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(71) Applicant: **Intersig NV**
9200 Dendermonde (BE)

(72) Inventor: **OCKET, Piet**
9200 Dendermonde (BE)

(74) Representative: **De Clercq & Partners**
Edgard Gevaertdreef 10a
9830 Sint-Martens-Latem (BE)

(54) **REINFORCEMENT ELEMENT**

(57) This invention provides, inter alia, reinforcement elements and reinforcing structures for limiting shear stresses and/or preventing punching failure. Furthermore, this invention provides related concrete floors and buildings which have a high resistance to punching failure. It also provides related methods as well as the use of said reinforcement elements and reinforcing structures for limiting shear stresses and/or preventing punching failure in concrete floors and buildings.

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Description

TECHNICAL FIELD

[0001] The present invention relates to reinforcement elements for limiting shear stresses and/or preventing punching failure in floors which are supported by a column, or vice versa.

TECHNOLOGICAL BACKGROUND OF THE INVENTION

[0002] The load on a floor is concentrated in the locations where the floor is supported. A floor which is supported by columns results in a point load and associated stress concentrations. Consequently, large shear stresses occur in floors which are supported by columns. When these shear stresses exceed a critical value, the structure fails as a result of punching shear, in which the floor around the column cracks and subsequently collapses around the column.

[0003] In order to prevent punching failure in floors which are supported by columns, reinforcement elements are used. However, existing reinforcement elements do not have an optimum reinforcing function and/or require the use of a large amount of valuable construction materials.

SUMMARY

[0004] Thus, it is one of the objects of the present invention to provide reinforcement elements which have an optimum reinforcing function in floors which are supported by columns or vice versa, and which only use a minimal amount of valuable construction materials.

[0005] In particular, a reinforcement element is described herein comprising a proximal end, a distal end, at least one transverse rod, and at least one longitudinal rod, wherein the at least one longitudinal rod comprises a top longitudinal rod, and wherein the at least one transverse rod is connected to the top longitudinal rod; wherein the at least one transverse rod comprises at least two slightly slanted legs and at least one greatly slanted leg; wherein both the slightly slanted legs and the at least one greatly slanted leg run obliquely upwards in the direction of the proximal end; and wherein the slightly slanted legs form an angle α with the top longitudinal rod which is greater than the angle β which the greatly slanted legs form with the top longitudinal rod; and characterized in that the two outer legs at the proximal end of the at least one transverse rod are at least two consecutive slightly slanted legs.

[0006] In some embodiments, the reinforcement element comprises two longitudinal rods, and one and only one transverse rod, the two longitudinal rods comprising a top longitudinal rod and a bottom longitudinal rod; wherein the transverse rod is connected to the top longitudinal rod and to the bottom longitudinal rod; wherein the transverse rod comprises at least two slightly slanted legs and at least one greatly slanted leg; wherein both the slightly slanted legs and the at least one greatly slanted leg run obliquely upwards in the direction of the proximal end; and wherein the slightly slanted legs form an angle α with the top longitudinal rod which is greater than the angle β which the greatly slanted legs form with the top longitudinal rod; and characterized in that the two outer legs at the proximal end of the transverse rod are two consecutive slightly slanted legs.

[0007] In some embodiments, the reinforcement element as described herein comprises two transverse rods, wherein both transverse rods are connected to the top longitudinal rod and/or to the bottom longitudinal rod; wherein each transverse rod comprises at least two slightly slanted legs and at least one greatly slanted leg; wherein both the slightly slanted legs and the at least one greatly slanted leg run obliquely upwards in the direction of the proximal end; and wherein the slightly slanted legs form an angle α with the top longitudinal rod which is greater than the angle β which the greatly slanted legs form with the top longitudinal rod; and wherein the two outer legs at the proximal end of each transverse rod are at least two consecutive slightly slanted legs. Preferably, the two transverse rods are parallel to each other.

[0008] In some embodiments, the reinforcement element furthermore comprises a support rod, the support rod comprising a perpendicular part and a parallel part, wherein the perpendicular part is at right angles to the longitudinal rods, and wherein the parallel part runs parallel to the longitudinal rods.

[0009] In some embodiments, the transverse rod comprises several slightly slanted legs and several greatly slanted legs between the three consecutive slightly slanted legs at the proximal end on one side and the distal end on the other side.

[0010] In some embodiments, the transverse rod is bent in several locations in order to form top bends and bottom bends, wherein the top bends project above the top longitudinal rod, and optionally wherein the bottom bends project below the bottom longitudinal rod.

[0011] In some embodiments, the transverse rod and/or the longitudinal rods are uninterrupted.

[0012] In some embodiments, the longitudinal rods are mutually parallel within a margin of error of 1.0°.

[0013] In some embodiments, the reinforcement element comprises two transverse rods, wherein both transverse rods are connected to the top longitudinal rod; wherein each transverse rod comprises at least two slightly slanted legs and at least one greatly slanted leg; wherein both the slightly slanted legs and the at least one greatly slanted leg run obliquely upwards in the direction of the proximal end; and wherein the slightly slanted legs form an angle α with the top longitudinal rod which is greater than the angle β which the greatly slanted legs form with the top longitudinal rod; and wherein the two outer legs at the proximal end of each transverse rod are at least two consecutive slightly slanted legs.

[0014] In some embodiments, the reinforcement element comprises at least three substantially parallel longitudinal rods; the longitudinal rods comprising a top longitudinal rod and two bottom longitudinal rods, wherein each bottom longitudinal rod is connected to the top longitudinal rod by means of a transverse rod.

[0015] In some embodiments, each transverse rod comprises at least three slightly slanted legs and at least one greatly slanted leg; and the three outer legs at the proximal end of each transverse rod are three consecutive slightly slanted legs.

[0016] In some embodiments, each transverse rod comprises several slightly slanted legs and several greatly slanted legs between the three consecutive slightly slanted legs at the proximal end and the distal end.

[0017] In some embodiments, the transverse rods are bent at several locations in order to form top bends and bottom bends, wherein the top bends project above the top longitudinal rod, and optionally wherein the bottom bends project below the bottom longitudinal rods.

[0018] In some embodiments, the transverse rods and/or the longitudinal rods are uninterrupted.

[0019] In some embodiments, the longitudinal rods are mutually parallel within a margin of error of 1.0°.

[0020] In some embodiments, the reinforcement element comprises a transition point between the proximal end and the distal end, wherein the reinforcement element comprises further slightly slanted legs and further greatly slanted legs between the transition point and the distal end, wherein the further slightly slanted legs and the further greatly slanted legs run obliquely upwards in the direction of the distal end, wherein the slightly slanted legs form an angle α with the bottom longitudinal rods which is greater than the angle β which the greatly slanted legs form with the bottom longitudinal rods, and wherein the three outermost legs at the distal end are three consecutive slightly slanted legs.

[0021] In some embodiments, the greatly slanted legs form an angle β with the top longitudinal rod which is greater than 40.0° and which is smaller than 75.0°; and the slightly slanted legs form an angle α with the top longitudinal rod which is smaller than 90.0° and which is at least 5.0° greater than the angle β between the greatly slanted legs and the top longitudinal rod.

[0022] In some embodiments, the at least two consecutive slightly slanted legs at the proximal end of the at least one transverse rod are mutually parallel within a margin of error of 10.0°, or 5.0°, or 2.0°, or 1.0°, or 0.1°.

[0023] In some embodiments, all slightly slanted legs are mutually parallel within a margin of error of 1.0°; and all greatly slanted legs are mutually parallel within a margin of error of 1.0°.

[0024] Furthermore, a method for producing a reinforcement element is provided herein, the method comprising the following steps:

- providing at least one longitudinal rod and at least one transverse rod, wherein the at least one transverse rod and the at least one longitudinal rod each comprise a proximal end and a distal end and wherein the at least one longitudinal rod comprises a top longitudinal rod;
- bending the at least one transverse rod at the proximal end in order to form at least two consecutive slightly slanted legs;
- further towards the distal end with respect to the at least two consecutive slightly slanted legs: bending the at least one transverse rod in order to form at least one greatly slanted leg and optionally one or several slightly slanted legs;
- attaching the transverse rod to the top longitudinal rod.

[0025] In some embodiments, the method comprises the following steps:

- providing two longitudinal rods and a transverse rod, wherein the transverse rod and the two longitudinal rods each comprise a proximal end and a distal end, and wherein the two longitudinal rods comprise a top longitudinal rod and a bottom longitudinal rod;
- bending the transverse rod at the proximal end in order to form at least two consecutive slightly slanted legs;
- further towards the distal end with respect to the at least two consecutive slightly slanted legs: bending the transverse rod in order to form at least one greatly slanted leg and optionally one or several slightly slanted legs;
- attaching the transverse rod to the top longitudinal rod and to the bottom longitudinal rod, thus attaching the bottom longitudinal rod to the top longitudinal rod with the help of the transverse rod.

[0026] In some embodiments, the method comprises the following steps:

- providing at least one longitudinal rod and two transverse rods, wherein the transverse rods and the longitudinal rod comprise a proximal end and a distal end, and wherein the longitudinal rod is a top longitudinal rod;
- bending the transverse rods at the proximal end in order to form at least two consecutive slightly slanted legs;
- further towards the distal end with respect to the at least two consecutive slightly slanted legs: bending the transverse rods in order to form at least one greatly slanted leg and optionally one or more slightly slanted legs;
- attaching the transverse rods to the top longitudinal rod.

[0027] In some embodiments, the method comprises the steps:

- providing three longitudinal rods and two transverse rods, wherein the transverse rods and the longitudinal rods comprise a proximal end and a distal end, and wherein the three longitudinal rods comprise a top longitudinal rod and two bottom longitudinal rods;
- bending the transverse rods at the proximal end in order to form at least two consecutive slightly slanted legs;
- further towards the distal end with respect to the at least two consecutive slightly slanted legs: bending the transverse rods in order to form at least one greatly slanted leg and optionally one or more slightly slanted legs;
- attaching each bottom longitudinal rod to the top longitudinal rod with the help of one of the transverse rods.

[0028] In some embodiments, at least three consecutive slightly slanted legs are formed when bending the transverse rods at the proximal end.

[0029] This invention furthermore provides a reinforcing structure for limiting shear stresses and/or for preventing punching failure in a concrete floor, wherein the reinforcing structure comprises at least two reinforcement elements as described herein, and wherein the at least two reinforcement elements are arranged virtually parallel or rotationally symmetrical.

[0030] In some embodiments, the at least two reinforcement elements comprise two or more opposite reinforcement elements; and the proximal ends of the two opposite reinforcement elements are connected to each other via a bracket.

[0031] In some embodiments, the reinforcing structure is embedded in a set cement-containing material.

[0032] In some embodiments, the concrete floor rests on the column or the column rests on the concrete floor.

[0033] This invention furthermore provides the use of a reinforcement element as described herein for limiting shear stresses and/or for preventing punching failure in a concrete floor which rests on a column or in a concrete floor on which a column rests.

DESCRIPTION OF THE FIGURES

[0034] The following description of the figures relates to specific embodiments of the present invention and is only given by way of example. This description is not limiting with regard to the subject matter described herein, the applications thereof, or the use thereof. In the figures, identical or similar devices or parts are denoted by identical reference numerals.

Figs. 1 (A-C), 2, 3 (A-B) and 7-9 each show a side view of the proximal end (110) of an embodiment of a reinforcement element (100).

Fig. 4 shows a top view of the proximal end (110) of a reinforcement element (100).

Fig. 5 shows a side view of the distal end (120) of a reinforcement element (100).

Fig. 6 (A-E) shows a front view of a reinforcement element (100), looking at the proximal end (110).

Fig. 10 (A-B) shows a top view of reinforcement elements (100), arranged around a column (600).

Fig. 11 (A-B) shows a side view of two mutually facing reinforcement elements (100) arranged around a column (600).

Fig. 12 shows a reinforcement element (100) wherein the structure of the reinforcement element (100) is mirrored around a transition point (130).

Fig. 13 shows a reinforcement element (100) wherein the proximal ends of the reinforcement element (100) are connected to each other.

Fig. 14 shows four views of an embodiment of a reinforcement element (100) in panels a) to d).

Fig. 15 shows how two reinforcement elements (101, 102), a first reinforcement element (101) and a second reinforcement element (102), are placed one behind the other.

Fig. 16 shows how different reinforcement elements (103, 104, 105) are placed next to each other in order to form a stack (140).

Fig. 17 shows a side view of an arrangement of reinforcement elements (100).

Fig. 18 (A-B) shows a reinforcement element (100) as described in Fig. 14 comprising two transverse rods.

[0035] The following reference numerals are used in the description and in the figures: 100 - reinforcement element; 101 - reinforcement element; 102 - reinforcement element; 103 - reinforcement element; 104 - reinforcement element; 105 - reinforcement element; 110 - proximal end of the reinforcement element; 120 - distal end of the reinforcement element; 130 - transition point; 140 - stack of reinforcement elements; 210 - top longitudinal rod; 220 - bottom longitudinal rod; 300 - transverse rod; 310 - slightly slanted leg; 311 - consecutive slightly slanted legs; 315 - slightly slanted leg between the transition point and the distal end; 316 - three consecutive slightly slanted legs at the distal end; 320 - greatly slanted leg; 321 - consecutive greatly slanted legs; 325 - greatly slanted leg between the transition point and the distal end; 330 - top bend; 340 - bottom bend; 400 - support rod; 410 - perpendicular part; 420 - parallel part; 500 - bracket; 510 - inwardly bent end; 520 - outwardly bent end; 530 - elongate inner part; 600 - column; α - angle between slightly slanted leg and bottom longitudinal rod; β - angle between greatly slanted leg and bottom longitudinal rod.

DETAILED DESCRIPTION

[0036] As used below in this text, the singular forms "a", "an", "the" include both the singular and the plural, unless the context clearly indicates otherwise.

[0037] The terms "comprise", "comprises" as used below are synonymous with "including", "include" or "contain", "contains" and are inclusive or open and do not exclude additional unmentioned parts, elements or method steps. Where this description refers to a product or process which "comprises" specific features, parts or steps, this refers to the possibility that other features, parts or steps may also be present, but may also refer to embodiments which only contain the listed features, parts or steps.

[0038] The enumeration of numeric values by means of ranges of figures comprises all values and fractions in these ranges, as well as the cited end points.

[0039] The term "approximately" as used when referring to a measurable value, such as a parameter, an amount, a time period, and the like, is intended to include variations of +/-10% or less, preferably +/-5% or less, more preferably +/-1% or less, and still more preferably +/-0.1% or less, of and from the specified value, in so far as the variations apply in order to function in the invention disclosed herein. It should be understood that the value to which the term "approximately" refers per se has also been disclosed.

[0040] All documents cited in this specification are hereby deemed to be incorporated in their entirety by way of reference.

[0041] Unless defined otherwise, all terms disclosed in the invention, including technical and scientific terms, have the meaning which a person skilled in the art usually gives them. For further guidance, definitions are included to further explain terms which are used in the description of the invention.

[0042] This invention provides a reinforcement element. The reinforcement element is suitable for limiting shear stresses and/or preventing punching failure in a concrete floor. Currently, although not mandatory, the present reinforcement elements are being used in prefabricated concrete elements, also referred to as precast concrete slab floors or wide-slab floors. A prefabricated concrete element is a unsupported system floor and consists of flat rectangular elements which are, for example 50 mm thick, made from prefabricated concrete with continuous lattice girders. In some embodiments, a prefabricated concrete element is placed on and/or around a column and the prefabricated concrete element comprises additional reinforcement in the form of additional reinforcement rods which are placed on top of the column around and on which the prefabricated concrete element rests, and which are placed between diametrically opposite reinforcement elements. The reinforcement elements, the mat, and the additional reinforcement rods are embedded in concrete. Via this concrete, the forces on the top longitudinal rod are transmitted to the additional reinforcement rods which, in turn, transmit these forces to opposite reinforcement elements.

[0043] In some embodiments, the additional reinforcement rods are connected to the diametrically opposite reinforcement elements.

[0044] In some embodiments, the additional reinforcement rods are not connected to the diametrically opposite reinforcement elements.

[0045] Preferably, the height of the bends is identical, that is to say the height of the projecting loops, smaller than or equal to the thickness of the mat which is situated on the reinforcement elements in a prefabricated concrete element.

[0046] In some embodiments, the mat consists of one layer of rods. In some embodiments, the mat consists of two layers of rods. In some embodiments, the rods in the layers of rods have a thickness between 6.0 mm and 50.0 mm, or a thickness between 8.0 mm and 25.0 mm, or a thickness between 10.0 mm and 15.0 mm, or a thickness between 11.0 mm and 13.0 mm.

[0047] Preferably, the prefabricated concrete element also comprises a net which is situated under the reinforcement elements. The mat which is situated under the reinforcement elements is similar to the mat which has been described above and may have identical or different characteristics. If desired, the reinforcement element has bends which project below the bottom longitudinal rod, or below the bottom longitudinal rods (see elsewhere in this text). In this case, the height of these bends is preferably smaller than or equal to the thickness of the mat which is situated under the reinforcement elements in the prefabricated concrete element.

[0048] The reinforcement element comprises a proximal end and a distal end. The proximal end and the distal end are opposite ends of the reinforcement element. In normal use, the proximal end is placed, for example, adjacent to a point of support in a floor where the floor rests on a column.

[0049] The reinforcement element comprises at least one transverse rod and at least one longitudinal rod. The at least one longitudinal rod comprises a top longitudinal rod, and the at least one transverse rod is connected to the top longitudinal rod, for example by means of welded connections.

[0050] The at least one transverse rod comprises at least two slightly slanted legs and at least one greatly slanted leg.

[0051] Both the slightly slanted legs and the greatly slanted legs run obliquely upwards in the direction of the proximal end. In other words, the distance between a specific leg and the proximal end is smaller at the location of the top longitudinal rod than at some distance from the top longitudinal rod.

[0052] In some embodiments, the reinforcement element comprises a top longitudinal rod and a bottom longitudinal rod. In these embodiments, the distance between a specific leg and the proximal end is smaller at the location of the top longitudinal rod than at the location of the bottom longitudinal rod.

