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(54) **Method for making a floor with flat intrados prefabricated elements and the floor obtained thereby**

(57) The invention relates to the field of techniques for making decks and can find application in the sector of civil engineering.

By means of the method according to the present invention a deck (1) is made comprising concrete precast elements (2), lightweight elements (3a, 3b) and parts of cast-in-situ concrete (4); each of said precast elements (2) has a flat intrados and comprises a lower slab (2a), first ribs (2b) arranged above said lower slab (2a), first connecting reinforcements (2c) projecting above said first ribs (2b) and second connecting reinforcements (2d) arranged at the longitudinal edges of said precast element (2); each precast element (2) is self-bearing during the step of casting said cast-in-situ concrete (4).

Said parts of cast-in-situ concrete (4) comprise an upper slab (4a) and second ribs (4b) arranged at the longitudinal joints (6) between the adjoining precast elements (2).

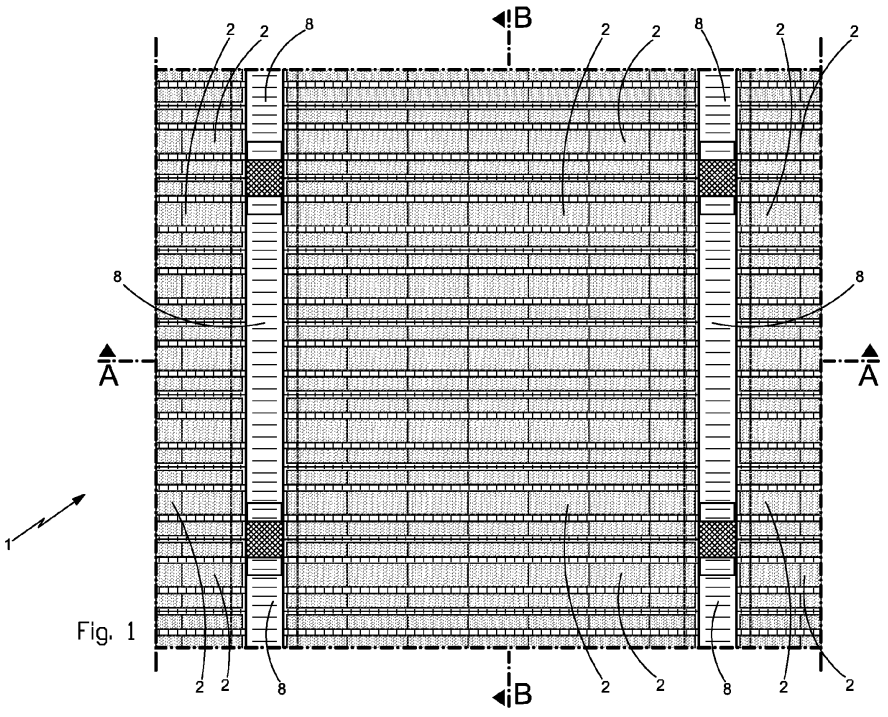

Fig. 1

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Description

[0001] The object of the present invention is a method for making a deck with flat intrados precast elements and the deck thus obtained. This deck with flat intrados precast elements can be used, for example, for making decks such as floors, for example, for residential buildings, office buildings, or commercial buildings, (such as supermarkets, etc.), or for sports use (such as gyms, etc.), etc.

[0002] Various typologies of decks are known in the art, which involve the use of precast elements that will be then completed on site by casting additional concrete.

[0003] Among these typologies, floor plates with lattice girders are known, each of which comprises electrowelded steel lattice girders and a lower slab made of reinforced concrete in which the lower bars of said lattice girders are also embedded. Floor plates with lattice girders are made in a factory for the production of precast elements and then carried to the construction site after suitable foamed polystyrene elements have been fitted among the various lattice girders, which elements mainly act as lightweight elements. These floor plates with lattice girders are arranged on site using temporary steel struts which allow the floor plates with lattice girders to bear their own weight as well as the subsequent final casting of concrete as will be described below. After the operations of strutting on site have been completed, the additional reinforcing bars (adding reinforcements) are placed. The concrete cast by which the deck is completed is then carried out. The floor plates with lattice girders are very frequently used mainly for spans that are not particularly large. The floor plates with lattice girders suffer from the drawback that they require provisional strutting which is expensive and cause a slowing down in the operations at the building site. Furthermore, the floor plates with lattice girders often suffer from more or less extended cracking phenomena at the intrados of the reinforced concrete (lower) slab.

[0004] Another typology of precast elements which is very used in the construction practice for making decks (floors) consists of the hollowcore slabs obtained by means of extrusion or vibro-compacting. These hollowcore slabs are self-bearing and do not require, contrary to the floor plates with lattice girders, temporary strutting; this is an undisputable advantage of the hollowcore slabs over the floor plates with lattice girders. However, the hollowcore slabs suffer from some drawbacks as will be better detailed below. The hollowcore slabs are precast elements which are heavy, such that the beams which support the decks (floors) consisting of said slabs require a greater load-bearing capacity than the load-bearing capacity required, for example, in case of those decks (floors) made using floor plates with lattice girders. Furthermore, the hollowcore slabs are not provided with ordinary steel reinforcements, because prestressing reinforcements (mainly strands) are only provided therein. The lack of ordinary steel reinforcements may, in some cases, give rise to several problems both in the connections between hollowcore slabs and beams and in the hollowcore slabs themselves.

[0005] In addition, the hollowcore slabs have a low resistance against transversal-bending stresses which stress the intrados transversal fibers of the slabs; in these cases, in fact, the cast-in-situ concrete upper slab is the only one to counteract said forces, which has a much lower thickness than the total thickness of the deck.

[0006] A prior art example is described in EP 1350898 in which no reinforcements are provided to project from the extrados of the precast element, i.e. no reinforcements are provided in order to connect the precast concrete with the cast-in-situ concrete.

[0007] In EP 1350898 the entire slab is precast except for the upper part thereof, which is cast in place, being thus possible to introduce on site ordinary reinforcements only at the cast-in-situ upper slab (topping); this imposes restraints both in the mutual connection between the precast elements and in the connection between said precast elements and the beams supporting the elements; the slabs described in the above patent are considerably heavy, which increases the costs for assembly and transportation.

[0008] An object of the present invention is to provide a deck having flat intrados precast elements that are self-bearing even during the casting of the adding cast-in-situ concrete and that can be effectively connected to each other by means of said adding cast-in-situ concrete after suitable adding reinforcements have been placed.

[0009] A further object of the present invention is to provide a deck that, on site, results to be lighter than the other decks that are made according to prior art, which comprise self-bearing precast elements (such as the hollowcore slabs).

[0010] A further object of the present invention is to provide a deck that has low values of heat transmission rate.

[0011] These and other objects are achieved by the method for making a deck with flat intrados precast elements and by the deck thus obtained, which are both the objects of the present invention, the latter being characterized by means of what is provided in the claims below.

[0012] The characteristics and the advantages of the present invention will be better detailed in the description below of several embodiments illustrated by way of non-limiting examples in the attached drawings in which:

- Fig. 1 illustrates, according to a top plan view, a portion of a deck with flat intrados precast elements that is obtained according to the present invention, according to a first embodiment; this deck is illustrated during a step of the method for making said deck;
- Fig. 2 shows, in the same scale as Fig. 1, the section according to line A-A in Fig. 1;
- Fig. 3 shows, in the same scale as in Fig. 1, the section according to line B-B in Fig. 1;
- Fig. 4 is a plan view, in the same scale as in Fig. 1,

partially according to a top view and partially according to a cut-away view, of a portion of the deck with flat intrados precast elements as shown in Fig. 1; this deck is shown in a further step of the method for making said deck;

- Fig.5 shows, in the same scale as in Fig. 4, the section according to line C-C in Fig. 4;
- Fig.6 shows, in the same scale as in Fig. 4, the section according to line D-D in Fig. 4;
- Fig.7 illustrates, in greater scale than that in Fig. 6, a detail of Fig.6;
- Fig.8 illustrates, in greater scale than that in Fig. 7, a precast element comprised within the deck with flat intrados precast elements illustrated in Fig. 1 to 7;
- Fig.9 illustrates, in cross-section, a portion of a deck with flat intrados precast elements, obtained according to the present invention, according to a further embodiment;
- Fig. 10 illustrates, in greater scale than that in Fig. 9, a precast element comprised within the deck with flat intrados precast elements illustrated in Fig. 9;
- Fig.11 is a plan view, according to a top view, of a portion of a deck with flat intrados precast elements as obtained according to the present invention, according to a further embodiment; this deck is illustrated during a step of the method for making said deck;
- Fig.12 shows, in the same scale as in Fig. 11, the section according to line E-E in Fig. 11;
- Fig.13 illustrates, in the same scale as in Fig. 11, the section shown in Fig. 12, in another step of the method for making the deck illustrated in Fig. 11 and 12;
- Fig.14 illustrates a detail of Fig.13 in a greater scale than that in Fig. 13;
- Fig.15 illustrates a detail of Fig.14, in a greater scale than that in Fig. 14, ;
- Fig.16 illustrates, in a greater scale than that in Fig. 15, a precast element comprised in the deck with flat intrados precast elements illustrated in Fig. 11 to 15.

