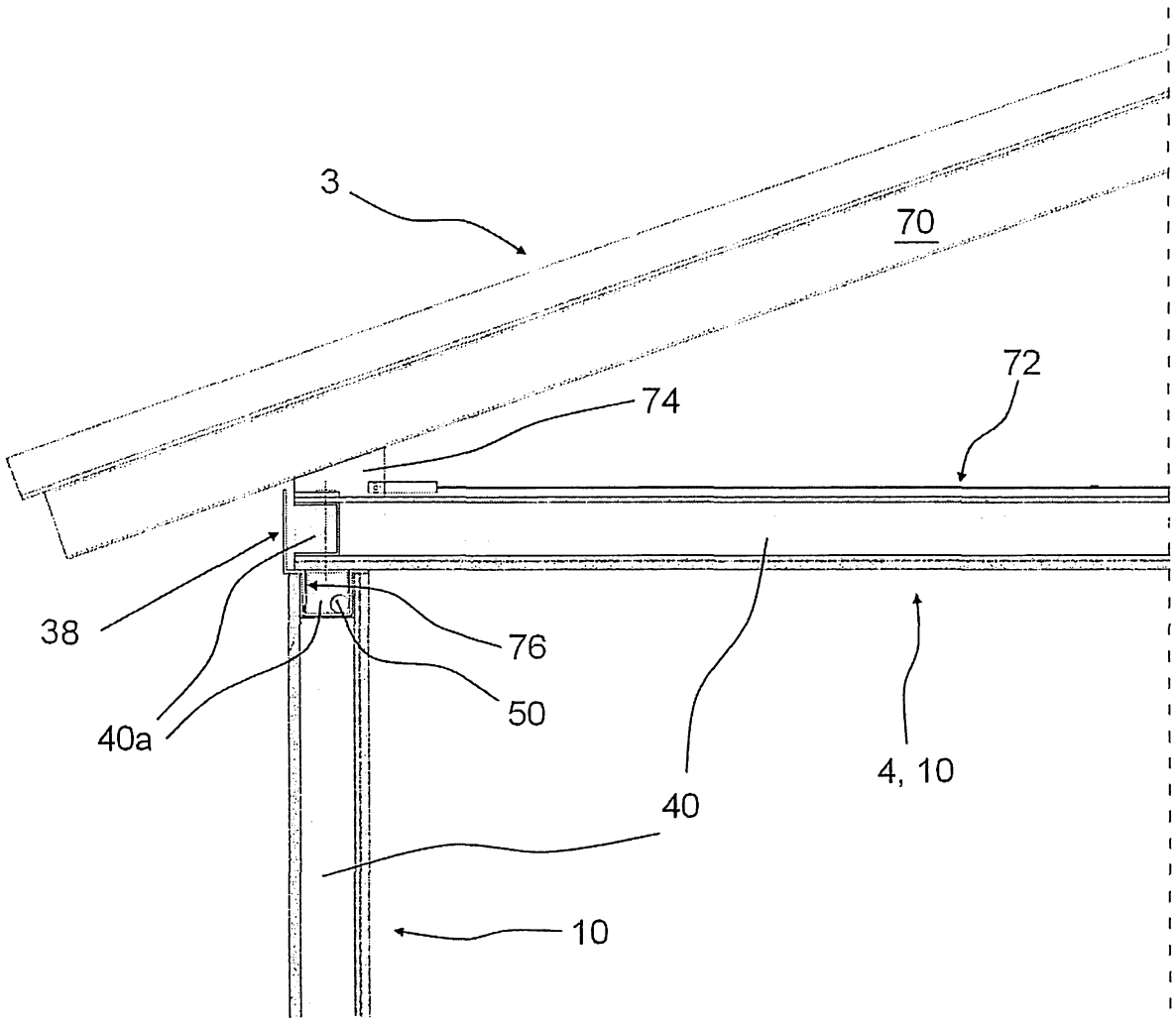

Fig. 13

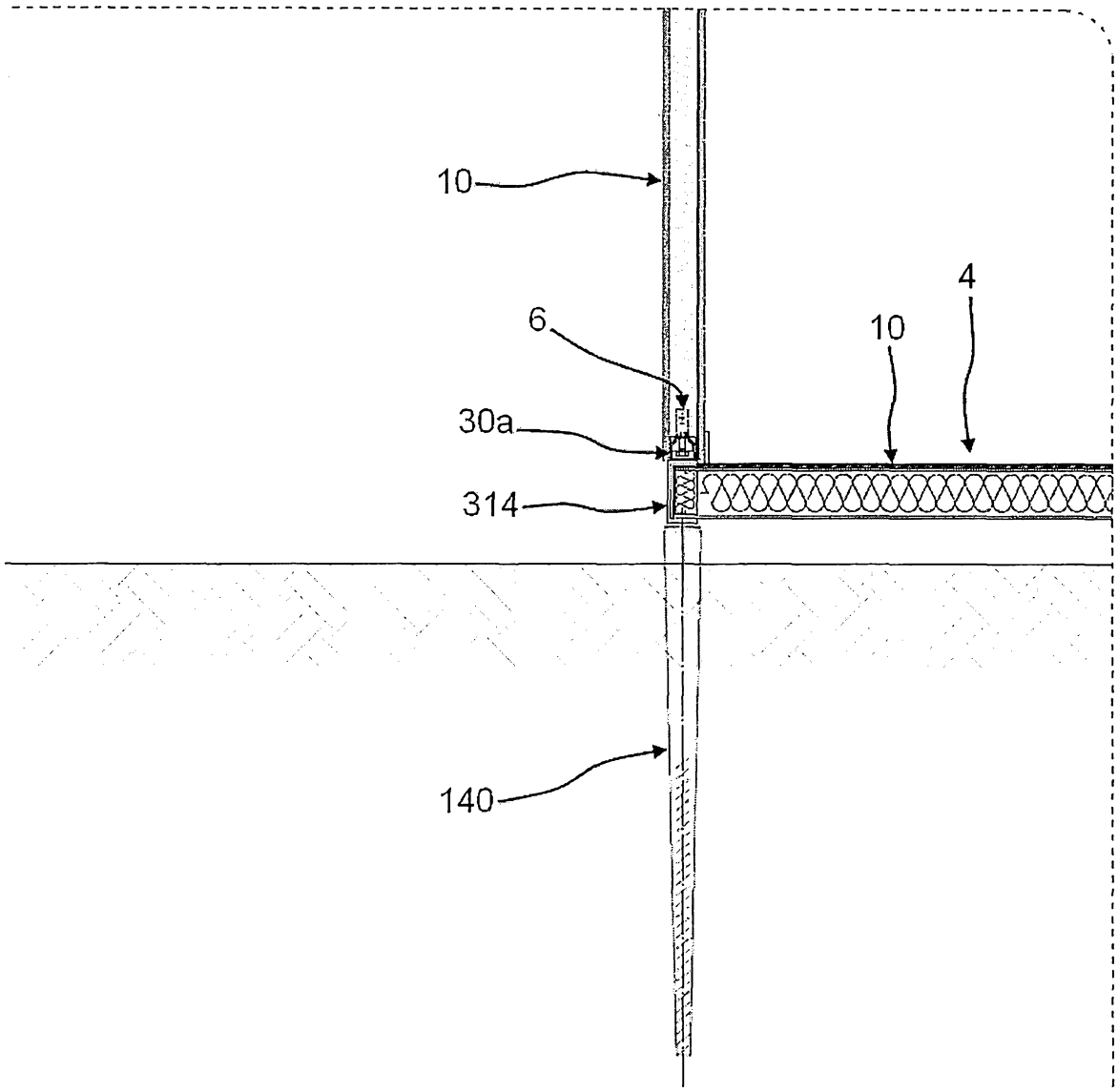

Fig. 14

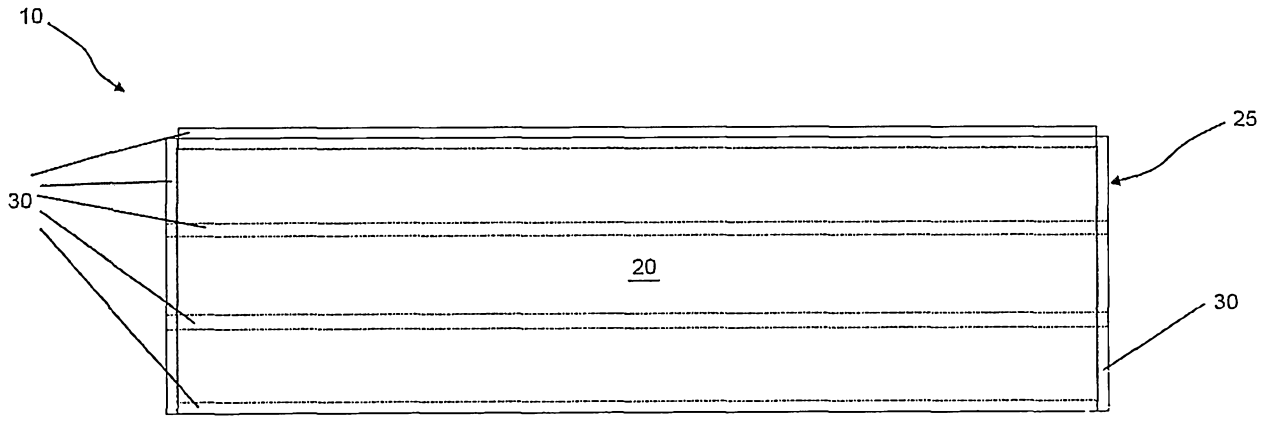

Fig. 15

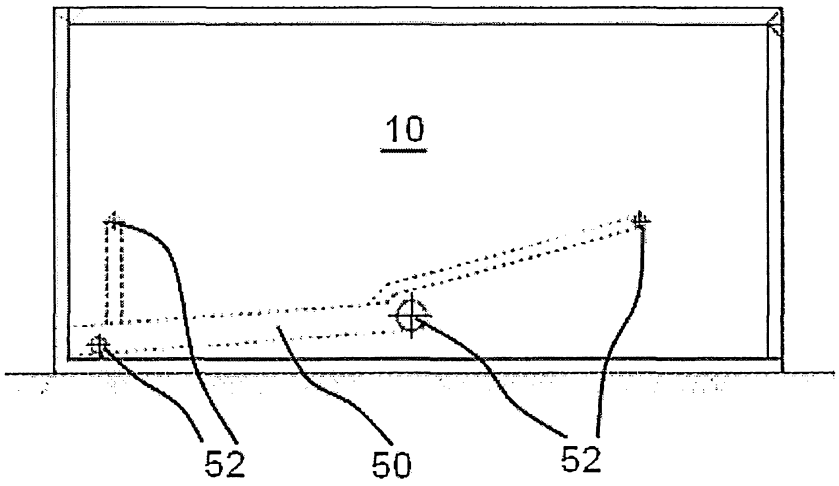

Fig. 16a

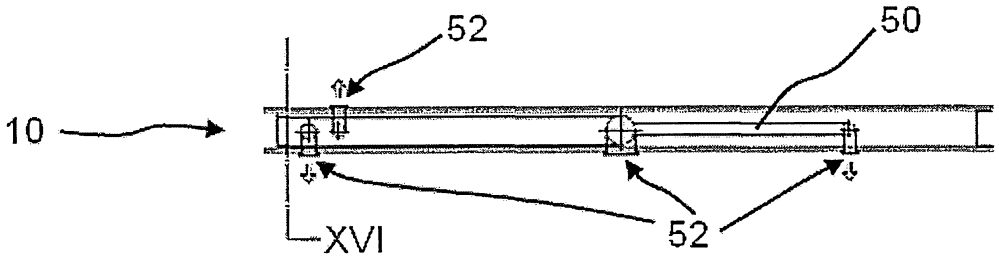

Fig. 16b