[0053] Both the slightly slanted legs and the at least one greatly slanted leg run obliquely upwards in the direction of the proximal end. The slightly slanted legs form an angle α with the top longitudinal rod which is greater than the angle β which the greatly slanted legs form with the top longitudinal rod. In other words, the slightly slanted legs form an angle with the top longitudinal rod which is greater than the angle which the greatly slanted legs form with the top longitudinal rod.

[0054] The two outer legs at the proximal end of the transverse rod are two consecutive slightly slanted legs. In other words, the two outermost legs at the proximal end are slightly slanted legs. The outermost legs at the proximal end are the legs which are situated closest to the proximal end of the reinforcement element. In still other words, the outermost legs at the proximal end are the last legs at the proximal end. Providing two consecutive slightly slanted legs at the proximal end limits shear stresses and/or increases the resistance of a floor to punching failure, for example a concrete floor in which the reinforcement element is incorporated.

[0055] Preferably, these two consecutive slightly slanted legs are followed by a greatly slanted leg in the direction of the distal end.

[0056] These reinforcement elements are highly effective in reducing shear stresses and/or preventing punching failure, for example in concrete floors which rest on a column.

[0057] In some embodiments, the two outer legs at the proximal end of the transverse rod are two consecutive slightly slanted legs, which are immediately followed by a greatly slanted leg towards the distal end. Preferably, in these embodiments, these two consecutive slightly slanted legs are made of discontinuous pieces of steel wire. This facilitates the production of such reinforcement elements.

[0058] The production of the reinforcement elements may furthermore be facilitated by providing exactly three consecutive slightly slanted legs. In some embodiments, the three outer legs at the proximal end of the transverse rod thus are three consecutive slightly slanted legs which are immediately followed by a greatly slanted leg towards the distal end. Preferably, these three consecutive slightly slanted legs are made from a continuous steel wire. This facilitates the production of such reinforcement elements.

[0059] In some embodiments, the at least one transverse rod comprises several slightly slanted legs and several greatly slanted legs between the at least two consecutive slightly slanted legs at the proximal end on one side and the distal end on the other side. In other words, the consecutive slightly slanted legs at the proximal end are followed by several slightly slanted legs and several greatly slanted legs. In this way, a reinforcement element of a certain length is obtained.

[0060] In some embodiments, the at least one transverse rod comprises several legs consisting of alternately one slightly slanted leg and one greatly slanted leg, which are positioned between the at least two consecutive slightly slanted legs at the proximal end on one side and the distal end on the other side. In other words, the consecutive slightly slanted legs at the proximal end are alternately followed by one greatly slanted leg and one slightly slanted leg.

[0061] In some embodiments, the greatly slanted legs form an angle β with the top longitudinal rod which is greater than 40.0° and which is smaller than 75.0°. The slightly slanted legs form an angle α with the top longitudinal rod which is smaller than 90.0° and which is at least 5.0° greater than the angle β between the greatly slanted legs and the top longitudinal rod. This improves the mechanical properties of the present reinforcement elements.

[0062] Preferably, the longitudinal rods are parallel. In this case, the angle between the slightly slanted legs and the bottom longitudinal rods is equal to the angle between the slightly slanted legs and the top longitudinal rod. Also, the angle between the greatly slanted legs and the bottom longitudinal rods is then equal to the angle between the greatly slanted legs and the top longitudinal rod.

[0063] In some embodiments, the angle β which the greatly slanted legs form with the top longitudinal rod is greater than 35.0° and smaller than 60.0°, or greater than 40.0° and smaller than 50.0°.

[0064] In some embodiments, the angle α which the slightly slanted legs form with the top longitudinal rod is between 70.0° and 90.0°, or between 75.0° and 89.0°, or between 80.0° and 88.0°.

[0065] In some embodiments, the angle between the slightly slanted legs and the top longitudinal rod is at least 10.0°, or 15.0°, or 20.0°, or 25.0°, or 30.0°, or 40.0°, or 50.0° greater than the angle between the greatly slanted legs and the top longitudinal rod.

[0066] In some embodiments, the at least two consecutive slightly slanted legs at the proximal end of the at least one transverse rod are mutually parallel within a margin of error of 10.0°, 5.0°, 1.0°, or 0.1°.

[0067] In some embodiments, all slightly slanted legs are mutually parallel within a margin of error of 10.0°, 5.0°, 1.0°, or 0.1°. Also, in these embodiments, preferably all greatly slanted legs are mutually parallel within a margin of error of 10.0°, 5.0°, 1.0°, or 0.1°.

[0068] In some embodiments, the at least one transverse rod and/or the at least one longitudinal rod have a diameter between 1.0 mm and 20.0 mm, for example a diameter of 2.0 to 18.0 mm, or a diameter of 3.0 mm to 16.0 mm, or a diameter of 4.0 to 14.0 mm, or a diameter of 5.0 mm to 13.0 mm, or a diameter of 6.0 to 12.0 mm. Larger diameters make the reinforcement elements stronger, but require the use of additional material. Smaller diameters make it possible to use less material, but result in reduced strength.

[0069] Preferably, the longitudinal rods and the transverse rods are made of steel, carbon, or a composite material such as glass-fibre reinforcement (for example Vrod®, Aslan®, Combar®).

[0070] In some embodiments, each transverse rod, between the consecutive slightly slanted legs at the proximal end on one side and the distal end on the other side, comprises several legs consisting of alternately one slightly slanted leg and one greatly slanted leg. In other words, the consecutive slightly slanted legs at the proximal end are followed by alternately one greatly slanted leg and one slightly slanted leg.

[0071] In some embodiments, each transverse rod, between the consecutive slightly slanted legs at the proximal end on one side and the distal end on the other side, comprises several legs consisting of alternately one slightly slanted leg and several consecutive greatly slanted legs, for example 2, 3, or more consecutive greatly slanted legs. In other words, the consecutive slightly slanted legs at the proximal end are followed by alternately several consecutive greatly slanted legs, for example 2, 3, or more consecutive greatly slanted legs, and one slightly slanted leg.

[0072] In some embodiments, each transverse rod, between the consecutive slightly slanted legs at the proximal end on one side and the distal end on the other side, comprises several legs consisting of alternately one greatly slanted leg and several consecutive slightly slanted legs, for example 2, 3, or more consecutive slightly slanted legs. In other words, the consecutive slightly slanted legs at the proximal end are followed by alternately one greatly slanted leg and several consecutive slightly slanted legs, for example 2, 3, or more consecutive slightly slanted legs.

[0073] In some embodiments, each transverse rod, between the consecutive slightly slanted legs at the proximal end on one side and the distal end on the other side, comprises several legs consisting of alternately several consecutive slightly slanted legs and several consecutive greatly slanted legs. In other words, the consecutive slightly slanted legs at the proximal end are followed by alternately several consecutive greatly slanted legs and several consecutive slightly slanted legs. The number of consecutive slanted legs is, for example, 2, 3, or more.

[0074] These various variations of the structure of the present reinforcement elements make it possible to adapt the present reinforcement elements to the needs of specific applications.

[0075] In some embodiments, the reinforcement element comprises two longitudinal rods and one and only one transverse rod. In other words, the reinforcement element in these embodiments comprises one transverse rod, and not more than one transverse rod. The two longitudinal rods comprise a bottom longitudinal rod and a top longitudinal rod. The transverse rod is connected to the top longitudinal rod and to the bottom longitudinal rod, for example by means of welded connections. In this way, the top longitudinal rod and the bottom longitudinal rod are connected to each other by means of the transverse rod.

[0076] In some embodiments, the reinforcement element as described herein comprises two transverse rods, wherein both transverse rods are connected to the top longitudinal rod and/or to the bottom longitudinal rod; wherein each transverse rod comprises at least two slightly slanted legs and at least one greatly slanted leg; wherein both the slightly slanted legs and the at least one greatly slanted leg run obliquely upwards in the direction of the proximal end; and wherein the slightly slanted legs form an angle α with the top longitudinal rod which is greater than the angle β which the greatly slanted legs form with the top longitudinal rod; and wherein the two outer legs at the proximal end of each transverse rod are at least two consecutive slightly slanted legs. Preferably, the two transverse rods are parallel to each other.

[0077] The transverse rod comprises at least two slightly slanted legs and at least one greatly slanted leg.

[0078] In some embodiments, the reinforcement element comprises two and not more than two longitudinal rods: a top longitudinal rod and a bottom longitudinal rod.

[0079] In some embodiments, the reinforcement element furthermore comprises a support rod. The support rod comprises a perpendicular part and a parallel part. The perpendicular part is at right angles to the longitudinal rods, for example within a margin of error of less than 10.0°, or less than 5.0°, or less than 1.0°, or less than 0.1°. The parallel part is parallel to the longitudinal rods, for example within a margin of error of less than 10.0°, or less than 5.0°, or less than 1.0°, or less than 0.1°.

[0080] The support rod supports the reinforcement element, so that the reinforcement element can easily be put upright, for example during positioning.

[0081] In some embodiments, the support rod is a branch of the bottom longitudinal rod. This simplifies the structure of the reinforcement element.

[0082] In some embodiments, the support rod is a branch of the bottom longitudinal rod at the proximal end and the parallel part of the support rod is bent away from the proximal end and towards the distal end. Additionally or alternatively, a branch of the bottom longitudinal rod is bent at the distal end in order to form a support rod. In this case, the parallel part of the support rod is bent away from the distal end and towards the proximal end.

[0083] In some embodiments, the support rod has a thickness which is equal to the thickness of the bottom longitudinal rod.

[0084] In some embodiments, the reinforcement element comprises several support rods, for example, 2, 3, or 4 support rods. This may further simplify positioning of a reinforcement element.

[0085] In some embodiments, the transverse rod comprises three consecutive slightly slanted legs at the proximal end.

[0086] In some embodiments, the transverse rod is bent at several locations in order to form top bends and bottom bends. The top bends project above the top longitudinal rod. The fact that the top bends project above the top longitudinal rod results in an improved transmission of the forces from the transverse rods to the top longitudinal rod and to the material in which the reinforcement element is embedded. This increases the strength of floors in which the present reinforcement element is used.

[0087] Preferably, the bends are formed as sectors of a circle and the diameter of the sectors of a circle is equal to at least 5 times the diameter of the transverse rod.

[0088] Optionally, the bottom bends project below the bottom longitudinal rod.

[0089] In some embodiments, the bottom bends project 0.5 to 5.0 cm, or 1 to 2.5 cm below the bottom longitudinal rods and/or the top bends project 0.5 to 10.0 cm, or 1 to 5 cm above the top longitudinal rods. If the bends project above or below a longitudinal rod over a distance which is greater than the average of the diameters of the longitudinal rod and the transverse rod, then an opening is formed between the longitudinal rod and the transverse rod.

[0090] If the bends project above the top longitudinal rod and/or below the bottom longitudinal rod, then the transverse rod intersects with the top longitudinal rod and/or the bottom longitudinal rod at two locations per bend. Preferably, the transverse rod is welded onto the longitudinal rods at the locations where the transverse rod intersects with the longitudinal rods.

[0091] In some embodiments, the transverse rod is uninterrupted. In other words, in some embodiments, the transverse rod is continuous.

[0092] In some embodiments, the longitudinal rods are uninterrupted. In other words, in some embodiments, the longitudinal rods are continuous.

[0093] In some embodiments, both the transverse rod and the longitudinal rods are uninterrupted. In other words, in some embodiments, the longitudinal rods and the transverse rod are continuous.

[0094] In some embodiments, the transverse rods are interrupted in the bends, where the bends project above the top longitudinal rod or below the bottom longitudinal rod. In some embodiments, the interrupted bends are formed as a hook. In this way, it is possible to achieve a simple connection with reinforcement mats and/or additional rods of the reinforcement.

[0095] In some embodiments, the transverse rods are constructed as several individual rods. In other words, the transverse rods are constructed as separate rods. Each individual rod forms an individual leg. The individual legs are attached, preferably by welding, to the top longitudinal rod and the bottom longitudinal rod.

[0096] Preferably, the longitudinal rods, that is the top longitudinal rod and the bottom longitudinal rod, are mutually parallel within a margin of error of 1.0°. This improves the uniformity of the mechanical properties of the reinforcement element.

[0097] In some embodiments, the reinforcement element comprises two transverse rods and at least one longitudinal rod, wherein the at least one longitudinal rod is a top longitudinal rod. In other words, the reinforcement element, in some embodiments, comprises two transverse rods and a top longitudinal rod. Both transverse rods are connected to the top longitudinal rod.

[0098] Each transverse rod comprises at least two slightly slanted legs and at least one greatly slanted leg. Both the slightly slanted legs and the at least one greatly slanted leg run obliquely upwards in the direction of the proximal end. In other words, both the greatly slanted legs and the slightly slanted legs are inclined in the direction of the proximal end.

[0099] The slightly slanted legs form an angle α with the top longitudinal rod which is greater than the angle β which the greatly slanted legs form with the top longitudinal rod. The two outer legs at the proximal end of each transverse rod are at least two consecutive slightly slanted legs. The two outer legs at the proximal end of each transverse rod are also the legs which are situated closest to the proximal end of the reinforcement element. In other words, the outermost legs at the proximal end are the last legs at the proximal end.

[0100] In another embodiment, the reinforcement element comprises three longitudinal rods: a top longitudinal rod and two bottom longitudinal rods. The three longitudinal rods are preferably arranged like the longitudinal ribs of a triangular prism. Preferably, the three longitudinal rods are uninterrupted. In other words, the three longitudinal rods are preferably continuous. As has already been mentioned above, the reinforcement element, in some embodiments, comprises two transverse rods. Each transverse rod connects the top longitudinal rod to one of the bottom longitudinal rods. In other words, a first transverse rod connects the top longitudinal rod to the first bottom longitudinal rod and a second transverse rod connects the top longitudinal rod to the second bottom longitudinal rod. Each transverse rod is thus connected to the top longitudinal rod and one of the bottom longitudinal rods. The bottom longitudinal rods may be connected either on the inner side or on the outer side of the transverse rods.

[0101] In some embodiments, the reinforcement element comprises at least three substantially parallel longitudinal rods; the longitudinal rods comprising a top longitudinal rod and two bottom longitudinal rods, wherein each bottom longitudinal rod is connected to the top longitudinal rod by means of a transverse rod.

[0102] Preferably, the longitudinal rods are mutually parallel within a margin of error of 5.0°, 1.0°, 0.5°, or 0.1°. This improves the uniformity of the mechanical properties of the reinforcement element.

[0103] Preferably, the distance between the top longitudinal rod and the first bottom longitudinal rod is equal to the distance between the top longitudinal rod and the second bottom longitudinal rod. Thus, the cross section of the reinforcement element is an isosceles triangle in these embodiments. Due to their symmetrical structure, such reinforcement elements have improved mechanical properties.

[0104] In a specific embodiment of the reinforcement element as described herein, the cross section of the reinforcement element in these embodiments is an obtuse triangle. Such reinforcement elements provide improved mechanical properties.

[0105] As mentioned above, each transverse rod comprises at least two consecutive slightly slanted legs at the proximal end. In some embodiments, the number of slightly slanted legs at the proximal end is odd, for example equal to 3, 5, 7, 9, or more. In some embodiments, each transverse rod comprises at least three slightly slanted legs and at least one greatly slanted leg. In these embodiments, the three outer legs at the proximal end of each transverse rod are three consecutive slightly slanted legs.

[0106] In other words, each transverse rod at the proximal end ends in at least two slightly slanted legs, preferably an odd number of slightly slanted legs, more preferably three slightly slanted legs. Expressed in yet another way, the at least two outer legs at the proximal end are at least two consecutive slightly slanted legs. Preferably, an odd number of outer legs at the proximal end is an odd number of slightly slanted legs. More preferably, the three outer legs at the proximal end are at least three consecutive slightly slanted legs.

[0107] Preferably, the transverse rods are bent at several locations at the location of the bottom longitudinal rods and the top longitudinal rod in order to form bends - bottom bends at the location of the bottom longitudinal rods and top bends at the location of the top longitudinal rod. More preferably, the top bends project above the top longitudinal rod and/or the bottom bends project below the bottom longitudinal rods. Because the top bends project above the top longitudinal rod, the forces of the transverse rods are transmitted to the top longitudinal rod and to the concrete in a more efficient way. This increases the strength of floors in which the present reinforcing structure is used.

[0108] In some embodiments, the bottom bends project 0.0 to 7.0 cm, or 0.5 to 2.5 cm below the bottom longitudinal rods and/or the top bends project 0 to 7.0 cm, or 0.5 to 2.5 cm above the top longitudinal rods. If the bends project below or above longitudinal rods over a distance which is greater than the average of the diameters of the longitudinal rods and the transverse rods, then an opening is formed between the longitudinal rods and the transverse rods.

[0109] If the bends project above the top longitudinal rods and/or below the bottom longitudinal rods, then the transverse rods intersect with these in two positions per bend. Preferably, the transverse rods are welded onto the longitudinal rods at the locations where the transverse rods intersect with the longitudinal rods.

[0110] In some embodiments, the transverse rods and/or the longitudinal rods are uninterrupted. In other words, in some embodiments, the transverse rods and/or the longitudinal rods are continuous. This facilitates the structure of the reinforcement elements and provides a good mechanical strength.

[0111] In some embodiments, the transverse rods are interrupted in the bends, where the bends project above the top longitudinal rod or below a bottom longitudinal rod. In some embodiments, the interrupted bends are formed as a hook. In this way, it is possible to achieve a simple connection with reinforcement mats and/or additional rods of the reinforcement.

[0112] In some embodiments, the transverse rods are provided as several individual rods. In other words, the transverse rods are provided as separate rods. Each individual rod forms an individual leg, and wherein the individual legs are attached, preferably by welding, to the top longitudinal rod and one of the bottom longitudinal rods.

[0113] In some embodiments, the longitudinal rods are mutually parallel within a margin of error of 1.0°.

