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(54) **Insulated concrete panel, use and method for manufacture thereof**

(57) There is disclosed an insulated concrete panel with a reinforced 3, supporting back wall 2, a thick layer of insulation 6, 7 and a relatively thin concreted front wall 11 without reinforcement. The concreted front wall 11 is divided into sections or fields 12 which are divided by crack indicators 15. The crack indicators 15 are covered by a slide film 17, 18. The front wall 11 is covered by a plaster layer 10 which is reinforced by a glass fibre netting 9.

When the front wall 11 is subjected to actions of

force, e.g. by the wind or push/pull in the building parts or by thermal actions, the crack indicators 15 and the slide film 17, 18 will provide for distribution of the stresses arising in the concrete panel in each field 12 in the front wall 11. These stresses are distributed to the glass fibre netting 9 in the plaster layer 10 over the crack indicators 15. The risk of crack formation in the surface of the concrete panel is thereby reduced.

A method for making the insulated concrete element and its use are also disclosed.

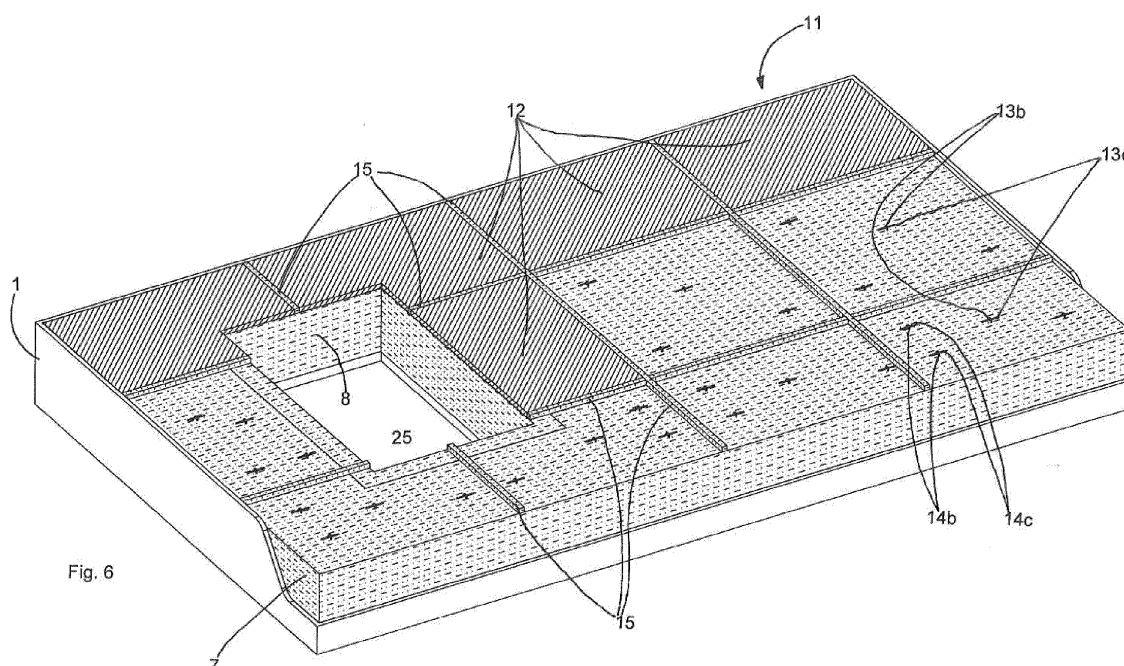


Fig. 6

Description

[0001] The invention concerns a highly insulated concrete panel, including a reinforced back wall, reinforced columns and girders connected with the back wall, and one or more layers of insulating material.

[0002] The invention also concerns a method for making the concrete panel and use of the insulated concrete panels.

Prior art

[0003] In connection with the increasing requirements for reduction of thermal loss from buildings, the thickness of the facades will grow into even very thick structures. This means that the prior art with a supporting concrete back wall - insulation - concrete façade plate (concrete sandwich elements) are encumbered with substantial disadvantages. The relatively heavy façade plate cannot be supported by using the prior art technology when it is to be suspended with a spacing of 30 - 40 cm or more from the supporting back wall. A bracket which is to support the front plate at a distance of 30-40 cm from the stable back plate has to be very strong and is normally made of stainless steel. This design will thereby entail substantial thermal bridges, in particular at the strong metal brackets, resulting in reduction of the insulation capability. A supporting sandwich panel is typically constructed with 150 mm supporting back wall and e.g. 300 mm insulation in order to meet the current new national and possibly international requirements to insulation, and a front plate which is typically 70 mm thick. This provides a total wall thickness of 520 mm. Compared with the previous rules in force as to insulation requirements and thereby the lesser thicknesses of the wall panels, this entails a significant reduction in the net area of the buildings, typically 5-7 m² per flat/residence.

[0004] US 4 512 126 A discloses a concrete panel where the supporting wall constitutes the front wall and thereby the outer side of the construction. This design is unsuitable as thermal actions from the surroundings will cause crack formation in the area between supporting columns and girders in the panel and the wall surface itself. The panel thereby loses its strength and leakages arise in the walls possibly causing problems with moisture and fungus mould inside the building.

[0005] EP 2 224 071 A2 discloses a highly insulated concrete panel where the reinforced supporting wall constitutes the back wall of the panel facing towards the interior of the building. In order to comply with the requirements to tightness and reduction of heat loss from buildings existing in Denmark, the insulated concrete panel contains a thick layer of compression-resistant insulation which is divided into two or more sub-layers. The outermost layer of the panel and thereby of the building is a plaster layer which is reinforced by glass fibre netting. The glass fibre netting reinforced plaster layer is applied directly upon the outer surface of the insulation layer. A

similar element is also known from DE 200 10 281 U1.

[0006] These highly insulated concrete panels are very well suited as prefabricated concrete panels, but also having some drawbacks. The relatively thin plaster layer constituting the façade of the building is not suited for supporting objects to be screwed into the outer wall, including e.g. signs, lamps and other electric installations etc. Moreover, the plastered façade surface can be susceptible to impact and shock actions which can deform the insulation layer and thereby cause cracks in the plaster layer on the façade. In order to fireproof the concrete panels from the outside, it is also necessary that the outer insulation layer or a part thereof consists of a compression-resistant mineral wool. This implies an additional work operation to be performed during the production at the concrete panel factory as this layer is to be fastened to the other layer or layers of insulation, e.g. by gluing and/or by using insulation nails.

Object of the Invention

[0007] It is therefore a object of the invention to obviate the above mentioned drawbacks of the prior art and to provide a highly insulated concrete panel and a method for the manufacture thereof. It is also the object of the invention to provide a concrete panel which is suited for prefabrication, is made with a light construction, where the insulation layer can be built up by thicknesses that exactly correspond to the energy class wanted by the developer, and which is without any thermal bridges and thus comply with national and possible international requirements to heat loss of buildings. Furthermore it is wanted to achieve: robustness against moisture and/or shocks/impacts, maximum heat accumulation capability, constructions with carrying capability for roof elements and/or storey partitionings, low weight, optimised thickness, good tightness after mounting, concreted sealed joints and easy production by which as much as possible of the work is done under a roof in a factory.

[0008] The joints between the concrete panels are traditionally made as by other concrete panel constructions with toothed and possibly reinforced joints which allow for disc action which ensures the stability of the building and the integrity (robustness) of the finished building.

[0009] It is furthermore an object of the whole panel production that it is rational (short production time) and that different variants of the panels can be produced easily with only small changes in the production procedure.

Description of the Invention

[0010] These objects are achieved by a highly insulated concrete panel having a front wall poured in concrete and divided into fields, between which fields crack indicators are provided.

[0011] Hereby is achieved a highly insulated concrete panel with a significantly reduced risk of crack formation in the finished external surface when the front wall is sub-

jected to thermal actions, making the front wall expand or contract, and which is provided with good fireproofing as well. As the front wall is finished after concreting, the surface will be very even, and the increased smoothness of the surface of the concrete panel provides a better base for the subsequent application of a glass fibre reinforced plaster layer.

[0012] Moreover, the sensitivity of the façade to impacts and shock is reduced as the front wall enhances the strength as compared with a concrete panel of the type disclosed in EP 2 224 071 A2.

[0013] The strength of the facade of the concrete panel according to the invention is furthermore increased such that it is possible to produce highly insulated concrete panels with a roof fascia and without reinforcements in the fascia, and it will be possible to suspend cantilevered balconies and/or galleries at the outer side of the building. As the concrete layer constituting the front wall also covers possible rabbet elements and thus extends right up to the edges of the door or window openings, these edges of the openings will be substantially reinforced as well.

[0014] The hollow sound appearing when tapping on the outer side/facade of a concrete panel of the type disclosed in EP 2 224 071 A2 is eliminated. The concrete panel according to the invention enables suspending articles such as lamps, signs etc. upon the façade of the building as there is a firm base for screwing the articles on. It is also possible to embed wires and supports for external electric installations. Furthermore, the securing of the insulation layers in the highly insulated concrete panel is substantially improved as compared with the concrete panel disclosed in EP 2 224 071 A2.

[0015] In an embodiment of the invention there is provided a layer of slide film over the crack indicators. The slide film ensures that the final plaster layer does not adhere to the crack indicators. The glass fibre reinforced plaster layer will thereby span freely across the crack indicators. The glass fibre netting can hereby absorb and distribute the forces from the edge action in the fields of the front wall across a greater area such that the glass fibre netting in the plaster layer is less prone to be deformed or destroyed with crack formation in the surface as a result. In that the crack indicators in one embodiment of the invention is covered by the slide film, a work operation in the production of the concrete panel is spared as it is avoided to lay out the slide film when the front wall has been poured. In a further embodiment, the crack indicators are made of material on which concrete and/or a subsequently applied plaster layer cannot adhere. The crack indicators are thereby easier to produce as it not necessary to cover the crack indicators with the slide film.

[0016] In a further embodiment of the invention, there is provided a fire resistant material at the top side of the crack indicators, preferably between the crack indicators and the slide film. The fire resistant material expands when heated above a certain temperature, e.g. 80°C, effectively sealing against penetration of fire, smoke and gas. Hereby is achieved sealing against penetration of

e.g. fire which is advantageous if using a flammable insulation material of e.g. polystyrene or polyurethane, as the fire resistant material reduces the risk of melting of the flammable insulation material inside the panel or the material possibly starting to burn during a fire.