[0013] In order to facilitate the understanding of the steps of the method for making a deck with flat intrados precast elements which is obtained according to the present invention, with reference to Fig. 1, 2, 3, 4, 5, 6, 7 and 8, is first described a deck 1 with flat intrados precast elements, which is obtained according to the present invention, according to a first embodiment. This deck is one of the joists of an office building.

[0014] The deck 1 comprises flat intrados precast elements 2 of prestressed concrete, lightening elements 3a, 3b and parts of cast-in-situ concrete 4. Each of the precast elements 2 comprises a lower slab 2a, two first ribs 2b placed above the lower slab 2a, first connecting reinforcements 2c projecting above the two first ribs 2b and second connecting reinforcements 2d placed at the longitudinal edges of the precast element 2, which reinforcements are partially embedded in the concrete of the lower slab 2a and projecting above the extrados of the lower slab 2a; the first ribs 2b are made simultaneously with the lower slab 2a; each precast element 2 is self-bearing during the steps of casting the cast-in-situ concrete 4; the precast elements 2 are placed next to each other such that longitudinal joints 6 are provided between adjoining precast elements 2; at each of the longitudinal joints 6 between two adjoining precast elements 2 coupling reinforcements 5 are provided which comprise transversal parts that are placed at the extrados of the lower slab 2a of said adjoining precast elements 2. The coupling reinforcements 5 consist of brackets (each of which is made by one or two parts). Said parts of cast-in-situ concrete 4 comprise an upper slab 4a and second ribs 4b placed at the longitudinal joints 6 between the adjoining precast elements 2; at each one of the second ribs 4b the two adjoining precast elements 2 are joined to each other by means of the coupling reinforcements 5 (placed at said second rib 4b) and by means of the second connecting reinforcements 2d; the second connecting reinforcements 2d projecting above the extrados of the lower slab 2a and the coupling reinforcements 5 are embedded in said parts of cast-in-situ concrete 4; the height of the second ribs 4b is more than twice the height of the lower slab 2a of the precast elements 2; the lightweight elements 3a, 3b have the intrados arranged proximate to the extrados of the lower slab 2a of the precast elements 2; the first ribs 2b and the second ribs 4b are connected to the upper slab 4a by means of the first connecting reinforcements 2c, the second connecting reinforcements 2d and the coupling reinforcements 5.

[0015] The deck 1 also comprises adding reinforcements 10 comprising bars 12, meshes 9 and the coupling reinforcements 5. The adding reinforcements 10 are positioned in place and embedded within the cast-in-situ concrete 4.

[0016] The lightweight elements 3a are placed between the first ribs 2b; the lightweight elements 3b are placed between a first rib 2b and a second rib 4b; it should be understood that the lightweight elements 3b also have the function of a disposable formwork for making (by casting the cast-in-situ concrete 4) the second ribs 4b; the lightweight elements 3a, 3b also have the function of disposable formwork for making (by casting the cast-in-situ concrete 4) the upper slab 4a. The precast elements 2 are prestressed by means of pre-tensioned adhering strands 11 made of high-strength steel. In each precast element 2, the first ribs 2b comprise joining elements 7 therebelow, which connect said first ribs 2b to the lower slab 2a; these joining elements 7, which are a part of the first ribs 2b, facilitate the positioning of the reinforcements that are comprised within said precast element 2, and particularly the positioning of the strands 11. In each of the precast elements 2 the first connecting reinforcements 2c consist of brackets, and the second connecting reinforcements 2d consist of the ends of a mesh that, in the middle part thereof, is embedded in the lower slab 2a. The deck 1 is supported by structural elements 8 each of which consists of an inverted T-shaped section

beam made of precast prestressed concrete; the structural elements 8 support both the precast elements 2 during the first step of the method for making the deck 1 (see below), and the deck 1 when the making of the latter has been completed.

[0017] It should be noted that in Fig. 7 and 8, for simplicity of illustration, the relevant structural element 8 has not been depicted.

[0018] The method for making the deck 1 with flat intrados precast elements is described below. This method comprises the following steps:

- First step: the precast elements 2 of prestressed concrete, which had been previously made in a factory for the production of precast elements, are placed on site; the precast elements 2 are placed by positioning them with the ends thereof on the structural elements 8 supporting the deck 1; each precast element 2 is self-bearing during the steps of casting the (cast-in-situ) concrete 4 at the end of the first step of the method each precast element 2 is positioned with the ends thereof at the load-bearing structural elements 8; the lightweight elements 3a, 3b are placed at the extrados of the lower slab 2a of the precast elements 2; the precast elements 2 are placed next to each other, such that the longitudinal joints 6 between adjoining precast elements 2 are provided;
- second step: the adding reinforcements 10 are placed; said adding reinforcements 10 comprise, *inter alia,* the transversal coupling reinforcements 5 that are placed proximate to the longitudinal joints 6 between two adjoining precast elements 2; the coupling reinforcements 5 consist of brackets (each of which is made of one or two parts) and comprise transversal parts that are arranged proximate to the extrados of the lower slab 2a of said adjoining precast elements 2;
- third step: the concrete 4 is cast on site thereby making the upper slab 4a and the second ribs 4b; at the end of the third step of the method, the second ribs 4b are arranged at the longitudinal joints 6 between the two adjoining precast elements 2; at each one of the second ribs 4b the two adjoining precast elements 2 are joined to each other by means of the coupling reinforcements 5 and of the second connecting reinforcements 2d; the second connecting reinforcements 2d projecting above the extrados of the lower slab 2a and the coupling reinforcements 5 are embedded in the cast-in-situ concrete 4; at the end of the third step of the method, after the cast-in-situ concrete 4 has suitably cured, the first ribs 2b and the second ribs 4b are connected to the upper slab 4a by means of the first connecting reinforcements 2c, the second connecting reinforcements 2d and the coupling reinforcements 5.

[0019] It should be understood that the shape of the cross-section of each of the precast elements 2 and particularly the presence of the two first ribs 2b provides that the precast element 2, when the concrete 4 is being cast in place, is endowed with sufficient stability against torsional actions; it is understood that, under particular conditions, temporary and/or permanent retainers (not shown in the drawings) should be provided, which are suitable to provide the stability of the precast element 2 at the suitable safety index, even in most severe conditions.

[0020] It should be understood that the precast elements 2 are made in a factory for the production of precast elements, on a prestressing bed at which the above-mentioned pre-tensioned strands 11 are placed (*inter alia*), by casting the concrete with which the lower slab 2a and the first ribs 2b are simultaneously made. Subsequently, after said concrete has reached a suitable curing level, the prestressing forces are applied to the precast elements 2, by shortening the hydraulic stressing jacks placed at the anchoring heads of said prestressing bed.

[0021] With reference to Fig. 9 and 10, a deck 20 with flat intrados precast elements is described, which is obtained according to the present invention, according to another embodiment. This deck 20 is one of the floors of a commercial building. The deck 20 comprises flat intrados precast elements 21 of prestressed concrete, lightweight elements 22a, 22b and parts of cast-in-situ concrete 23. Each of the precast elements 21 comprises a lower slab 21a, two first ribs 21b arranged above the lower slab 21a, an upper flange 21e, first connecting reinforcements 21c projecting above the two first ribs 21b and second connecting reinforcements 21d arranged at the longitudinal edges of the precast element 21, which are partially embedded in the concrete of the lower slab 21a and projecting above the extrados of the lower slab 21a; in each of the precast elements 21, the upper flange 21e, together with the two first ribs 21b and with that part of lower slab 21a which is comprised between the outer wires of the two first ribs 21b, provides a closed section; the two first ribs 21b and the upper flange 21e are integral with each other; a portion of each of the first ribs 21b is made simultaneously with the lower slab 21a. Each precast element 21 is self-bearing during the steps of casting the cast-in-situ concrete 23; the precast elements 21 are placed next to each other so that longitudinal joints 25 are provided between adjoining precast elements 21; at each of the longitudinal joints 25, between two adjoining precast elements 21, coupling reinforcements 24 are provided which comprise transversal parts arranged proximate to the extrados of the lower slab 21a of said two adjoining precast elements 21.

[0022] Said parts of cast-in-situ concrete 23 comprise an upper slab 23a and second ribs 23b arranged at the longitudinal joints 25 between the adjoining precast elements 21; at each of the second ribs 23b the two adjoining precast elements 21 are joined to each other by means of the coupling reinforcements 24 and of the second connecting reinforcements 21d; the second connecting re-

inforcements 21d projecting above the extrados of the lower slab 21a and the coupling reinforcements 24 (arranged at said second rib 23b) are embedded in said parts of cast-in-situ concrete 23; the height of the second ribs 23b is more than twice the height of the lower slab 21a of the precast elements 21; the lightweight elements 22a, 22b have the intrados arranged at the extrados of the lower slab 21a of the precast elements 21; the first ribs 21b and second ribs 23b are connected to the upper slab 23a by means of the first connecting reinforcements 21c, second connecting reinforcements 21d and coupling reinforcements 24.

[0023] The deck 20 also comprises adding reinforcements 26 that are placed on site and embedded within the cast-in-situ concrete 23.

[0024] The method for making the deck 20 is technically equivalent to the above-described method for making the deck 1.

