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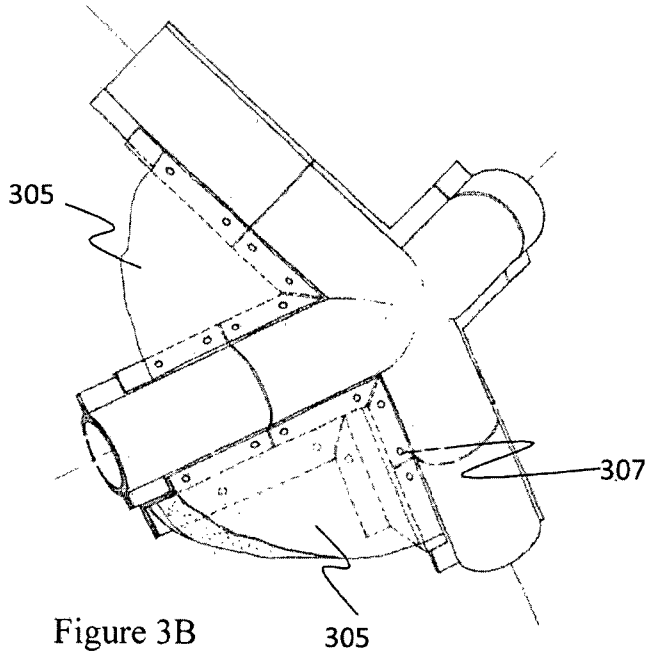


Figure 3B

(57) Abstract: A building system comprising a plurality of tubes, a plurality of connection nodes comprising tubular sections for connection to the tubes, wherein the tubes are arranged to connect between the connection nodes to form a frame for a building, wherein at least one continuous cavity is formed through at least a portion of the nodes and tubes when the nodes and tubes are connected, the building system further comprising fluid tight seals between the tubes and connection nodes to enable fluid to flow through the at least one continuous cavity.

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BUILDING SYSTEM AND PANEL FOR A BUILDING SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to building system and panel for a building system. In particular, the present invention relates to a building system with a frame that enables fluid to flow there through, a building system with a tensile element, a composite panel for a building system, a building system with a platform structure, and a building system that defines at least one human useable zone.

BACKGROUND

[0002] Known building systems revolve around the assembling of various materials in a particular manner on a chosen site to form the building, which is then used as a human useable zone. For example, the human useable zone may be a home, house, apartment, collection of homes and/or apartments, one or more office buildings, shelter(s), office block(s), temporary building structure(s), hangar(s), storage area(s), stadiums, grandstands or other defined space in which people may utilise the space internal or external to the frame of the building for their desired needs.

[0003] For example, the basic bricks and mortar system requires the bricks to be delivered and laid using cement in a specified manner to create the basic outline of the building, additional items and processes are then applied to gradually build the premises at the site. This requires all the materials to be delivered separately to the site and for a large amount of man power to be used for the separate processes in order to produce the desired structure.

[0004] Modular systems have been developed, which utilise multiple components that fit together to form a shell. However, these systems generally are not easily adaptable and therefore generally provide a fixed solution. Further, these types of systems may only be structurally sound

when the structure is formed as a single level resulting in structural and design limitations.

[0005] An object of the present invention is to provide an improved building system that provides flexibility in configurations. A further object of the present invention is to provide improved structural stability for building systems. Each object is to be read distinctively with the object of at least providing the public with a useful choice.

[0006] The present invention aims to overcome, or at least alleviate, some or all of the afore-mentioned problems.

[0007] Further objects and advantages of the invention will be brought out in the following portions of the specification, wherein the detailed description is for the purpose of fully disclosing the preferred embodiment of the invention without placing limitations thereon.

[0008] The background discussion (including any potential prior art) is not to be taken as an admission of the common general knowledge in the art in any country. Any references discussed state the assertions of the author of those references and not the assertions of the applicant of this application. As such, the applicant reserves the right to challenge the accuracy and relevance of the references discussed.

SUMMARY

[0009] It is acknowledged that the terms "comprise", "comprises" and "comprising" may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, these terms are intended to have an inclusive meaning - i.e. they will be taken to mean an inclusion of the listed components that the use directly references, but optionally also the inclusion of other non-specified components or elements. It will be

understood that this intended meaning also similarly applies to the terms mentioned when used to define steps in a method or process.

[00010] It will be understood that, when describing various integers, such as modules, components, elements etc., any integer may be constituted by a single integer or multiple integers.

[00011] According to one aspect, the present invention provides a building system comprising a plurality of tubes, a plurality of connection nodes comprising tubular sections for connection to the tubes, wherein the tubes are arranged to connect between the connection nodes to form a frame for a building, wherein at least one continuous cavity is formed through at least a portion of the nodes and tubes when the nodes and tubes are connected, the building system further comprising fluid tight seals between the tubes and connection nodes to enable fluid to flow through the at least one continuous cavity.

[00012] According to a further aspect, the present invention provides a building system comprising a plurality of tubes, a plurality of connection nodes comprising tubular sections for connection to the tubes, and at least one tensile element, wherein the tubes are arranged to connect between the connection nodes to form a frame, and the frame forms at least part of a human useable zone of predetermined size, shape and geometry, wherein a continuous cavity is formed through at least a portion of the tubular sections and tubes when the tubular sections and tubes are connected, the cavity arranged to receive the at least one tensile element, wherein the tensile element is attached between at least two points on the frame for countering tension in the frame.

[00013] According to yet a further aspect, the present invention provides a building system comprising a plurality of connection nodes, a plurality of tubes, and a platform structure, wherein the tubes are arranged to connect between the connection nodes to form a frame, the tubes comprise at least one planar portion extending from an outer

circumference of the tubes in a direction that is substantially perpendicular to the tangent of the outer circumference, and the platform structure is attached to the at least one planar portion of at least two tubes, wherein at least a portion of the connection nodes comprise at least three extending portions that are arranged to connect with at least three tubes to form the frame.

[00014] According to yet a further aspect, the present invention provides a composite panel for a building system, the panel comprising at least two panel portions, wherein each of the at least two panel portions comprises a first metal outer layer, a second metal outer layer, and a foam core positioned in between the first and second metal outer layers, wherein first and a second panel portions are bonded together to form the composite panel having an inner surface and an outer surface, and the panel is adapted for use as a flooring component of a building structure.

[00015] According to yet a further aspect, the present invention provides a building system comprising a plurality of connection nodes, a plurality of tubes, and a plurality of panels, wherein the tubes are arranged to connect between the connection nodes to form a frame, and the panels are attachable to the frame to define at least one human useable zone of predetermined size, shape and geometry, wherein at least a portion of the connection nodes comprise at least two extending portions that are arranged to connect with at least two tubes, and the at least two extending portions are positioned at an angle of 135 degrees relative to each other to form the frame having an octagonal plan cross-section, wherein the tubes comprise a planar portion extending from an outer circumference of the tubes in a direction that is substantially perpendicular to the tangent of the outer circumference, and the planar portion forms a panel attachment surface for attachment to the panels.

BRIEF DESCRIPTION OF THE DRAWINGS

[00016] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

[00017] Figures 1A to 1C show a connection node according to an embodiment of the present invention;

[00018] Figures 1D to 1E show a further connection node according to an embodiment of the present invention;

[00019] Figure 2 shows a connector element according to an embodiment of the present invention;

[00020] Figures 3A and 3B show a connection node with connector elements according to an embodiment of the present invention;

[00021] Figures 4A to 4L show cross sectional views of various connector element configurations according to various embodiments of the present invention;

[00022] Figures 5A and 5B show examples of a frame structure according to an embodiment of the present invention;

[00023] Figures 6A to 6F show various composite panel arrangements according to an embodiment of the present invention;

[00024] Figures 7A to 7D show attachment elements according to an embodiment of the present invention;

[00025] Figure 7E shows an example of how attachment elements are attached to connection nodes and connector elements according to an embodiment of the present invention.

[00026] Figures 8A to 8D show attachment elements in use within a building system according to an embodiment of the present invention;

[00027] Figure 8E shows a flooring system according to an embodiment of the present invention.

[00028] Figure 9A shows a first configuration of two frames connected together according to an embodiment of the present invention;

[00029] Figure 9B shows a second configuration of two frames connected together according to an embodiment of the present invention;

[00030] Figure 9C shows a frame incorporating separation zones according to an embodiment of the present invention;

[00031] Figure 9D shows a plurality of frames with separation zones orientated in a vertical direction according to an embodiment of the present invention;

[00032] Figure 9E shows a plurality of frames with separation zones orientated in a horizontal direction according to an embodiment of the present invention;

[00033] Figure 9F shows a plurality of frames attached to a further frame with separation zones orientated in both a horizontal and vertical direction according to an embodiment of the present invention;

[00034] Figure 9G shows a first configuration of a floor section of a frame according to an embodiment of the present invention;

[00035] Figure 9H shows a second configuration of a floor section of a frame according to an embodiment of the present invention;

[00036] Figures 10A to 10E show various geometrical arrangements based on the configuration shown in figure 9B according to an embodiment of the present invention;

[00037] Figures 10F to 10J show various geometrical arrangements based on the configuration shown in figure 9A according to an embodiment of the present invention;

[00038] Figures 11A and 11B show a tensile system according to an embodiment of the present invention.

[00039] Figures 12A to 12C show an expandable roofing and flooring system according to an embodiment of the present invention.

[00040] Figures 13A to 13C show a fluid system according to an embodiment of the present invention.

[00041] Figures 14 shows a platform system according to an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

First Embodiment

[00042] The following description describes various components and elements that are used to form one or more building structures according various embodiments.

[00043] Figures 1A and 1B show an example of a connection node 101 from opposing sides. According to this embodiment, the connection node is a casting made from aluminium. It will be understood that the connection node may be made from other suitable materials and using other suitable manufacturing methods, such as metal extrusions for example.

[00044] The connection node 101 shown in figure 1A and figure 1B is one example of several different forms that the connection node may have. This particular example has five extending portions 103A to 103E that extend from a common point on the connection node.

[00045] It will be understood that the connection nodes may have at least two extending portions, for example two, three, four, five or six extending portions, that extend from a common point on the connection node. However, the distance between the common central connection point and the end of each extending portion is a fixed distance regardless of the number of extending portions. As shown in Figure 1C, according to this embodiment, the distance between the point of central connection (common point) 111 and the end of each extending portion (i.e. the point on the extending portion that comes into contact with a further connection) is 185 mm. It will be understood that this length may be varied to form different sized structures, but that the chosen length must be the same for all extending portions in any one structure.

[00046] The angles between the extending portions will vary depending on the configuration of the connection node. However, it is important to note that in order to define the shape of the final construction of certain embodiments and enable all parts of the system to fit together, various extending portions within some of the connector nodes are positioned at defined angles. For example, as can be seen in figures 1A and 1B, various extending portions (e.g. 103A and 103D) are positioned at an angle of 135° from each other (using the point of central connection as a reference point). It will become apparent that the angle 135° is important as it relates to an octagon shape, which is the cross sectional shape of the formed frames according to this embodiment and so forms a frame having an octagonal plan cross-section.

[00047] It can also be seen that other extending portions (e.g. 103A and 103C) are positioned at right angles to each other.

[00048] Each of the extending portions has a hollow interior and a circular cross-section having an outer diameter of approximately 101.6 mm and an inner diameter of approximately 93.6 mm. Thus the walls of the extending portions have a thickness of approximately 4mm. It will be understood that these dimensions are approximate and that, as an alternative, the inner and outer diameters may be varied.

[00049] Planar portions 105A to 105D (fins) are formed on the connection node such that they extend substantially perpendicular to the tangent of the outer circumference of the extending portions 103. The fins provide a panel attachment surface for attaching panels as described in more detail below.

[00050] The distal end of each extending portion has an outer diameter that is smaller than the outer diameter of the remaining part of the extending portion. This end of the extending portion forms a male interface 109 that corresponds with a female interface on a connector element (interconnecting tube) as described below. A groove is provided around the circumference of the male interface 109 to receive an O-ring 107. The O-ring seal provides a waterproof seal at the point where the extending portion connects to the connector element.

[00051] The orientation of each of the extending portions (103A to 103E) relative to the common point on the connection node is chosen to define the overall geometry of the building structure, as will become apparent below.

[00052] As explained above, further configurations of connector nodes are also provided having fewer or more extending portions extending from the common point on the connection node.

[00053] Figure 2 shows a connector element 201 according to this embodiment. The connector element is a tube with a hollow interior. Each connector element has a circular cross-section having an outer diameter

of approximately 101.6 mm and an inner diameter of approximately 93.6 mm. Thus, the walls of the connector elements have a thickness of approximately 4 mm. It will be understood that these dimensions are approximate and that, as an alternative, the inner and outer diameters may be varied.

[00054] The lengths of the connector elements may vary depending upon their position within the building structure. For example, the connector elements may be anywhere between 0.5 metres and 2 metres long. Preferably, according to this embodiment, the connector elements are formed having four different lengths. The connecting elements may be 730 mm, 1185 mm, 1535 mm or 1830 mm depending upon the position within the structure that the connector elements are being placed.

[00055] A female interface 203 that corresponds with the male interface 109 on the connector nodes is formed on each end of the tube. An internal surface 205 of the female interface provides a sealing surface that cooperates with the O-ring seal 107.

[00056] Further, each connector element 201 has two planar portions 207 (fins) that extend substantially perpendicular to the tangent of the outer circumference of the connector element in the same manner as the fins described above in relation to the connection nodes.

[00057] Figures 3A and 3B show a connection node 101 with a number of connector elements (tubes) 201 attached to the connection node. That is, the female interfaces of the tubes are engaged with the male interfaces of the extending portions on the connection nodes.

[00058] According to figure 3A, it can be seen that the orientation of the tubes with respect to the connection nodes is such that the fins 105 on the connection nodes and the fins 207 on the tubes are joined together and aligned (301) to provide a substantially continuous panel attachment surface 303 for attaching panels as described below.

[00059] Referring to figure 3B, a portion of a panel 305 is shown connected to a portion of the panel attachment surface 303. The panel 305 is attached to the fins (105 and 301) on the connection node and tubes respectively using connectors 307, such as rivets. Further details of how the panels are connected are provided below.

[00060] Figures 4A to 4L show cross sectional views of various configurations of connector elements (tubes) that may be used to form the building structure. Each connector element has an outer diameter of approximately 101.6 mm and an inner diameter of 93.6 mm, in the same manner as the connection nodes. Each tube has an internal channel 401.

[00061] Further, each of the fins extends approximately 25 mm from the outer surface of the tube and has a width of approximately 4 mm. It will be understood that these dimensions are approximate and that, as an alternative, the inner and outer diameters may be varied.

[00062] The various configurations shown in figures 4A to 4L vary by way of the number of fins and the relative positioning of the fins around the outer circumference of the tube.

[00063] Figure 4A shows a basic tube with no fins. Figure 4B shows a tube with a single fin 105. Figure 4C shows a tube with two fins 105, where the fins are diametrically opposed to each other. Figure 4D shows a tube with two fins 105 where the fins are separated around the outer circumference of the tube by 90°.

[00064] Figure 4E shows a tube with three fins 105 where a first and second fin is separated by 90°, a third fin is separated from the second fin by 90° and the first fin by 180° around the circumference of the tube.

[00065] Figure 4F shows a tube with three fins 105 where a first and second fin are separated by 90°, and a third fin is separated from the first and second fins by 135°.

[00066] Figure 4G shows a tube with two fins 105, where the fins are separated by 144.74°.

[00067] Figure 4H shows a tube with two fins 105, where the fins are separated by 135°.

[00068] Figure 4I shows a tube with three fins 105 where a first and second fin are separated by 90°, and a third fin is separated from the second fin by 144.74° and separated from the first fin by 125.26°.