[0017] The invention also concerns a method for making the front wall of the highly insulated concrete panel, wherein after concreting the reinforced back wall of the concrete panel and the supporting columns and girders there is laid one or more layers of insulating material, wherein the method includes laying of crack indicators upon the upper surface of the insulation material such that a number of fields are formed between the crack indicators, and concreting a concrete layer for forming a front wall of concrete divided into fields.

[0018] In a variant of the method, the field-divided front wall and the crack indicators are applied a plaster layer which is reinforced with glass fibre netting. Prior to this step it is advantageous to remove excess concrete on the crack indicators after concreting the front wall, ensuring that the surface of the crack indicators is clean so that the subsequent plaster layer does not adhere to the crack indicators.

[0019] In a further variant of the method, the front wall is covered by a covering of wood, natural stone, a facing or brick siding, or combinations thereof as it is optionally attached to a base which can be fastened directly in the front wall.

[0020] Finally, the invention concerns using highly insulated concrete panels for constructing buildings with one or more storeys. When the concrete panels are prefabricated and e.g. applied the reinforced plaster layer at the panel factory, the part of the work to be performed on the construction site is minimised as it is only the joints between the panel which are to be finished with insulation, joint filler and glass fibre reinforced plaster layer. Finally, the outer surface of the building is finished with a finishing plaster layer such that the building can appear without visible joints between the panels.

The Drawing

[0021] The invention will be explained in detail in the following with reference to the drawing, where:

- Fig. 1 shows a cross-section of a traditional concrete sandwich panel;
- Fig. 2 shows a highly insulated, prior art concrete panel without a poured front wall of concrete, also seen in cross-section;
- Fig. 3 shows plate, girder and column reinforcement mounted and laid in the mould before concreting the back wall of the concrete panel according to the invention;
- Fig. 4 shows a first insulation layer of compression-resistant insulation mounted after concreting the back wall and after mounting possible rabbet elements for doors

- and windows;
- Fig. 5 shows the concreted girders and columns of the concrete panel;
- Fig. 6 shows a second layer of insulation mounted on the concrete panel and part of the concreted front wall;
- Fig. 7 shows a schematic drawing of the concrete panel according to the invention where a concreted front plate is divided into sections or fields and shown without the final plaster layer;
- Fig. 8 shows a cross-section through a highly insulating concrete panel;
- Fig. 9a shows a detail of a variant of the invention in cross-section;
- Fig. 9b shows the same detail of a further variant of the invention in cross-section;
- Fig. 10 illustrates anchoring of the front wall to the back wall for absorbing vertical actions of force;
- Fig. 11 illustrates anchoring of the front wall to the back wall for absorbing horizontal actions of force, such as wind forces;
- Fig. 12 illustrates anchoring of the front wall to the back wall via the rabbet element forming an edge around door or window openings;
- Fig. 13 shows the end of the concrete panel at a fascia;
- Fig. 14a is a cross-sectional view of a detail of anchoring a bracket for mounting balconies or galleries at the outer side of the building;
- Fig. 14b shows a schematic drawing of the outer side of the front wall at the anchoring of the fitting shown in Fig. 14a;
- Fig. 15 shows the joint between two highly insulated concrete panels;
- Fig. 16 shows a cross-section through a joint between the panels at a storey partitioning; and
- Figs. 17a-d shows examples of distribution of crack indicators and thereby the field division in the front wall of highly insulated concrete panels according to the invention.

Detailed Description

[0022] Fig. 1 shows a vertical cross-section in a conventional sandwich panel with reinforced front plate 11 and back plate 2 and an insulation layer 7 therebetween. Fig. 2 shows a vertical section in a highly insulated concrete panel according to EP 2 224 071 A2 with double insulating capability compared with conventional sandwich panels with the same thickness. National and possibly international requirements to the heat loss in low-energy or zero-energy houses are fulfilled by a concrete panel 2 of this type.

[0023] The highly insulated concrete panel according to the invention can be seen on Figs. 7-17. The concrete panel includes a back wall 2 with columns 4 and girders 5. The back wall 2 and columns 4 and girders 5 are made of reinforced 3 (see Fig. 3) concrete. Between columns 4 and girders 5 lie a first insulation layer 6 and a second insulation layer 7 covering the first insulation layer 6 and the surface of the columns 4 and girders 5. Upon the second insulation layer 7 is poured a front wall 11.

[0024] The front wall 11 is preferably poured in fibre reinforced concrete and is divided into a number of separate fields 12. It is thus preferred that the fields 12 of the front wall 11 are not steel reinforced but anchored in the back wall 2 with a number of suspensions 13b (see Figs. 5, 6, 10) and a number of ties 14b (see Figs. 5, 6, 11), see the detailed explanation below. Between the fields 12 in the front wall 11, crack indicators 15 are provided which are fastened to the second insulation layer 7 by a suitable anchoring 16 e.g. by bonding and/or by nails 16, e.g. of metal or preferably plastic. The crack indicators 15 thus surround each field 12 in the front wall 11 along its entire circumference. The crack indicators are preferably covered by a slide film 17, 18. The slide film 17, 18 prevents concrete from adhering to the crack indicator.

[0025] The front wall 11, i.e. the fields 12 and the crack indicators 15 are covered by a layer of mineral plaster 10 which is reinforced by glass fibre netting 9. It is preferred that an outermost strip of the front wall 11 along the edges of the concrete panel is kept free from plaster. The missing plaster along the edges may subsequently be applied at the construction site after assembling the concrete panels. Then a final wind- and water-repelling plaster layer can be applied as well. The facade of the building will thereby appear as a surface without visible joints. As alternative, the front wall 11 can be covered with another type of covering, e.g. a facing or brick siding, wood panelling, clinkers/tiles, or covering/plates of natural stone.

[0026] The making of the concrete panel according to the invention corresponds substantially to the making of the highly insulated concrete panel shown in Fig. 2 and disclosed in EP 2 224 071 A1 insofar concerning back wall, columns and girders and laying of the insulation layers, and which hereby is incorporated by reference.

[0027] Figs. 3-6 show concreting of the reinforced back wall 2 and reinforced supporting columns 4 and girders 5, laying of insulation layer 6, 7 and possible insertion of a rabbet element 8. The rabbet element 8 is described in EP 2224070 A and provides a firm base in which doors and windows can be secured, preferably by conventional screws. Concrete columns 4 and concrete girders 5 are delimited by the concreting at one side by the edge scaffolding 1 and at the other side by the first layer of the compression-resistant insulation 6.

[0028] Suitable insulation materials are in particular compression-resistant materials in plate form, including mineral wool, e.g. glass or rock wool, foam glass, plastic

based insulation materials, including polystyrene (PS), polyurethane (PU or PUR) or polyisocyanurate (PIR) and/or combinations thereof.

[0029] The first layer 6 of the insulation material is placed upon the concreted back wall 2 such that it forms a permanent scaffolding for the columns 4 and the girders 5. Then columns 4 and girders 5 are concreted around their reinforcement. Then a further layer 7 of insulation is laid, covering the entire first insulation layer 6 of the concrete panel and the front side of the columns 4 and the girders 5, the layer 7 extending at least to the edge of the concrete panel which is at right angles to the plane of the panel, or projecting beyond the outermost edge of the concrete panel.

[0030] On Fig. 3, in the concrete panel mould 1 there are mounted plate 3, girder and column reinforcement statically optimised for each individual concrete panel. Moreover, support for electric and domestic water installations etc. according to need and desire can be mounted.

[0031] Prior to concreting the back wall 2, a number of suspensions 13b have been mounted as well as a number of ties 14b which are fastened in a conventional way to the reinforcement 3 of the back wall, see below.

[0032] The flat part of the back wall 2 which becomes visible on the finished concrete panel, and which is thus intended to face the interior of the finished building, faces the bottom of the concrete panel mould 1. After concreting the back wall 2, possible rabbit elements 8 for windows and/or doors are mounted subsequently. The mounting can e.g. occur by the anchoring of the rabbit elements 8 is pressed down into the still wet concrete of the back wall 2, or possibly be screwed into the entirely or partially hardened concrete back wall 2.

[0033] On Fig. 4, a first layer of compression resistant insulation 6 is mounted in the concrete panel mould 1, the insulation e.g. constituted by hard mineral wool, polystyrene, glass foam, or a combination thereof. The insulation material 6 is mounted such that it fills the areas upon the back wall 2 and out to the area for the supporting columns 4 and girders 5 such that it forms a permanent scaffolding at the concreting of the statically optimised girders 5 and columns 4 which are shown concreted on Fig. 5. By using the compression resistant insulation 6 as permanent scaffolding for the supporting girders 5 and columns 4 in the back wall construction, the dimensioning, i.e. the width and height of the supporting girders 5 and columns 4 can be varied with regard to strength requirements in individual building constructions by simply cutting the first insulation layer 6 to size for varying the width of girders 5 and columns 4. The depth of columns 5 and girders 4 can be varied by varying the thickness of the insulation layer 6 and the height of the edge scaffolding 1 of the concrete panel mould.

[0034] The second insulation layer 7 of the concrete panel which is also compression resistant is shown mounted on Fig. 6. As it appears, the insulation layer 7 is laid on the concrete panel, extending right up to the outermost edge of the concrete girders 5 and the con-

crete columns 4, the edge being perpendicular to the plane of the concrete panel 18. If the concrete panel e.g. is to cover a joint at a storey partitioning (see Fig. 16) or to function as the end of the building at a corner, a roof fascia (see Fig. 13) or the like, the second insulation layer will project beyond this edge on the concrete panel, and the concrete panel mould 1 will of course be adapted such that it also can accommodate this second insulation layer. The thickness of the total insulation layer is dimensioned according to the task and may cover everything from national and international minimum requirements and up to the requirements of a zero-energy building. In practice, however, there is to be at least 100 mm insulation in front of columns and girders in order to avoid thermal bridges.

[0035] The insulation layers can be of the same material, alternatively of two different materials, of the type mentioned above.

[0036] Prior to concreting the front wall 11 of the concrete panel, a number of crack indicators 15 are disposed on the surface of the last laid insulation layer 7, see e.g. Figs. 6, 8, 9a-b. The crack indicators 15 divide the surface into preferably square or rectangular fields 12. For example, about 0.5 - 1 m crack indicators per square meter of surface are to be used on the concrete panel, or preferably 0.6 - 0.8 m/m², see examples of laying of crack indicators 15 on various concrete panels according to the invention on Figs. 17a-17d.

