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(54) MODULAR TRUSS STRUCTURE

(57) The above object is accomplished by a truss structure and in particular a truss structure comprising a series of truss base elements, wherein each truss base element comprises a series of elongated structural shapes, a first series of braces, a first series of holes provided on a first outer face of the first elongated structural shape, a second series of holes provided on a second outer face of the second elongated structural shape. Each hole of the first and second series of holes have a hole diameter D1 and a hole center C, wherein D1 is determined according to the relation R=H/D1, wherein R is determined according to 1.1≤R≤3.0, preferably 1.4≤R≤2.6, and more preferably R = 2.0. It is an object to provide for an alternative, sustainable modular truss structure with improved degree of customisation and shape flexibility while still guaranteeing stability for connecting external loads or other compatible structures.

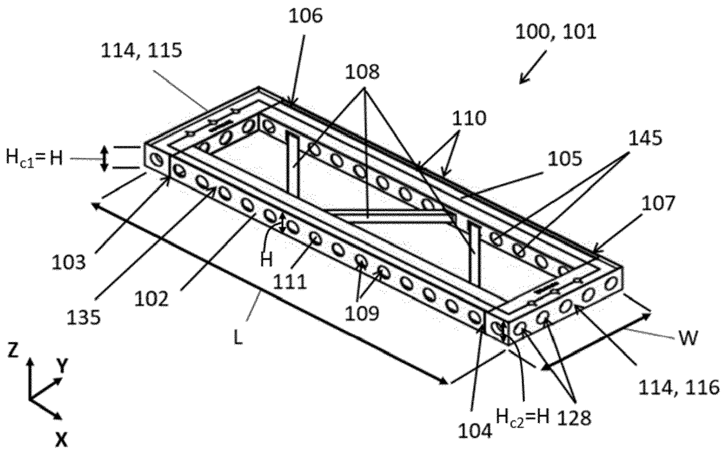

Fig. 1A

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Description

Field of the invention

[0001] The present invention relates to the technical field of trusses, in particular to a modular truss structure, for example for use in temporary structures used in, for example, trade shows and conventions. Further the technical field relates to any suitable assembly comprising such trusses and methods of manufacturing and/or assembling such trusses and/or such assemblies.

Background of the invention

[0002] As known to a person skilled in the art a truss is typically defined as an assembly of beams and/or other elements that are joined to create a rigid structure. Typically, in engineering a truss is a structure that comprises a plurality of force members, where these members are configured such that the assembly of these members which form the truss, behave, as a whole as a single object. Trusses typically comprise a plurality of triangular units constructed with straight members whose ends are connected at joints referred to as nodes. A truss, which could also be referred to as a space truss, has members and nodes that extend into three dimensions. Such a truss extending in three dimensions, might for example comprise a plurality of two dimensional modules, or truss base elements, which can for example comprise a planar truss in which the longitudinal direction of the members is aligned with predetermined two-dimensional plane. Typically, for a truss spanning a horizontal distance, the top and bottom beams in a truss are referred to as top and bottom chords, the interior beams of the truss are also referred to as webs or braces, and the areas inside the webs are also referred to panels or polygons. It is clear that, in the context of such a load-bearing truss structure, typically such a truss spanning a horizontal distance, is typically loaded by the weight and/or forces of elements supported by and/or on the truss, and that braces and chords of such a truss structure are typically configured to be elements that can withstand both tension and compression along the direction of their longitudinal axis.

[0003] Trusses are for example assembled to create scaffolds, roofing constructions, support frames and other constructions. Trusses can also be used in the construction of lighting ceilings, scenic constructions for concerts, fashion shows, presentations, trade fair stands and the like, for instance for mounting thereon pieces of scenery, curtains, speakers, display modules, spotlights, stages and the like. The modularity of trusses and constructions and/or assemblies making use of such trusses together with their relatively rapid and simple assembly and disassembly make such truss constructions particularly suitable for temporary use during events.

[0004] US 2004/0187426A1 describes trusses for supporting lighting, scenic and other loads. According to one embodiment, a truss unit comprises four chords or elongated structural shapes that are interconnected with cross braces. The end portions of the four chords are connected with end plates comprising pass holes, which allows connecting the truss unit with another truss or object. This document also discloses that further tubes or other loads can be attached to the truss using clamps or cheseboros. A drawback of the embodiment disclosed in US 2004/0187426A1 is that it requires the use of clamps to attach loads or other elements to the truss. These clamps may move, e.g. linearly, from their fastening positions if not correctly installed, representing a possible danger. In addition, the mounting of the clamps makes the bounding box of the construction larger (cf. Fig. 8C and 8E of that document), and there are no means of nicely finishing the truss structure. Moreover, these structures may cause high local stresses in the material because of the limited contact between round tube trusses with flat surfaces on the extremes, thereby increasing the risk for local deformations and/or indentations of these chords of the truss, thereby increasing the risk of buckling of these load carrying chords, which are also subjected to the largest compression and/or tension forces. Further, when creating an assembly from a plurality of such truss structures, the coupling elements connecting the truss structures are subject to large loads and typically form weak points in such truss structure assembly, which additionally put limits on the efficiency of the truss structure assembly and the method of assembling such a truss structure assembly.

Summary of the invention

[0005] In light of this drawback of the prior art, there remains a need to provide for an alternative, sustainable modular truss structure with improved degree of modularity, customisation and shape flexibility while still guaranteeing stability, robustness and load carrying capacity for connecting external loads or other compatible structures. Additionally, it is an object to provide such truss structures, truss structure assemblies and corresponding methods for use and/or assembly with an increased level of robustness, efficiency and load carrying capacity. The above object is accomplished by a truss structure according to a first aspect of the invention, and in particular a truss structure comprising one or more truss base elements, wherein each truss base element comprises a series of elongated structural shapes comprising a first elongated structural shape extending from a first end portion to a second end portion according to an X-direction, a second elongated structural shape extending from a third end portion to a fourth end portion according to the X-direction, wherein the first elongated structural shape and the second elongated structural shape have a height H measured according to a Z-direction, wherein the Z-direction is perpendicular to the X-direction, and wherein the first and second elongated structural shapes are spatially separated according to a Y-direction perpendicular to the X- and Z-direction, a first series of braces connecting the first elongated structural shape to the second elongated structural shape, a first series of holes provided on a first outer face of the first elongated structural shape, a second series of holes provided on a second outer face of the second elongated structural shape, wherein the first and second outer faces are facing away from the first series of braces, wherein each first and second series of holes comprise a plurality of holes, wherein each hole of the first and second series of holes have a hole diameter D1 and a hole center C, wherein D1 is determined according to the relation R=H/D1, wherein R is determined according to $1.1 \leq R \leq 3.0$, preferably $1.4 \leq R \leq 2.6$, and more preferably R = 2.0.

[0006] According to an embodiment the plurality of holes are adapted to receive connecting means. Such connecting means could for example be configured, when received in the holes of the truss base element to connect the truss base elements with another structure comprising similar holes, such as for example another truss base element of another truss structure comprising such a series of holes, a frame comprising a similar elongated structural shape with a similar series of holes, such as for example a frame similar as known from BE1020560A3, which is incorporated herein by reference, any other suitable element or object suitable to be connected to the truss base elements by means of such a connecting means. Preferably the connecting means are configured as a releasable connecting means.

[0007] An advantage of the present embodiment is that loads can be fastened at different positions onto the truss structure, using matching connectors, connecting means or fastening means passing through the holes, while still maintaining a truss structure that is strong and stable enough to support the loads fastened to it. There is no need to use additional clamps or cheseboros to fasten additional truss base elements or loads. This increases robustness as there is a decreased risk for deformation of the truss structure under the action of the fastening means and thus a decreased risk for buckling, rupture and/or other mechanical failures due to concentrated stresses at such uncontrolled and undesirable deformations when under high loads. Another advantage of the embodiment is that the diameter of the holes may be relatively large in comparison with the surface area of the first and second outer face, while the first series of braces guaranty a stable and load-bearing truss structure. This has also the beneficial property that the assembling or disassembling of the truss structure may be performed relatively fast because the connecting means may be easily received by the holes and their participating holes at the other face or side of the elongated structural shape, and at the same time with a hole and participating hole of another truss base element. The series of braces limit the torsion and prevent deflection or buckling, and spread stressed in the truss structure when loads are applied. Furthermore, the holes allow for a modular and customized truss structure when combining the truss base element with other truss base elements according to an embodiment. Additionally, the truss base elements may be re-used in other configurations and settings.

[0008] According to a further embodiment there is provided a truss structure, wherein each truss base element further comprises a series of reinforcing means, wherein each reinforcing means of the series of reinforcing means is adapted to fix to and to connect the first and the second elongated structural shapes.

[0009] An advantage of such an embodiment is that the diameter of the holes may be relatively large in comparison with the surface area of the first and second outer face, while the first series of braces and reinforcing means guaranty a stable and load-bearing truss structure.

[0010] According to a preferred embodiment, the hole center C of each hole of the plurality of holes of each first and second series of holes are provided at a predetermined selection of spatial points, wherein the selection of spatial points are part of a spatial grid extending along the X, Y, Z directions, and wherein each spatial point of the spatial grid is at a predetermined distance K from another spatial point.

[0011] An advantage of this specific embodiment is that the truss base elements may efficiently be manufactured because the holes are provided at a predetermined selection of spatial points that are part of a spatial grid, and wherein the distance between the spatial points is predetermined. Additionally, a modular truss structure having a compatible hole pattern is provided which has the benefit of connecting and fastening other truss base elements or part of truss structures according to the present invention in a time efficient, user-friendly and flexible way. Indeed, in comparison with other well-known truss structures, very limited or even no aligning means are required to connect and fasten other truss base elements.

[0012] According to a preferred embodiment a first reinforcing means of the series of reinforcing means has a height H_{C1} which is a factor m times the height H of the first and the second elongated structural shapes, wherein the factor m is selected in the range from 0,75 to 1,25, preferably the factor m is equal to 1, and wherein H is a multiplicity of the predetermined distance K. An advantage of this embodiment is that the truss structure is further stabilized. In addition, in comparison with other well-known truss structures, the reinforcing means further limits the torsion and prevent deflection or buckling, and spread stressed in the truss structure when loads are applied. In addition, another advantage of this specific embodiment is that the diameter of the holes may be relatively large in comparison with the surface area of the first and second outer face, while the reinforcing means guaranty a stable and load-bearing truss structure.

[0013] According to a preferred embodiment, the reinforcing means is adapted to receive at least a part of the first end portion of the first elongated structural shape and at least a part of the third end portion of the second elongated structural shape. An advantage if this specific embodiment is, besides the aforementioned advantages of providing a reinforced truss base element, that the embodiment provides a modular truss structure. Lengthy truss base elements may also be formed by a plurality of short truss base elements connected to each other using these specific reinforcing means.

[0014] According to a preferred embodiment wherein the reinforcing means comprises a third series of holes, wherein the third series of holes comprises a plurality of holes having a hole diameter D2, wherein D2 is determined according to the relation R=H/D2, wherein R is determined according to $1.1 \leq R \leq 3.0$, preferably $1.4 \leq R \leq 2.6$, and more preferably R = 2.0. An advantage if this specific embodiment is, besides the aforementioned advantages of providing a reinforced truss base element, that the embodiment provides a modular truss structure. Lengthy truss base elements may also be formed by a plurality of short truss base elements connected to each other using these specific reinforcing means. Moreover, the holes may be compatible with other truss base structures according to the present invention or specific other frames.

[0015] According to a preferred embodiment, the hole center C of each hole of the plurality of holes of the third series of holes is provided at a predetermined selection of spatial points, wherein the selection of spatial points is part of the spatial grid. An advantage of this specific embodiment is that the truss base elements may efficiently be manufactured because the holes are provided at a predetermined selection of spatial points that are part of a spatial grid, and wherein the distance between the spatial points is predetermined. Additionally, a modular truss structure having a compatible hole pattern is provided which has the benefit of connecting and fastening other truss base elements or part of truss structures according to the present invention in an time efficient, user-friendly and flexible way. Indeed, in comparison with other well-known truss structures, very limited or even no aligning means are required to connect and fasten other truss base elements.

[0016] According to a preferred embodiment, the third series of holes comprises at least a flange at an inner side of the holes. An advantage of the preferred embodiment is that loads can be fastened at each extremity of the truss structure, and that only fasteners compatible with the flange can be used to fasten loads to the truss structure.

[0017] According to a preferred embodiment, the first and second elongated structural shapes have a substantially rectangular cross-section in the Y-Z plane. An advantage of the present embodiment is that holes and braces may more easily be added to the elongated structural shapes in comparison with round-shaped tubes or cylinders. Moreover, rectangular-shaped profiles are easier to align and fix to each other when connected to each other using connecting means received by at least a series of holes.

[0018] According to a preferred embodiment, a second outer face of the first elongated structural shape comprises a longitudinal groove adapted for mounting a hard panel or a cover, wherein the groove comprises three walls and having a substantially rectangular cross-section, and wherein the second outer face is connected to the first outer face of the first elongated structural shape. An advantage of the present embodiment is that when two elongated structural shapes are put into contact with each other, at least two faces abut against each other with a greater surface area, then if their structural shape profile would be, for example, circular. Moreover, the truss structure obtained are easier to assemble with other truss structures.

[0019] According to a preferred embodiment, a second outer face of the second elongated structural shape comprises a longitudinal groove adapted for mounting a hard panel or a cover, wherein the groove comprises three walls and having a substantially rectangular cross-section, and wherein the second outer face is connected to the first outer face of the second elongated structural shape. An advantage of the present embodiment is that when two elongated structural shapes are put into contact with each other, at least two faces abut against each other with a greater surface area, then if their structural shape profile would be, for example, circular. Moreover, the truss structure obtained are easier to assemble with other truss structures.

[0020] According to a preferred embodiment, the hole diameter D1 is smaller than the predetermined distance K. An advantage of this preferred embodiment is that the opening of the holes cannot overlap each other. According to a preferred embodiment the ratio of K / D1 is in the range of 1.5 up to and including 4, more preferably 2. In addition, an advantage of this specific embodiment is that the truss base elements may efficiently be manufactured because the holes are provided at a predetermined selection of spatial points that are part of a spatial grid, and wherein the distance between the spatial points is predetermined. Additionally, a modular truss structure having a compatible hole pattern is provided which has the benefit of connecting and fastening other truss base elements or part of truss structures according to the present invention in a time efficient, user-friendly and flexible way. Indeed, in comparison with other well-known truss structures, very limited or even no aligning means are required to connect and fasten other truss base elements.

[0021] According to a preferred embodiment, the truss base element has a predetermined length L and a predetermined width W, wherein L equals i times the predetermined distance K, and wherein L equals k times predetermined distance K, wherein i and k are positive integers. An advantage of this specific embodiment is that the truss base elements may be used as modular blocks for a modular truss structure. Additionally, the truss base elements may be re-used in other configurations and settings.

[0022] According to a preferred embodiment, the structure comprises a first truss base element, defining a first surface substantially extending in the X,Y directions, a second truss base element defining a second surface, and a second series of braces connecting the first truss base element to the second truss base element. An advantage of this preferred embodiment is that the second series of braces may provide additional strength and support to the truss structure. The second series of braces also limit the torsion and prevent deflection or buckling, and spread stressed in the truss structure when loads are applied. Hence, it is an advantage of the present embodiment that the truss structure is stabilized whilst the connection of any load to the truss structure can bear the heaviest loads because an optimal distribution of forces is achieved. In addition, a lightweight material may be selected, e.g. aluminum, for the manufacturing of the truss structure which allows.

[0023] According to a preferred embodiment, the first surface and second surface are parallel to each other.

[0024] According to a preferred embodiment, wherein the minimum distance B between the first surface and the second surface equals p times the predetermined distance K, wherein p is a positive integer larger than 2, preferably equal to 4.

Brief description of the drawings

[0025] The drawings are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. Any reference signs in the claims shall not be construed as limiting the scope. In the different drawings, the same reference signs refer to the same or analogous elements.

Figure 1A, also referred to as Fig. 1A, is a perspective view of a truss structure in accordance with an embodiment of the present invention, wherein the truss structure comprises a single truss base element. Figure 1B, also referred to as Fig. 1B, is a perspective view of a further embodiment of a truss structure, wherein the truss structure comprises two truss base elements connected together by a second series of braces.

Figure 2A, also referred to as Fig. 2A, is a lateral section view of an embodiment of a connecting piece along the line A-A in Figure 2C, wherein recesses and a stiffening web are visible. Figure 2B, also referred to as Fig. 2B, is a top section view of the embodiment of the connecting piece illustrated in Fig. 2A.

Figure 2C, also referred to as Fig. 2C, is a top view of the embodiment of the connecting piece illustrated in Fig. 2A and Fig. 2B.

Figure 2D, also referred to as Fig. 2D, is a lateral view of the embodiment of the connecting piece illustrated in Fig. 2A - 2C, similar to the embodiment of the connecting piece shown in Fig. 1A.

Figure 3A, also referred to as Fig. 3A, is a perspective view of a truss structure in accordance with an embodiment, wherein the truss structure comprises two truss base elements. Figure 3B, also referred to as Fig. 3B, is a top view of the embodiment of the truss structure illustrated in Fig. 3A.

Figures 4A and 4B, also referred to as Fig. 4A and 4B, are a cross section of the structural shape profile in accordance with an embodiment for use with different embodiments of a cover. Figures 4C and 4D, also referred to as Fig. 4C and 4D, are a perspective view of a truss structure wherein the first and second groove present on each elongated structural shape, are used to mount a cover.

Figure 5A, also referred to as Fig. 5A, illustrates an enlarged perspective view of part of an embodiment of the truss structure. Figure 5B, also referred to as Fig. 5B, illustrates an enlarged lateral view of the truss structure in accordance with an embodiment.

Figure 6, also referred to as Fig. 6, illustrates adjacent holes in accordance with an embodiment.

Figure 7A, also referred to as Fig. 7A, is a perspective view of a truss structure in accordance with an embodiment, wherein the truss structure comprises two truss base elements. Figure 7B, also referred to as Fig. 7B, is a lateral view of the truss structure illustrated in Fig. 7A. Figure 7C, also referred to as Fig. 7C, is a front view of the truss structure illustrated in Fig. 7A. Figure 7D, also referred to as Fig. 7D, is a top view of the truss structure illustrated in Fig. 7A.

Figure 8, also referred to as Fig. 8, illustrates an alignment device that can be used in combination with a preferred embodiment.

Figure 9, also referred to as Fig. 9, illustrates an embodiment of a truss structure comprising one truss base element, which shows internal faces and external faces.

Figures 10A - 10F, also referred to as Fig. 10A - 10F, illustrate truss base elements in accordance with different embodiments, wherein each figure illustrates a perspective view of the truss base element.

Figure 12, also referred to as Fig. 12, illustrates the truss base element of Fig. 1A according to an exploded view, where one of the two connecting pieces is detached from the elongated structural shapes.

Figure 11A, 11B and 11C, also referred to as Fig. 11A, 11B and 11C, illustrates a specific embodiment of the spatial grid.

Figure 14, also referred to as Fig.14, there is demonstrated an exploded view of a truss base element according to a specific embodiment.

Figure 15, also referred to as Fig.15, there is demonstrated an exploded view of a truss base element according to a specific embodiment.

Figure 16, also referred to as Fig.16, there is demonstrated an exploded view of a truss base element according to a specific embodiment.

Figure 17, also referred to as Fig.17, there is demonstrated an exploded view of a truss base element according to a specific embodiment

Figure 18, also referred to as Fig.18, there is demonstrated an exploded view of a truss base element according to a specific embodiment.

Figures 17 and 18, also referred to as Fig. 17 and 18 respectively show a plane view and a perspective view of a further embodiment of a truss base element.

Figures 19 - 22, also referred to as Fig. 19 - 22, respectively show different views, sections and details of a truss structure assembly.

Figure 23, also referred to as Fig. 23, shows a plurality of different embodiments of elongated structural shapes comprising different embodiments of series comprising a plurality of different embodiments of holes.

Figure 24, also referred to as Fig. 24, shows an alternative embodiment of a truss structure assembly.

Figures 25-27, also referred to as Fig. 25 - 27, respectively show different fragments XXV, XXVI and XXVII of the embodiment of Figure 24 in further detail.

Detailed description of illustrative embodiments

[0026] Below, there will be described particular embodiments with reference to certain drawings but it is clear that this does not limit the scope of protection, which is defined by the claims. The drawings described are only schematic and are non-limiting. The dimensions and the relative dimensions do not necessarily correspond to actual reductions to practice of the embodiments.

[0027] Furthermore, the terms first, second and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequence, either temporally, spatially, in ranking or in any other matter. It has to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments described herein are capable of operating in other sequences than described or illustrated herein.