[00069] Figure 4J shows a tube with three fins 105, where a first and second fin are diametrically opposed to each other, and a third fin is separated from the first fin by 35.26° and separated from the second fin by 144.74°.

[00070] Figure 4K shows a tube with three fins 105, where a first and second fin are separated by 90°, and a third fin is separated from the first fin by 35.26 ° and the second fin by 125.26°.

[00071] Figure 4L shows a tube with four fins 105, where a first and second fin is separated by 90°, a second and third fin is separated by 90° where the first and third fin are separated by 180°. Further, the fourth fin is separated from the first fin by 35.26° and the second fin by 125.26°,

[00072] Although the above defined angular specifications are required for the specific geometric structure as described herein for this embodiment, it will be understood that, as an alternative, the angular measurements may be adjusted for different geometric configurations. Further, it will be understood that the measurements provided are approximate based upon standard tolerances.

[00073] Figures 5A and 5B show examples of a basic frame structure 501 according to this embodiment. The frame is made up of 28 connector nodes 101. Each connector node is connected to at least one other

connector node via a tube 201. A total of 64 tubes are provided according to this configuration. Although not clearly shown in figures 5A and 5B, it will be understood that the tubes shown in figures 5A and 5B include fins that extend from the outer circumference of the tubes to provide panel attachment surfaces as shown in figure 3A and 3B.

[00074] The basic frame structure forms a shape, which, if in solid form, is known as an Elongated Square Gyrobicupola, or the 37th Johnson Solid. By connecting the connection nodes, tubes and panels together a human useable zone of predetermined size, shape and geometry is created within the boundary of the frame. This zone is predetermined based on the chosen geometry and size of the connection nodes, tubes and panels.

[00075] It can be seen that the areas bounded by the outer tubes provide panel attachment areas at various positions around the outer perimeter of the frame 501. That is, panels that are substantially rectangular or triangular in shape (i.e. plan view) may be attached to these panel attachment areas. For example, a first panel attachment area 503 is suitable for a wall panel. A second panel attachment area 505 is suitable for a ceiling panel. A third panel attachment area 507 is suitable for a floor panel.

[00076] Referring to figure 5B, a space 509 is provided underneath the panel attachment areas being used for attaching the floor panels. The space 509 may be used, for example, as a utility space for placing electrical and communication cabling, gas and water pipes and other utility works throughout the building structure.

[00077] It can be seen, that the frame has eight outer panel attachment surfaces around the central portion of the frame, which is effectively shaped like an octagon when viewed from above. Four of those surfaces are side surfaces 511, and the other four are corner surfaces 513.

[00078] Figure 6A shows a profile view of a composite panel 601 according to this embodiment. The composite panel includes two separate panels that are joined together.

[00079] A first panel is formed from an outer metal layer 603, a foam layer 605 and a second metal layer 607. The first metal layer 603 and foam layer have substantially the same x, y dimensions. The second metal layer 607 is slightly larger than the first layer (and the foam) to provide an overlapping metal area.

[00080] A second panel is formed from an outer metal layer 609, a foam layer 611 and a second metal layer 613. The second metal layer of the first panel is attached or bonded to the first metal layer of the second panel to form the composite panel.

[00081] It will be understood that the metal layers may be formed from any suitable metal, such as aluminium or steel for example. Further, it will be understood that the foam layers are formed from any suitable foam material, such as polyurethane foam. Further, the foam material may have fire retardant properties.

[00082] Figure 6B shows a cross sectional view of the composite panel. The same reference numerals as in figure 6A are used to show the same components. Further, according to this embodiment, the first and second panels are bonded together using any suitable metal adhesive 615. However, it will be understood that the first and second panels may be bonded together using any other suitable attachment means.

[00083] Figure 6C shows a composite panel that has been specifically adapted for the provision of services within the structure being formed. A service furrow or channel 617 is formed within the composite panel to enable services pipes, plumbing, cabling, wiring or conduits 619 to be provided within the channel. As shown in figures 6D to 6F various different connection elements or outlets may be specifically attached to a

front or rear surface of a composite panel, such as an electrical switch outlet 621, electrical power outlet 623 and a utility outlet 625, such as a water, gas or any other suitable utility outlet. For example, the outlet may be used to connect one or more of a light element, media communications socket, internal or external water pipe, utility meter, air conditioning unit, alarm system, intelligent home control system etc.

[00084] The composite panel may be used to form a part of the inner or external walls, floor or sealing of the structure being built.

[00085] Figures 7A to 7D show attachment elements (clips) for attaching the panels to the fins on the connection nodes and tubes. Four different types of attachment elements are provided according to this embodiment.

[00086] Figure 7A shows a cross section of a first clip 701A. The clip includes a planar member 703, with an extending member 705 extending from the planar member at an angle that is substantially perpendicular to the longitudinal surface of the planar member. The extending member 705 is located approximately halfway across the width (as viewed in figure 7A) of the planar member 703. The width of the planar member is substantially 60 mm and the thickness is substantially 3 mm. The height of the extending member (i.e. the distance it extends from the planar member) is substantially 25 mm and the thickness is substantially 4 mm.

[00087] Figure 7B shows a cross section of a second clip 701B. The clip includes a planar member 707, with a first extending member 709 extending from the planar member at an angle that is substantially perpendicular to the longitudinal surface of the planar member. A second extending member 711 also extends from the planar member at an angle that is substantially perpendicular to the longitudinal surface of the planar member. The first and second extending members are substantially parallel to each other and separated by approximately 5 mm to form a channel 712 that is arranged to receive a corresponding fin. The width of

the planar member is substantially 61 mm and the thickness is substantially 3 mm. The height of each of the first and second extending members (i.e. the distance they extend from the planar member) is substantially 24 mm and their thickness is substantially 3 mm.

[00088] Figure 7C shows a cross section of a third clip 701C. The clip includes a planar member 713, with a first extending member 715 extending from the planar member 713 from a first distal end of the planar member. The first extending member 715 extends in a first direction which is substantially perpendicular to a first longitudinal surface of the planar member. A second extending member 717 extends from the planar member 713 from a second distal end opposing the first distal end of the planar member. The second extending member 717 extends in a second direction (opposite to the first direction) which is substantially perpendicular to a second longitudinal surface opposing the first longitudinal surface (i.e. on the opposite side) of the planar member. The second extending member and first extending member are substantially parallel to each other. A third extending member 719 also extends in the second direction separated from the second extending member by approximate 5 mm to form a channel 720 that is arranged to receive a corresponding fin.

[00089] Figure 7D shows a cross section of a fourth clip 701D. The clip includes a planar member 721, with a first extending member 723 and second extending member 725. The first and second extending members are substantially positioned in the same location, and have the same dimensions, as the first and second extending members of the third clip described above.

[00090] Regarding the first and fourth clips described above in relation to figures 7A and 7D, the fins may be attached to any part of the extending member(s) or planar members. Regarding all of the clips described above, the fins may be attached to the clips using any suitable

attachment means, such as a rivet. Each of the clips shown is approximately 600 mm in length.

[00091] The clips shown in figures 7B and 7C are used, for example, to connect the cast corner nodes to the connector elements as shown in figure 7E. For example, clip 701B is used to connect the frame when a window or door element is to be provided within an opening. Clip 701C is used when a solid composite foam panel is to be introduced into that portion of the frame.

[00092] The clips shown in figures 7A and 7D are also used to connect elements together, such as panels to panels, or panels to door and/or window frames as discussed in more detail below with reference to figures 8C and 8D.

[00093] Referring to figure 7E, in order to connect a corner (substantially perpendicular) portion of a connection node 101 to a connector element 201 (via the fins), three clips (Connector 1, 2 and 3) are used including two end clips 727A and 727B and a single central clip 729. The total length of the three connectors when attached to the fins is equal to the length of the opening along the connection nodes and connector element. According to this embodiment, the clips are riveted to the connection nodes in the corners, to the connector elements in between the two corner nodes and also through the metal layers of the composite panels to provide a braced panel for the frame.

[00094] Figures 8A and 8B show attachment elements in use in various scenarios.

[00095] Referring to figure 8A, a typical section through the frame is shown. A tube 201 such as that shown in figure 4H includes fins 105 that are provided within a channel within the clips 701C. The fins are attached to the clips using rivets 801. A finish in the form of gyprock (or similar) 803 is also provided.

[00096] Referring to figure 8B, a typical section through a floor portion of the structure is shown. A tube 201 such as that shown in figure 4K includes fins 105 that are provided within a channel within the clips 701B and 701C. The fins are attached to the clips using rivets 801. An aluminium window section 805 is also connected to clip 701B via rivets. A prefinished surface 807, which according to this embodiment is an Alpolic TM surface, is also applied to the outer walls of the structure. A services channel 809 is provide in the gap between the composite panel and connector element to allow services (e.g. water, gas, electricity, communications etc.) to be provided.

[00097] Also shown within figures 8A and 8B are the composite panels 601 that are attached to the clips. Therefore, it can be seen that the panels may be attached to the fins of the tubes and connection nodes using the available clips. A further type of composite panel 811 is also provided. This composite panel is formed from a single foam layer with an inner and outer metal layer.

[00098] Figure 8B also shows a fibre cement layer 813 formed upon a floor panel 601. Upon the cement layer 813 is provided a carpet and underlay layer 815.

[00099] Referring to figure 8C, a vertically orientated panel 601A with an outer layer of Apolic 807 is connected to a horizontally orientated panel 601B using clips 701B and 701D. The clip 701B is attached to panel 601A though gyprock 803 via suitable attachment elements 802, such as screws for example. Clip 701D is attached to clip 701B by passing first extending member 723 into channel 712 (see figures 7B and 7D), and riveting the two clips together using rivet 801. Clip 701D is then attached to panel 601B via second extending member 725 using any suitable attachment mechanism.

[000100] Referring to figure 8D, a vertically orientated panel 601A is attached to a door frame 819 using clips 701B and 701A. Clip 701B is

attached to panel 601A through gyprock 803 via suitable attachment elements 802, such as screws for example. Extending member 705 of clip 701A is attached to clip 701B by passing the extending member 705 into channel 712 (see figures 7A and 7B), and riveting the two clips together using rivet 801. Planar member 703 of clip 701A is placed against a door frame 819 and attached using suitable attachment elements 802, such as screws for example. A door 821 and hinge 823 are also provided. Gyprock 803 is also provided to cover the clip arrangements along with architraves 817.

[000101] It will be understood that the above example of using a door frame and door assembly in figure 8D may equally be applicable to a window frame and window assembly.

[000102] Figure 8E shows a further example of composite panels being used as a flooring system. As can be seen in figure 8E a composite panel 601 (as described with reference to figures 6A and 6B) is attached between two tubes 201A/B using four attachment elements (clips). According to this example, the composite panel measures 2.1 metres by 2.1 metres. In this example, each of the four clips is as described with reference to figure 7C. Also, the tubes used are as described with reference to figure 4C. However, it will be understood that one or more tubes as described with reference to figure 4B may also be used in positions on the flooring system where only a single composite panel is to be attached, such as at the perimeter of a floor. A flooring surface 813 may then be placed upon, attached or affixed to the panels using any suitable techniques. For example, the flooring material may be FC (fibre cement) sheeting or similar.

[000103] It can be seen from figure 8E that the attachment elements have a channel formed therein between two opposing extending members (the first and third extending members) for receiving the relevant fin on the tubes. Further, the composite panel is attached to the first and second

extending members via a suitable attachment device such as a rivet or adhesive (such as glue), for example. The attachment elements are arranged against the composite panel such that the upper surface of the first extending member provides support to the overlapping metal area of the metal surface 607 on the composite floor panel, the upper surface of the second extending member provides support for the smaller surface area of the composite panel and the planar member of the clip abuts the edge of the smaller panel portion.

[000104] It will be understood that the flooring panels may also include channels formed therein for receiving one or more cables, wiring, pipes and plumbing as described herein.

[000105] Figure 9A shows a first configuration of two frames 501 connected together. The two frames are attached to each other via the side surfaces 901 of each of the frames.

[000106] Figure 9B shows a second configuration of two frames 501 connected together. The two frames are attached to each other via the corner surfaces 903 of each of the frames.

[000107] Figure 9C shows a frame incorporating separation zones. The basic frame structure 501 has additional components added to it in the form of tubes and connector nodes 905A to 905E to form separation zones or areas 907. The separation areas are provided to separate the main frame 501 from other attached main frames by a defined space 907. According to this view, it can be seen that the separation areas are provided above and below the main frame 501, as well as on each side surface of the main frame.

[000108] Figure 9D shows two sets of frames with separation zones orientated in a vertical direction. This configuration shows a first set 909 of individual frames 501A, 501B and 501C separated by two separation zones 907A and 907B. That is, first and second individual frames (501A

and 501B) are separated by a first separation zone 907A and second and third individual frames (501B and 501C) are separated by a second separation zone 907B.

[000109] A second set 911 of individual frames 501D and 501E are separated by a third separation zone 907C. A fourth separation zone 907D is formed on top of the individual frame 501D and a fifth separation zone 907E is formed on the bottom of the individual frame 501E.

[000110] The relative height of the two sets of frames is then offset to interlock the two sets such that the side surface of a frame abuts the side surface of a separation zone. The two sets of frames are joined by changing and sharing the interconnecting node connectors and tubes where the frames are being joined. Therefore the two sets of frames are joined via adjacent surface areas or zones 913. This interconnection provides an improved structural integrity to the entire building structure by forming vertical columns within the structure.

[000111] Figure 9E shows a plurality of frames with separation zones orientated in a horizontal direction in substantially the same offset manner as described above with reference to figure 9D. This provides a similar improved structural integrity to the building structure by forming horizontal braces within the structure.

[000112] Figure 9F shows a different method of providing interlocking frames. A frame system as described with reference to figure 9C has additional basic frame portions 501 attached to it by sharing connection nodes and tubes.

[000113] Figure 9G shows a first configuration of a floor section 911 with all horizontal supports 912 included in an X and Y orientation. Floor panel attachment areas 913 are provided. It will be understood that the panels are attached to the fins on the connection nodes and connector elements (tubes).

[000114] Figure 9H shows a second configuration of a floor section 911 where the Y orientated horizontal supports have been removed, leaving only the horizontal supports 912 oriented along the X-axis.

[000115] Once the full building structure frame has been put together and formed and all the required panels have been attached, the building structure may be tensioned at the appropriate place by running tensile elements through the cavities formed within the tubular sections and nodes. Upon tightening these tensile elements, tension in the frame is countered and the system is made structurally sound. For example, the tensile element(s) may be a tensile rod or a tensile cable. It will be understood that the tensile elements may be installed progressively as a way to hold the structure together during construction in cases where the panels are not yet sufficiently holding the structure together.

[000116] Figures 11A and 11B show further details of the tensioning system that may be incorporated in various embodiments of the herein described building system. For example, the tensioning system may be incorporated in the single pod examples as shown in figures 5A and 5B, or multiple pod system as shown in figures 9A to 9F. Further, the tensioning system may be used in the flooring system as shown in figures 9G and 9H, or a roofing and/or flooring system shown in figures 12A to 12C. It will be understood that various portions of the frame system may be analysed to determine whether they are compressive or in tension. When in tension, the tensioning system as described may be used through one or more of the cavities provided by the various elements of the system to counter the tensile force,

[000117] According to this example, a tensile element in the form of a cable 1101 made from steel or any other suitable tensioning material is passed through the cavity of any number of tubes and/or nodes until a first distal end is attached to the end of a tube 201, according to this example. The first distal end of the tensile cable passes through a central aperture

of an attachment device 1103. According to this example, the attachment device is a casting formed from any suitable material, such as aluminium or steel for example. The outer circumference of the attachment device matches the inner circumference of the tube 201 and slides into the tube cavity 203. A first side of a projection 1104 located around the outer periphery of the attachment device abuts the edge of the tube 201. A washer 1105 is placed over the tensile cable. The end of the tensile cable includes a thread for receiving a first nut 1107. The first nut is placed onto the thread and tightened until the cable is tensioned to a sufficient tension suitable to counter the tension forces in the frame. A second nut, a lock nut 1109, is then placed onto the thread to lock the first nut 1107 in position. A cap 1111 is then placed over the tensile cable attachment element 1103 until the edge of the cap abuts a second side (opposing the first side) of the projection 1104. As an alternative, a modified node may be used instead of a cap, where one of the extending portions of the node functions as a cap.