[0025] It should be understood that the precast elements 21 are made in a factory for the production of precast elements, on a prestressing bed at which the pretensioned prestressing reinforcements (*inter alia*) are placed. A concrete cast is first carried out, with which the lower slab 21a and said portion of the first ribs 21b are made; this portion of the first ribs 21b has the extrados arranged at the same level as the intrados of the upper flange 21e, not yet made; subsequently, after the positioning of the lightweight elements 22a and of additional reinforcements that then remain embedded in the concrete of the upper flange 21e, the remaining portion of the first ribs 21b and the upper flange 21e are then made, by means of a further concrete cast. After the concrete has reached a suitable curing degree, the prestressing forces are applied to the precast elements 21, by shortening the hydraulic stressing jacks arranged at the anchoring heads of said prestressing bed.

[0026] It should be understood that the upper flange 21e of each precast element 21 is made before casting the cast-in-situ concrete 23.

[0027] The precast elements 21 are provided with a considerable torsional rigidity which is given to them by the closed (cross) section formed by the upper flange 21e, by the two first ribs 21b and by that part of lower slab 21a which is arranged at the first ribs 21b and is comprised within the outer wires of said two first ribs 21b.

[0028] With reference to Fig. 11, 12, 13, 14, 15 and 16 a deck 40 is described with flat intrados precast elements, which is obtained according to the present invention, according to another embodiment. This deck 40 is one of the floors of a commercial building.

[0029] The deck 40 comprises flat intrados precast elements 41 of prestressed concrete, flat intrados precast elements 47 of prestressed concrete, lightweight elements 42a, 42b, plates 46 and parts of cast-in-situ concrete 43. Each of the precast elements 41 comprises a lower slab 41a, two first ribs 41b which are arranged above the lower slab 41a, first connecting reinforcements 41c projecting above the two first ribs 41b and second connecting reinforcements 41d arranged at the longitudinal edges of the precast element 41, which reinforcements are partially embedded in the concrete of the lower slab 41a and projecting above the extrados of the lower slab 41a; the first ribs 41b are made simultaneously with the lower slab 41a.

[0030] Each of the precast elements 47 comprises a lower slab 47a, two first ribs 47b arranged above the lower slab 47a, first connecting reinforcements 47c which project above the two first ribs 47b and second connecting reinforcements 47d arranged at the longitudinal edges of the precast element 47, which reinforcements are partially embedded in the concrete of the lower slab 47a and projecting above the extrados of the lower slab 47a; the first ribs 47b are made simultaneously with the lower slab 47a. Each precast element 41 and each precast element 47 is self-bearing during the steps of casting the cast-in-situ concrete 43. Longitudinal joints 45 are provided between adjoining precast elements 41; a longitudinal joint 45 is further provided between each precast element 41 and each precast element 47 adjoining thereto; at each of the longitudinal joints 45 coupling reinforcements 44 are provided, which comprise transversal parts arranged proximate to the extrados of the lower slab 41a of said two adjoining precast elements 41, or of the lower slab 41a and of the lower slab 47a respectively of a precast element 41 and of a precast element 47 adjoining thereto. The precast elements 47 are placed sequentially and have the longitudinal axes arranged on a same straight line.

[0031] Said parts of cast-in-situ concrete 43 comprise an upper slab 43a and second ribs 43b arranged at the longitudinal joints 45. At each of the second ribs 43b arranged between due adjoining precast elements 41, the two adjoining precast elements 41 are joined to each other by means of the coupling reinforcements 44 and of the second connecting reinforcements 41d; the second connecting reinforcements 41d projecting above the extrados of the lower slab 41a and the coupling reinforcements 44 are embedded in said parts of cast-in-situ concrete 43. At each of the second ribs 43b arranged between a precast element 41 and a precast element 47 adjoining to each other, the precast element 41 and the precast element 47 adjoining to each other are joined to each other by means of the coupling reinforcements 44, of the second connecting reinforcements 41d and of the second connecting reinforcements 47d; the second connecting reinforcements 41d projecting above the extrados of the lower slab 41a, the second connecting reinforcements 47d projecting above the extrados of the lower slab 47a and the coupling reinforcements 44 are embedded in said parts of cast-in-situ concrete 43. The height of the second ribs 43b is more than twice the height of the lower slab 41a of the precast elements 41 (this thickness is equal to the thickness of the lower slab 47a of the precast elements 47); the lightweight elements 42a, 42b have the intrados arranged at the extrados of the lower slab 41a of the precast elements 41. The first

ribs 41b, 47b and the second ribs 43b are connected to the upper slab 43a by means of the first connecting reinforcements 41c, the second connecting reinforcements 41d, the first connecting reinforcements 47c, the second connecting reinforcements 47d and the coupling reinforcements 44.

[0032] The deck 40 also comprises adding reinforcements 52 which comprise bars, meshes and the coupling reinforcements 44. The adding reinforcements 52 are placed on site and embedded within the cast-in-situ concrete 43.

[0033] The deck 40 is supported by structural elements 53 each of which consists of a precast beam of prestressed concrete with inverted T-shaped section;

[0034] The structural elements 53 support both the precast elements 41, 47 during the first step of the method for making both the deck 40 (see below), and the deck 40 when the latter has been completed.

[0035] It should be noted that in Fig. 15 and 16, for simplicity of illustration, the relevant structural element 53 has not been shown.

[0036] The deck 40 further comprises the plates 46, with a function of disposable formwork, which are sequentially arranged at the precast elements 47. It should be noted that in Fig.11 only some of the plates 46 are shown. It should be also noted that in Fig.16 one of the plates 46 is also illustrated.

[0037] With reference to each of the precast elements 47 the following is pointed out: each of the plates 46 arranged at said precast element 47 is positioned, with the ends thereof, at the extrados of the two first ribs 47b; the intrados of the plates 46, the two adjacent faces of the two first ribs 47b and the intrados of that part of the lower slab 47a which is comprised between said two first ribs 47b define a channel 48, which is arranged within the deck 40; the channel 48 results to be accessible through openings 49 provided in the lower slab 47a in the part comprised between the two first ribs 47b; the openings 49 provided in the lower slab 47a are closed by means of closure elements 51 made of sheet steel and placed at sheet steel frames 50 each of which is arranged on the perimeter of the corresponding opening 49. It should be noted that, in each of the precast elements 47 the channel 48 can be normally used for passing tubing or installations therein; the channel 48 may also be normally used as channeling for the conditioning system; in this case, in addition to the openings 49 also other openings are provided in which diffuser elements (outlets) are placed for venting the air treated by the channel 48. It is understood that, depending on the different cases and conditions, it is required that the structural elements 53 supporting the deck 40 are provided with the holes that are required for providing the communication between the channels 48 that are provided in the several precast elements 47.

[0038] The method for making the deck 40 is technically equivalent to the method for making the deck 1 as described above.

[0039] It should be understood that during the second step of the method for making the deck 40, at each precast element 47, the plates 46 are placed which have the function of disposable formwork. With reference to each of the precast elements 47 it should be pointed out that: each of the plates 46 is positioned with the ends thereof on the extrados of the two first ribs 47b; the intrados of the plates 46, the two adjacent faces of the two first ribs 47b and the intrados of that part of the lower slab 47a which is comprised between said two first ribs 47b define the channel 48.

[0040] The casting of the cast-in-situ concrete 43 is then carried out.

[0041] Generally, the precast elements comprised in a deck obtained according to the present invention can be provided with more than two first ribs; it should be noted that two first ribs are normally used.

[0042] A deck with flat intrados precast elements obtained according to the present invention can be supported by precast I-shaped, inversed T-shaped, etc., beams of prestressed concrete, or can be supported by mixed lattice beams of steel and concrete, or can be supported by concrete beams made on site.

[0043] It should be understood that in a deck with flat intrados precast elements obtained according to the present invention each of the precast elements can be positioned on the beam even using a cantilever support.

[0044] The lightweight elements, such as the lightweight elements 3a, 3b, are preferably placed at the extrados of the lower slab of the precast elements when the concrete with which the precast element has been made is still wet. Alternatively, these lightweight elements can be placed after the precast elements have been made, however paying attention to join, using means, the lightweight elements to the precast elements.

[0045] The lightweight elements comprised in a deck with flat intrados precast elements can also be made using, in addition to foamed polystyrene, other suitable materials.

[0046] It should be understood that in the present disclosure and in the drawings attached thereto, the lift inserts, which are provided in the precast elements comprised in the decks as obtained according to the present invention, as well as the inserts for venting the gases that can be originated from the lightweight elements in case of fire are not shown.

[0047] The flat intrados precast elements used in the decks obtained according to the present invention are normally made of prestressed concrete by means of adhering pre-tensioned strands; it is however possible that flat intrados precast elements used in the decks obtained according to the present invention are made of reinforced concrete.

[0048] It should be understood that a deck with intrados precast elements obtained according to the present invention can also have considerable heights since the precast elements (that are comprised therein) may have considerable heights and since that the upper slab of

cast-in-situ concrete may, depending on the case and as required, also have great thicknesses.

[0049] The decks with flat intrados precast elements obtained according to the present invention can be used for making floors and generally joints of an office building, a residential building, a commercial building, a parking building, a sports building, etc.. The decks with flat intrados precast elements obtained according to the present invention can be also advantageously used as covering floors for buildings in general. The decks with flat intrados precast elements obtained according to the present invention can be also used even in the presence of large spans and/or loads, and particularly in the presence of loads deriving from the transit of vehicles.