[0037] The crack indicators 15 are fastened to the insulation layer 7 by plastic or metal nails 16 (Figs. 9a, 9b) or may alternatively be bonded hereto, e.g. by double adhesive tape (not shown).

[0038] The crack indicators 15 are preferably made of a compression resistant material, including e.g. fibre-reinforced concrete, mineral wool, foam glass, or a synthetic material, e.g. PVC, PS, PUR, PIR or similar. The crack indicators 15 are preferably made as long bars with suitable cross-section, for example square or rectangular cross-section in order to make production of the crack indicators 15 as simple as possible. The shape of the cross-section of the crack indicators 15 is, however, not essential, as it is only to be ensured that they provide a suitable width between the fields in the front wall 11. The cross-section of the crack indicators 15 may thus also correspond to the cross-section in a frustum of a cone or have dove-tail shape.

[0039] In one embodiment, the surfaces of the crack indicators 15 are covered by a layer of slide film 18, the function of which is described below.

[0040] In a further embodiment of the invention there is provided an expanding fire-retardant material (not shown) at the top side of the crack indicators, preferably between the crack indicators and the slide film. The fire-retardant material expands by heating above a certain temperature, e.g. 80°C, effectively sealing against penetration of fire, smoke and gas. The fire-retardant material is e.g. a fire-retardant joint filler which is applied to the crack indicator in connection with laying of the latter,

or is laid in a groove in the crack indicators prior to the laying of them on the insulation material. Alternatively, a prefabricated band of an expanding fire-retardant material can be applied which is laid upon the crack indicator or which is mounted in beforehand on the outer side of the crack indicator, i.e. the side of the crack indicator facing the outer side of the building.

[0041] Sealing against penetration of e.g. gases, smoke and particularly fire is hereby achieved which is particularly advantageous if using a flammable insulation material like e.g. polystyrene-based insulation materials.

[0042] Examples of suitable fire-retardant joint fillers are conventional one-component joint fillers, e.g. acrylic fire-retardant joint fillers, e.g. fire acrylic 565™ from Danalim, Sabesto fire-retardant acrylic from Würth or conventional fire-retardant two-component joint fillers, e.g. Arboko1476™ from Adshead Radcliffe.

[0043] Top concrete, i.e. the front wall 11, is then poured in the normal way and is finished in line with the scaffolding 1 on the concrete panel mould. The front wall is preferably poured in fibre-reinforced concrete.

[0044] At the concreting of the front wall 11, the crack indicators 15 will divide the front wall 11 into a number of fields 12 which are preferably square or rectangular.

[0045] The height of the crack indicators 15 corresponds largely to the desired thickness of the concrete layer in the front wall 11 such that the crack indicators 15 are covered by the least possible concrete during the pouring of the front wall 11. It is preferred that the thickness of the front wall 11 and thereby also the height of the crack indicators is 20-50 mm, preferably 25 - 40 mm. In comparison, a steel-reinforced front wall of concrete in a traditional concrete sandwich panel (see Fig. 1) will have thickness between 70 and 90 mm.

[0046] It should be attempted that the concrete B on the crack indicators 15 themselves is removed, alternatively that the crack indicators 15 are not covered by more than 3-4 mm of concrete, see Fig. 9b. When this thin layer of concrete B is hardened it will crack along the edge of the crack indicators 15, for example when the front wall 11 expands or contracts when the concrete panel is subjected to thermal actions.

[0047] After pouring the concrete layer for the front wall 11, a slide film 17 is laid over all crack indicators 15 in order to avoid that the subsequent glass fibre netting 9 reinforced plaster layer 10 adheres to the crack indicators 15. Thereby it is ensured that the plaster layer 10 only adheres to the concrete fields 12 in the front wall 11. The slide film 17 can have a width which is greater than the crack indicators 15. If the crack indicators 15 are made with a surface of slide film 18 as described above, the laying of the slide film 17 can be avoided and a work operation in the concrete panel factory can be spared. A layer 10 of mineral plaster which is reinforced by glass fibre netting 9 is laid, preferably wet- in- wet, in the usual way at the outer side of the concrete panel, i.e. across the fields 12 and the crack indicators 15 in the front wall 11. Subsequently is applied a wind- and water- repelling

plaster layer (not shown) .

[0048] If the concrete panel contains openings 25 for doors and/or windows, it will be advantageous if the front wall 11 is poured right up to the edge of the rabbet elements 8 surrounding the door or window openings 25. The concrete layer in the front wall 11 can be anchored to the rabbet elements 8 by fastening screws, nails or similar anchoring means 20 along the edge at the opening in the rabbet element 8, e.g. at every 200-400 mm, preferably at every 250-350 mm.

[0049] After hardening the plaster layer will adhere to the concrete in the fields 12 of the front wall 11 but not in the area over the crack indicators 15 due to the applied slide film 17, 18. The glass fibre reinforced plaster layer 9, 10 will thus have a "free span" where it does adhere, which is e.g. up to about 50 mm, or preferably between 25 and 35 mm.

[0050] The plaster 10, or more correctly the glass fibre netting reinforcement 9 herein, will distribute the actions of force from thermal movements of the fields 12 of the front wall 11 to the entire area over the crack indicators 15. cracks possibly appearing will thereby be so small that they do not become visible in the finished surface.

[0051] The division into fields 12 of the front wall 11 of the concrete panel allows for expansion and contraction of the concrete in the front wall 11 as a result of thermal actions from the surroundings as the crack indicators form an expansion joint/crack 19 between each concrete surface 12 in the sectionalised front wall 11 and the surface 19a on the crack indicators 15. If the thermal movements are e.g. about 0.8 mm/field 12, the field division with the crack indicators 15 will mean 0.4 mm crack at either side of the crack indicator (calculated for -20°C to +50°C). This field division of the front wall 11 is to provide that the plaster layer in principle does not adhere to the concrete at the crack indicators. The slide film 15 is therefore mounted over the indicators before laying the plaster layer 10 and the glass fibre netting 9. In that way the plaster will "span" across the width of the slide film.

[0052] By the division into fields 12 of the front wall 11 of the concrete panel the temperature-dependent expansion of the assembled front wall 11 is controlled. As the crack indicators 15 are made of a compression-resistant material and furthermore covered by the glass fibre reinforced plaster layer 10, the entire front wall 11 will appear without any markings from the cracks 19 or the crack indicators 15 on the outer plaster surface of the concrete panel.

[0053] If the crack indicators 15 are made of a material such as a synthetic material which does not adhere to the concrete and/or the basic plaster 10, the slide film 17, 18 can be omitted.

[0054] The suspensions 13b are preferably conventional triangular suspensions that are fastened in the reinforcement 3 of the back wall 2 and are anchored in the front wall by mounting a crossbar 13c (see Fig. 6) in the apex of the triangle to be anchored in the front wall 11. These suspensions 13b in principle function in the same

way as conventional suspensions 13a in traditional sandwich elements (see e.g. Fig. 1) as they ensure vertical bearing of the concreted front wall 1 and can absorb vertical shear forces from the front wall 11, see Fig. 10. There is to be provided 0.7 suspensions per m² of surface on the panel or corresponding to one suspension 13b per field 12 in the front wall 11. The suspensions 13b are preferably made of stainless steel and are dimensioned such that they go through the insulation layers 6, 7 and are thus anchored in the front wall 11 as well. In order that the suspensions can pass through the insulation layers 6, 7, slits have been cut in the insulation layers 6, 7 corresponding to the positions of the suspensions 13b. If the fields 12 in the front wall 11 are up to 1.2 x 1.2 m, ties 13b made of e.g. 2-6 mm, including 3-5 mm stainless steel wire, be sufficiently stable and have sufficient strength for most constructional purposes. In practice, most often one suspension 13b per field 12 in the front wall 11 will be sufficient; however, it is possible to use more than one suspension, e.g. two, three, four or more, per field 12 in the front wall 11 if required.

[0055] Besides securing the insulation layer/layers 6, 7 between back and front walls 2, 11, the ties 14b are also to function as anchoring between back wall 2 and front wall 11, as these ties 14b particularly absorb horizontal actions of force, e.g. from the wind. The ties 14b are e.g. made of stainless steel wire with a diameter dimensioned to the required breaking strength. After concreting the front wall 11, the outer free end of each tie 14b is bent down into the wet concrete over a crossbar 14c (see Fig. 6) in order to ensure the anchoring in the front wall 11. In a preferred embodiment of the concrete panel, the ties 14b have breaking load of 3-5 kN apiece, preferably 3.8-4.5 kN apiece, corresponding to ties 14b of stainless steel wire with a diameter of 2-6 mm, preferably 2.5-4 mm when the front wall 11 is divided into fields 12 of the above mentioned size.

[0056] If the concreted front wall 11 in the concrete panel is made of fibre-reinforced concrete and e.g. has a thickness of 30 mm, suspensions 13b and ties 14b can "span" across up to 0.90 m by panels with maximum thickness of the insulation layers 6, 7.

[0057] This means, for example, that as an average at least two ties are to be provided per field 12 of up to 1.2 x 1.2 m in the front wall 11.

[0058] In practice, it will most often be sufficient to mount two to four ties 14b and one suspension 13b for each field in the front wall 11 of up to 1.2 x 1.2 m. Each field 12 in the front wall 11 will thereby have at least three points per field 12 at which the field 12 is anchored to the back wall 2.

[0059] As the front wall 11 in the concrete panel is not steel reinforced, is possible to produce concrete panels with a front wall with reduced thickness compared with a traditional sandwich concrete panel. When the front wall 11 is divided into fields 12, the size of the suspensions 13b and ties 14b anchoring each field 12 in the front wall 11 to the back wall 2 can be reduced. This will

much reduce the risk of thermal bridges occurring in the wall. The field division 12 of the front wall 11 under the glass fibre reinforce plaster layer 9, 10 provides that the edge actions to which each field 12 in the front wall 11 is subjected due to movements caused by temperature fluctuations or other actions will be distributed to the glass fibre reinforcement 9 in the plaster layer 10 in the whole area over the crack indicators 15. This is possible as the plaster layer in this area does not adhere to a base. The deformation resulting from the action of force will hereby be distributed to a larger area, and the risk of cracks arising at points where the glass fibre reinforcement 9 is deformed or possibly torn apart will therefore be substantially reduced as well as the cracks appearing in the area over the crack indicators 15 will be of substantially smaller size.