[000118] It will be understood that a fluid seal as described herein may also be placed inside the tube around the tensile element to provide a seal for any fluids that are to be introduced into the tube cavity.

[000119] As a further alternative, the cap may be replaced with a node 101 or a further tube.

[000120] It will be understood that one or both ends of the tensile element may be attached to a tube or a node. Further, it will be understood that the second distal end of the tensile element 1101 may be attached to a tube or node in the same manner as described above. Further, it will be understood that one or both ends of the tensile element may be adjustable for adjusting the tension. Where only one end of the tensile element is adjustable, the other end may be permanently affixed to the tube or node by any suitable means. It will further be understood that alternative mechanisms for attaching the tensile element to the frame

(whether a node or a tube) are envisaged, such as clamping and leveraging the tensile element.

[000121] Figures 10A to 10E show various geometrical arrangements based on the configuration shown in figure 9B. Figure 10A shows a full matrix of all the interconnecting elements (tubes) as a plan view looking through the structure. By passing through horizontal layers of the building structure, it can be seen that columns 1001 are formed as shown in figures 10B and 10C, which show the layout of the structure at different levels. Also, human useable spaces or zones 1003 are formed. By disconnecting internal portions of the frame structure, designers are able to modify the living/working areas created by the structure as seen in figure 10C, which is a plan view of a living space with the upper portion of the frame not shown. In other words, the human usable zone created by assembling the frame structure is further defined by removing certain internal elements of the frame structure. By keeping the column supports (and brace supports), the structural integrity of the building is maintained while at the same time providing flexibility for the internal design. Figures 10D and 10E show a slightly different configuration of frames to figures 10B and 10C to indicate how the zones may be altered.

[000122] Figures 10F to 10J show various geometrical arrangements based on the configuration shown in figure 9A. Figure 10F shows a full matrix of all the interconnecting elements (tubes) as a plan view looking through the structure. Figures 10G & 10H and figures 10I & 10J show two different configurations of frames identifying the column portions 1001 and human useable areas 1003 of the structure. The same principal as described above with reference to figures 10A to 10E applies.

Further Embodiments

[000123] It will be understood that the embodiments of the present invention described herein are by way of example only, and that various

changes and modifications may be made without departing from the scope of invention.

[000124] For example, it will be understood that the various elements and components of the herein described system may be used and/or modified to enable different shaped frames to be formed for different uses. For example, various different forms of building structure may be constructed, such as factory spaces, homes, offices, hangars, retail environments etc.

[000125] Figures 12A – 12C show how various elements of the system as described herein may be modified to construct a building with large roof spans, such as an aircraft hangar or stadium for example. According to this example, Figure 12A shows how two portions of a frame 1201 forming a floor structure 1203 and a roof structure 1205 may be connected together using four vertical tubes 1207. According to this example, the floor and roof structures maintain the octagonal cross sectional plan of the building system as described herein and are formed from the upper or lower portions of the pods described with reference to figures 5A and 5B with further interconnecting tubes and nodes to provide increased structural support and/or strength. The roofing and flooring structures are separated by a distance as defined by the length of the tubes 1207.

[000126] As can be seen in figure 12B, a number (three in this example) of floor and roof portions 1201A, B and C may be interconnected to provide a large longitudinal roofing and flooring structure. Figure 12C shows how the structure may be expanded using any number of further floor and roof portions (1201D, 1201E) to form any footprint required for the building.

[000127] The flooring and/or roofing structures described and as shown in the figures may also include the tensioning system described herein to counteract any tension within the structure. For example, the

roofing system may be in compression and the flooring system in tension, thus requiring the tension elements to be passed through the cavities formed in the tubular elements and nodes.

[000128] Further, cross braces may be provided between the vertical tubes 1207 to provide additional support for bracing the structure.

[000129] It will be understood that this large span roofing and flooring system may be used in conjunction with the platform system described herein to form stadiums and grandstands.

[000130] Figures 13A and 13B show a sealing system for a fluid flow system that may be applied to various embodiments of the herein described system. This fluid flow system may be used to enable fluid to flow through one or more continuous cavities formed through at least a portion of the nodes and tubular sections. The fluid may be any suitable gas or liquid. The term "continuous cavity" in this context means a cavity that flows through one element (such as a tube or node) to other elements unimpeded. It is not intended to necessarily mean that the cavity is formed in a loop, but may optionally include this. For example, the continuous cavity may flow from point A through two or more tubes and/or nodes to point B that is distinct from point A. As a further example, the continuous cavity may flow from point A through two or more tubes and/or nodes and back to point A via one or more fluid supply systems as described herein.

[000131] For certain gases or liquids (such as corrosive gases or liquids, or where certain gases or liquids are more prone to leaking) a suitable coating may be provided on the internal surface of the tubes or nodes to provide protection or extra sealing for the tubes and nodes. For example, a thin plastic layer may be coated on the internal surface.

[000132] As seen in figures 13A and 13B, a fluid tight seal 1301 is provided for use in a tube 201 of the herein described system. These

seals, or any other type of seal, may be positioned or placed at any point throughout the system to create and modify one or more continuous cavities within the frame.

[000133] According to the example shown in figures 13A and 13B, a tension element 1101 is also provided. However, it will be understood that the herein described fluid system does not necessarily require the inclusion of the tensioning system.

[000134] The disc like fluid tight seal 1301 is formed from one or more rubber based synthetic materials depending on the function of the seal and the type of fluid it is sealing. The seal is inserted within the tube at the appropriate place where the continuous flow of the fluid is to stop. The diameter of the seal is approximately the same diameter as the internal diameter of the tube 201. The outer edge 1302 around the periphery of the seal abuts the internal surface 1303 of the tube. At this stage, a fluid tight seal is not yet maintained. A number of wing nuts (1305A-C) are provided through apertures formed through the seal, whereupon tightening the wing nuts causes the seal to be compressed at the area where it is tightened and the outer edge 1307A of the seal to push up against the internal surface of the tube. Further, the surface 1307B of the seal resting against the tensioning element 1101 is also forced up against the tensioning element. This causes a fluid tight seal to be formed around the periphery of the seal against the internal surface of the tube, as well as around the aperture of the seal and the tensioning element (where used).

[000135] According to this embodiment, the seal includes a central aperture for receiving the tensioning element. It will be understood that, as an alternative, the seal may not have a central aperture where a tensioning element is not being used.

[000136] Figure 13C shows an example of a fluid supply system that enables fluid to be supplied and flow through one or more continuous cavities 401 formed through at least a portion of the tubes and tubular

sections. The fluid supply system includes a control unit 1309 that can selectively operate at least one pump 1311 that is in fluid communication via a fluid valve 1313 with a continuous cavity 401. The control unit includes a switching device that is adapted to switch the pump on or off and open and close the valve 1313 dependent upon a control input. The control input is a signal sent from a device 1319 that may be one or more of a temperature gauge, heat sensor, smoke detector and air conditioning control unit, for example. Upon activating the pump 1311 and opening the valve 1313, fluid 1317 stored in a fluid tank 1315 may then be pumped around the continuous cavity 401. It will be understood, that as an alternative, the fluid tank 1315 may be incorporated as part of the continuous cavity 401 to enable the fluid to recirculate.

[000137] For example, the fluid supply system may include cold water that may be circulated around a portion of the frame to provide a cooling mechanism. Also, the water may be pumped through water sprinklers upon detection of a fire from a smoke alarm, heat sensor or temperature gauge. The water sprinklers may be directly attached to one or more tubes and/or nodes. Also, the water may be pumped around portions of the frame to provide a mechanism for cooling the frame and potentially cooling a social space or work area formed by the frame upon detection that the temperature in a particular space has exceeded a pre-set value. As a further alternative, the fluid being pumped through or around a continuous cavity may be heated to provide a heating function for raising the temperature in a human useable zone.

[000138] According to a further example, the fluid may be a water and glycol mixture to provide a heat retardant function which aims to keep the water from freezing and so stop the aluminium frame from becoming too warm. This fluid mixture may be pumped around the system upon detection of a fire from a smoke alarm, heat sensor or temperature gauge, or merely during hot weather.

[000139] As a further alternative, additional cooling or heating devices may be incorporated to aid the cooling or heating of the fluid or fluid mixture such as air conditioning units or refrigeration units.

[000140] According to a further example, the fluid may be air. For example, a pump may be used to circulate air around portions of the frame. Various tubes may include outlets for providing ventilation into a social space or work area. As a further example, air conditioning units may be used to cool or heat the air being supplied to control the environment in the social space or work area.

[000141] As a further example, the continuous tubular system may be used to evacuate waste liquids from the building, such as storm water for example. That is, the storm water may be evacuated by activating a valve that allows the water to pass from guttering in fluid communication with the tubular system, through one or more tubes and/or nodes to be drained or stored for future use.

[000142] Internal portions of the frame may be coated to act as a container for the storage of high pressure compressed air, which can be stored and reused to drive mechanical devices such as fans, pumps and air conditioning units. The compressed air may be produced by vertical turbine wind generators which are an optional component within the tubular structure.

[000143] As a further example, separate containers may be added into the cavities within the frame structure. These fluid containers may be high pressure tanks, sewerage tanks, storm water detention tanks etc.

[000144] Air pressure within the system may be maintained by a column of liquid contained within another part of the same tubular structure. Water pressure within the system may be maintained by linking vertical tubular sections together, such that the higher the building the higher the water pressure for supply.

[000145] Figure 14 shows how various elements of the herein described system may be used to build platform and seating supports. For example, platform and seating supports may be provided for grandstands and stadiums, for example, where a human useable zone is provided external to the frame of the platform structure.

[000146] The tubular system may be reconfigured to create a structural system that will support platforms and seating for spectators in stadiums and other forms of grandstand. The specific geometry of the platform and seating supports as described herein may integrate with the tubular wall & roof systems and geometry of the building system as herein described. However, it will be understood that the specific geometry described above may be modified for use in a platform and/or seating system. For example, the angles between the extending portions from the nodes may be modified to provide a viewing platform for use in a stadium that is less than 45 degrees from the surface plane. This provides a suitable gradient upon which spectators may be located to enable each row in the platform arrangement to view what is happening on the surface.

[000147] Figure 14 shows a side view of a portion of a platform system integrating various components of the herein described building system, where this portion of the platform is repeated in the horizontal and vertical direction to provide platform system. A first tube 201A is attached between two nodes 101A and 101B. According to this example, the nodes may include three or four extending portions in a T-shape or X-shape configuration to allow tubes to be attached, where the extending portions are positioned at 90 degrees to each other and lie in the same plane (as shown in figures 1D and 1E. Further extending portions may be provided where needed to provide additional support, for example.

[000148] Figure 1D shows connection node 101C, which includes three extending portions 113A, 113B and 113C in a T-shape configuration. All three extending portions lie in the same plane. The first extending

portion 113A is separated from the second extending portion 113B by 90 degrees. The second extending portion 113B is separated from the third extending portion 113C by 90 degrees and the first extending portion 113A is diametrically opposed to the third extending portion 113C.

[000149] Figure 1E shows connection node 101D, which includes four extending portions 115A, 115B, 115C and 115D in an X-shape configuration. All four extending portions lie in the same plane. The first extending portion 115A is separated from the second extending portion 115B by 90 degrees. The second extending portion 115B is separated from the third extending portion 115C by 90 degrees. The third extending portion 115C is separated from the fourth extending portion 115D by 90 degrees. The fourth extending portion 115D is separated from the first extending portion 115A by 90 degrees. The first extending portion 115A is diametrically opposed to the third extending portion 115C. The second extending portion 115B is diametrically opposed to the fourth extending portion 115D.

[000150] Further tubes (including 201B & 201C) extend from the nodes 101A and 101B (see figure 14) as well as further nodes (not shown). It will be understood that any number of nodes and tubes may be used to extend the platform arrangement as described herein. According to this example, the tubes extending horizontally (201B, 201C) include two fins as described with reference to figure 4D.

[000151] According to this example, a platform structure having an L-shaped profile 1401 is provided. This structure may be made from steel or aluminium, for example. Additional supports in the form of gussets (1403A and 1403B) may be provided where needed. The platform structure 1401 includes a first surface 1405 against which a seat 1409 may be attached. A second surface 1407 of the platform structure 1401 is provided for spectators to walk upon. A first end of the platform structure is attached to a planar portion of a first tube 201B and a second end of the platform

structure is attached to a planar portion of a second tube 201C. The platform structure effectively forms a riser 1405 and a tread 1407, where the tread surface is sufficient enough for persons to move along the platform structure when a seat is provided.

[000152] It will be understood that the platform structure may incorporate tubes with only a single fin (such as described with reference to figure 4B) where those tubes are located at the upper or lower regions of the platform structure.

[000153] Further, it will be understood that a number of tubes with or without any fins may be provided in between various nodes to form the vertical elements of the platform structure.

[000154] Further, it will be understood that the platform structure may be made from a formed metal element that incorporates multiple stages of the platform. For example, the platform structure may have multiple risers and/or multiple treads, where a portion of the platform structure is formed to accommodate the tubular system of the frame.

Claims

1. A building system comprising a plurality of tubes, a plurality of connection nodes comprising tubular sections for connection to the tubes, wherein the tubes are arranged to connect between the connection nodes to form a frame for a building, wherein at least one continuous cavity is formed through at least a portion of the nodes and tubes when the nodes and tubes are connected, the building system further comprising fluid tight seals between the tubes and connection nodes to enable fluid to flow through the at least one continuous cavity.

2. The building system of claim 1 further comprising a fluid supply system, the fluid supply system comprising at least one pump in fluid communication with the at least one continuous cavity for pumping fluid around the at least one continuous cavity.

3. The building system of claim 2 further comprising a switching unit adapted to switch the pump on or off dependent upon a control input.

4. The building system of claim 3, wherein the control input is a signal from one or more of a temperature gauge, heat sensor, smoke detector and air conditioning control unit.

5. The building system of claim 1 wherein the fluid is a gas or liquid.

6. A building system comprising a plurality of tubes, a plurality of connection nodes comprising tubular sections for connection to the tubes, and at least one tensile element, wherein the tubes are arranged to connect between the connection nodes to form a frame, and the frame forms at least part of a human useable zone of predetermined size, shape and geometry, wherein a continuous cavity is formed through at least a portion of the tubular sections

and tubes when the tubular sections and tubes are connected, the cavity arranged to receive the at least one tensile element, wherein the tensile element is attached between at least two points on the frame for countering tension in the frame.

7. The building system of claim 6 wherein the frame forms at least part a roof structure, floor structure and wall structure.

8. The building system of claim 6 further comprising at least two tensile element attachment devices, wherein each of the at least two tensile element attachment devices is attached to a tube or connection node.

9. The building system of claim 8 further comprising a first tensile element attachment device for attaching a first distal end of the at least one tensile element to at least one tubular section or tube and a second tensile element attachment device for attaching a second distal end of the at least one tensile element to at least one tubular section or tube.

10. The building system of claim 6 further comprising a plurality of panels, wherein the panels are attachable to the frame to define the least one human useable zone.

11. The building system of claim 10 wherein at least a portion of the connection nodes comprise at least two extending portions that are arranged to connect with at least two tubes, and the at least two extending portions are positioned at an angle of 135 degrees relative to each other to form the frame having an octagonal plan cross-section.

12. The building system of claim 11 wherein the tubes comprise a planar portion extending from an outer circumference of the tubes in a direction that is substantially perpendicular to the tangent of the

outer circumference, and a planar portion that forms a panel attachment surface for attachment to the panels.

