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(71) Applicant: **Briqueteries de Ploegsteert SA**
7783 Le Bizet (BE)

(72) Inventor: **COSNIER, Bernard**
59520 Halluin (FR)

(74) Representative: **Gevers Patents**
Intellectual Property House
Holidaystraat 5
1831 Diegem (BE)

(54) **AN IMPROVED PRE-FABRICATED LIGHTWEIGHT JOIST FOR CONSTRUCTING CONCRETE FLOORS**

(57) A pre-fabricated lightweight joist (1) for constructing concrete floors, the joist (1) comprising an elongated channel (2) for receiving concrete, the joist (1) further comprising an elongated lattice structure (5) formed by an elongated upper bar (6) connected by a truss (7) to two elongated lower bars (8a, 8b), wherein the two elongated lower bars (8a, 8b) are mechanically anchored within the elongated channel (2), wherein each one of

the opposing sidewalls (4a, 4b) of the elongated channel (2) is provided with an elongated groove (9a, 9b), and wherein the two elongated lower bars (8a, 8b) are mechanically anchored within the elongated channel (2) by extending at least one anchoring plate (10) between the elongated grooves (9a, 9b) such that the at least one anchoring plate (10) is provided between the two elongated lower bars (8a, 8b) and the elongated upper bar (6).

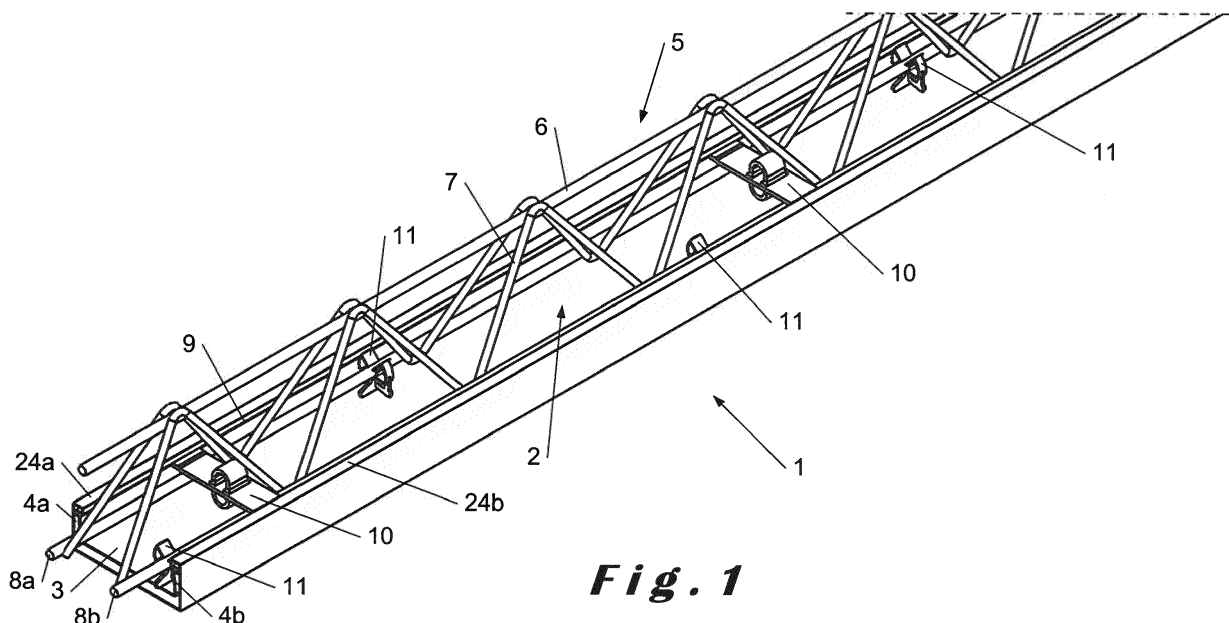


Fig. 1

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Description

Technical Field

[0001] The present invention relates to a pre-fabricated lightweight joist for constructing concrete floors. The invention further relates to an intermediate structure and a concrete floor comprising the pre-fabricating lightweight joists. The invention further relates to a method for making the pre-fabricated lightweight joists.

State of the art

[0002] The manufacture of concrete floors, for example spanning between multiple supporting walls of a construction such as a building, is known in the state of the art. The conventional method comprises as a first step providing a plurality of elongated joists extending in a longitudinal direction, each joist comprising an elongated channel having a substantially U-shaped cross-section delimited by a bottom wall and two opposing sidewalls, and an elongated lattice structure formed by an elongated upper bar connected by a truss to two elongated lower bars, wherein the two elongated lower bars are positioned within the elongated channel along the longitudinal direction. The plurality of joists are positioned parallel to each other on the supporting walls, for example with their longitudinal extremities, in particular with the longitudinal extremities of their elongated lattice structure, supported by opposing supporting walls. Vertical loads exerted onto the joists are supported by vertical load supporting means such as the opposing supporting walls and such as temporary shoring posts supporting the elongated channel at discrete positions along the longitudinal direction. A space is left between neighboring parallel joists, which space is subsequently bridged by positioning interjoist components such as hollow-core slabs in between two neighboring joists. The interjoist components are typically supported by free ends of the elongated channel sidewalls of two neighboring joists. The joists supported a.o. on the supporting walls and the interjoist components supported on the sidewalls of the elongated channels together form an intermediate structure which remains as such for a substantial amount of time i.e. until in a final manufacturing step concrete is poured onto the intermediate structure such as to create the final concrete floor. This intermediate structure of joists and interjoist components must however be mechanically stable prior to pouring the concrete, i.e. it must be able to support substantial weights, for example of construction workers walking on the intermediate structure. It is therefore important that the two elongated lower bars are mechanically anchored to the elongated channel prior to pouring the concrete onto the intermediate structure. By mechanically anchoring the two elongated lower bars into their elongated channel, the weight exerted onto the interjoist components is securely supported by the vertical load supporting means via the elongated lattice structure, sub-

stantially independent of the vicinity of the vertical load supporting means to the position of vertical load application.

[0003] In the state of the art, the two elongated lower bars are mechanically anchored into the elongated channel by pre-filling the elongated channel with concrete such as to surround the two elongated lower bars with concrete, which after hardening forms a mechanically stable joist. It is however desirable to pre-fabricate the joists, for example at a factory, and to transport the pre-fabricated joists to the construction location where the concrete floor has to be constructed. Pre-fabricated joists are particularly desired in order to decrease construction times. Pre-fabricated joists wherein concrete is pre-filled in the elongated channel is however not practical, as the concrete substantially increases the weight of the pre-fabricated joists. These high-weight pre-fabricated joists are costly to transport from the factory to the construction location, and are particularly difficult to install, i.e. to lift the joists up to the position where it is supported by opposing supporting walls.