[0060] The concreted panels can be taken out of the moulds and finished by mounting doors and/or windows in the concrete panel factory, and otherwise mounted at the construction site as described in EP 2 224 071 A2 and as shown in Fig. 15, as columns 4 and/or girders 5 are poured together with concrete 21 between two adjacent panels. Insulation material 22 is put into the joint between the insulation layers 6, 7 in the adjacent panels, e.g. in the form of PU foam or mineral wool. To the required extent a joint base 23a is laid. Then a mastic joint 23 is applied between the front walls 11 in the two adjacent panels. The mastic joint 23 absorbs the movements occurring between two adjacent fields 12 in two adjacent panels when the front wall 11 is subjected to thermal actions. Finally, the joint is finished by laying a glass fibre netting 9 over the joint and covering the joint with a plaster layer 10 as described above, whereby the entire façade will appear without any visible joints between the concrete panels.

[0061] Figs. 14a-14b show how brackets 26 can be mounted for securing cantilevered balconies or galleries at the outer side/facade of the building in a concrete panel according to the invention.

[0062] The bracket 26 is mounted in the reinforcement 3 of the back wall before concreting the back wall 2. In the area 11a around the bracket 26 the thickness of the insulation layer 7 is reduced such that the concreted front wall 11 attains increased thickness in this area 11a in order to stabilise the bracket 26, in particular against compressive and tensile actions and/or by the action of weight of the balcony/gallery causing a moment of force on the bracket 26. In an embodiment, the front wall 11 is anchored to the back wall 3 with one or more additional suspensions/brackets 26. Crack indicators 15 may advantageously be disposed at a distance around the bracket, see Fig. 14b, whereby the risk of cracks appearing in the outer plaster layer is reduced in the area around the brackets 26 for fastening balconies or galleries.

Claims

1. A highly insulated concrete panel, including a reinforced back wall, reinforced columns and girders connected with the back wall, and one or more layers of insulating material, **characterised in that** the insulated concrete panel has a front wall (11) poured in concrete and divided into fields (12), between which fields (12) crack indicators (15) are provided. 5
2. Insulated concrete panel according to claim 1, **characterised in that** a layer of slide film (17, 18) is provided over the crack indicators (15). 10
3. Insulated concrete panel according to claim 2, **characterised in that** the crack indicators (15) are covered by the slide film (18). 15
4. Insulated concrete panel according to any of claims 1-3, **characterised in that** the crack indicators (15) are made of material on which concrete and/or a subsequently applied plaster layer (10) cannot adhere. 20
5. Insulated concrete panel according to any of claims 1-4, **characterised in that** the front wall (11) is covered by a plaster layer (9) reinforced by glass fibre netting (10) and/or by a covering of wood, natural stone, a facing or brick siding, and/or combinations thereof. 25
30
6. Insulated concrete panel according to any of claims 1-4, **characterised in that** a fire resistant material is provided at the top side of the crack indicators, preferably between the crack indicators and the slide film. 35
7. A method for making the front wall of a highly insulated concrete panel, wherein the concrete panel includes a reinforced back wall with girders and columns and one or more layers of insulating material, wherein after concreting the reinforced back wall (2) of the concrete panel and the supporting columns (4) and girders (5) there is laid one or more layers of insulating material (6, 7), wherein the method includes laying of crack indicators (15) upon the upper surface of the insulation material (6, 7) such that a number of fields (12) is formed between the crack indicators (15), and concreting a concrete layer for forming a front wall (11) of concrete divided into fields (12). 40
45
50
8. Method according to claim 7, **characterised in that** a layer of slide film (17, 18) is laid over the crack indicators (15). 55
9. Method according to claim 7 or 8, **characterised in that** excess concrete upon the crack indicators (15) is removed after concreting the front wall (11).
10. Method according to any of claims 7-9, **characterised in that** the front wall (11) divided into fields (12) and the crack indicators (15) are applied a plaster layer (10) which is reinforced by glass fibre netting (9).
11. Method according to any of claims 7-9, **characterised in that** the front wall (11) is covered by a covering of wood, natural stone, a facing or brick siding, or combinations thereof.
12. Method according to any of claims 7-9, **characterised in that** a fire resistant material is applied at the top side of the crack indicators, preferably between the crack indicators and the slide film.
13. Use of an insulated concrete panel according to any of claims 1-6 or made by the method according to any of claims 7-12 for constructing buildings with one or more storeys.