13. A building system comprising a plurality of connection nodes, a plurality of tubes, and a platform structure, wherein the tubes are arranged to connect between the connection nodes to form a frame, the tubes comprise at least one planar portion extending from an outer circumference of the tubes in a direction that is substantially perpendicular to the tangent of the outer circumference, and the platform structure is attached to the at least one planar portion of at least two tubes, wherein at least a portion of the connection nodes comprise at least three extending portions that are arranged to connect with at least three tubes to form the frame.

14. The building system of claim 13, wherein the platform structure provides a first surface for attaching a seat and a second surface for providing a walking area.

15. The building system of claim 13, wherein the platform structure further comprises a seat attached to a first surface of the platform structure.

16. The building system of claim 13, wherein the platform structure further comprises one or more supporting structures.

17. The building system of claim 13, wherein the frame defines a seating or platform area for a stadium.

18. The building system of claim 13, wherein the at least two extending portions are positioned at an angle of 135 degrees relative to each other.

19. A composite panel for a building system, the panel comprising at least two panel portions, wherein each of the at least two panel

portions comprises a first metal outer layer, a second metal outer layer, and a foam core positioned in between the first and second metal outer layers, wherein first and a second panel portions are bonded together to form the composite panel having an inner surface and an outer surface, and the panel is adapted for use as a flooring component of a building structure.

20. The panel of claim 19, wherein at least one of the panel portions comprises one or more channels formed therein for receiving one or more of cables, wiring, pipes, and plumbing

21. The panel of claim 20 further comprising connection elements for connecting further cables, wiring, pipes and plumbing.

22. The panel of claim 19, wherein the foam core comprises polyurethane foam.

23. A flooring system comprising a plurality of composite panels as claimed in claim 19 for placing a flooring surface thereupon, the flooring system further comprising a plurality of tubes and a plurality of attachment elements, wherein the tubes comprise at least one planar portion extending from an outer circumference of the tubes in a direction that is substantially perpendicular to the tangent of the outer circumference, and the planar portion forms a composite panel attachment surface for attachment to the composite panel by the attachment elements.

24. The flooring system of claim 19 wherein the plurality of tubes includes at least two tubes comprising at least two planar portions, wherein the two planar portions are diametrically opposed to each other.

25. The flooring system of claim 19, wherein the attachment elements comprise a channel for receiving the planar portion.

26. The flooring system of claim 25, wherein the channel of the attachment elements is formed between two extending members attached to a planar member of the attachment element.

27. The flooring system of claim 19, wherein the attachment elements comprise a planar member and a first, second and third extending member, wherein the planar member abuts a side of the composite panel, the first and second extending members are attached to the composite panel, and the first and third extending members are attached to the planar portion.

28. The flooring system of claim 19, wherein the attachment elements comprise a planar member, and a first, second and third extending member, wherein the first extending member extends from the planar member from a first distal end of the planar member, and extends in a first direction which is substantially perpendicular to a first longitudinal surface of the planar member, wherein the second extending member extends from the planar member from a second distal end opposing the first distal end of the planar member, and the second extending member extends in a second direction, opposite to the first direction, which is substantially perpendicular to a second longitudinal surface opposing the first longitudinal surface of the planar member, and wherein the second extending member and first extending member are substantially parallel to each other, wherein the third extending member extends in the second direction separated from the second extending member.

29. A building system comprising a plurality of connection nodes, a plurality of tubes, and a plurality of panels, wherein the tubes are arranged to connect between the connection nodes to form a frame, and the panels are attachable to the frame to define at least one human useable zone of predetermined size, shape and geometry, wherein at least a portion of the connection nodes comprise at least

two extending portions that are arranged to connect with at least two tubes, and the at least two extending portions are positioned at an angle of 135 degrees relative to each other to form the frame having an octagonal plan cross-section, wherein the tubes comprise a planar portion extending from an outer circumference of the tubes in a direction that is substantially perpendicular to the tangent of the outer circumference, and the planar portion forms a panel attachment surface for attachment to the panels.

30. The building system of claim 29, wherein the connection nodes are castings or metal extrusions.

31. The building system of claim 29 wherein each extending portion comprises a tubular section for connection to the tubes, wherein the tubular section further comprises a further planar portion to form a further panel attachment surface for attachment to at least one of the panels.

32. The building system of claim 29 further comprising a plurality of attachment elements that are arranged to attach the panels to the frame via the planar portions of the tubular sections and the planar portions of the tubes.

33. The building system of claim 29, wherein the attachment elements comprise opposing members forming a channel for receiving the planar portions.

34. The building system of claim 33, wherein the tubular section comprises a main section, and a distal section of smaller circumference to the main section, wherein the distal section includes a recess around its outer circumference for attaching a seal.

35. The building system of claim 34, wherein the tubes comprise an inner circumference that corresponds with the outer circumference of the distal section, wherein the inner circumference is for receiving at least a portion of the distal section therein.

36. The building system of claim 35, further comprising at least one tensile element arranged through cavities formed within the tubular sections and tubes for countering tension in the frame.

37. The building system of claim 29, wherein each extending portion has a circular cross section.

38. The building system of claim 29, wherein the connection nodes comprise at least three extending portions that are arranged to connect with at least three tubes.

39. The building system of claim 38, wherein the connection nodes comprise at least four extending portions that are arranged to connect with at least four tubes.

40. The flooring system of claim 19, wherein the plurality of tubes forms at least part of a building system as claimed in any one of claims 1, 6, 13 or 29.

