(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 464 854 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.11.2024 Bulletin 2024/47

(21) Application number: **24175638.6**

(22) Date of filing: **14.05.2024**

(51) International Patent Classification (IPC):
E04B 5/10 *(2006.01)* ***E04B 5/40*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E04B 5/40; E04B 5/10

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **16.05.2023 IT 202300009858**

(71) Applicant: **Besd Technology S.r.l.**
16121 Genova GE (IT)

(72) Inventor: **Riolfo, Alex**
16121 Genova (IT)

(74) Representative: **Perani & Partners S.p.A.**
Piazza Armando Diaz, 7
20123 Milano (IT)

(54) PREFABRICATED STRUCTURAL ELEMENT FOR THE CONSTRUCTION A SLAB OF A BUILDING

(57) The present invention relates to a prefabricated structural element (1), for the construction of a slab (100) of a building construction, comprising:
- a frame (2) peripherally delimiting the prefabricated structural element (1), defining a seat (3) inside it, and made of a plurality of frame elements (4a, 4b, 4c, 4d) connected to each other at respective connection portions (40a, 40b, 40c, 40d), each frame element (4a, 4b, 4c, 4d) extends along a longitudinal direction (L1-L1, L2-L2, L3-L3, L4-L4) between the respective connection portions (40a, 40b, 40c, 40d) and along a transversal direction (T1-T1, T2-T2, T3-T3, T4-T4) directed transversal to the longitudinal direction (L1-L1, L2-L2, L3-L3, L4-L4), each frame element (4a, 4b, 4c, 4d) comprises:
- a lower flange (41a, 41b, 41c, 41d) projecting into the seat (3) along the transverse direction (T1-T1, T2-T2, T3-T3, T4-T4),
- an upper flange (42a, 42b, 42c, 42d) projecting into the seat (3) along the transverse direction (T1-T1, T2-T2, T3-T3, T4-T4) and lying in an upper plane (PS),

- two or more support profiles (5) configured to support at least one layer (101) of the slab (100) and fixed to the lower flange (41a, 41b, 41c, 41d) of at least one of the frame elements (4a, 4b, 4c, 4d).

A characteristic of the present invention is that each frame element (4a, 4b, 4c, 4d) comprises at least one reinforcing element (6a, 6b, 6c, 6d) attached to the upper flange (42a, 42b, 42c, 42d) in such a way as to project outwardly from the upper plane (PS) and extending along the respective transverse direction (T1-T1, T2-T2, T3-T3, T4-T4) towards the cavity (3) to link the upper flange (42a, 42b, 42c, 42d) to the lower flange (41a, 41b, 41c, 41d).
[Figure Sa]

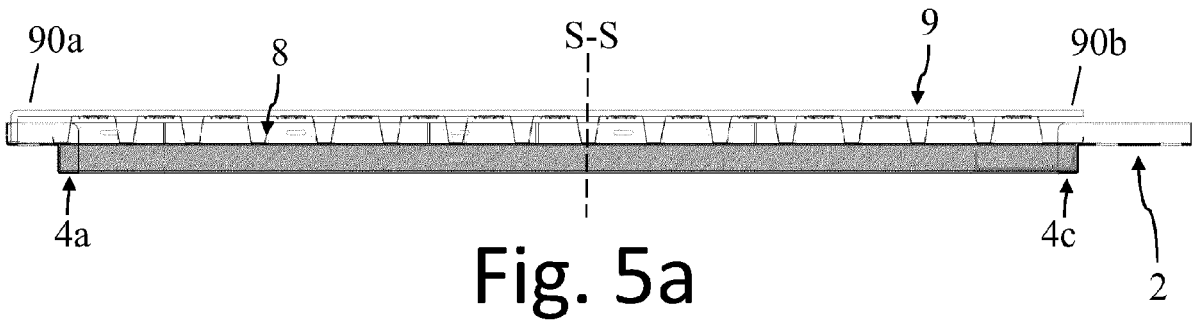


Fig. 5a

EP 4 464 854 A1

Description

Technical Field

[0001] The present invention relates to a prefabricated structural element for the construction of a slab that finds useful use in both wet and dry prefabricated construction.

[0002] It is also the object of the present invention to provide a slab comprising a plurality of such interconnected prefabricated structural elements.

State of the Art

[0003] Building prefabrication has been known for some time, that is the process for the construction of buildings by means of elements made, on site or in industry, and then mounted with strongly codified procedures.

[0004] This way of constructing buildings makes it possible to speed up the process for the construction of building structures, anticipating part of the operations that are traditionally carried out on the building site.

[0005] It is therefore evident that building prefabrication allows greater construction speeds and less uncertainty in construction times to be obtained compared to traditional construction techniques on site.

[0006] Typically, building prefabrication is carried out by realising individual building components, such as beams, columns, trusses, closure panels and the like, which are then assembled on site using binders to form the load-bearing and closing structure of the building.

[0007] Italian patent No. 102021000009668, filed by the same applicant of the present invention, describes a structural slab element comprising a frame made from a press-formed metal sheet that defines a seat within it.

[0008] This frame comprises an upper flange and an opposite lower flange. In detail, the lower flange projects into the seat and is adapted to support one or more layers of the slab, while the upper flange projects outwardly from the seat and is configured to rest on a load-bearing beam to support the slab structure element.

[0009] In prefabricated construction, there is a need to provide prefabricated elements that are as non-deformable as possible and capable of supporting high structural loads.

[0010] The upper and lower flanges of the slab structural element described in Italian document No. 102021000009668, when loaded, tend to change their mutual position, in particular to vary their mutual inclination by bending. Therefore, in order to increase the non-deformability of the slab structural element, it is necessary to reinforce the frame by using sheets with high thicknesses.

[0011] Disadvantageously, this not only increases the natural and economic resources employed, but also adds to the weight of the structural frame element, which complicates transport and installation procedures.

[0012] Moreover, disadvantageously, the high weight of the structural frame element increases the static load that must support the load-bearing structure of the building, which, in turn, will need to be strengthened using more natural and economic resources.

Object of the invention

[0013] In this context, the technical task underlying the present invention is to propose a prefabricated structural element for the construction of slabs which overcomes the drawbacks of the prior art as described above.

[0014] It is therefore the aim of the present invention to make available a prefabricated structural element for the construction of slabs with a high degree of stiffness and non-deformability with respect to known ones.

[0015] In particular, it is the purpose of the present invention to make available a prefabricated structural element for the construction of slabs with a low weight yet capable of maintaining a high degree of non-deformability, stiffness and capacity to support high loads.

[0016] In other words, it is the purpose of the present invention to provide a prefabricated structural element for the construction of slabs that can minimise its weight without compromising its non-deformability, stiffness and load-bearing capacity.

[0017] It is also the purpose of the present invention to make available a prefabricated structural element for the construction of slabs capable of minimising the natural resources used in its construction.

[0018] Furthermore, it is the purpose of the present invention to provide a prefabricated structural element capable of reducing the static structural load that must support the load-bearing structure of the building in which it is installed.

SUMMARY OF THE INVENTION

[0019] The specified technical task and purposes are substantially achieved by a prefabricated structural element for the construction of slabs in accordance with one or more of the appended claims.

[0020] In particular, a prefabricated structural element for the construction of slabs according to the present invention comprises a frame peripherally delimiting the prefabricated structural element and defining a seat within it.

[0021] This frame comprises a plurality of interconnected frame elements at their respective connection portions.

[0022] Each frame element extends along a respective longitudinal direction between the connecting potions, and along a respective transverse direction directed transversely to the longitudinal direction.

[0023] In detail, each frame element comprises a lower flange lying in a lower plane and an upper flange lying in an upper plane opposite the lower one along a thickness direction of the prefabricated structural element. The lower and upper flanges project into the seat and outwardly from the seat along the transverse direction, respectively.

[0024] The prefabricated structural element also comprises two or more support profiles configured to support at least one layer of the frame. These profiles are arranged in the seat and attached to the lower flange of at least one of the frame elements.

[0025] The frame element comprises at least one reinforcing element attached to the upper flange so that it projects from the upper plane along the thickness direction and extends along the respective transverse direction towards the cavity to connect the upper flange to the lower flange.

[0026] It should be noted that the reinforcing elements constrain the upper flange to which they are attached to the respective lower flange, preventing them from changing their mutual position when loaded, in particular, changing their mutual inclination by bending. Advantageously, this makes it possible to stiffen the prefabricated structural element by increasing its non-deformability and the rigidity of the frame.

[0027] It should also be noted that, at the maximum load-bearing capacity of the prefabricated structural element, the increase in stiffness and non-deformability achieved through the reinforcing elements makes it possible to lighten the frame, thus reducing the weight of the prefabricated structural element and, therefore, the static load to which the load-bearing structure of the building construction is subjected.

LIST OF FIGURES

[0028] Further characteristics and advantages of the present invention will become more apparent from the approximate and thus non-limiting description of a preferred, but not exclusive, embodiment of a prefabricated structural element for the construction of slabs, as illustrated in the accompanying drawings, wherein:

- Figure 1 shows a top view of a prefabricated structural element for the construction of a slab according to the present invention with some components in transparency to show those below;
- Figure 2 shows a top view of the prefabricated structural element in Figure 1 with some components removed to better show others,
- Figures 3a, 3b, 3c and 3d show top views of some components of the prefabricated structural element in Figure 1,
- Figure 4a shows a sectional view of the component in Figure 3a sectioned along the section plane C-C,
- Figure 4b shows a section view of the component in Figure 3b sectioned along the section plane D-D,
- Figure 4c shows a sectional view of the component in Figure 3c sectioned along the section plane E-E,
- Figure 4d shows a sectional view of the component in Figure 3d sectioned along the section plane F-F,
- Figure 5a shows a sectional view of the prefabricated structural element in Figure 1 sectioned along the section plane A-A and with some components in transparency to show those behind,
- Figure 5b shows an enlargement of a first detail of Figure 5a,
- Figure 5c shows an enlargement of a second detail of Figure 5a,
- Figure 6a shows a sectional view of the prefabricated structural element of Figure 1 sectioned along the section plane B-B and with some components in

[0029] transparency to show those behind,

- Figure 6b shows an enlargement of a first detail of Figure 6a,
- Figure 6c shows an enlargement of a second detail of Figure 6a,
- Figure 7 shows a component of the prefabricated structural element in Figure 1,
- Figure 8 shows a further component of the prefabricated structural element in Figure 1,
- Figure 9a shows a side view of an element of the component in Figure 3 a,
- Figure 9b shows a side view of an element of the component in Figure 3b,
- Figure 9c shows a side view of an element of the component in Figure 3 c,
- Figure 9d shows a side view of an element of the component in Figure 3d,
- Figure 10 shows a top view of a slab according to the present invention;
- Figure 11 shows a sectional view of the slab in Figure 10 sectioned along the section plane G-G.