[0028] Reference throughout this specification to "embodiment", "embodiments", "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout its specification are not necessarily all referring to the same embodiment, but could refer to the same embodiment. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

[0029] In the description provided herein, numerous specific details are set forth. However, it has to be understood that embodiments may be practiced without these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description.

[0030] Where in embodiments reference is made to "a hole" in a truss base element of a truss structure, reference may be made to a blind hole wherein the hole has no participating hole or opening opposed to the hole. Reference may also be made to a pass-through hole in which the hole has a participating hole or opening opposed to the hole.

[0031] Where in embodiments reference is made to "a hole diameter", reference may be made to the diameter of a circle defining a round-shaped hole, or the diameter of the circumscribed circle or circumcircle of a polygon defining the polygon-shaped hole, wherein the circumcircle is defined by all the vertices of the polygon. Further, as described in further detail below, the diameter of the holes can also be interpreted as the diameter of the maximum distance of two points of the circumference of the hole at opposite sides with respect to the center of the circumference of the hole. In the case of a polygonal, or rounded polygonal shape of the circumference of the holes, the diameter is to be interpreted as the largest distance between any pair of vertices of the circumference. Preferably, for the holes, a bounding rectangle of which the sides are aligned with X and Y direction encloses the holes, of which the ratio of the length of this rectangle along the X direction versus the width of this rectangle along the Y direction or vice versa, is smaller than or equal to two.

[0032] Where in embodiments reference is made to "a hole center", reference is made to the circumcenter of the circumscribed circle or circumcircle. When in embodiments the hole or opening is round-shaped, or in other words circular, the hole center corresponds with the circle center of a circle defining the hole or opening.

[0033] Where in embodiments reference is made to "plane", reference is made to a two-dimensional surface that extends infinitely far.

[0034] Where in embodiments reference is made to "adjacent holes", reference is made to at least two holes which hole center C lies on the same plane of a spatial grid extending along the X, Y, Z directions.

[0035] Where in embodiments reference is made to "end portion", reference is made to the portion of the elongated structural shapes at which the elongated structural shape comes to an end. Where in embodiments reference is made to "load", reference is made to any kind of equipment, such as lighting equipment, speaker, display modules, or any other structure that can be fastened with fastening means to the holes present onto the truss structure.

[0036] Where in the context of this application reference is made to "a series of" elements, reference is made to a set comprising a plurality of such elements.

[0037] Fig. 1A illustrates a truss structure 100 according to a specific embodiment. The truss structure 100 comprises a single truss base element 101 to connect display modules, lighting, other truss structures 100 or truss base elements 101, speakers and so on. Moreover, multiple truss base elements 101 can be connected together to form a stronger and larger truss structure 100 that can support heavier loads, and be connected to more loads and at more positions.

[0038] For example, Fig. 1B illustrates a truss structure 100 comprising two identical truss base elements 101 connected together, which truss base elements 101 are the same as the elements illustrated in Fig. 1A.

[0039] The truss base element 101 according to an embodiment shown in Fig. 1A, comprises two elongated structural shapes, i.e. a first elongated structural shape 102 and a second elongated structural shape 105, connected together by means of braces 108.

[0040] In Fig. 1A, the elongated structural shapes 102, 105 are represented as in the X-direction extending long beams parallel to each other. In other words, the X-direction is parallel to the central longitudinal axis of the elongated structural shapes 102, 105.

[0041] A first elongated structural shape 102 extending from a first end portion 103 to a second end portion 104, and a second elongated structural shape 105 extending from a third end portion 106 to a fourth end portion 107 are represented, wherein the end portions are located at opposite ends of the elongated structural shapes 102, 205.

[0042] In Fig. 1A, a first series of braces 108 is present to connect the first elongated structural shape 102 to the second elongated structural shape 105. A brace from the series of braces has an elongated shape extending from a first outer end point, also referred to as "first end point", to a second outer end point, also referred to as "second end point", wherein the first end point is disposed opposed to the second end point. At least a part of the first outer end point of each brace 108 is fixed on a part of the outside perimeter of the first elongated structural shape 102, whereas at least a part of the outer second end point of the brace 108 is fixed on a part of the outside perimeter of the second elongated structural shape 105. The first series of braces 108 fixes the relative position of the first 102 and second 105 elongated structural shape with respect to each other and stabilizes a truss base element 101.

[0043] At least one brace of the first series of braces 108 is required to connect together two elongated structural shapes 102, 105 and the number of braces required is determined by the length of the truss structure 100 and/or by its use. Heavier loads connected to the truss structure would require more braces, lighter loads would require less braces.

[0044] In Fig. 1A, a first series of braces 108, which comprises three braces, connects the first elongated structural shape 102 to the second elongated structural shape 105. According to a preferred embodiment, the outer ends of the braces of the series of braces 108 may be welded, assembled or a combination thereof, on the first 102 and second 105 elongated structural shapes. An advantage of assembling the braces 108 is to save time during the manufacturing or production process of the truss base elements 101, whereas an advantage of welding the braces 108 is to save time during the assembling of a truss base element 101 or truss structure 100.

[0045] In Fig. 1A, the three braces have a distinctive oblique structure and a zigzag design that allows for the best distribution of weight. In a particular embodiment, the braces connect the elongated structural shapes 102, 105, at an angle of approximately 45 degrees. In other words, the braces 108, together with the elongated structural shapes102, 105, form a substantially triangular web of the truss structure. The angle at which the braces are connected to the first and second elongated structural shapes can be different, in fact, braces that are positioned perpendicular to the first and second elongated structural shapes can also be utilized.

[0046] Further, the truss structure 100 is provided with each truss base element 101 comprising a first series of holes 109 provided on a first outer face 135 of the first elongated structural shape 102, and a second series of holes 110 provided on a second outer face of the second elongated structural shape 105, and wherein each said first and second series of holes comprise a plurality of holes 111, each hole 111 having a hole diameter D1 and a hole center C. According to an embodiment, D1 is determined according to the relation R=H/D1, wherein R is determined according to $1.1 \leq R \leq 3.0$, preferably $1.4 \leq R \leq 2.6$, and more preferably R = 2.0. The plurality of holes are adapted to receive connecting means to connect the truss base elements 101 to other structures and/or truss base elements of other truss structures which comprise similar holes 111 as will be described in further detail below. According to the embodiment of the truss base element 101 shown in Figure 1A, it is clear that the first outer face 135 is the face of the first elongated structural shape 102 that is directed away from the second elongated structural shape 105. Similarly, the second outer face of the second elongated structural shape 105, is the face that is pointed away from the first second elongated structural shape 102.

[0047] The number of holes 111 of the first series of holes 109 and the second series of holes 110 can vary, in accordance with the designated use for the truss structure 100, and its length. According to an embodiment, the first series of holes 109 and the second series of holes 110 comprise a series of adjacent holes 145. Moreover, according to another embodiment, the first elongated structural shape 102 and the second elongated structural shape 105 are connected together so that a rotation by 180-degrees around the center of mass of the truss base element 101 interchanges the position of the first elongated structural shape 102 and the second elongated structural shape 105. As evident from Fig. 1A, the distribution of braces and holes allows for the reutilization of parts, specifically, the two elongated structural shapes can be the same, but differently connected to each other.

[0048] According to a specific embodiment, the truss structure 100 comprises reinforcing means 114, 115, 116 provided to reinforce the truss base element 101, wherein each reinforcing means of the series of reinforcing means is adapted to fix to and to connect the first 102 and the second 105 elongated structural shapes.

[0049] The reinforcing means of the series of reinforcing means can be braces, brackets, plates or other, connecting together two end portions of two different elongated structural shapes. In other words, reinforcing means are elements specifically adapted to strengthen the structure at the position of the first, second, third and fourth end portion, so that the risk of torsion at the proximity of said the end portions is minimized.

[0050] In Fig. 1A, the reinforcing means are specific connecting pieces adapted with further series of holes, to allow further modularity and possibilities of connection. Therefore, Fig. 1A illustrates reinforcing means according to a specific embodiment, wherein the reinforcing means are a first connecting piece 115 connected to the first end portion 103 of the first elongated structural shape 102 and to the third end portion 106 of the second elongated structural shape 105; and a second connecting piece 116 connected to the second end portion 104 of the first elongated structural shape 102 and to the fourth end portion 107 of the second elongated structural shape 105.

[0051] The first and second connecting pieces 115, 116 are also illustrated in Fig. 2A, 2B, and 2C. In Fig. 2A, 2B and 2C, the first and second connecting pieces 115, 116 are considered identical, and for such reason only one connecting piece per figure is shown. Nevertheless, the connecting pieces 115, 116 does not have to be identical. The first connecting piece 115 and the second connecting piece 116 provide for a solid connection between the first and second elongated structural shape 102, 105, so that torsion of the truss base element 101 is minimized. According to preferred embodiments such connecting pieces 115, 116 are fixedly connected to the first and second elongated structural shape 102, 105, by fixing means which are different from the connecting means configured to cooperate with the holes 111. Preferably the fixing means are stronger than the connecting means and are intended to fix the connecting pieces 115, 116 in a more permanent way than the modular loads or connections realized by means of the connecting means that are removably inserted into the holes 111. According to particular embodiments, the fixing means might comprise a suitable nut and bolt or any other suitable fixing means of which the tensile strength is larger than that of the connecting means for the holes, according to still further embodiments the fixing means could be configured to fix the connecting pieces 115 in a non-removable way, such as for example by means of welding, gluing or any other suitable means for fixedly connecting the connecting pieces 115 to the elongated structural shapes 102, 105.

[0052] The truss structures 100 in accordance with specific embodiments are made of aluminum, but other materials, without being limited thereto, like steel, plastics, or composite materials may be used. The applied material has to be sufficiently strong and weldable or should allow easy assembly. Aluminum metal, in particular the alloy aluminum 6000, is preferred because of its strength and being lightweight, and its being easy to extrude and weld.

[0053] According to a specific embodiment, each hole center C of the plurality of holes 111 on the first outer face 135 of the first elongated structural shape 102 may be aligned with a participating hole disposed opposed to and on a second outer face (not visible on Fig.1A) of the first elongated structural shape 102. It is clear that, according to this embodiment, this second outer face, is the face of the first elongated structural shape 102 facing the second elongated structural shape 105 of the truss base element 101. Connecting means (not shown in Fig. 1A) to connect a first truss base element 101 with a second truss base element may be received by a hole and its opposed hole of a first elongated structural shape 102 of the first truss base element and a hole and its opposed hole of the second truss base element. An advantage of the connecting means in combination with the predetermined hole pattern of the plurality of holes according to a specific embodiment, is that user-friendly alignment of the truss base element with respect to each other without the need of additional alignment or correcting tools. An embodiment of such a connecting means is for example shown in Figure 22 and will be described in further detail below. Such connecting means or connectors are for example configured to cooperate with the holes for a releasable connection of the elongated structural shape 102, 105 of a truss base element 101 of a truss structure to a truss base element 101 of another truss structure, or to another structure, such as for example a frame as will be described in more detail below, which comprises a plurality of similar holes 111 on its outer face of similar elongated structural shapes.

[0054] In Fig. 1A, the first series of holes 109 and the second series of holes 110 are directed so that the entrance of each hole of a first series of holes 109 is directed towards the entrance of holes of the second series of holes 110. In accordance with the specific design requirements for the truss base structure, the entrance of the holes of a first series of holes 109 could also be not directed towards the entrance of a second series of holes 110, as for example shown in Fig. 3A. Embodiments of the truss base elements 101 can be connected together utilizing a variety of fastening means, such as clamping elements that enters two different holes of two different truss base elements 101, or an hole of a truss base element 101 with any other compatible hole positioned on a load to be fastened to the truss structure 100. Other ways of connecting two truss base elements 101 can also be utilized, such as using threaded male-female connectors. According to a preferred embodiment, the protrusions and recessed elements could also be inverted, so that the protrusion is positioned on the connection piece and the recess on the elongated structural shapes 102, 105.

[0055] The first and second series of holes 109, 110 can comprise either the same number of holes 111 or a different number of holes 111. The type of holes in the truss base structure can change in relation to the specific design of the truss base element 101 to be used or the specific position of the holes. The holes illustrated in Fig. 1A are circular, but other shapes for the holes can be utilized as well, such as square like, triangular, hexagonal and so on. However, preferably the holes have a circumference that forms a closed curve, a polygon comprising rounded corners, etc. and preferably does not comprise any straight corner points and/or other abrupt discontinuous points in the shape of its circumference, thereby reducing the risk for local stress concentrations at these points. The diameter of these holes should then be interpreted as the diameter of the maximum distance of two points of the circumference of the hole at opposite sides with respect to the center of the circumference of the hole. In the case of a polygonal, or rounded polygonal shape of the circumference of the holes, the diameter is to be interpreted as the largest distance between any pair of vertices of the circumference. As already mentioned above, preferably, for the holes, a bounding rectangle of which the sides are aligned with X and Z direction encloses the holes, of which the ratio of the length of this rectangle along the X direction versus the width of this rectangle along the Z direction or vice versa, is smaller than or equal to two. Figure 23 shows a plurality of different embodiments of the elongated structural shapes 102, 105 comprising different embodiments of series comprising a plurality of the above-mentioned embodiments of the holes 111.

[0056] According to a specific embodiment, the hole centers C of each hole of the plurality of holes of each first 109 and second 110 series of holes are provided at a predetermined selection of spatial points 159, wherein the selection of spatial points 159 are part of a spatial grid 158 extending along the X, Y, Z directions, and wherein each spatial point 159 of the spatial grid 158 is at a predetermined distance K from another spatial point 159. This is further illustrated in Fig. 13A, 13B and 13C and reference thereto. This configuration may also be applied to, but is not limited to, holes located at the inner faces, i.e. faces facing towards the first series of braces, of a truss base element 101.

[0057] Fig. 1B illustrates a truss structure according to a specific embodiment having two identical truss base elements 150, 151 connected together by a second series of braces 152. The second series of braces 152 comprises braces connecting each elongated structural shape of the first truss base element 150 above, to their respective elongated structural shapes of the second truss base element 151 below. The first truss base element 150 may define a first surface substantially extending in the X, Y directions, whereas the second truss base element 151 may define a second surface. According to a specific embodiment, the first surface may be substantially parallel to the second surface, wherein the first second series of braces 152 connecting the first truss base element 150 to the second truss base element may be located in the X-Z plane. According to a specific embodiment, the minimum distance B between the first surface and the second surface equals p times the predetermined distance K, wherein p is a positive integer larger than 2, preferably equal to 4. Thus for example p is equal to 3, 4, 5, 6, or higher, but preferably p is equal to 4. The predetermined distance K is defined by the spatial grid 158. In accordance with a preferred embodiment, the predetermined distance K equals 62.0 cm.

[0058] Fig. 2A, 2B and 2C illustrate either a first or a second connecting piece 115, 116. Fig. 2A illustrates a first connecting piece in accordance with an embodiment. The first connecting piece 115 comprises a first recess 117 adapted to engage with a first protrusion 118 provided at the first end portion 103 of the first elongated structural shape 102, and a second recess 119 adapted to engage with a second protrusion 120 provided at the third end portion 106 of the second elongated structural shape 105. The second connecting piece illustrated in Fig. 1A is identical to the first connecting piece shown in Fig. 2A, but it differs from such first connecting piece in that it is connected to two other end portions and protrusions of the elongated structural shapes. Specifically, the second connecting piece 116 comprises a third recess 121 adapted to engage with a third protrusion 122 provided at the second end portion 104 of the first elongated structural shape 102, and a fourth recess 123 adapted to engage with a fourth protrusion 126 provided at the fourth end portion 107 of the second elongated structural shape 105. The protrusions at the end portions of the elongated structural shapes engage the recesses disposed onto the connecting pieces, wherein the protrusion and the elongated structural shapes attached therewith can be fastened together by different fastening means, such as a threaded bolt to be inserted through the connecting piece, and engaging a female thread on the protrusion. The protrusions are also illustrated in Fig. 3A, 3B and Fig. 16A. By means of bolts and nuts, the connection between two different truss base elements is strengthen in proximity of the elongated structural shapes. It has been therefore found that the use of connecting pieces in accordance with the embodiments above is beneficial to the structural integrity of the truss structure 100.

[0059] Fig. 2A further illustrates either a first connecting piece 115 having a fifth series of holes 132, or a second connecting piece 116 having a sixth series of holes 133, wherein each said fifth and sixth series of holes 132, 133 comprise at least one hole having a hole diameter D, which according to the embodiment shown is equal to the diameter D1 of the holes 111 of the first and second series of holes, and a hole center C.

[0060] In accordance an embodiment, the fifth and sixth series of holes 132, 133 illustrated in Fig. 2A, 2B and 2C comprise two holes at a corner of a connecting piece, with the two holes being not adjacent, and therefore not on the sample plane, but are rather positioned onto two perpendicular planes. Each fifth or sixth series of holes comprise in accordance to a specific embodiment, at least one a blind hole or a pass-through hole that are not used to connect truss base elements 101 to loads. When a production operator assembles the truss structure, he has to bring the various elements, meaning the elongated structural shapes 102, 105 and the connecting pieces 115, 116 as illustrated in Fig. 1A, in contact, so that they can be connected together. In this case, the operation can be difficult due to the components of the truss structure being too large or too heavy for the user to handle. In this scenario, the fifth and sixth series of holes can be used during assembly operations of the truss structure to temporarily bring together different elements of the truss structure, while at the same time a stronger connection can be achieved with other means. Said holes belonging to the fifth and sixth series of holes can function as handles onto which the fingers of the user mounting the truss structure can be inserted, and the various elements of the truss structure be brought in proximity to each other.

[0061] Alternatively, to temporarily bring together different elements of the truss structure by means of the holes belonging to the fifth or sixth series of holes, an alignment device 124 such as the one illustrated in Fig. 8 can be used. For example, said alignment device can be inserted into holes 111 as the ones illustrated in Fig. 6 so that the connecting piece can be temporarily aligned with the elongated structural shape by inserting the protrusions the alignment device is provided with into two different and adjacent series of holes. Blind holes can be provided at other positions of the truss structure, for example onto an elongated structural shape, so that they might serve with the same alignment function.

[0062] Fig. 2B illustrates a further embodiment, wherein the first connecting piece 115 and the second connecting piece 116 comprise a stiffening web 127 positioned inside said first, second, third and fourth recesses 117, 119, 121, 123. It has been surprisingly found that the presence of a stiffening web 127 comprising stiffeners 149 that distribute the forces inside the connecting piece is beneficial to the integrity of the truss structure 100 and minimizes torsion at the end portions of the elongated structural shapes. Fig. 2B shows a specific design of the stiffening web 127, wherein five stiffeners 149 radially extend from a fastening hole 148 present into the connecting piece, said fastening hole 148 allows for the fastening of an elongated structural shape with the connecting piece by insertion into said fastening hole 148 of a bolt having a screw thread that is compatible with a screw thread present onto a protrusion of the elongated structural shape. In such a way, a bolt having a screw thread of M14 or M16 can be screwed inside a protrusion onto the elongated structural shape, with part of the recess of the connecting piece abutting against the nut of the bolt used. The fastening hole 148 can have a diameter D3 that is different and/or completely unrelated with the diameter D1, D2, D of other holes 111, 128, 129, 132, 133 in the truss structure 100, as it is not meant to attach loads, but to fasten together a connecting piece with an elongated structural shape.

[0063] According to a preferred embodiment, the stiffeners 149 extending from the fastening hole 129 are positioned at 0 degrees, 90 degrees, 135 degrees, 225 degrees and 270 degrees, as illustrated in Fig. 2B. The design of the stiffening web 127 can change and it is dependent on the type of load that has to be supported by the truss structure 100.

[0064] Moreover, Fig. 2A, 2B and 2C also illustrate a first connecting piece 115 comprising a third series of holes 128, and the second connecting piece 116 comprising a fourth series of holes 129, wherein each said third and fourth series of holes 128, 129 comprise a plurality of holes 111, each hole 111 having a hole diameter D2, which according to the embodiment shown is equal to the diameter D1 = D of the holes 111 of the first and second series of holes, and a hole center C. The third and fourth series of holes comprise preferably pass-through holes that can be used to connect loads to the connecting piece. The first and second connecting pieces 115, 116 add additional rigidity to the truss structure 100 and modularity, as loads or other truss base elements 101 can be connected at each on top, at the bottom, on the right and at the left of the truss base element 101. It is thus clear that, according to such embodiments, the fixing means of the connecting pieces that provide for the connection of the connecting piece to the elongated structural elements 102, 105 are different from the coupling means for coupling the truss base elements 101 to truss base elements 101 of other similar truss structures 100 of a truss structure assembly as further described in more detail below. It is further also clear that the series of holes 128, 129 for these coupling means are positioned at a location in between the elongated structural elements 102, 105, which leads to the advantage that they are subjected to the smaller tensile and compressive loads generated by any loads transvers to the longitudinal axis of the truss base element 101, as they are closer to the central longitudinal axis of the truss base element 101.