[0050] An advantage of the present invention is that the precast elements comprised in a deck (as obtained according to the present invention) are self-bearing and allow avoiding expensive strutting on site.

[0051] A further advantage of the present invention is that the normal placement on site of the precast elements (comprised in a deck with flat intrados precast elements (as obtained according to the present invention) and the subsequent step of casting the cast-in-situ concrete, result to be sufficiently quick and easy.

[0052] A further advantage of the present invention is that a deck (as obtained according to the present invention) is provided with a small value of heat transmission rate.

[0053] A further advantage of the present invention is that the strains of a deck with flat intrados precast elements (as obtained according to the present invention) are normally of a small extent.

[0054] A further advantage of the present invention is that a deck with flat intrados precast elements (as obtained according to the present invention) can be considered to be sufficiently light, if the performance thereof are duly taken into account.

Claims

1. A method for making a deck with flat intrados precast elements comprising the following steps:

   - first step: concrete precast elements (2, 21, 41, 47) are placed on site, which had been previously made in a factory for the production of precast elements; said precast elements (2, 21, 41, 47) are placed by positioning them with the ends thereof on structural elements (8, 53) which support the deck (1, 20, 40); each precast element (2, 21, 41, 47) has a flat intrados and is self-bearing during the steps of casting the cast-in-situ concrete (4, 23, 43); **characterized in that** each of said precast elements (2, 21, 41, 47) comprises a lower slab (2a, 21a, 41a, 47a), first ribs (2b, 21b, 41b, 47b) arranged above said lower slab (2a, 21a, 41a, 47a), first connecting reinforcements (2c, 21c, 41c, 47c) projecting above said first ribs (2b, 21b, 41b, 47b) and second connecting reinforcements (2d, 21d, 41d, 47d) arranged at the longitudinal edges of said precast element (2, 21, 41, 47), which reinforcements are partially embedded in the concrete of the lower slab (2a, 21a, 41a, 47a) and projecting above the extrados of said lower slab; at least one portion of each of said first ribs (2b, 21b, 41b, 47b) has been made simultaneously with said lower slab (2a, 21a, 41a, 47a); at the end of the first step of the method each of said precast elements (2, 21, 41, 47) is supported with the ends thereof at said load-bearing structural elements (8, 53); at the extrados of the lower slab (2a, 21a, 41a, 47a) of said precast elements (2, 21, 41, 47) lightweight elements (3a, 3b, 22a, 22b, 42a, 42b) are placed; the precast elements (2, 21, 41, 47) are placed next to each other, so that longitudinal joints (6, 25, 45) are provided between adjoining precast elements (2, 21, 41, 47);
   - second step: the adding reinforcements (10, 26, 52) are placed; said adding reinforcements (10, 26, 52) also comprise transversal coupling reinforcements (5, 24, 44) which are placed at said longitudinal joints (6, 25, 45) between two adjoining precast elements (2, 21, 41, 47); said coupling reinforcements (5, 24, 44) comprise transversal parts arranged proximate to the extrados of the lower slab (2a, 21a, 41a, 47a) of said adjoining precast elements (2, 21, 41, 47);
   - third step: the casting of concrete (4, 23, 43) is carried out on site thereby making an upper slab (4a, 23a, 43a) and second ribs (4b, 23b, 43b); said second ribs (4b, 23b, 43b) are arranged at the longitudinal joints (6, 25, 45) between two adjoining precast elements (2, 21, 41, 47); at each of said second ribs (4b, 23b, 43b) the two adjoining precast elements (2, 21, 41, 47) are joined to each other by means of said coupling reinforcements (5, 24, 44) and of said second connecting reinforcements (2d, 21d, 41d, 47d); said second connecting reinforcements (2d, 21d, 41d, 47d) projecting above the extrados of the lower slab (2a, 21a, 41a, 47a) and said coupling reinforcements (5, 24, 44) are embedded in the cast-in-situ concrete (4, 23, 43); at the end of said third step of the method, after the cast-in-situ concrete (4, 23, 43) has suitably cured, the first ribs (2b, 21b, 41b, 47b) and the second ribs (4b, 23b, 43b) are connected to the upper slab (4a, 23a, 43a) by means of the first connecting reinforcements (2c, 21c, 41c, 47c), the second connecting reinforcements (2d, 21d, 41d, 47d) and the coupling reinforcements (5, 24, 44).

2. The method according to claim 1) **characterized in that** during the second step of said method, at one or more precast elements (47), plates (46) are placed which have the function of disposable formwork; in each of said one or more precast elements (47), each of the plates (46) is positioned at the extrados of two adjoining first ribs (47b); the intrados of the plates (46), the two adjacent faces of the two first ribs (47b) and the intrados of that part of lower slab (47a) which is comprised between said adjoining two first ribs (47b), define a channel (48).

3. A deck with flat intrados precast elements as obtained according to the method of claim 1), comprising concrete flat intrados precast elements (2, 21, 41, 47), lightweight elements (3a, 3b, 22a, 22b, 42a, 42b) and parts of cast-in-situ concrete (4, 23, 43), **characterized in that** each of said precast elements (2, 21, 41, 47) comprises a lower slab (2a, 21a, 41a, 47a), first ribs (2b, 21b, 41b, 47b) placed above said lower slab (2a, 21a, 41a, 47a), first connecting reinforcements (2c, 21c, 41c, 47c) projecting above said first ribs (2b, 21b, 41b, 47b) and second connecting reinforcements (2d, 21d, 41d, 47d) placed at the longitudinal edges of said precast element (2, 21, 41, 47), which reinforcements are partially embedded in the concrete of the lower slab (2a, 21a, 41a, 47a) and projecting above the extrados of said lower slab; at least one portion of each of said first ribs (2b, 21b, 41b, 47b) is made simultaneously with said lower slab (2a, 21a, 41a, 47a); each precast element (2, 21, 41, 47) is self-bearing during the casting of said cast-in-situ concrete (4, 23, 43); the precast elements (2, 21, 41, 47) are placed next to each other so that longitudinal joints (6, 25, 45) are provided between adjoining precast elements (2, 21, 41, 47); at each of said longitudinal joints (6, 25, 45) between two adjoining precast elements (2, 21, 41, 47) coupling reinforcements (5, 24, 44) are provided which comprise transversal parts placed proximate to the extrados of the lower slab (2a, 21a, 41a, 47a) of said adjoining precast elements (2, 21, 41, 47); said parts of cast-in-situ concrete (4, 23, 43) comprise an upper slab (4a, 23a, 43a) and second ribs (4b, 23b, 43b) arranged at the longitudinal joints (6, 25, 45) between the adjoining precast elements (2, 21, 41, 47); at each of said second ribs (4b, 23b, 43b) the two adjoining precast elements (2, 21, 41, 47) are joined to each other by means of said coupling reinforcements (5, 24, 44) and of said second connecting reinforcements (2d, 21d, 41d, 47d); said second connecting reinforcements (2d, 21d, 41d, 47d) projecting above the extrados of the lower slab (2a, 21a, 41a, 47a) and said coupling reinforcements (5, 24, 44) are embedded in said parts of cast-in-situ concrete (4, 23, 43); the lightweight elements (3a, 3b, 22a, 22b, 42a, 42b) have the intrados positioned at the extrados of the lower slab (2a, 21a, 41a, 47a) of the precast elements (2, 21, 41, 47); said first ribs (2b, 21b, 41b, 47b) and said second ribs (4b, 23b, 43b) are connected to the upper slab (4a, 23a , 43a) by means of the first connecting reinforcements (2c, 21c, 41c, 47c), second connecting reinforcements (2d, 21d, 41d, 47d) and coupling reinforcements (5, 24, 44).

4. The deck with flat intrados precast elements according to claim 3), **characterized in that** the height of the second ribs (4b, 23b, 43b) is more than twice the height of the lower slab (2a, 21a, 41a, 47a) of said precast elements (2, 21, 41, 47).

5. The deck with flat intrados precast elements according to claim 3), **characterized in that** each precast element (21) also comprises an upper flange (21e) integral with the upper ends of two of the first ribs (21b); said upper flange (21e) is made before casting the cast-in-situ concrete (23).

6. The deck with flat intrados precast elements according to claim 3) **characterized in that** each of the precast elements (2, 21, 41, 47) comprises two first ribs (2b, 21b, 41b, 47b).

7. The deck with flat intrados precast elements according to claim 3) **characterized in that** it comprises at least one or more plates (46) having the function of disposable formwork, which are positioned at one or more precast elements (47); in each of said one or more precast elements (47), each of the one ore more plates (46) arranged at said precast element (47) is positioned with the ends thereof on the extrados of two adjoining first ribs (47b); the intrados of said plates (46), the two adjacent faces of said two adjoining first ribs (47b) and the intrados of that part of lower slab (47a) which is comprised between said two adjoining first ribs (47b) define a channel (48), which is arranged within the deck (40); said channel (48) results to be accessible through openings (49) that are provided in said lower slab (47a) **in that** part which is comprised between said two first ribs (47b).

8. The deck with flat intrados precast elements according to claim 3) **characterized in that** in each precast element (2, 21, 41, 47) the first ribs (2b, 21b, 41b, 47b) comprise joining elements (7) therebelow, which connect said first ribs to the lower slab (2a, 21a, 41a, 47a).