DETAILED DESCRIPTION

[0030] With reference to the accompanying figures, the present description concerns a prefabricated structural element 1 - or prefabricated structural unit - for the construction of a slab of a prefabricated building construction.

[0031] In the context of the present description, prefabricated building constructions are understood to be those constructions made, at least in part, by assembling elements made in industry and then assembled on the load-bearing structure 1001 of the building using highly codified procedures.

[0032] It should be specified that the prefabricated structural element 1 makes a prefabricated module for the construction of a slab of a building construction. Thus, the slab is constructed by arranging several prefabricated structural elements 1 (modules) side by side on the horizontal load-bearing structure 1001 of the building construction.

[0033] The prefabricated structural element 1 can be used for the construction of prefabricated slabs either wet or dry, i.e. with or without the use of cement mortars, resins and the like.

[0034] Referring to Figure 10, the prefabricated structural element 1 comprises a frame 2 configured to rest

on the horizontal load-bearing structure 1001 of the building construction to support the prefabricated structural element 1.

[0035] In particular, the frame 2 is configured to be interposed between at least two load-bearing beams of the building construction so as to be embedded between them.

[0036] With reference to Figures 1 and 2, the frame 2 delimits the perimeter of the prefabricated structural element 1 and defines within it a seat 3, which, in accordance with the following description, is adapted to accommodate components of the prefabricated element 1. That is to say, the frame 2 is a structural element with a frame-like geometric conformation that extends along a closed - e.g. quadrangular - path and defines the cavity within it.

[0037] In detail, the frame 2 comprises a plurality of frame elements 4a, 4b, 4c, 4d connected to each other at respective connection portions 40a, 40b, 40c, 40d which, in the embodiment of Figure 3, are arranged at end portions of the frame elements 4a, 4b, 4c, 4d.

[0038] Again with reference to Figure 3, each frame element 4a, 4b, 4c, 4d extends predominantly along a respective longitudinal direction L1-L1, L2-L2, L3-L3, L4-L4 between the respective connection portions 40a, 40b, 40c, 40d.

[0039] According to one aspect, each frame element 4a, 4b, 4c, 4d extends predominantly along a respective longitudinal direction L1-L1, L2-L2, L3-L3, L4-L4 defining one side of the frame 2.

[0040] In accordance with what is shown in Figure 10, *in situ,* the frame elements 4a, 4b, 4c, 4d of distinct prefabricated structural elements 1 rest on the horizontal load-bearing structure 1001 of the building construction so as to lie side by side and thus create the slab.

[0041] Each frame element 4a, 4b, 4c, 4d also extends along a respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4 directed transversely, preferably perpendicularly, to the respective longitudinal direction L1-L1, L2-L2, L3-L3, L4-L4.

[0042] The frame elements 4a, 4b, 4c, 4d are preferably made of metal material (e.g. steel or aluminium) and connected to each other, for example, by welding.

[0043] The frame elements 4a, 4b, 4c, 4d, when interconnected, are organised along a closed path that surrounds the cavity 3 and gives a certain geometric shape in plan to the prefabricated structural element 1.

[0044] In the embodiment shown in Figures 1 and 2, the prefabricated structural element 1 presents, in plan, a quadrangular geometry in which the frame elements 4a, 4b, 4c, 4d are arranged with their respective longitudinal directions L1-L1, L2-L2, L3-L3, L4-L4 oriented along the sides of a rectangle.

[0045] It should be noted that, in alternative embodiments, the prefabricated element 1 may have different geometric shapes in plan from those shown in the accompanying figures, such as triangular, trapezoidal or pentagonal. Obviously, in such alternative embodiments, the number of frame elements used to create the frame 2 will vary with the number of sides of the geometry described by the prefabricated structural element 1.

[0046] With reference to Figures 4a-4d, 5a-5c and 6a-6c, each frame element 4a, 4b, 4c, 4d comprises a lower flange 41a, 41b, 41c, 41d lying in a lower plane PI delimiting the cavity 3 below, and an upper flange 42a, 42b, 42c, 42d lying in an upper plane PS opposite the lower plane PI along a thickness direction S-S of the prefabricated structural element 1. Preferably, the lower plane PI and the upper plane PS are parallel and spaced along the thickness direction S-S.

[0047] In detail, each lower flange 41a, 41b, 41c, 41d projects into the seat 3 along the respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4, while each upper flange 42a, 42b, 42c, 42d projects outwardly from the seat 3 along the respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4. Therefore, the lower flange 41a, 41b, 41c, 41d and the upper flange 42a, 42b, 42c, 42d of each frame element 4a, 4b, 4c, 4d extend in opposite directions along the respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4.

[0048] Preferably, the lower flanges 41a, 41b, 41c, 41d and the upper flanges 42a, 42b, 42c, 42d extend along the respective longitudinal directions L1-L1, L2-L2, L3-L3, L4-L4 between the respective connection portions 40a, 40b, 40c, 40d.

[0049] In particular, preferably, the lower flanges 41a, 41b, 41c, 41d and the upper flanges 42a, 42b, 42c, 42d of adjoining frame elements 4a, 4b, 4c, 4d are mutually attached, for example, by welding.

[0050] The upper flanges 42a, 42b, 42c, 42d are configured to rest on and be attached to the load-bearing structure 1001 (or load-bearing framework) of the building construction in which the prefabricated structural element 1 is installed to make the slab 100.

[0051] With reference to Figures 3b and 3d, the upper flanges 42a, 42b, 42c, 42d, where necessary, may have notches for joint-covering connections 1001a of beams of the load-bearing structure 1001.

[0052] The lower flanges 41a, 41b, 41c, 41d are configured to create a support surface 41 delimiting the cavity 3 at the bottom and to which various structural components such as the profiles 5 and bracing elements 10 described below can be attached.

[0053] It should be noted that, as shown in Figures 4a-4d, the lower flange 41a, 41b, 41c, 41d of each frame element 4a, 4b, 4c, 4d is connected/fitted to the respective upper flange 42a, 42b, 42c, 42d.

[0054] In particular, according to one aspect, each frame element 4a, 4b, 4c, 4d comprises a connection portion 43a, 43b, 43c, 43d extending between the upper plane PS and the lower plane PI along the thickness direction S-S joining the upper flanges 42a, 42b, 42c, 42d to the respective lower flanges 41a, 41b, 41c, 41d. The connection portions 43a, 43b, 43c, 43d surround and delimit the cavity 3 laterally.

[0055] Preferably, the frame elements 4a, 4b, 4c, 4d are produced by sheet metal forming processes such as

bending or moulding. In particular, the frame elements 4a, 4b, 4c, 4d are obtained through sheet metal press-forming processes.

[0056] Preferably, the frame elements 4a, 4b, 4c, 4d are Z-shaped profiles in which the upper and lower flange make up the upper and lower sections of the Z-shaped profile, respectively, and the connection portion the central section connecting the upper and lower sections.

[0057] It should be specified that according to an alternative embodiment, the frame 3 is made in a monolithic block (monolithic frame), e.g. through a punching or deep-drawing process. In this alternative embodiment, the frame elements 4a, 4b, 4c, 4d are to be identified with equivalent portions of the monolithic frame defining the sides of the monolithic frame.

[0058] Referring to Figures 2, 5a-5c, and 6a-6c, the prefabricated structural element 1 further comprises two or more support profiles 5 configured to support at least one layer 101 of the slab 100.

[0059] According to one aspect, if the prefabricated structural element 1 is used for wet floor construction, the at least one layer 101 of the slab 100 comprises a corrugated metal sheet 8 configured to support a concrete layer and shown in Figure 8. More details on this corrugated metal sheet 8 will be provided in a later part of the description.

[0060] The aforesaid profiles 5 are arranged in the seat 3 and fixed to the lower flange 41a, 41b, 41c, 41d of at least one of the frame elements 4a, 4b, 4c, 4d.

[0061] In the embodiment shown in Figures 2, 5a-5c and 6a-6c, the profiles 5 have an I-shaped cross-section, specifically they are IPE joists.

[0062] In addition, again with reference to the embodiment in Figure 2, 5a-5c and 6a-6c, the profiles 5 extend between a pair of opposite frame elements 4a, 4c by connecting the respective lower flanges 41a, 41c to which they are attached, for example, by welding.

[0063] Preferably, the profiles 5 comprise a first profile 5b and a second profile 5d attached to the lower flanges 41b, 41d of opposite frame elements 4b, 4d and extend along the respective longitudinal directions L2-L2, L4-L4, as shown in Figure 2, 6b and 6c.

[0064] It should be specified that opposite frame elements mean non-contiguous frame elements, i.e. which do not have the connection portions 40a, 40b, 40c, 40d directly connected.

[0065] Further, the profiles 5a can be interposed between the first and second profiles 5b, 5d as, for example, along the centreline - which, in some embodiments, coincides with the axis of symmetry - of the frame 2, as shown in Figure 6a.

[0066] As shown in Figures 5b, 5c, 6b and 6c, each frame element 4a, 4b, 4c, 4d comprises at least one reinforcing element 6a, 6b, 6c, 6d attached to the respective upper flange 42a, 42b, 42c, 42d so as to project upwardly from the upper plane PS along the thickness direction S-S. In other words, each reinforcing element 6a, 6b, 6c, 6d extends in the thickness direction S-S from the upper flange 42a, 42b, 42c, 42d to which it is attached.

[0067] Preferably, each reinforcing element 6a, 6b, 6c, 6d extends perpendicular to the upper flange 42a, 42b, 42c, 42d to which it is attached.