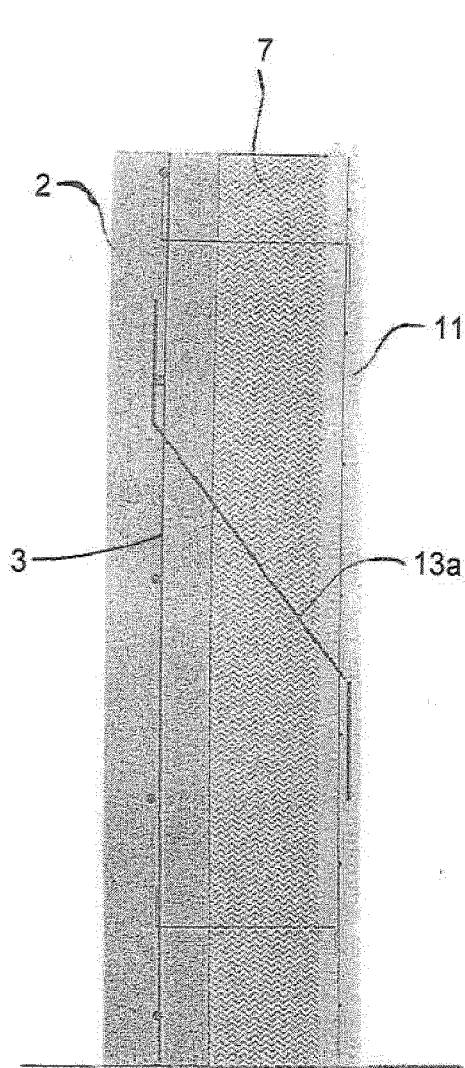


Fig. 1

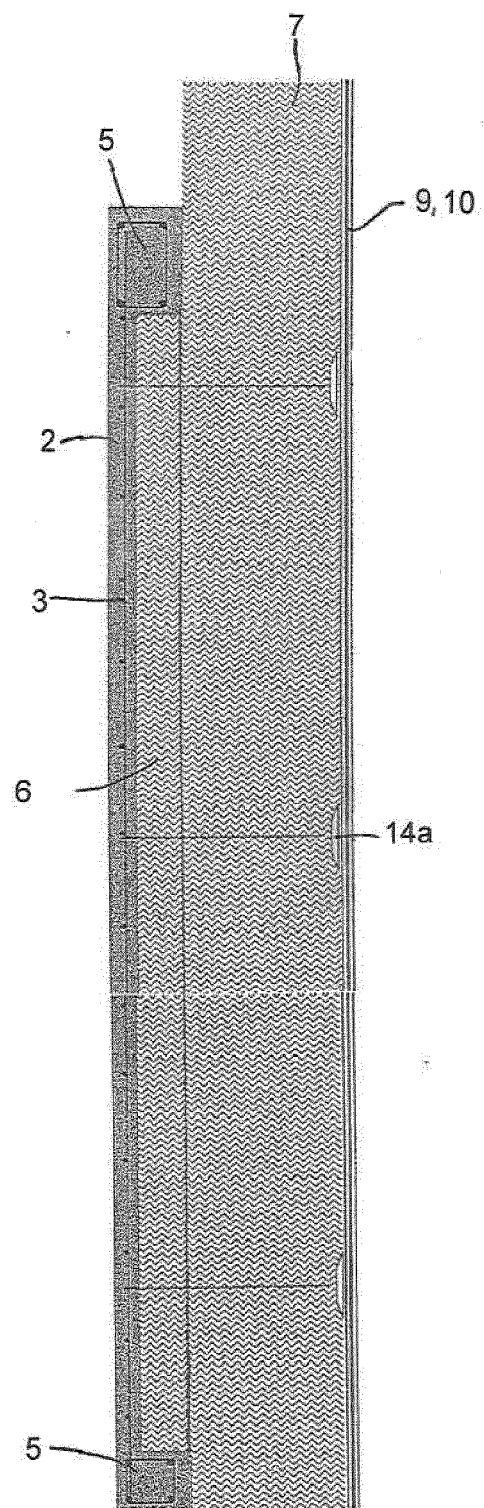
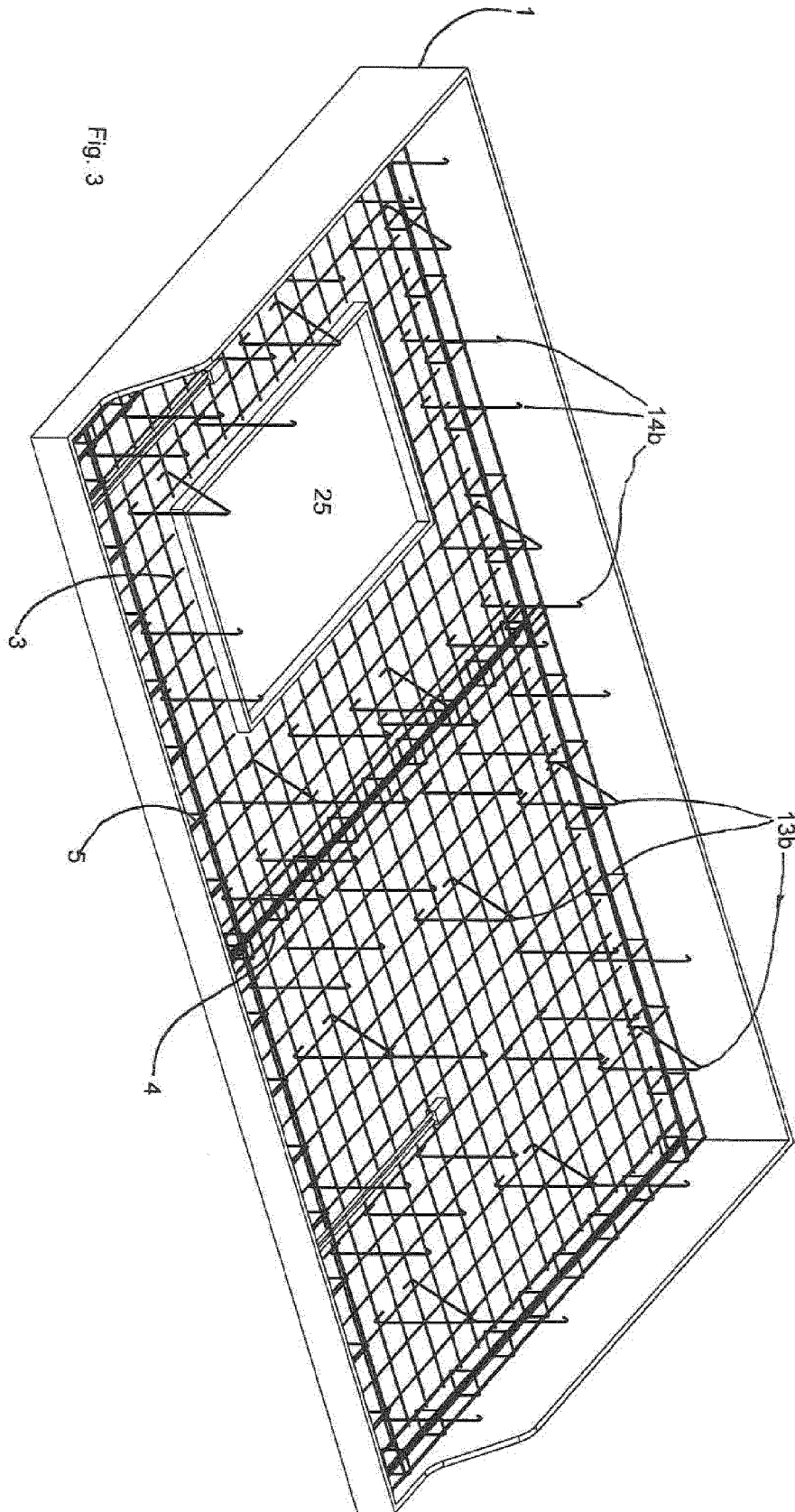