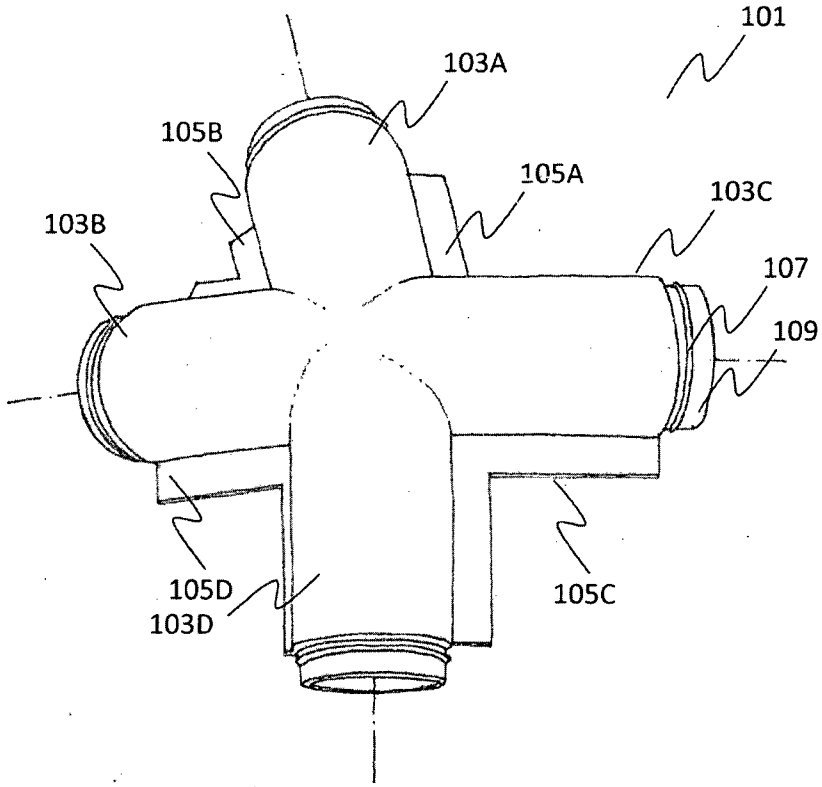


Figure 1A

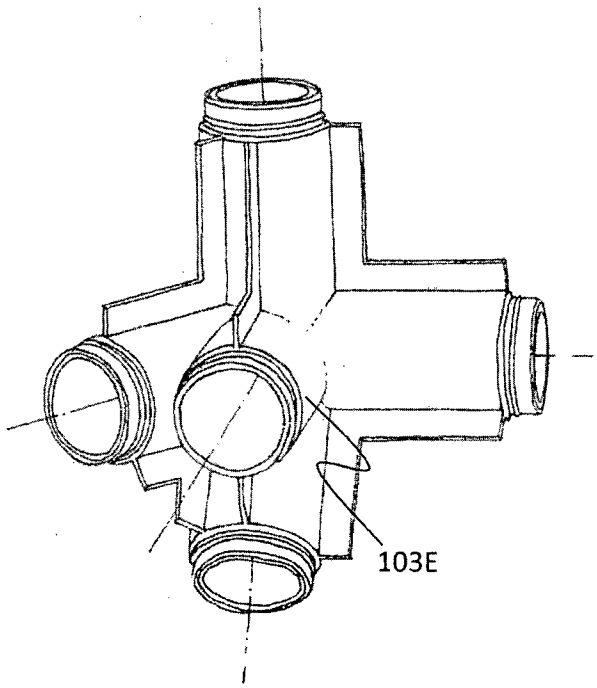


Figure 1B

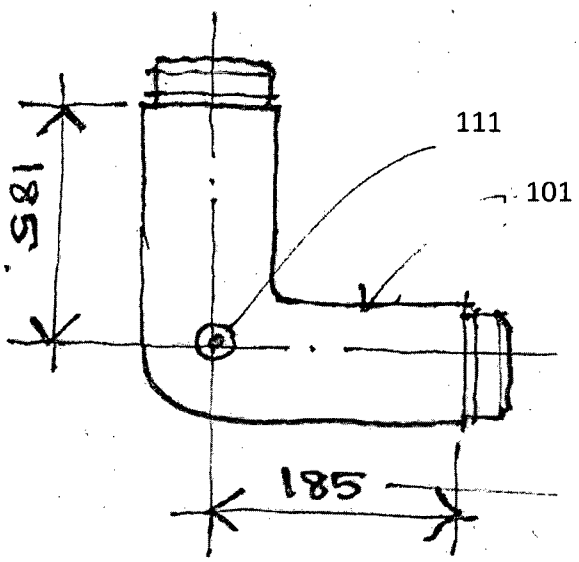


Figure 1C

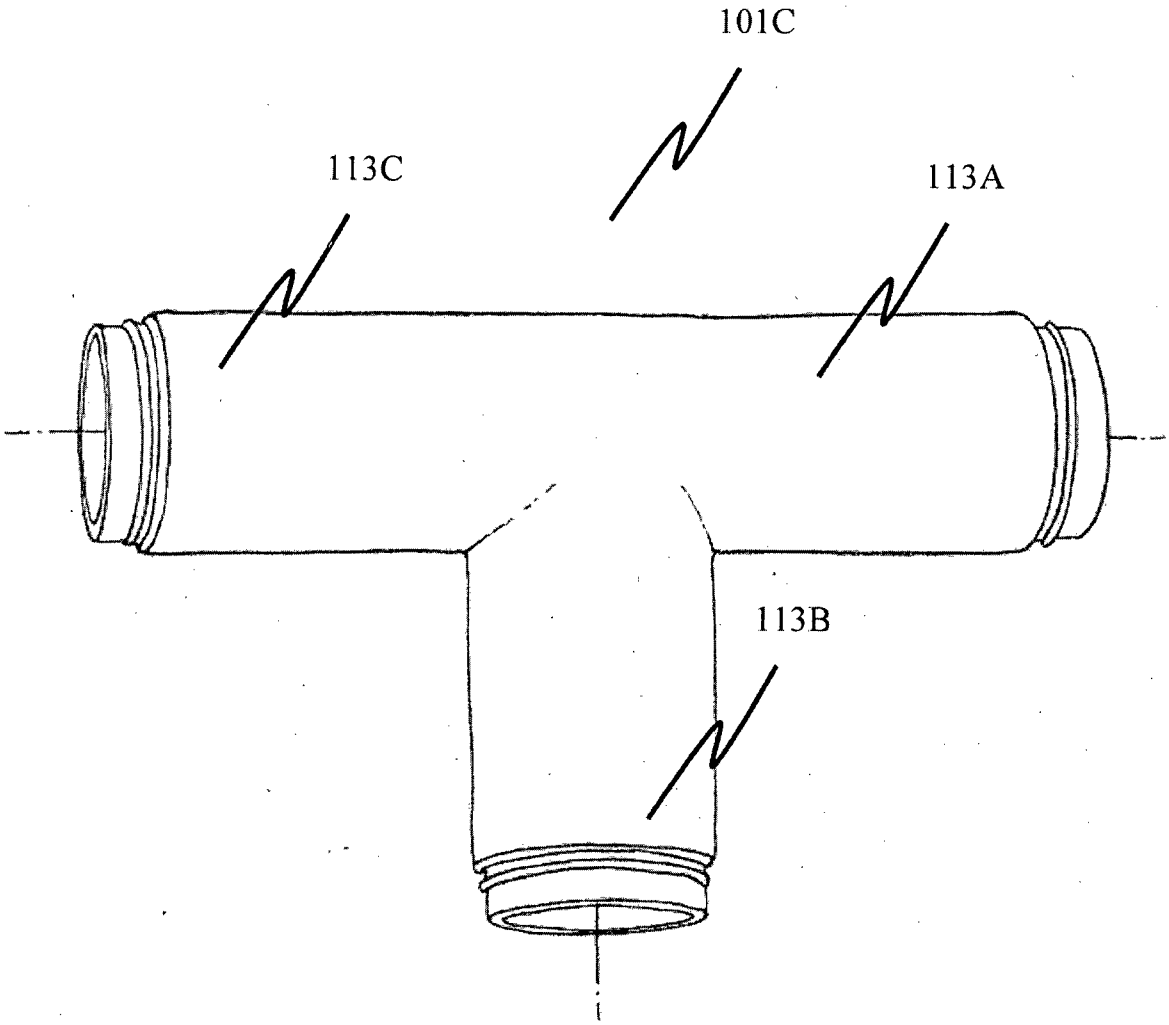


Figure 1D

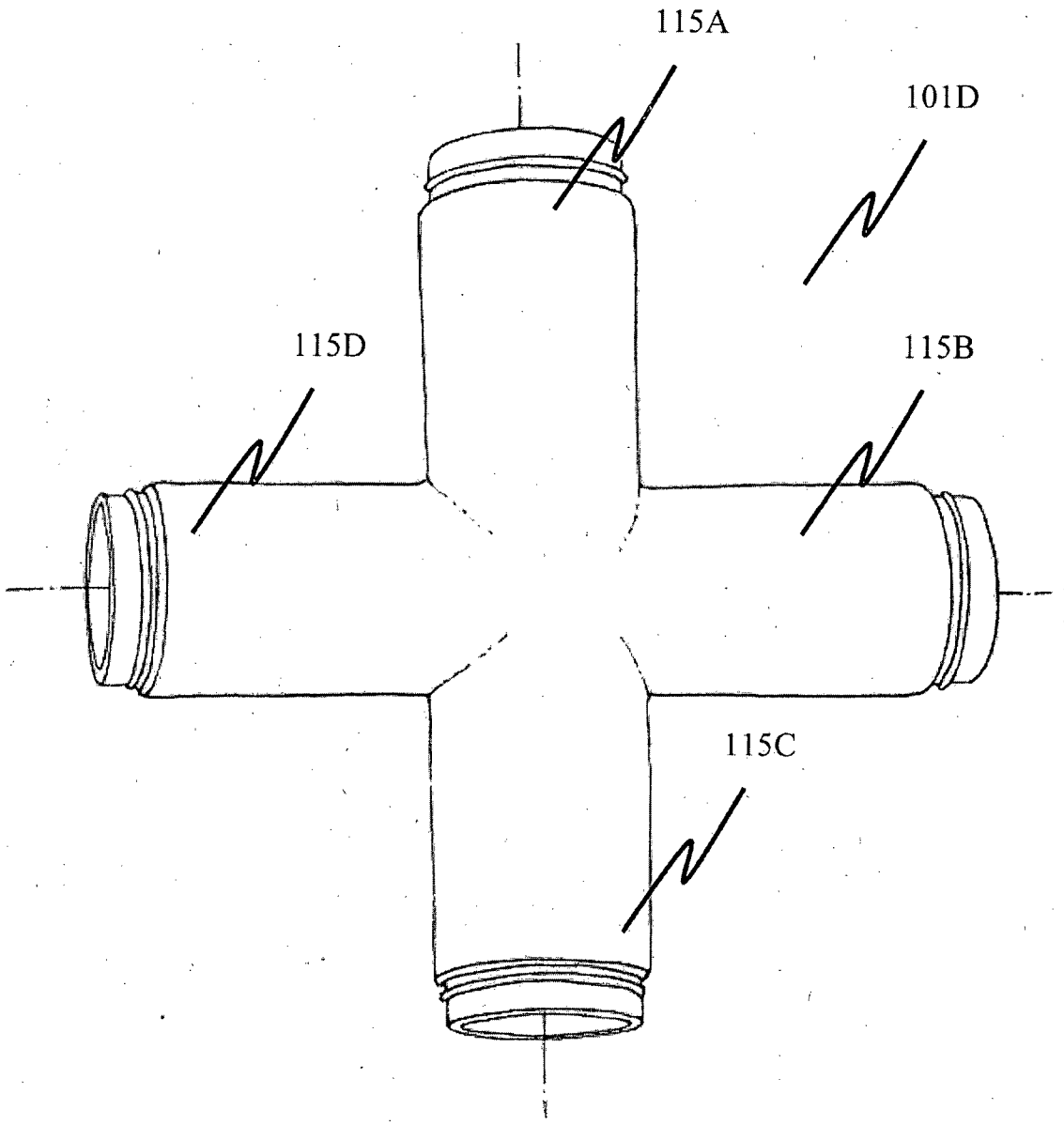


Figure 1E

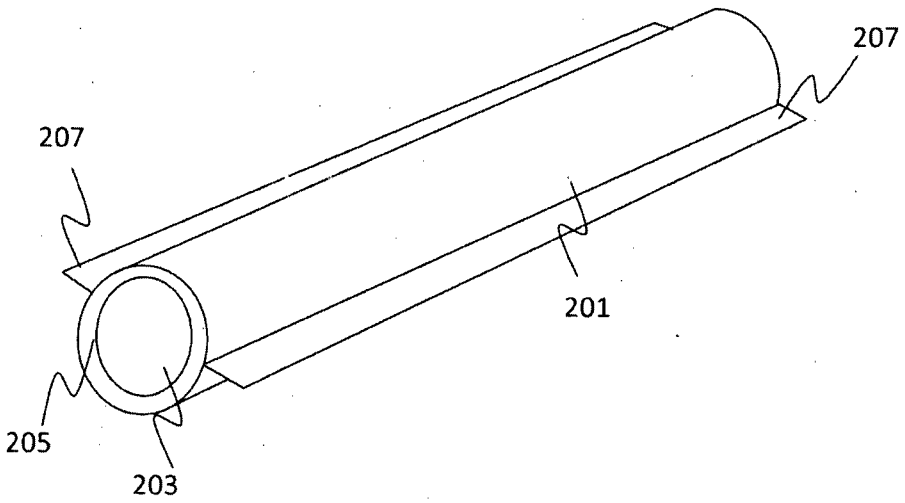


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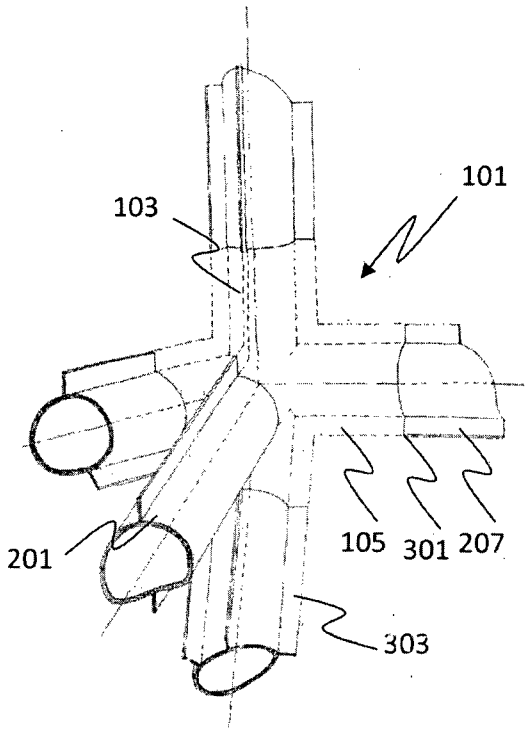


Figure 3A

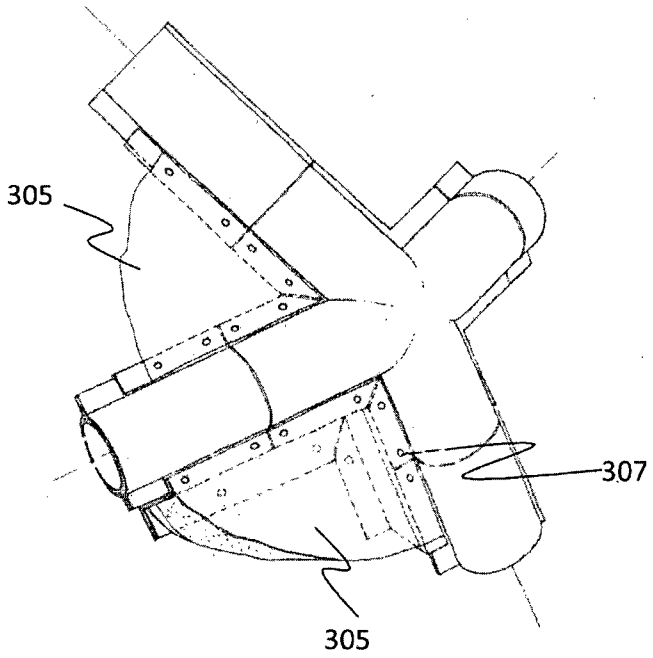


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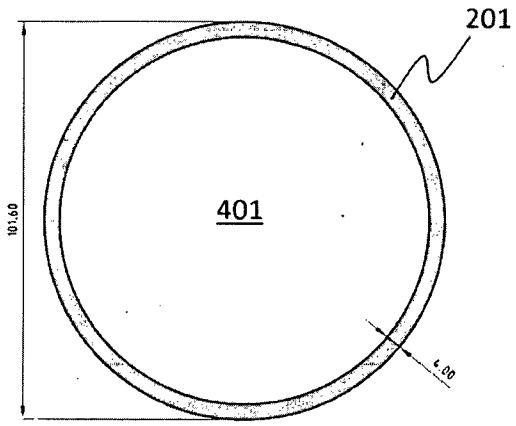


Figure 4A

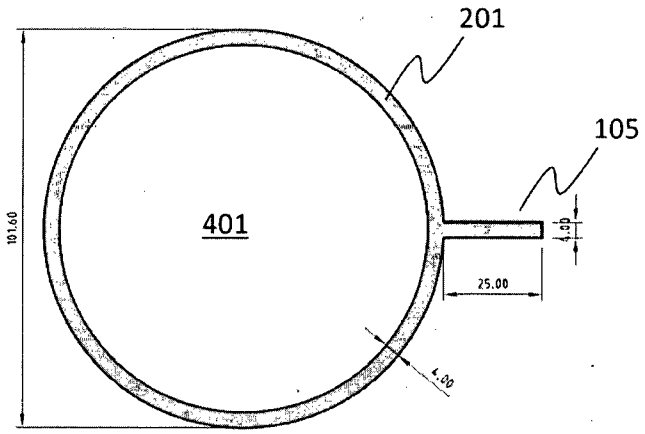


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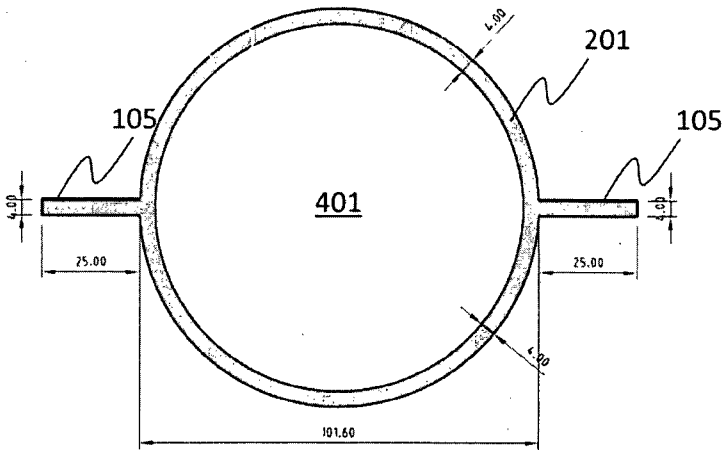


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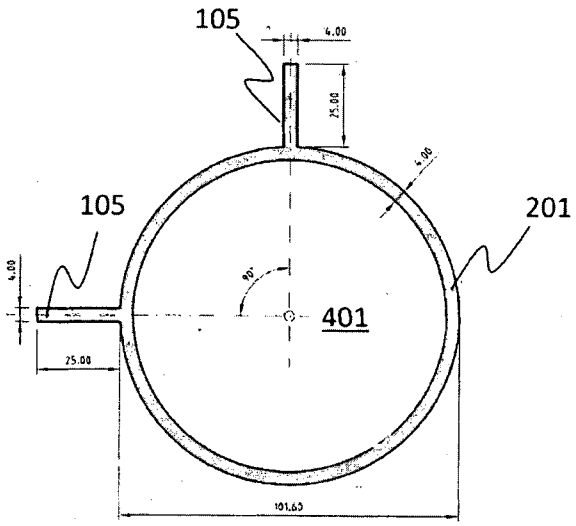


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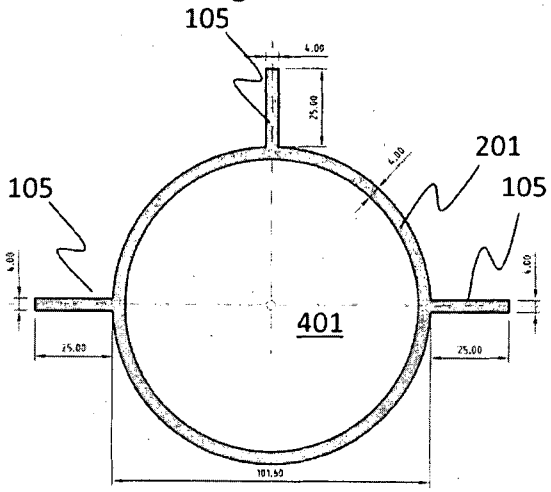


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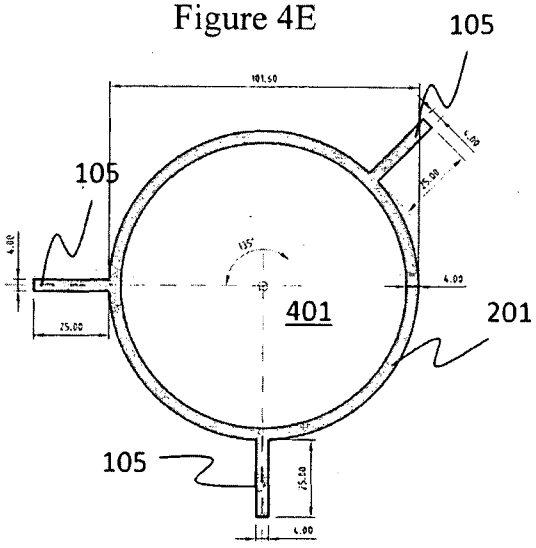


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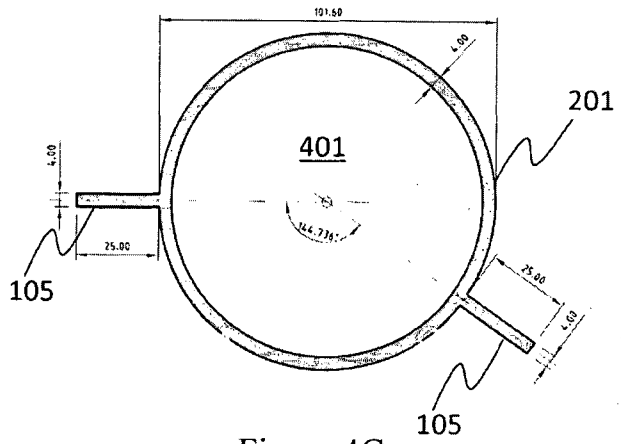


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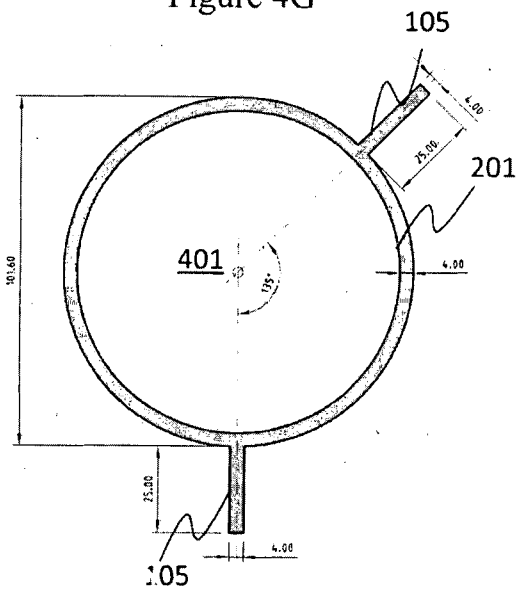


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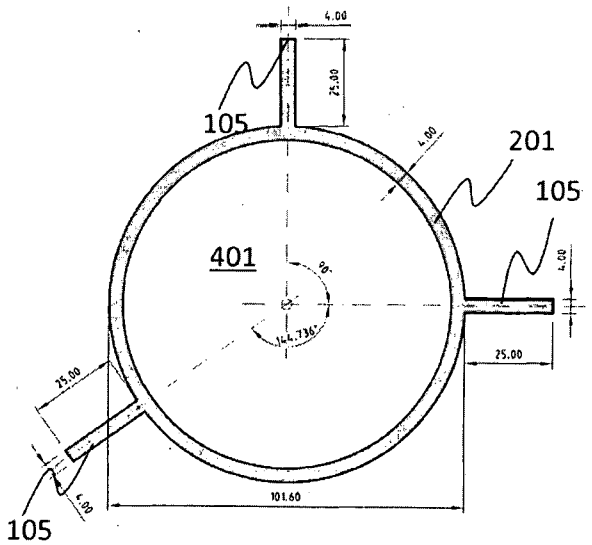


Figure 4I

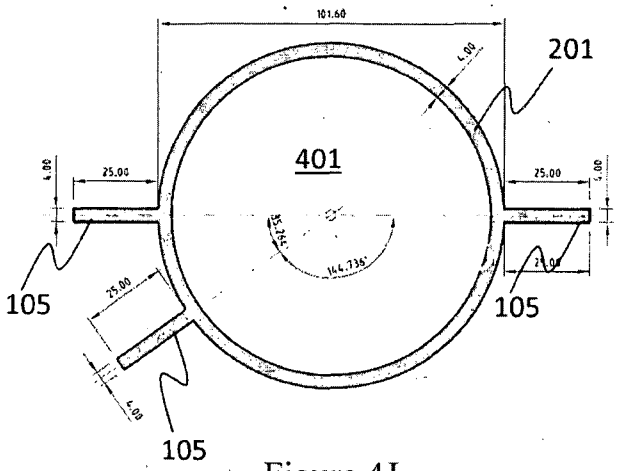


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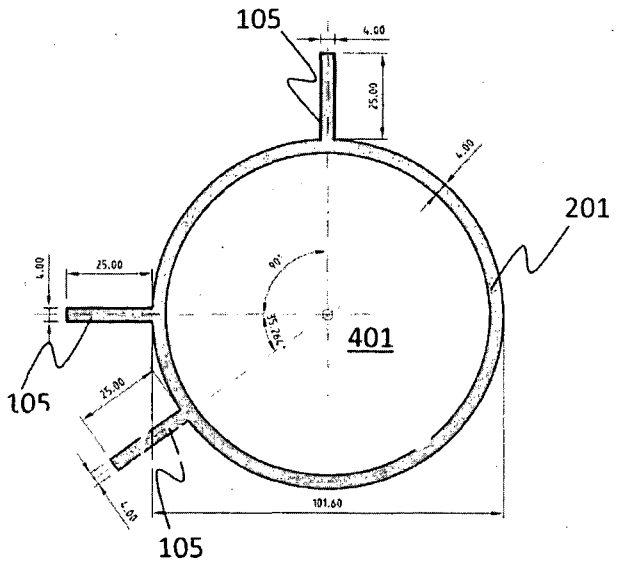