[0065] Fig. 2A, 2B and 2C further illustrate the third series of holes 128 and the fourth series of holes 129 comprising at least a flange 130 at an inner side 131 of the holes. Due to the dimensions of the truss structure, which is longer than wider, the holes onto the elongated structural and the holes present onto the connecting pieces might not be able to support the same weight. In light of this, it was required to design specific connectors that were strong enough to support the weight of loads attached to the connecting pieces. To allow for a differentiation between the connectors to be used on the first and second elongated structural shape, and the first and second connecting pieces, flanges 130 are provided inside the third and fourth series of holes, into the first and second connecting piece 115, 116. Said flanges 130 selectively allow for the insertion of specifically designed connectors, rather than connectors that would be accommodated by holes provided onto the first and second elongated structural shapes. As explained above the connectors of the fixing means for the first and second elongated structural shapes 102, 105 preferably have a tensile strength that is larger than the coupling means for coupling the truss base element to another truss base element with a compatible series of holes. Fig. 2C shows the presence of two flanges 130 per pass-through hole, nevertheless, according to an embodiment, only one flange would allow to obstruct none specifically designed connectors to be inserted into the connecting pieces 115, 116.

[0066] Fig. 3A and 3B illustrate a specific embodiment, wherein two truss base elements are connected together. Fig. 3A illustrates a first truss base element 150 and a second truss base element 151. Connecting pieces 115, 116, acting as reinforcing means 114, connect the first 150 with the second 151 truss base element. The connecting pieces illustrated in Fig. 3A and 3B do not present holes, and are connected to the end portion 103, 104, 106, 107 of the elongated structural shapes 102, 105 of the first truss base element 150. Protrusions 118, 120, 122, 126 are present at the end of each elongated structural shape, to possibly allow for the connection of further connecting pieces to the elongated structural shapes 102, 105, which further connecting pieces are adapted to receive such protrusions. Fig. 3B is a top view of the truss structure illustrated in Fig. 3A. In Fig. 3B, only protrusions 120, 126 and elongated structural shape 105 can be seen, as protrusions 118 and 122 and elongated structural shape 102 are hidden by protrusion 120, 126 and elongated structural shape 105. The truss structure 100 according to this preferred embodiment has a certain degree of symmetry that allows for enhanced modularity.

[0067] Fig. 4A illustrates a cross section, according to the section A-A' as illustrated in Fig. 5A, of either the first elongated structural shape 102 or the second elongated structural shape 105 of a specific embodiment. This cross-section may be, without being limited to, substantially round-shaped or substantially polygon-shaped, e.g. rectangular-shaped, trapezium-shaped, parallelogram-shaped, or polygon-shaped.

[0068] The cross-section as demonstrated in Fig. 4A is a substantially rectangular-shaped structural shape profile 134 comprising a first, second, third and fourth face 135, 136, 137, 138, wherein the first face 135 is connected to the second face 136, the second face 136 is connected to the third face 137 and the third face 137 is connected to the fourth face 138, and the fourth face 138 is connected to the first face 135. According to a specific embodiment, between any of said first, second, third and fourth faces 135, 136, 137, 138, a groove 139 for mounting a cover 140 is provided. Fig. 4A illustrates a first groove 154 situated between the fourth face 138 and the first face 135, and a second groove 155 situated between the first face 135 and the second face 136. This embodiment is preferred because having a first and a second groove allows for a cover to be mounted above the truss structure of Fig. 1A, and a second cover to be mounted below the truss structure of Fig. 1A. By means of such cover or covers, either the first or the second series of braces can be hidden from sight, and an aesthetical finish can be given to the truss structure. In such a way, a specific look can be given to the structure without the cover interfering with the loads to be supported by the truss structure or without rendering some holes of the truss structure unusable. According to the embodiment shown in Figure 4A the cover 140 is preferably releasably fastened to the elongated structural profile by means of suitable releasable coupling element 142, such as for example a suitable hook and loop fastener, a suitable releasable tape element, etc. that is provided on the facing faces of the rectangular-shaped structural shape profile 134 and the cover 140.

[0069] Fig. 4B illustrates a truss structure wherein a cover can be inserted into each first and second groove of each elongated structural shape, so that the first series of braces and the second series of braces are hidden from sight. According to such an embodiment, the cover 140 is for example embodied as a canvas, provided with a suitable tendon along its circumference. As shown, the tendon 144 of such a cover 140 can be applied in the groove to attach the cover to the truss structure efficiently in a releasable way. In this way, as for example shown in more detail in Figures 4C and 4D, which respectively show an embodiment of a truss structure 100 before and after coupling of such a cover 140, by means of insertion of the tendons 144 at the circumference of the cover 140 into the corresponding grooves 154 in the elongated structural profiles 102, 105, and according to this particular embodiment also in the reinforcing means 114, the truss structure 100 can be finished by means of aesthetical covers in an efficient way, which for example hade the braces 108 and even substantially the entire truss structure 100 from view, when for example viewed from the Z direction according to the embodiment shown.

[0070] The number of grooves 154, 155 and their shape depends on the area of the truss structure to be covered. The more parts of the truss structure are intended to be covered, the more grooves would be required for mounting a cover. The groove can be positioned elsewhere, and its shape can differ from the ones illustrated in Fig. 4A. The positioning of at least one groove on the truss structure 100 has the advantage that cover made out of fabric or other material can be used to protect the truss structure 100 and or to improve their aesthetic.

[0071] The first, second, third, and fourth faces illustrated in Fig. 4A are substantially flat. Nevertheless, faces with a different geometry can also be imagined, such as round. Designs that use structural shape profiles such as triangular, octagonal, pentagonal and so on can also be implemented. The use of flat faces as the advantage that holes are easier to form on such surfaces. Fig. 4B illustrates a specific embodiment wherein a hole is provided onto the first face and brace is connected onto the third face of the structural shape profile. It is clear that, according to such a preferred embodiment, no such holes are provided in the other faces, but these opposing pair of faces of the profile for the elongated structural shape 102, 105. This is advantageous as these faces, which do not comprise holes, provide for an improved load bearing capacity of the profile as a whole, especially, when the truss structure is arranged in such a way that the faces of the elongated structural shape that do not comprise such series of holes are loaded with a higher compressive or tensile load than the faces comprising the series of holes.

[0072] Fig. 5A illustrates an elongated structural shape 102 or second elongated structural shape 105 having a height H, and wherein the truss structure 100 is provided in accordance with a ratio R, defined according to R=H/D, wherein D is the diameter of any hole and the elongated structural shapes are provided so that the diameter of their holes and the height H of the elongated structural shape are in accordance with $1.1 \leq R \leq 3.0$, preferably $1.4 \leq R \leq 2.6$. According to the preferred embodiment shown R = 2.0 .

[0073] Fig. 5B illustrates a side-view of an elongated structural shape 102, 105 according to a specific embodiment comprising a plurality of holes 109, 110, wherein the hole center of each hole is disposed at a predetermined selection of spatial points 159 wherein the selection of spatial points 159 is part of a spatial grid 158 extending along the X-direction, and wherein each spatial point 159 of the spatial grid 158 is at a predetermined distance K from another spatial point 159.

[0074] The truss structures 100 in accordance with the described embodiments comprise the presence of holes. The presence of holes in structures is detrimental for the integrity of the structures themselves. According to a specific embodiment, the series of holes are provided at a predetermined selection of spatial points 159, wherein the selection of spatial points 159 are part of a spatial grid 158 extending along the X, Y, Z directions, and wherein each spatial point 159 of the spatial grid 158 is at a predetermined distance K from another spatial point 159. This has the advantage of limiting the torsion and preventing deflection or buckling, and spreading stresses in the truss structure when loads are applied. It has been surprisingly found that elongated structural shapes in accordance with the present embodiments for which $1.1 \leq R \leq 3.0$, preferably $1.4 \leq R \leq 2.6$ provide for strong structures and strong connections between the parts to be assembled together.

[0075] Fig. 6 illustrates a further view of part of a truss base element 101 comprising an elongated structural shape connected to a connecting piece, which is visible at the left end of Fig. 6. The holes, part of the elongated structural shape, are either blind holes or pass-through holes, depending on their position. In Fig. 6, the only hole positioned onto the connecting piece is a blind hole. Fig. 6 shows the presence of nine of such holes, four blind holes 141 and five pass-through holes 142. Blind holes are position onto the elongated structural shape opposite of a brace. Visible through the pass-through holes, are braces connecting the elongated structural shape illustrated in Fig. 6 with another elongated structural shape.

[0076] According to a specific embodiment, the hole centers C of each hole of the plurality of holes of each first 109 and second 110 series of holes are provided at a predetermined selection of spatial points 159, wherein the selection of spatial points 159 are part of a spatial grid 158 extending along the X, Y, Z directions, and wherein each spatial point 159 of the spatial grid 158 is at a predetermined distance K from another spatial point 159. This is further illustrated in Fig. 11A, 11B and 11C and reference thereto. This configuration may also be applied to, but is not limited to, holes located at the inner faces, i.e. faces facing towards the first series of braces, of a truss base element 101.

[0077] In the context of the such embodiments, adjacent holes are holes part of the same plane. Each of the nine holes represented is adjacent to at least another hole, so that a series of adjacent holes is formed. Each hole, either a blind hole or a pass-through hole, is at a center-to-center distance DX from each other, which can be expressed in function of the predetermined distance K.

[0078] In accordance with a specific embodiment, the holes are disposed onto the truss structure 100 so that for each adjacent hole X=K.n, with n being a positive integer number.

[0079] In accordance with this embodiment, loads can be connected at different locations to the truss structure 100. Fig. 6 illustrates side-view of a specific embodiment, comprising a first 102 or second 105 elongated structural shape in connection with a reinforcing means 114, 115, 116. According to an embodiment, the first connecting piece 115 has a height H_{C1} which is a factor m times the height H of the first 102 elongated structural shape, wherein the factor m is selected in the range from 0,75 to 1,25, and wherein H is a multiplicity of the predetermined distance K. Preferably m equals 1, and H = K. Preferably, according to embodiments, such as for example shown in the Figures, such as Figures 1A, 1B, 2C, 5A, 5B, the factor m is equal to 1 and H_{C1} is equal to H, thereby allowing the use of reference H and H_{C1} interchangeably as the height of the truss base element 101, the height of the elongated structural shapes 102, 105 of the truss base element 101 and the height of the reinforcing means 114, 115, 116.

[0080] The second connecting piece 116 has a height H_{C2} which is a factor m' times the height H of the second 105 elongated structural shape, wherein the factor m' is selected in the range from 0,75 to 1,25, and wherein H is a multiplicity of the predetermined distance K. Preferably, according to embodiments, such as for example shown in the Figures, such as Figures 1A, 1B, 2C, 5A, 5B, the factor m' is equal to 1 and H_{C2} is equal to H, thereby allowing the use of reference H and H_{C2} interchangeably as the height of the truss base element 101, the height of the elongated structural shapes 102, 105 of the truss base element 101 and the height of the reinforcing means 114, 115, 116.

[0081] According to particular embodiments, the heights of the connecting pieces can either be identical, i.e. m equals m', as shown in Fig. 6, or differ. According to a specific embodiment, the heights of the two connecting pieces are in accordance with H_{C1} =m.H, and H_{C2} =m'.H, wherein m is a number comprised between 0.75 and 1.25.

[0082] According to a specific embodiment, as already mentioned above, m=m'=1, and the height of the two connecting pieces and an elongated structural shape is the same, whereby H = H_{C1} = H_{C2}, whereby references H = H_{C1} = H_{C2} can be used interchangeably as the height of the connecting pieces and/or the elongated structural shapes of the trus base elements 101.

[0083] According to a further embodiment, each hole center C of the holes of the first and second series of holes is situated on the same plane XY. The plane XY is illustrated in Fig. 6 as a dashed line, and is a plane parallel to either the first or the second elongated structural shape. According to a preferred embodiment, the plane XY bisects either the first or the second elongated structural shape along the length L of the truss base element. The plane XY therefore comprises each hole center C of the first series of holes and each hole center C of the second series of holes. An advantage according to the present embodiment is that the first or second elongated structural shapes can be manufactured more easily, as they can be obtained from a single elongated structural shape by cutting it along shortest dimension and then utilized to form a truss base element after a 180 degrees rotation of one of the two shorter elongated structural shapes obtained. According to a further embodiment, the plane XY further comprises also each hole center C of the third series of holes and each hole center C of the fourth series of holes. The third and fourth series of holes are not illustrated in Fig. 6; nevertheless, such embodiment can be seen for example in Fig. 1A. In Fig. 1A, also the fifth and sixth series of holes have their centers comprised onto the plane XY. An advantage of this embodiment is that the XY plane matches all the centers C of the aforementioned grid.

[0084] In accordance with an embodiment, the hole diameter D1=D2=D is between 30mm and 32mm, preferably 31mm, with a tolerance of $\pm$0.5mm.

[0085] Fig. 7A, 7B, 7C and 7D illustrate a truss structure 100 according to an embodiment wherein the series of truss base elements 101 comprises a first truss base element 150 and a second truss base element 151, and wherein the truss structure 100 further comprises a second series of braces 152 connecting the first truss base element 150 to the second truss base element 151.

[0086] Fig. 8 illustrates an alignment device that can be used in combination with a preferred embodiment. The device has protrusions that are circular in shape, to engage with the inside of the holes of the embodiment of the truss structures 100. The distance of the centers of the protrusions on the alignment device is equal to the distance DX of the truss structure 100, so that the protrusions on the alignment device can enter holes of the truss structure 100.

[0087] Fig. 9 better illustrates an embodiment of truss base element 101, wherein n is selected from: 1, 2 and 3. The inventors have found that if n is selected from 1, 2 and 3, the number of holes in the truss structure is maximized whilst the truss structure 100 does not deform when loads are connected to it. Wherein the center-to-center distance between two adjacent hole centers is in accordance with DX=K.n, and n is equal to 1, the number of usable holes is maximized. According to other preferred embodiments, n may also be larger than 1. According to a specific embodiment, a combination of different n values may also be considered, such as for example shown in Figure 23.

[0088] According to a specific embodiment, wherein the center-to-center distance DX between two adjacent holes is larger than K, for example 2.K or 3.K, the hole-free area between adjacent holes may be used to attach at least a part of the first series of braces 108. Braces are used to connect elongated structural shapes together, therefore, at the position where a brace is connected to an elongated structural shape, holes are preferably not positioned thereon. , Additionally, preferably the hole diameter D1, D2, which according to the embodiments shown D1=D2=D, of the holes 111 is smaller than the predetermined distance K. Preferably the ratio of K / D1 is in the range of 1.5 up to and including 4, more preferably 2. For example, according to particular embodiments in which the distance K is 62 mm, the diameter D1 and/or D2 of the holes 111, 128, 129, which according the embodiments is equal and can be referred to as D, is for example one of the following: 31mm or 20mm. According to an alternative embodiment in which the distance K is for example 50mm, the diameter D1, D2 and/or D could for example be 31mm, 25mm, 20mm, etc. It is however clear that still further alternative embodiments are possible.

[0089] In Fig. 9, a truss base element 101 according to a specific embodiment is shown, which comprises a first 102 and a second 105 elongated structural shape. It is evident from Fig. 9 that a series of continuous adjacent holes is provided on a first outer face 135 of the first elongated structural shape 102, a second series of holes 110 provided on a second outer face of the second elongated structural shape 105. The second outer face of the second elongated structural shape 105 is not visible in Fig. 9 and the indicated second series of holes 110 is indirectly visible by indicating their participating holes disposed on a third face of the second elongated structural shape, wherein the second face of the second elongated structural shape is facing away from the first series of braces 108, and wherein the third face of the second elongated structural shape is facing the first series of braces 108. According to the truss base element 101 illustrated in Fig. 9, the hole centers of each adjacent holes are located on the first outer face 135 of the first elongated structural shape are disposed at a distance DX=K. n from each other, wherein n=1, and K equals the predetermined distance K from another spatial point 159 in the spatial grid 158.

[0090] On the other end, onto the second elongated structural shape, the series of adjacent holes is not continuous, because braces are connected at the internal faces of the truss structure. Due to the characteristic design adopted, if one brace is present in between two adjacent holes, the center-to-center distance between two adjacent holes X=K. n, wherein n=2, and K equals the predetermined distance K from another spatial point 159 in the spatial grid 158.

[0091] Figure 10 and 11 illustrate truss base elements of different dimensions. Figure 10 it is illustrated from left to right, and from top to bottom, different views of the same truss base element, in order, a lateral view along the width W of the truss base element, a lateral view along the length of the truss base element, a top view of the truss base element, and a perspective view of the truss base element. In accordance with an embodiment, the truss base element 101 has a length L and a width W, wherein L=I.K and W=k.K, with I, k being integer numbers, and K the predetermined distance K between spatial points on the grid 158. An advantage of the present embodiment is that the truss structure 100 is easier to manufacture and to assemble with other truss structures 100.

[0092] Fig. 10 illustrates different perspectives of a truss base element according to an embodiment similar to that shown in Figure 1A. The center-to-center distance between adjacent holes of the plurality of holes, wherein each hole has a hole center C, define the length L, the width W and the height H of the truss base element. In particular, the length L, the width W and the height H may be expressed in function of the predetermined distance K of the defined spatial grid, wherein L = K.I, W = K.w, and H = K.h, wherein i, w and h are predetermined positive integers, and wherein the center-to-center distance between adjacent holes DX = n.K, wherein n is a positive integer. Preferably h is equal to one, or H = K.

[0093] According to a particular embodiment, for example as shown in Figure 10D, holes 111, 128, 129 may have a hole diameter D1=D2=D equal to 31mm, a height H of 62mm, a length of 1984mm and a width of 310mm. In light of the formula expressed above, I equals to 32 and w equals to 5. The measure of length L has a tolerance of ±0.5mm, and the measure of width W has a tolerance of ±0.50mm.

[0094] As further example, for example as shown in Figure 10A, a truss base element in accordance with an embodiment has holes with a hole diameter D equal to 31mm, a height H of 62mm, a length of 496mm and a width of 310mm. In light of the formula expressed above, I equals to 8 and w equals to 5. The measure of length L has a tolerance of ±0.5mm, and the measure of width W has a tolerance of ±0.50mm.

[0095] As further example, for example as shown in Figure 10B, a truss base element in accordance with an embodiment has holes with a hole diameter D equal to 31mm, a height H of 62mm, a length of 992mm and a width of 310mm. In light of the formula expressed above, I equals to 16 and w equals to 5. The measure of length L has a tolerance of ±0.5mm, and the measure of width W has a tolerance of ±0.50mm.

[0096] As further example, for example as shown in Figure 10C, a truss base element in accordance with an embodiment has holes with a hole diameter D equal to 31mm, a height H of 62mm, a length of 1488mm and a width of 310mm. In light of the formula expressed above, I equals to 24 and w equals to 5. The measure of length L has a tolerance of ±0.5mm, and the measure of width W has a tolerance of ±0.50mm.

[0097] As further example, for example as shown in Figure 10E, a truss base element in accordance with an embodiment has holes with a hole diameter D equal to 31mm, a height H of 62mm, a length of 2480mm and a width of 310mm. In light of the formula expressed above, I equals to 40 and w equals to 5. The measure of length L has a tolerance of ±0.5mm, and the measure of width W has a tolerance of ±0.50mm.

[0098] As further example, for example as shown in Figure 10F, a truss base element in accordance with an embodiment has holes with a hole diameter D equal to 31mm, a height H of 62mm, a length of 2976mm and a width of 310mm. In light of the formula expressed above, I equals to 48 and w equals to 5. The measure of length L has a tolerance of ±0.5mm, and the measure of width W has a tolerance of ±0,30mm.

[0099] Fig. 11A, 11B and 11C illustrate examples of patterns of the plurality of holes according to specific embodiments.

[0100] The holes are provided at a predetermined selection of spatial points 159, wherein the selection of spatial points 159 are part of a spatial grid 158 extending along the X, Y, Z directions, and wherein each spatial point 159 of the spatial grid 158 is at a predetermined distance K from another spatial point 159. Specific embodiments may also comprise smaller holes 112 not belonging to the pattern 156 defined by the plurality of holes 111, such as for example shown in Figure 23. These figures also indicated the relation between the plurality of holes in e.g. a first elongated structural shape 102 and the spatial grid 158. According to a preferred embodiment, hole centers C of each hole of the plurality of holes of each first 109 and second 110 series of holes are provided at the predetermined selection of spatial points 159, wherein the selection of spatial points 159 are part of a spatial grid 158 extending along the X, Y, Z directions, and wherein each spatial point 159 of the spatial grid 158 is at a predetermined distance K from another spatial point 159.