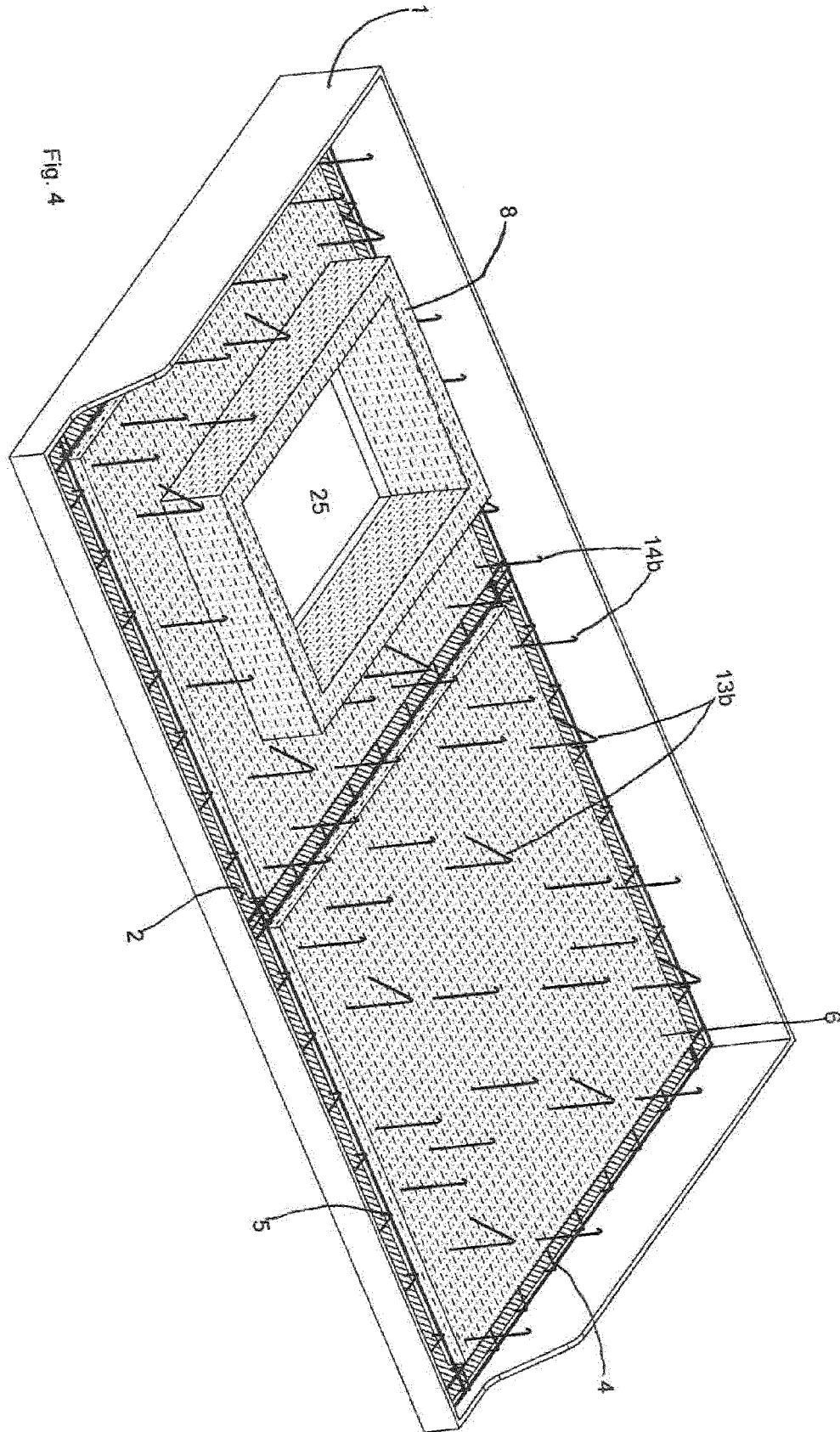


Fig. 2





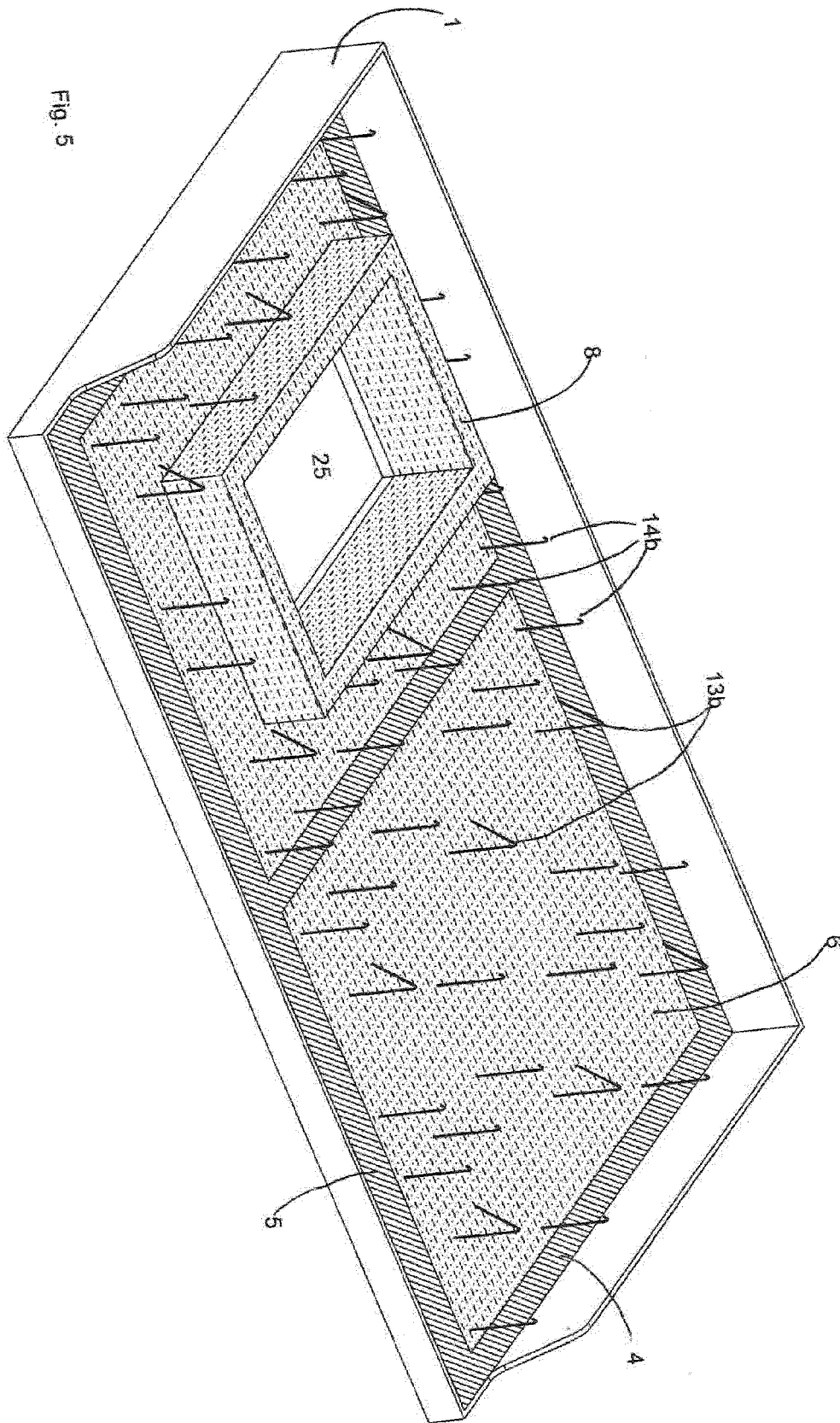
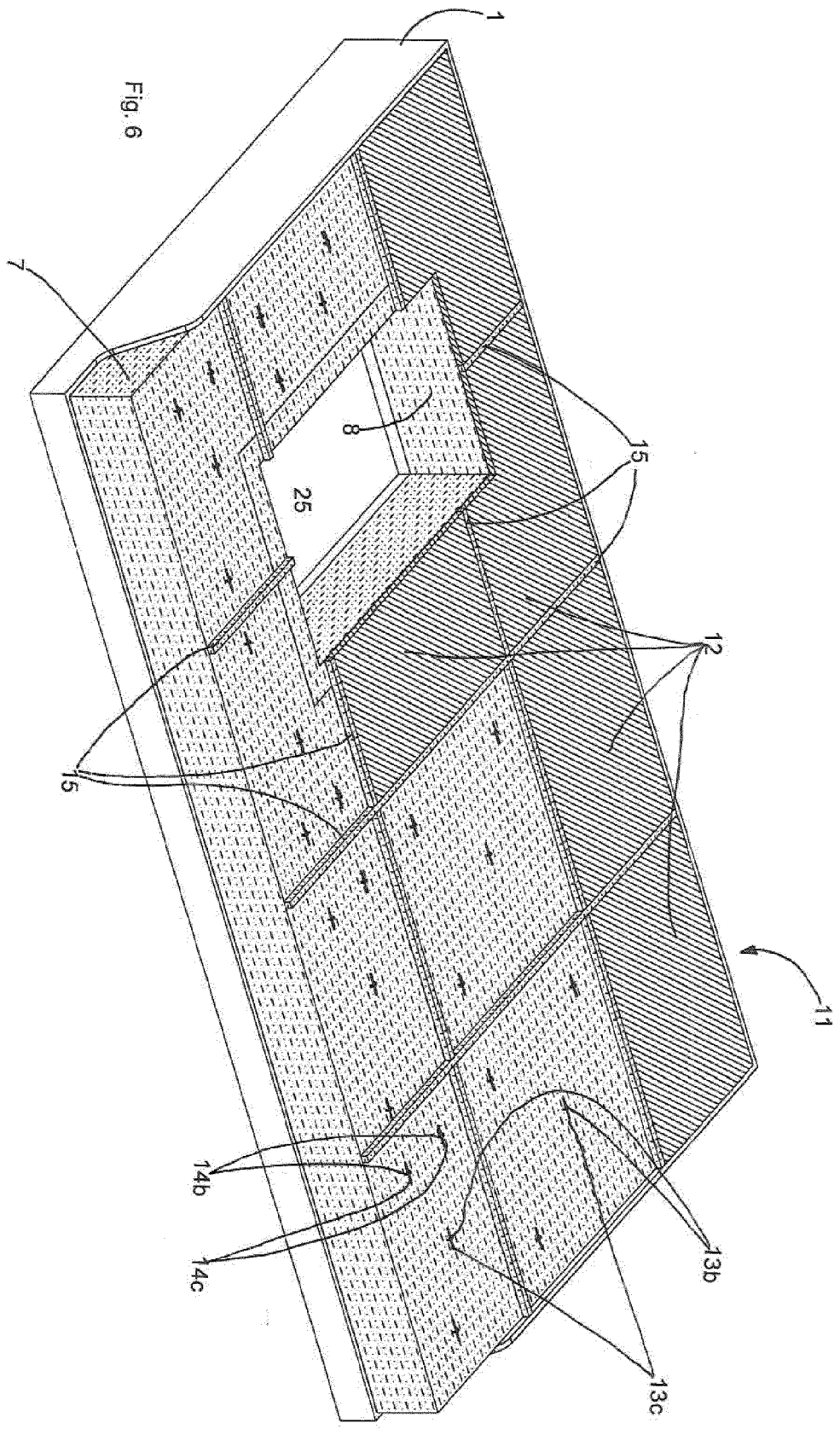