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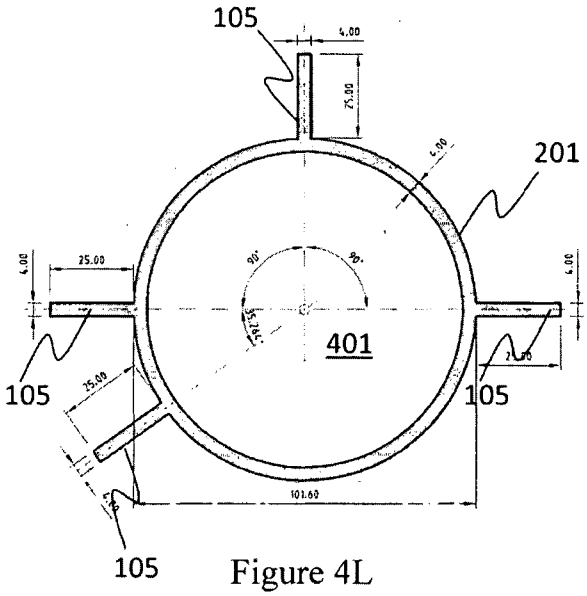


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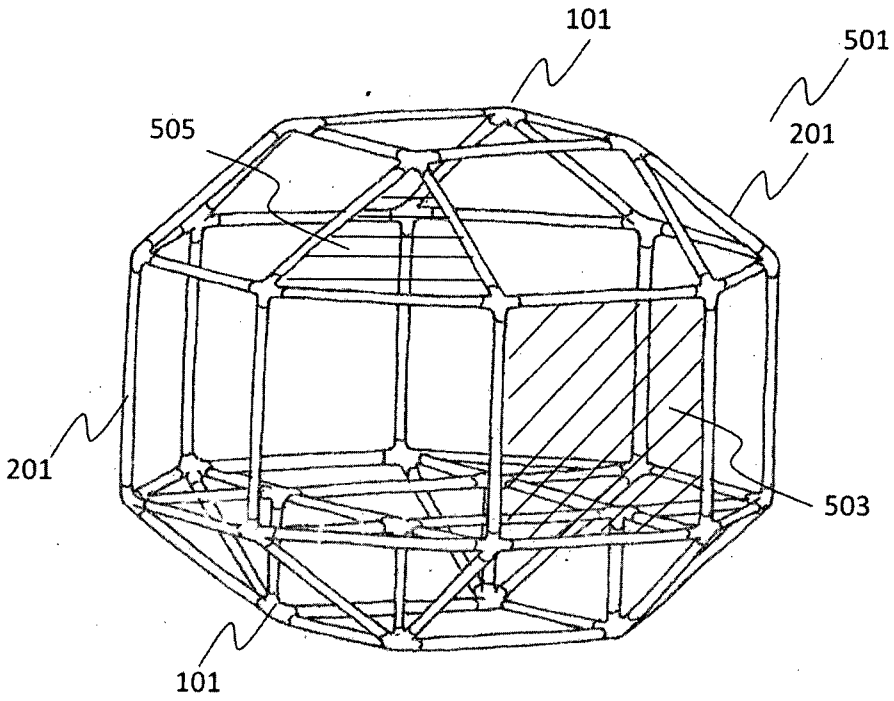


Figure 5A

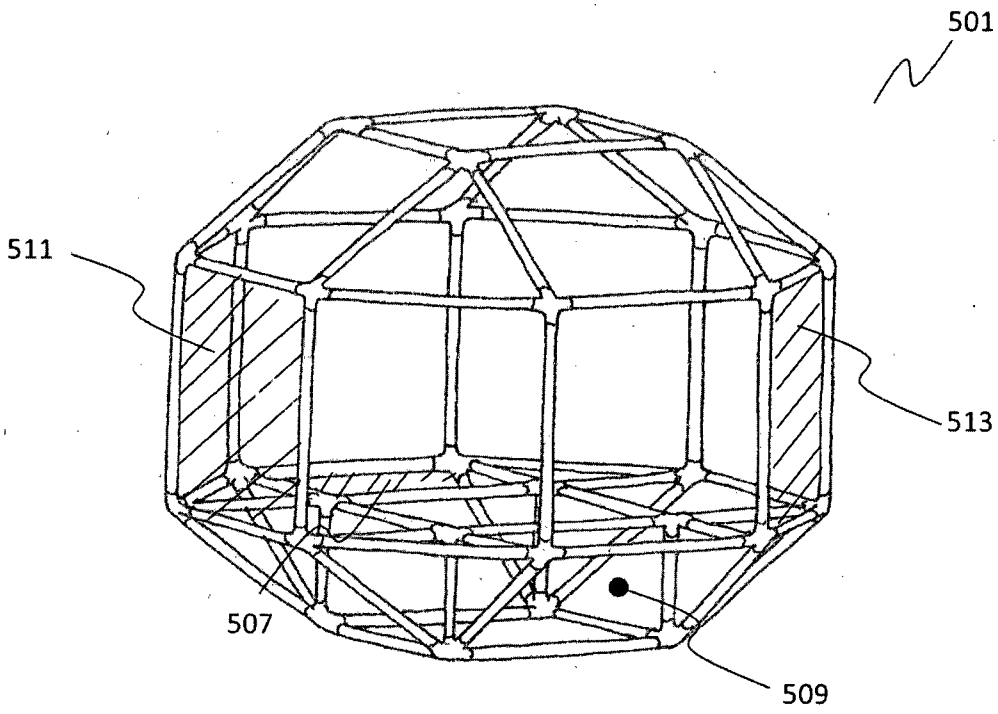


Figure 5B

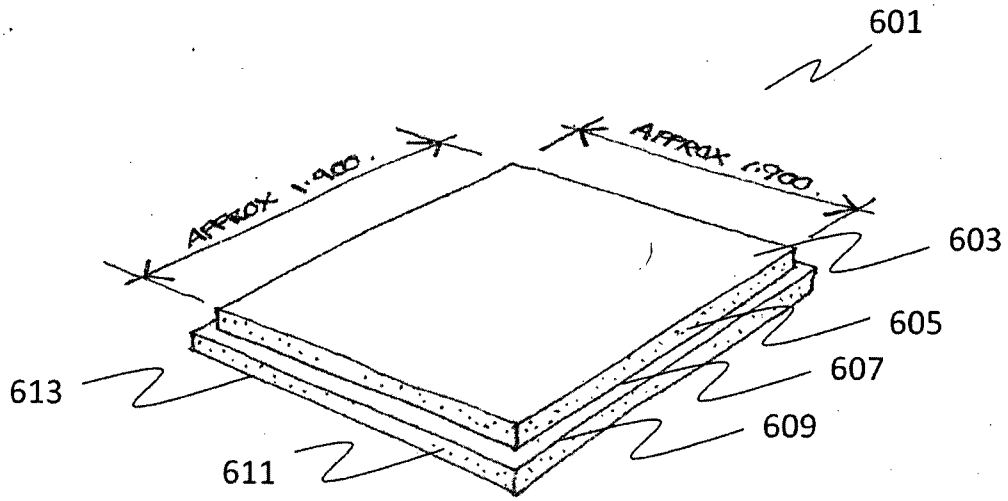


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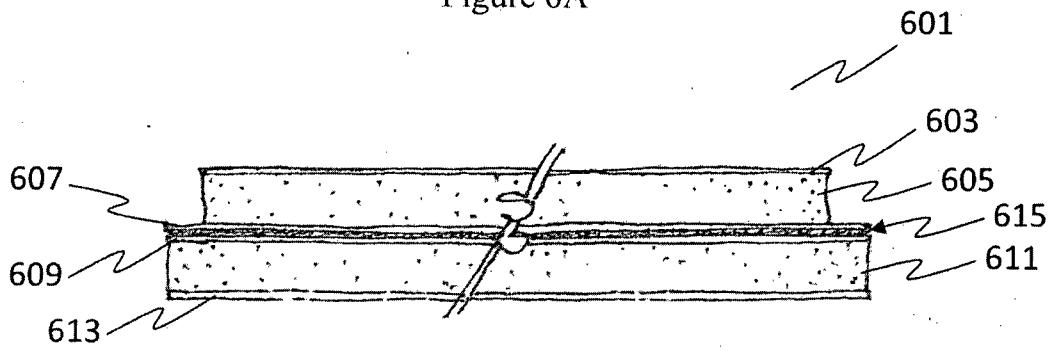


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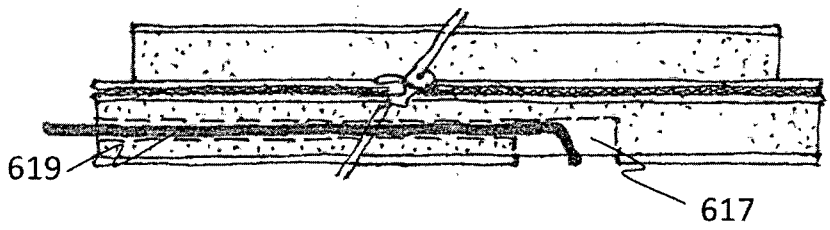


Figure 6C

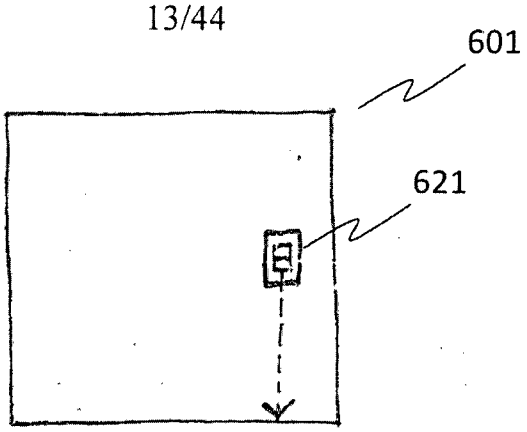


Figure 6D

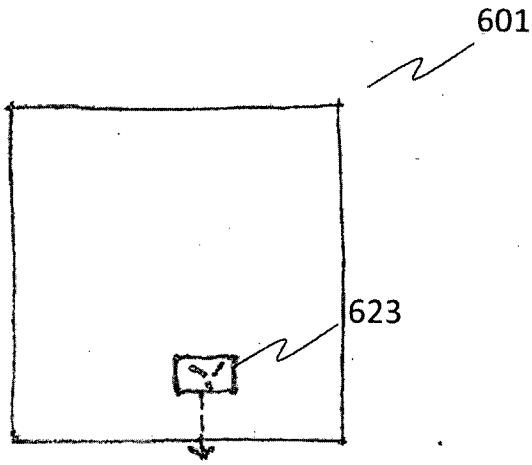


Figure 6E

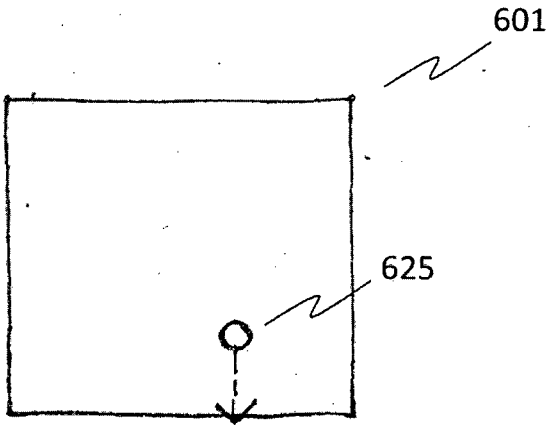


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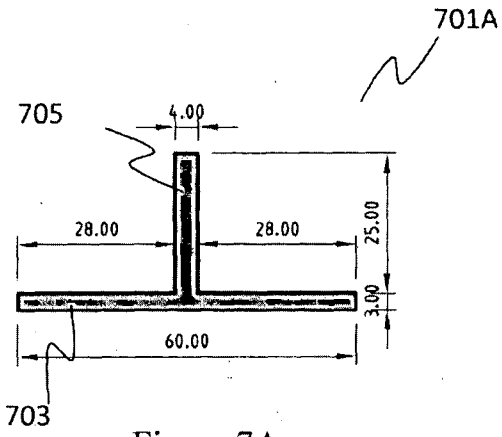


Figure 7A

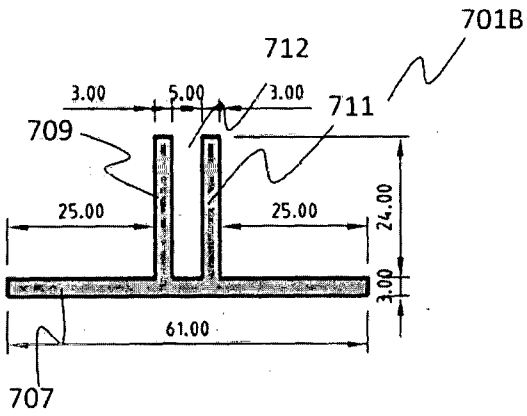


Figure 7B

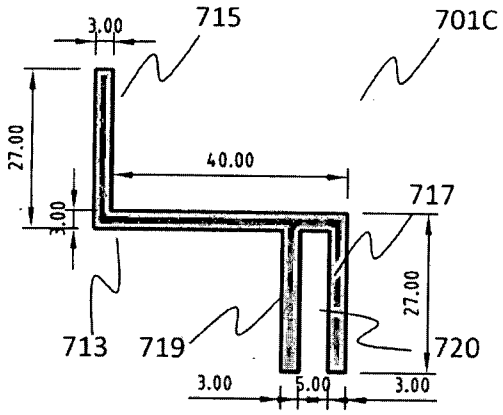


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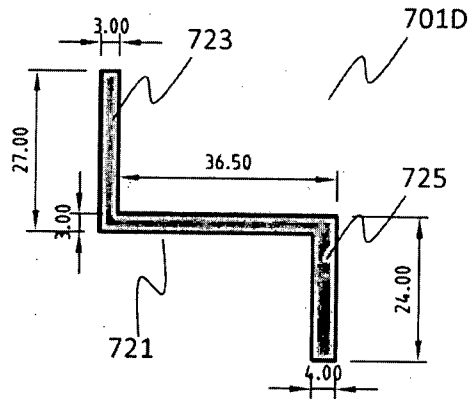