[0101] Referring to Fig.12, there is demonstrated an exploded view a truss base element 101 according to a specific embodiment. Reference is made to the description of Fig. 1A and related figures and description for details about the indicated features.

[0102] Referring to Fig.13, there is demonstrated an exploded view a truss base element 101 according to a specific embodiment. Reference is made to the description of Fig. 1B and related figures and description for details about the indicated features.

[0103] Referring to Fig.14A and Fig.14B, there is demonstrated an exploded view a truss base element 101 according to a specific embodiment. Reference is made to the description of Fig. 2A, 2B and 2C and related figures and description for details about the indicated features.

[0104] Referring to Fig.15, there is demonstrated an exploded view a truss base element 101 according to a specific embodiment. Reference is made to the description of Fig. 1A and related figures and description for details about the indicated features.

[0105] Referring to Fig.16, there is demonstrated an exploded view a truss base element 101 according to a specific embodiment. Reference is made to the description of Fig. 1A and related figures and description for details about the indicated features.

[0106] Still a further embodiment of the truss structure 100 and/or truss base element 101, similar to the embodiments shown in for example Figure 1A and Figure 3A are for example shown in Figures 17 and 18, which show respectively a plane view and a perspective view along the direction indicated by the arrows X, Y and Z as mentioned above. Similar elements have been indicated with similar references and function in a similar way as described above. However different from the above-mentioned embodiments, according to such an embodiment the advantageous connecting pieces acting as reinforcing means are not present in this embodiment. As shown in accordance with this simple embodiment, the braces 108 ensure the load bearing capacity of the truss structure in cooperation with the elongated structural shapes. As further shown, according to such an embodiment, there could be provided at the end portions 103, 104, 106, 107 of the elongated structural shapes 102, 105 of the truss base element 101, suitable means for connecting these end portions to another truss structure, for example by means of a suitable connecting means. Such an embodiment still provides for an increased robustness of any loads connected to the holes 111 by means of suitable connecting means as there is a decreased risk of deformation and/or unallowed local stresses being of the elongated structural shape by means of such connecting means that connect such loads to the truss structure. It is thus clear that according to such embodiments, the braces 108 of the truss base elements 101 are configured to fix and connect the first and second elongated structural shapes 102, 105. According to the embodiment shown in Figures 17 and 18 similar protrusions 118, 120, 122, 126 are present at the end 103, 104, 106, 107 of each elongated structural shape 102, 105, to possibly allow for the connection of further structural elements and/or truss structures to the elongated structural shapes 102, 105 of the truss structure 100, for example by means of connection elements and/or connection pieces that are adapted to receive such protrusions, however, it is clear that alternative embodiments are possible in which the ends of the structural shapes 102, 105 of the truss structure 100 are configured to be connected to such structures in any other suitable way, by means of any other suitable connection element.

[0107] According to a specific embodiment, there is provided a truss structure assembly 10, such as for example shown in Figures 19 -22, is provided comprising a series of truss structures 100 according to embodiments similar as for example described above, and similar references refer to similar elements which function in a similar way. According to the embodiment shown in Figure 19, a series of truss structures 100 is covering a horizontal distance, while at both sides of the truss structure assembly a series of vertical truss structures 100 are provided. In between the vertical and horizontal series of truss structures, corner pieces 11, preferably provided with a hole pattern that matches the hole grid 158 of the truss structures 100 of the truss structure assembly 10 are provided. As shown in more detail in Figure 20, which shows a top view of the detail 20 of Figure 19 in more detail, the truss structure assembly 10 comprises a first truss structure 100 and a second truss structure connected to the first truss structure 100. As further shown in more detail in the section along line A-A in Figure 20, which is shown in Figure 21, the truss structure assembly 10 further comprises truss structure connecting means 160 or connectors 160 connecting the first truss structure 100 with the second truss structure 100. Such an embodiment of a connecting means 160 is shown in more detail in Figure 22. According to this embodiment the connecting means 160 is configured as a releasable connecting means 160 which is configured to be inserted through the aligned holes 128, 129 of the facing connecting pieces 115, 116 of the truss structure base elements of two adjacent and aligned truss structures 100. As further shown the embodiment of the connecting means 160 comprises flange coupling surfaces 162, which are configured to cooperate with the flanges 130 of the holes into which they are inserted. Further as shown the connector 160, according to the embodiment shown, comprises a releasable connector cap 164 comprising a releasable lock 166 configured to cooperate to releasably lock on to the corresponding end of the connector 160, thereby allowing for an efficient and robust releasable connection of adjacent truss structures 100 by means of the connectors 160. As already mentioned above, these connectors 160 are preferably different from the fastening means 170 for connecting the end portions 103, 104, 106, 107 or the elongated structural shapes 102, 105 to the corresponding connecting pieces 115, 116, which are for example a suitable bolt and thread connection, or a fixed connection such as a weld connection. It is further clear, that especially the series of truss structures 100 spanning a horizontal distance, such as for example shown in Figures 19 - 22 can be considered a load-bearing truss assembly, comprising a series of load-bearing truss structures 100. As schematically shown by the arrows W, such load bearing truss structures 100 and their corresponding assembly, are typically loaded by a weight W and/or forces of elements supported by and/or on the truss structure 100, by means of suitable connectors that cooperate with and are insertable through the holes 111 of the elongated structural shapes 102, 105 of the truss base elements 101 of the truss structures 100.

[0108] A further embodiment of a truss structure assembly 10 is shown in Figures 24 to 27. According to this embodiment a similar truss structure assembly 10 is shown as in Figures 19-22, to which additionally further structures 200 are connected by means of releasable connecting means, such as suitable connectors 260 similar as the connector 160 which cooperates with the holes 111 in the elongated structural shapes 102, 105 of the truss base element 101 of the truss structures 100 of the truss structure assembly 10. Similar elements have been referenced by means of similar references and function in a similar way. According to the embodiment shown, the structures 200 connected to the truss structures 100 for example comprise a frame 210 comprising a similar elongated structural shape with a similar series of holes, such as for example a frame 210 similar as known from BE1020560A3, which is incorporated herein by reference. As shown in the detail of Figure 25, such a frame 210 could for example be provided with a similar series of holes as in the embodiments of the truss structure 100 described above, thereby allowing a connecting means 260 to be inserted through the aligned holes of the facing elongated structural elements of the truss structure base elements and the similar elongated structural elements of the adjacent and aligned frame 210. The connecting means could for example be connectors similar to the connector 160 described above, however according to particular embodiments other suitable connectors, such as for example connectors known from BE1020560A3 could be used to couple the truss structure 100 to other structures 200. Using different connectors 160, 260 for connecting a truss structure 100 respectively to another truss structure 100 and another structure 200, which is not a truss structure 100, can be advantageous as the connectors 260 for connecting these other structures 200 can be connectors that do not need to be configured to withstand such high stresses as the connectors 160 for connecting a series of truss structures 100 as they are not a load-bearing component of the truss structure assembly 10. As shown in the detail of Figure 26, such a frame 210 could for example be connected to a plurality of the truss structures 100 of a truss structure assembly 10 by means of a suitable plurality of connectors 260. As further shown in the detail of Figure 27, alternative embodiments of connectors 260 could for example be used to connect the truss structures 100 of a truss assembly 10 with structures 200, such as the above-mentioned frames 210 of which the corresponding holes are not aligned with those of the truss structure, but for example at right angles, or in any other suitable relative orientation. It is clear that still further alternative embodiments are possible in which one or more of the truss base elements of the truss structures of the truss assembly are connected with any other suitable element or object suitable to be connected to the truss base elements by means of such a connecting means. Such structures 200 comprising a plurality of holes are adapted to receive connecting means for connecting the structures 200 to the truss base elements 101 of the truss structure 100 via the holes 111 in their elongated structural shapes 102, 105, and/or any other suitable holes in the truss structure 100. Such connecting means 260 could for example be configured, when received in the holes of the truss base element to connect the truss base elements 101 with another structure 200 comprising similar holes. According to still a further embodiment it is clear that also another truss base element 100 of another truss structure 1000 comprising such a series of holes, could be connected to the truss structure 100 in such a way. It is clear that preferably, similar as described above the holes of the truss structure 100 of the truss structure assembly 10 and of a structure 200 connected to the truss structure assembly 10 are provided at a predetermined selection of spatial points 159, wherein the selection of spatial points 159 is part of the spatial grid 158 of the truss structure assembly 10.

Legend:

[0109]

100 Truss structure
101 Truss base element
102 First elongated structural shape
103 First end portion
104 Second end portion
105 Second elongated structural shape
106 Third end portion
107 Fourth end portion
108 First series of braces
109 First series of holes
110 Second series of holes
111 Hole
112 small holes not belonging to the hole pattern
114 Reinforcing means
115 First connecting piece
116 Second connecting piece
117 First recess
118 First protrusion
119 Second recess

120 Second protrusion
121 Third recess
122 Third protrusion
123 Fourth recess
124 Alignment device
126 Fourth protrusion
127 Stiffening web
128 Third series of holes
129 Fourth series of holes
130 Flange
131 Inner side of the hole
132 Fifth series of holes
133 Sixth series of holes
134 Structural shape profile
135 First face
136 Second face
137 Third face
138 Fourth face
139 Groove
140 Cover
141 blind hole
142 releasable coupling element
143 pass through hole
144 tendon cable
145 Adjacent holes
148 Fastening hole
149 Stiffener
150 First truss base element
151 Second truss base element
152 Second series of braces
154 First groove
155 Second groove
156 Hole pattern
158 Hole grid
159 Spatial point
160 connector
162 flange coupling surface
164 releasable connector cap
166 releasable lock
170 fastening means
200 structure
210 frame
260 connector
DX Distance from two respective hole centers
L Length of the truss base element
H Height of the elongated structural shape
H_{C1} Height of the first connecting piece
H_{C2} Height of the second connecting piece
W Width of the truss base element
R Ratio
D1, D2, D Hole diameter
C Hole center

Claims

1. A truss structure (100) comprising one or more of truss base elements (101), wherein each truss base element (101) comprises:

   a series of elongated structural shapes comprising a first elongated structural shape (102) extending from a first end portion (103) to a second end portion (104) according to an X-direction, a second elongated structural shape (105) extending from a third end portion (106) to a fourth end portion (107) according to the X-direction, wherein the first elongated structural shape (102) and the second elongated structural shape (105) have a height H measured according to a Z-direction, wherein the Z-direction is perpendicular to the X-direction, and wherein the first (102) and second (105) elongated structural shapes are spatially separated according to a Y-direction perpendicular to the X- and Z-direction;
   a first series of braces (108) connecting the first elongated structural shape (102) to the second elongated structural shape (105);
   a first series of holes (109) provided on a first outer face (135) of the first elongated structural shape (102), a second series of holes (110) provided on a second outer face of the second elongated structural shape (105), wherein the first and second outer faces are facing away from the first series of braces (108), wherein each first (109) and second (110) series of holes comprise a plurality of holes, wherein each hole (111) of the first (109) and second (110) series of holes have a hole diameter D1 and a hole center C, wherein D1 is determined according to the relation R=H/D1, wherein R is determined according to $1.1 \leq R \leq 3.0$, preferably $1.4 \leq R \leq 2.6$, and more preferably R = 2.0.

2. The truss structure according to claim 1, wherein each truss base element (101) further comprises a series of reinforcing means (114, 115, 116), wherein each reinforcing means of the series of reinforcing means is adapted to fix to and to connect the first (102) and the second (105) elongated structural shapes.

3. The truss structure (100) according to claim 1 or 2, wherein the hole center C of each hole of the plurality of holes of each first (109) and second (110) series of holes are provided at a predetermined selection of spatial points (159), wherein the selection of spatial points (159) are part of a spatial grid (158) extending along the X, Y, Z directions, and wherein each spatial point (159) of the spatial grid (158) is at a predetermined distance K from another spatial point (159), preferably H is a multiplicity of the predetermined distance K, more preferably H = K.h, wherein h is a positive integer, preferably h is equal to one

4. The truss structure (100) according to claim 2 or 3, wherein a first reinforcing means (115) of the series of reinforcing means has a height H_{C1} which is a factor m times the height H of the first (102) and the second (105) elongated structural shapes, wherein the factor m is selected in the range from 0,75 to 1,25, preferably m is equal to one.

5. The truss structure (100) according to any of the claims 2 to 4, wherein the reinforcing means is adapted to receive at least a part of the first end portion (103) of the first elongated structural shape (102) and at least a part of the third end portion (106) of the second elongated structural shape (105).

6. The truss structure (100) according to any of the claims 2 to 5, wherein the reinforcing means comprises a third series of holes (128), wherein the third series of holes (128) comprises a plurality of holes having a hole diameter D2, wherein D2 is determined according to the relation R=H/D2, wherein R is determined according to $1.1 \leq R \leq 3.0$, preferably $1.4 \leq R \leq 2.6$, and more preferably R = 2.0.

7. The truss structure (100) according to claim 6 when dependent on claim 3, wherein the hole center C of each hole of the plurality of holes of the third series of holes (128) is provided at a predetermined selection of spatial points (159), wherein the selection of spatial points (159) is part of the spatial grid (158).

8. The truss structure (100) according to claim 6 or 7, wherein the third series of holes (128) comprises at least a flange (130) at an inner side (131) of the holes.

9. The truss structure (100) according to any one of the preceding claims, wherein the first (102) and second (105) elongated structural shapes have a substantially rectangular cross-section in the Y-Z plane.

10. The truss structure (100) according to any one of the preceding claims, wherein a second outer face (136) of the first elongated structural shape (102) comprises a longitudinal groove (139, 154, 155) adapted for mounting a hard panel or a cover, wherein the groove (139, 154, 155) comprises three walls and having a substantially rectangular cross-section, and wherein the second outer face (136) is connected to the first outer face (135) of the first elongated structural shape (102)

11. The truss structure (100) according to any one of the preceding claims, wherein a third outer face of the second elongated structural shape (105) comprises a longitudinal groove (139, 154, 155) adapted for mounting a hard panel or a cover, wherein the groove (139, 154, 155) comprises three walls and having a substantially rectangular cross-section, and wherein the third outer face is connected to the second outer face of the second elongated structural shape (105).

12. The truss structure (100) according to any one of the preceding claims, wherein the hole diameter D1 is smaller than the predetermined distance K, preferably the ratio of K / D1 is in the range of 1.5 up to and including 4, more preferably 2.

13. The truss structure (100) according to any one of the preceding claims, wherein the truss base element (101) has a predetermined length Land a predetermined width W, wherein L equals i times the predetermined distance K, and wherein W equals k times predetermined distance K, wherein i and k are positive integers.

14. The truss structure (100) according to any one of the preceding claims, wherein the truss structure (100) comprises:

a first truss base element (150), defining a first surface substantially extending in the X, Y directions;
a second truss base element (151) defining a second surface; and
a second series of braces (152) connecting the first truss base element (150) to the second truss base element (152).

15. The truss structure (100) according to claim 14, wherein the first surface and second surface are substantially parallel to each other; and/or wherein the minimum distance B between the first surface and the second surface equals p times the predetermined distance K, wherein p is a positive integer larger than 2, preferably equal to 4.