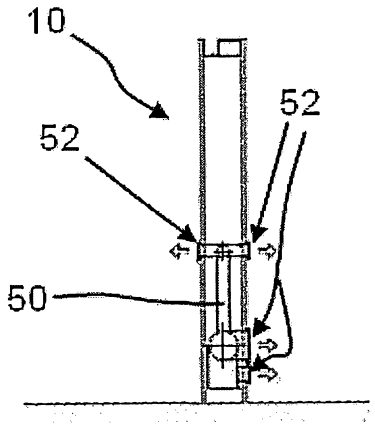

Fig. 16c

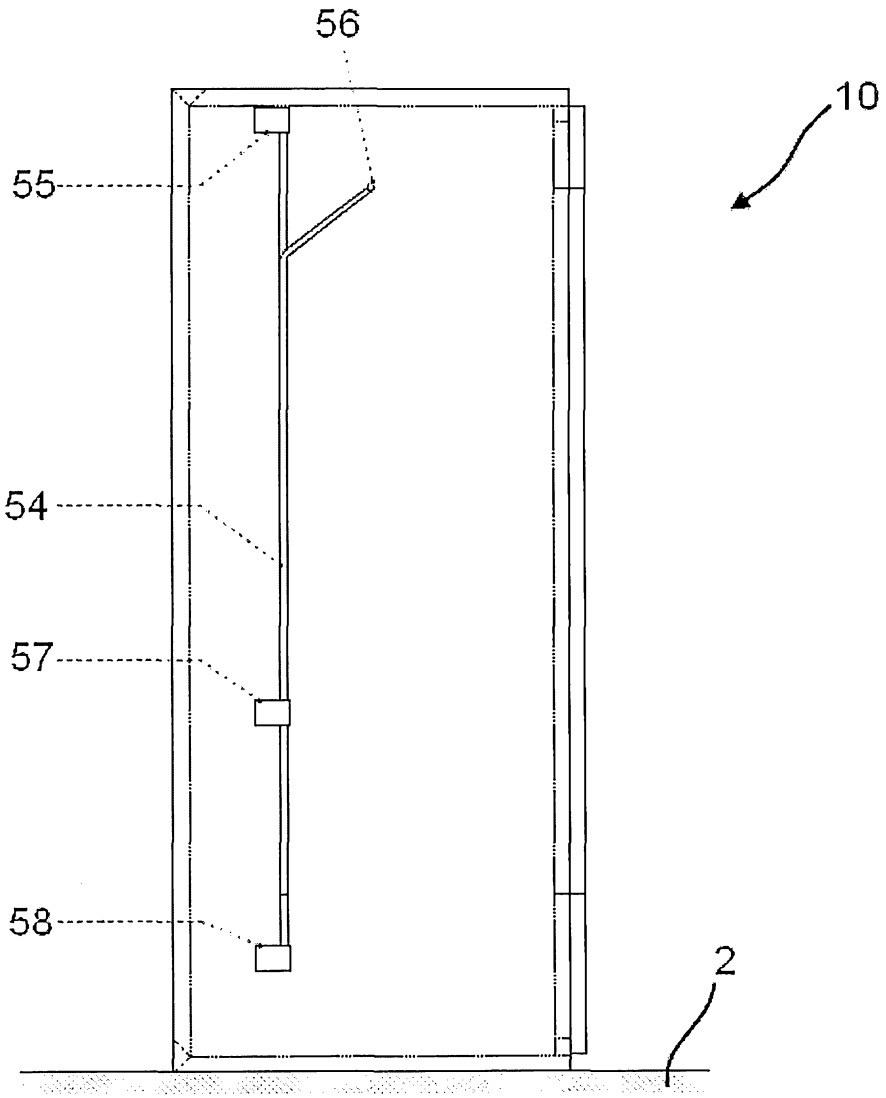

Fig. 17

Abstract

The modular prefabricated panel (10) comprises: a first coating layer (20); a second coating layer (22); and a frame (25), which is arranged between said first