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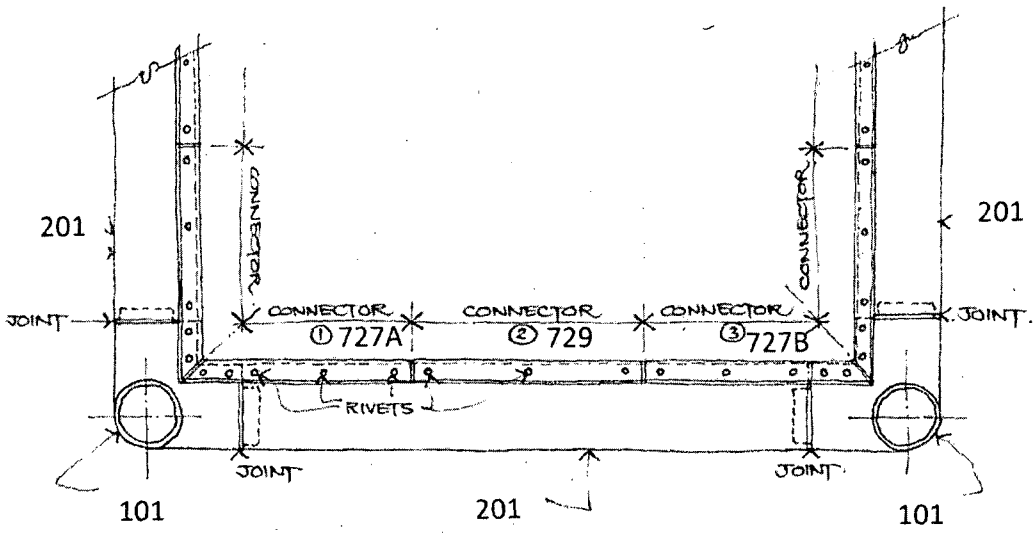

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Figure 7E

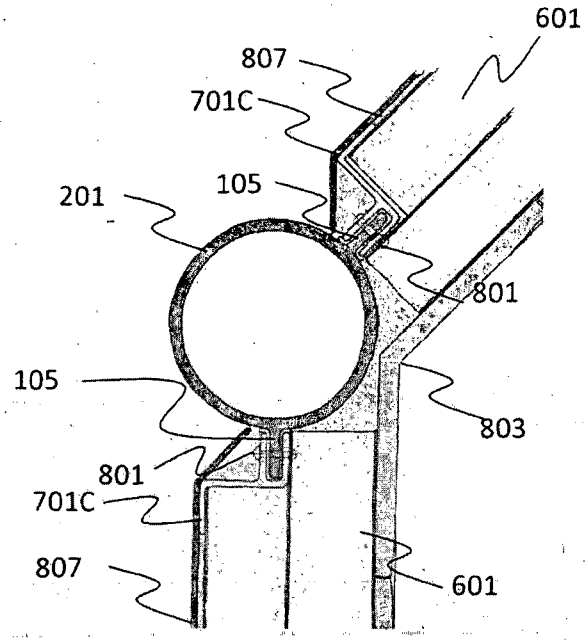


Figure 8A

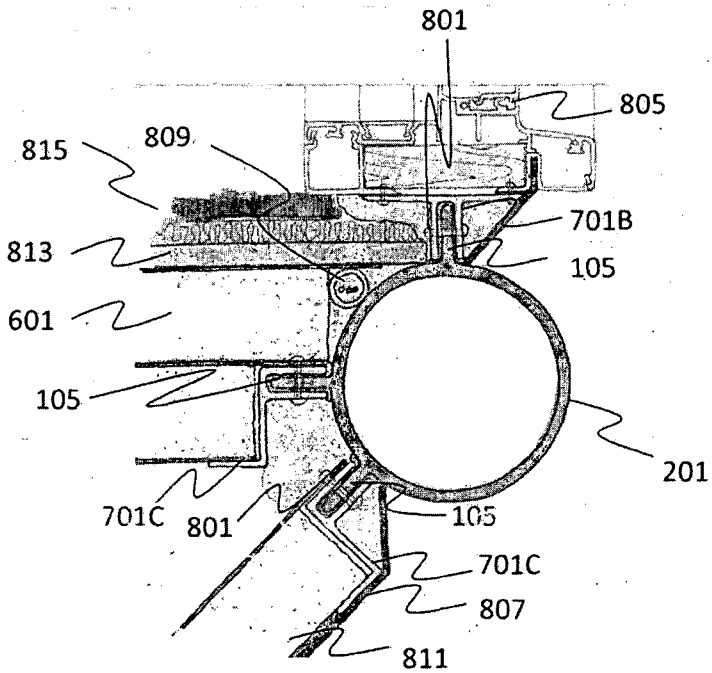


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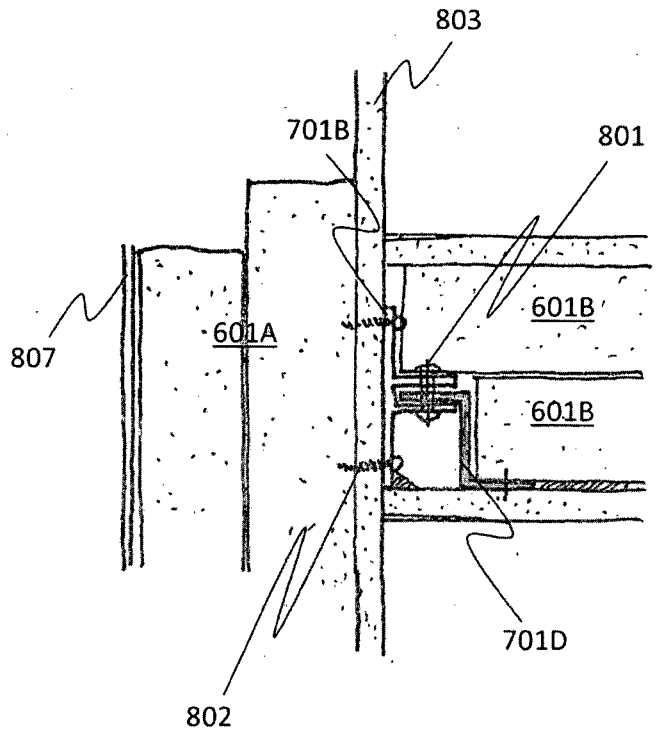


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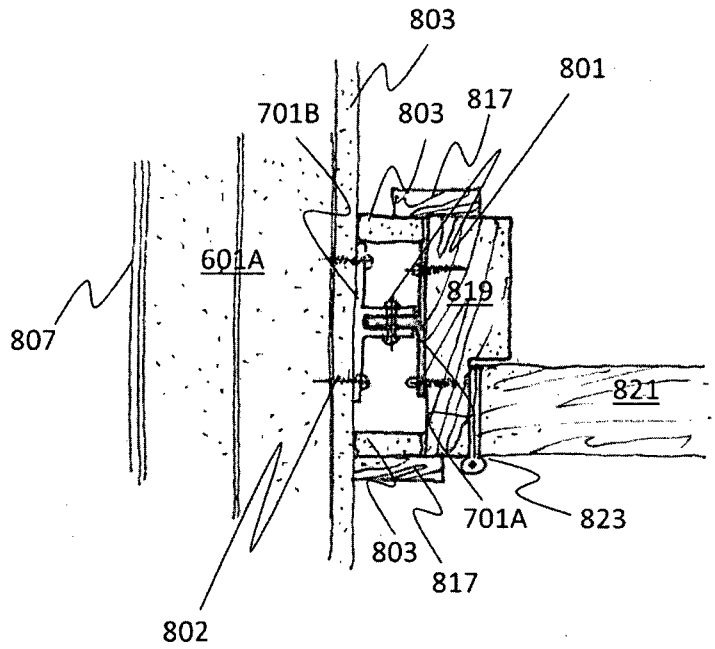


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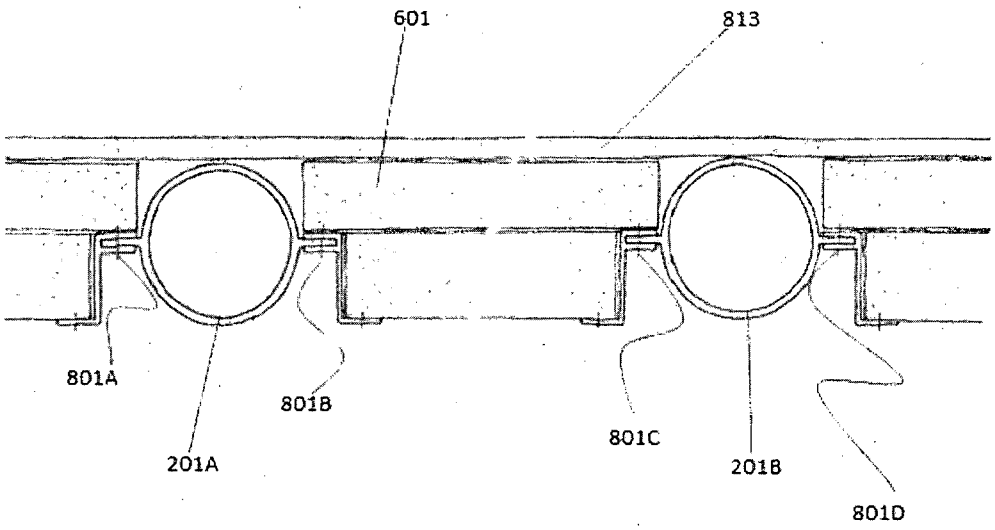