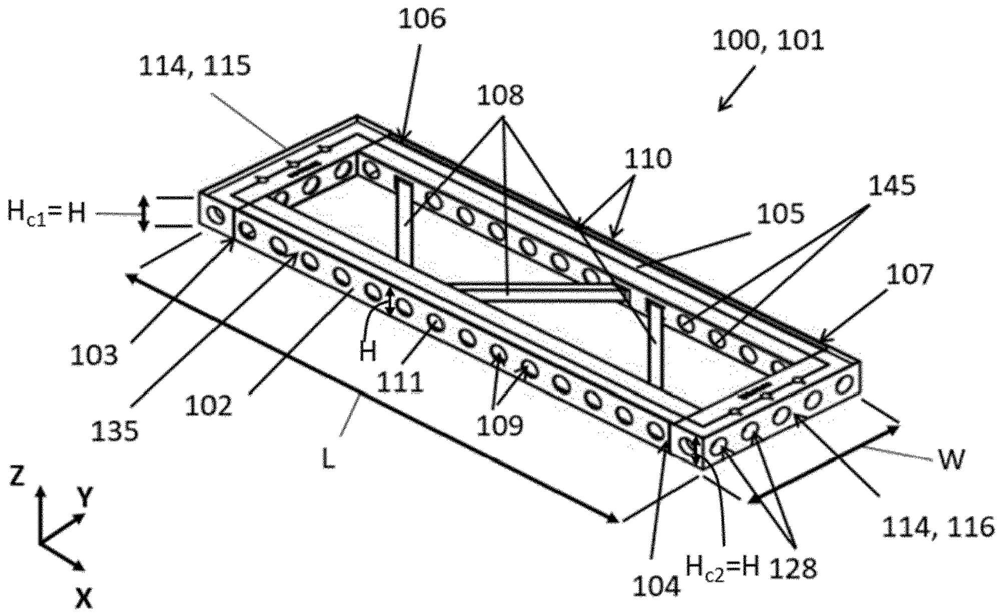

106
100, 101
114, 115
108
110
145
105
107
H_{c1}=H
103
135
102
H
111
109
L
W
114, 116
104
H_{c2}=H
128
Z
Y
X

Fig. 1A

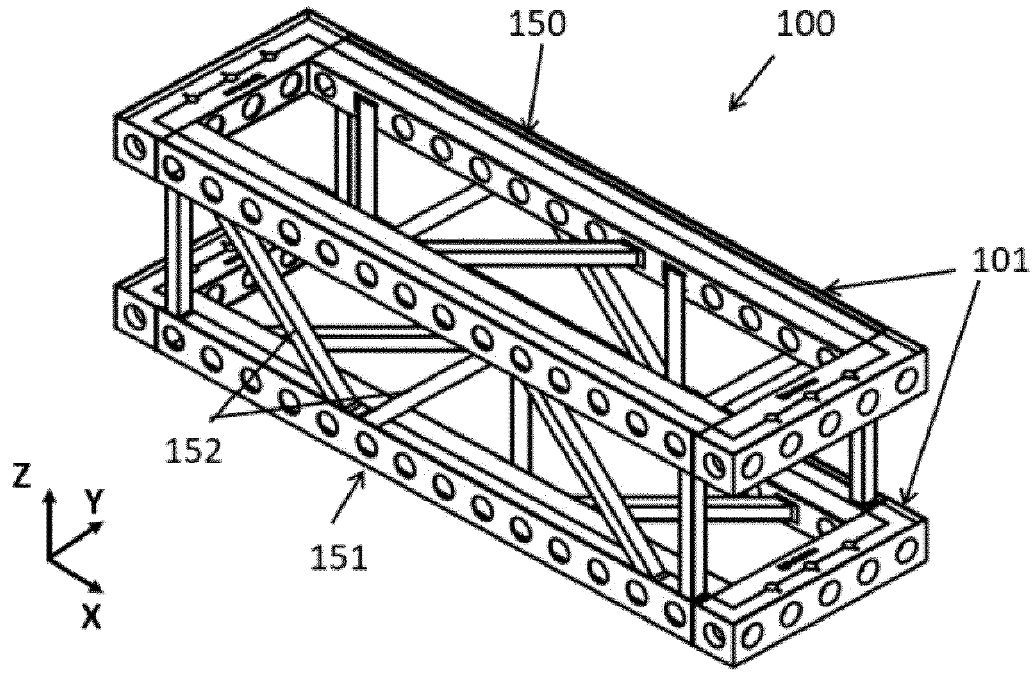

150
100
101
152
151
Z
Y
X

Fig. 1B

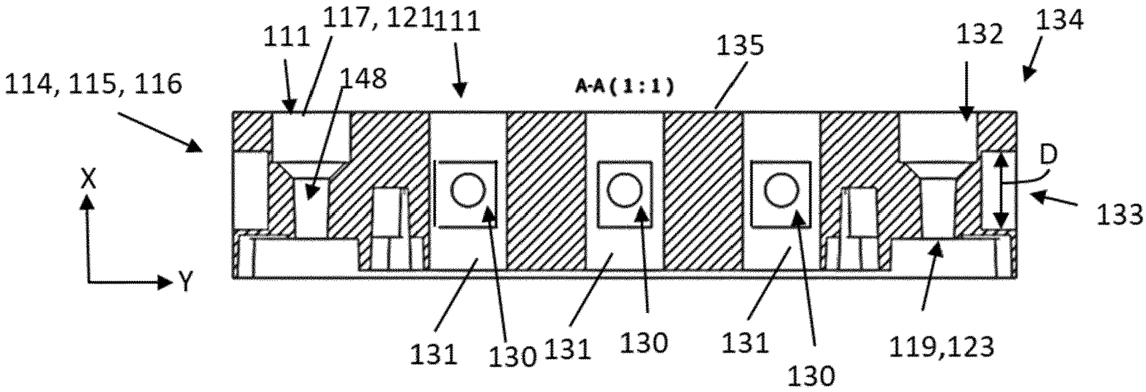


Fig. 2A

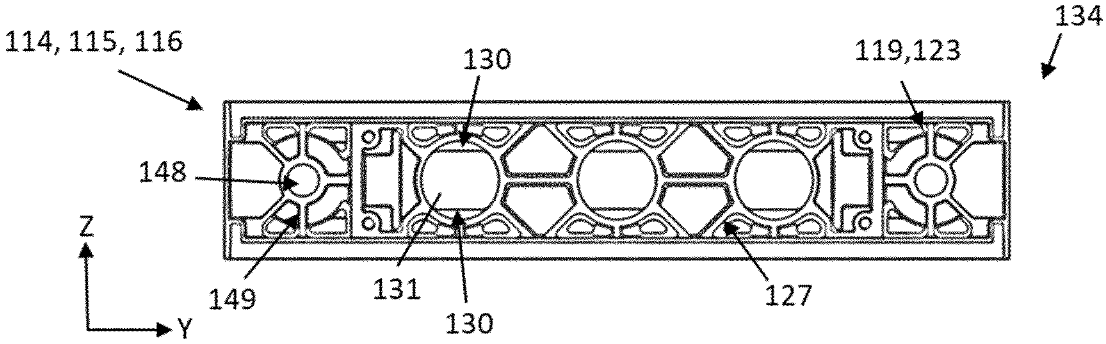


Fig. 2B

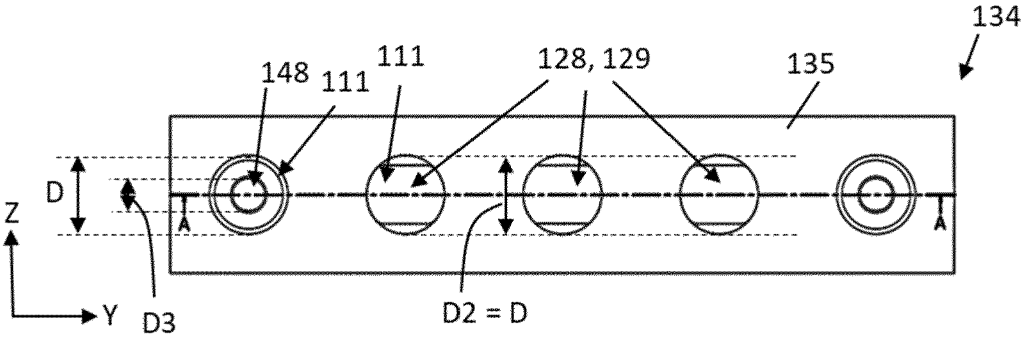


Fig. 2C

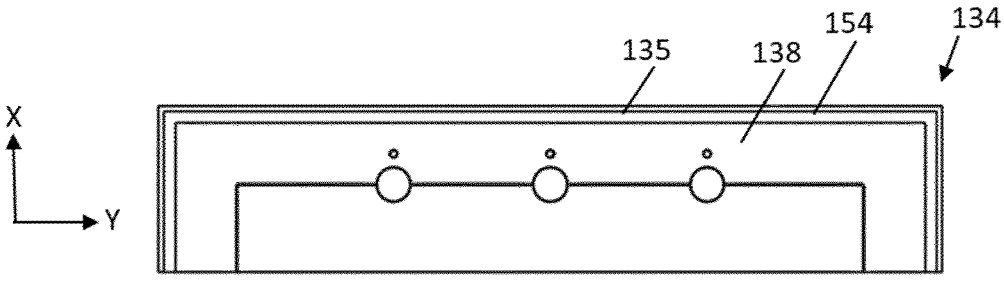
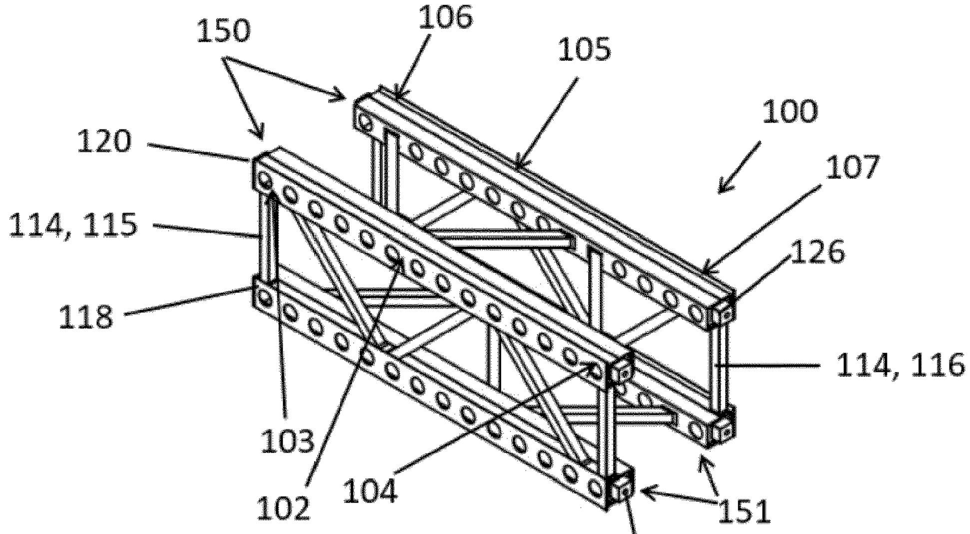


Fig. 2D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106
105
100
120
107
114, 115
126
118
114, 116
103
102
104
151
122

Fig. 3A

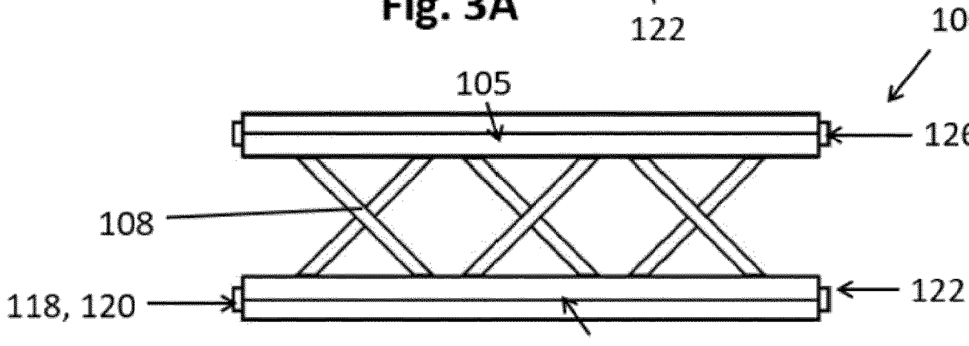

100
105
126
108
118, 120
122
102

Fig. 3B

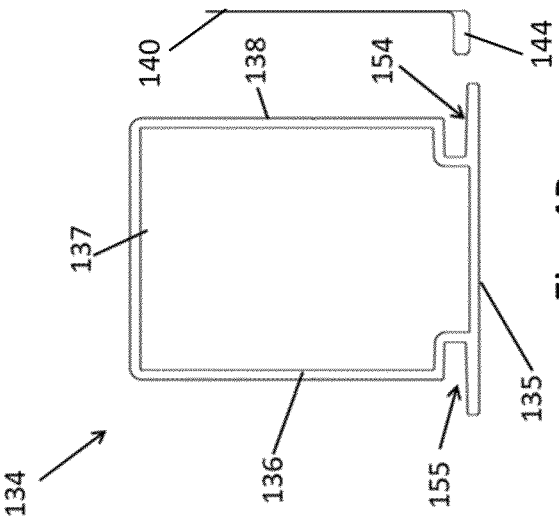

140
138
154
144
137
134
136
155
135

Fig. 4B

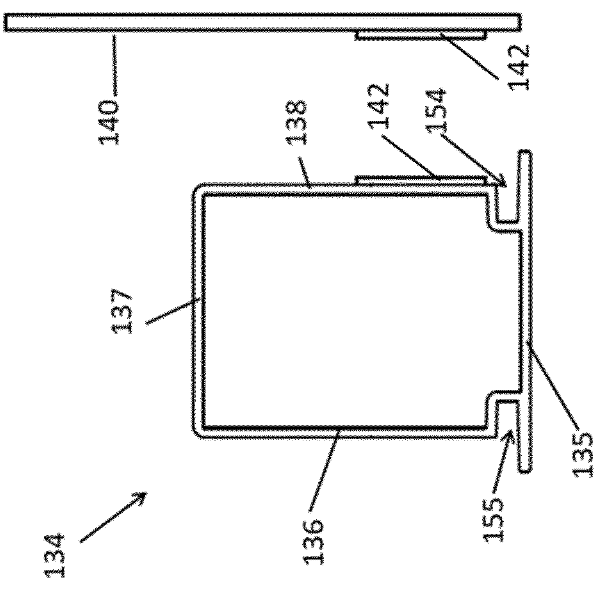
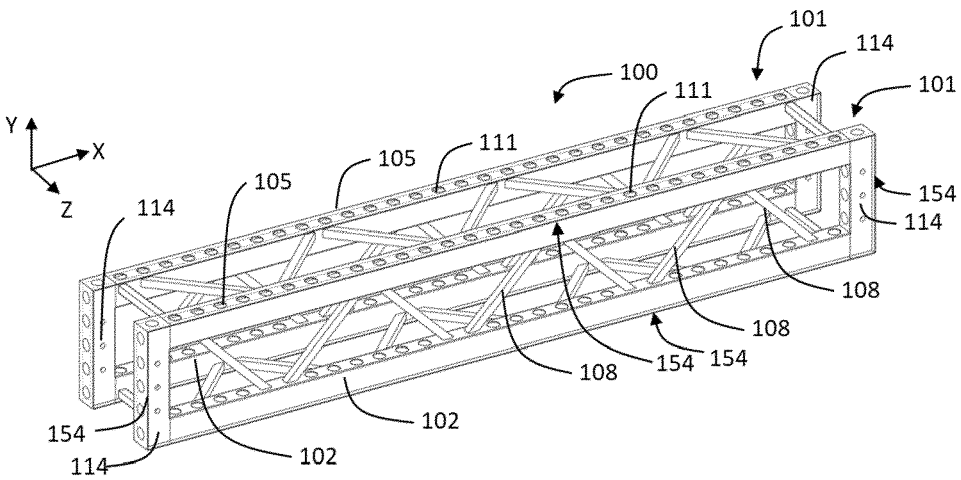

140
142
138
142
154
137
134
136
155
135

Fig. 4A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114
100
111
101
Y
X
Z
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114
114
108
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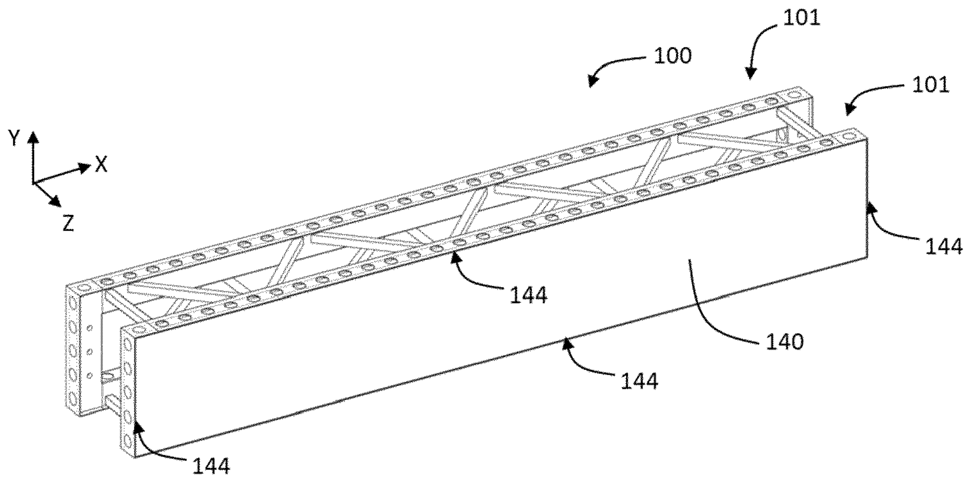
102
114
102

Fig. 4C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100
101
Y
X
Z
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144
140
144
144

Fig. 4D

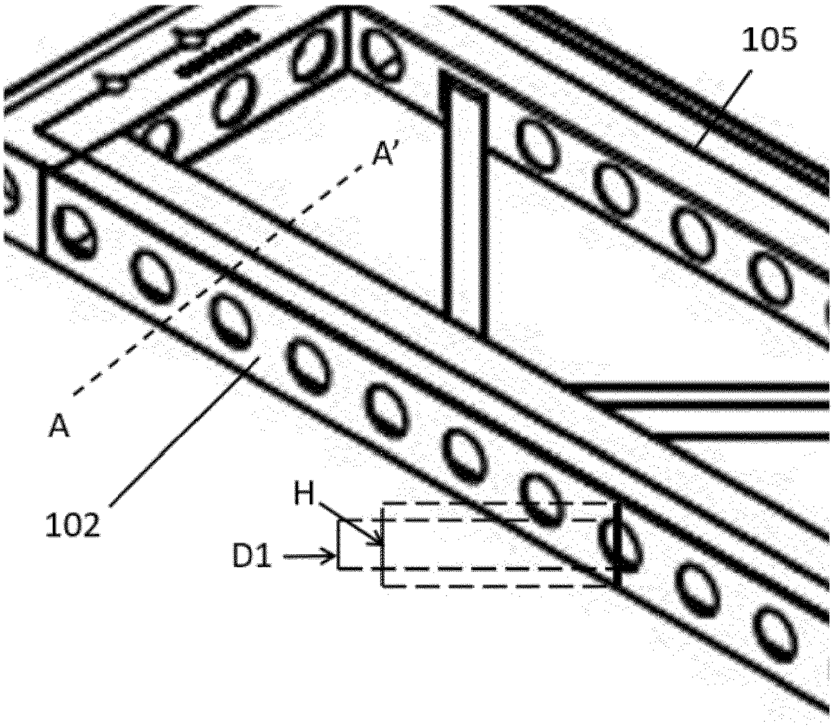
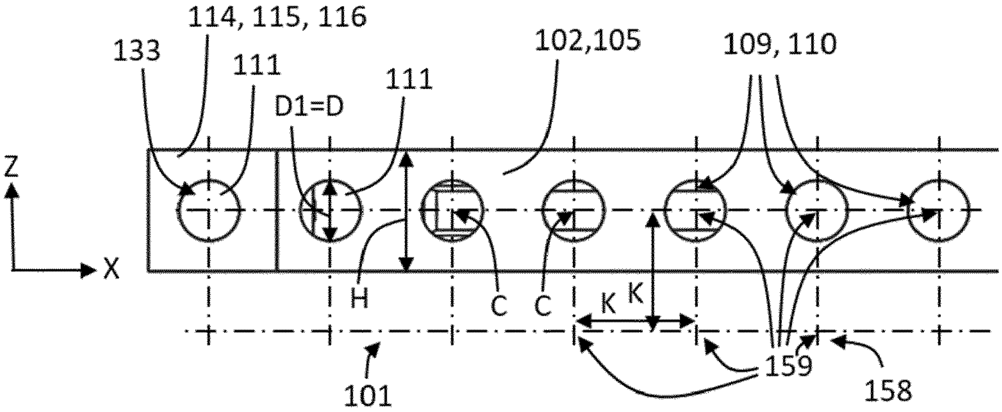

105
A'
A
102
H
D1

Fig. 5A


114, 115, 116
133
111
102,105
109, 110
D1=D
111
Z
X
H
C
C
K
K
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159
158

