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(54) **CONSTRUCTION SYSTEM FOR SINGLE-LAYER SPACE FRAMES**

(57) The invention relates to a construction system for single-layer space frames, comprising a generating surface formed by means of hollow struts (1) and nodes (2), wherein the nodes (2) have a side connecting surface, and connection means for connecting the end of each of the struts (1) converging therein, in which the nodes (2) are formed by a solid body, the side surface of which has connection planes (3) for the connection to

each of the struts (1), respectively, wherein the connection means are arranged in each connection plane (3), each one being perpendicular to the axis of the strut (1) converging therein and having the same shape and dimensions as the section of said strut (1), and it comprises covering means for covering the connection means in each of the connection planes (3).

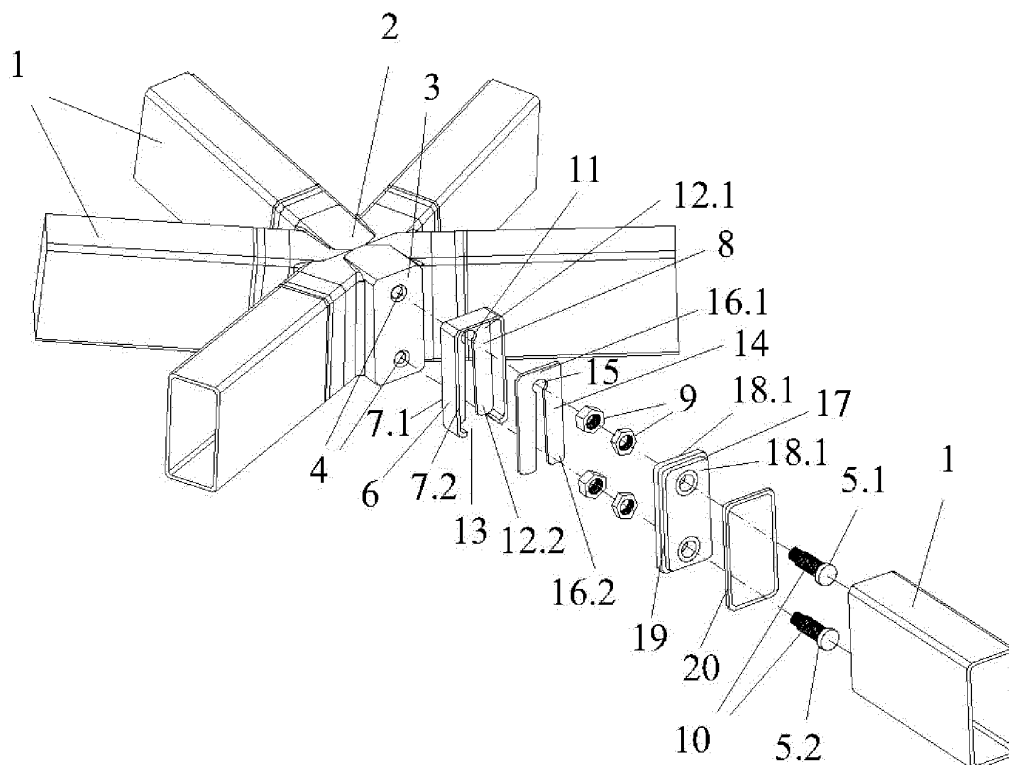


Fig. 4

Description

Technical Field of the Invention

[0001] The present invention corresponds to the technical field of single-layer space frames, comprising a generating surface formed by means of a structural assembly of hollow struts and nodes.

Background of the Invention

[0002] Single-layer frames, also known as shells or membrane-type structures, have their nodes on one surface, generally adopting a double curvature, which is known as the generating surface. The frame is formed from this surface by means of a lattice of triangles or quadrilaterals, such that the assembly constitutes a polyhedron inscribed on the mentioned surface.

[0003] The axes of the struts of the actual frame coincide with the ridges of the mentioned polyhedron. With the exception of some frames that have very simple and regular geometries, for example in the barrel vaults (adopting a single curvature) or in certain types of domes (provided that they have rotational symmetry), the degree of diversity of the struts and of the angles formed between said struts is extremely high, which has an enormous effect on the production processes.

[0004] For the purpose of optimizing the ability to transport these frames to enable building them at sites located far away from the production plant, a system that breaks the structural assembly down into two unique types of elements, i.e., nodes and struts, has been developed.