[0114] In some embodiments, the reinforcement element comprises a transition point between the proximal end and the distal end. Between the transition point and the proximal end, the reinforcement element has a structure as described above. Between the transition point and the distal end, the reinforcement element has a structure which is the mirror image of the structure between the transition point and the proximal end. In other words: between the transition point and the distal end, both the slightly slanted legs and the greatly slanted legs run obliquely upwards in the direction of the distal end. The slightly slanted legs form an angle α with the top longitudinal rod which is greater than the angle β which the greatly slanted legs form with the top longitudinal rod. The angle α is preferably equal to said angle α which the slightly slanted legs form with the top longitudinal rod between the transition point and the proximal end. The angle β is preferably equal to the angle β which the greatly slanted legs form with the top longitudinal rod between the transition point and the proximal end. The three outer legs at the distal end are three consecutive slightly slanted legs. In other words, the transverse rods at the distal end are bent in order to form three consecutive slightly slanted legs. Such a reinforcement element is particularly useful if a floor has to be reinforced in the vicinity of two columns. After all, by laying a reinforcement element in accordance with this example between the columns, the resistance to punching failure is increased around the two columns simultaneously.

[0115] In some embodiments, the at least two consecutive slightly slanted legs at the proximal end of the at least one transverse rod are mutually parallel within a margin of error of 10.0°, or 5.0°, or 2.0°, or 1.0°, or 0.1°.

[0116] In some embodiments, all slightly slanted legs are mutually parallel within a margin of error of 1.0°; and/or all greatly slanted legs are mutually parallel within a margin of error of 1.0°.

[0117] This invention furthermore provides a method for producing a reinforcement element. Preferably, the reinforcement element is a reinforcement element as described herein. In a specific embodiment, the method comprises the following steps:

- providing at least one longitudinal rod and at least one transverse rod, wherein the at least one transverse rod and the at least one longitudinal rod each comprise a proximal end and a distal end and wherein the at least one longitudinal rod comprises a top longitudinal rod;

- bending the at least one transverse rod at the proximal end in order to form at least two consecutive slightly slanted legs;
- further towards the distal end with respect to the at least two consecutive slightly slanted legs: bending the at least one transverse rod in order to form at least one greatly slanted leg and optionally one or several slightly slanted legs;
- attaching the transverse rod to the top longitudinal rod.

[0118] This invention furthermore provides a further method for producing a reinforcement element. Preferably, the reinforcement element is a reinforcement element as described above.

[0119] The method comprises providing two longitudinal rods and a transverse rod. The two longitudinal rods comprise a top longitudinal rod and a bottom longitudinal rod. The transverse rod, the bottom longitudinal rod, and the top longitudinal rod comprise a proximal end and a distal end. The distal and proximal ends of the transverse rods and the longitudinal rods correspond to the ends which are positioned at the distal and the proximal end of the reinforcement element, respectively.

[0120] The transverse rod is bent at the proximal end in order to form at least two consecutive slightly slanted legs.

[0121] Further towards the distal end with respect to the at least two consecutive slightly slanted legs, the transverse rod is bent in order to form at least one greatly slanted leg and optionally in order to form one or several slightly slanted legs. Preferably, the transverse rod is bent further towards the distal end with respect to the at least two consecutive slightly slanted legs in order alternately to form one greatly slanted leg and one slightly slanted leg. How exactly the transverse rod is bent depends on the desired configuration of the reinforcement element.

[0122] The bending of the transverse rod is preferably performed consecutively. In other words, the bending of the transverse rod is preferably carried out bend by bend.

[0123] In addition, it is also possible to produce a reinforcement element as provided herein by producing the longitudinal rods, the transverse rod, and, optionally, the support rod separately and subsequently welding them together.

[0124] Furthermore, the transverse rod is also attached to the top longitudinal rod and to the bottom longitudinal rod, for example by means of welding. Thus, the bottom longitudinal rod and the top longitudinal rod are attached to each other with the help of the transverse rod.

[0125] Preferably, the transverse rod is welded to the longitudinal rods at the locations where the transverse rod intersects with a longitudinal rod.

[0126] In some embodiments, all bends in the transverse rod are bent first, before the transverse rod is attached to the longitudinal rods. However, it is also possible to alternate one or several bends and one or several fastening operations with one another.

[0127] In some embodiments, the method furthermore comprises bending a support rod. Preferably, the support rod is a branch of the bottom longitudinal rod. In other words, the support rod and the bottom longitudinal rod are preferably made from one and the same rod. The support rod comprises a perpendicular part and a parallel part. The perpendicular part is bent, so that it is at right angles to the longitudinal rods, for example within a margin of error of less than 10.0°, or less than 5.0°, or less than 1.0°, or less than 0.1°. The parallel part is bent, so that it is parallel to the longitudinal rods, for example within a margin of error of less than 10.0°, or less than 5.0°, or less than 1.0°, or less than 0.1°.

[0128] This invention furthermore provides an alternative method for producing a reinforcement element. Preferably, the reinforcement element is a reinforcement element as provided herein. In a specific embodiment, the method comprises the following steps:

- providing at least one longitudinal rod and two transverse rods, wherein the transverse rods and the longitudinal rod comprise a proximal end and a distal end, and wherein the longitudinal rod is a top longitudinal rod;
- bending the transverse rods at the proximal end in order to form at least two consecutive slightly slanted legs;
- further towards the distal end with respect to the at least two consecutive slightly slanted legs: bending the transverse rods in order to form at least one greatly slanted leg and optionally one or more slightly slanted legs;
- attaching the transverse rods to the top longitudinal rod.

[0129] Preferably, the method comprises providing three longitudinal rods and two transverse rods. The transverse rods and the longitudinal rods have a proximal end and a distal end. The distal and proximal ends of the transverse rods and the longitudinal rods correspond to the ends which are positioned at the distal and proximal end of the reinforcement element, respectively. At the proximal end of the transverse rods, the transverse rods are bent in order to form three consecutive slightly slanted legs. Further towards the distal end, the transverse rods are bent in order to form at least one greatly slanted leg and optionally one or more slightly slanted legs, preferably in order to form both slightly slanted legs and greatly slanted legs. How exactly the transverse rods are bent depends on the desired appearance of the reinforcement element.

[0130] In these embodiments, the method furthermore comprises the step of attaching each bottom longitudinal rod to the top longitudinal rod with the help of one of the transverse rods. In other words, the method comprises the step of fastening the transverse rods to the longitudinal rods. Each transverse rod is fastened to the top longitudinal rod and to one of the bottom longitudinal rods. Preferably, the transverse rods are fastened to the longitudinal rods by means of welding. Preferably, the transverse rods are welded to the longitudinal rods at the locations where the transverse rods intersect with the longitudinal rods. In some embodiments, all bends in the transverse rods are bent first, before fastening the transverse rods to the longitudinal rods. However, it is also possible to alternate one or several bends and one or several fastening operations with one another.

[0131] In some embodiments, the method comprises the steps:

- providing three longitudinal rods and two transverse rods, wherein the transverse rods and the longitudinal rods comprise a proximal end and a distal end, and wherein the three longitudinal rods comprise a top longitudinal rod and two bottom longitudinal rods;
- bending the transverse rods at the proximal end in order to form at least two consecutive slightly slanted legs;
- further towards the distal end with respect to the at least two consecutive slightly slanted legs: bending the transverse rods in order to form at least one greatly slanted leg and optionally one or more slightly slanted legs;
- attaching each bottom longitudinal rod to the top longitudinal rod with the help of one of the transverse rods.

[0132] In some embodiments, at least three consecutive slightly slanted legs are formed when bending the transverse rods at the proximal end.

[0133] In some embodiments, the transverse rods are bent in order alternately to form one slightly slanted leg and one greatly slanted leg. In some embodiments, the transverse rods are bent in order alternately to form one slightly slanted leg and several consecutive greatly slanted legs. In some embodiments, the transverse rods are bent in order alternately to form one greatly slanted leg and several consecutive slightly slanted legs. In some embodiments, the transverse rods are bent in order alternately to form several consecutive slightly slanted legs and several consecutive greatly slanted legs. The number of consecutive slanted legs is, for example, 3. The bending of the transverse rods is preferably performed consecutively, that is bend by bend.

[0134] In addition, it is also possible to obtain a reinforcement element as provided herein by producing the bent pieces separately and subsequently welding them to the longitudinal rods.

[0135] This invention furthermore provides a reinforcing structure for limiting shear stresses and/or for limiting punching failure in a concrete floor. The reinforcing structure comprises at least two reinforcement elements as provided herein. The at least two reinforcement elements are preferably arranged virtually parallel or rotationally symmetrical. If the reinforcement elements are arranged rotationally symmetrical, then the reinforcement elements are preferably arranged rotationally symmetrical around a point of support. A point of support is a point where a floor rests on a column or where a column rests on a floor.

[0136] In another specific embodiment, the at least two reinforcement elements are arranged radially and/or rotationally symmetrical around a central point. During normal use of the reinforcing structure in a concrete floor for limiting shear stresses and/or preventing punching failure, the central point corresponds to a point where the concrete floor is supported by a column or where the column rests on the concrete floor.

[0137] Preferably, the reinforcing structure comprises more than two reinforcement elements, such as 3, 4, 5, 6, 8, 10, 20, 30, or more reinforcement elements.

[0138] The proximal ends of the at least two reinforcement elements are closer to the central point. In other words, the distance between the proximal ends of the reinforcement elements and the central point is smaller than the distance between the distal ends of the reinforcement elements and the central point.

[0139] In some embodiments, the proximal ends of opposite reinforcement elements are connected to each other via a bracket. A bracket is a tool for connecting opposite reinforcement elements. Preferably, the bracket is made from a steel rod by means of 1 or more, for example 2, bending operations. Opposite reinforcement elements are reinforcement elements which have been rotated around the central point through an angle of 180.0°, within a margin of error of 60.0°, or 50.0°, or 40.0°, or 30.0°, or 20.0°, or 10.0°, or 5.0°, or 1.0°, or 0.1°.

[0140] In some embodiments, the bracket comprises an inwardly bent end, an outwardly bent end, and an elongate inner part. In these embodiments, the bracket is attached to two opposite reinforcement elements by means of the inwardly bent end and the outwardly bent end.

[0141] As used herein, an object is understood to be "elongate" if the length of that object is longer than twice the width of that object; preferably the length is longer than three times, four times or five times the width of the object.

[0142] In some embodiments, the bracket is connected to the proximal end of the opposite reinforcement elements by means of a mechanical connection.

[0143] The length of the elongate inner part corresponds to the length between the opposite reinforcement elements.

[0144] The inwardly bent end is an end of the bracket where the bracket is bent through an angle of between 100.0° and 170.0°, for example an angle of between 120.0° and 160.0°, or between 120.0° and 145°, or between 145.0° and 160.0°. In some embodiments, the inwardly bent end has a length of between 10.0 cm and 30.0 cm.

[0145] The outwardly bent end is the end of the bracket which is opposite to the inwardly bent end. The outwardly bent end is bent through an angle of between 10.0° and 80.0°, for example between 30.0° and 60.0°, or between 30.0° and 45.0°, or between 45.0° and 60.0°.

[0146] In an alternative embodiment, the proximal ends of opposite reinforcement elements are connected to each other by connecting the top longitudinal rods to each other, for example by allowing the top longitudinal rod to continue as described herein. In other words, in this embodiment, the opposite reinforcement elements share the same top longitudinal rod.

[0147] In some embodiments, the reinforcing structure furthermore comprises a top reinforcing layer and a bottom reinforcing layer. The top reinforcing layer and the bottom reinforcing layer comprise one or several reinforcement mats. At least two reinforcement elements are arranged between the top reinforcing layer and the bottom reinforcing layer.

[0148] This invention furthermore provides a floor comprising a reinforcing structure as described above. Preferably, the floor is a concrete floor. The reinforcing structure is embedded in a material containing set cement. Preferably, the material containing set cement is concrete.

[0149] This invention furthermore provides a building comprising one or several columns and a floor as described above. The floor rests on the one or several columns. Alternatively or additionally, one or several columns may also rest on the floor. Each column is placed below or above a central point around which the reinforcement elements are arranged.

[0150] This invention furthermore provides the use of a reinforcement element as provided herein for limiting shear stresses and/or for preventing punching failure in a concrete floor which rests on a column or in a concrete floor on which a column rests.

EXAMPLES

Example 1

[0151] In a first example, reference is made to Fig. 1(A-C), Fig. 2, Fig. 3(A-B), Fig. 4, Fig. 5 and Fig. 6 (A-E). These figures show a reinforcement element (100). The reinforcement element (100) comprises a proximal end (110) and a distal end (120). The proximal end (110) and the distal end (120) are situated at opposite ends of the reinforcement element (100). During normal use, the reinforcement element (100) is placed in a concrete floor, with the proximal end (110) adjacent to a point where the concrete floor rests on a column.

[0152] In particular, Fig. 1 (A-C), Fig. 2 and Fig. 3 (A-B) show a side view of a reinforcement element (100) in the vicinity of the proximal end (110). Fig. 4 shows a top view of the reinforcement element (100) in the vicinity of the proximal end (110). Fig. 5 shows a side view of the reinforcement element (100) in the vicinity of the distal end (120). Fig. 6 (A-E) shows a front view of the reinforcement element (100) looking at the proximal end (110). A rear view of the reinforcement element (100) looking at the distal end (120) looks similar.

[0153] The reinforcement element comprises a top longitudinal rod (210), optionally two bottom longitudinal rods (220), and two transverse rods (300). The longitudinal rods (210,220) run in the length direction of the reinforcement element (100). Each transverse rod (300) meanders between the top longitudinal rod (210) and optionally a bottom longitudinal rod (220) in order to form legs (310,320). Between consecutive legs (310,320), the transverse rods (300) are bent in order to form bends (330,340): top bends (330) and bottom bends (340). Each bottom bend (340) projects below one of the bottom longitudinal rods (220). Each top bend (330) projects above the top longitudinal rod (210). In this way, the transverse rods (300) intersect with the longitudinal rods (210,220) at the location of the bends (330,340). At the position where the transverse rods (300) intersect with the longitudinal rods (210,220), the transverse rods (300) are welded onto the longitudinal rods (210,220).

[0154] Each transverse rod comprises slightly slanted legs (310) and greatly slanted legs (320). Both the slightly slanted legs (310) and the greatly slanted legs (320) slant in the direction of the proximal end (110) of the reinforcement element (100). The slightly slanted legs (310) form an angle α with the longitudinal rods (210,220) which equals 85°. The greatly slanted legs (320) form an angle β with the longitudinal rods (210,220) which equals 55°. Because the longitudinal rods are parallel, the angle between the slightly slanted legs and the bottom longitudinal rods is equal to the angle between the slightly slanted legs and the top longitudinal rod. Also, the angle between the greatly slanted legs and the bottom longitudinal rods is equal to the angle between the greatly slanted legs and the top longitudinal rod.

[0155] At both the proximal end (110) and the distal end (120), the longitudinal rods (210,220) and the transverse rods (300) end. At the proximal end (110), the transverse rods (300) are bent in order to form at least two and preferably three consecutive slightly slanted legs (311).

[0156] These at least two, and preferably three, consecutive slightly slanted legs (311) limit shear stresses and/or increase the resistance to punching failure of a concrete floor in which the reinforcement element (100) is fitted. The at least two, and preferably three, consecutive slightly slanted legs (311) are parallel to each other. The mutual distance between the three consecutive slightly slanted legs (311) is approximately 3 to 5 times the diameter of the legs.

[0157] More towards the distal part (120), greatly slanted legs (320) and slightly slanted legs (310) alternate. In other words: after the at least two, and preferably three, consecutive slightly slanted legs (311), the transverse rods (300) are bent in order alternately to form greatly slanted legs (320) and slightly slanted legs (310). At the distal end (120), each transverse rod (300) ends in a greatly slanted leg (320). At the end of this greatly slanted leg (320), each transverse rod (300) is welded onto a bottom longitudinal rod (220).

Example 2

[0158] By way of further example, reference is made to Fig. 7, Fig. 8, and Fig. 9. These figures show different embodiments of the present reinforcement elements (100) which are identical to the embodiment of the first example, except that the transverse rods (300) are bent in different ways between the three consecutive slightly slanted legs (311) at the proximal end (110) on one side and the distal end (120) on the other side.

[0159] In Fig. 7, the transverse rods (300) are bent over the entire length of the reinforcement element (100) in order alternately to form three consecutive slightly slanted legs (311) and three consecutive greatly slanted legs (321).

[0160] In Fig. 8, the transverse rods (300) are bent between the three consecutive slightly slanted legs (311) at the proximal end (110) on one side and the distal end (120) on the other side in order alternately to form three consecutive greatly slanted legs (321) and one slightly slanted leg (310).

[0161] In Fig. 9, the transverse rods (300) are bent over the entire length of the reinforcement element (100), in order alternately to form three consecutive slightly slanted legs (311) and one greatly slanted leg (320).

[0162] The variations shown in Fig. 7, Fig. 8, and Fig. 9 limit shear stresses and/or increase the resistance to punching failure of concrete floors in which the reinforcement element is fitted, but require the use of additional material for the production of the reinforcement elements. However, in this case the use of a greater amount of steel does reduce the amount of concrete required.

Example 3

[0163] By way of further example, we refer to Fig. 10A, Fig. 10B, Fig. 11A and Fig. 11B. Fig. 10A shows a top view of an arrangement of four reinforcement elements (100) according to Example 1 in a concrete floor which is supported by a column (600). Fig. 10B shows a top view of an arrangement of six reinforcement elements (100) according to Example 1 in a concrete floor which is supported by a column (600). Fig. 11A and Fig. 11B show a side view of the arrangement of reinforcement elements (100). For the sake of clarity, only two diametrically opposite reinforcement elements (100) are shown. However, in practice, typically more reinforcement elements are used.

[0164] In Fig. 10A, the reinforcement elements (100) are placed around the column (600) with their proximal end (110) adjacent to the column (600). An optional bracket (500) is provided which is fastened to the proximal ends (110) of diametrically opposite reinforcement elements (100). The bracket (500) is a bent steel wire which spans the column (600). The bracket (500) comprises bent ends (510) and an elongate inner part (530).

[0165] By way of the inwardly bent ends (510), the diametrically opposite reinforcement elements (100) are connected to each other by their proximal ends (110). This connection is brought about by weaving the ends (510) of the bracket (500) between a transverse rod (300) and the top longitudinal rod (210) of the reinforcement elements (100).