Fig. 5B

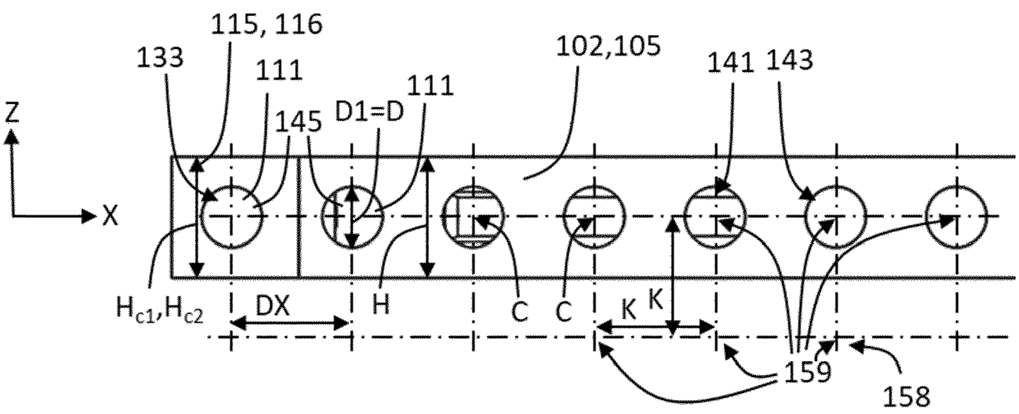

Fig. 6

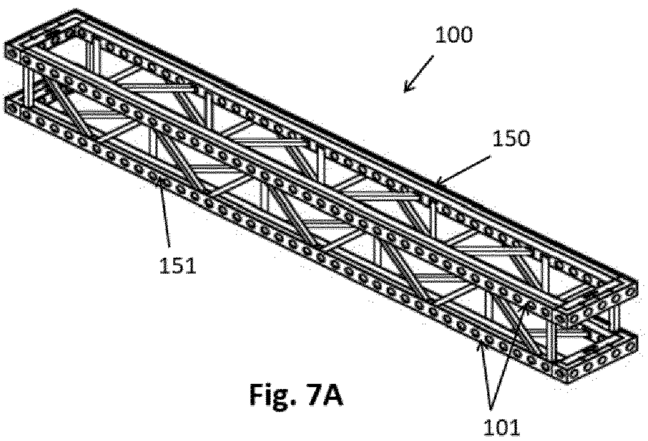

Fig. 7A

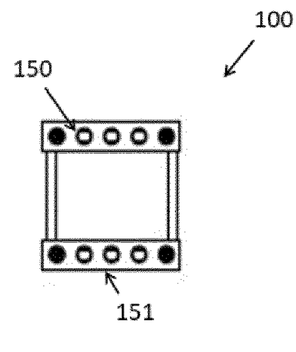

Fig. 7B

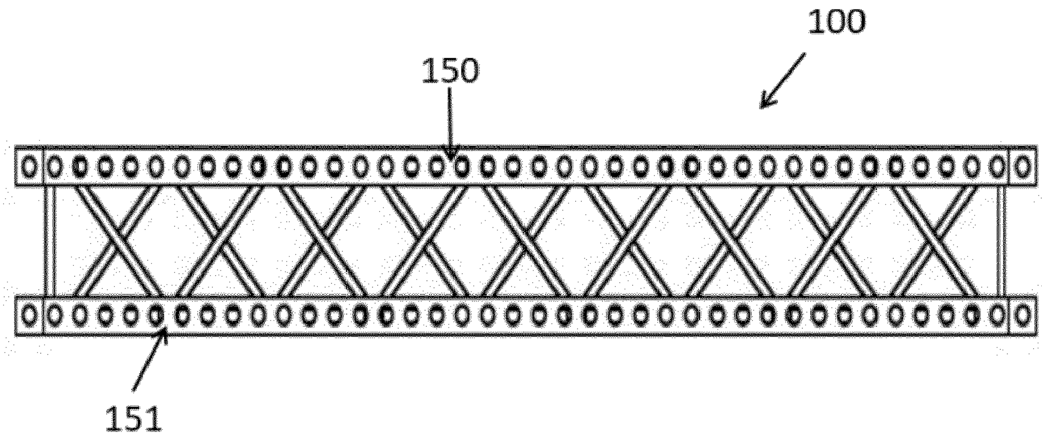

Fig. 7C

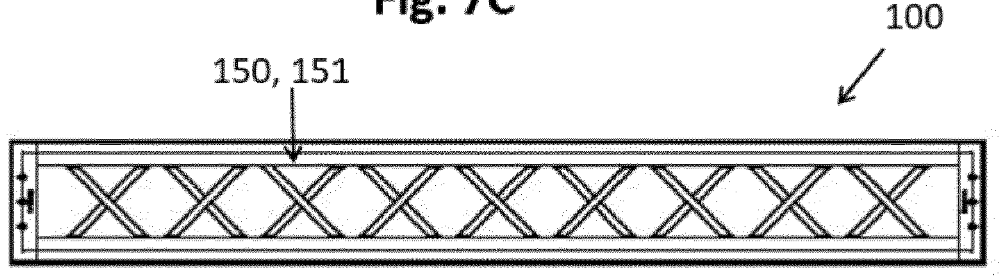

Fig. 7D

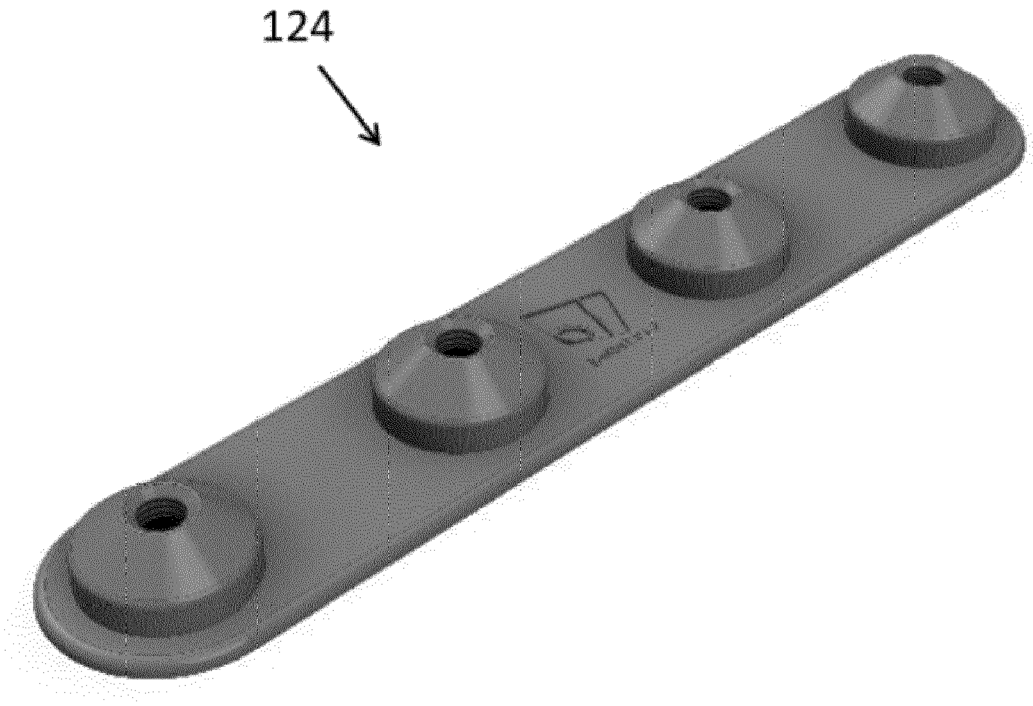

Fig. 8

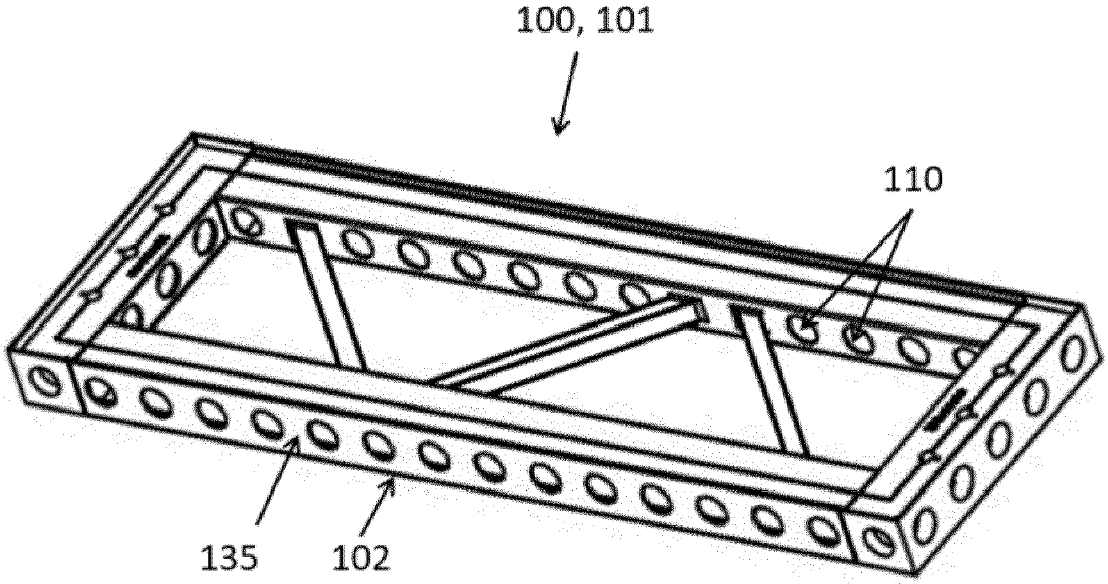

Fig. 9

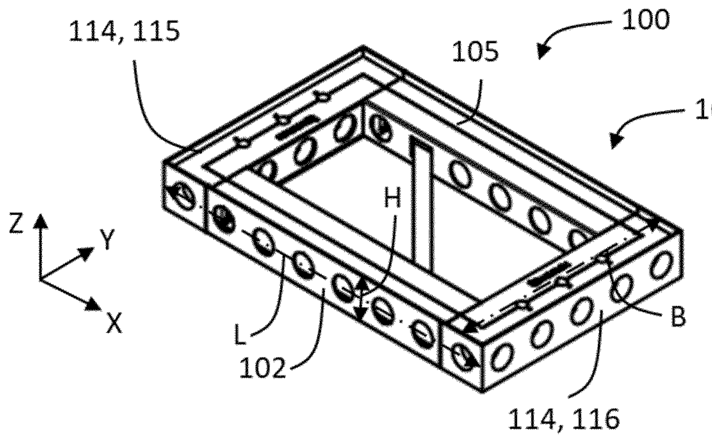

Fig. 10A

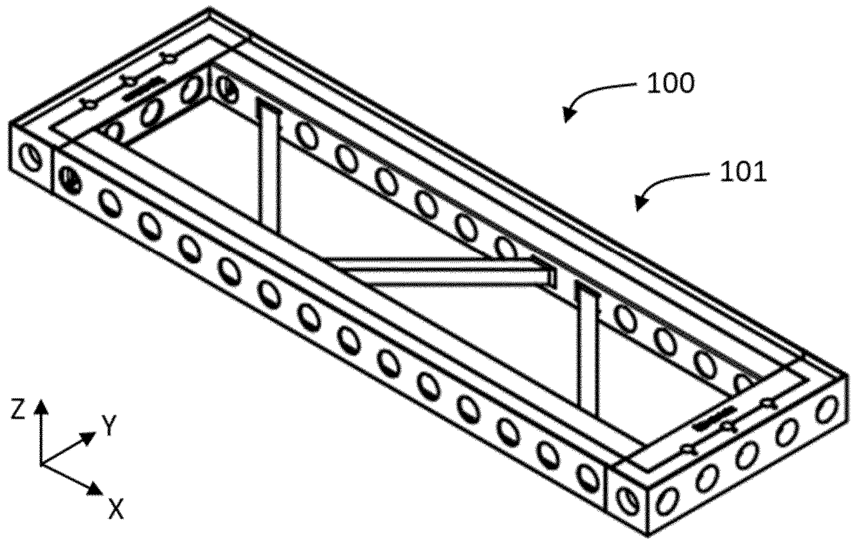

Fig. 10B

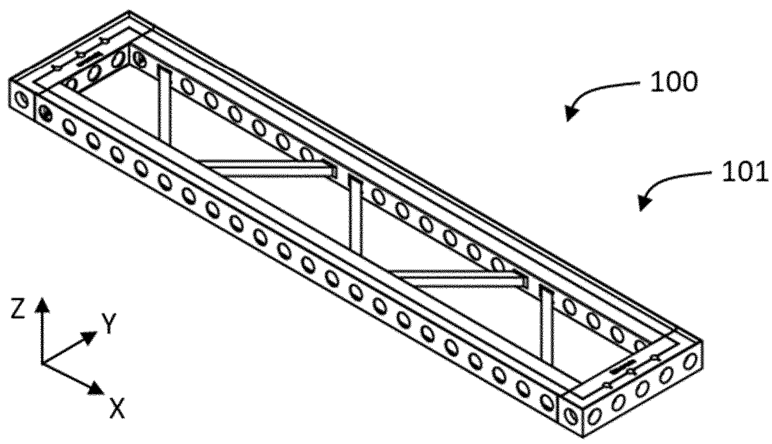

Fig. 10C

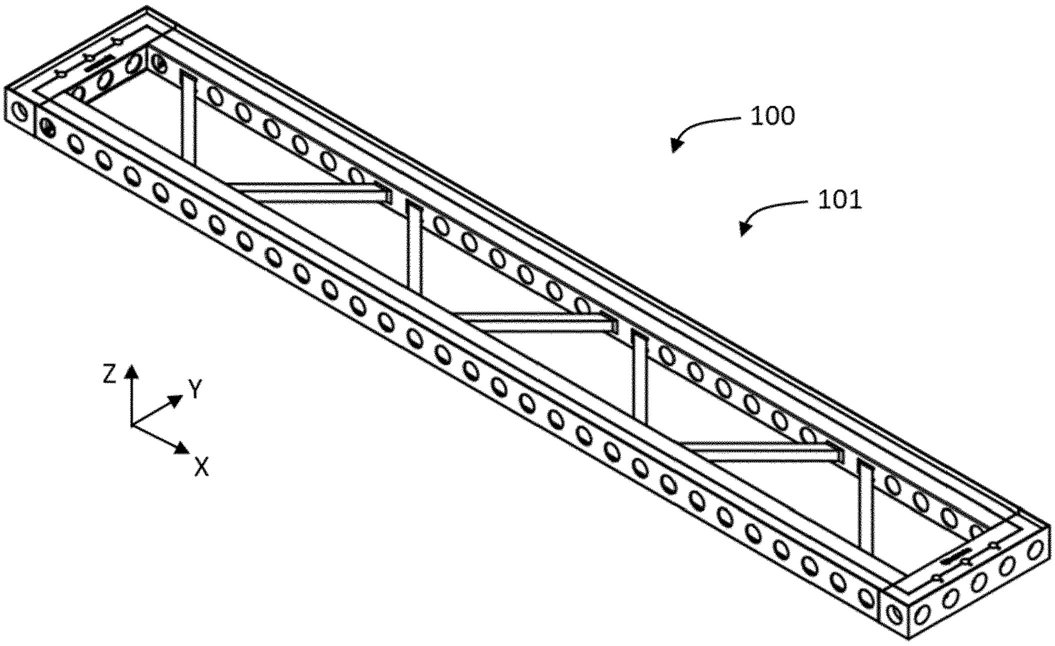

Fig. 10D

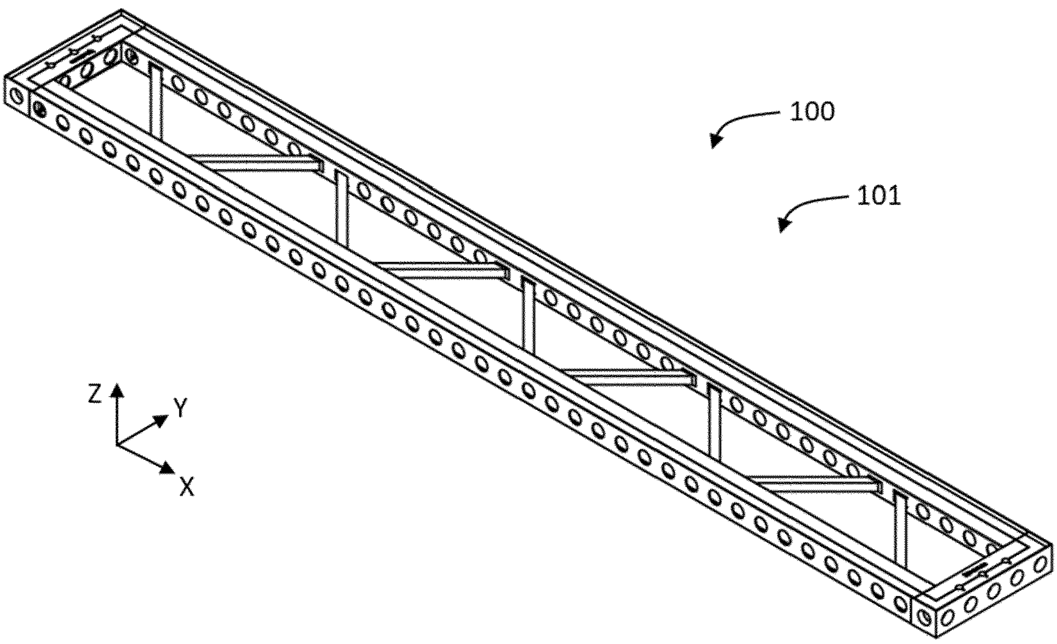

Fig. 10E

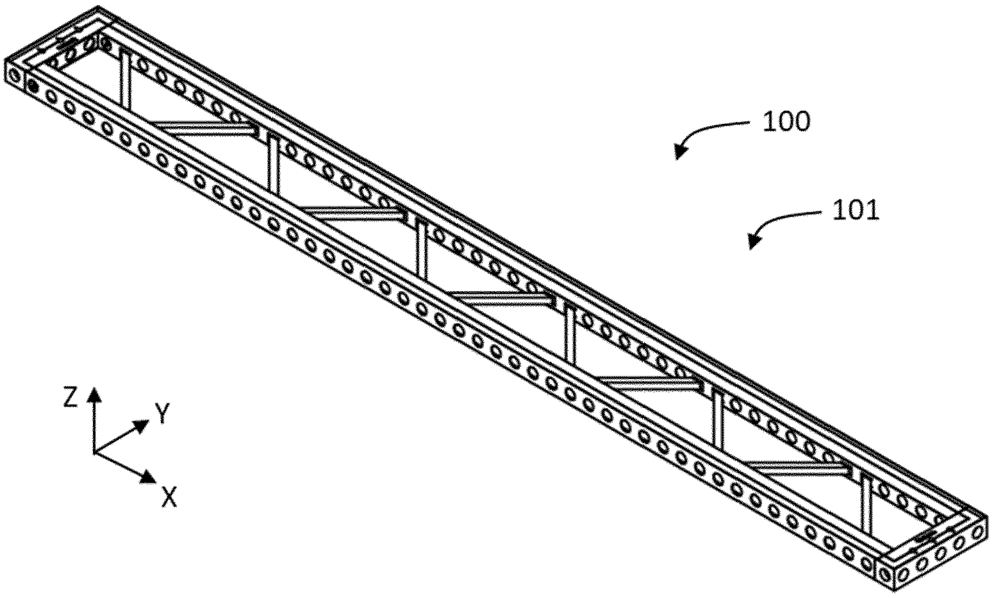

Fig. 10F

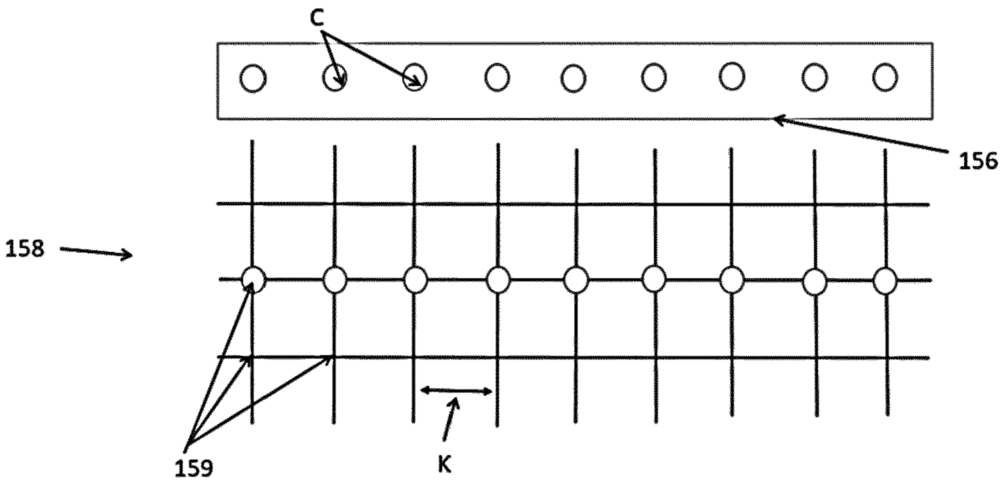

Fig. 11A

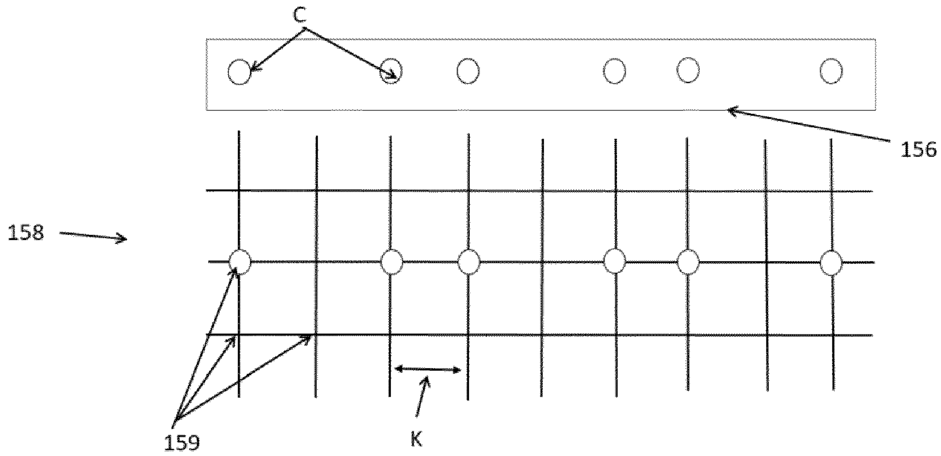