[0068] Each reinforcing element 6a, 6b, 6c, 6d also extends along the relevant transverse direction T1-T1, T2-T2, T3-T3, T4-T4 towards the cavity 3 to connect the upper flange 42a, 42b, 42c, 42d to the lower flange 41a, 41b, 41c, 41d. In other words, each reinforcing element 6a, 6b, 6c, 6d extends along the respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4 to connect/constrain the upper flange 42a, 42b, 42c, 42d to the lower flange 41a, 41b, 41c, 41d.

[0069] Advantageously, by constraining the upper flange 42a, 42b, 42c, 42d to the respective lower flange 41a, 41b, 41c, 41d, the reinforcing element 6a, 6b, 6c, 6d prevents these from changing their mutual position when loaded, in particular by bending.

[0070] Preferably, each reinforcing element 6a, 6b, 6c, 6d further extends along the relative transverse direction T1-T1, T2-T2, T3-T3, T4-T4 and has at least one portion (e.g., portion hereafter referred to as a second portion 62a, 62b, 62c, 62d) arranged within the cavity 3 or above the cavity 3 so that its projection along the thickness direction S-S falls within the latter.

[0071] According to an aspect shown in the accompanying figures, each frame element 4a, 4b, 4c, 4d comprises a plurality of reinforcing elements 6a, 6b, 6c, 6d arranged in succession along the respective longitudinal direction L1-L1, L2-L2, L3-L3, L4-L4 between the respective connection portions.

[0072] It should be specified that the number and arrangement of reinforcing elements 6a, 6b, 6c, 6d along the longitudinal direction L1-L1, L2-L2, L3-L3, L4-L4 of the frame element 4a, 4b, 4c, 4d depends on the design loads.

[0073] Referring to the embodiments shown in Figures 9a-9d, the reinforcing element 6a, 6b, 6c, 6d is a plate-like structural element (i.e., an element with two dimensions prevailing over the third dimension) making a reinforcing rib configured to connect the upper flange 42a, 42b, 42c, 42d to the lower flange 41a, 41b, 41c, 41d.

[0074] According to an embodiment, each reinforcing element 6a, 6b, 6c, 6d is a plate 60a, 60b, 60c, 60d making a reinforcing rib configured to connect the upper flange 42a, 42b, 42c, 42d to the lower flange (41a, 41b, 41c, 41d).

[0075] In particular, the reinforcing element 6a, 6b, 6c, 6d is arranged on the respective frame element 4a, 4b, 4c, 4d in such a way that the axis (i.e. normal to the plane defined by the prevalent plate extension directions) is directed parallel to the respective longitudinal direction L1-L1, L2-L2, L3-L3, L4-L4. In other words, each reinforcing element 6a, 6b, 6c, 6d extends predominantly orthogonal to the longitudinal direction L1-L1, L2-L2, L3-L3, L4-L4 of the frame element 4a, 4b, 4c, 4d on which it is mounted.

[0076] With reference to Figures 3a- 3c e 4a-4d, the

upper flange 42a, 42b, 42c, 42d of each frame element 4a, 4b, 4c, 4d extends along the respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4 between an inner edge I1, I2, 13, I4 peripherally delimiting the seat 3 and an outer edge E1, E2, E3, E4 peripherally delimiting the prefabricated structural element 1. Thus, the inner edges I1, I2, I3, I4 of the upper flanges 42a, 42b, 42c, 42d surround the seat 3 while the outer edges E1, E2, E3, E4 define the perimeter sides of the prefabricated slab element 1.

[0077] According to an aspect shown in Figures 4a-4d, 5a, 5b, 6a, and 6b, each reinforcing element 6a, 6b, 6c, 6d extends parallel to the respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4 between a first portion 61a, 61b, 61c, 61d attached to the upper flange 42a, 42b, 42c, 42d and a second portion 62a, 62b, 62c, 62d projecting from the inner edge I1, I2, I3, I4 towards the seat 3. This second portion 62a, 62b, 62c, 62d is configured to be connected, directly or indirectly, to the lower flange 41a, 41b, 41c, 41d.

[0078] Preferably, the reinforcing elements 6a, 6b, 6c, 6d are divided into a first group G1 in which the second portion 62a, 62b, 62c, 62d is configured to be indirectly connected to the lower flange 41a, 41b, 41c, 41d (Figures 4b, 4d, 6b, 6c, 9b and 9c), and in a second group G2 in which the second portion 62a, 62b, 62c, 62d is configured to be directly connected to the lower flange 41a, 41b, 41c, 41d (Figures 4a, 4c, 5b, 5c, 9a and 9d).

[0079] In the embodiment shown in Figures 4a, 4c, 5b, 5c, 9a and 9d, the second portion 62a, 62c of the reinforcing elements 6a, 6c of the second group G2 extends in the thickness direction S-S beyond the first portion 61a, 61c and is attached to the lower flange 41a, 41b, 41c, 41d. Preferably, the reinforcing elements 6a, 6c of the second G2 group are L-shaped ribs as shown in Figures 9a and 9d.

[0080] As shown in Figures 6b, 6c, the profiles 5 extend along the thickness direction S-S between a lower portion 51 fixed to the lower flange 41a, 41b, 41c, 41d of at least one of the frame elements 4a, 4b, 4c, 4d and an upper portion 52 configured to bear the at least one layer 101 of the slab 100.

[0081] In the embodiment shown in Figures 4b, 4d, 6b, 6c, 9b and 9c, the second portion 62b, 62d of the reinforcing elements 6b, 6d of the first group G1 is fixed to the upper portion 52 of a respective profile 5, thus being indirectly connected to the respective lower flange 41a, 41b, 41c, 41d. Preferably, the reinforcing elements 6b, 6d of the first group G1 are straight ribs as shown in Figures 9b and 9c.

[0082] With reference to Figures 4a, 4b, 4d, the upper flange 42a, 42b, 42c of at least one frame element 4a, 4b, 4c, 4d comprises a shoulder 7 projecting from the upper plane PS in the thickness direction S-S and extending predominantly along at least part of the respective outer edge E1, E2, E3, E4.

[0083] It should be specified that the shoulder 7 protrudes upwardly from the upper plane PS, i.e. from the part of the upper flange 42a, 42b, 42c, 42d opposite the one configured to rest on the load-bearing structure 1001 of the building construction.

[0084] Preferably, the shoulder 7 is oriented orthogonally to the respective upper flange 42a, 42b, 42c, 42d.

[0085] Further, preferably, the shoulder 7 is made as a single piece with the respective upper flange 42a, 42b, 42c, 42d, for example, by a bending process. Alternatively, the shoulder 7 could be a distinct element from the upper flange 42a, 42b, 42c, 42d and be attached to the latter by, for example, welding.

[0086] According to one aspect, each shoulder 7 makes/identifies a plate projecting upwardly from a respective upper flange 42a, 42b, 42c, 42d and extending predominantly parallel to the longitudinal direction L1-L1, L2-L2, L3-L3, L4-L4 of the respective frame element 4a, 4b, 4c, 4d and the thickness direction S-S. In other words, preferably, each shoulder 7 makes a plate projecting upwardly from a respective upper flange 42a, 42b, 42c, 42d and having its axis in the transverse direction T1-T1, T2-T2, T3-T3, T4-T4 of the respective frame element 4a, 4b, 4c, 4d.

[0087] It should be noted that, in the construction of the slab 100, the shoulder 7 can be used to mutually connect/attach adjacent prefabricated structural elements 1. In particular, with reference to Figures 5b and 11, the shoulder 7 may comprise one or more connecting holes 70, preferably slotted, adapted to be traversed by respective bolts 71 used to connect adjacent prefabricated structural elements 1.

[0088] According to one aspect, *in situ,* the adjacent prefabricated structural elements 1 are arranged with their respective shoulders 7 facing each other, in particular in abutment, and mutually attached e.g. by means of a bolted connection.

[0089] Advantageously, such a connection of the shoulders 7 makes it possible to distribute part of the load between the prefabricated structural elements 1 and thus increase the load-bearing capacity of the floor 100.

[0090] Again with reference to the embodiment of figures 4a, 4b, 4d, the reinforcing element 6a, 6b, 6d is fixed to the shoulder 7 of the respective frame element 4a, 4b, 4c. Therefore, the reinforcing element 6a, 6b, 6c extends along the respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4 from the shoulder 7 to which it is attached towards the cavity 3.

[0091] According to one aspect, at least one reinforcing element 6a, 6b, 6d extends predominantly transverse to the respective shoulder 7, preferably along the respective transverse direction T1-T1, T2-T2, T3-T3, T4-T4.

[0092] It should therefore be noted that the shoulders 7 not only allow for a stable connection between distinct prefabricated structural elements 1, but also with a structural function. In particular, the flange 7 increases the rigidity of the frame by introducing mass away from the main axis of inertia of the frame 3 and cooperates with the upper and lower flanges to distribute loads between them.

[0093] The prefabricated structural element 1, when used for making wet slabs 100, comprises a corrugated metal sheet 8, configured to support a layer of concrete, fixed to the profiles 5 and to at least part of the upper flanges 42a, 42b, 42c, 42d of the frame elements 4a, 4b, 4c, 4d.

[0094] The corrugated metal sheet 8 is a well-known component in the construction industry and, therefore, will not be described further. However, it should be noted that, where necessary, the corrugated metal sheet 8 may include notches (not shown in the figures) adapted to accommodate part of the reinforcing elements 6a, 6b, 6c, 6d.

[0095] The prefabricated structural element 1, when used for making wet slabs 100, also comprises a plurality of rod-shaped elements 9 arranged in succession above the corrugated metal sheet 8.

[0096] Each rod-shaped element 9 extends along a respective direction of prevailing extension D-D between a pair of end portions 90a, 90b.

[0097] With reference to Figures 5a, 5b, the rod-shaped elements 9 have at least one of the end portions 90a extending transversally to the direction of prevailing extension D-D and attached to the shoulder 7 and to the upper flange 42a, 42b, 42c, 42d of a respective frame element 4a, 4b, 4c, 4d.

[0098] In use, the rod-shaped elements 9 act as spacers and support a reinforcement grid (not shown in the figures) of the slab 100.

[0099] The prefabricated structural element 1, in order to further increase its maximum load-bearing capacity, may also comprise bracing elements 10 arranged in the seat 3 and fixed to the frame 2. With reference to Figures 1 and 2, the bracing elements 10 form triangular geometries with one or more frame elements 4a, 4b, 4c, 4d.