[0166] In Fig. 10B, the reinforcement elements (100) are positioned linearly around the column (600). The reinforcement elements (100) may optionally be connected to each other by means of a bracket (500), as illustrated in Fig. 11A, or by allowing the top longitudinal rod to continue (600), as is illustrated in Fig. 11B.

Example 4

[0167] By way of further example, we refer to Fig. 12 and Fig. 13. Fig. 12 shows a reinforcement element (100) in which the structure of the reinforcement element (100) is mirrored around a transition point (130) which is situated in the centre of the reinforcement element (100), between the proximal end (110) and the distal end (120).

[0168] Between the transition point (130) and the proximal end (110), the reinforcement element has a structure which is identical to the structure described in Example 1: both the slightly slanted legs (310) and the greatly slanted legs (320) run obliquely upwards in the direction of the proximal end (110) and, at the proximal end (110), the transverse rods (300) are bent in order to form three consecutive slightly slanted legs (311).

[0169] Between the transition point (130) and the distal end (120), the reinforcement element (100) has a structure which is the mirror image of the structure between the transition point (130) and the proximal end: both the slightly slanted legs (315) and the greatly slanted legs (325) run obliquely upwards in the direction of the distal end (120). The slightly slanted legs form an angle α with the bottom longitudinal rods which is greater than the angle β which the greatly slanted legs form with the bottom longitudinal rods. The angle α is equal to said angle α which the slightly slanted legs form with the bottom longitudinal rods between the transition point (130) and the proximal end (110). The angle β is equal to the angle β which the greatly slanted legs (320) form with the bottom longitudinal rods (220) between the transition point (130) and the proximal end (110).

[0170] The three outer legs at the distal end (120) are three consecutive slightly slanted legs (316). In other words, the transverse rods (300) at the distal end (120) are bent in order to form three consecutive slightly slanted legs (316).

[0171] A reinforcement element (100) according to the present example is particularly useful if a floor is to be reinforced in the vicinity of two columns. After all, by laying a reinforcement element (100) according to this example between the columns, the resistance to punching failure is increased simultaneously around the two columns.

[0172] Fig. 13 shows a reinforcement element (100) whose proximal ends are connected to each other.

Example 5

[0173] In a further example, reference is made to Fig. 14. This figure shows four views of a reinforcement element (100) in panels a) to d). In particular, panels a), b), c), and d) show a side view, a front view, a top view and a perspective view of the reinforcement element (100), respectively.

[0174] The reinforcement element (100) comprises a proximal end (110) and a distal end (120). The proximal end (110) and the distal end (120) are situated at opposite ends of the reinforcement element (100). During normal use, the reinforcement element (100) is placed in a concrete floor, with the proximal end (110) adjacent to a point where the concrete floor rests on a column.

[0175] The reinforcement element comprises a top longitudinal rod (210), a bottom longitudinal rod (220) and a transverse rod (300). The longitudinal rods (210,220) run in the length direction of the reinforcement element (100). The transverse rod (300) meanders between the top longitudinal rod (210) and the bottom longitudinal rod (220) in order to form legs (310,320). Between consecutive legs (310), the transverse rod (300) is bent in order to form bends (330,340): top bends (330) and bottom bends (340). Each bottom bend (340) projects below the bottom longitudinal rod (220). Each top bend (330) projects above the top longitudinal rod (210). In this way, the transverse rod (300) intersects with the longitudinal rods (210,220) at the location of the bends (330,340). At the position where the transverse rod (300) intersects with the longitudinal rods (210,220), the transverse rod (300) is welded onto the longitudinal rods (210,220).

[0176] The transverse rod (300) comprises slightly slanted legs (310) and greatly slanted legs (320). Both the slightly slanted legs (310) and the greatly slanted legs (320) slant in the direction of the proximal end (110) of the reinforcement element (100). The slightly slanted legs (310) form an angle α with the longitudinal rods (210,220) which equals 85°. The greatly slanted legs (320) form an angle β with the longitudinal rods (210,220) which equals 55°. Because the longitudinal rods are parallel, the angle between the slightly slanted legs and the bottom longitudinal rod is equal to the angle between the slightly slanted legs and the top longitudinal rod. Also, the angle between the greatly slanted legs and the bottom longitudinal rod is equal to the angle between the greatly slanted legs and the top longitudinal rod.

[0177] At both the proximal end (110) and the distal end (120), the longitudinal rods (210,220) and the transverse rod (300) end. At the proximal end, the transverse rod (300) ends in particular at the location of the top longitudinal rod (210). At the distal end (120), the transverse rod ends at the location of the bottom longitudinal rod (220). At the proximal end (110), the transverse rod (300) is bent in order to form at least two consecutive slightly slanted legs (311).

[0178] The at least two consecutive slightly slanted legs (311) limit shear stresses and/or increase the resistance to punching failure of a concrete floor in which the reinforcement element (100) is fitted. The at least two consecutive slightly slanted legs (311) are parallel to each other. The mutual distance between the at least two consecutive slightly slanted legs (311) is approximately 3 to 5 times the diameter of the legs.

[0179] More towards the distal part (120), greatly slanted legs (320) and slightly slanted legs (310) alternate. In other words: after the at least two slightly slanted legs (311), the transverse rod (300) is bent in order alternately to form greatly slanted legs (320) and slightly slanted legs (310). At the distal end (120), the transverse rod (300) ends with a greatly slanted leg (320). At the end of this greatly slanted leg (320), the transverse rod (300) is welded onto the bottom longitudinal rod (220).

[0180] Furthermore, a branch of the bottom longitudinal rod (220) is bent at the proximal end (110) in order to form a support rod (400). In particular, the support rod (400) comprises a perpendicular part (410) and a parallel part (420). The perpendicular part (410) is at right angles to the longitudinal rods (210,220). The parallel part (420) is parallel to the longitudinal rods (210,220) and is bent away from the proximal end (110) and towards the distal end (120). As an alternative embodiment (not shown), a branch of the bottom longitudinal rod is bent at the distal end in order to form a support rod. In this case, the parallel part of the support rod is bent away from the distal end and towards the proximal end.

[0181] Fig. 18 (A-B) shows the reinforcement element according to Fig. 14 wherein the reinforcement element comprises two transverse rods.

Example 6

[0182] By way of further example, we refer to Fig. 15. This figure comprises three panels a), b), and c), and shows how two reinforcement elements (101, 102), a first reinforcement element (101) and a second reinforcement element (102), have been positioned one behind the other.

Example 7

[0183] By way of further example, we refer to Fig. 16. This figure comprises three panels a), b), and c), and shows how different reinforcement elements (103, 104, 105) have been positioned next to one another in order to form a stack (140).

Example 8

[0184] By way of further example, we refer to Fig. 17. Fig. 17 shows a side view of an arrangement of reinforcement elements (100). For the sake of clarity, only two diametrically opposite reinforcement elements (100) are shown. A mat (not shown) lies over the reinforcement elements (100). Depending on the expected load on the column, it may be useful to provide additional reinforcement. In the case of a relatively high load, additional reinforcement rods (not shown) may be provided on top of and over the column (400). These additional reinforcement rods do not necessarily have to be connected to the reinforcement elements (100). The reinforcement elements (100), the mat and the additional reinforcement rods are embedded in concrete. Via this concrete, the forces acting on the top longitudinal rod are transmitted to the additional reinforcement rods, which in turn transmit these forces to opposite reinforcement elements (400).

Claims

1. Reinforcement element (100) comprising a proximal end (110), a distal end (120), at least one transverse rod (300), and at least one longitudinal rod (210,220), wherein the at least one longitudinal rod (210,220) comprises a top longitudinal rod (210), and wherein the at least one transverse rod (300) is connected to the top longitudinal rod (210);

- wherein the at least one transverse rod (300) comprises at least two slightly slanted legs (310) and at least one greatly slanted leg (320); wherein both the slightly slanted legs (310) and the at least one greatly slanted leg (320) run obliquely upwards in the direction of the proximal end (110); and wherein the slightly slanted legs (310) form an angle α with the top longitudinal rod (210) which is greater than the angle β which the greatly slanted legs (320) form with the top longitudinal rod (210);
- and **characterized in that** the two outer legs at the proximal end (110) of the at least one transverse rod (300) are at least two consecutive slightly slanted legs (311).

2. Reinforcement element (100) according to Claim 1, comprising two longitudinal rods (210,220), and one and only one transverse rod (300), the two longitudinal rods (210,220) comprising a top longitudinal rod (210) and a bottom longitudinal rod (220),

- wherein the transverse rod (300) is connected to the top longitudinal rod (210) and to the bottom longitudinal rod (220);
- wherein the transverse rod (300) comprises at least two slightly slanted legs (310) and at least one greatly slanted leg (320);
- wherein both the slightly slanted legs (310) and the at least one greatly slanted leg (320) run obliquely upwards in the direction of the proximal end (110);
- and wherein the slightly slanted legs (310) form an angle α with the top longitudinal rod (210) which is greater than the angle β which the greatly slanted legs (320) form with the top longitudinal rod (210);
- and **characterized in that** the two outer legs at the proximal end (110) of the transverse rod (300) are two consecutive slightly slanted legs (311);

the reinforcement element optionally furthermore comprising a support rod (400), the support rod comprising a perpendicular part (410) and a parallel part (420), wherein the perpendicular part (410) is at right angles to the longitudinal rods (210,220), and wherein the parallel part (420) runs parallel to the longitudinal rods (210,220).

3. Reinforcement element (100) according to Claim 1 or 2, wherein the transverse rod (300) comprises several slightly slanted legs (310) and several greatly slanted legs (320) between the three consecutive slightly slanted legs (311) at the proximal end (110) on one side and the distal end (120) on the other side; optionally wherein the transverse rod (300) is bent in several locations in order to form top bends (330) and bottom bends (340), wherein the top bends (330) project above the top longitudinal rod (210), and optionally wherein the bottom bends (340) project below the bottom longitudinal rod (220).

4. Reinforcement element (100) according to Claim 2 or 3, wherein the transverse rod (300) and/or the longitudinal rods (210,220) are uninterrupted; optionally wherein the longitudinal rods (210,220) are mutually parallel within a margin of error of 1.0°.

5. Reinforcement element (100) according to Claim 1, comprising two transverse rods (300), wherein both transverse rods are connected to the top longitudinal rod (210);

- wherein each transverse rod (300) comprises at least two slightly slanted legs (310) and at least one greatly slanted leg (320); wherein both the slightly slanted legs (310) and the at least one greatly slanted leg (320) run obliquely upwards in the direction of the proximal end (110); and wherein the slightly slanted legs (310) form an angle α with the top longitudinal rod (210) which is greater than the angle β which the greatly slanted legs (320) form with the top longitudinal rod (210);
- and wherein the two outer legs at the proximal end (110) of each transverse rod (300) are at least two consecutive slightly slanted legs (311);

optionally comprising at least three substantially parallel longitudinal rods (210,220); the longitudinal rods (210,220) comprising a top longitudinal rod (210) and two bottom longitudinal rods (220), wherein each bottom longitudinal rod (220) is connected to the top longitudinal rod (210) by means of a transverse rod (300).

6. Reinforcement element (100) according to Claim 5, wherein each transverse rod (300) comprises at least three slightly slanted legs (310) and at least one greatly slanted leg (320); and wherein the three outer legs at the proximal end (110) of each transverse rod (300) are three consecutive slightly slanted legs (311), optionally wherein each transverse rod (300) comprises several slightly slanted legs (310) and several greatly slanted legs (320) between the three consecutive slightly slanted legs (311) at the proximal end (110) and the distal end (120).

7. Reinforcement element (100) according to Claim 5 or 6, wherein the transverse rods (300) are bent at several locations in order to form top bends (330) and bottom bends (340), wherein the top bends (330) project above the top longitudinal rod (210), and optionally wherein the bottom bends (340) project below the bottom longitudinal rods (220).

8. Reinforcement element (100) according to Claim 6 or 7, wherein the transverse rods (300) and/or the longitudinal rods (210,220) are uninterrupted; optionally the longitudinal rods are mutually parallel within a margin of error of 1.0°.

9. Reinforcement element (100) according to any of Claims 1 to 8, wherein the reinforcement element comprises a transition point (130) between the proximal end (110) and the distal end (120), wherein the reinforcement element (100) comprises further slightly slanted legs (315) and further greatly slanted legs (325) between the transition point (130) and the distal end (120), wherein the further slightly slanted legs (315) and the further greatly slanted legs (325) run obliquely upwards in the direction of the distal end (120), wherein the slightly slanted legs (310) form an angle α with the bottom longitudinal rods (220) which is greater than the angle β which the greatly slanted legs (320) form with the bottom longitudinal rods (220), and wherein the three outermost legs at the distal end (120) are three consecutive slightly slanted legs (316).

10. Reinforcement element (100) according to any of Claims 1 to 9,

    - wherein the greatly slanted legs (320) form an angle β with the top longitudinal rod (210) which is greater than 40.0° and which is smaller than 75.0°; and
    - wherein the slightly slanted legs (310) form an angle α with the top longitudinal rod (210) which is smaller than 90.0° and which is at least 5.0° greater than the angle β between the greatly slanted legs (320) and the top longitudinal rod (210).

11. Reinforcement element (100) according to any of Claims 1 to 10, wherein the at least two consecutive slightly slanted legs (311) at the proximal end (110) of the at least one transverse rod (300) are mutually parallel within a margin of error of 1.0°; optionally wherein all slightly slanted legs (310) are mutually parallel within a margin of error of 1.0°; and wherein all greatly slanted legs (310) are mutually parallel within a margin of error of 1.0°.

12. Method for producing a reinforcement element (100), the method comprising the following steps:

    - providing at least one longitudinal rod (210,220) and at least one transverse rod (300), wherein the at least one transverse rod (300) and the at least one longitudinal rod (210,220) each comprise a proximal end and a distal end and wherein the at least one longitudinal rod (210,220) comprises a top longitudinal rod (220);
    - bending the at least one transverse rod (300) at the proximal end (110) in order to form at least two consecutive slightly slanted legs (311);
    - further towards the distal end (120) with respect to the at least two consecutive slightly slanted legs (311): bending the at least one transverse rod (300) in order to form at least one greatly slanted leg (320) and optionally one or several slightly slanted legs (310);
    - attaching the transverse rod to the top longitudinal rod (210).

13. Method for producing a reinforcement element (100), the method comprising the following steps:

    - providing two longitudinal rods (210,220) and a transverse rod (300), wherein the transverse rod (300) and the two longitudinal rods (210,220) each comprise a proximal end and a distal end, and wherein the two longitudinal rods (210,220) comprise a top longitudinal rod (210) and a bottom longitudinal rod (220);
    - bending the transverse rod (300) at the proximal end (110) in order to form at least two consecutive slightly slanted legs (311);
    - further towards the distal end (120) with respect to the at least two consecutive slightly slanted legs (311): bending the transverse rod (300) in order to form at least one greatly slanted leg

(320) and optionally one or several slightly slanted legs (310);
- attaching the transverse rod to the top longitudinal rod (210) and to the bottom longitudinal rod (220), thus attaching the bottom longitudinal rod (220) to the top longitudinal rod (210) with the help of the transverse rod (300).

14. Method for producing a reinforcement element (100), the method comprising the following steps:

- providing at least one longitudinal rod (210) and two transverse rods (300), wherein the transverse rods (300) and the longitudinal rod (210) comprise a proximal end (110) and a distal end (120), and wherein the longitudinal rod is a top longitudinal rod (210);
- bending the transverse rods (300) at the proximal end (110) in order to form at least two consecutive slightly slanted legs (311);
- further towards the distal end (120) with respect to the at least two consecutive slightly slanted legs (311): bending the transverse rods (300) in order to form at least one greatly slanted leg (320) and optionally one or more slightly slanted legs (310);
- attaching the transverse rods (300) to the top longitudinal rod (210);

optionally wherein the method furthermore comprises the following steps:

- providing three longitudinal rods (210,220) and two transverse rods (300), wherein the transverse rods (300) and the longitudinal rods (210,220) comprise a proximal end (110) and a distal end (120), and wherein the three longitudinal rods comprise a top longitudinal rod and two bottom longitudinal rods;
- bending the transverse rods (300) at the proximal end (110) in order to form at least two consecutive slightly slanted legs (311);
- further towards the distal end (120) with respect to the at least two consecutive slightly slanted legs (311): bending the transverse rods (300) in order to form at least one greatly slanted leg (320) and optionally one or more slightly slanted legs (310);
- attaching each bottom longitudinal rod (220) to the top longitudinal rod (210) with the help of one of the transverse rods (300);

optionally wherein at least three consecutive slightly slanted legs (311) are formed when bending the transverse rods (300) at the proximal end (110).

15. Use of a reinforcement element according to any of Claims 1 to 11 for limiting shear stresses and/or for preventing punching failure in a concrete floor which rests on a column or in a concrete floor on which a column rests.