9. The deck with flat intrados precast elements according to claim 3) **characterized in that** each precast element (2, 21, 41, 47) is prestressed by means of pre-tensioned adhering strands (11).

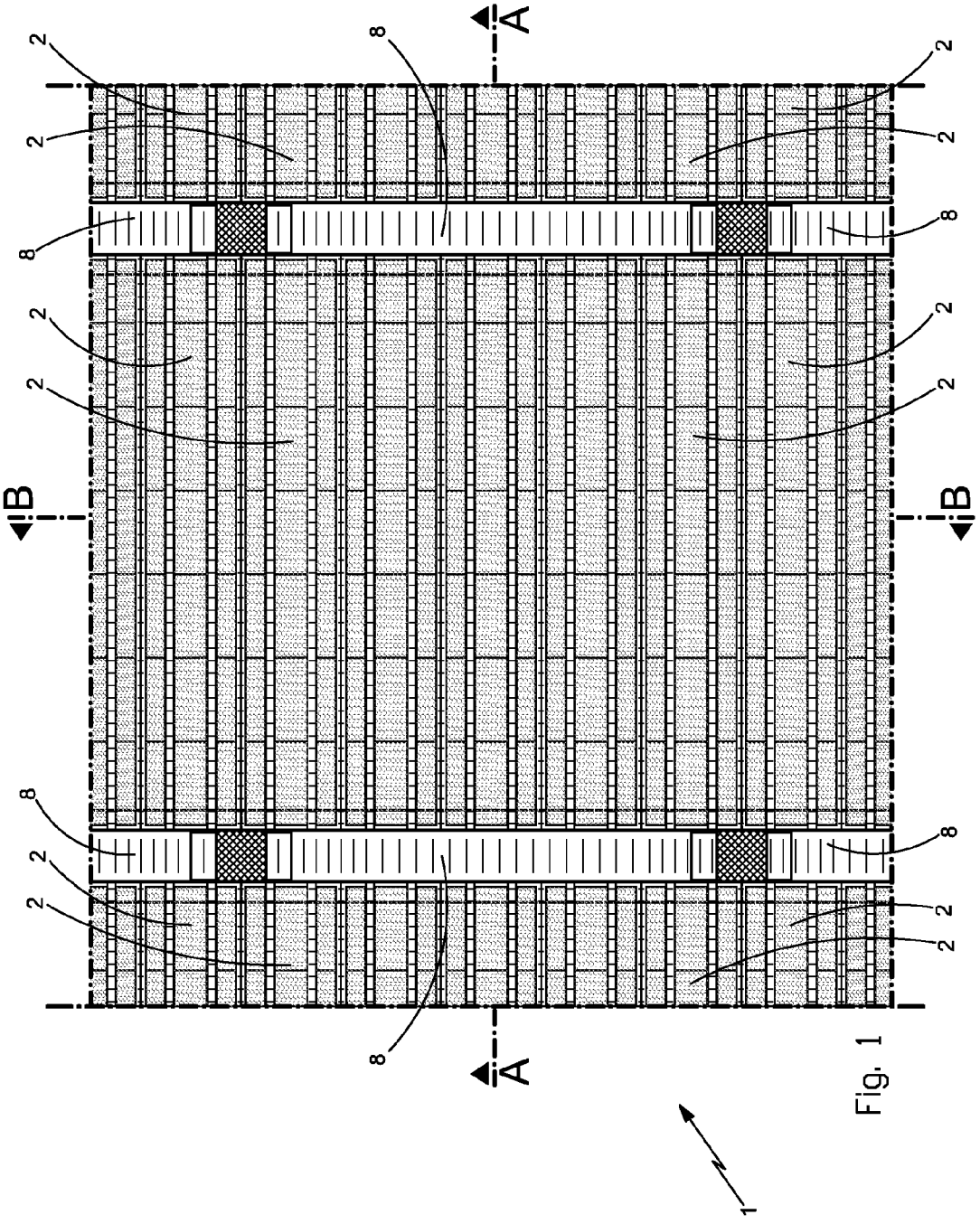


Fig. 1

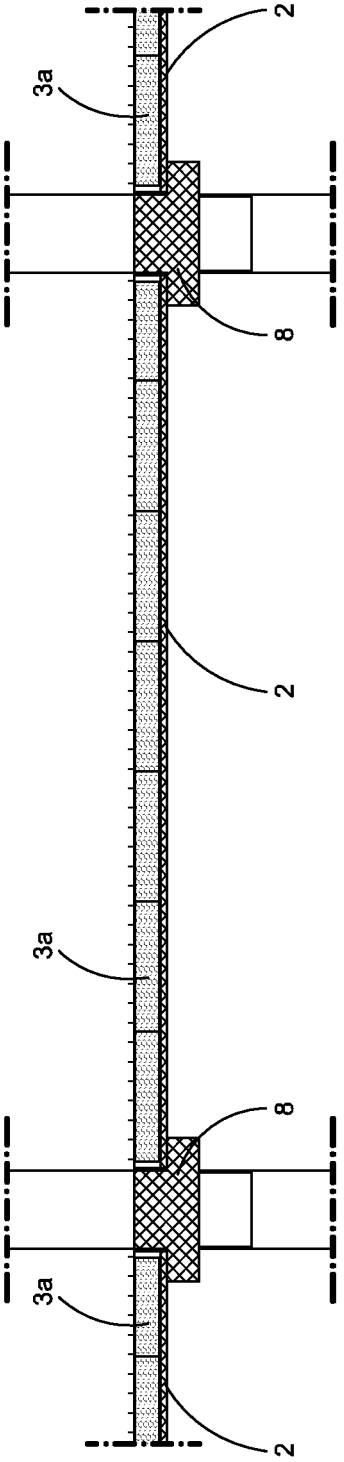