Fig. 11B

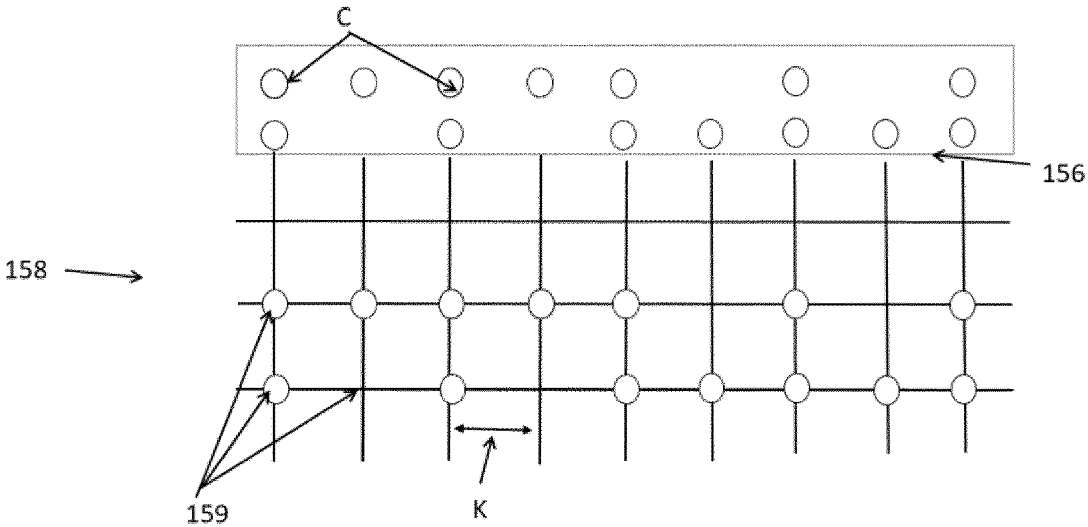

Fig. 11C

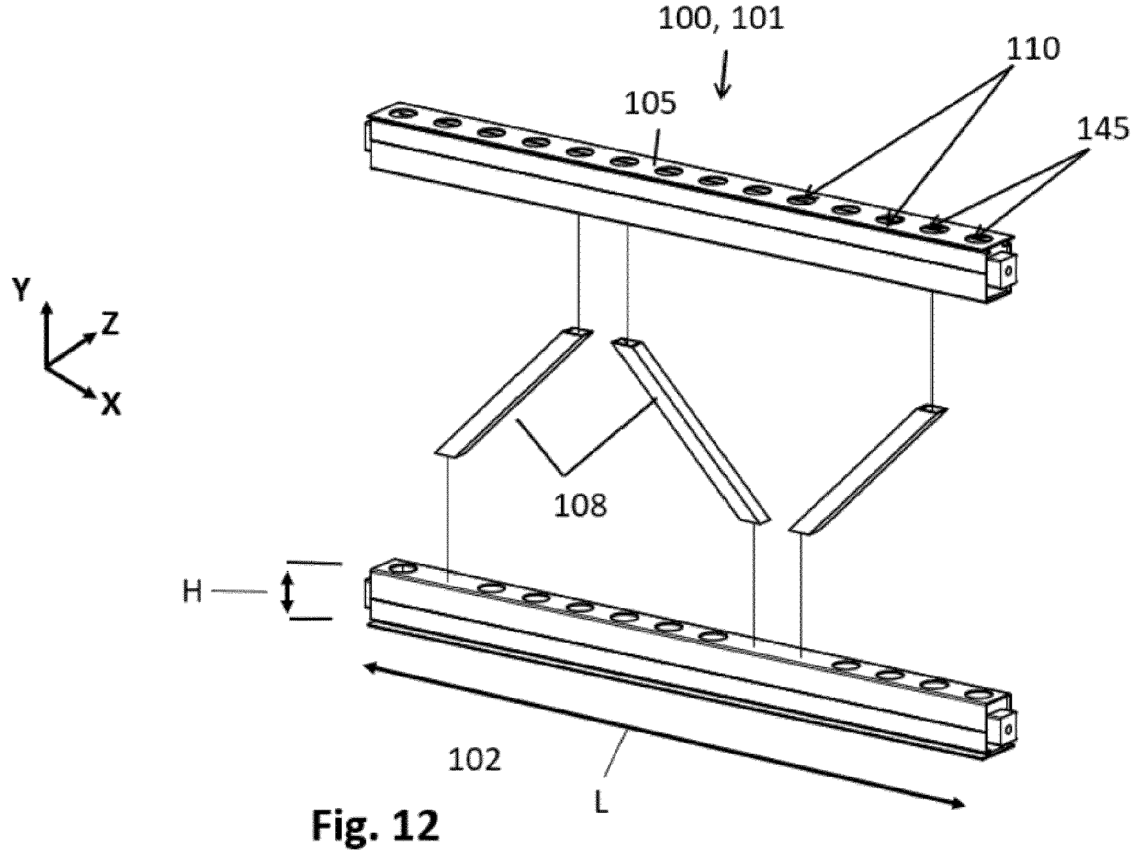

Fig. 12

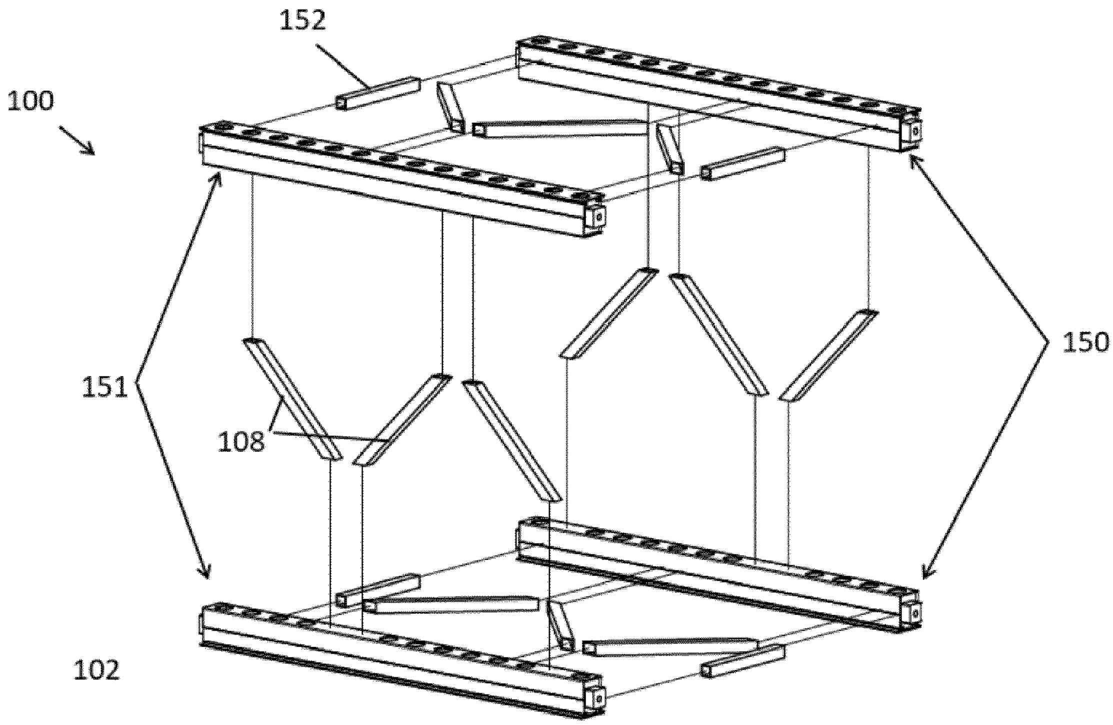

Fig. 13

Fig. 14B

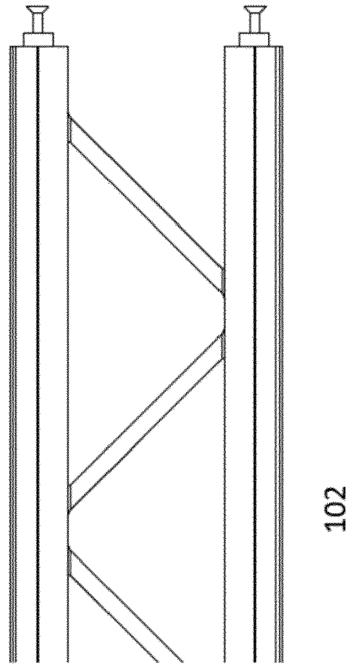

Fig. 14A

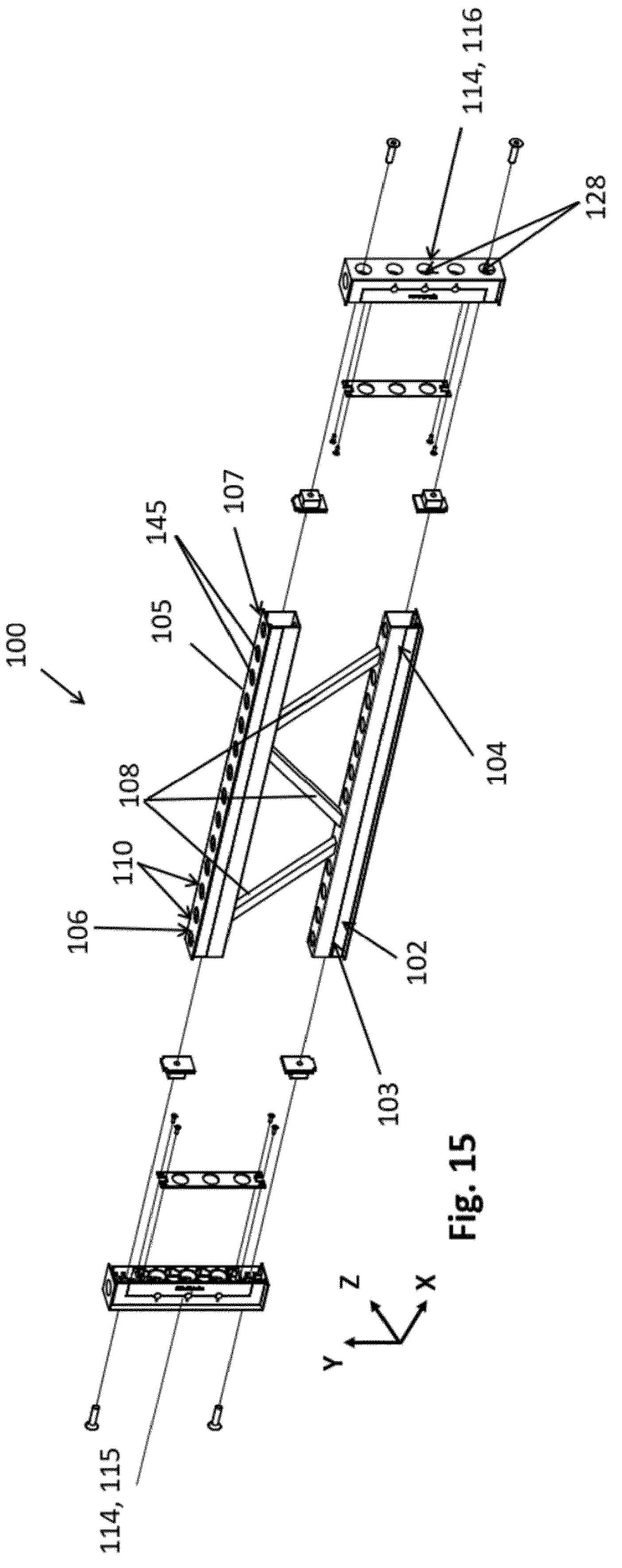

Fig. 15

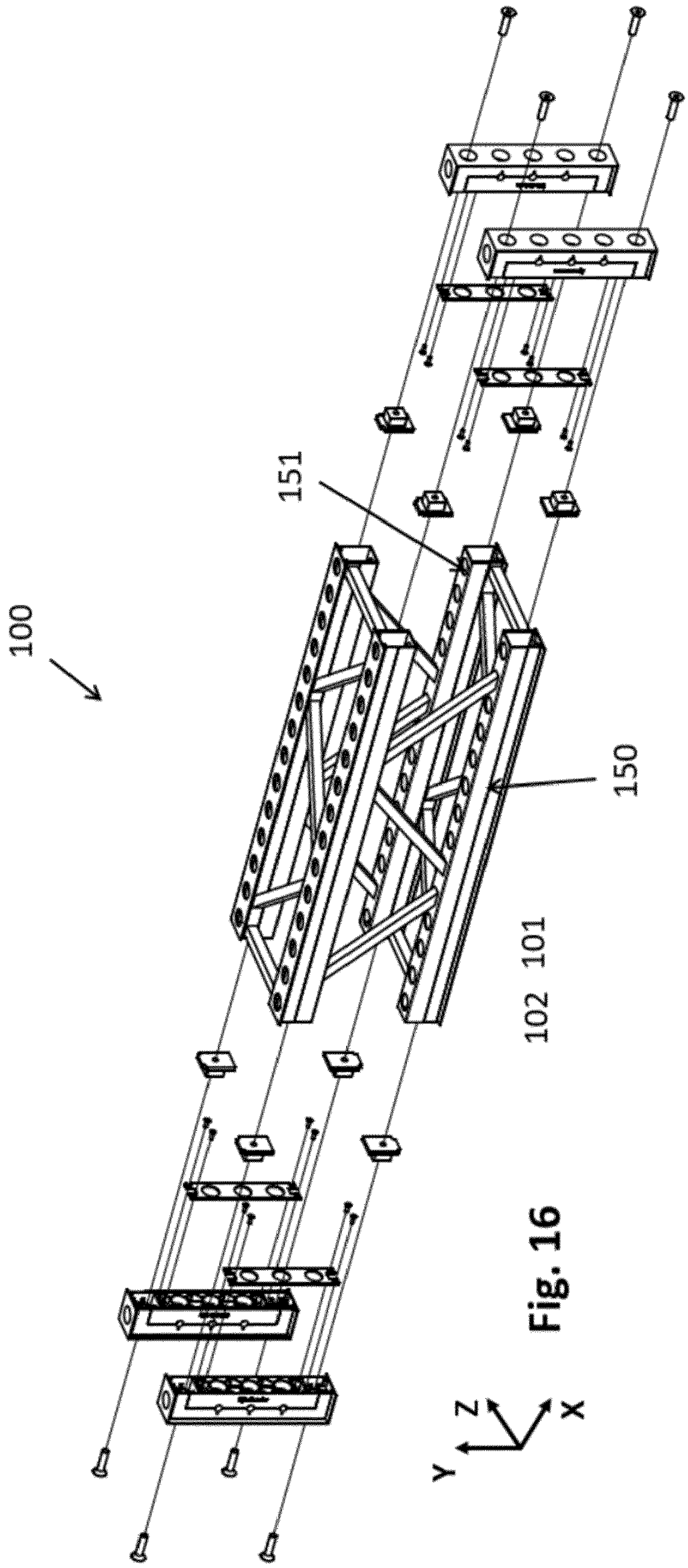

Fig. 16

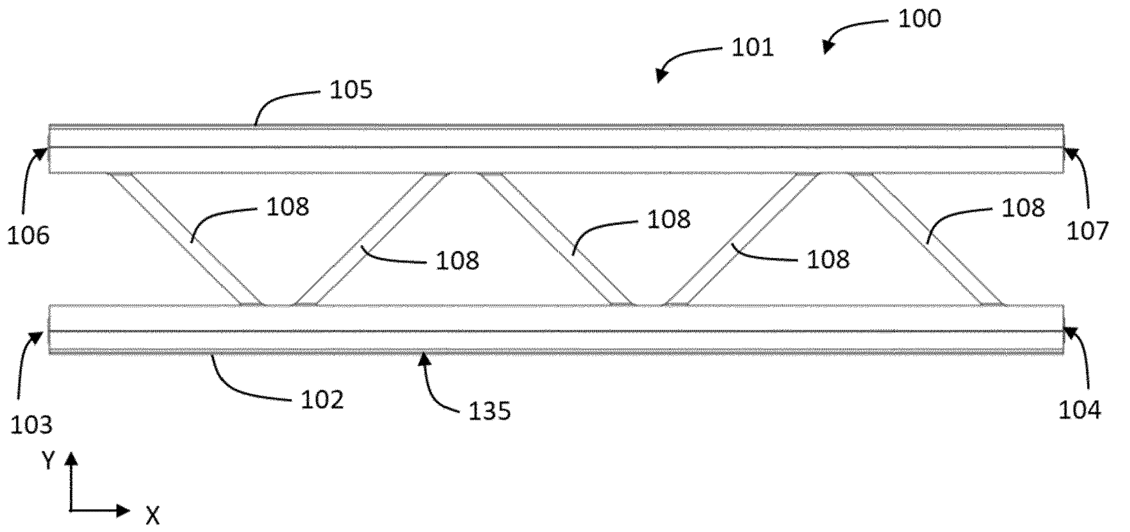
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Fig 17

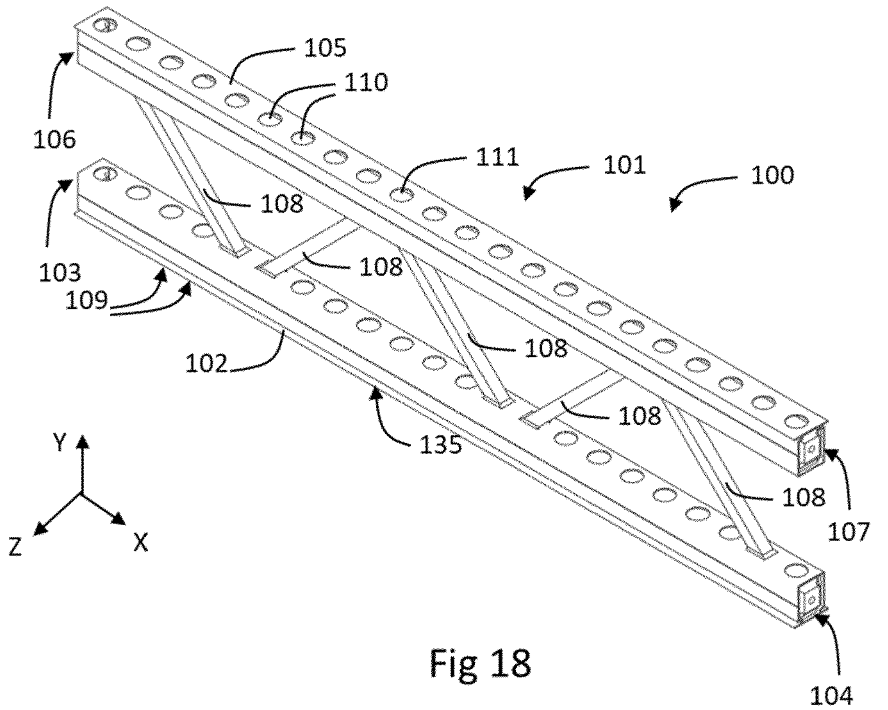
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Fig 18

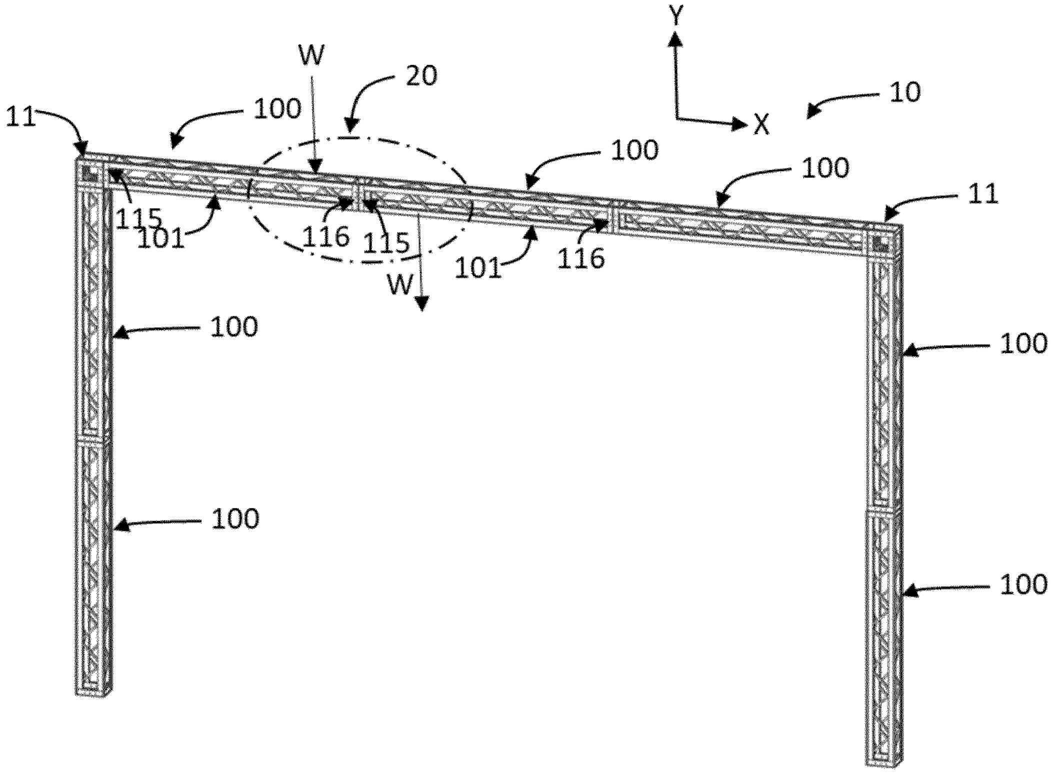
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Fig 19

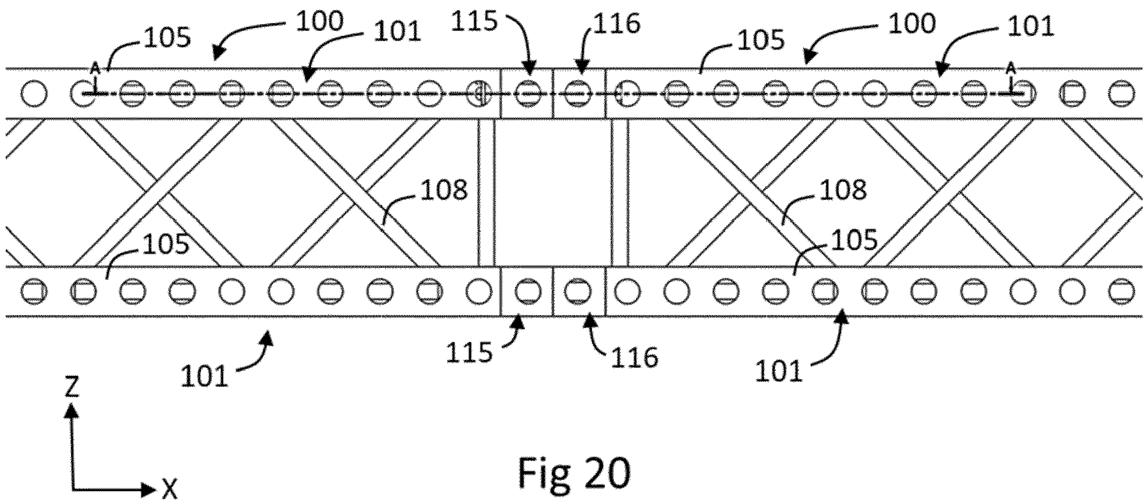
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Fig 20