[0005] These elements are manufactured in highly flexible and automated industrial facilities. Their pre-manufacture allows obtaining levels of diversification, precision and finishing that are far superior to those that are normally achieved in metallic constructions.

[0006] As a result of the high stackability of the elements finished in a workshop, including all the required paint layers, they are dispatched to the construction site in containers that allow obtaining high volumetric efficiency. On-site assembly is done exclusively by means of screwing, which provides a fast and secure assembly in this phase of the construction process.

[0007] Unlike what occurs in double-layer space frames, in which the strut-node attachments are considered to be articulated attachments, this system has been designed such that the strut-node attachment is a highly rigid connection, particularly in the direction perpendicular to the generating surface.

[0008] In this system, the nodes are basically cylindrical parts the main axis of which is arranged perpendicular to the plane that is tangent to the mentioned surface in the node itself. On the side surface of the cylinder and perpendicular to the axes, according to which the struts converging in said node enter, there are machined two threaded holes through which the connection of the end of each strut takes place.

[0009] The struts forming the frame usually have a tubular profile with a rectangular section, the principal axis of inertia thereof being oriented in a plane considerably perpendicular to the generating surface.

[0010] The purpose of both the profile and the arrangement thereof is to enable the struts to absorb bending stresses in the plane perpendicular to the surface of the roof; however, this is not the case in the plane that is tangent thereto in which the possible load-induced bending is of a much lower order of magnitude.

[0011] At each of their ends, the struts have a cover perpendicular to their axis which two screws in turn go through, said screws being located in the main plane of inertia of the strut and parallel to the axis thereof. The end of the strut is connected to the central part of the node by means of these screws.

[0012] The mentioned screws are similar to the proprietary screws of space grid structure systems, such as, for example, Nuclos system screws, SEO system screws, Mero system screws, ORTZ system screws, etc. For example, ORTZ system screws, which have been widely used in building ordinary (double-layer) space grid structures, have two threaded bodies: the body closest to the head, which has the largest diameter, is screwed in in the clockwise direction; and the opposite body, which enters the node, is screwed in in the counter-clockwise direction.

[0013] Two nuts are housed in the body screwed in in the clockwise direction, and when these nuts are tightened with respect to one another, they temporarily allow, by means of a nut-counter nut effect, acting on the screw without accessing the head thereof. The resistant capacity of the screws and the separation between them gives rise to a torque which is what enables the attachment for transmitting bending stresses, which usually combine with axial compressive stress, or, less frequently, tensile stress.

[0014] The remaining node systems used in space grid structures use screws differing in some aspects from those screws described by way of example, but in each case two nuts, a sleeve, an escutcheon covering the nuts or the like, are arranged between the strut and the node.

[0015] Unlike what usually occurs in double-layer space frames, and generally in most structural systems, with the structural system thus defined, no auxiliary frames or purlins are required for fixing the enclosure. The actual profile of the struts (rectangular tube) has a planar surface considerably parallel to the generating surface and is arranged such that it contributes to the support and anchoring of the enclosure elements.

[0016] The structural slenderness provided by the single layer, the harmonic section of its nodes and profiles, and the absence of purlins reduce the visual impact of these frames by providing them with a maximum degree of transparency. All this renders them extremely advantageous for use as a support for large glazed surfaces with high aesthetic exigency.

[0017] Nevertheless, even though these modes of at-

tachment between nodes and struts have many advantages, they also have drawbacks. In that sense, the screwing means are completely exposed in the position they adopt between the node and the strut in question, so in practice, this screwed attachment of the struts to the nodes may be quite visible, especially in those cases in which, depending on the angling between struts and the modulation, they are particularly exposed, offering possible inappropriate or unsuitable aesthetics.

[0018] No technical element or device intended for protecting and concealing the screwed attachments for the purpose of achieving the appropriate aesthetics of the assembly, while maintaining the technical features of the attachment, and at the same time the protection thereof, has been found in the state of the art.

Description of the Invention

[0019] The construction system for single-layer space frames herein proposed comprises a generating surface formed by means of a structural assembly of hollow struts and nodes, wherein the nodes have a central axis perpendicular to the tangent plane of the generating surface and a side surface having connection means for connecting the end of each of the struts converging therein.