FIG. 5



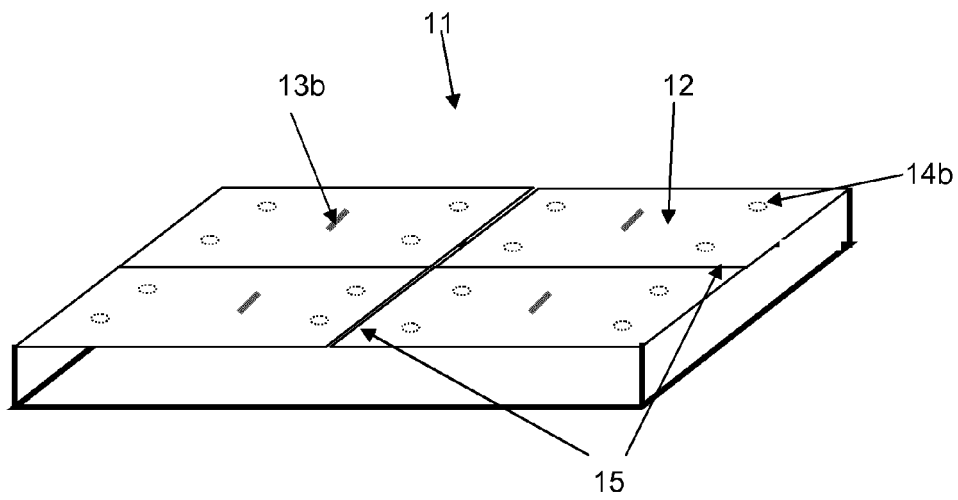


Fig. 7

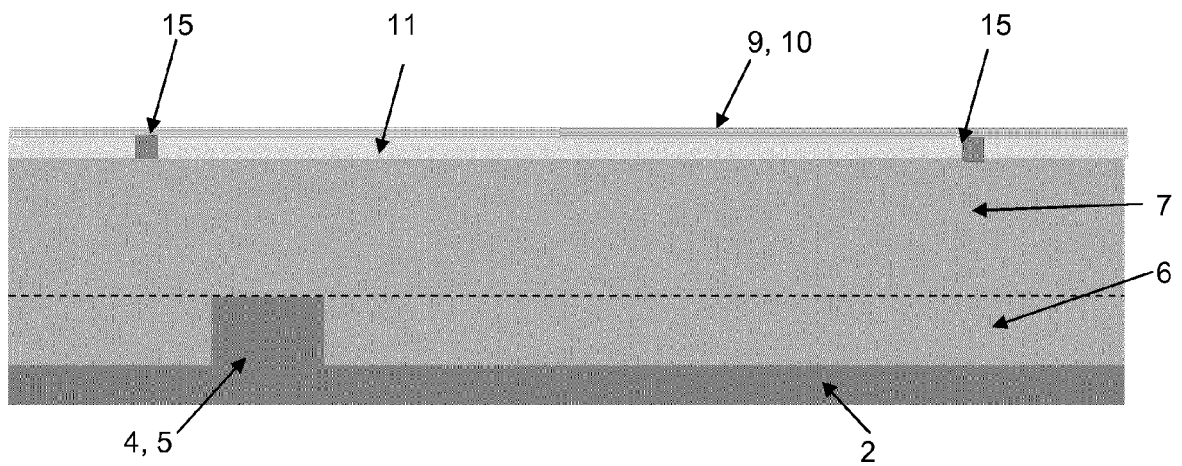


Fig. 8

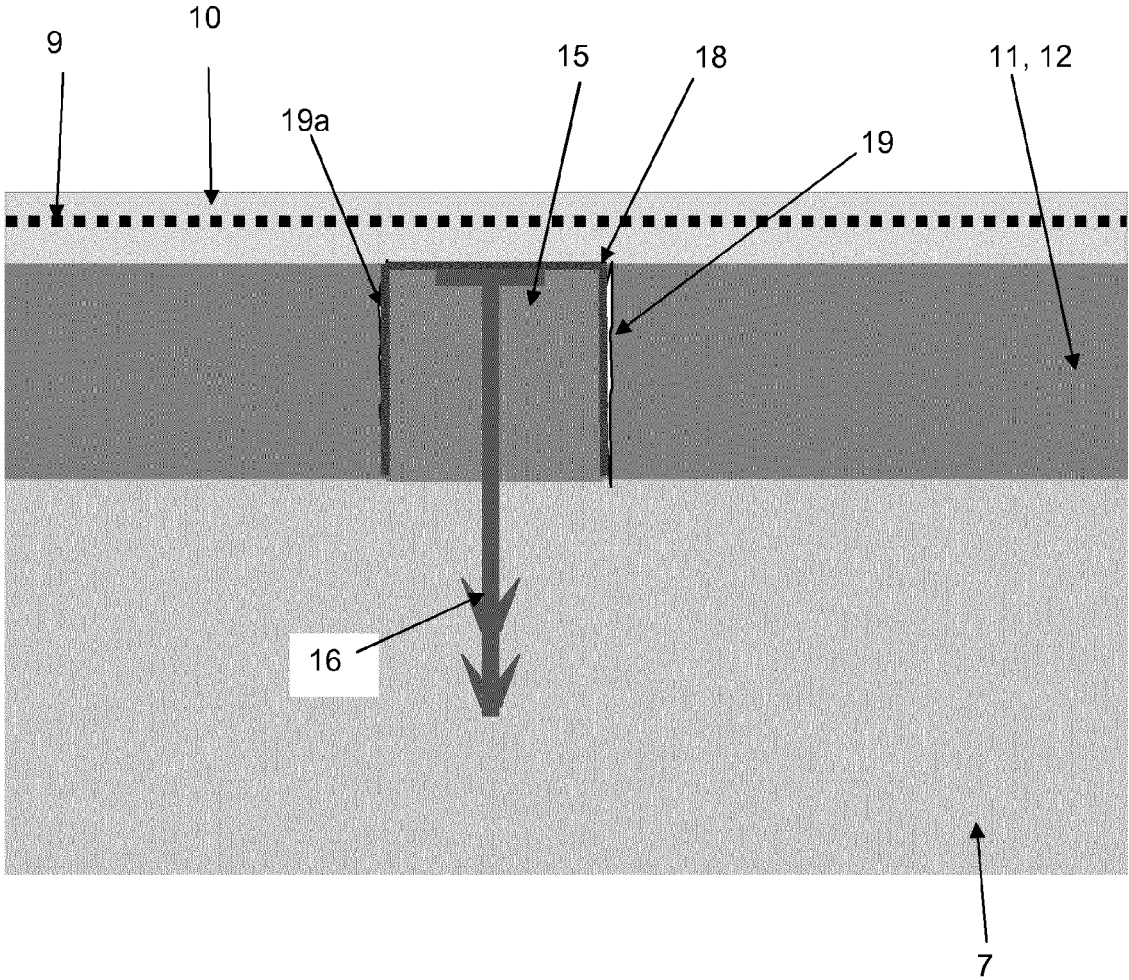


Fig. 9a

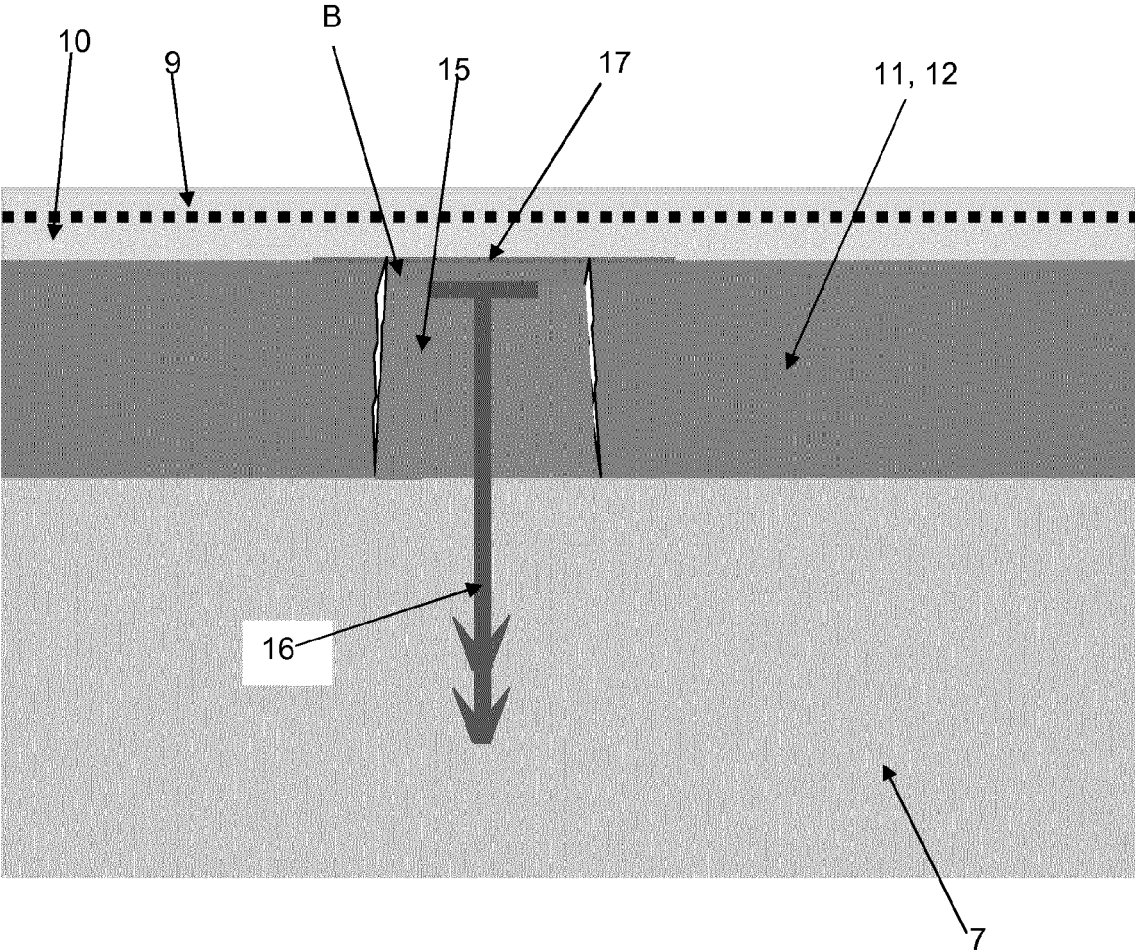


Fig. 9b

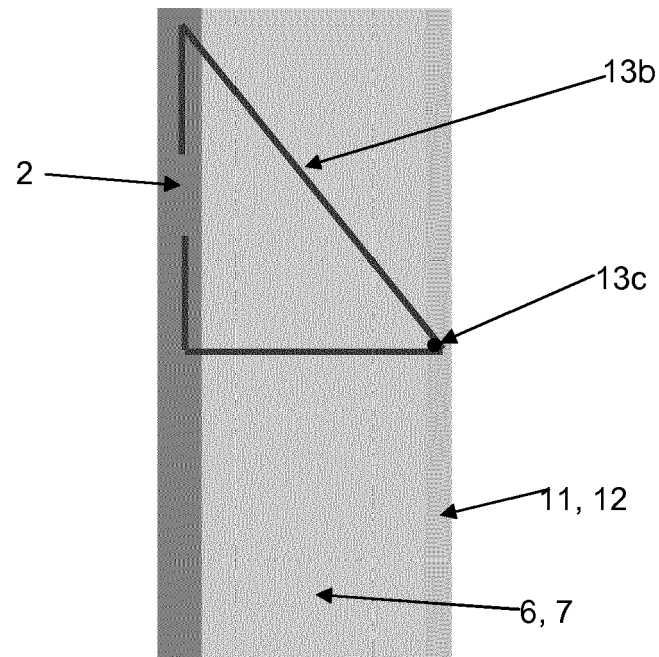


Fig. 10

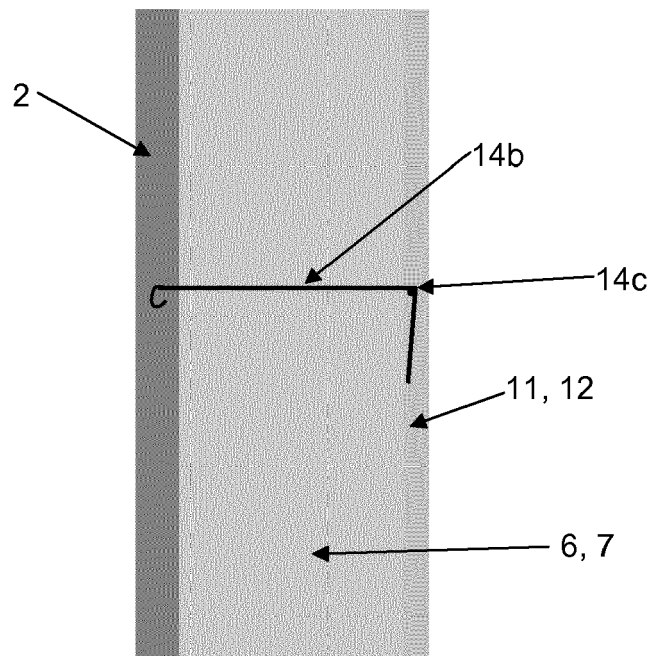
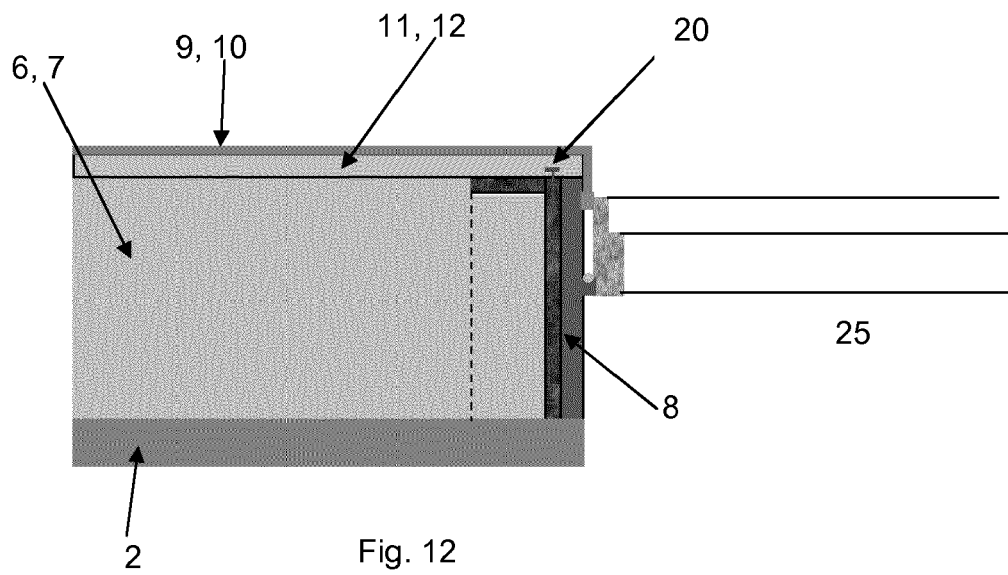