and second coating layers (20, 22) and comprises a plurality of beams (30), which are rigidly constrained to one another, each beam (30) being arranged in correspondence to a respective outer edge of said panel (10). The beam (30) is shaped so as to have at least one between a projection (33) and a recess (34) designed to be interlocked, in a removable manner, with at least one respective recess/projection (34, 33) of a respective beam (30) belonging to an adjacent panel (10).

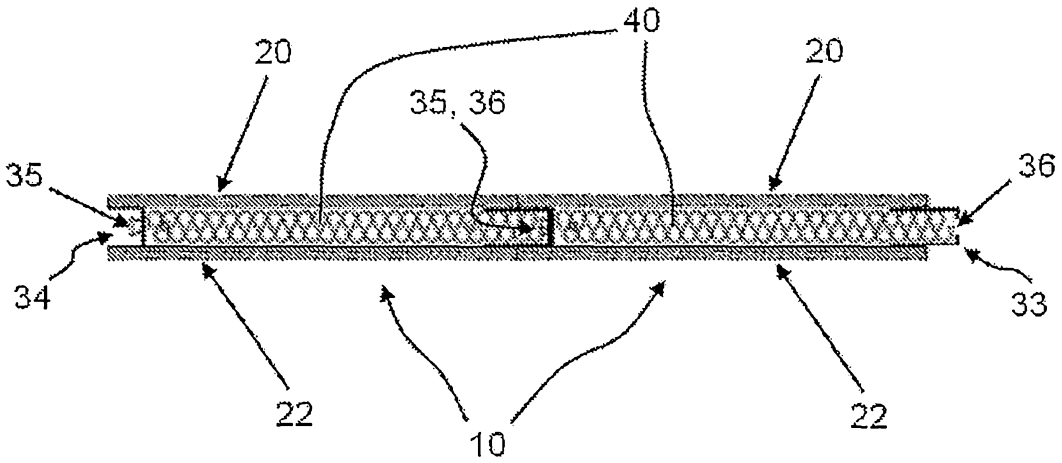

Fig. 6a