[0020] In this system, the nodes are formed by a solid body, the side surface of which has connection planes for the connection to each of the struts converging in said node, respectively, wherein the connection means are arranged in each connection plane, each of said connection planes being perpendicular to the axis of the strut converging therein and having the same shape and dimensions as the section of said strut.

[0021] Furthermore, this system comprises covering means for covering the connection means in each of the connection planes of the side surface of the node.

[0022] According to a preferred embodiment, the covering means are formed by at least one overlapping cover formed by means of a portion of a strut having the same section as the strut that is connected to said plane, respectively, the depth of the overlapping cover being such that it is suitable for containing therein the part of the connection means arranged externally with respect to the strut and the node, wherein said overlapping cover has a first end for being attached to the connection plane with a first laminar plate fixed thereto and an open opposite second end.

[0023] According to a preferred embodiment, the connection means are formed by at least two threaded holes in each connection plane and screwing elements therein.

[0024] In this case and in a preferred embodiment, the overlapping cover comprises passage means for the passage of the screwing elements, formed by a first hole in the first laminar plate, close to a first side thereof for the passage of a first screwing element, wherein said first hole is open towards a second side of the laminar plate, opposite the first side.

[0025] In turn, according to a preferred embodiment

the overlapping cover has a portion of one side thereof that is open, said side being opposite the side close to the first screwing element.

[0026] Likewise, in a preferred embodiment the covering means comprise a second laminar plate suitable for being fitted inside the overlapping cover, wherein said second laminar plate has passage means for the passage of the screwing elements, formed by a second hole close to a first side thereof for the passage of a first screwing element, wherein said second hole is open towards a second side of the laminar plate, opposite the first side.

[0027] According to a preferred embodiment, the covering means comprise a closure element of the second end open of the overlapping cover, formed by a planar body having a closed section, having a first face with the same section as the overlapping cover and an opposite second face the contour of which has an offset with respect to the contour of the first face.

[0028] In this case and in a preferred embodiment, said covering means comprise a closing edge suitable for being fitted in the offset of the contour of the second face of the closure element.

[0029] According to another aspect, in a preferred embodiment each screwing element comprises two nuts, the depth of the overlapping cover being such that it is suitable for containing therein said two nuts for each threaded hole.

[0030] A significant improvement of the state of the art is obtained with the construction system for single-layer space frames herein proposed.

[0031] In other words, in addition to successfully concealing the screwing means with this construction system, the node itself is concealed, thereby achieving visual continuity of the frame.

[0032] The solid geometry of the nodes is obtained automatically in the manufacturing design phase, resulting in an element that simulates the natural convergence of the tubes, thereby concealing the node element and providing a continuity rendering the transition between strut and node unnoticeable.

[0033] It is therefore a very effective system since it allows, in a very simple manner, solving the existing problem while maintaining all the technical advantages of the system.

Brief Description of the Drawings

[0034] For the purpose of helping to better understand the features of the invention according to a preferred practical embodiment thereof, a series of drawings is provided as an integral part of said description in which the following is depicted with an illustrative and non-limiting character:

Figure 1 shows a perspective view of the node of the construction system for a preferred embodiment of the invention.

Figure 2 shows a bottom perspective view of a node

of the construction system with the struts converging therein for a preferred embodiment of the invention. Figure 3 shows a view of section A-A' of Figure 2 of the construction system for a preferred embodiment of the invention.

Figure 4 shows an exploded view of the connection of one of the struts to the node of the construction system for a preferred embodiment of the invention.

Detailed Description of a Preferred Embodiment of the Invention

[0035] In view of the drawings that are provided, it can be seen how in a preferred embodiment of the invention, the construction system for single-layer space frames herein proposed comprises a generating surface formed by means of a structural assembly of hollow struts (1) and nodes (2). These nodes (2) have a central axis perpendicular to the tangent plane of the generating surface, a side connecting surface, and connection means for connecting the end of each of the struts (1) converging therein.

[0036] As shown in Figure 1, the nodes (2) of this system are formed by a solid body, the side surface of which has connection planes (3) for the connection to each of the struts (1) converging in said node (2), respectively.

[0037] On the other hand, the connection means are arranged in each connection plane (3), each of said connection planes (3) being perpendicular to the axis of the strut (1) converging therein and having the same shape and dimensions as the section of said strut (1).

[0038] In this preferred embodiment of the invention, as can be seen in said Figure 1, as well as in Figure 4, the connection means are formed by at least two threaded holes (4) in each connection plane (3) and screwing elements (5.1, 5.2) therein.