Fig. 11



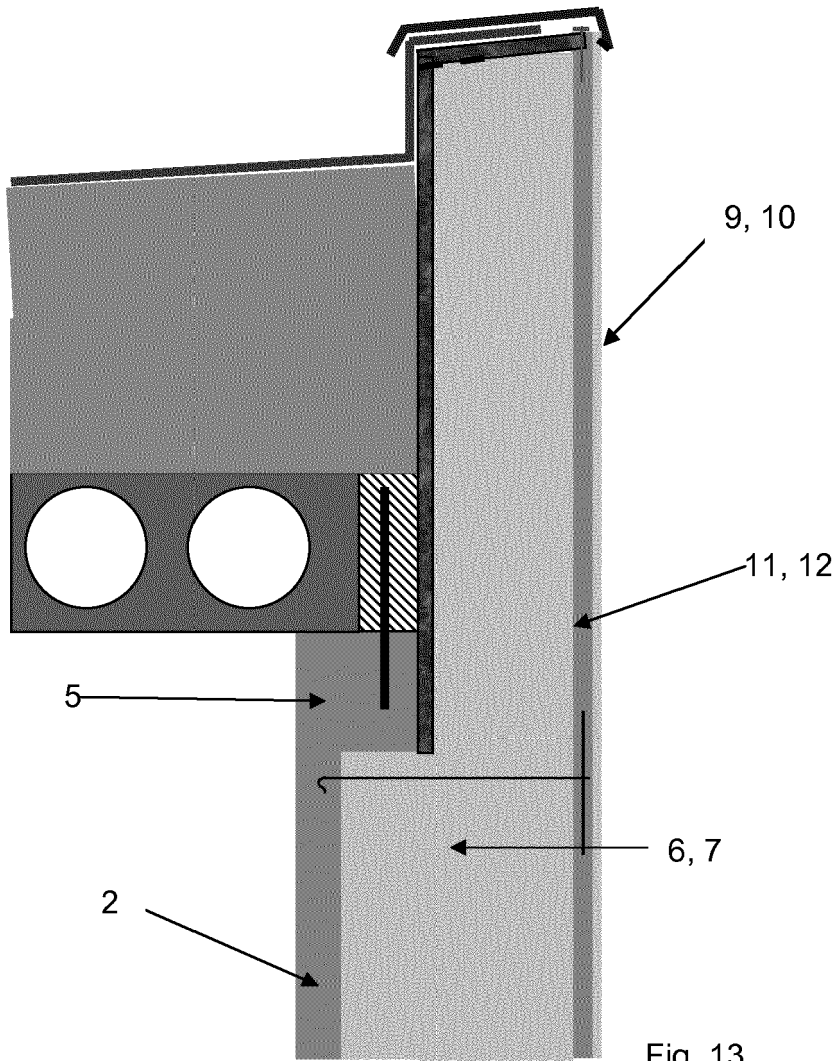
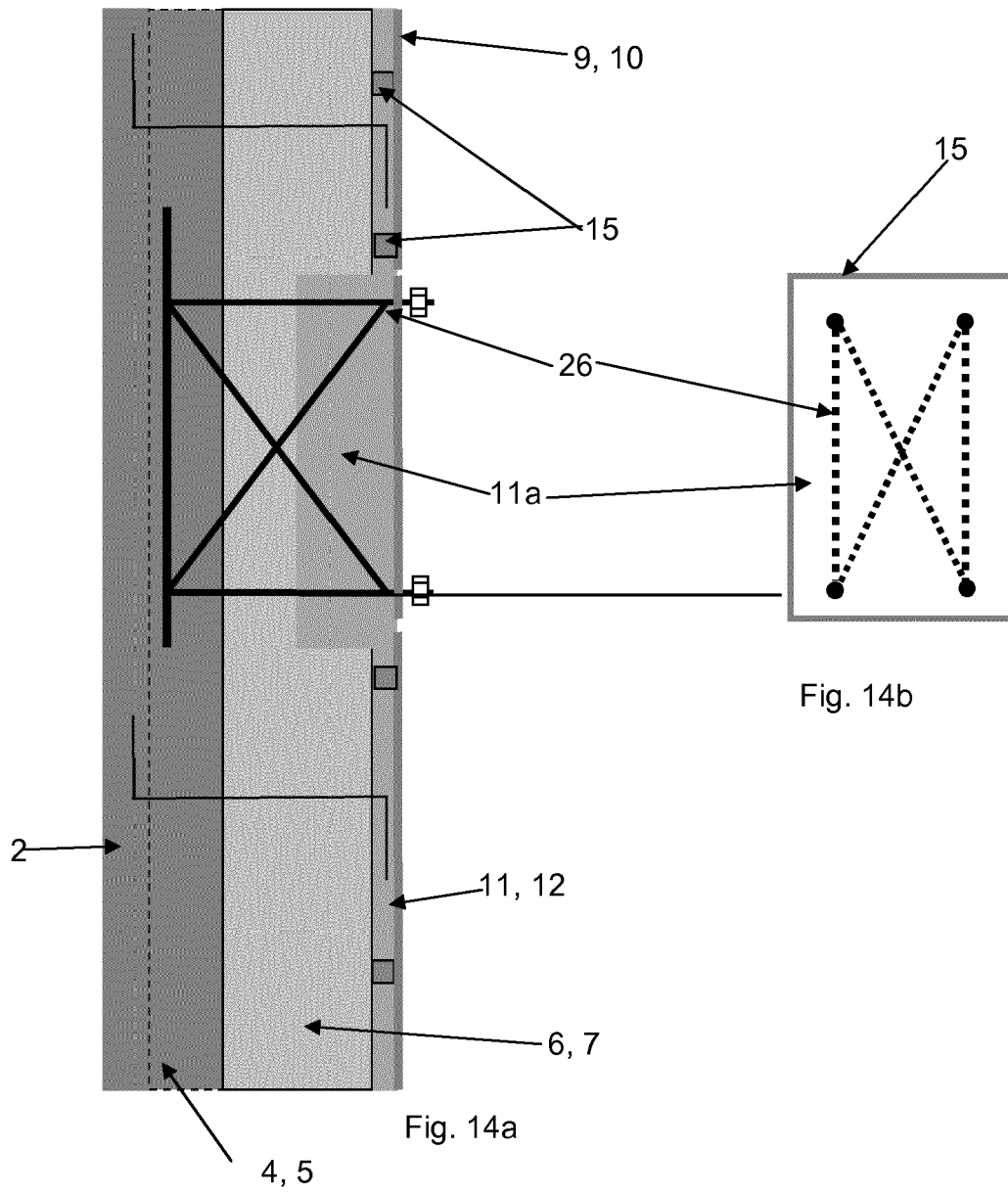
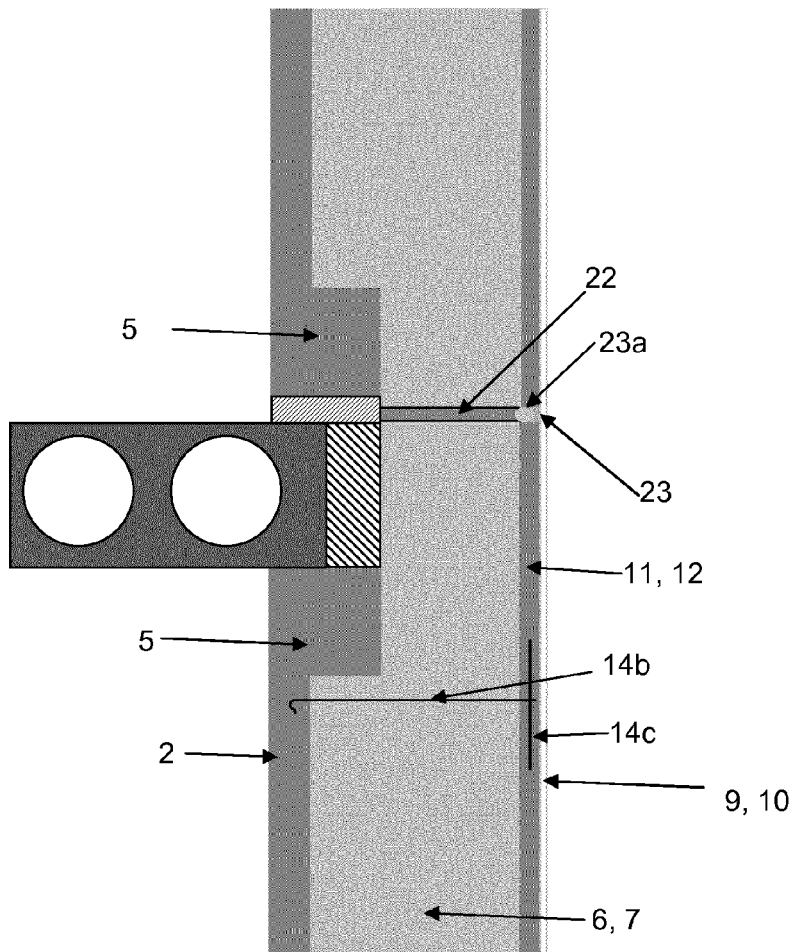
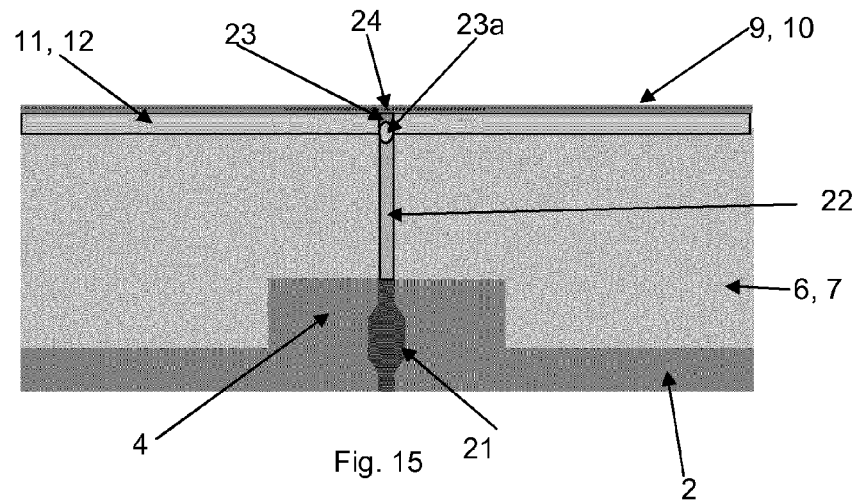


Fig. 13





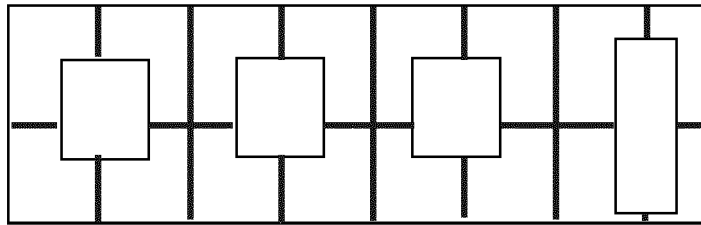


Fig. 17a

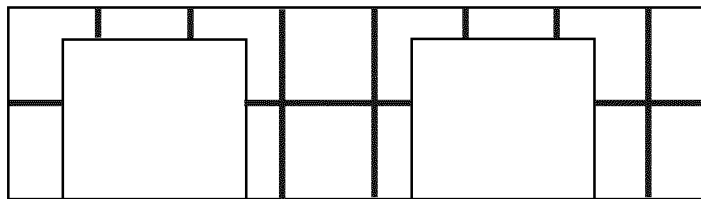


Fig. 17b

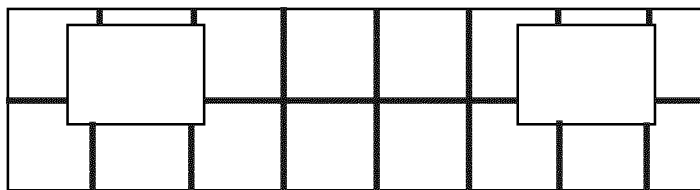


Fig. 17c

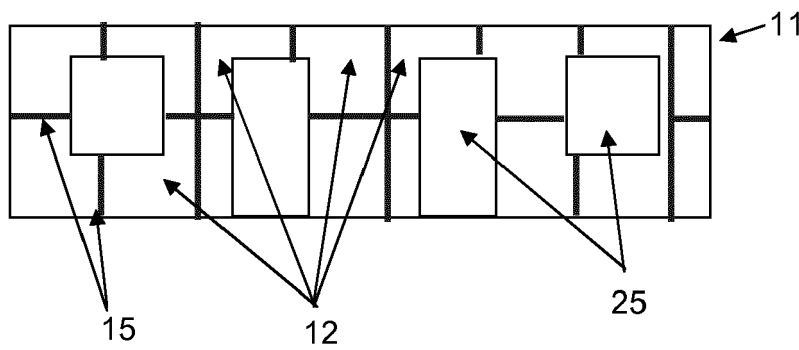


Fig. 17d

REFERENCES CITED IN THE DESCRIPTION

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