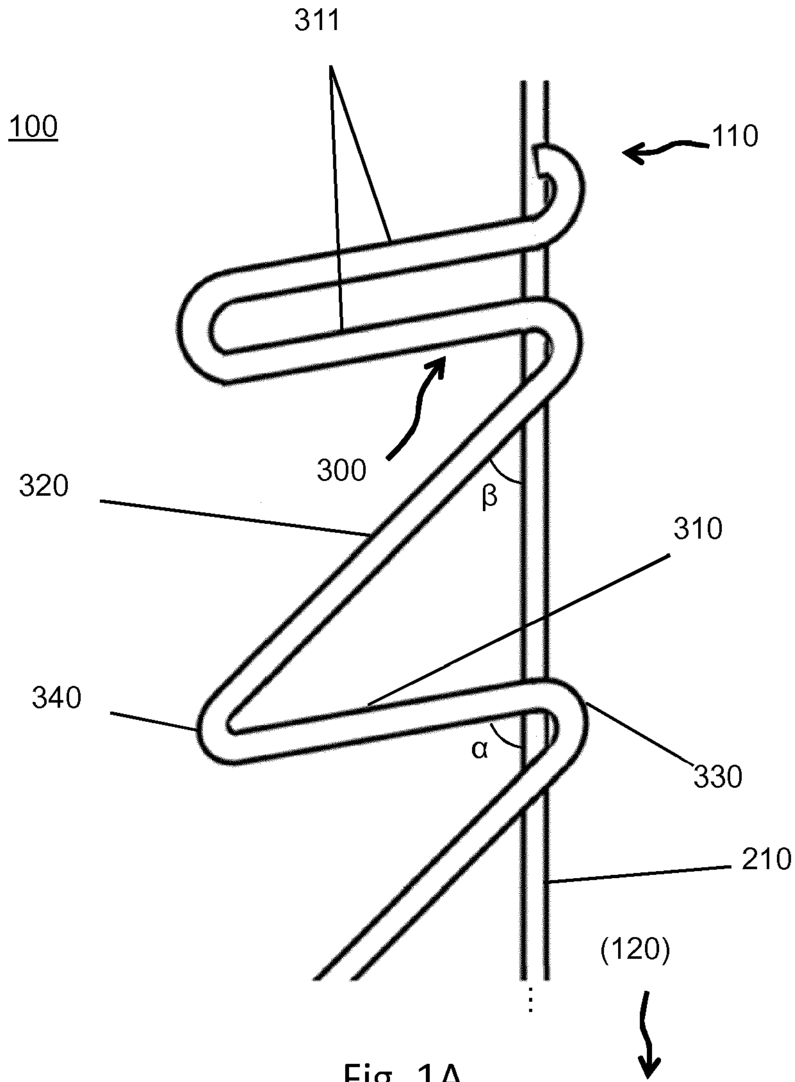

Fig. 1A

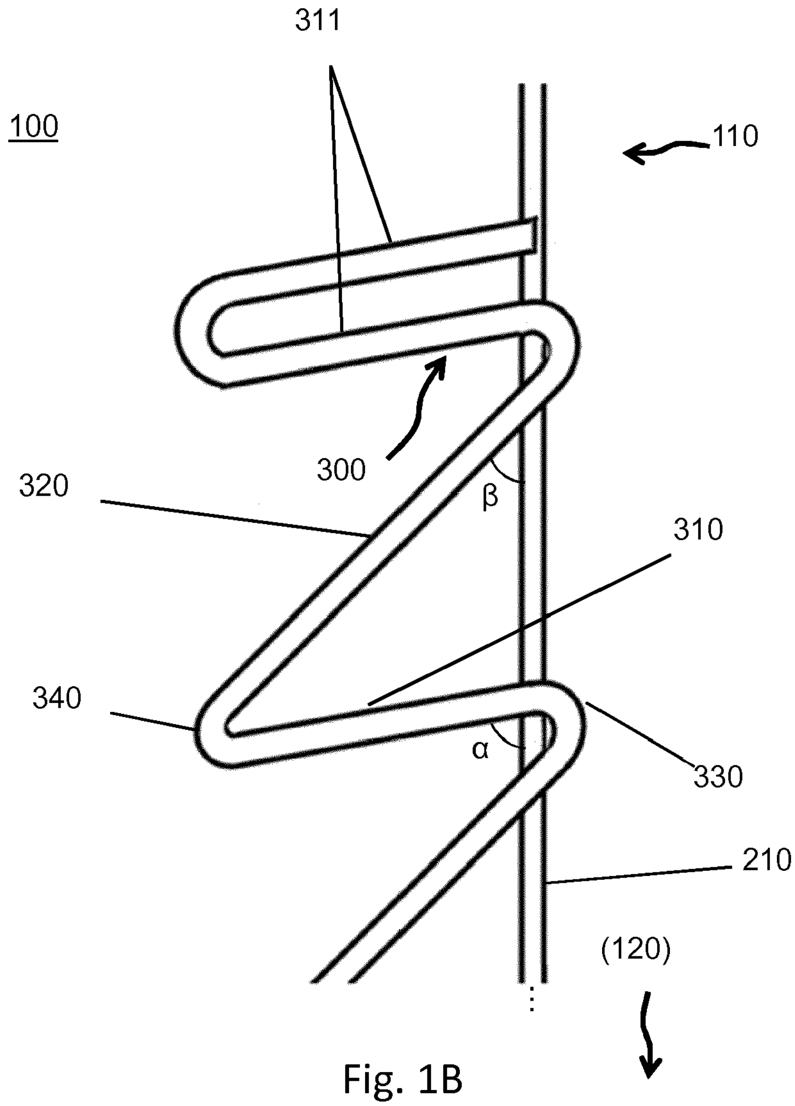

Fig. 1B

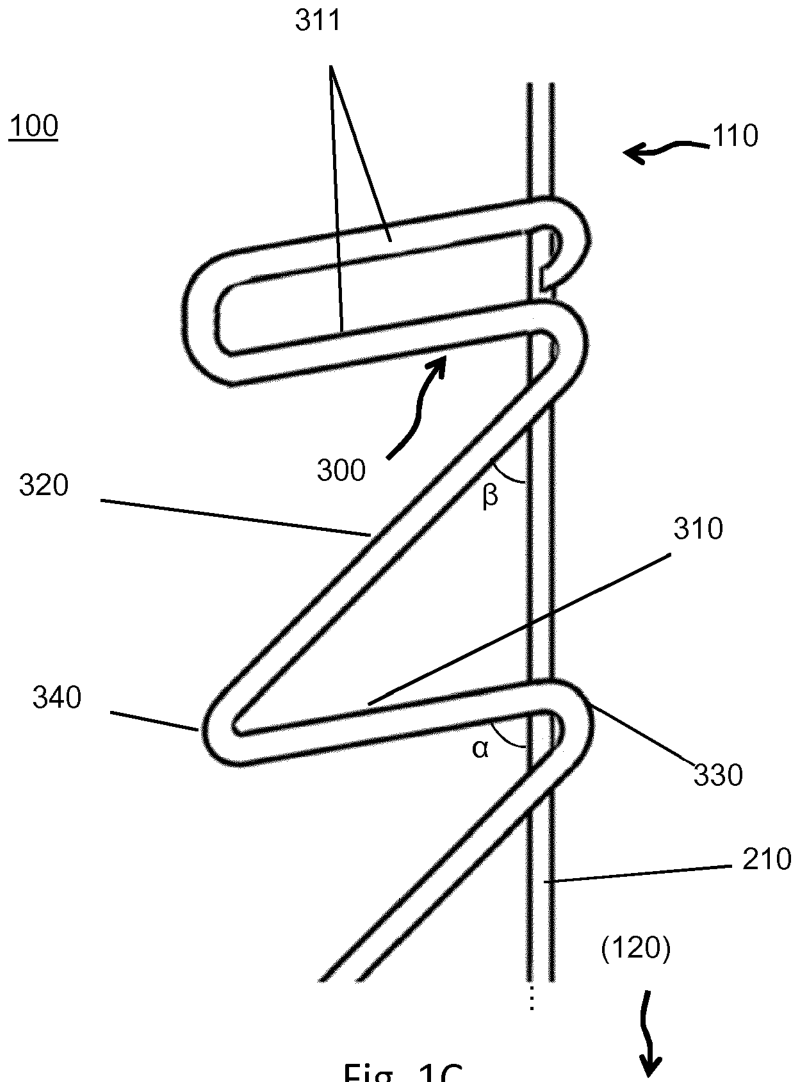

Fig. 1C

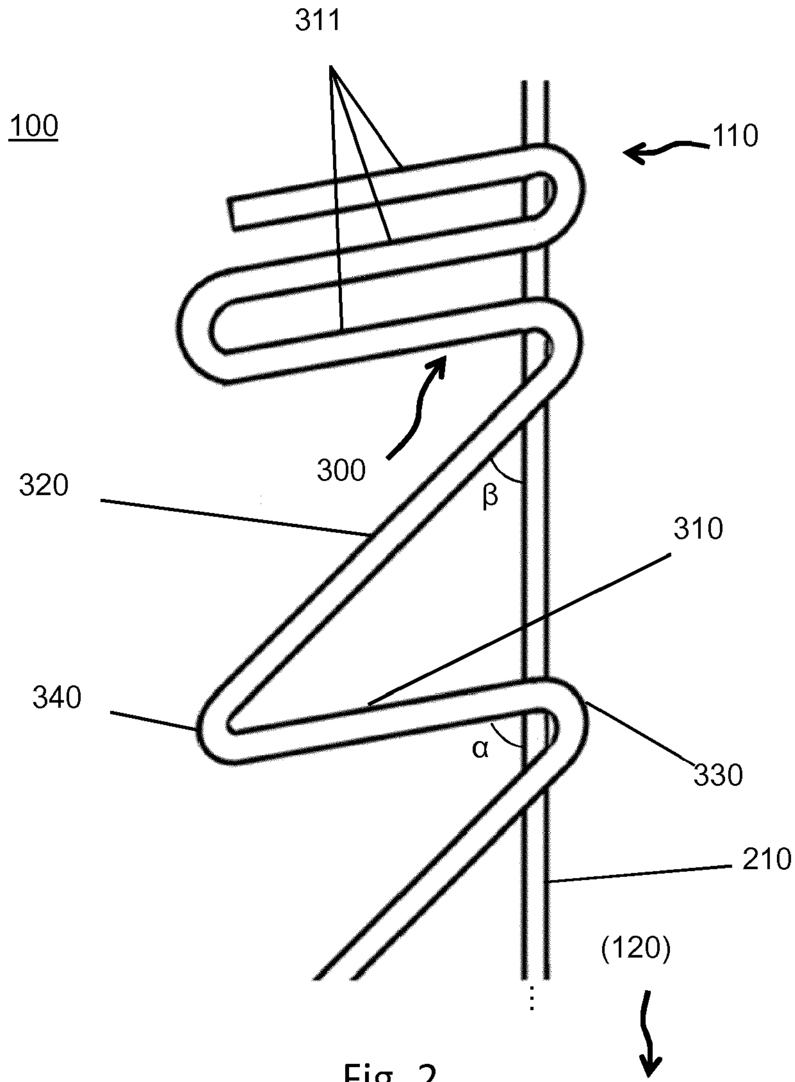

Fig. 2

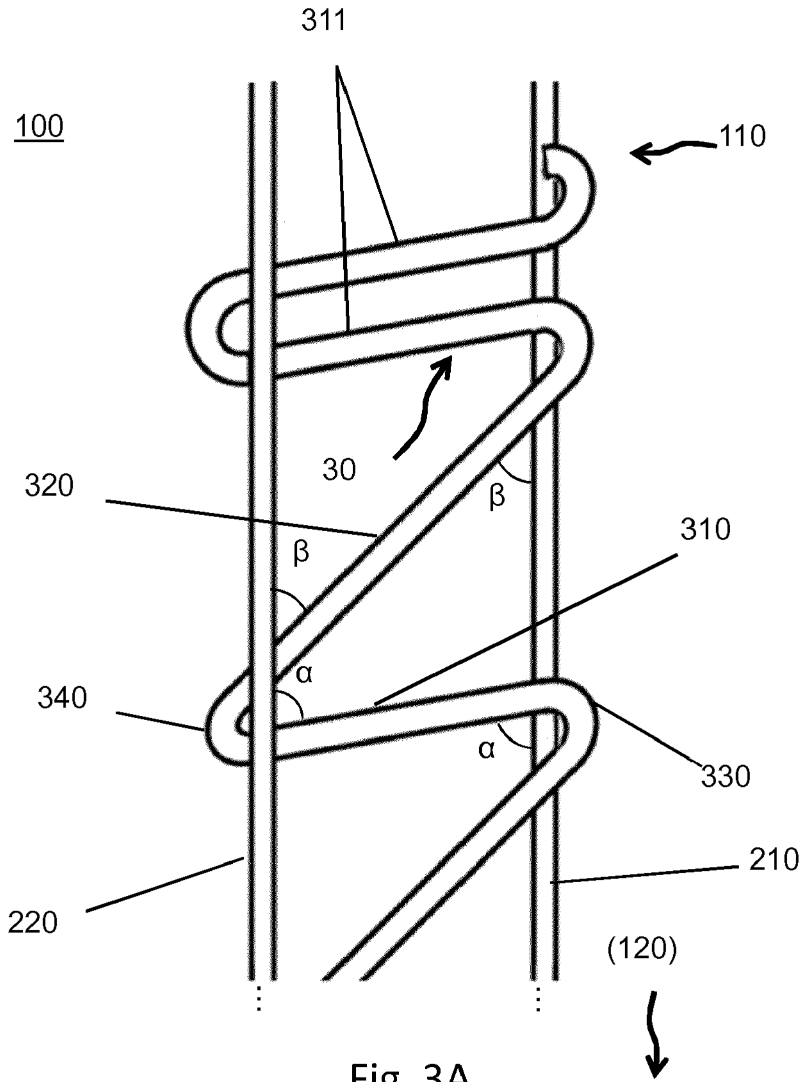

Fig. 3A

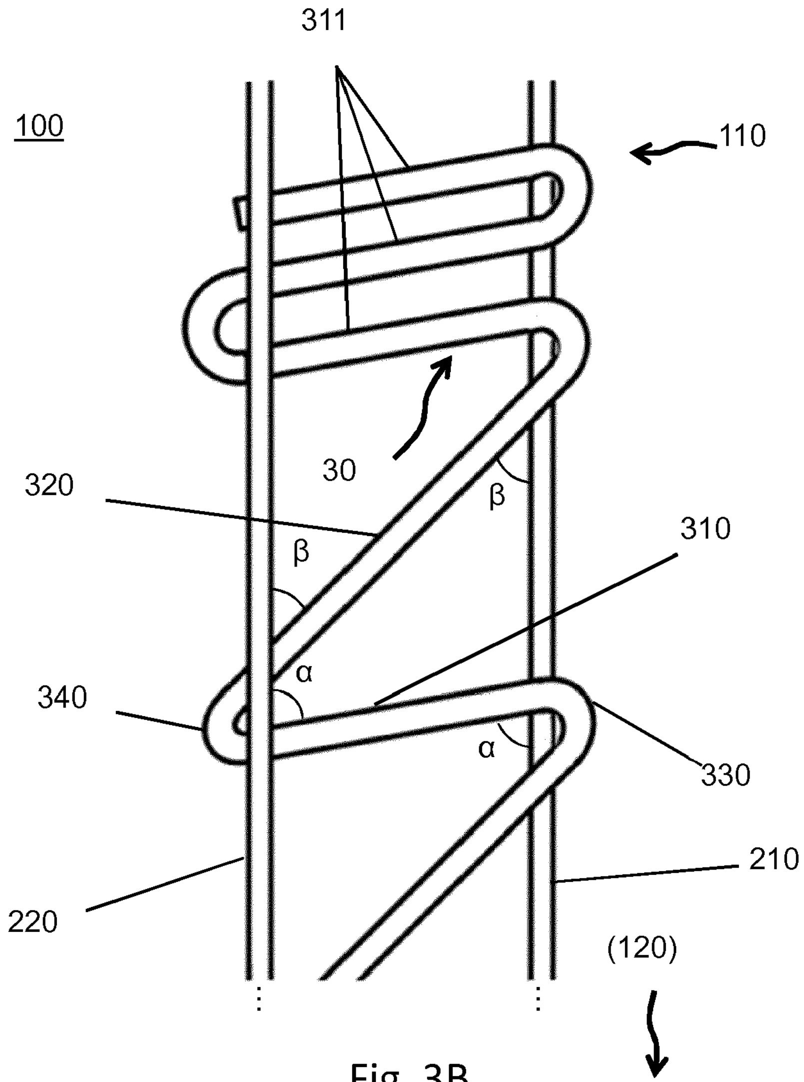

Fig. 3B

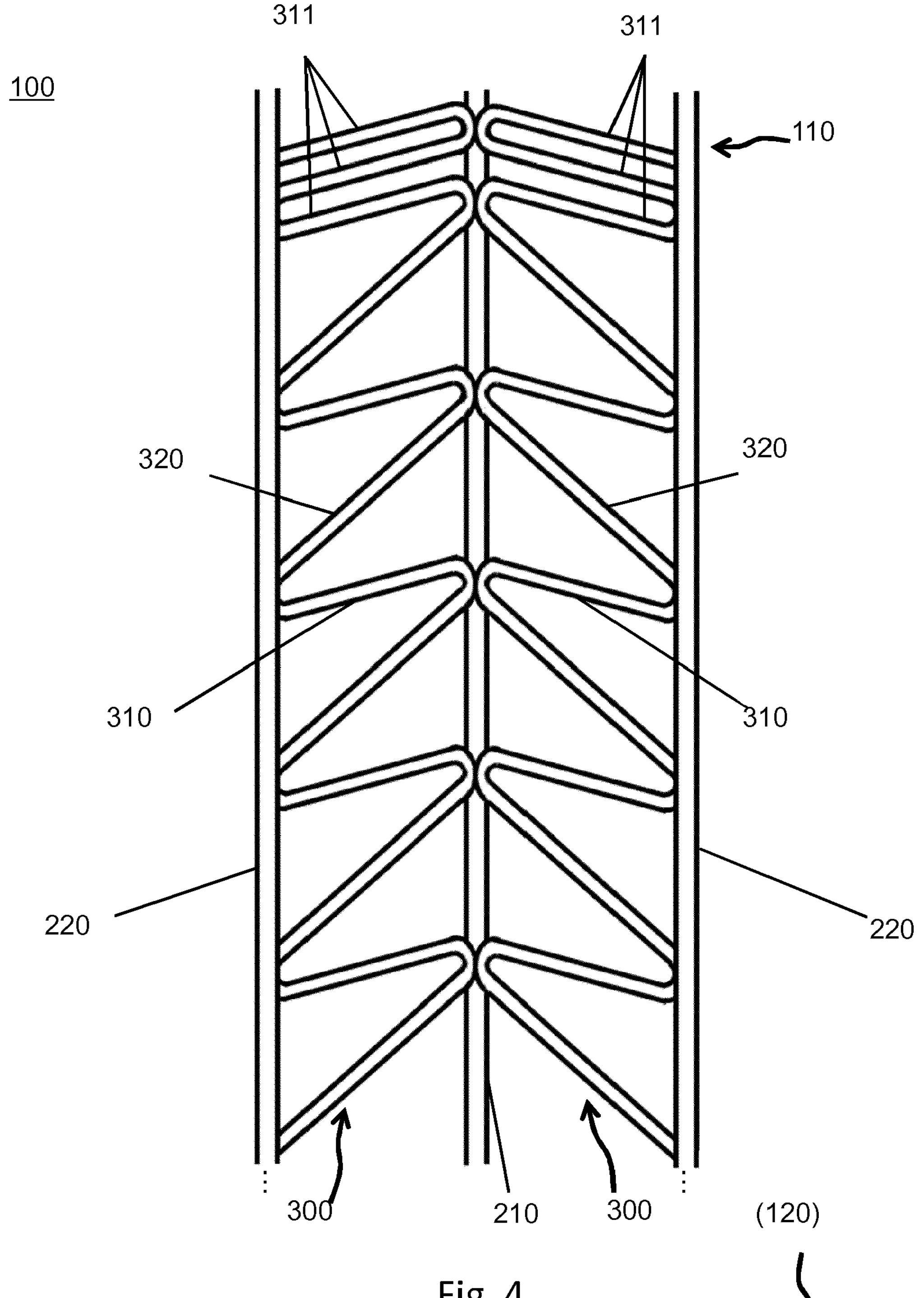

Fig. 4

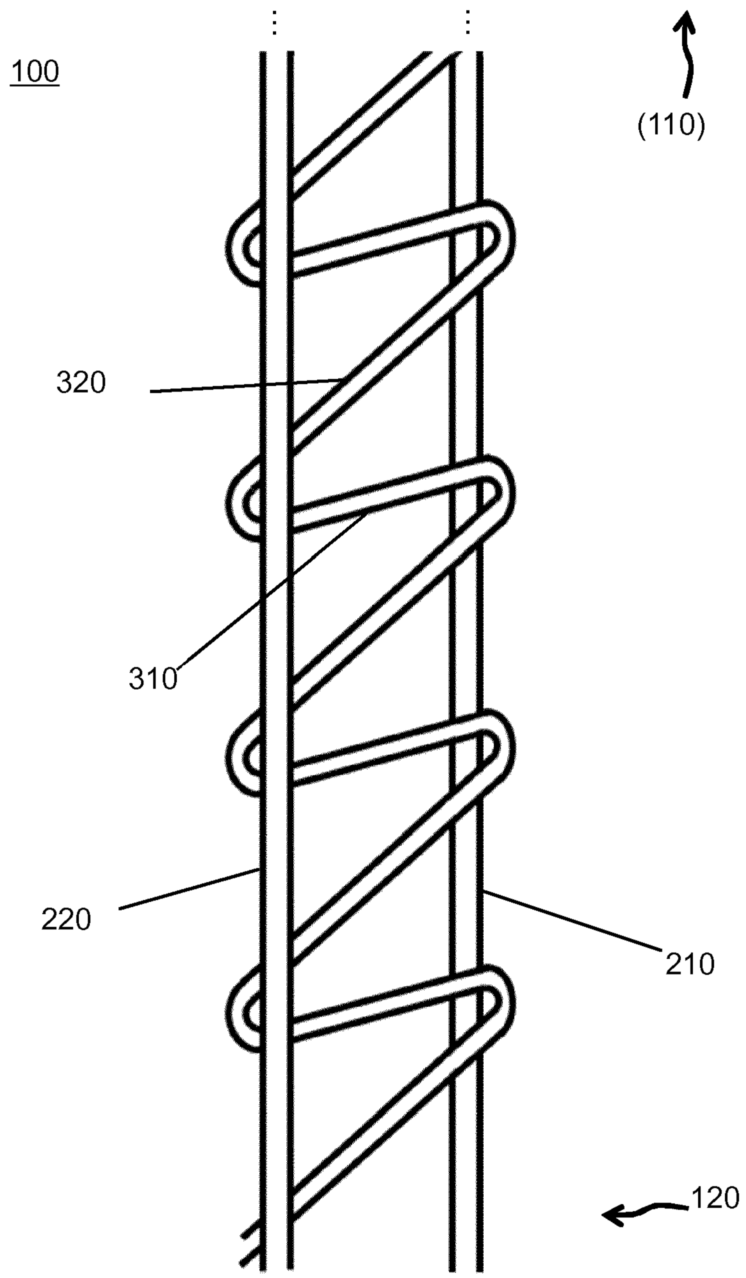

Fig. 5

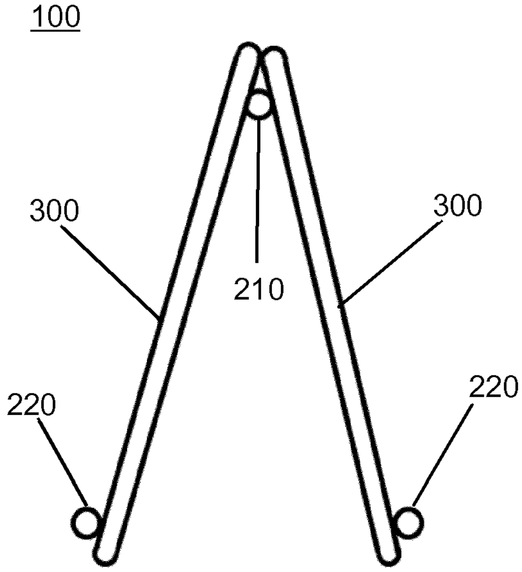

Fig. 6A

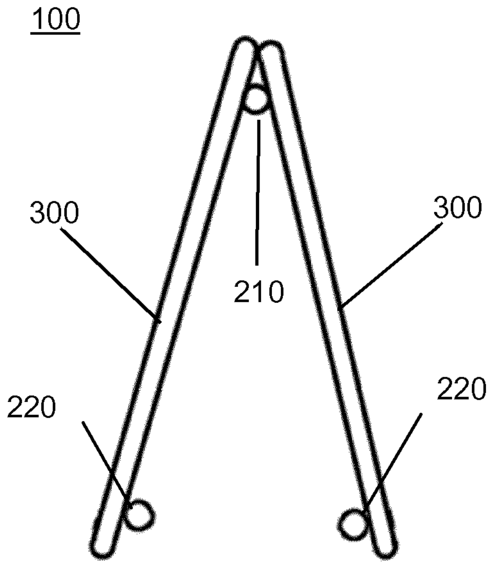

Fig. 6B

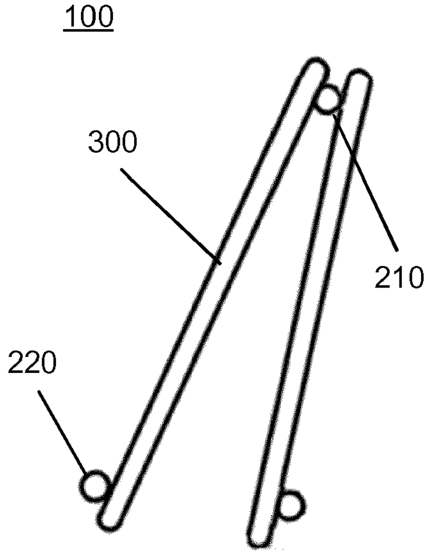

Fig. 6C

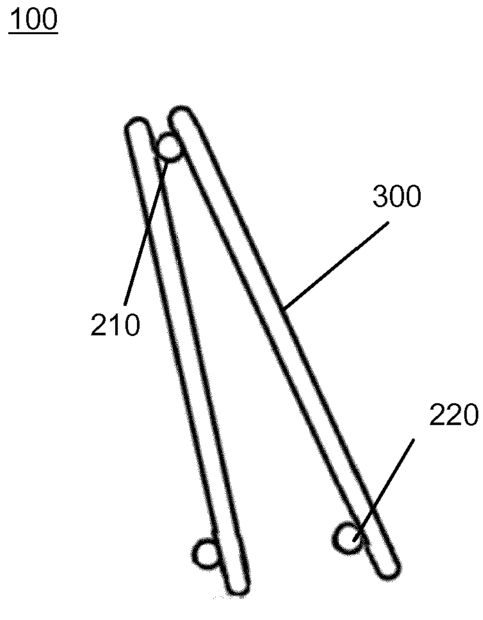

Fig. 6D