[0004] In the state of the art it is furthermore known to provide light-weight pre-fabricated joist. One such joist is disclosed in patent publication WO2016005679. These light-weight joists are not pre-filled with concrete, making them easier to transport and to install. These light-weight joists are furthermore provided with at least one spacer extending between the bottom wall of the elongated channel and the two elongated lower bars, such as to elevate the two elongated lower bars with respect to the bottom wall in order to ensure that the two elongated lower bars can be optimally surrounded by filling material such as concrete. The spacers of the prior art are for example constructed as clamping elements configured to receive and clamp the two elongated lower bars. In particular, the clamping element in patent publication WO2016005679 is referred to as a 'linking shim 5'. It has however been found in the present invention, that the intermediate structures formed by the light-weight pre-fabricated joists of the state of the art substantially lack mechanical stability. It has in particular been found that there is a risk that, upon vertically loading the intermediate structure, in particular an interjoist component of the intermediate structure, for example by a construction worker standing on an interjoist component, the free ends of the elongated channel sidewalls supporting the loaded interjoist component are bended towards the loaded interjoist component, to such a degree that the elongated lower bars closest to the interjoist component are released from the spacer such as the clamping element, thereby decreasing the mechanical stability of the intermediate structure. In the state of the art, in particular in patent publication WO2016005679, the lack of mechanical stability of the intermediate structure has been attempted to be solved by pre-filling the elongated channel with a lightweight filling material such as polyurethane that surrounds the two lower elongated bars.

Detailed description of the invention

[0005] It is a goal of the present invention to provide a lightweight pre-fabricated joist for manufacturing a concrete floor wherein the problem of mechanical stability in particular of the intermediate structure, as encountered in the state of the art, in particular in patent publication WO2016005679, is solved. Therefore, the present invention provides a lightweight pre-fabricated joist according to the first claim. The pre-fabricated lightweight joist for constructing concrete floors according to the present invention comprises an elongated channel for receiving concrete, wherein the elongated channel extends along a longitudinal direction. The elongated channel has a substantially U-shaped cross-section delimited by a bottom wall and two opposing sidewalls. Each of the walls of the elongated channel in particular extends along the longitudinal direction. The U-shaped cross-section is preferably taken along a plane perpendicular to the longitudinal direction. The joist further comprises an elongated lattice structure, in particular extending in the longitudinal direction. The lattice structure is formed by an elongated upper bar connected by a truss, for example a sinusoidal truss, to two elongated lower bars, for example forming a triangular structure in a plane perpendicular to the longitudinal direction. The lattice structure is preferably a metallic structure for example comprising steel. The two elongated lower bars are mechanically anchored within the elongated channel along the longitudinal direction. Each one of the opposing sidewalls of the elongated channel is thereto provided with first anchoring means, preferably comprising an elongated groove, i.e. elongated along the longitudinal direction. The joist further comprises at least one anchoring plate, for example arranged to engage the first anchoring means, preferably arranged to engage with the elongated grooves provided in the opposing sidewalls of the elongated channel. Each anchoring plate for example comprises second anchoring means complementary to the first anchoring means, the second anchoring means preferably comprising opposing first and second edges, forming protrusions suited to be inserted into the elongated grooves provided in the opposed sidewalls of the elongated channel. The two elongated lower bars of the elongated lattice are located within the elongated channel between the bottom wall of the elongated channel and the first anchoring means such as preferably the elongated grooves. The two elongated lower bars are mechanically anchored within the elongated channel by extending the at least one anchoring plate between the first anchoring means such as preferably the elongated grooves for example provided in the opposing sidewalls of the elongated channel, such that the at least one anchoring plate is provided between the two elongated lower bars and the elongated upper bar. The anchoring plate for example interconnects the opposing first anchoring means, for example interconnects the elongated grooves in the opposing sidewalls of the elongated channel.

[0006] It has been found that the joist of the present invention confers the desired mechanical stability to the resulting intermediate structure of joists and interjoist components, whilst limiting the weight of the joists thus enabling facilitated transport between the factory where the joists are pre-fabricated and the construction location, as well as enabling facilitated use of the pre-fabricated joists at the construction location such as facilitated mounting of the pre-fabricated joists onto the vertical load supporting means. It has in particular been found that the elongated channel sidewalls of the joists of the present invention, when assembled into the intermediate structure comprising parallel joists and interjoist components supported on the free ends of the sidewalls of neighboring parallel joists, have a limited tendency to bend towards the loaded interjoist component, thus limiting the risk that the elongated lower bars are released from the elongated channels, thus limiting the risk of mechanical instability of the intermediate structure. Without wanting to be bound by a theory, it is believed that the free ends of the sidewalls adjacent the loaded interjoist component are prevented from bending towards the interjoist component because the anchoring plate, being interconnected to both the opposing sidewalls of the elongated channel, acts as a spring countering the bending of the free end of the sidewall.

[0007] It is a further advantage of the present invention, in particular were spacers such as clamping elements are provided, such as the clamping elements disclosed in WO2016005679, that the at least one anchoring plate provides additional security means, for example maintaining mechanical stability even when elongated lower bars are unintentionally released from the clamping elements.

[0008] It is a further advantage of the present invention that elongated channels of the light-weight pre-fabricated joists of the present invention are not required to be filled with a filling material such as concrete or polyurethane in order to confer the mechanical stability to the joists and intermediate structures. This has the advantage that the elongated channel can be filled with concrete in the final step of manufacturing the concrete floor, namely when concrete is poured over the intermediate structure. The concrete that surrounds the two elongated lower bars in the elongated channel is therefore substantially monolithic with the remaining concrete in the concrete floor such as the concrete provided over the interjoist components. Providing a monolithic concrete structure drastically increases the mechanical stability of the concrete floor with respect to concrete floors comprising pre-filled joists such as joists pre-filled with concrete or pre-filled with polyurethane. In concrete floors comprising pre-filled joists an interface layer is present between the pre-filled material and the concrete that is poured during the final manufacturing step. It has been found that this interface layer is particularly prone to crack formation under excessive mechanical stress, for example upon bending of the joist due to vertical loads being applied to

it. It has particularly been found that cracks tend to form at the interface layer when the concrete floor is subject to fire, due to amongst others the bending of the joists due to the thermal expansion of the lattice structure. It has furthermore been found that many of the light-weight filling materials such as polyurethane that are used for pre-filling the joists have a low fire resistance and are thus subject to rapid mechanical degradation in case of fires. In particular in the case of joists that are pre-filled with polyurethane, it has been found that the polyurethane rapidly succumbs to the fire, leaving the lattice structure unsupported and accessible to the fire, causing swift collapse of the concrete floor. It has been found that concrete floors comprising the light-weight pre-fabricated joists according to the present invention have an increased resistance to residential fires, for example comprising at least 60 minutes. It has furthermore been found that fluids such as water, as well as moisture, for example caused by a leak, tend to penetrate the concrete floor along the interface layer, thereby subjecting the lattice structure to corrosion over time. This corrosion of the lattice structure drastically reduces the mechanical stability of the joists and intermediate components in the state of the art.

[0009] It is a further advantage of the present invention that the type and/or number of anchoring plates can be easily changed, for example increased, even after fabrication of the joists, for example until the pouring of the concrete in the last manufacturing step. It has in particular been found that an additional anchoring plate, for example of a different type than the anchoring plates already attached to the elongated channel, can be easily attached to the first anchoring means of the elongated channel such as to the elongated grooves provided in the opposed elongated channel sidewalls. The attachment of an additional anchoring plate for example does not require the removal of the elongated lattice and/or the other anchoring plates, from the elongated channel. Changing the amount and/or type of anchoring plates can for example be performed at the construction location, for example in view of changed loading requirements for the joists.

[0010] According to an embodiment of the present invention the at least one anchoring plate contacts the two elongated lower bars. A vertical load being applied to an interjoist component in the intermediate structure would push the channel downwards. As a consequence, also the interconnected anchoring plates are pushed downwards due to the vertical load. As the anchoring plates are placed above the two elongated lower bars, the anchoring plates will be supported by the elongated lattice structure, thus preventing further downward movement of the channel. The elongated lattice structure thus efficiently transfers the vertical load to the vertical load supporting means.