[0100] Preferably, the bracing elements 10 comprise at least one pair of beams 10a, 10b arranged in a V-shape, each of which is fixed at opposite ends to the lower flanges 41a, 41b, 41c, 41d of separate frame elements 4a, 4b, 4c, 4d.

[0101] In the embodiment of figure 2, a profile 5a is interposed between said pair of beams 10a, 10b. In particular, the beams 10a, 10b are fixed to the profile 5a at the vertex of the V.

[0102] In the embodiment shown in the accompanying figures, the beams 10a, 10b present a U-shaped cross-section, however, in alternative embodiments they may present a different geometry.

[0103] A slab of a building construction is also the subject matter of this description. This slab comprises a horizontal load-bearing structure 1001 of the building construction and a plurality of prefabricated structural elements 1 described above.

[0104] In particular, the load-bearing structure 1001 comprises a plurality of beams, e.g. I-shaped beams, organised in a horizontal plane and on which the prefabricated structural elements 1 rest and are anchored.

[0105] With reference to Figure 10 and in accordance with the above, the upper flanges 42a, 42b, 42c, 42d of the frame elements 4a, 4b, 4c, 4d rest on the load-bearing structure 1001 of the building construction and are connected to each other, for example, by means of the aforementioned shoulders 7.

[0106] Obviously an expert in the field may bring several modifications and variants to the aforementioned configurations for the purpose to fulfil contingent and specific needs. Such variants and modifications are all also contained within the scope of protection of the invention as defined in the following claims.

Claims

1. Prefabricated structural element (1) for creating a slab (100) of a building construction, the prefabricated structural element (1) comprising:

   - a frame (2) peripherally delimiting the prefabricated structural element (1) and defining therein a seat (3), said frame (2) comprising a plurality of frame elements (4a, 4b, 4c, 4d) connected to each other at respective connection portions (40a, 40b, 40c, 40d), each frame element (4a, 4b, 4c, 4d) extending along a longitudinal direction (L1-L1, L2-L2, L3-L3, L4-L4) between the respective connection portions (40a, 40b, 40c, 40d) and along a transversal direction (T1-T1, T2-T2, T3-T3, T4-T4) directed transversal to the longitudinal direction (L1-L1, L2-L2, L3-L3, L4-L4), each frame element (4a, 4b, 4c, 4d) comprising:

     - a lower flange (41a, 41b, 41c, 41d) projecting into the seat (3) along the transverse direction (T1-T1, T2-T2, T3-T3, T4-T4) and lying in a lower plane (PI),
     - an upper flange (42a, 42b, 42c, 42d) projecting outwardly from the seat (3) along the transverse direction (T1-T1, T2-T2, T3-T3, T4-T4) and lying in an upper plane (PS) opposite the lower plane (PI) along a thickness direction (S-S) of the prefabricated structural element (1), said upper flange (42a, 42b, 42c, 42d) being configured to rest on a load-bearing structure (1001) of the building to support the prefabricated structural element (1),

   - two or more support profiles (5) arranged in the seat (3), fixed to the lower flange (41a, 41b, 41c, 41d) of at least one of the frame elements (4a, 4b, 4c, 4d), and configured to support at least one layer (101) of the slab (100),

   characterised in that each frame element (4a, 4b, 4c, 4d) comprises at least one plate-like reinforcing

element (6a, 6b, 6c, 6d) making a reinforcing rib configured to connect the upper flange (42a, 42b, 42c, 42d) to the lower flange (41a, 41b, 41c, 41d), said reinforcing element (6a, 6b, 6c, 6d) being:

- attached to the upper flange (42a, 42b, 42c, 42d) so as to project upwards from the upper plane (PS) along the thickness direction (S-S); and
- extending along the respective transverse direction (T1-T1, T2-T2, T3-T3, T4-T4) towards the cavity (3) to connect the upper flange (42a, 42b, 42c, 42d) to the lower flange (41a, 41b, 41c, 41d).

2. Prefabricated structural element (1) according to claim 1, wherein each frame element (4a, 4b, 4c, 4d) comprises a plurality of reinforcing elements (6a, 6b, 6c, 6d) arranged in sequence along the respective longitudinal direction (L1-L1, L2-L2, L3-L3, L4-L4) between the respective connection portions (40a, 40b, 40c, 40d).

3. Prefabricated structural element (1) according to any one of the preceding claims, wherein each plate-like reinforcing element (6a, 6b, 6c, 6d) has an axis directed parallel to the longitudinal direction (L1-L1, L2-L2, L3-L3, L4-L4) of the frame element (4a, 4b, 4c, 4d) on which it is attached.

4. Prefabricated structural element (1) according to any one of the preceding claims, wherein

- the upper flange (42a, 42b, 42c, 42d) of each frame element (4a, 4b, 4c, 4d) extends along the respective transverse direction (T1-T1, T2-T2, T3-T3, T4-T4) between an inner edge (I1, I2, I3, I4) peripherally delimiting the seat (3) and an outer edge (E1, E2, E3, E4) peripherally delimiting the prefabricated structural element (1),
- each reinforcing element (6a, 6b, 6c, 6d) extends parallel to the transverse direction (T1-T1, T2-T2, T3-T3, T4-T4) between a first portion (61a, 61b, 61c, 61d) fixed to the upper flange (42a, 42b, 42c, 42d) and a second portion (62a, 62b, 62c, 62d) projecting from the inner edge (I1, I2, I3, I4) towards the seat (3) configured to be connected to the lower flange (41a, 41b, 41c, 41d).

5. Prefabricated structural element (1) according to claim 4, wherein:

- the profiles (5) extend along the thickness direction (S-S) between a lower portion (51) fixed to the lower flange (41a, 41b, 41c, 41d) of at least one of the frame elements (4a, 4b, 4c, 4d) and an upper portion (52) configured to bear the at least one layer (101) of the slab (100),
- the second portion (62b, 62d) of a first set (G1) of reinforcing elements (6b, 6d) is fixed to the upper portion (52) of a respective profile (5).

6. Prefabricated structural element (1) according to claim 4 or 5, wherein the second portion (62a, 62c) of a second set (G2) of reinforcing elements (6a, 6c) extends along the thickness direction (S-S) beyond the first portion (61a, 61c) and is fixed to the lower flange (41a, 41b, 41c, 41d).

7. Prefabricated structural element (1) according to any one of claims 4 to 6, wherein the upper flange (42a, 42b, 42c, 42d) of at least one frame element (4a, 4b, 4c, 4d) comprises a shoulder (7) projecting from the upper plane (PS) along the thickness direction (S-S) and extending mainly along at least part of the respective outer edge (E1, E2, E3, E4).

8. Prefabricated structural element (1) according to claim 7, wherein at least one reinforcing element (6a, 6b, 6c) is fixed to the shoulder (7) of the respective frame element (4a, 4b, 4c).

9. Prefabricated structural element (1) according to claim 7 or 8, wherein each shoulder (7) forms a plate projecting upwards from the respective upper flange (42a, 42b, 42c, 42d), said shoulder (7) extending predominantly parallel to the longitudinal direction (L1-L1, L2-L2, L3-L3, L4-L4) of the respective frame element (4a, 4b, 4c, 4d) and to the thickness direction (S-S).

10. Prefabricated structural element (1) according to any one of the preceding claims, comprising:

- a corrugated metal sheet (8) configured to bear a layer of concrete, the corrugated metal sheet (8) being fixed to the profiles (5) and to the upper flange (42a, 42b, 42c, 42d) of the frame elements (4a, 4b, 4c, 4d),
- a plurality of rod-shaped elements (9) arranged above the corrugated metal sheet (8) and extending along a respective direction of prevailing extension (D-D) between a pair of end portions (90a, 90b), at least one of the end portions (90a, 90b) extending transversely to the direction of prevailing extension (D-D) and being fixed to the shoulder (7) and upper flange (42a, 42b, 42c, 42d) of a respective frame element (4a, 4b, 4c, 4d).

11. Prefabricated structural element (1) according to any one of the preceding claims, comprising bracing elements (10) arranged in the seat (3) and fixed to the frame (2), the bracing elements (10) obtaining triangular geometries with one or more of the frame ele-

ments (4a, 4b, 4c, 4d).

12. Prefabricated structural element (1) according to claim 11, wherein the bracing elements (10) comprise at least one pair of beams (10a, 10b) arranged in a V-shape, each beam (10a, 10b) being attached at opposite ends to the bottom flanges (41a, 41b, 41c, 41d) of distinct frame elements (4a, 4b, 4c, 4d).

13. Prefabricated structural element (1) according to any one of the preceding claims, wherein each frame element (4a, 4b, 4c, 4d) comprises a connection portion (43a, 43b, 43c, 43d) extending between the upper plane (PS) and the lower plane (PI) along the thickness direction (S-S) joining the upper flange (42a, 42b, 42c, 42d) to the respective lower flange (41a, 41b, 41c, 41d), said connecting portions (43a, 43b, 43c, 43d) surrounding and delimiting the cavity (3).

14. Slab (100) comprising:

- a horizontal load-bearing structure (1001) of a building construction,
- a plurality of prefabricated structural elements (1) according to any one of the preceding claims having the upper flanges (42a, 42b, 42c, 42d) of the frame elements (4a, 4b, 4c, 4d) resting on the load-bearing structure (101) of the building construction and connected to each other.

15. Slab (100) according to claim 14, wherein:

- the upper flange (42a, 42b, 42c, 42d) of at least one frame element (4a, 4b, 4c, 4d) of each prefabricated structural element (1) comprises a shoulder (7) projecting from the upper plane (PS) along the thickness direction (S-S) and extending along at least part of an outer edge (E1, E2, E3, E4) of the upper flange (42a, 42b, 42c, 42d);
- the shoulders (7) of adjoining prefabricated structural elements (1) are mutually attached in order to constrain said adjoining prefabricated structural elements (1).