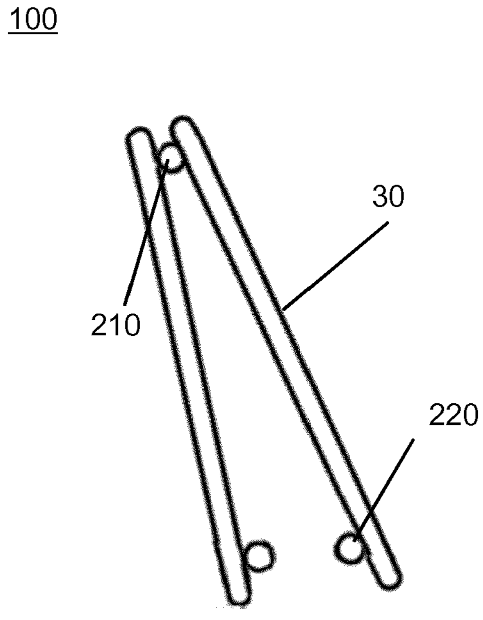

Fig. 6E

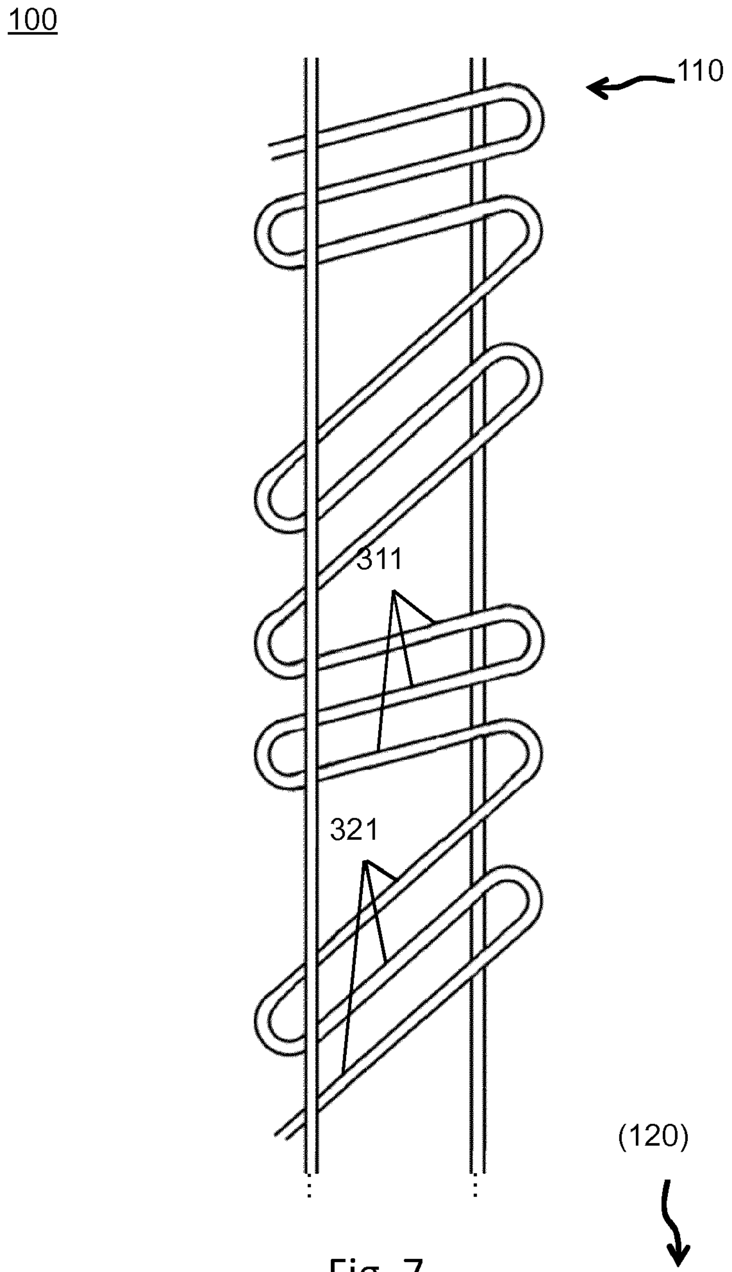

Fig. 7

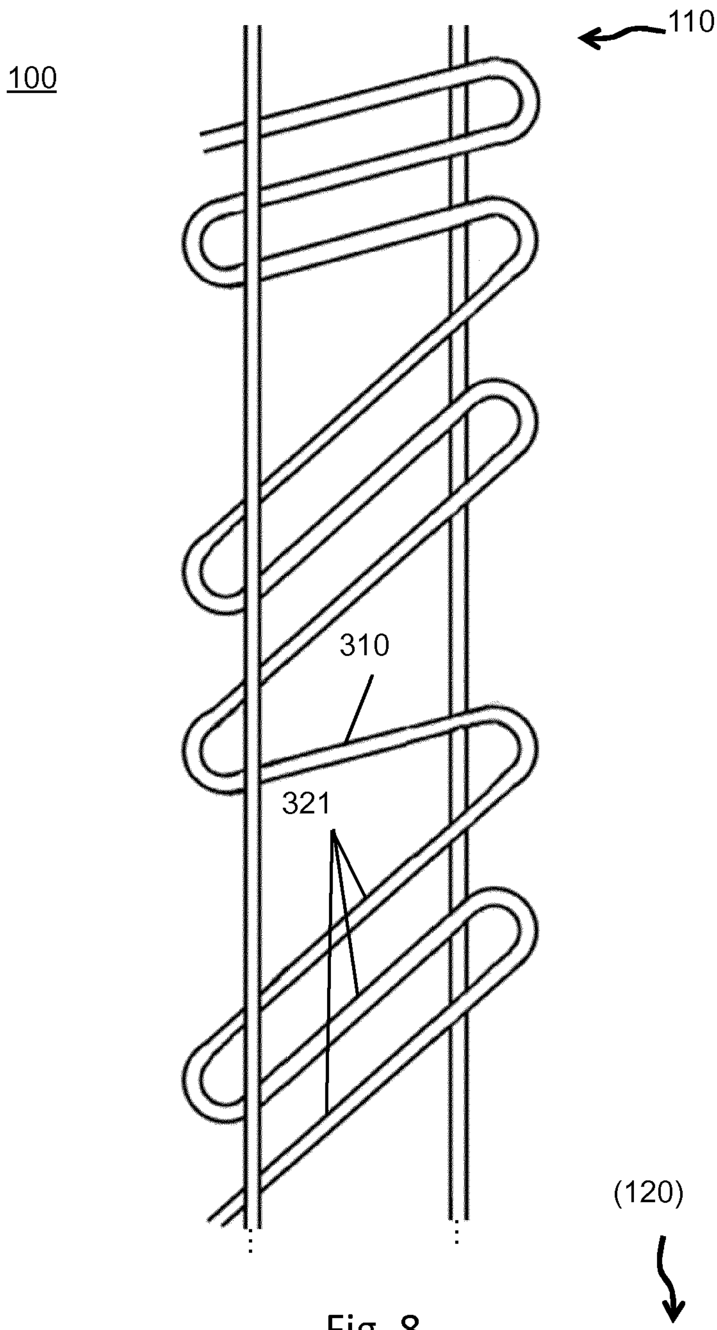

Fig. 8

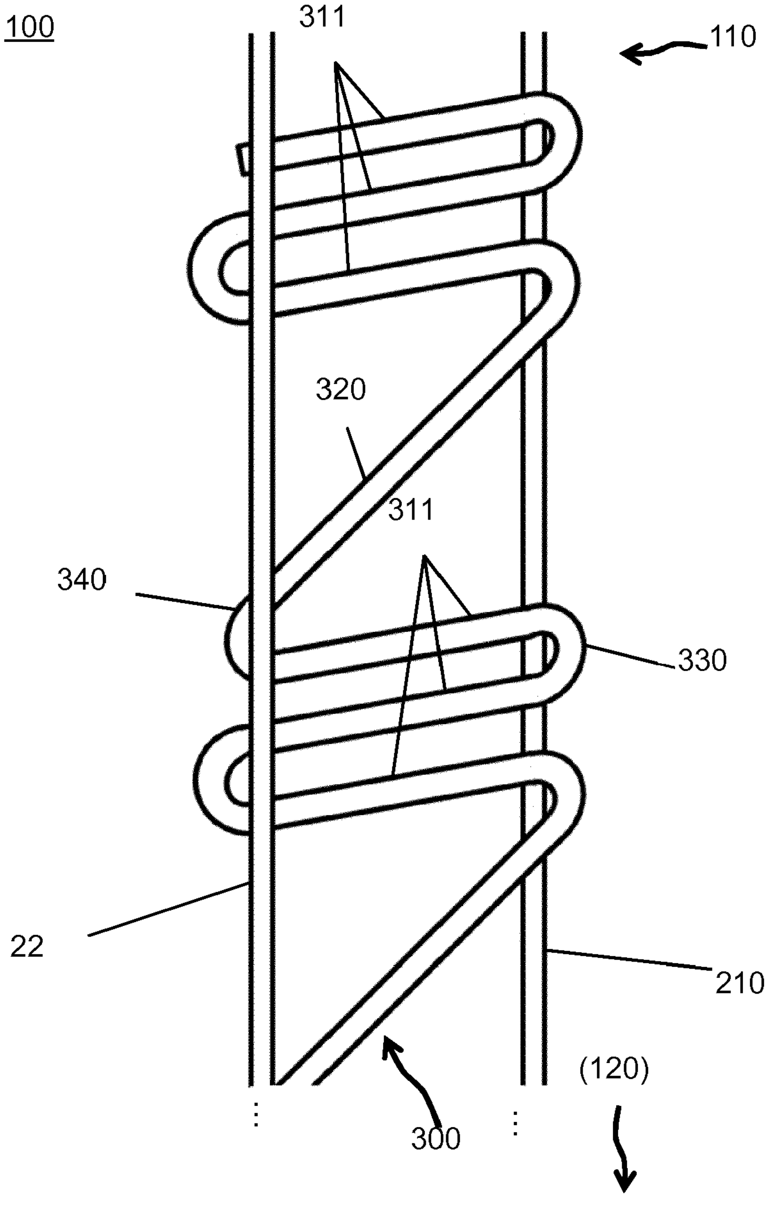

Fig. 9

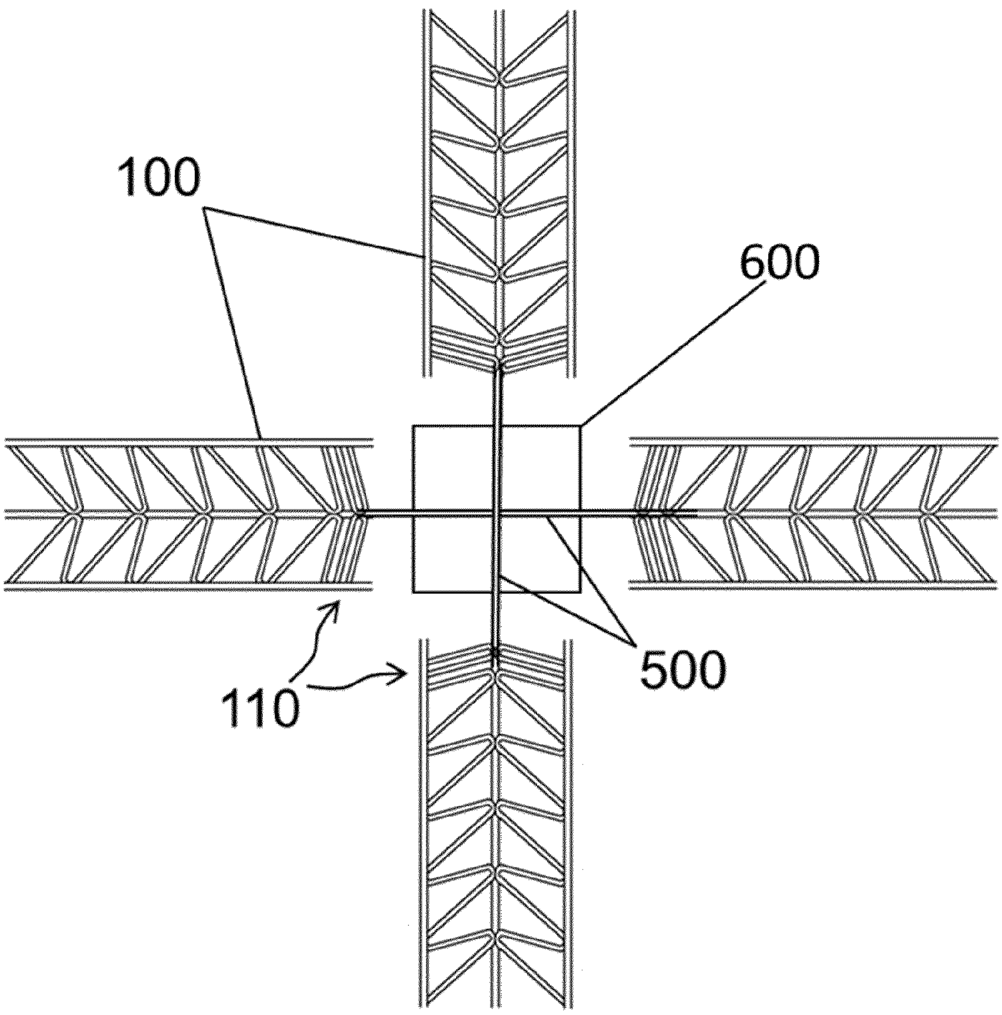

Fig. 10A

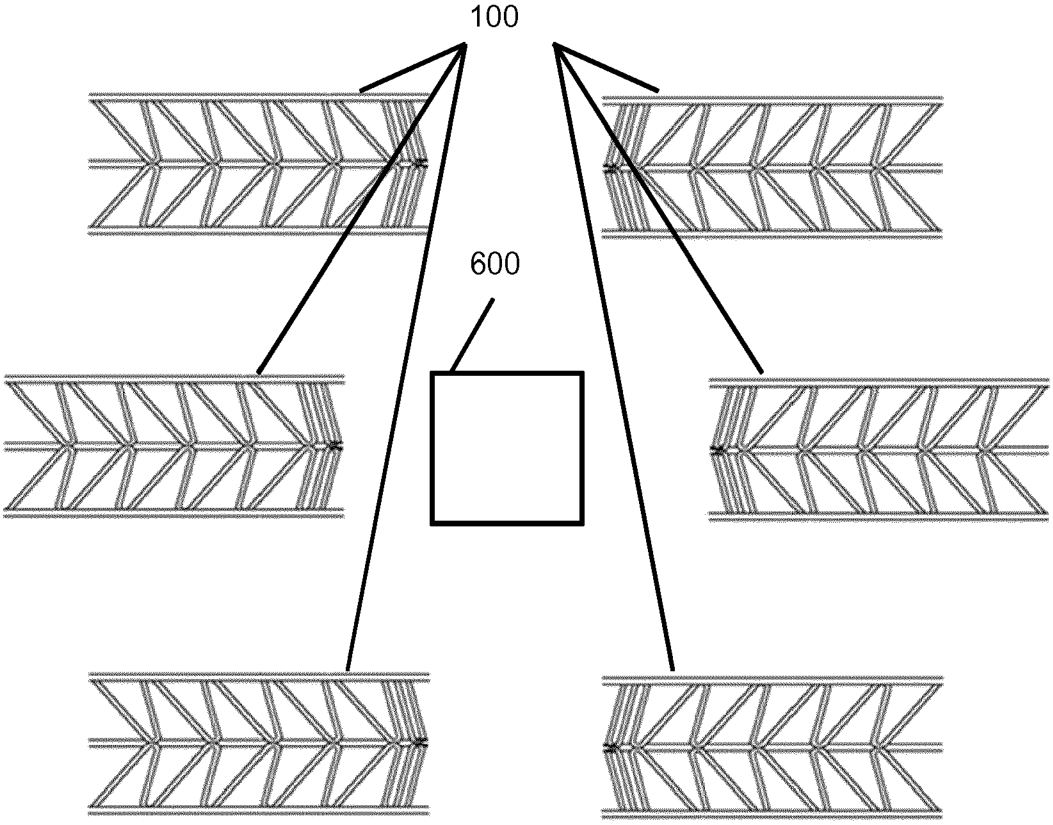

Fig. 10B

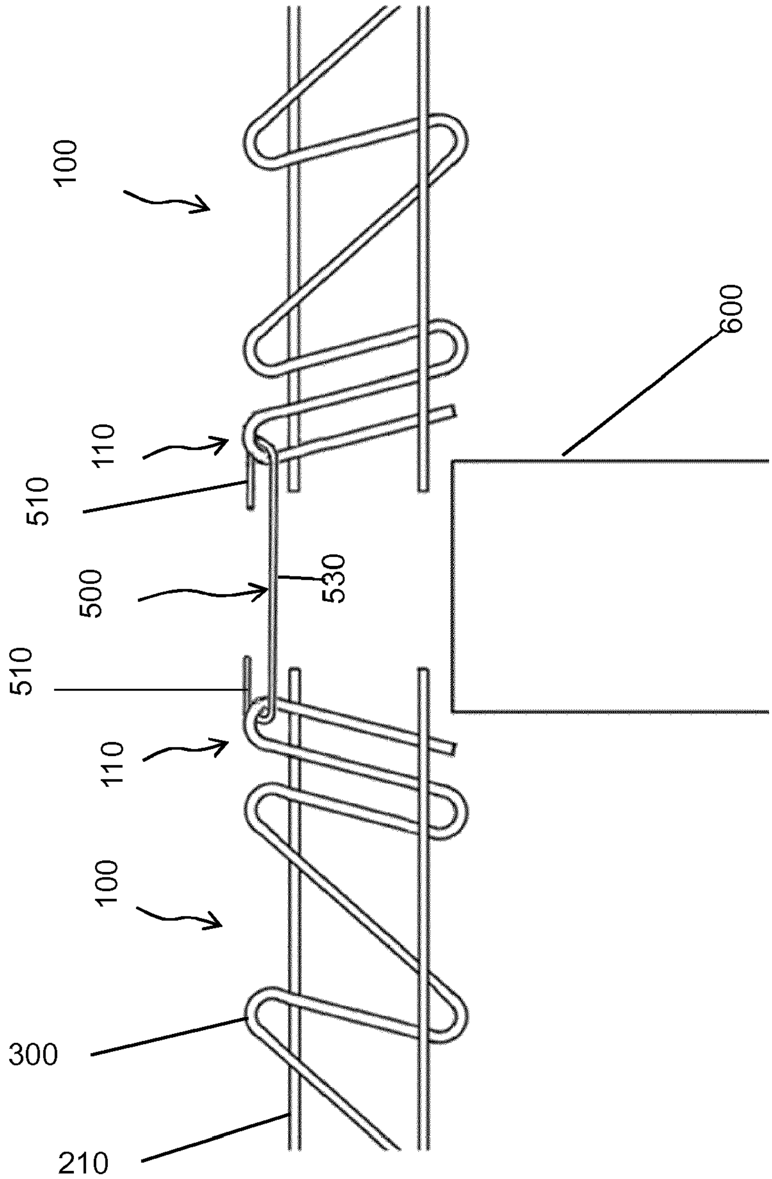

Fig. 11A

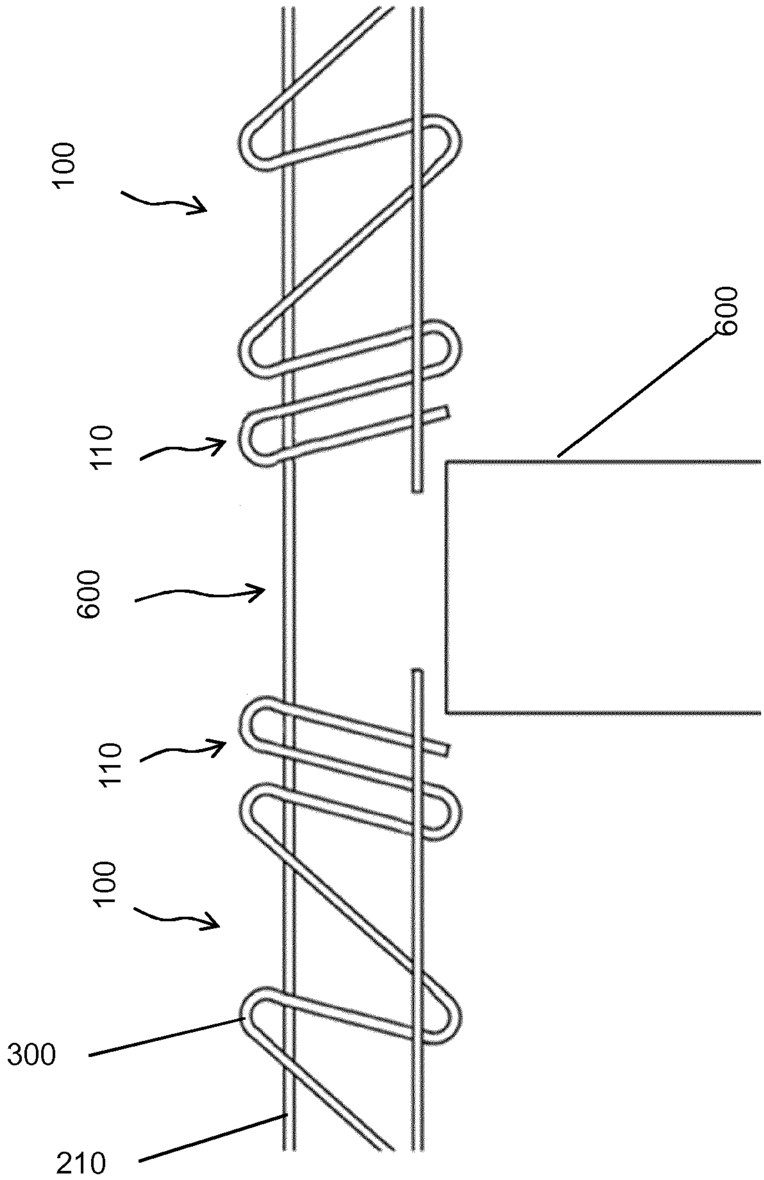

Fig. 11B

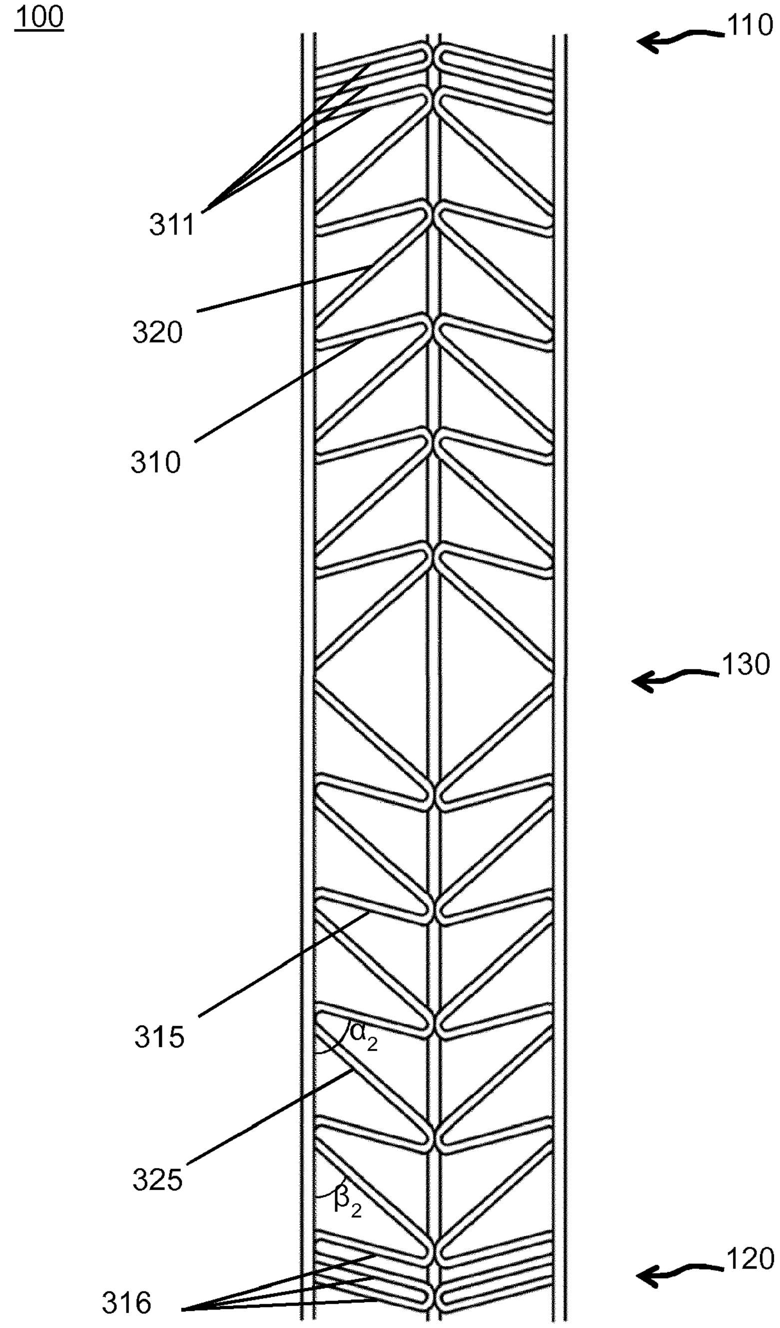

Fig. 12

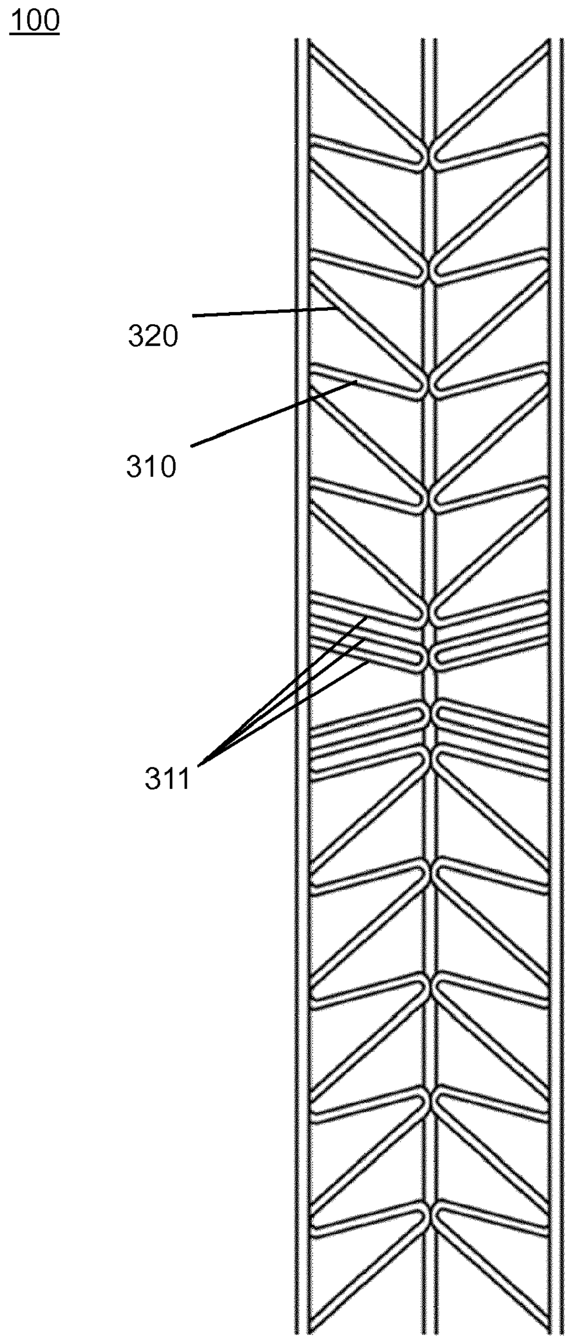

Fig. 13

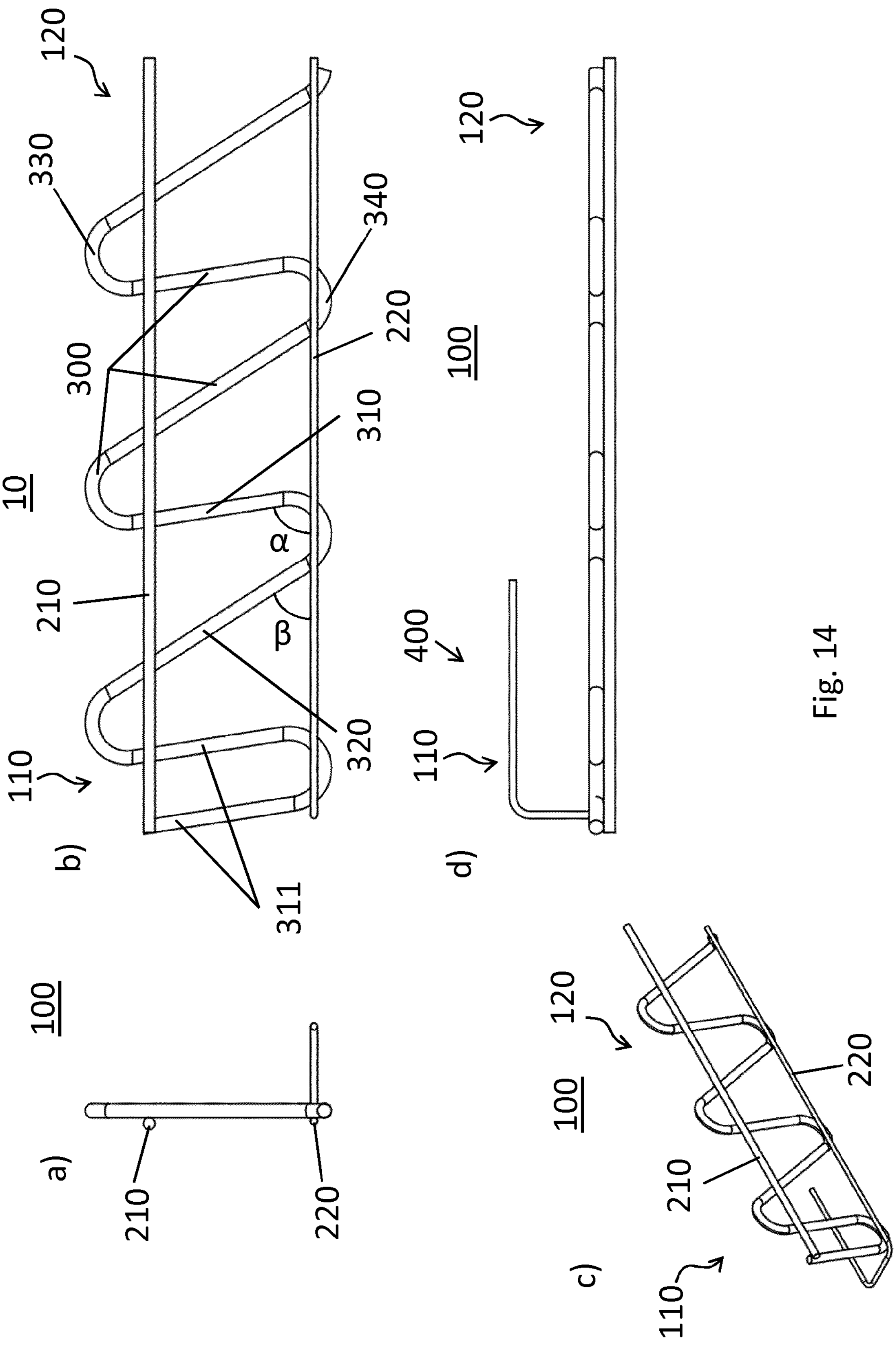
a)
100
210
220
b)
10
110
120
210
220
300
310
311
320
330
340
α
β
c)
100
110
120
210
220