[0011] According to an embodiment of the present invention the elongated channel has a height direction, preferably perpendicular to the bottom wall i.e. when the

bottom wall is flat. The elongated channel further has a width direction perpendicular to the longitudinal direction and the height direction, i.e. extending between the opposing sidewalls of the channel. The two elongated lower bars are mechanically anchored within the elongated channel by eliminating the translational degrees of freedom along the height direction, for example at least preventing the separation of the channel and the elongated lattice structure along the height direction.

[0012] According to an embodiment of the present invention the elongated channel is provided with spacers fixed to the bottom wall, wherein the spacers hold the two elongated lower bars at an elevated position with respect to the bottom wall. Providing spacers enables the concrete to better surround the two elongated lower bars when pouring the concrete in the last step of manufacturing the concrete floor. As an example the component referred to as 'linking shim 5' in patent publication WO2016005679 can be provided as a spacer. Preferably, the spacers are arranged to accommodate different types of lattice structures, i.e. as well lattice structures having elongated lower bars with large diameters and lattice structures having elongated lower bars with small diameters.

[0013] According to an embodiment of the present invention the two elongated lower bars are mechanically anchored within the elongated channel by further eliminating the translational degrees of freedom along the width direction, preferably by providing the spacers engaging the elongated lower bars. According to an embodiment of the present invention the two elongated lower bars are mechanically anchored within the elongated channel by further eliminating all rotational degrees of freedom. The present embodiment is preferably obtained by providing at least two non-axially positioned spacers, i.e. by providing at least one spacer for each elongated lower bar.

[0014] According to an embodiment of the present invention, the first anchoring means, preferably the elongated grooves such as the elongated groove provided in each sidewall, extend parallel to each other substantially in the longitudinal direction, preferably along substantially the entire length of the elongated channel, for example along the entire length of the elongated channel. Providing parallel first anchoring means facilitates the engagement with the anchoring plate. Preferably, the first anchoring means are provided within the channel, i.e. not on a surface of the sidewall outside of the channel. Preferably, the first anchoring means are provided adjacent to the sidewall free ends, thereby optimally preventing the bending of the sidewalls towards the adjacent loaded interjoist component.

[0015] According to an embodiment of the present invention, multiple anchoring plates are provided along the longitudinal direction. Preferably, the multiple anchoring plates are separated from each other along the longitudinal direction such as to allow the pouring of concrete into the elongated channel in the final manufacturing step

for making the concrete floors.

[0016] According to an embodiment of the present invention, the anchoring plate has a width extending between a first edge and an opposing second edge, a thickness extending between a first major surface and an opposing second major surface, and a depth extending between a third edge and an opposing fourth edge, wherein the width is bigger than the depth, and wherein the depth is bigger than the thickness. Preferably, the second anchoring means are provided along the first and second edges of the anchoring plates. Preferably, the first and second edges are the second anchoring means, i.e. form protrusions arranged to engage within the elongated grooves provided in the opposing channel sidewalls. In this case preferably the thickness of the anchoring plate, at least adjacent the first and second edges, is substantially equal, for example only slightly superior, to the height of the opening of the elongated grooves such that the anchoring plate can be securely press-fitted into the elongated grooves.

[0017] According to an embodiment of the present invention, the anchoring plate is movable between a first position wherein the second anchoring means provided on the anchoring plate engage the first anchoring means of the sidewalls, and a second position wherein the second anchoring means provided on the anchoring plate are disengaged from the first anchoring means of the sidewalls. Preferably, the anchoring plate can be brought from the second position to the first position, as well as from the first position to the second position, i.e. the anchoring plate is releasably engaged to the channel. Providing releasably connected anchoring plates enables to easily adjust the spacing between the anchoring plates, for example performed at the construction location, for example in view of changed loading requirements for the joists. According to a first implementation of the present embodiment, the anchoring plate is rotatable between a first position wherein the second anchoring means provided on the anchoring plate engage the first anchoring means of the sidewalls, and a second position wherein the second anchoring means provided on the anchoring plate are disengaged from the first anchoring means of the sidewalls. Preferably, the anchoring plate is rotatable between a first position wherein the first edge and the second opposing edge of the anchoring plate engage the opposing elongated grooves of the sidewalls, and a second position wherein the first edge and the second opposing edge of the anchoring plate are disengaged from the opposing grooves of the sidewalls. According to an alternative or complementary implementation of the present embodiment, the anchoring plate is bendable along its depth direction between a first position wherein the anchoring plate is substantially unbended such that second anchoring means provided on the anchoring plate engage the first anchoring means of the sidewalls, and a second position wherein the anchoring plate is substantially bended such that the second anchoring means provided on the anchoring plate are disengaged from the

first anchoring means of the sidewalls. Preferably, the anchoring plate is bendable along its depth direction between a first position wherein the anchoring plate is substantially unbended such that first edge and the second opposing edge of the anchoring plate engage the opposing elongated grooves of the sidewalls, and a second position wherein the anchoring plate is substantially bended such that the first edge and the second opposing edge of the anchoring plate is disengaged from the opposing grooves of the sidewalls.

[0018] According to an embodiment of the present invention, in particular where the first anchoring means are elongated grooves for example penetrating the sidewall in the width direction of the channel and extending along the longitudinal direction along the channel, the perpendicular distance between the bottoms of the opposing elongated grooves defines an inter-groove width. The bottoms of the elongated grooves are for example the positions along the width direction where the groove stops. The inter-groove width is preferably substantially constant along the longitudinal direction of the channel. The width of the anchoring plate is preferably equal or superior to the inter-groove width. The width of the anchoring plate is preferably substantially equal, for example only slightly superior to the inter-groove width, such that such that the anchoring plate can be securely press-fitted into the elongated grooves.

[0019] According to an embodiment of the present invention, the anchoring plate is provided with a protrusion extending from at least one of, preferably both of, the major surfaces of the anchoring plate in the height direction of the anchoring plate, wherein the protrusion is provided with a tunnel extending in the depth direction of the anchoring plate, wherein the tunnel is configured to receive a third elongated lower bar. The third elongated lower bar is preferably a metallic bar and preferably extends substantially parallel to two elongated lower bars of the lattice structure. The third elongated lower bar is preferably inserted into the tunnels once all anchoring plates are attached to the channel.

[0020] According to an embodiment of the present invention, the anchoring plate is a substantially flat plate. The anchoring plate for example is not curved.

[0021] According to an embodiment of the present invention, the anchoring plate comprises substantially flat end sections proximate the first edge and opposing second edge, and a substantially flat middle section between the end sections, wherein the middle section forms a raised plateau with respect to the end sections, and wherein the middle section is arranged to contact the two elongated lower bars. Preferably, the first and second end sections of the anchoring plate are symmetrically disposed to each other. The present embodiment has the particular advantage that one anchoring plate can be used for different types of lattice structures, i.e. for lattice structures having elongated lower bars with large diameters and small diameters. By merely flipping over the anchoring plate, for example such that the major surface

of the anchoring plate that previously faced the bottom wall of the channel is now facing towards the elongated upper bar, the distance between the raised plateau of the anchoring plate and the bottom wall can be adapted. When a lattice structure with small diameter elongated bars is used, the anchoring plate can for example be provided with the raised plateau bulging towards the bottom wall of the channel, such as to ensure that the anchoring plate engages and thus mechanically anchors the two elongated lower bars of the lattice structure. When a lattice structure with large diameter elongated bars is used, the anchoring plate can for example be flipped with the raised plateau bulging away from the bottom wall of the channel, such that the two elongated lower bars of the lattice structure to be placed between the anchoring plate and the bottom wall/or i.e. the spacers provided on the bottom wall.