[0039] This system further comprises covering means for covering the connection means in each of the connection planes (3) of the side surface of the node (2).

[0040] As can be seen in Figure 4, in this preferred embodiment of the invention said covering means are formed by an overlapping cover (6) formed by means of a portion of a strut having the same section as the strut (1) that is connected to said connection plane (3), respectively. Said overlapping cover (6) has a first end (7.1) for being attached to the connection plane (3) with a first laminar plate (8) fixed thereto and an open opposite second end (7.2).

[0041] Therefore, given that the connection plane (3) also has the same shape and dimensions as the section of the strut (1), continuity of the section of the strut (1) in the node (2) is achieved, and the merging of all the struts (1) converging in the node (2) is a result of the geometry of the node (2) itself, as shown in Figure 2.

[0042] Furthermore, as can be seen in Figures 3 and 4 each screwing element (5.1, 5.2) comprises two nuts (9), and the depth of said overlapping cover (6) is such that it is suitable for containing therein the part of the

connection means arranged externally with respect to the strut (1) and the node (2), which in this embodiment, with the connection means being formed by the two threaded holes (4) and the screwing elements (5.1, 5.2), each having said two nuts (9), the part located externally with respect to the strut (1) and the node (2) is formed not only by the threaded holes (4), but also by the shank (10) of each screwing element (5.1, 5.2) and also by said two nuts (9).

[0043] Said Figure 4 also shows that in this preferred embodiment of the invention, the overlapping cover (6) comprises passage means for the passage of the screwing elements (5.1, 5.2), formed by a first hole (11) in the first laminar plate (8), close to a first side (12.1) thereof for the passage of a first screwing element (5.1), wherein said first hole (11) is open towards a second side (12.2) of the first laminar plate (8), opposite the first side (12.1).

[0044] Furthermore, the overlapping cover (6) has a portion (13) of one side thereof that is open, said side being opposite the side close to the first connection element (5.1).

[0045] Therefore, when the strut (1) is connected to the node (2), if it were necessary to remove the strut (1) at some point, the nuts (9) of the screwing elements (5.1, 5.2) can be accessed in order to loosen them.

[0046] On the other hand, in this preferred embodiment of the invention, as can be seen in Figure 4, the covering means comprise a second laminar plate (14) suitable for being fitted inside the overlapping cover (6).

[0047] This second laminar plate (14) has passage means for the passage of the screwing elements (5.1, 5.2), formed by a second hole (15) close to a first side (16.1) thereof for the passage of a first screwing element (5.1), wherein said second hole (15) is open towards a second side (16.2) of the second laminar plate (14), opposite the first side (16.1).

[0048] In a preferred embodiment of the invention, the covering means further comprise a closure element (17) of the second open end of the overlapping cover (6). This closure element (17) is formed by a planar body having a closed section, having a first face (18.1) with the same section as the overlapping cover (6) and an opposite second face (18.2) the contour of which has an offset (19) with respect to the contour of the first face (18.1).

[0049] As can be seen in Figure 4, in this case the covering means further comprise a closing edge (20) suitable for being fitted in the offset (19) of the contour of the second face (18.2) of the closure element (17).

[0050] The embodiment described is only one example of the present invention, therefore the specific details, terms and phrases used herein must not be considered as limiting, but rather must only be understood as being a basis for the claims and as a representative basis providing a comprehensible description, as well as information sufficient for the person skilled in the art to apply the present invention.

[0051] Significant improvements with respect to the state of the art are achieved with the construction system

for single-layer space frames herein described.

[0052] In this sense, a construction system is obtained which allows concealing the attachments of the struts to the nodes, providing a complete sensation of continuity in the frame and allowing for protection of the most sensitive parts, which are precisely said attachments between struts and nodes.

[0053] By protecting the connection means between struts and nodes, a longer service life of the frame and a lower maintenance costs are obtained.

[0054] All this is achieved with an easy-to-place structural system that does not involve more connections, but rather correctly placed parts, so the cost does not significantly increase but the advantages that are obtained do.

[0055] Nor does the invention require the action of specialized technicians other than those technicians who connect the struts and nodes, so use of this system is neither complicated nor does it cost more.

[0056] Therefore, a simple and cost-effective system that protects and conceals connections between nodes and struts in a very effective manner is obtained.