Fig. 2

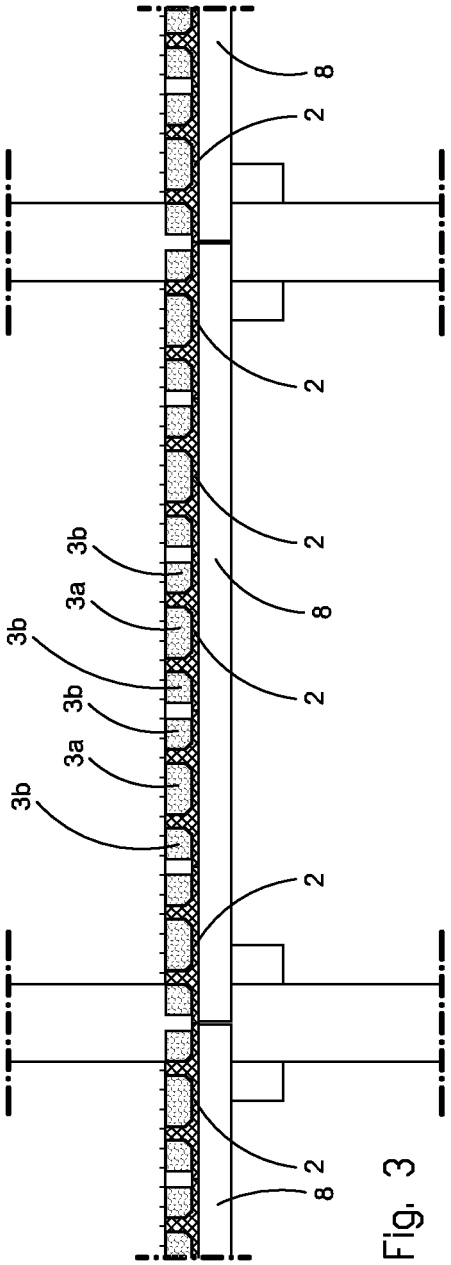


Fig. 3

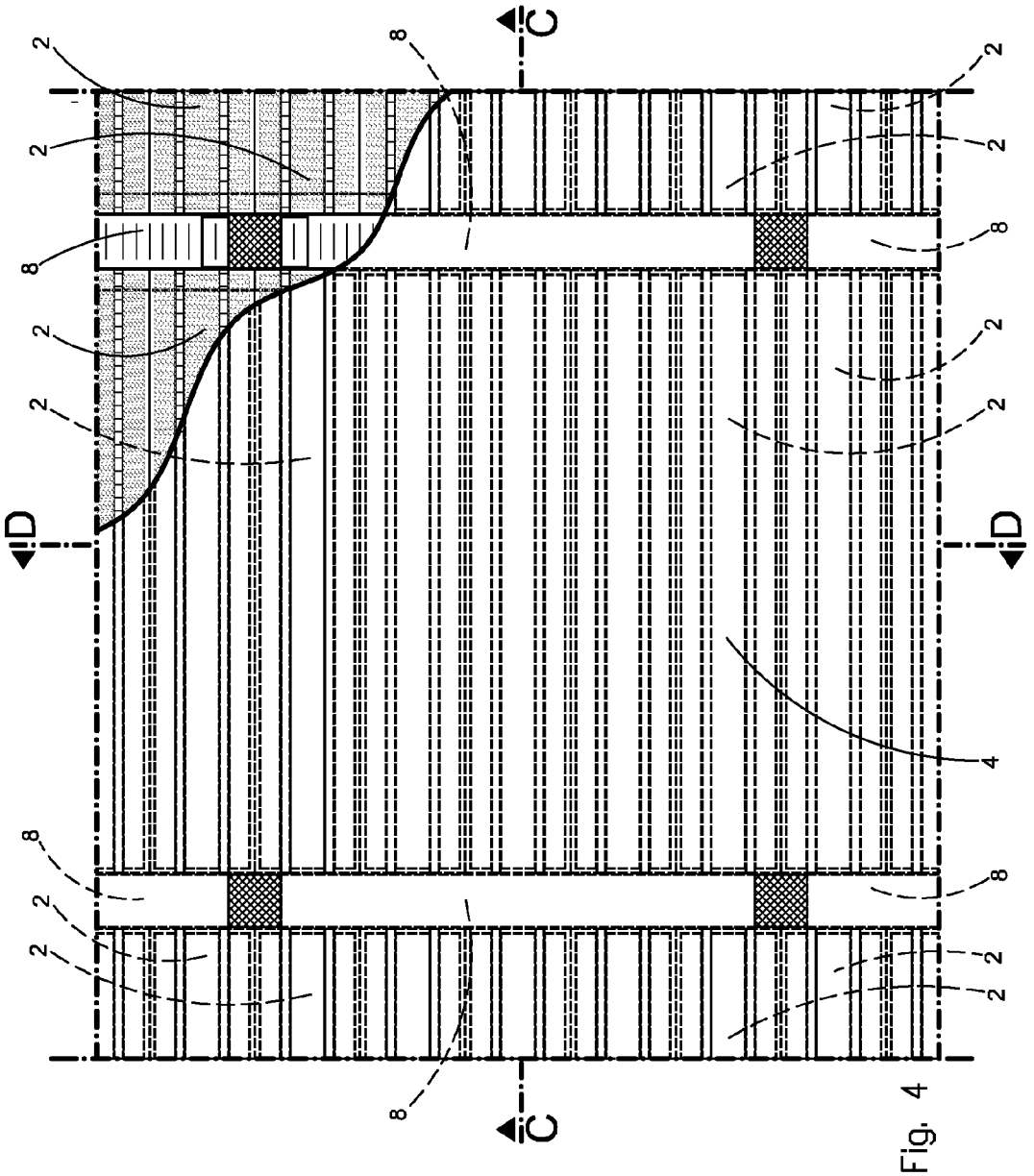


Fig. 4

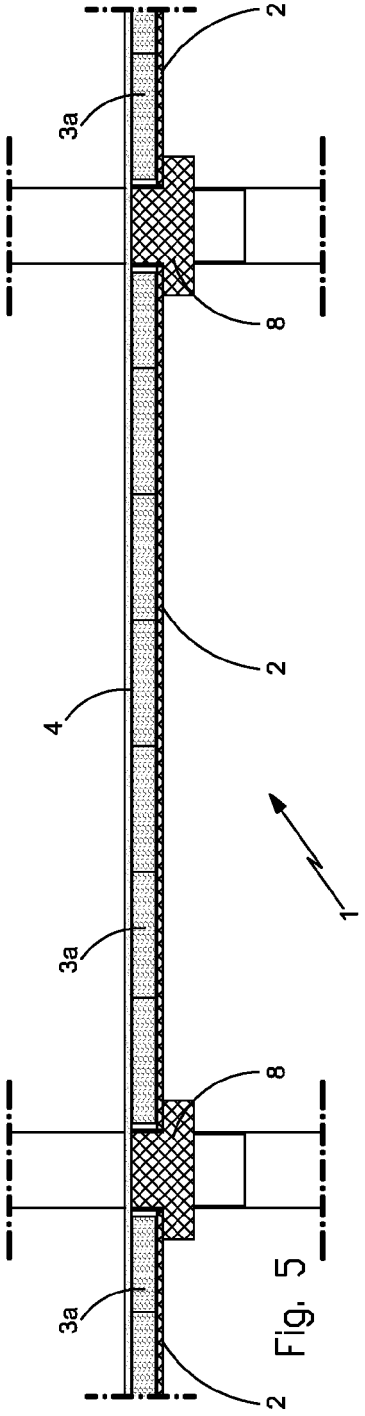


Fig. 5

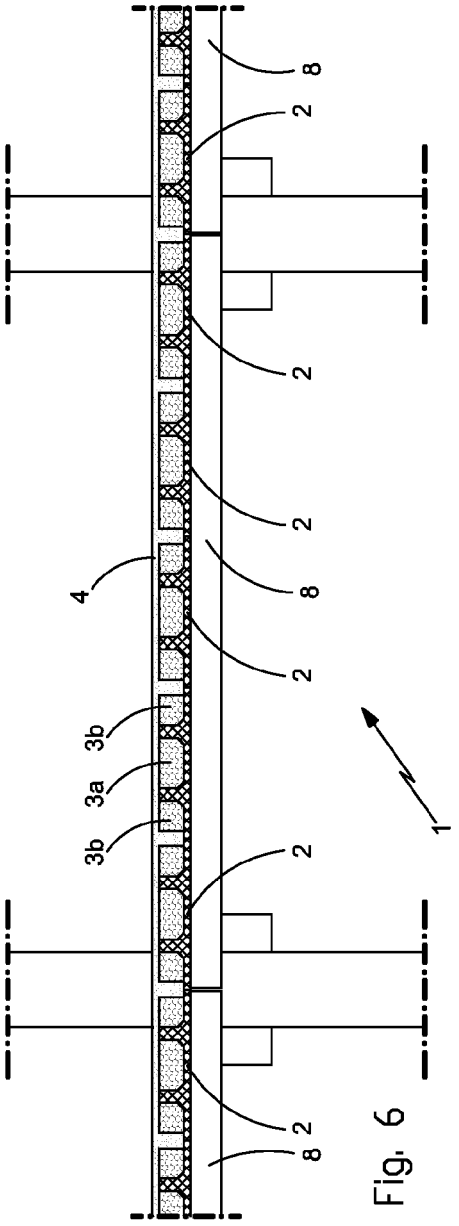


Fig. 6

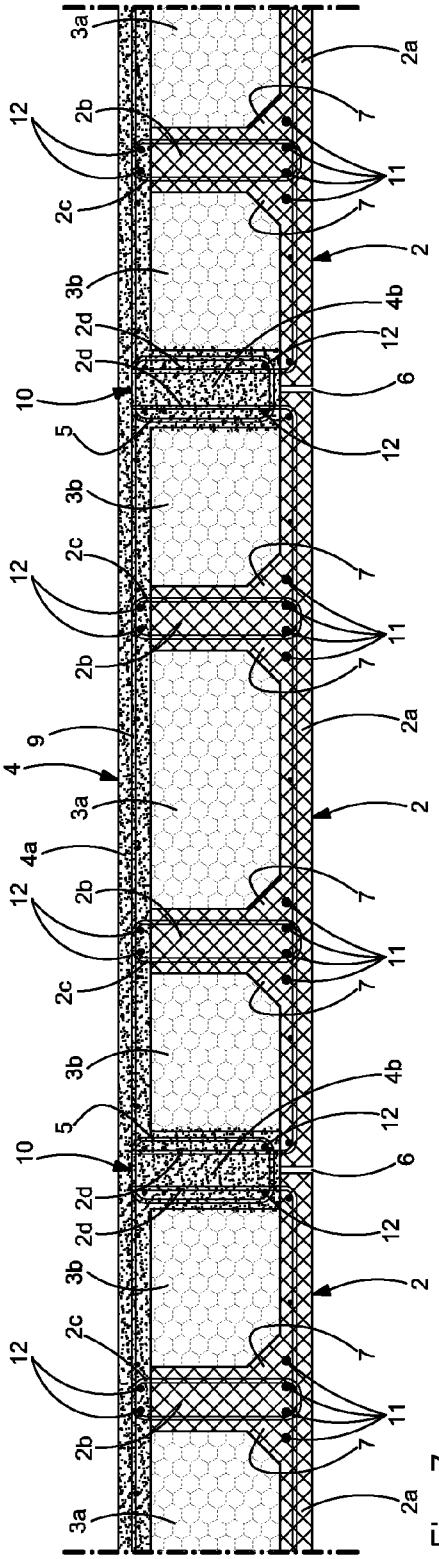


Fig. 7