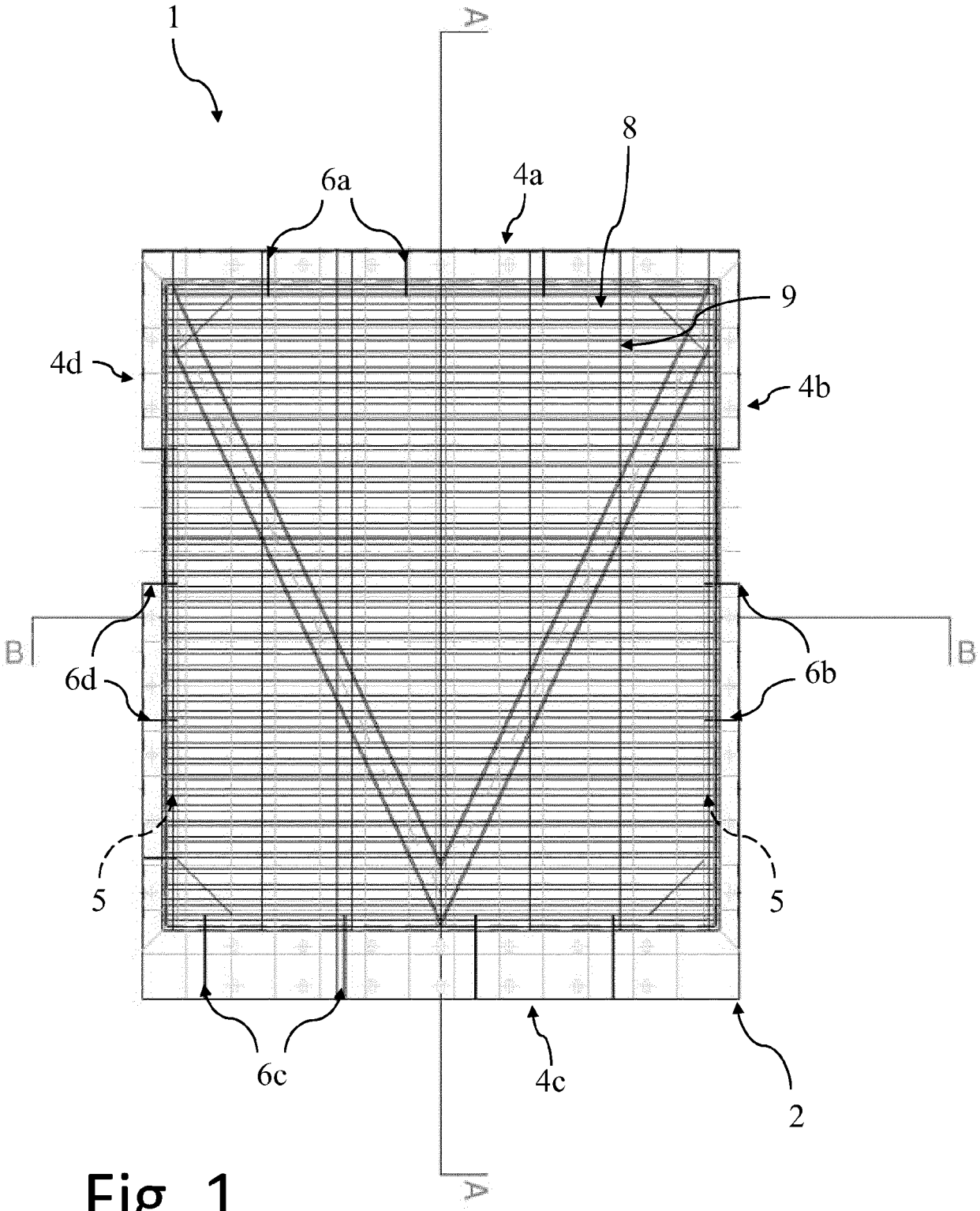


Fig. 1

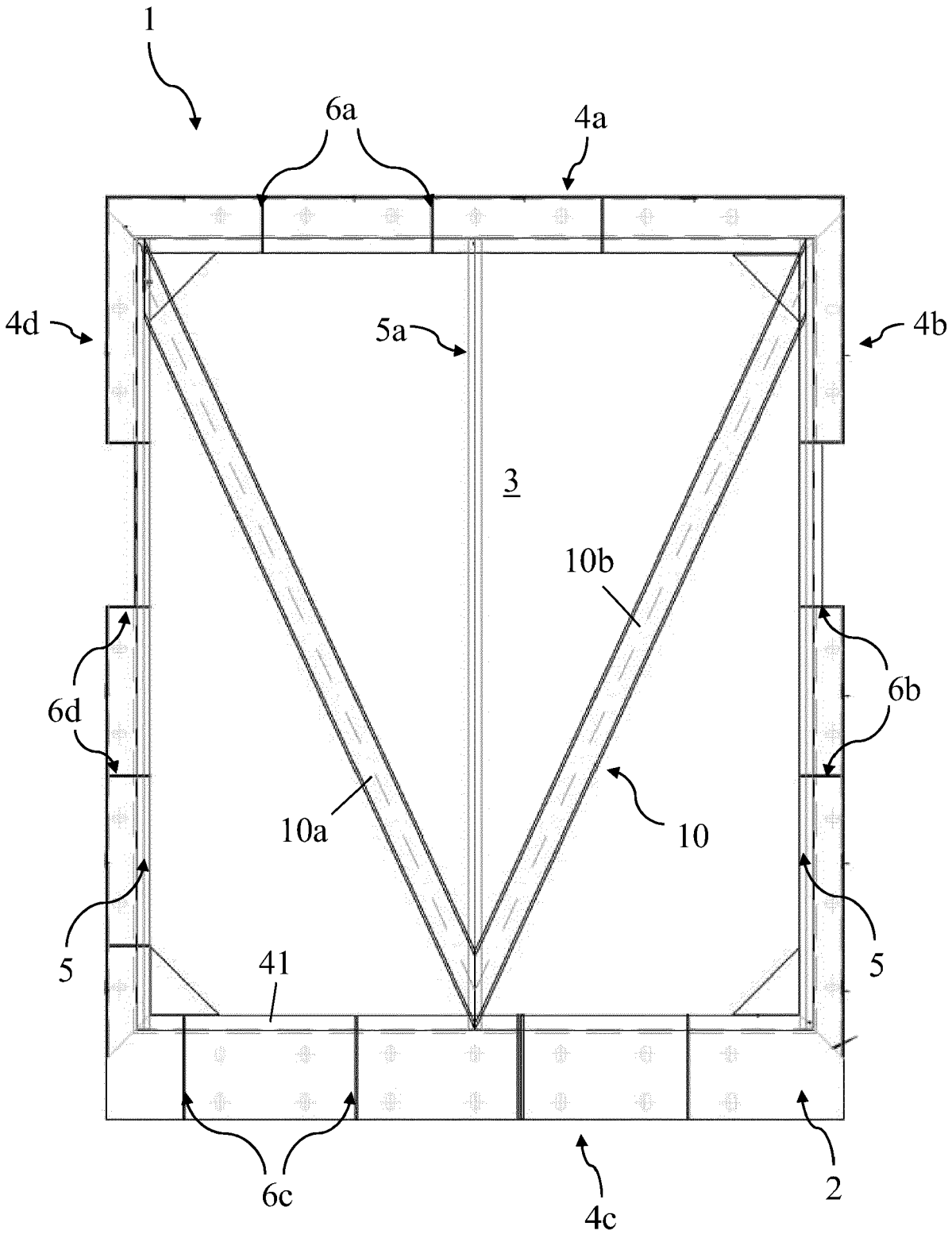
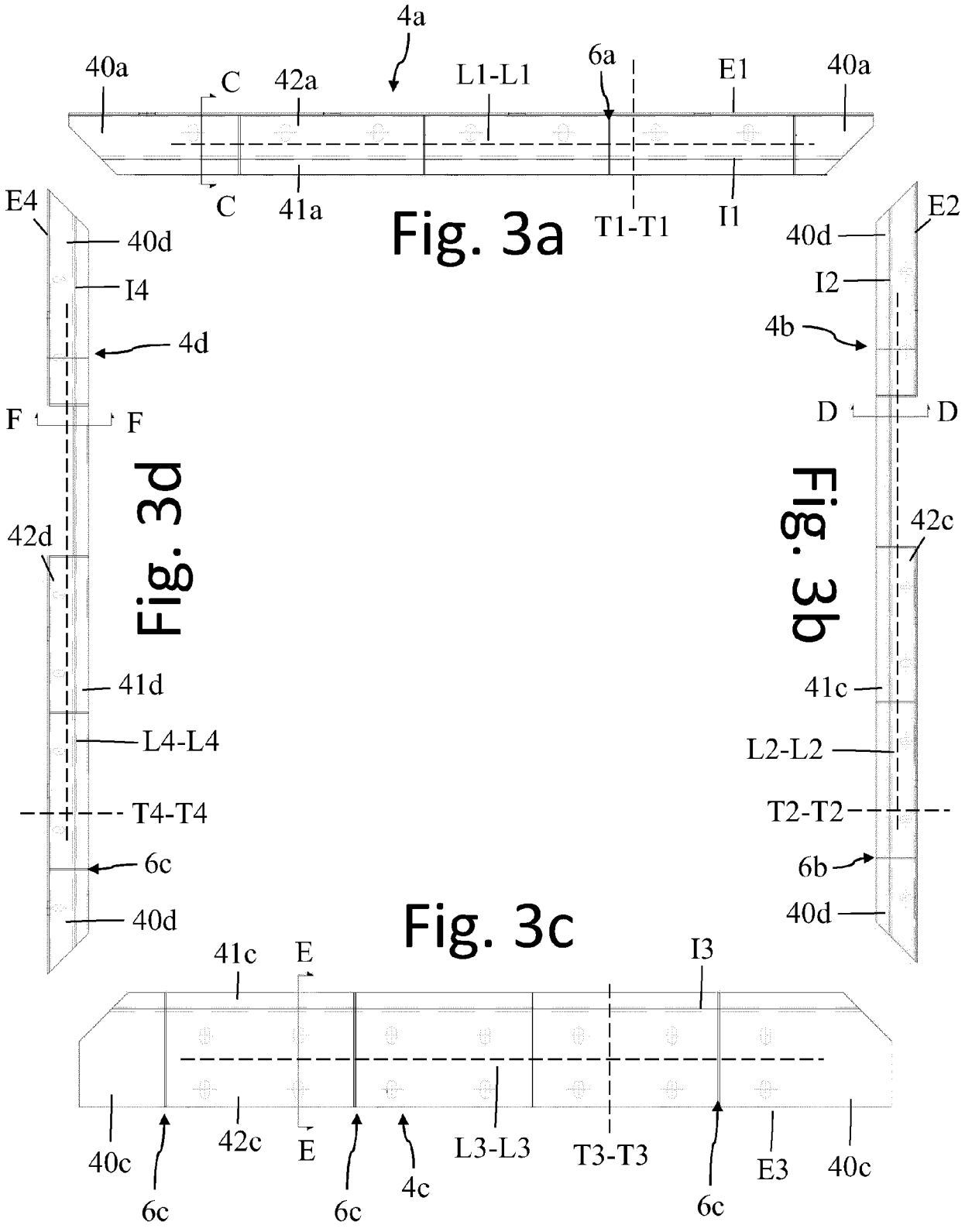