[0022] According to an embodiment of the present invention, the elongated channel walls, for example the bottom wall and the opposing sidewalls, are made from a thermally insulating material, preferably a thermally insulating plastic material. The present embodiment has the advantage that the joist provides thermal insulation, without requiring to provide further insulation material such as polyurethane foam within the channel. The channel according to the present invention, as opposed to conventional metallic channels, does not form a cold bridge. The present invention thus enables to create a monolithic concrete floor, due to the lack of pre-filling of the channel, whilst ensuring sufficient thermal insulation.

[0023] According to an embodiment of the present invention, the two elongated lower bars are substantially surrounded by air. Upon transporting the joists from the factory to the construction site, their channels are not filled, in particular not filled with concrete or polyurethane foam. The joists of the present invention thus are lightweight pre-fabricated joists, which are mechanically stable when assembled into an intermediate structure and which enable to provide a concrete floor where the concrete is substantially monolithic. According to an embodiment of the present invention, the joist is provided with at least one supporting element at each of its longitudinal extremities. The supporting element is provided with a top surface on which the two elongated lower bars of the lattice structure rest. The supporting element is furthermore provided with a bottom surface resting on the supporting wall of the construction such as the building. The supporting element for example transfers vertical loads from the lattice structure onto the supporting wall of the construction, enabling to optimally release the channel from the vertical load transmission to the supporting wall. The supporting element is preferably attached to the lattice structure, for example by welding or clamping the supporting element to the two elongated lower bars.

[0024] It is a further object of the present invention to provide an intermediate structure comprising at least two pre-fabricated lightweight joists as described above, and wherein an interjoist component is supported by the side-

wall free ends of the elongated channels of neighboring joists. In the intermediate structure the joists are supported by vertical load supporting means such as opposing supporting walls of the construction and optionally temporary shoring posts. The intermediate structure is not yet provided with concrete. Concrete is poured in the last manufacturing step for creating the concrete floor. According to an embodiment of the present invention, the two elongated lower bars in the intermediate structure are substantially surrounded by air.

[0025] It is a further object of the present invention to provide a concrete floor comprising at least two pre-fabricated lightweight joists as described above, and wherein an interjoist component is supported by the sidewall free ends of the elongated channels of neighboring joists, and wherein concrete has been poured on the joists and the interjoist component such as to substantially surround the elongated bars of the lattices of each joist. The concrete floor according to the present invention is a monolithic concrete structure, wherein no interface layer is present between the concrete provided in the channel and the concrete provided on the interjoist components.

[0026] It is a further object of the present invention to provide a method for making the pre-fabricated lightweight joist as described above. The method comprises the subsequent steps of:

- providing the elongated channel, the elongated lattice structure and the at least one anchoring plate,
- placing the two elongated lower bars of the elongated lattice structure between the bottom wall of the elongated channel and the first anchoring means, preferably the elongated grooves,
- mechanically anchoring the elongated lattice structure to the elongated channel by mating the second and first anchoring means, preferably by inserting the anchoring plate into the elongated grooves such that the anchoring plate extends between the elongated grooves, preferably such that the anchoring plate is placed between the two elongated lower bars on the one hand and the elongated upper bar on the other hand.

[0027] According to an embodiment of the method of the present invention, the step of mechanically anchoring the elongated lattice structure to the elongated channel comprises rotating the at least one anchoring plate from the second position to the first position.

Figures

[0028]

Figure 1 shows a perspective view of a joist according to one embodiment of the present invention.

Figure 2 shows a perspective view of an intermediate structure according to one embodiment of the present invention.

Figure 3 shows a perspective view of an anchoring plate according to one embodiment of the present invention.

Figures 4 and 5 show a joist according to an embodiment of the present invention, wherein two different types of lattice structures are anchored to the channel

Description of the figures

[0029] The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims. The drawings described are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. The dimensions and the relative dimensions do not necessarily correspond to actual reductions to practice of the invention.

[0030] Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. The terms are interchangeable under appropriate circumstances and the embodiments of the invention can operate in other sequences than described or illustrated herein.

[0031] Furthermore, the various embodiments, although referred to as "preferred" are to be construed as exemplary manners in which the invention may be implemented rather than as limiting the scope of the invention.

[0032] The term "comprising", used in the claims, should not be interpreted as being restricted to the elements or steps listed thereafter; it does not exclude other elements or steps. It needs to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising A and B" should not be limited to devices consisting only of components A and B, rather with respect to the present invention, the only enumerated components of the device are A and B, and further the claim should be interpreted as including equivalents of those components.

Figure 1 shows a perspective view of a joist 1 according to one embodiment of the present invention. The joist 1 is a pre-fabricated lightweight joist 1 for constructing concrete floors. The joist 1 comprises an elongated channel 2 for receiving concrete, the elongated channel 2 extending along a longitudinal direction, the elongated channel 2 having a substantially U-shaped cross-section delimited by a bottom wall 3 and two opposing sidewalls 4a, 4b. The elongated sidewalls 4a, 4b extend along a height direction from the bottom wall 3 up to a free end 24a, 24b. The free ends 24a, 24b of the sidewalls 4a, 4b are arranged for, in use, supporting interjoist components.

The joist 1 further comprising an elongated metallic lattice structure 5 formed by an elongated upper bar 6 connected by a V-shaped truss, i.e. an armature, to two elongated lower bars 8a, 8b. Each one of the opposing sidewalls 4a, 4b of the elongated channel 2 is provided with a first anchoring means comprising an elongated groove 9a, 9b extending in the longitudinal direction adjacent to the free ends 24a, 24b of the sidewalls 4a, 4b. The joist 1 further comprises multiple anchoring plates 10 arranged to alleviate the separation of the channel 2 and the lattice structure 5 along the height direction. Therefore, the two elongated lower bars 8a, 8b of the elongated lattice 5 are located within the elongated channel 2 between the bottom wall 3 of the elongated channel 2 and the elongated grooves 9a, 9b. The two elongated lower bars 8a, 8b are mechanically anchored within the elongated channel 2 by extending the multiple anchoring plates 10 between the elongated grooves 9a, 9b such that the multiple anchoring plates 10 are provided between the two elongated lower bars 8a, 8b and the elongated upper bar 6. The two elongated lower bars 8a, 8b are raised with respect to the bottom wall 3 of the channel 2 by a set of spacers 11.

Figure 2 shows a perspective view of an intermediate structure 22 according to one embodiment of the present invention. The intermediate structure 22 comprises multiple two pre-fabricated lightweight joists 1 such as the joists 1 presented in figure 1. Multiple interjoist component 23 are supported by the sidewall free ends 24a, 24b of the elongated channels 2 of neighboring joists 1. At their longitudinal extremities, the joists 1 are supported on opposing supporting walls of the construction, for example of the building. A concrete floor can be formed by pouring concrete onto the intermediate structure 22.