Claims

1. Construction system for single-layer space frames, comprising a generating surface formed by means of a structural assembly of hollow struts (1) and nodes (2), wherein the nodes (2) have a central axis perpendicular to the tangent plane of the generating surface, a side connecting surface, and connection means for connecting the end of each of the struts (1) converging therein, **characterized in that** the nodes (2) are formed by a solid body, the side surface of which has connection planes (3) for the connection to each of the struts (1) converging in said node (2), respectively, wherein the connection means are arranged in each connection plane (3), each of said connection planes (3) being perpendicular to the axis of the strut (1) converging therein and having the same shape and dimensions as the section of said strut (1), and it comprises covering means for covering the connection means in each of the connection planes (3).
2. Construction system for single-layer space frames according to claim 1, **characterized in that** the covering means are formed by at least one overlapping cover (6) formed by means of a portion of a strut having the same section as the strut (1) that is connected to said plane, respectively, the depth of the overlapping cover (6) being such that it is suitable for containing therein the part of the connection means arranged externally with respect to the strut (1) and the node (2), wherein said overlapping cover (6) has a first end (7.1) for being attached to the connection plane (3) with a first laminar plate (8) fixed thereto and an open opposite second end (7.2).
3. Construction system for single-layer space frames according to claim 2, **characterized in that** the connection means are formed by at least two threaded holes (4) in each connection plane (3) and screwing elements (5.1, 5.2) therein.
4. Construction system for single-layer space frames according to claims 2 and 3, **characterized in that** the overlapping cover (6) comprises passage means for the passage of the screwing elements (5.1, 5.2), formed by a first hole (11) in the first laminar plate (8), close to a first side (12.1) thereof for the passage of a first screwing element (5.1), wherein said first hole (11) is open towards a second side (12.2) of the first laminar plate (8), opposite the first side (12.1).
5. Construction system for single-layer space frames according to claim 4, **characterized in that** the overlapping cover (6) has a portion (13) of one side thereof that is open, said side being opposite the side close to the first screwing element (5.1).
6. Construction system for single-layer space frames according to any of claims 4 and 5, **characterized in that** the covering means comprise a second laminar plate (14) suitable for being fitted inside the overlapping cover (6), wherein said second laminar plate (14) has passage means for the passage of the screwing elements (5.1, 5.2) formed by a second hole (15) close to a first side (16.1) thereof for the passage of a first screwing element (5.1), wherein said second hole (15) is open towards a second side (16.2) of the second laminar plate (14), opposite the first side (16.1).
7. Construction system for single-layer space frames according to any of the preceding claims, **characterized in that** the covering means comprise a closure element (17) of the second open end (7.2) of the overlapping cover (6), formed by a planar body having a closed section, having a first face (18.1) with the same section as the overlapping cover (6) and an opposite second face (18.2) the contour of which has an offset (19) with respect to the contour of the first face (18.1).
8. Construction system for single-layer space frames according to claim 7, **characterized in that** the covering means comprise a closing edge (20) suitable for being fitted in the offset (19) of the contour of the second face (18.2) of the closure element (17).
9. Construction system for single-layer space frames according to any of the preceding claims, **characterized in that** each screwing element (5.1, 5.2) comprises two nuts (9), the depth of the overlapping cover (6) being such that it is suitable for containing therein said two nuts (9) for each threaded hole (4).