Fig. 2


4a
40a
C
42a
L1-L1
6a
E1
40a
C
41a
T1-T1
I1
Fig. 3a
E4
40d
I4
4d
F
F
Fig. 3d
42d
41d
L4-L4
T4-T4
6c
40d
E2
40d
I2
4b
D
D
Fig. 3b
42c
41c
L2-L2
T2-T2
6b
40d
Fig. 3c
41c
E
I3
40c
6c
42c
E
6c
4c
L3-L3
T3-T3
6c
E3
40c

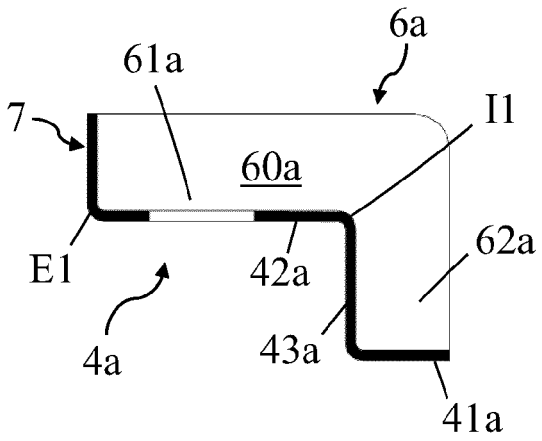


Fig. 4a

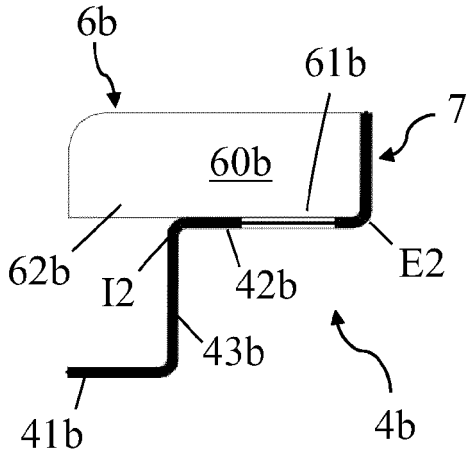


Fig. 4b

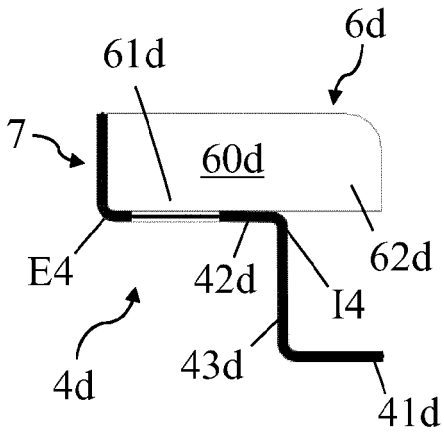


Fig. 4d

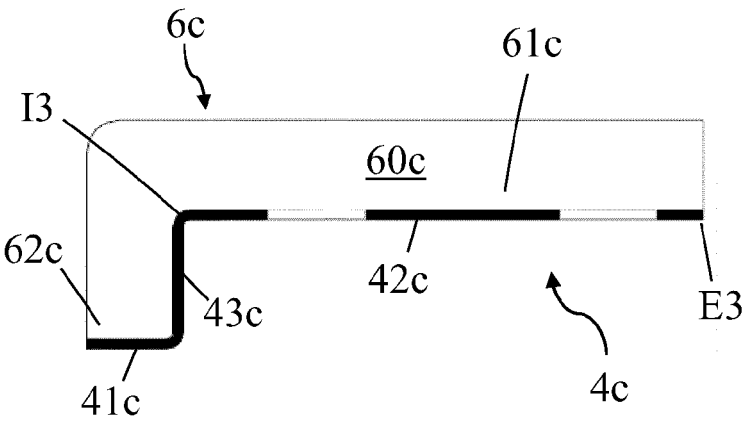


Fig. 4c

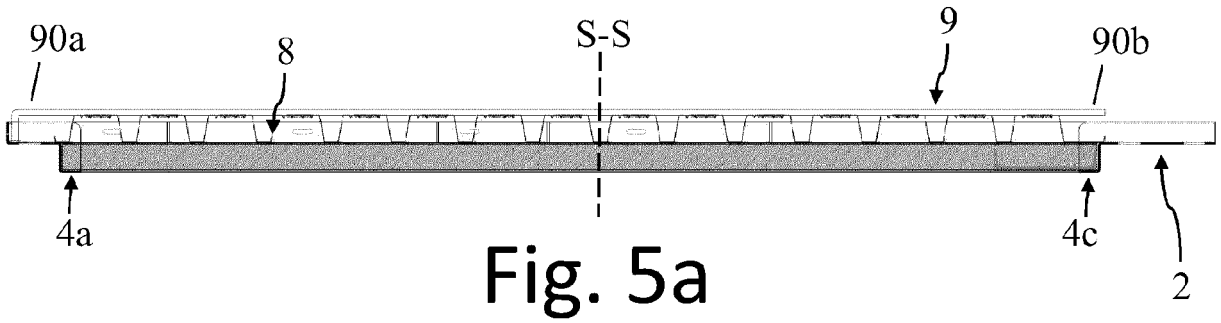


Fig. 5a

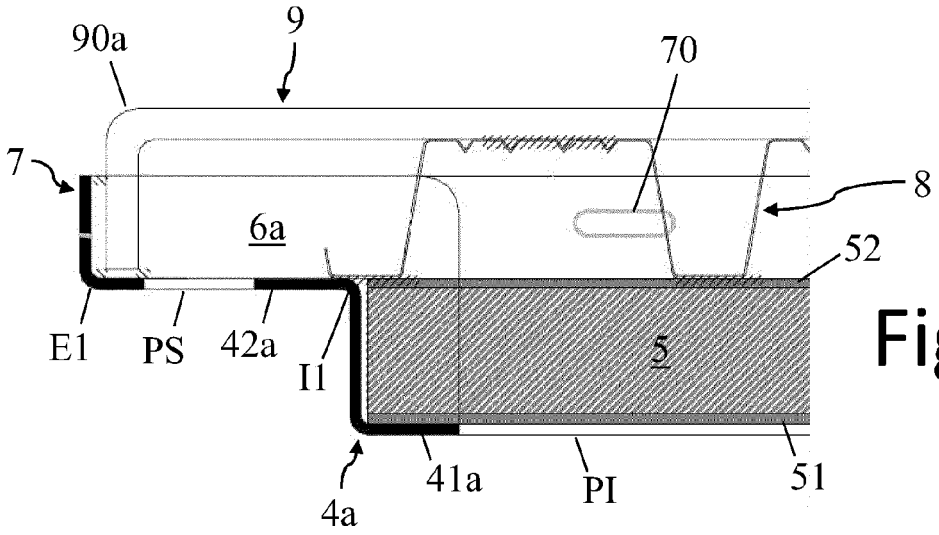
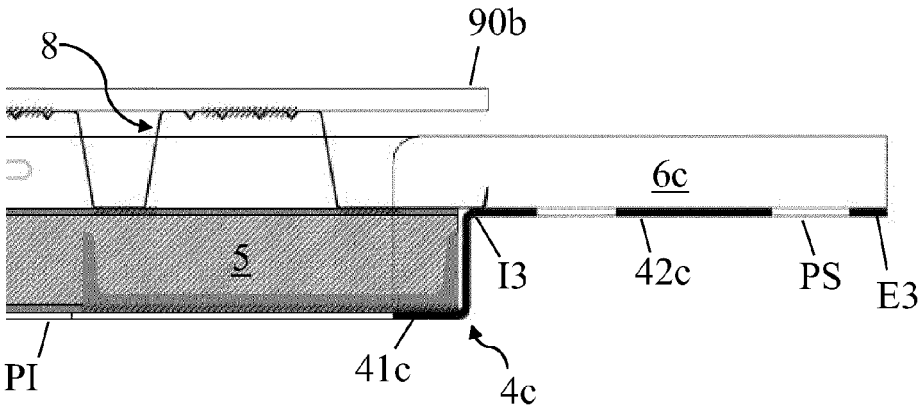