Figure 3 shows a perspective view of an anchoring plate 10 according to one embodiment of the present invention, for example as used in the joists 1 of figure 1 or 2. The anchoring plate 10 has a width extending between a first edge 12 and an opposing second edge 13, a thickness extending between a first major surface 14 and an opposing second major surface 15, and a depth extending between a third edge 16 and an opposing fourth edge 17. The width is bigger than the depth, and the depth is bigger than the thickness. The first and second edges 12, 13 are the second anchoring means, i.e. form protrusions arranged to engage within the elongated grooves 9a, 9b provided in the opposing channel sidewalls 4a, 4b. The anchoring plate 10 is provided with two protrusions 18a, 18b each one extending from the major surfaces 14, 15 of the anchoring plate in the height direction of the anchoring plate 10. Each protrusion 18a, 18b is provided with a tunnel 19a, 19b extending in the depth direction of the anchoring plate 10. The tunnel 19a, 19b is configured to receive a third elongated metallic lower bar. The anchoring plate 10 comprises substantially flat end sections 20b, 20a proximate the first edge 12 and opposing second edge 13, and a substantially flat middle section 21 between the end sections 20a, 20b. The mid-

dle section 21 forms a raised plateau with respect to the end sections 20a, 20b. The middle section 21 is arranged to contact the two elongated lower bars 8a, 8b. The present embodiment has the particular advantage that one anchoring plate 10 can be used for different types of lattice structures 5, i.e. for lattice structures 5 having elongated lower bars 8a, 8b with large diameters and small diameters as respectively shown in figures 4 and 5. By merely flipping over the anchoring plate 10, for example such that the major surface 15 of the anchoring plate 10 that previously faced the bottom wall 3 of the channel 2 is now facing towards the elongated upper bar 6, the distance between the anchoring plate 10 and the bottom wall 3 can be adapted. When a lattice structure 5 with small diameter elongated bars 8a, 8b is used, as shown in figure 5, the anchoring plate 10 can for example be provided with the raised plateau 21 bulging towards the bottom wall 3 of the channel 2, such as to ensure that the anchoring plate 10 engages and thus mechanically anchors the two elongated lower bars 8a, 8b of the lattice structure 5. When a lattice structure 5 with large diameter elongated bars 8a, 8b is used, as shown in figure 4, the anchoring plate 10 can for example be flipped with the raised plateau 21 bulging away from the bottom wall 3 of the channel 2, such that the two elongated lower bars 8a, 8b of the lattice structure 5 can be placed between the anchoring plate 10 and the spacers 11 provided on the bottom wall 3.

Claims

1. A pre-fabricated lightweight joist (1) for constructing concrete floors, the joist (1) comprising an elongated channel (2) for receiving concrete, the elongated channel (2) extending along a longitudinal direction, the elongated channel (2) having a substantially U-shaped cross-section delimited by a bottom wall (3) and two opposing sidewalls (4a, 4b), the joist (1) further comprising an elongated lattice structure (5) formed by an elongated upper bar (6) connected by a truss (7) to two elongated lower bars (8a, 8b), wherein the two elongated lower bars (8a, 8b) are mechanically anchored within the elongated channel (2) along the longitudinal direction, **characterized in that** each one of the opposing sidewalls (4a, 4b) of the elongated channel (2) is provided with an elongated groove (9a, 9b), wherein the joist (1) further comprises at least one anchoring plate (10), wherein the two elongated lower bars (8a, 8b) of the elongated lattice (5) are located within the elongated channel (2) between the bottom wall (3) of the elongated channel (2) and the elongated grooves (9a, 9b), and wherein the two elongated lower bars (8a, 8b) are mechanically anchored within the elongated channel (2) by extending the at least one anchoring plate (10) between the elongated grooves (9a, 9b) such that the at least one anchoring plate (10) is provided be-

tween the two elongated lower bars (8a, 8b) and the elongated upper bar (6).

2. The pre-fabricated lightweight joist (1) according to the preceding claim wherein the at least one anchoring plate (10) contacts the two elongated lower bars (8a, 8b).
3. The pre-fabricated lightweight joist (1) according to the preceding claim, wherein the elongated channel (2) has a height direction, and a width direction perpendicular to the longitudinal direction and the height direction, wherein the two elongated lower bars (8a, 8b) are mechanically anchored within the elongated channel (2) by eliminating the translational degrees of freedom along the height direction.
4. The pre-fabricated lightweight joist (1) according to the preceding claim, wherein the elongated channel (2) is provided with spacers (11) fixed to the bottom wall (3), wherein the spacers (11) hold the two elongated lower bars (8a, 8b) at an elevated position with respect to the bottom wall (3).
5. The pre-fabricated lightweight joist (1) according to any one of the preceding claims wherein the elongated grooves (9a, 9b) run parallel to each other substantially in the longitudinal direction, preferably along substantially the entire length of the elongated channel (2).
6. The pre-fabricated lightweight joist (1) according to any one of the preceding claims, wherein the anchoring plate (10) has a width extending between a first edge (12) and an opposing second edge (13), a thickness extending between a first major surface (14) and an opposing second major surface (15), and a depth extending between a third edge (16) and an opposing fourth edge (17), wherein the width is bigger than the depth, and wherein the depth is bigger than the thickness.
7. The pre-fabricated lightweight joist (1) according to the preceding claim, wherein the anchoring plate (10) is rotatable between a first position wherein the first edge (12) and the second opposing edge (13) of the anchoring plate (10) engage the opposing elongated grooves (9a, 9b) of the sidewalls (4a, 4b), and a second position wherein the first edge (12) and the second opposing edge (13) of the anchoring plate (10) are disengaged from the opposing grooves (9a, 9b) of the sidewalls (4a, 4b).
8. The pre-fabricated lightweight joist (1) according to the preceding claim, wherein the perpendicular distance between the bottoms of the opposing elongated grooves (9a, 9b) defines an inter-groove width, wherein the inter-groove width is substantially con-

stant along the longitudinal direction, and wherein the width of the anchoring plate (10) is equal or superior to the inter-groove width.

9. The pre-fabricated lightweight joist (1) according to any one of the preceding claims 6 - 8, wherein the anchoring plate (10) is provided with a protrusion (18a, 18b) extending from at least one of the major surfaces (14, 15) of the anchoring plate (10) in the height direction of the anchoring plate (10), wherein the protrusion (18a, 18b) is provided with a tunnel (19a, 19b) extending in the depth direction of the anchoring plate (10), wherein the tunnel (19a, 19b) is configured to receive a third elongated lower bar. 5
10. The pre-fabricated lightweight joist (1) according to any one of the preceding claims 6 -9, wherein the anchoring plate (10) comprises substantially flat end sections (20a, 20b) proximate the first edge (12) and opposing second edge (13), and a substantially flat middle section (21) between the end sections (20a, 20b), wherein the middle section (21) forms a raised plateau with respect to the end sections (20a, 20b), and wherein the middle section (21) is arranged to contact the two elongated lower bars (8a, 8b). 10 20 25
11. The pre-fabricated lightweight joist (1) according to any one of the preceding claims, wherein the elongated channel (2) walls (3, 4a, 4b) are made from a thermally insulating material, preferably a thermally insulating plastic material. 30
12. A intermediate structure (22) comprising at least two pre-fabricated lightweight joists (1) according to any one of the preceding claims, wherein an interjoist component (23) is supported by the sidewall free ends (24a, 24b) of the elongated channels (2) of neighboring joists (1). 35
13. A concrete floor comprising at least two pre-fabricated lightweight joists (1) according to any one of the preceding claims 1 -11, wherein an interjoist component (23) is supported by the sidewall free ends (24a, 24b) of the elongated channels (2) of neighboring joists (1), wherein concrete has been poured on the joists (1) and the interjoist component (23) such as to substantially surround the elongated bars (6, 8a, 8b) of the lattices (5) of each joist (1). 40 45
14. Method for making the pre-fabricated lightweight joist (1) according to any one of the preceding claims 1 - 11, the method comprising the subsequent steps of: 50
 - providing the elongated channel (2), the elongated lattice structure (5) and the at least one anchoring plate (10), 55
 - placing the two elongated lower bars (8a, 8b)

of the elongated lattice structure (5) between the bottom wall (3) of the elongated channel (2) and the elongated grooves (9a, 9b),

- mechanically anchoring the elongated lattice structure (5) to the elongated channel (2) by inserting the anchoring plate (10) into the elongated grooves (9a, 9b) such that the anchoring plate (10) extends between the elongated grooves (9a, 9b).