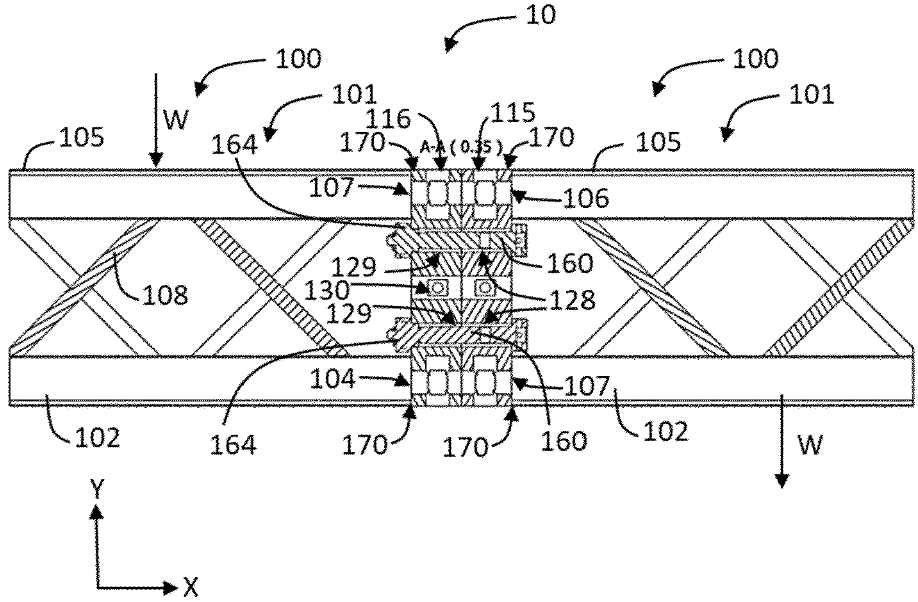
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Fig 21

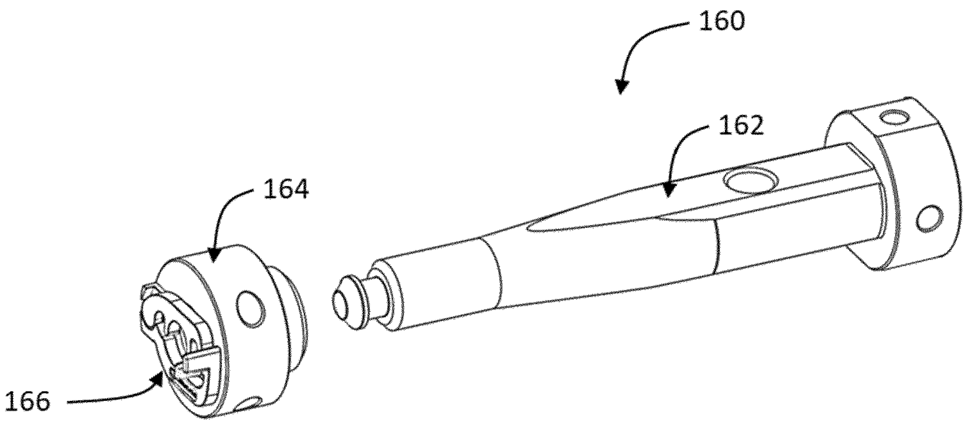
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Fig 22

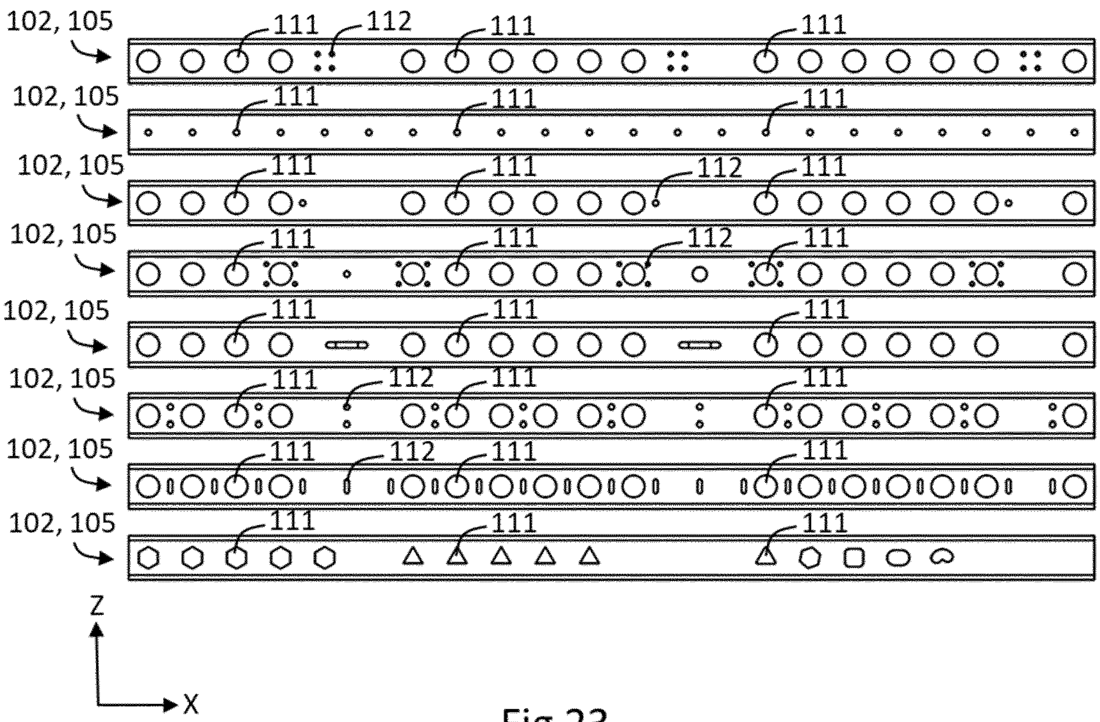

Fig 23

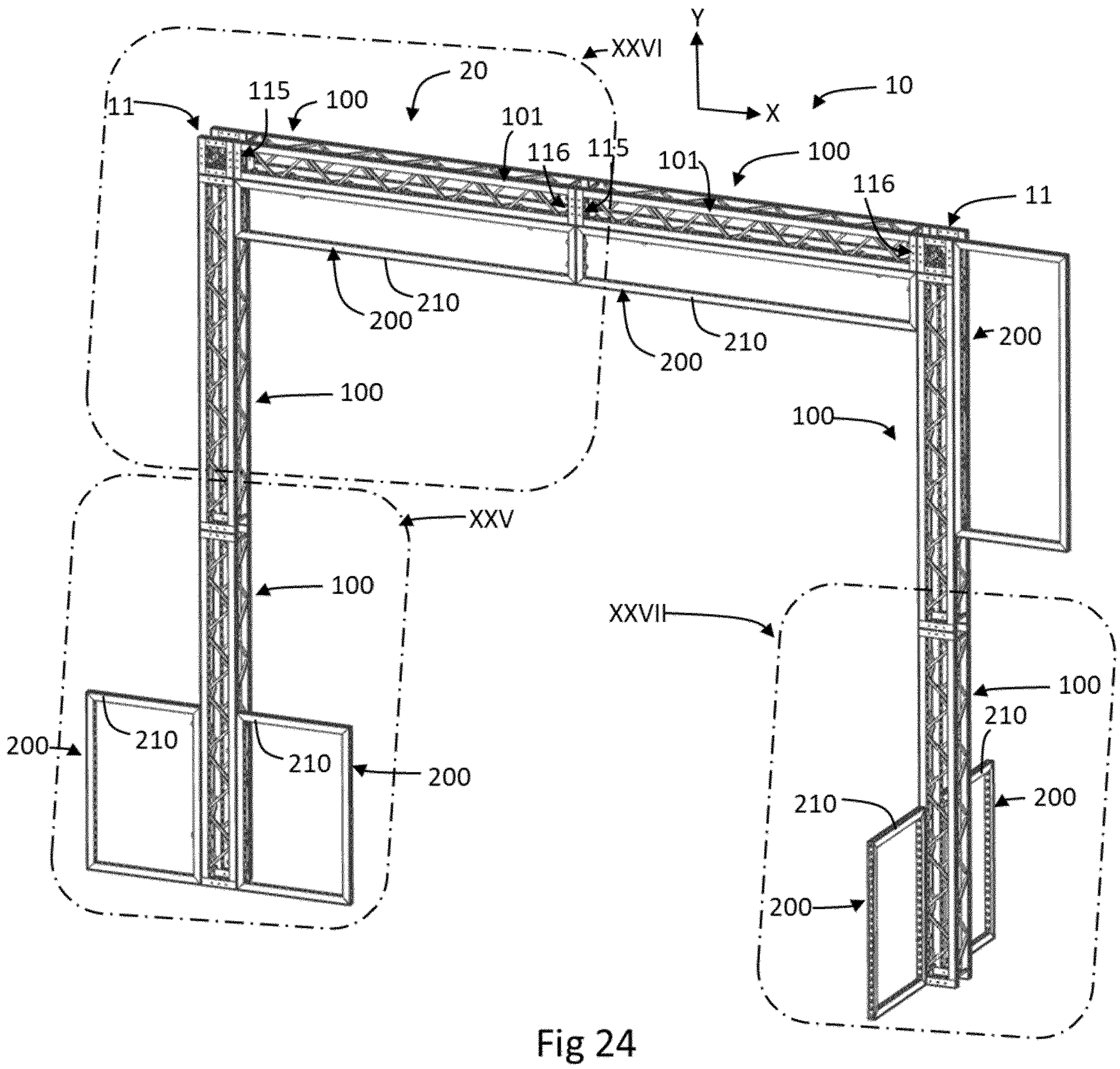
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Fig 24

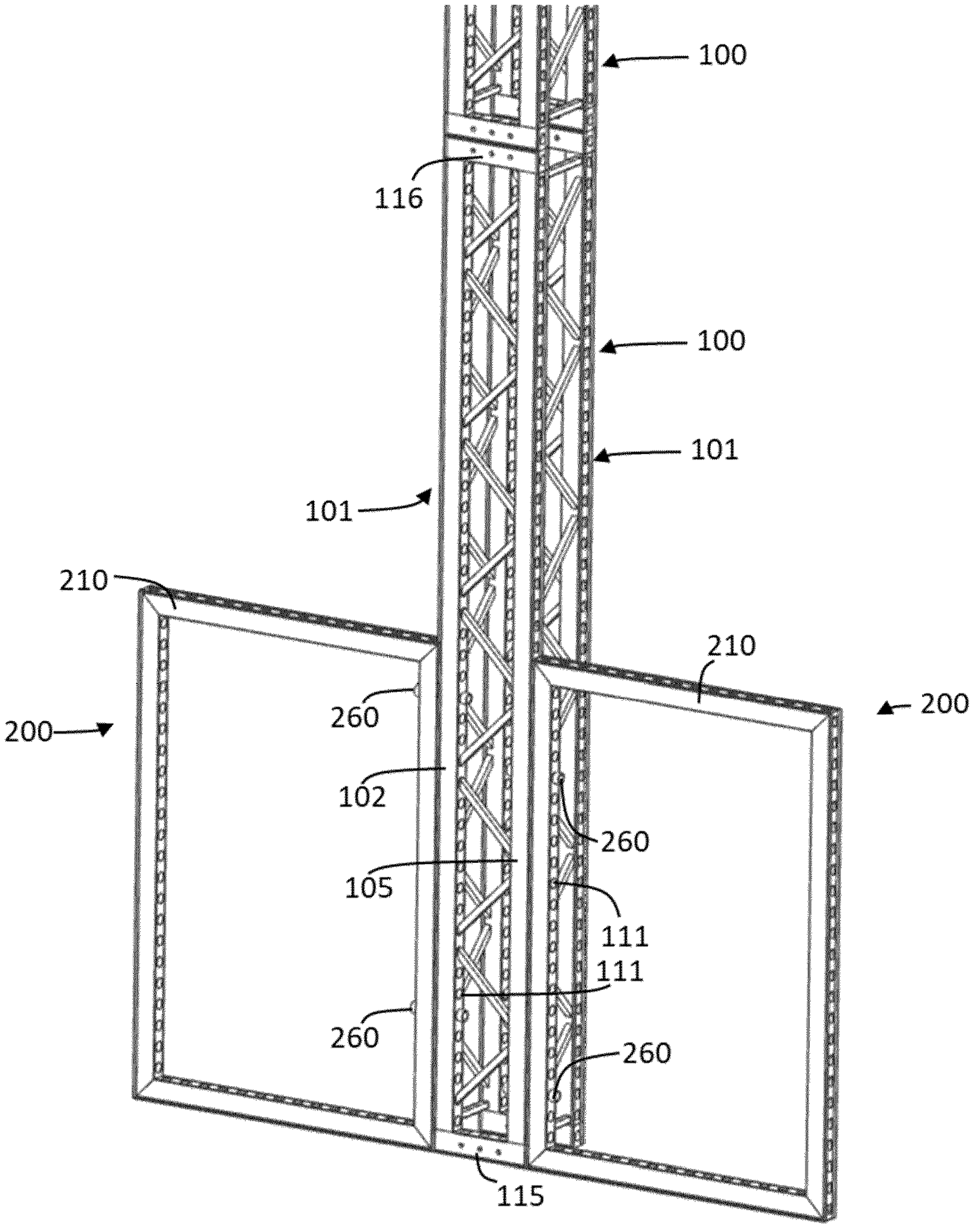
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Fig 25

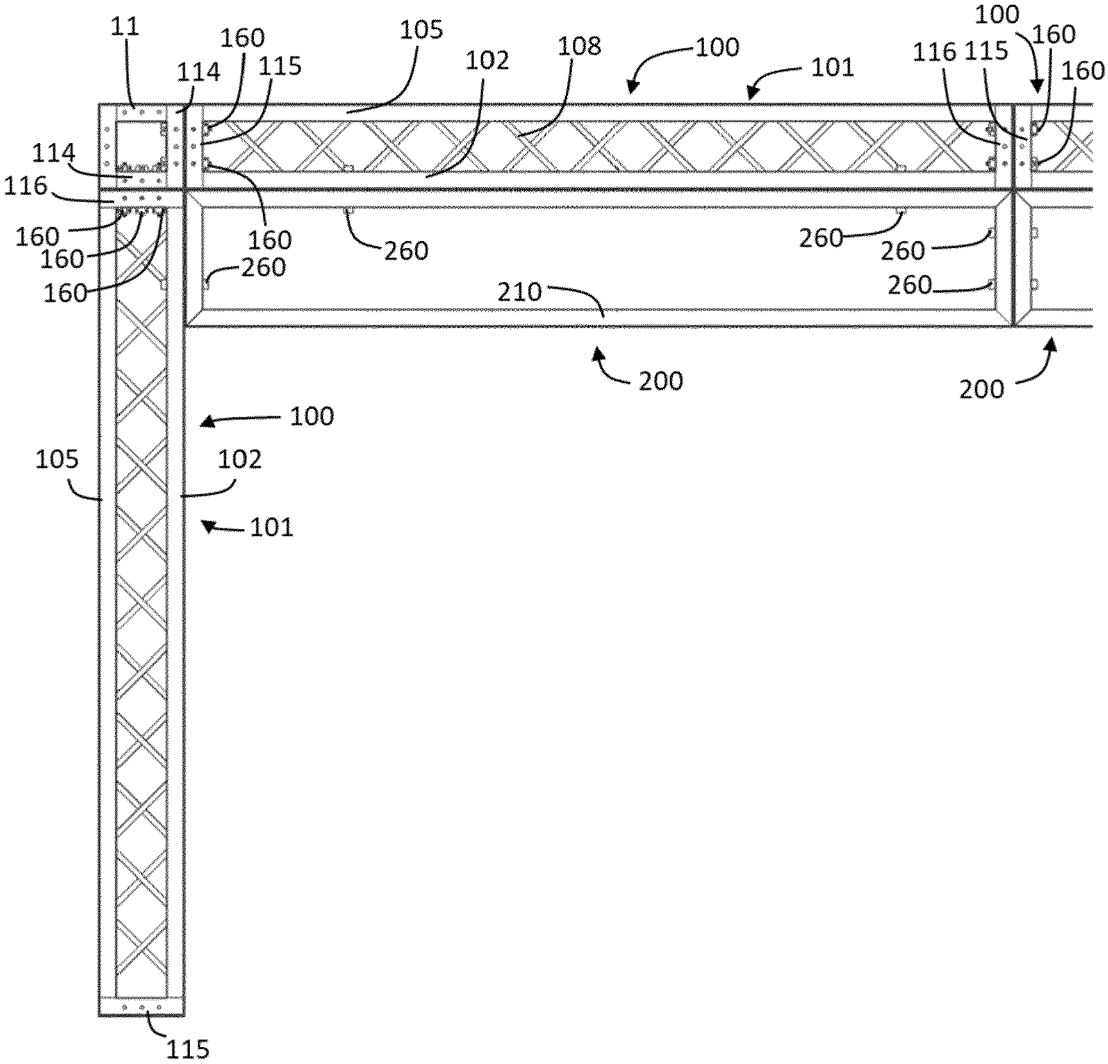
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Fig 26

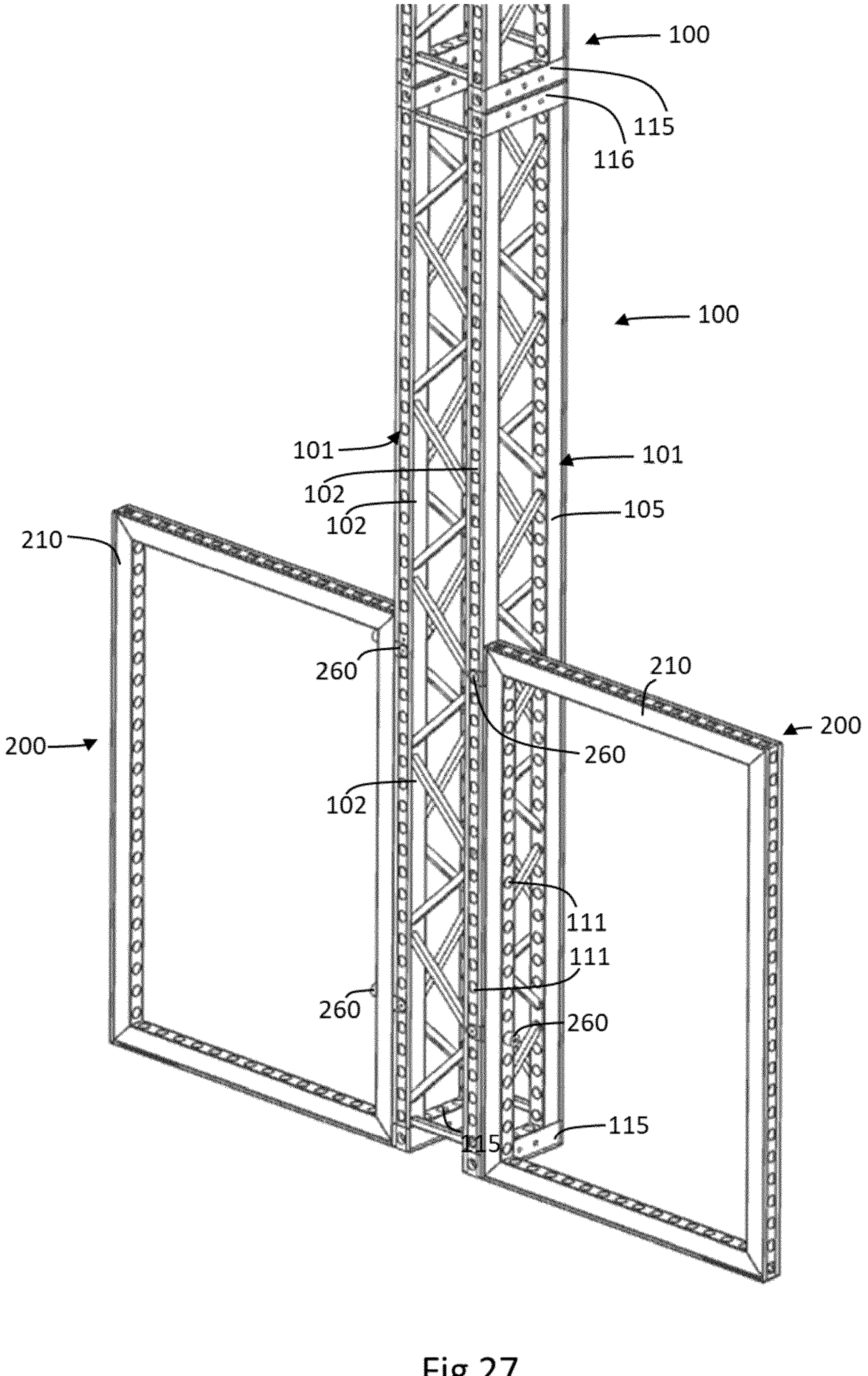
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Fig 27

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EUROPEAN SEARCH REPORT

Application Number
EP 20 15 5988

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,D	BE 1 020 560 A3 (BEMATRIX BVBA [BE]) 3 December 2013 (2013-12-03) * figures 1-3, 6, 8 *	1-4,6,7, 9-13	INV. E04C3/08 E04C3/40 E04H1/12
X	US 6 014 842 A (MATSUBARA HIDEO [JP]) 18 January 2000 (2000-01-18) * figures 34-40 *	1-7,9, 12,13	
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X	WO 2016/040984 A1 (PRESTON JOHN [AU]) 24 March 2016 (2016-03-24) * figures 1, 2 *	1-7,12, 13	
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TECHNICAL FIELDS SEARCHED (IPC)

E04C
E04H

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	7 July 2020	Bauer, Josef

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07-07-2020

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