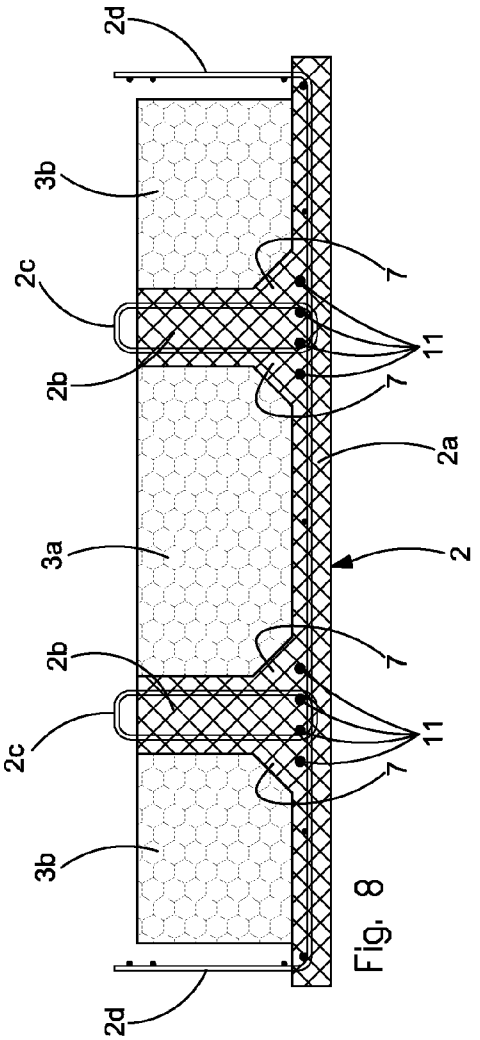


Fig. 8

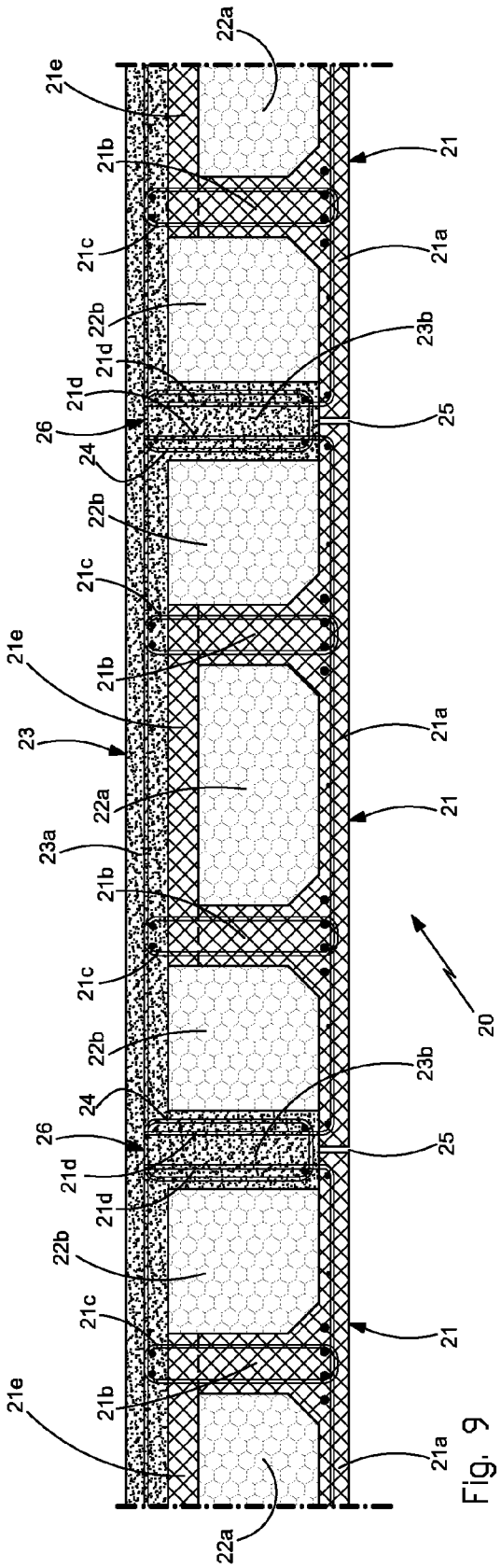
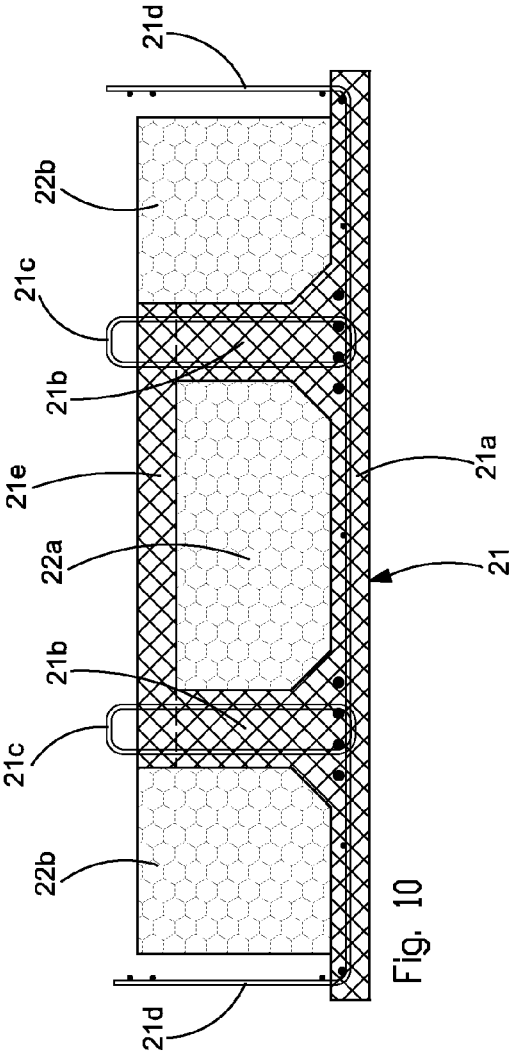

22a
21e
21b
21c
21d
21
21a
22b
23b
25
26
24
23
23a
20

Fig. 9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22b
21c
21b
21e
21a
22a
21