15. Method according to the preceding claim, for making the pre-fabricated lightweight joist (1) according claim 7, wherein the step of mechanically anchoring the elongated lattice structure (5) to the elongated channel (2) comprises rotating the at least one anchoring plate (10) from the second position to the first position.

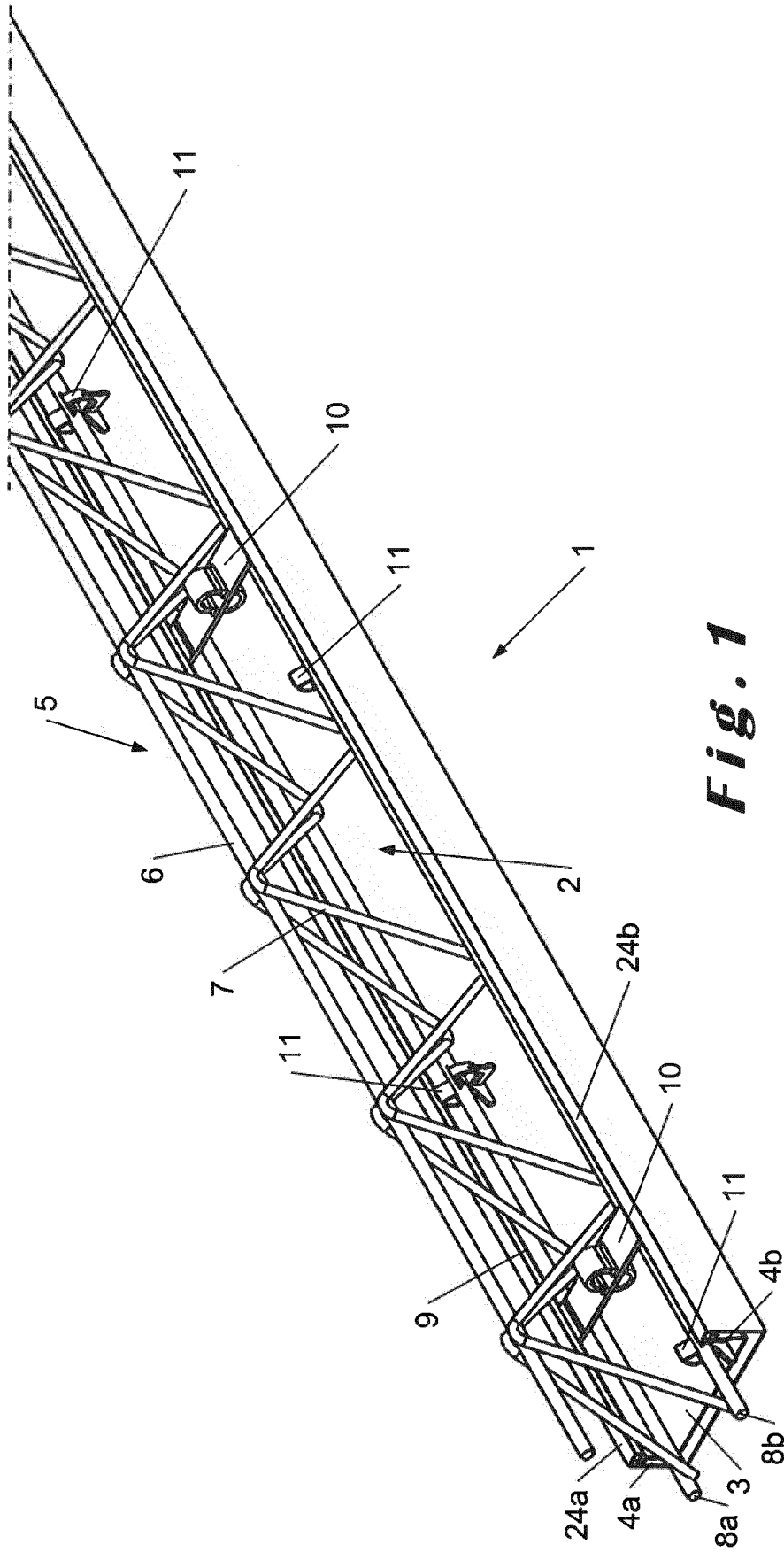


Fig. 1

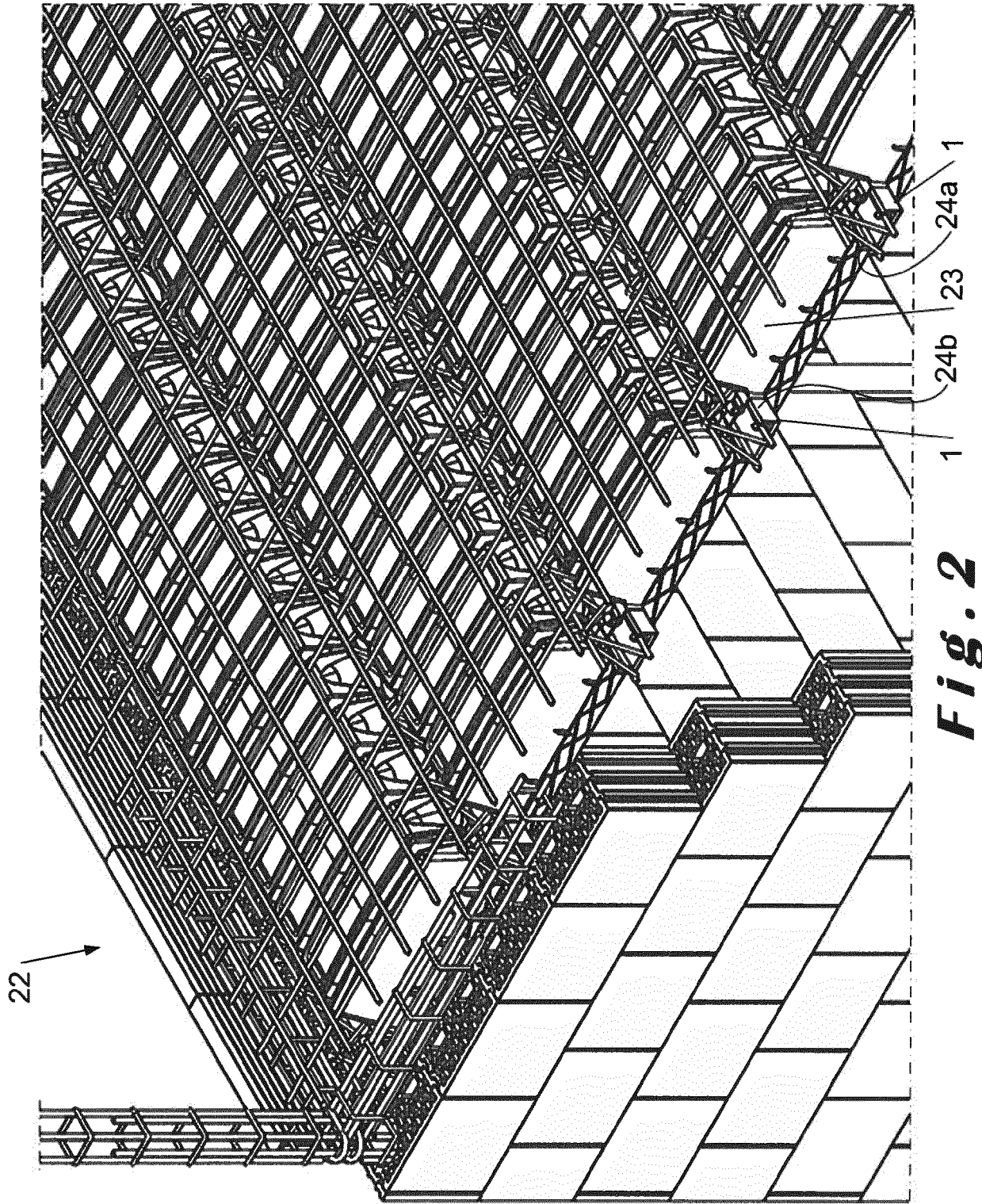


Fig. 2

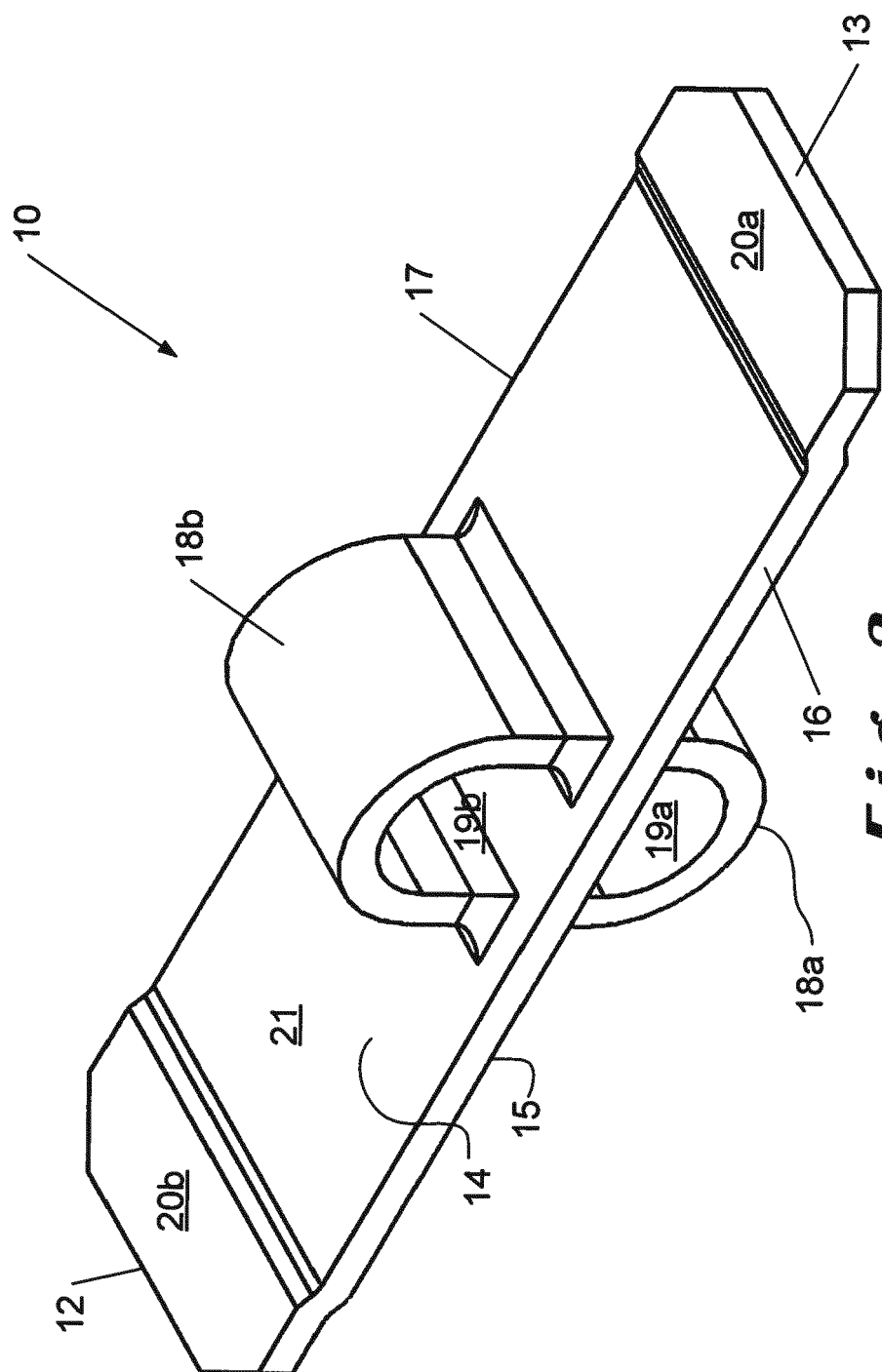


Fig. 3

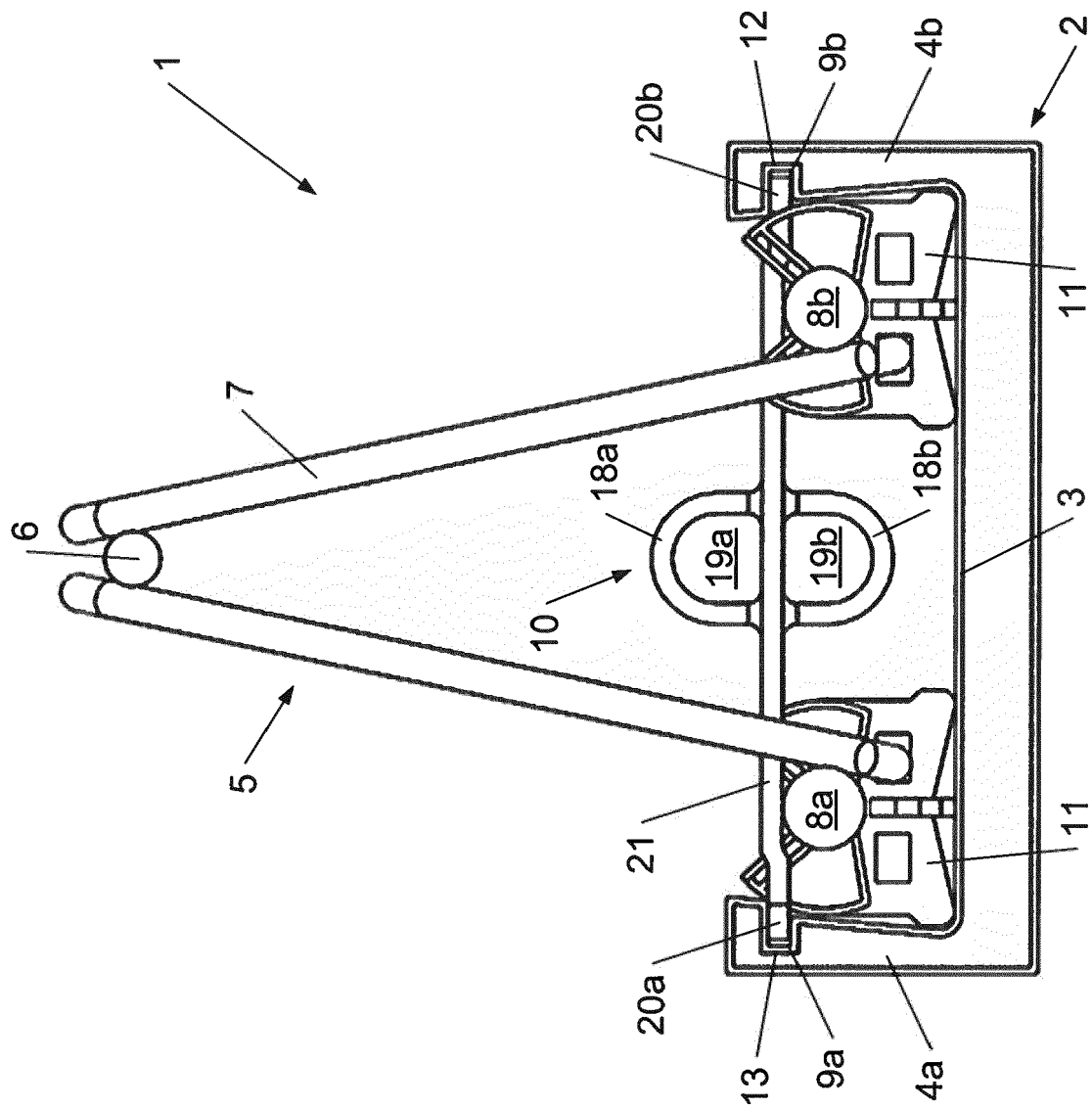


Fig. 4

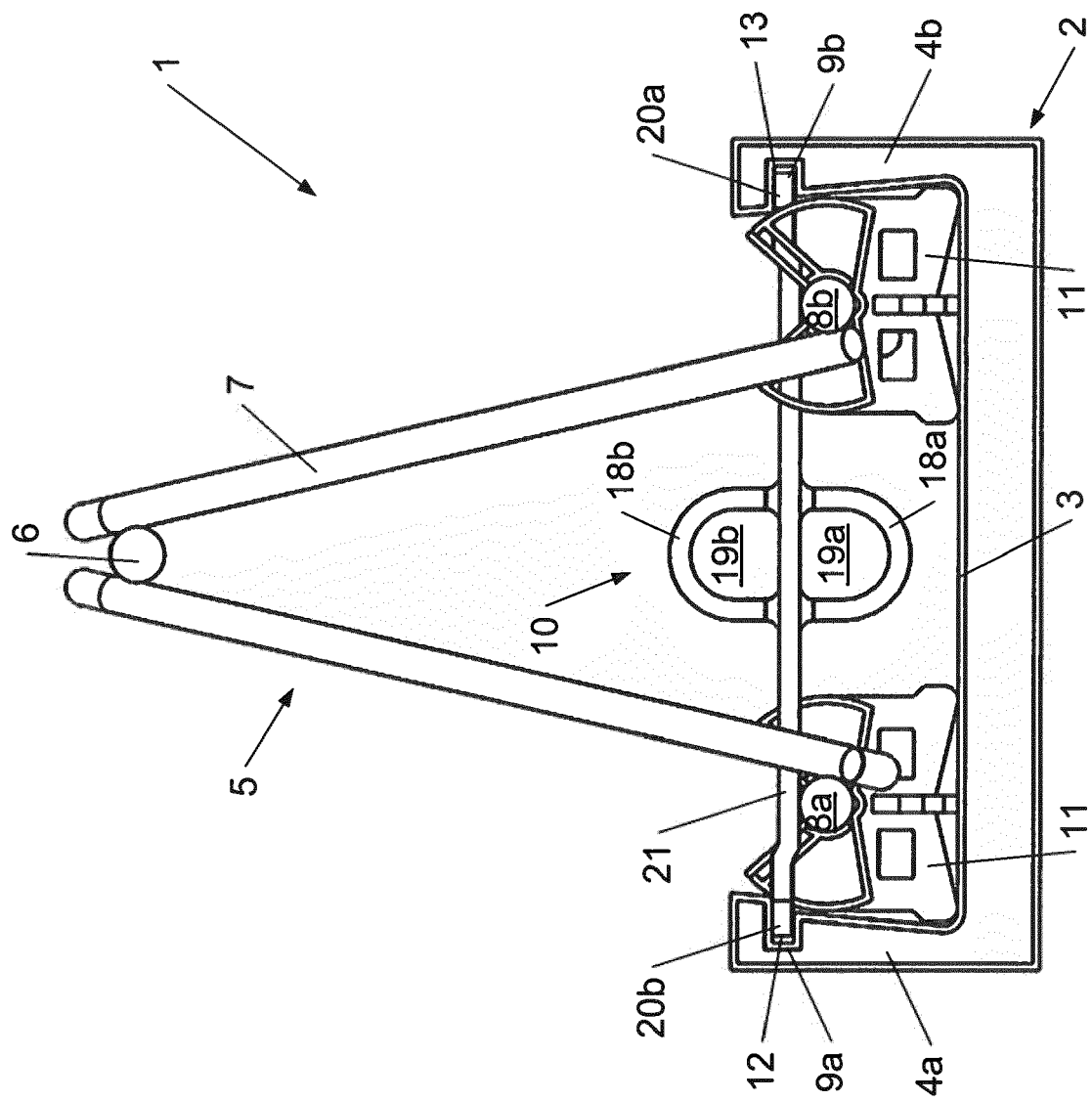


Fig. 5



EUROPEAN SEARCH REPORT

 Application Number
 EP 19 17 7226

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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	WO 2013/019134 A1 (KEKANOVIC MILAN [RS]) 7 February 2013 (2013-02-07) * figures 1,2,3 *	1-6,9-14	INV. E04B5/19 E04C5/065
A	-----	7,8,15	
X	FR 2 918 087 A1 (FOUET DANIEL [FR]) 2 January 2009 (2009-01-02) * figures 2,6,8,9 *	1-6, 11-14	
X	DE 896 999 C (BETONWERKE MUTTER & SCHUESSLER) 16 November 1953 (1953-11-16) * figures 1-5 *	1-3,5,6, 12-14	

			TECHNICAL FIELDS SEARCHED (IPC)
			E04B E04C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 29 October 2019	Examiner Petrinja, Etjel
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			

 1
 EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 17 7226

5

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
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2013019134 A1	07-02-2013	CN 103797197 A	14-05-2014
		EP 2739799 A1	11-06-2014
		RS 20110350 A1	28-02-2013
		WO 2013019134 A1	07-02-2013

FR 2918087 A1	02-01-2009	NONE	

DE 896999 C	16-11-1953	NONE	

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

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Patent documents cited in the description

- WO 2016005679 A [0004] [0005] [0007] [0012]