Fig. 5b

Fig. 5c



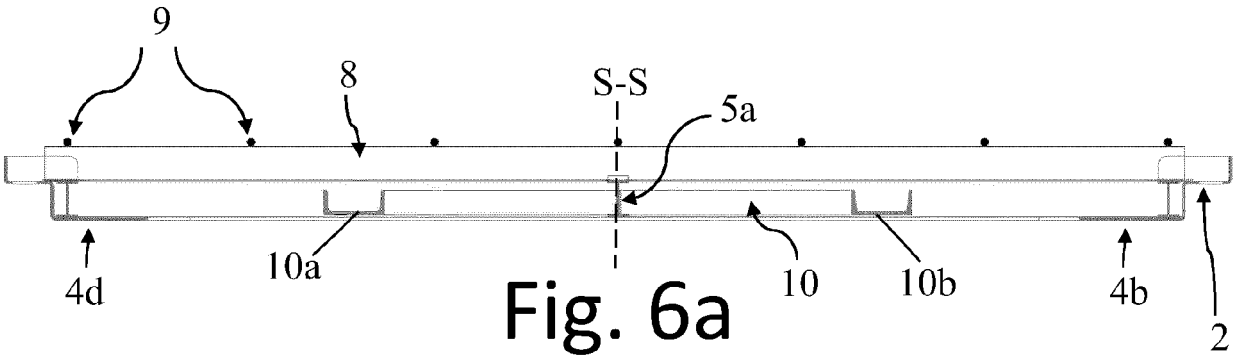


Fig. 6a

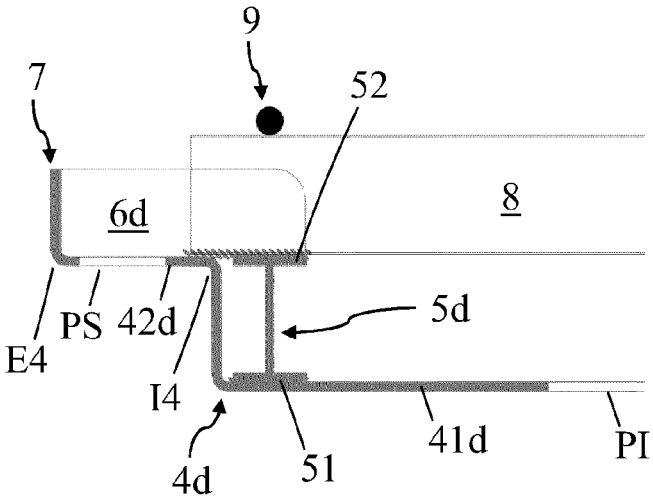
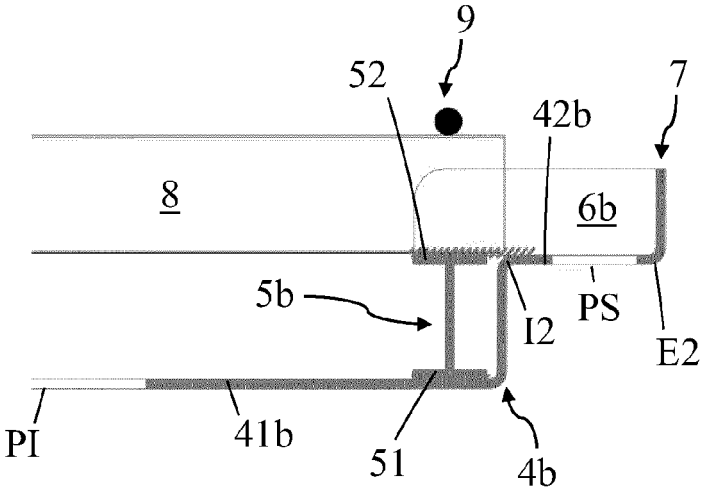