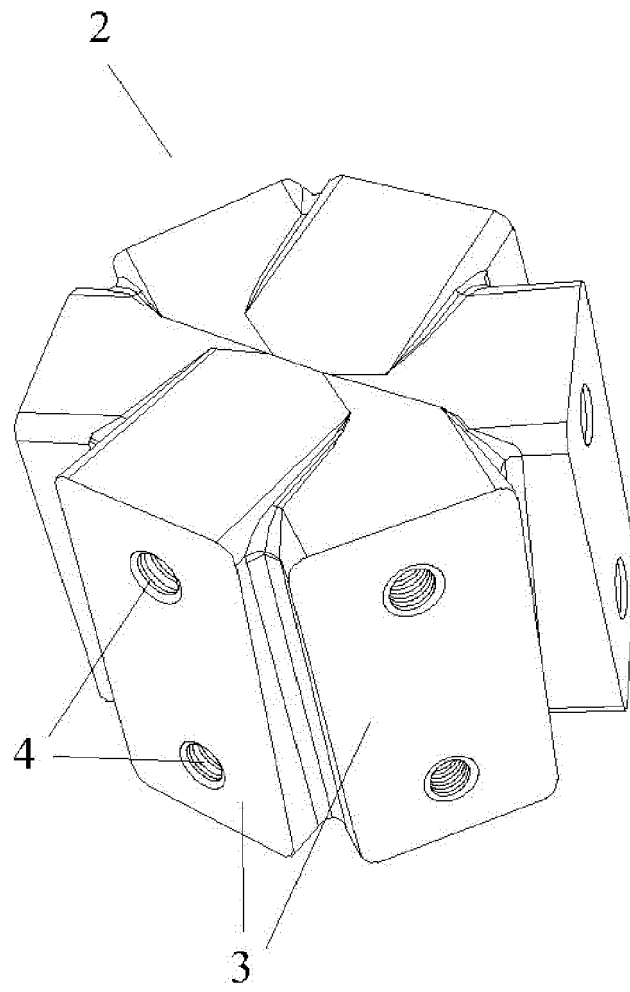


Fig. 1

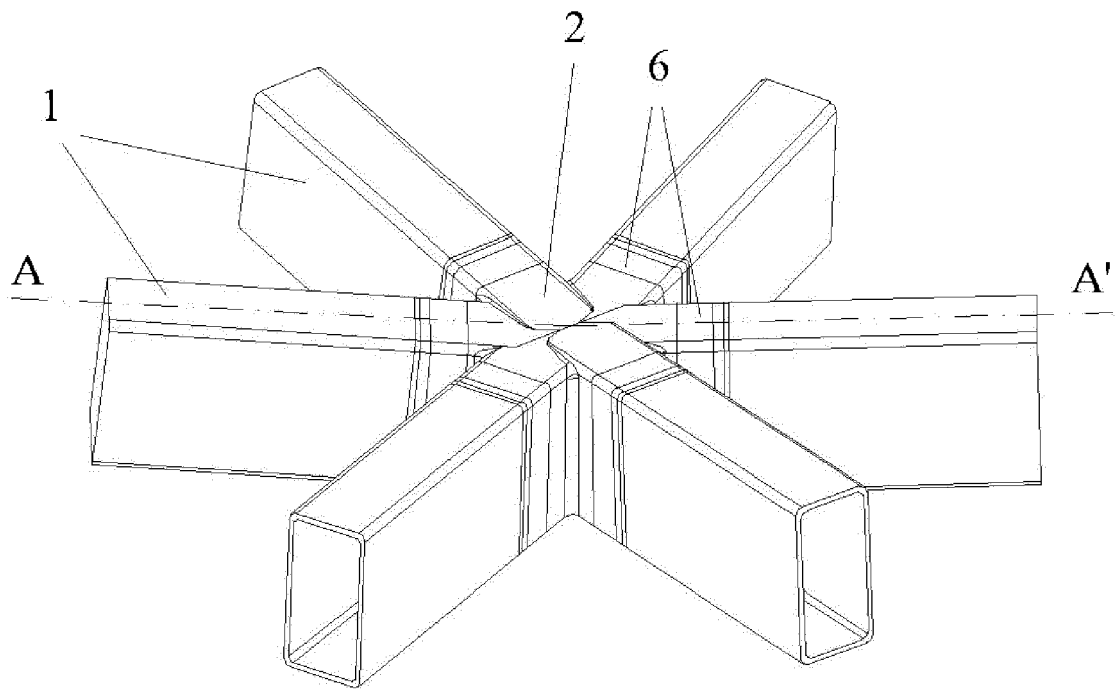


Fig. 2

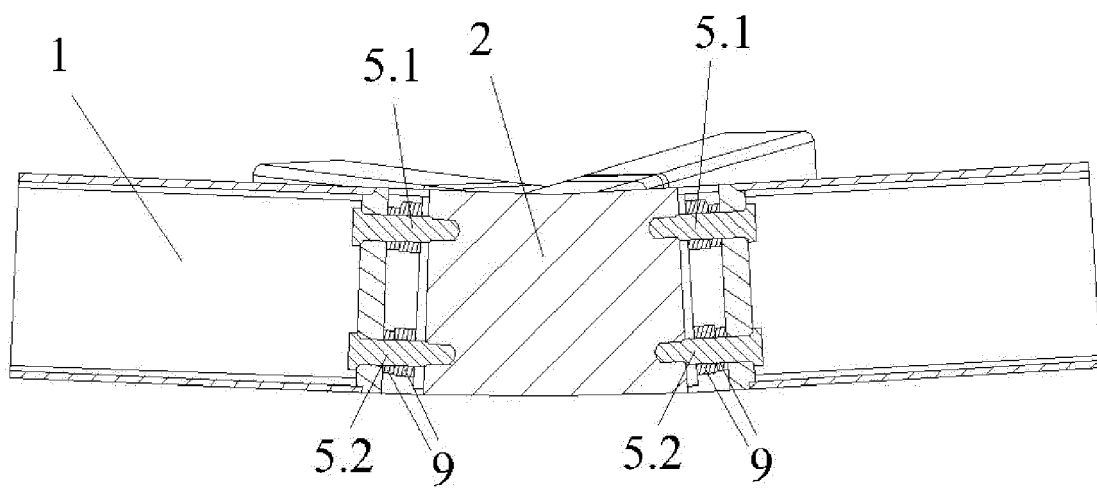


Fig. 3

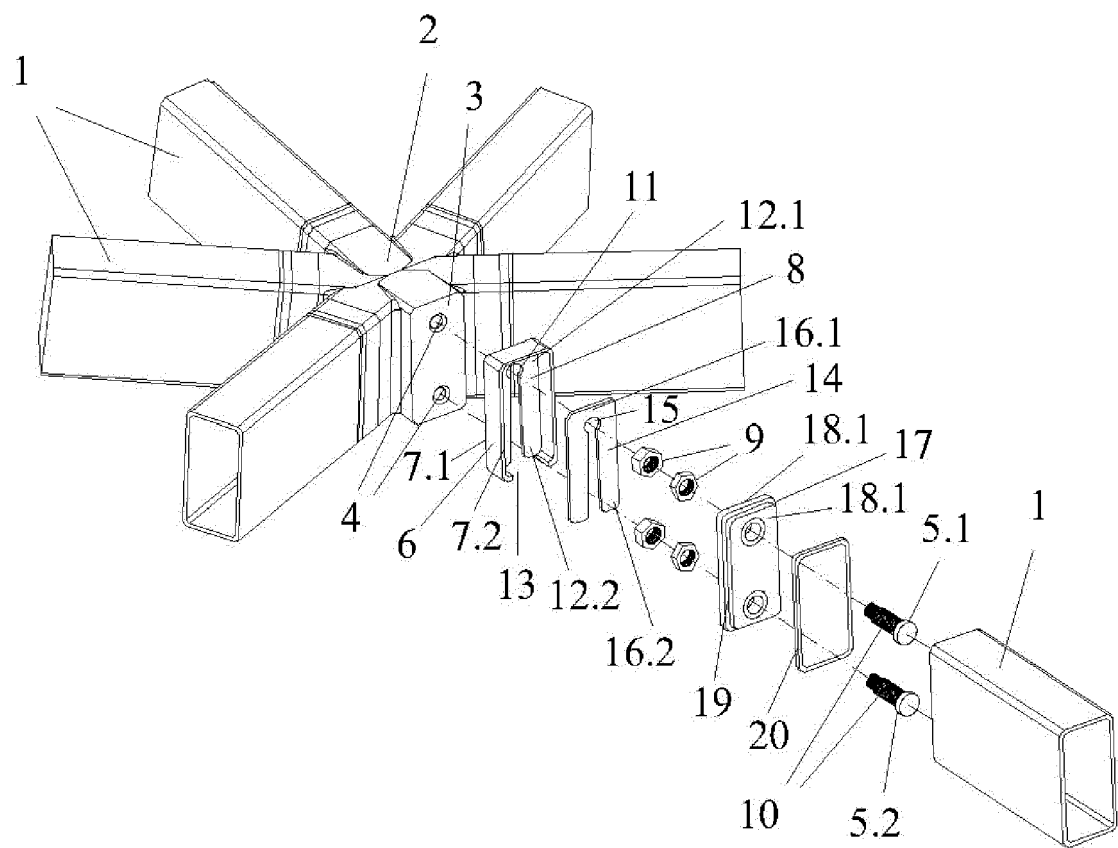


Fig. 4



EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 August 2018	Examiner Melhem, Charbel
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17-08-2018

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