Fig. 10

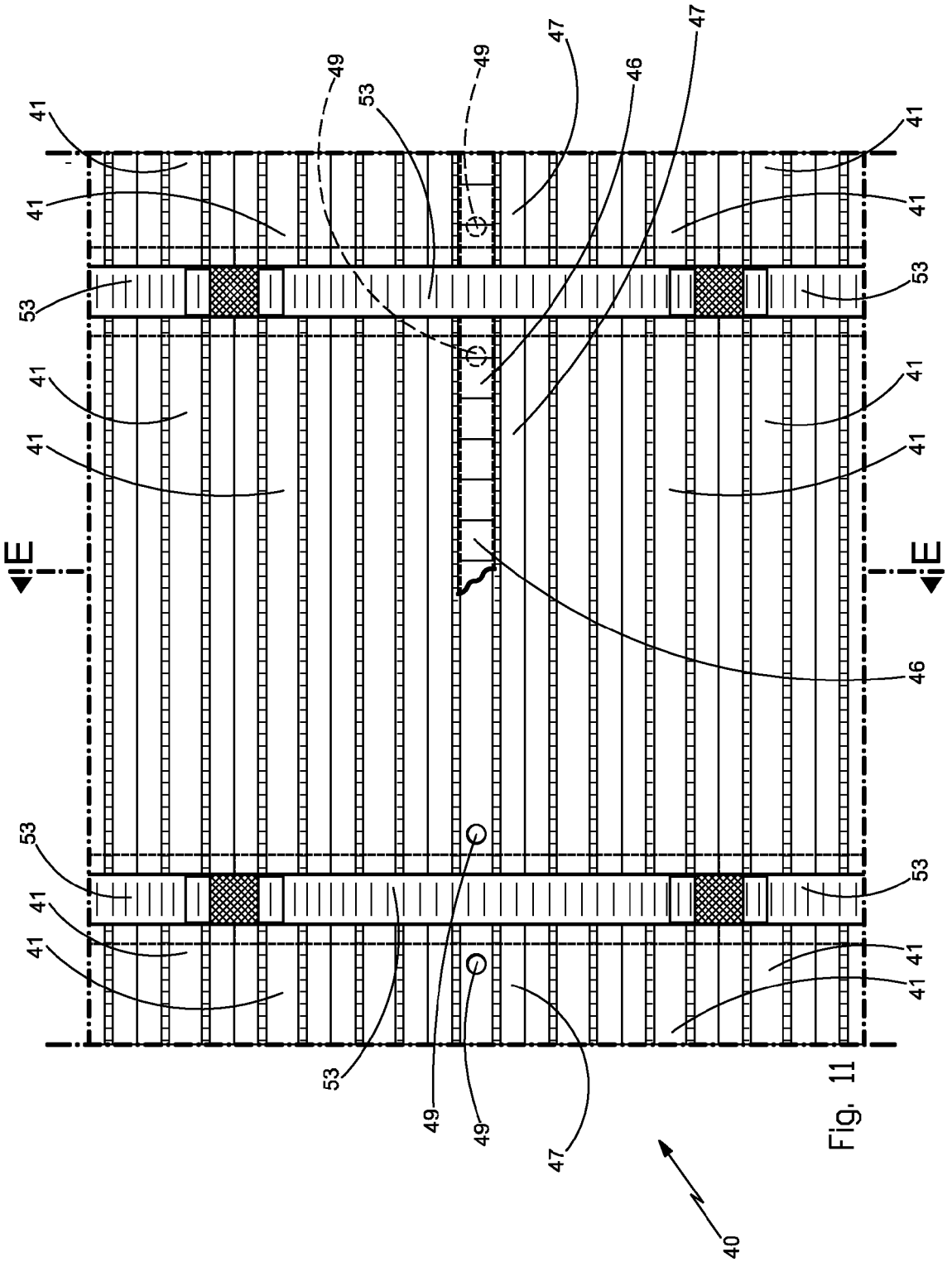


Fig. 11

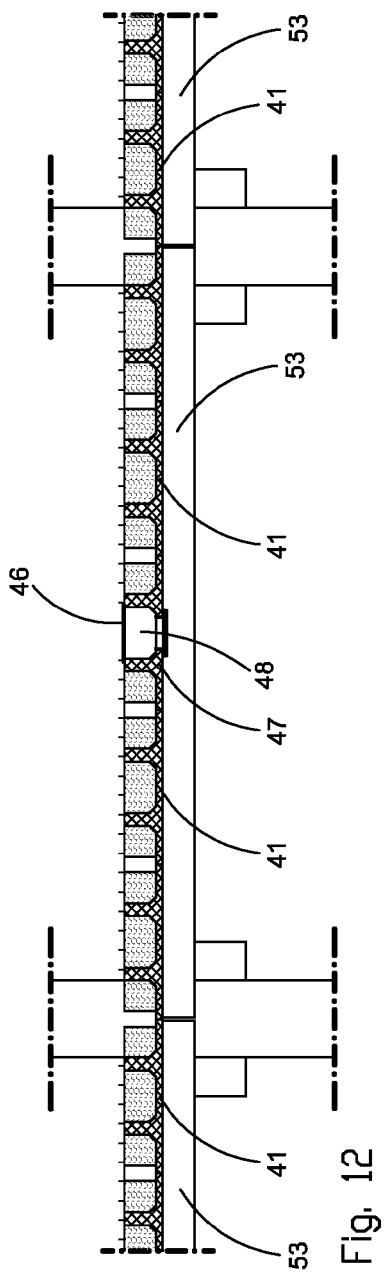


Fig. 12

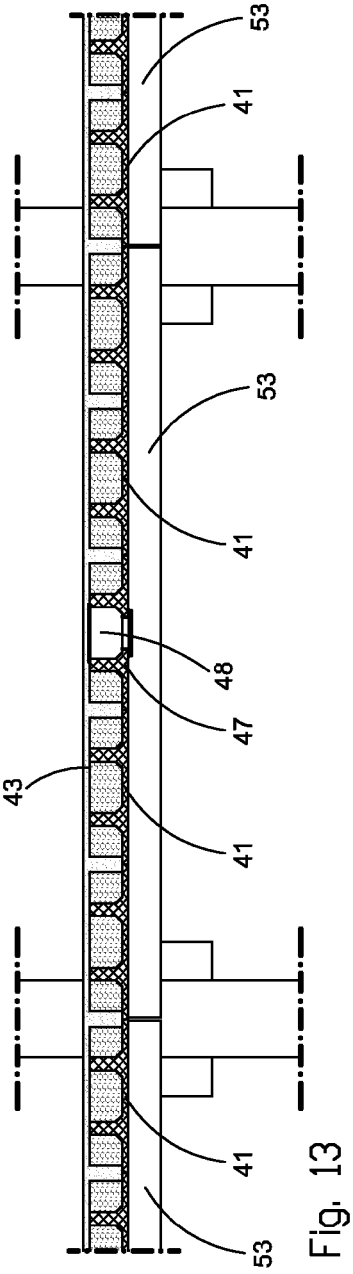


Fig. 13

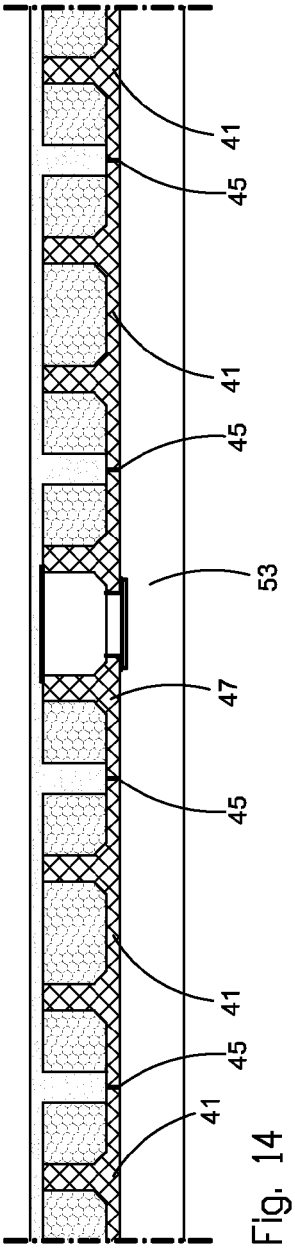
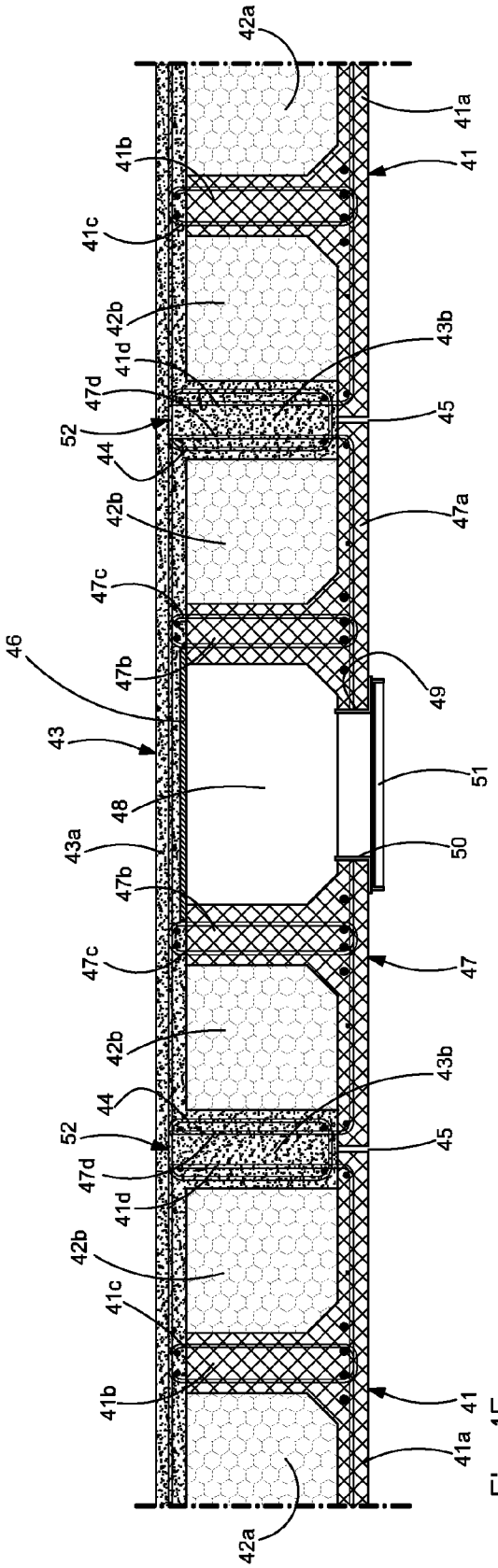


Fig. 14


42a
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41b
41
41c
42b
43b
41d
47d
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44
47a
47c
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47b
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48
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43a
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41c
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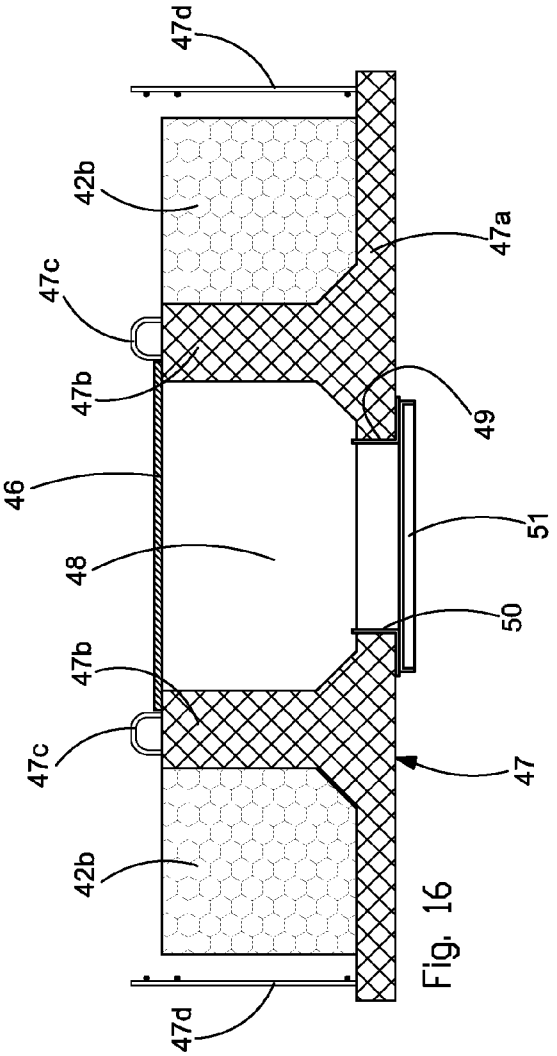
41a
42a

Fig. 15


47d
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47c
47b
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51
48
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47b
47c
47
42b
47d

Fig. 16

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EUROPEAN SEARCH REPORT

Application Number
EP 10 19 1827

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	DE 295 18 718 U1 (WACON GMBH [DE]) 25 January 1996 (1996-01-25) * page 3, line 8 - page 4, line 17; figures 1-2 *	1,3	
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A	FR 2 669 061 A1 (TUYAUX BONNA [FR]) 15 May 1992 (1992-05-15) * the whole document *	1,3	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 March 2011	Lopes, Claudia

CATEGORY OF CITED DOCUMENTS

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