Fig. 6b

Fig. 6c



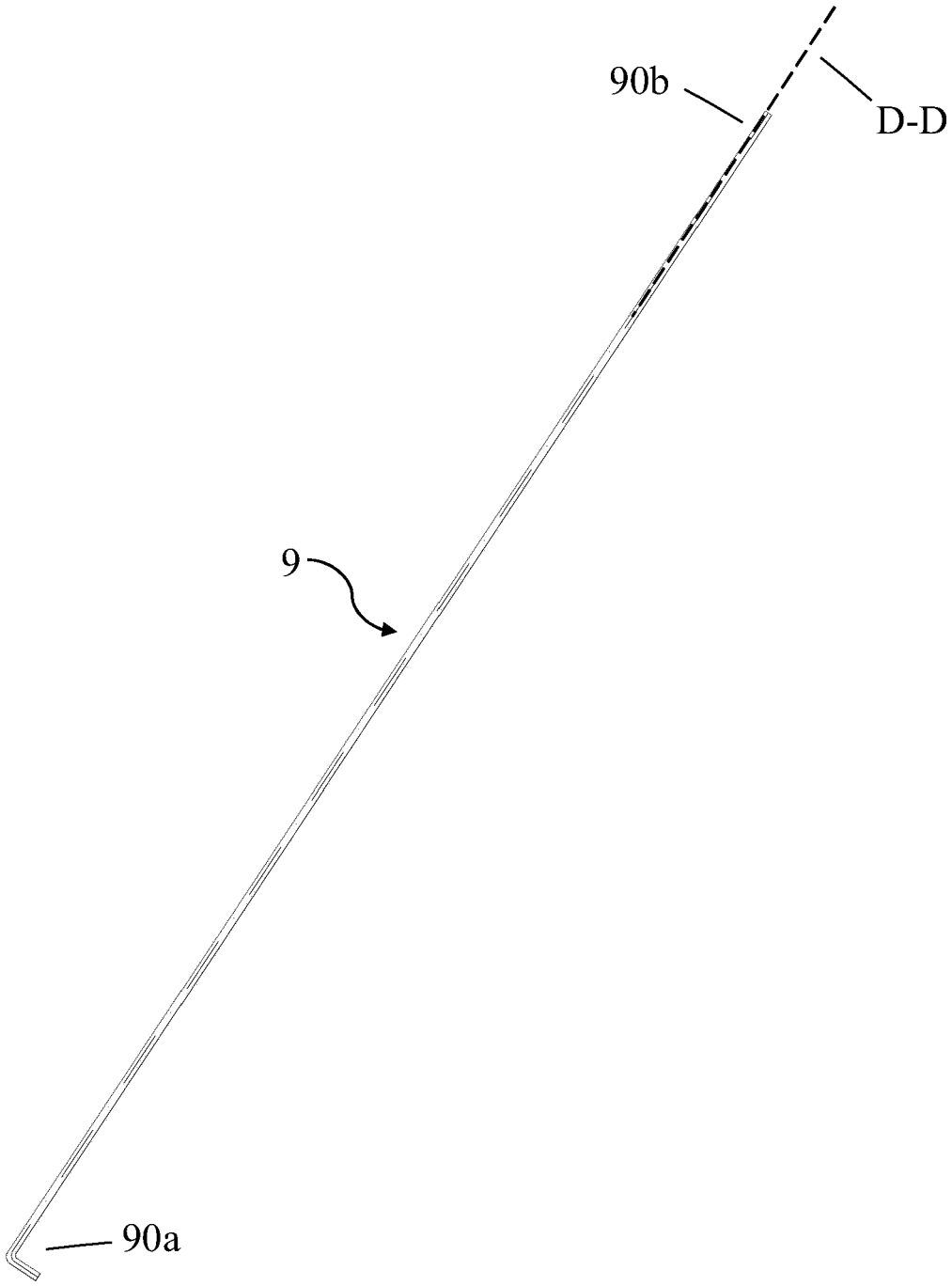


Fig. 7

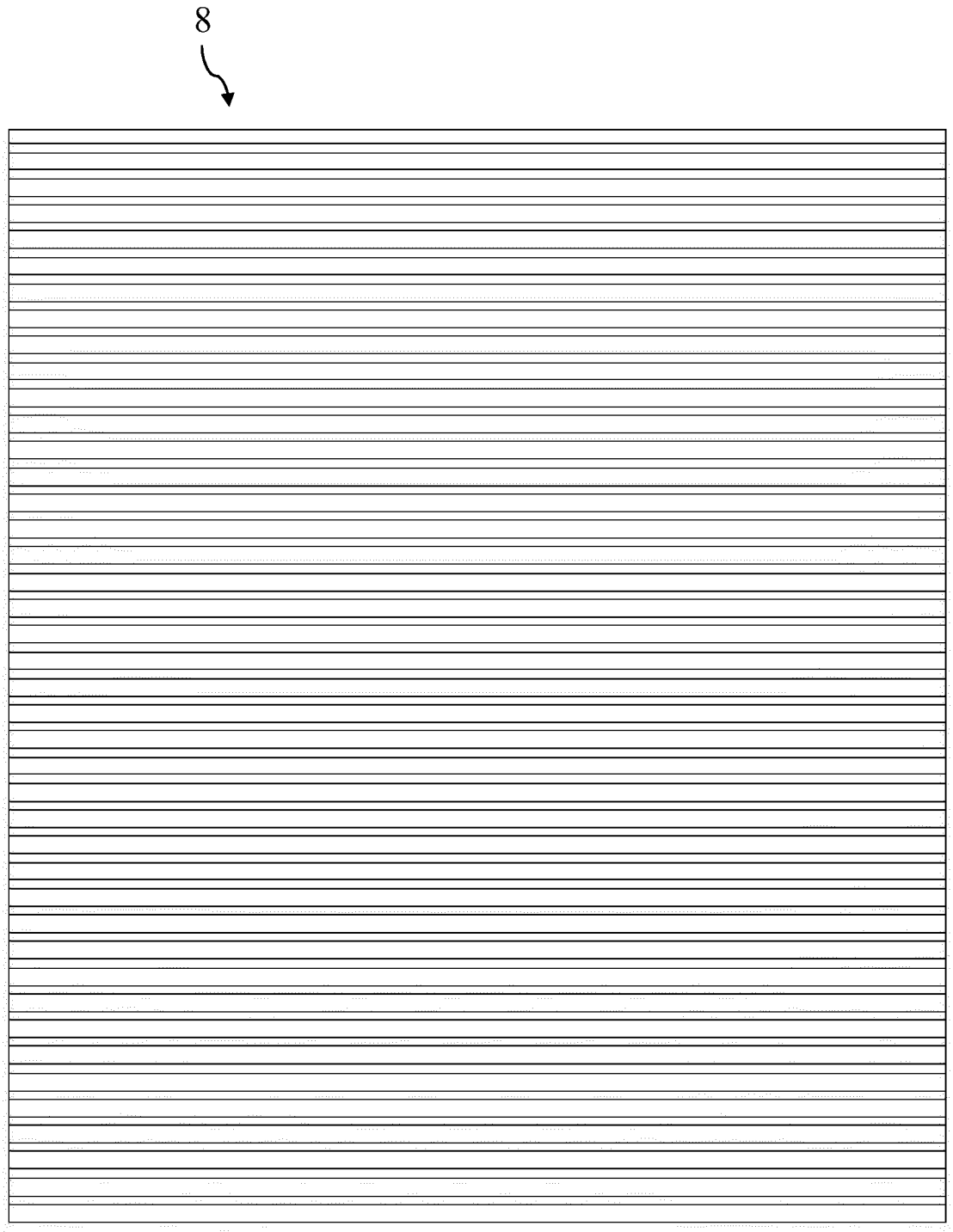


Fig. 8

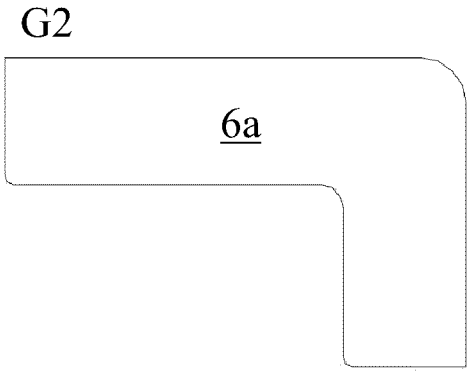


Fig. 9a

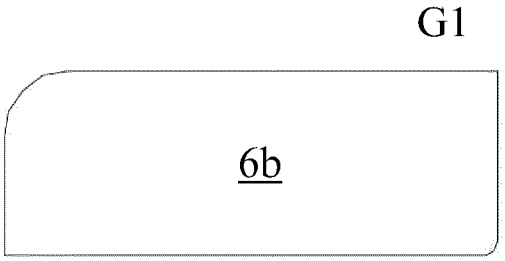


Fig. 9b

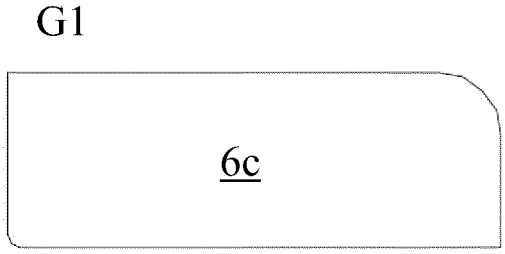


Fig. 9c

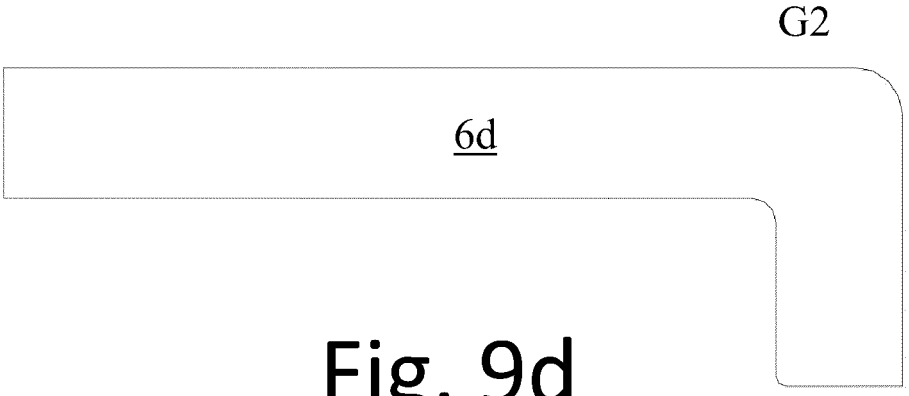


Fig. 9d

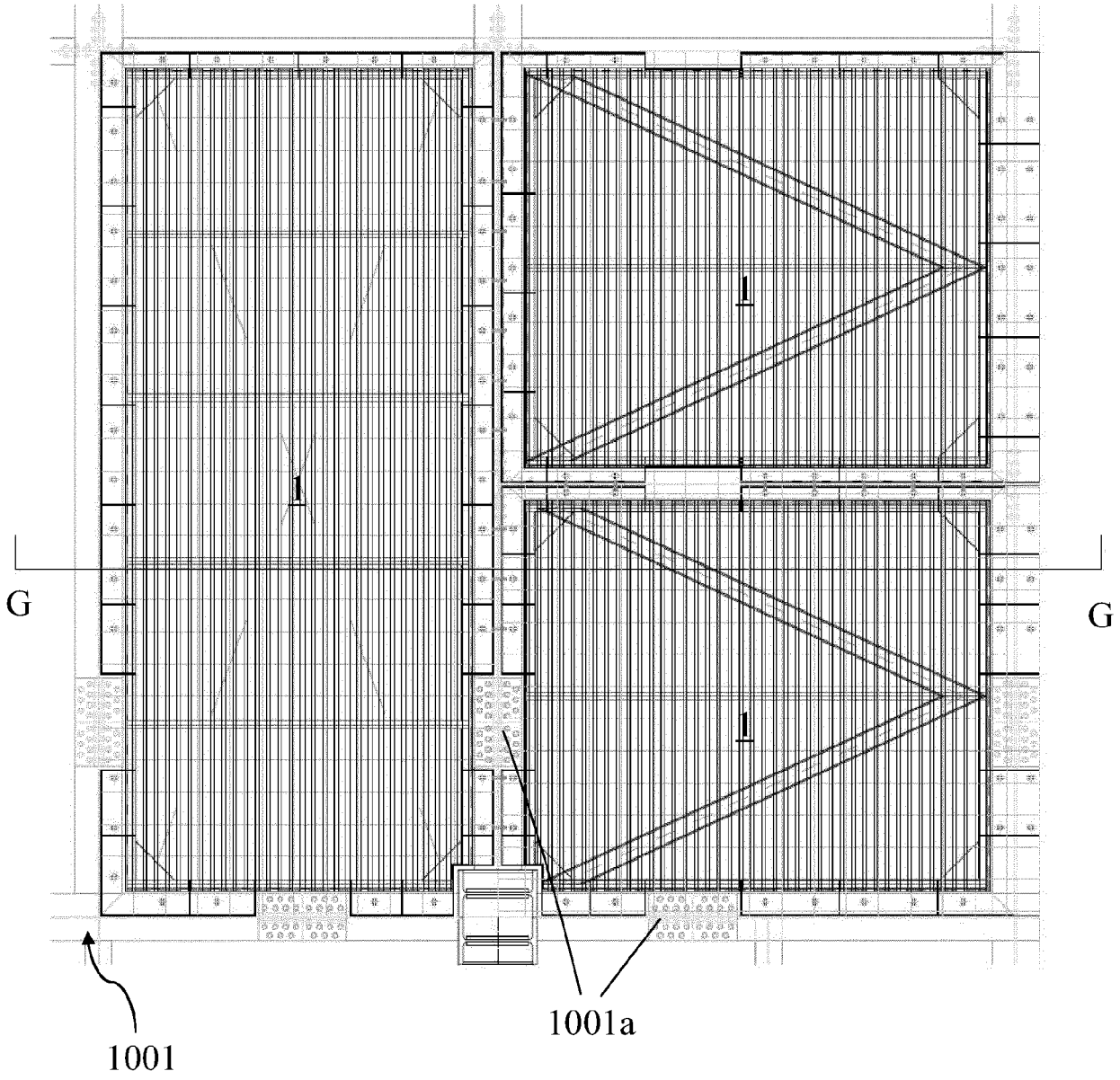


Fig. 10

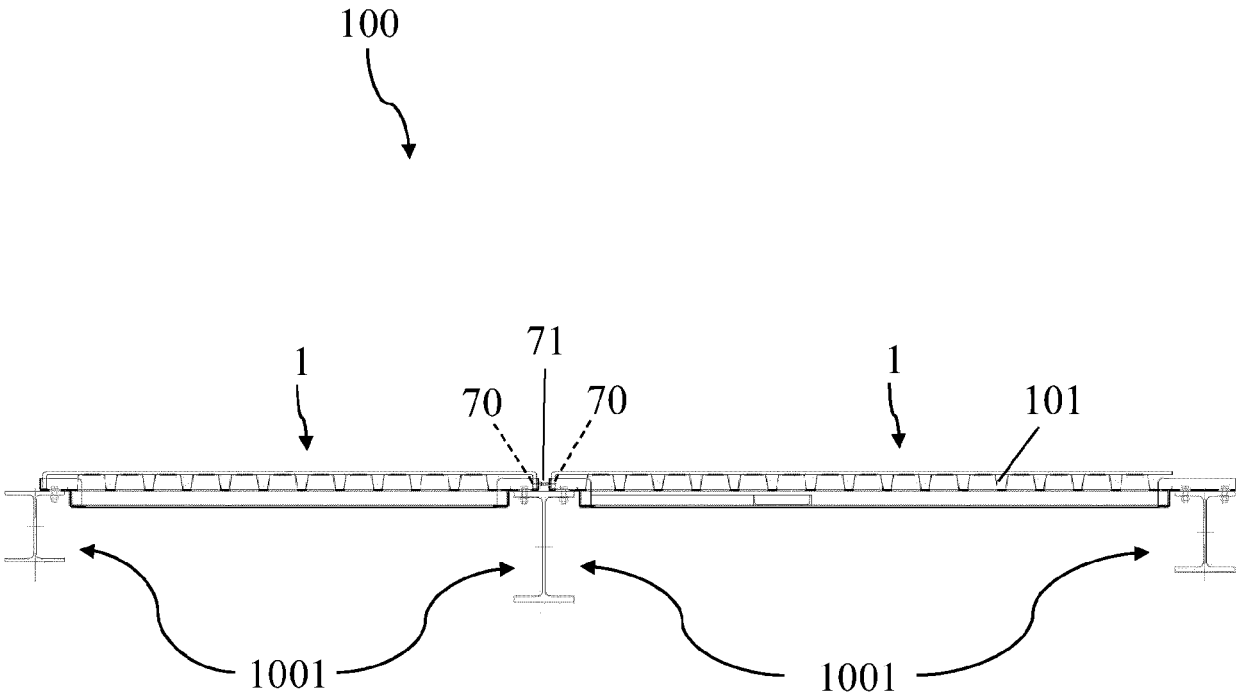


Fig. 11

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 17 5638

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	GB 2 165 870 A (HONG SHEET METAL) 23 April 1986 (1986-04-23) * figures 1-22 *	1-3, 11-14	INV. E04B5/10 E04B5/40
X A	WO 2015/087070 A1 (LAING O ROURKE PLC [GB]) 18 June 2015 (2015-06-18) * figures 1-9 *	1-9, 11-15 10	
X	EP 1 650 371 A1 (OSPINA CABEZAS PEDRO NEL [EC]) 26 April 2006 (2006-04-26) * figures 1-7 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

E04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 September 2024	Petrinja, Etiel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 17 5638

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-09-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2165870 A	23-04-1986	NONE	
WO 2015087070 A1	18-06-2015	AU 2014363228 A1	07-07-2016
		GB 2535955 A	31-08-2016
		WO 2015087070 A1	18-06-2015
EP 1650371 A1	26-04-2006	AT E393271 T1	15-05-2008
		CN 1823203 A	23-08-2006
		EC SP034697 A	28-06-2004
		EP 1650371 A1	26-04-2006
		US 2008083181 A1	10-04-2008
		WO 2005007986 A1	27-01-2005

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- IT 102021000009668 **[0007] [0010]**