d)
100
110
120
400

Fig. 14

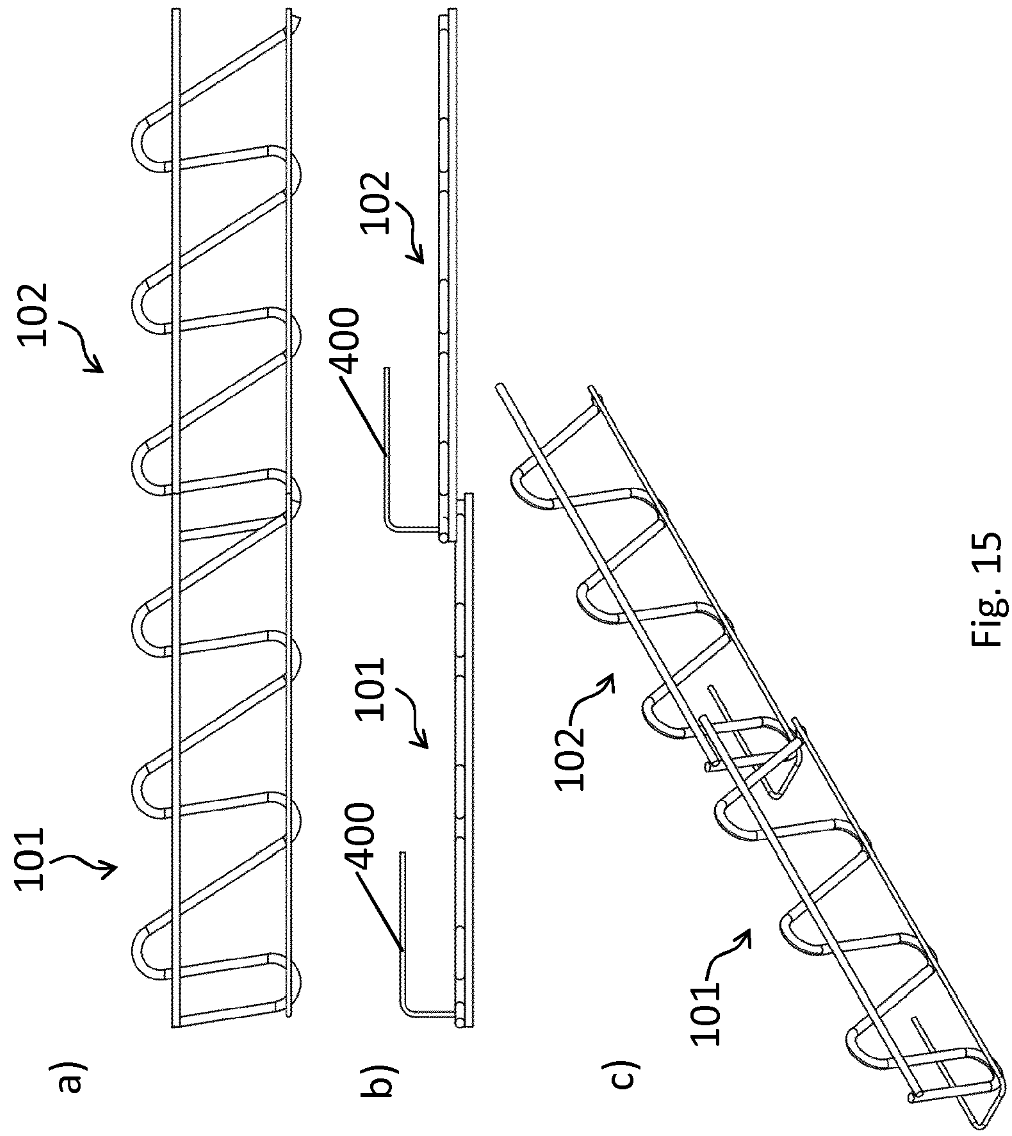

Fig. 15

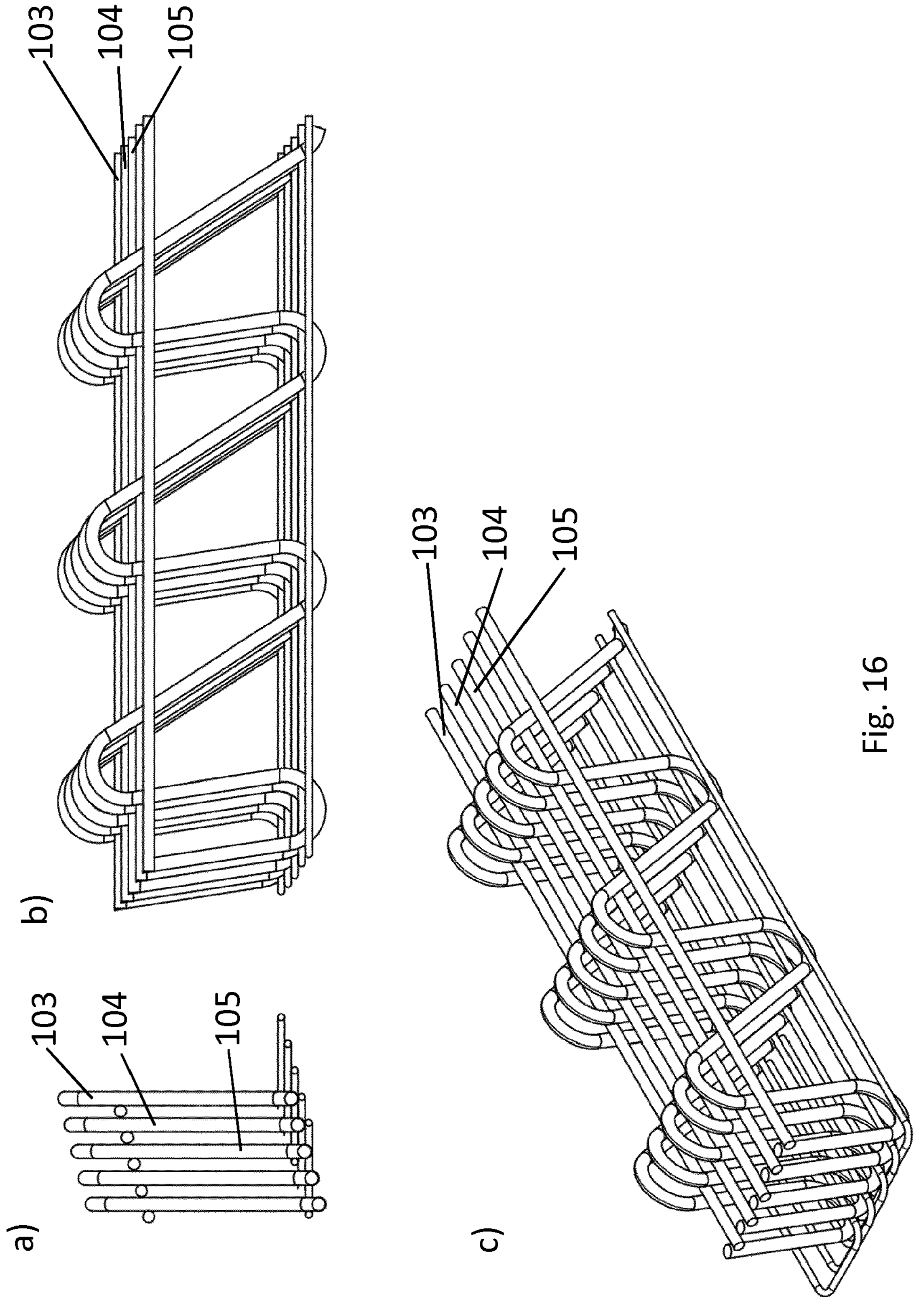

Fig. 16

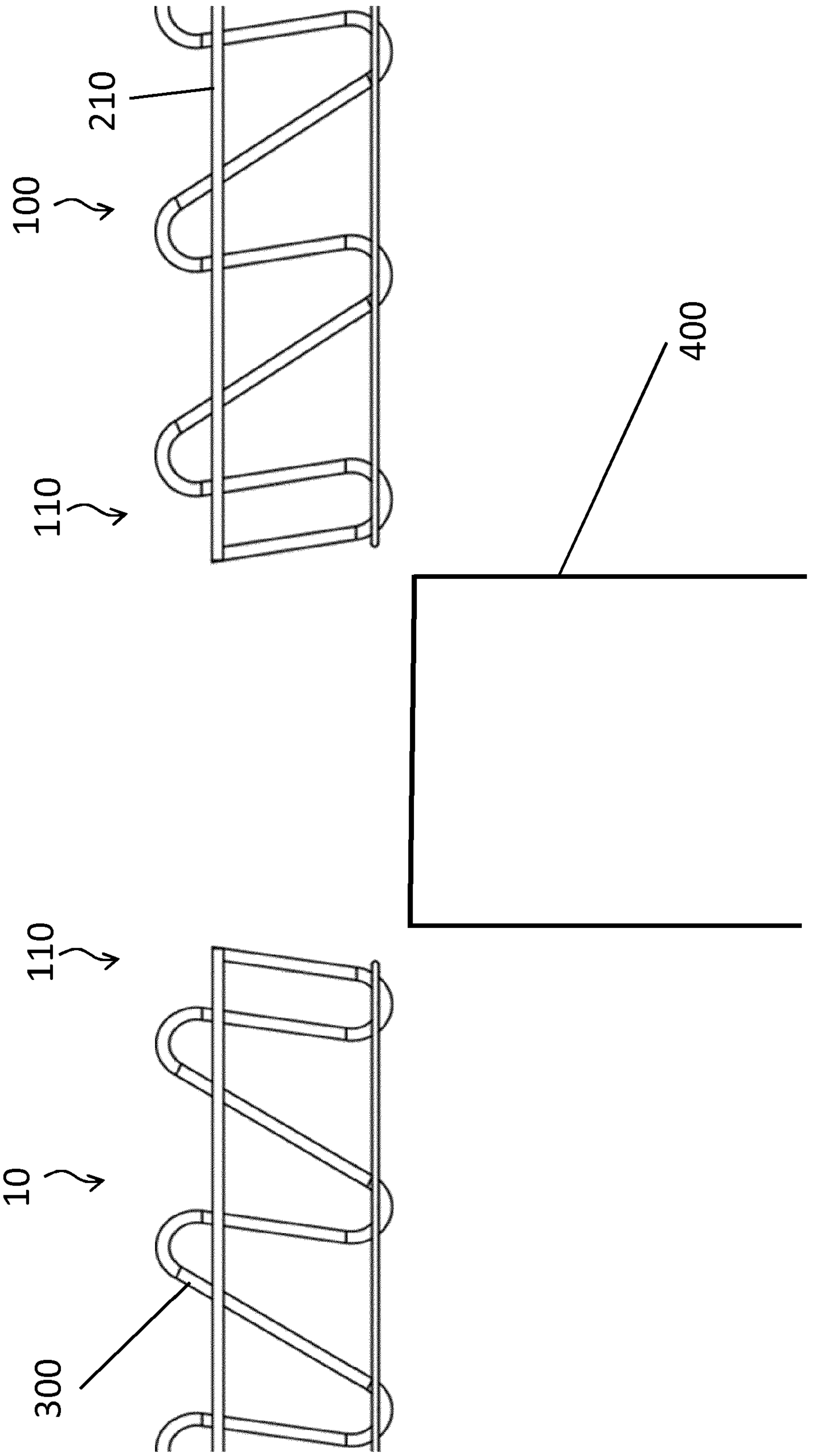

Fig. 17

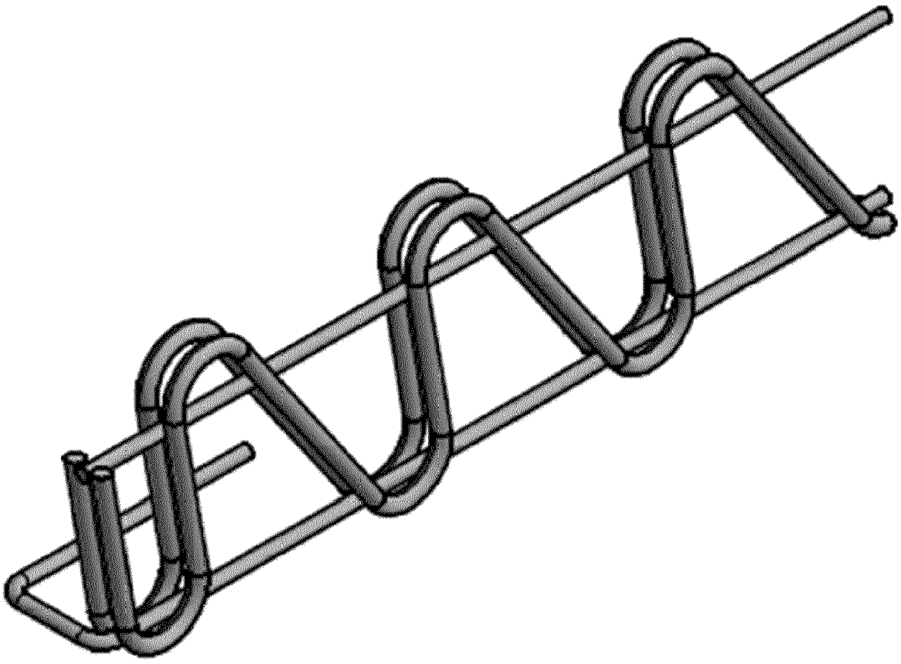

Fig. 18 A

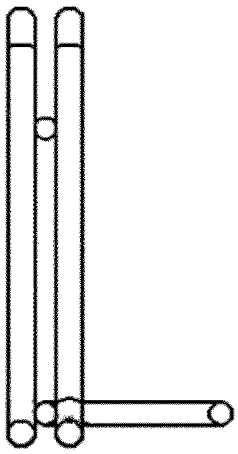

Fig. 18 B

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EUROPEAN SEARCH REPORT

Application Number
EP 19 15 9904

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	EP 2 698 484 A1 (FILIGRAN TRAEGERSYSTEME [DE]) 19 February 2014 (2014-02-19) * paragraph [0023] - paragraph [0030]; figures 1-4 *	1-15	INV. E04C5/06 ADD. E04B5/16
X	RU 2 637 668 C1 (FEDERALNOE GOSUDARSTVENNOE BYUDZHETNOE OBRAZOVATELNOE UCHREZHDENIE VYS) 6 December 2017 (2017-12-06) * abstract; figures 1-4 *	1-15	
A	WO 2011/067027 A1 (FISCHER RISTA AG [CH]; MUTTONI AURELIO [CH]; LUECHINGER BRUNO [CH]; FE) 9 June 2011 (2011-06-09) * page 15, line 15 - page 16, line 5; figures 8A, 8B *	1	

TECHNICAL FIELDS SEARCHED (IPC)

E04C
E04B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	17 July 2019	Galanti, Flavio

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 15 9904

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17-07-2019

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