FIGURE 8E

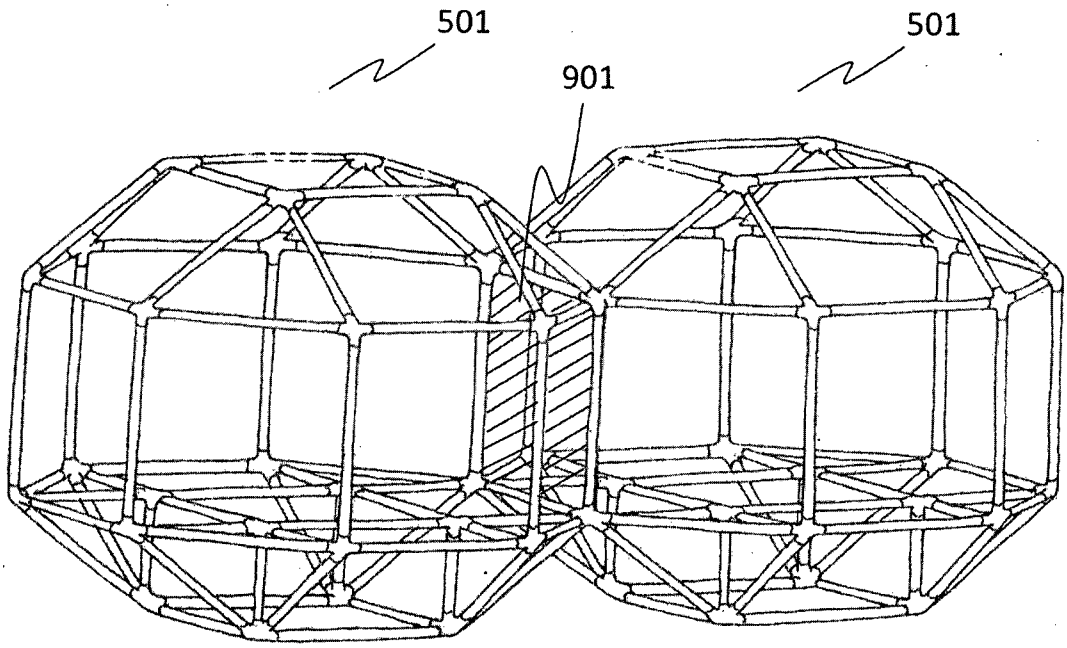


Figure 9A

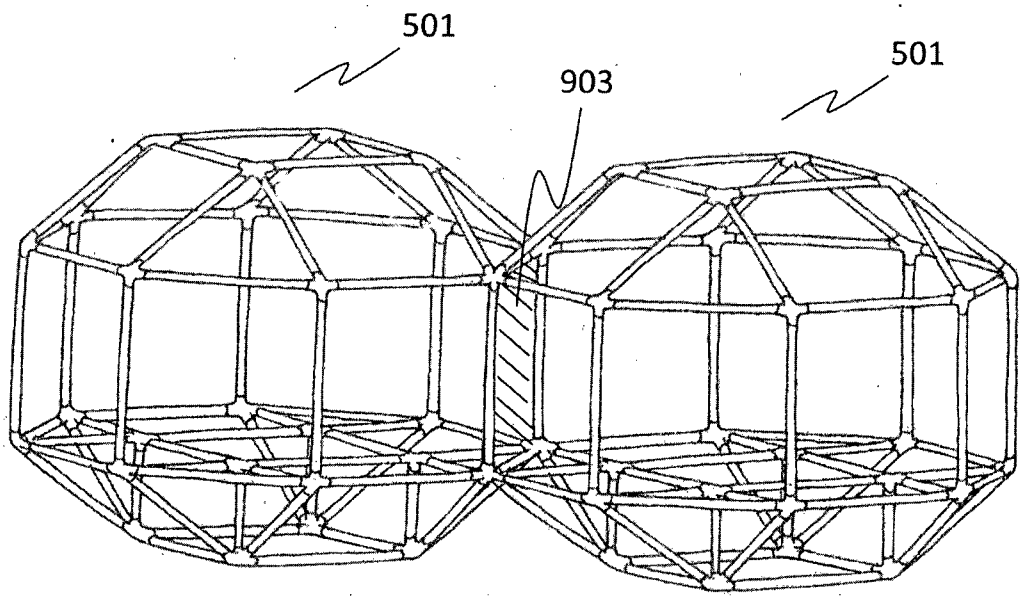


Figure 9B

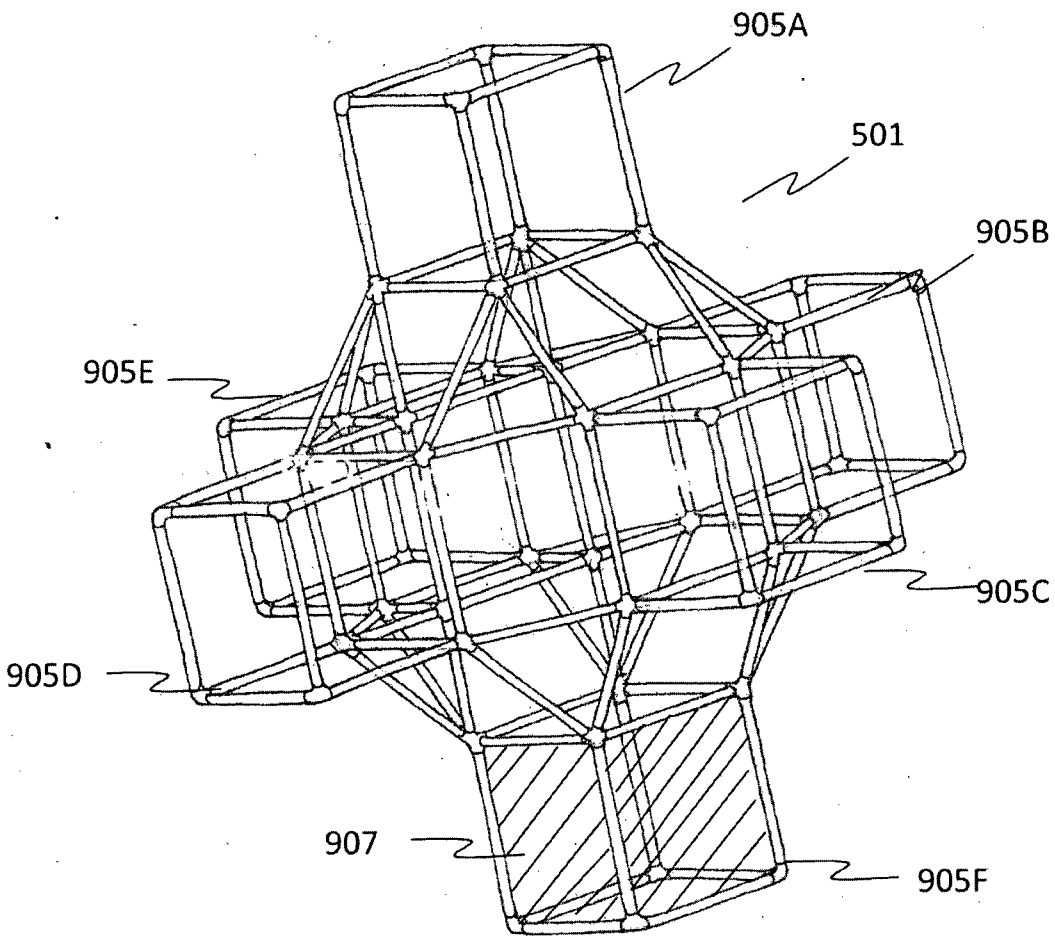


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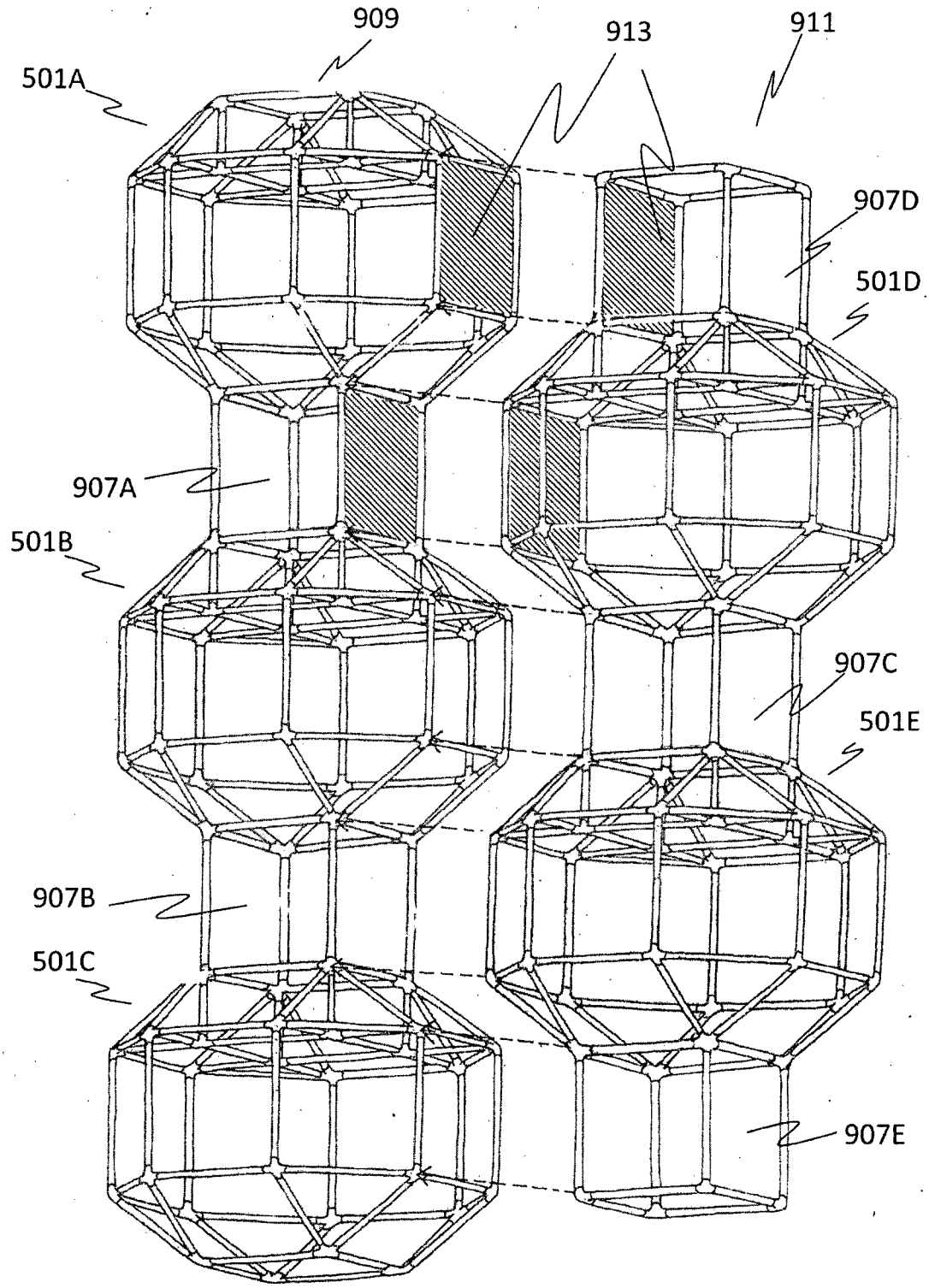


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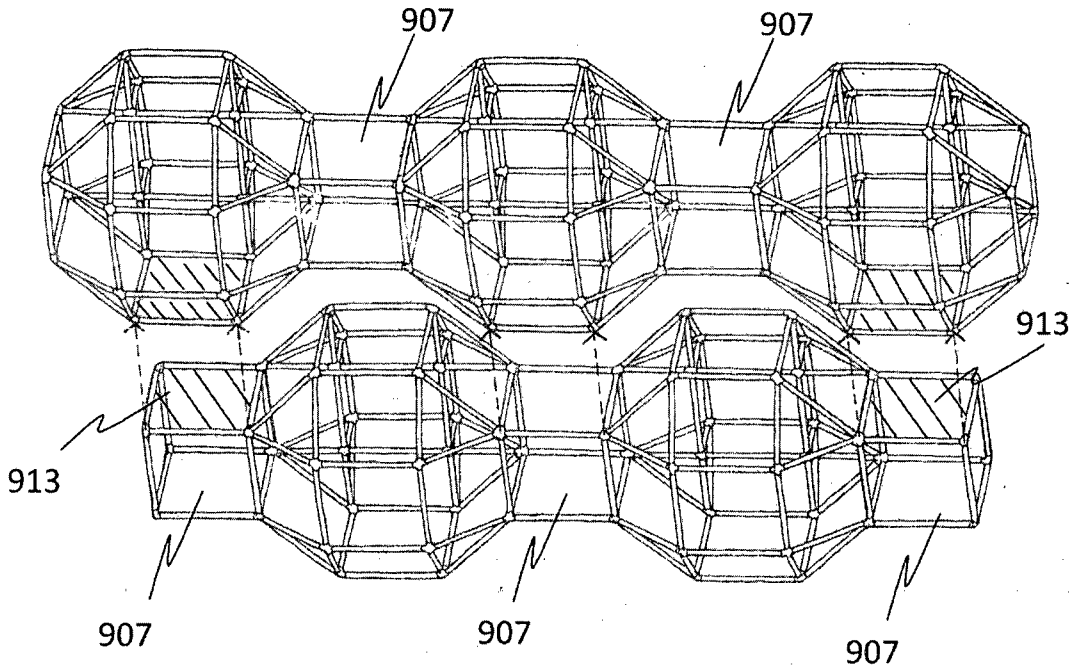


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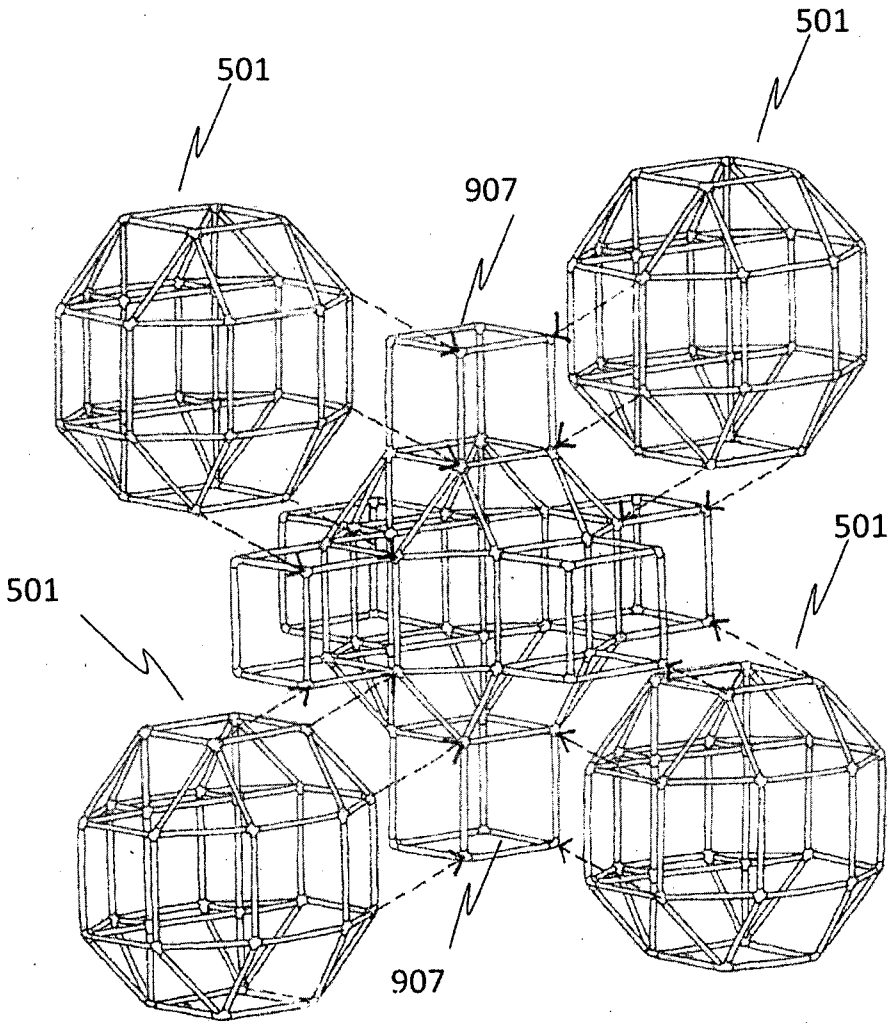


Figure 9F

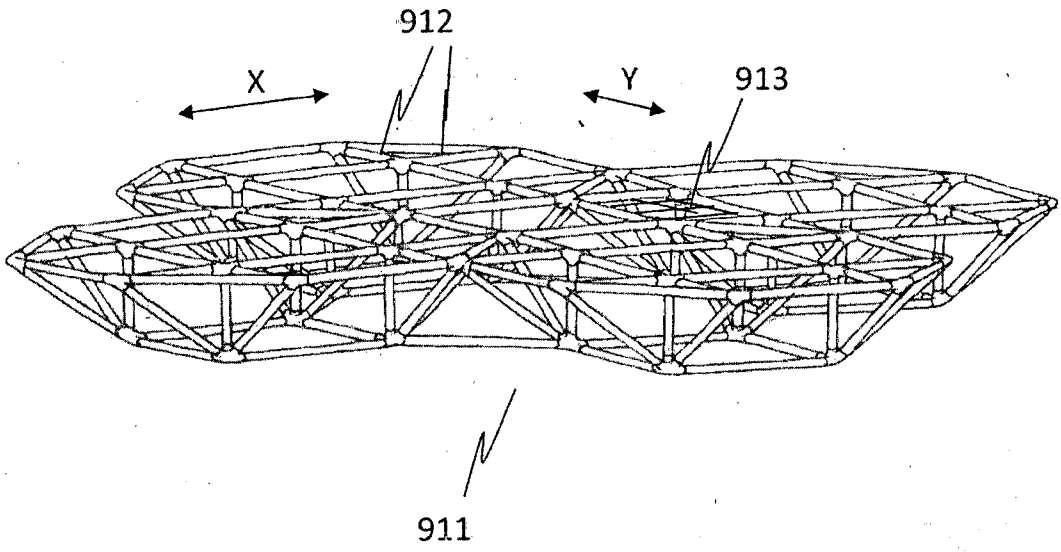


Figure 9G

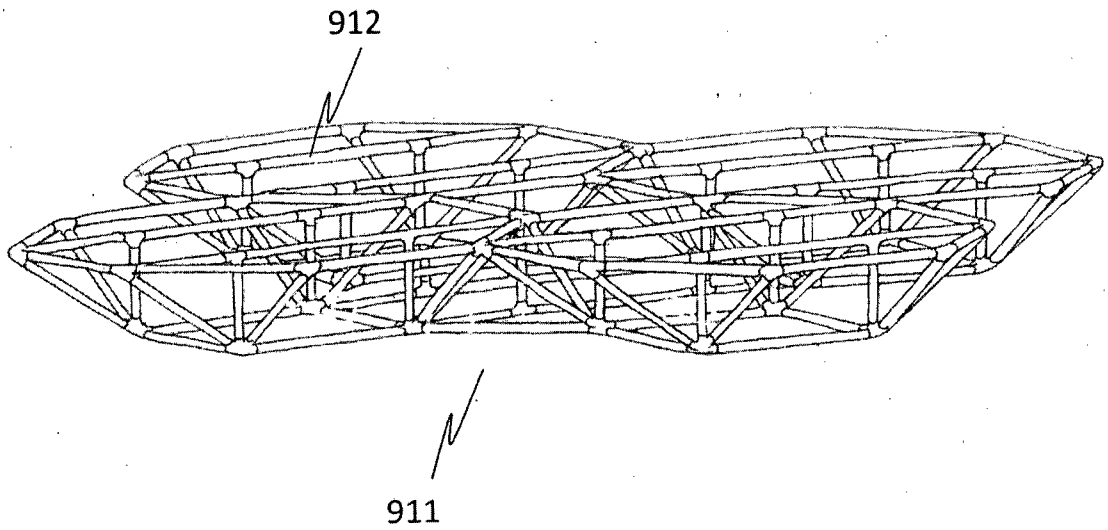


Figure 9H

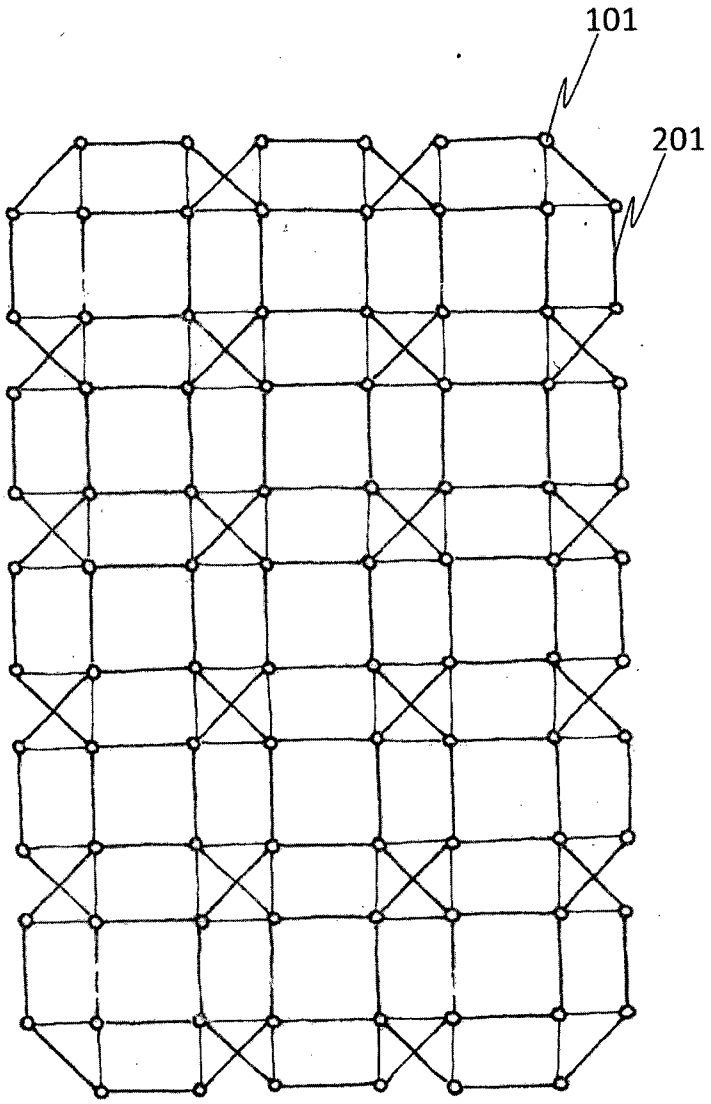


Figure 10A

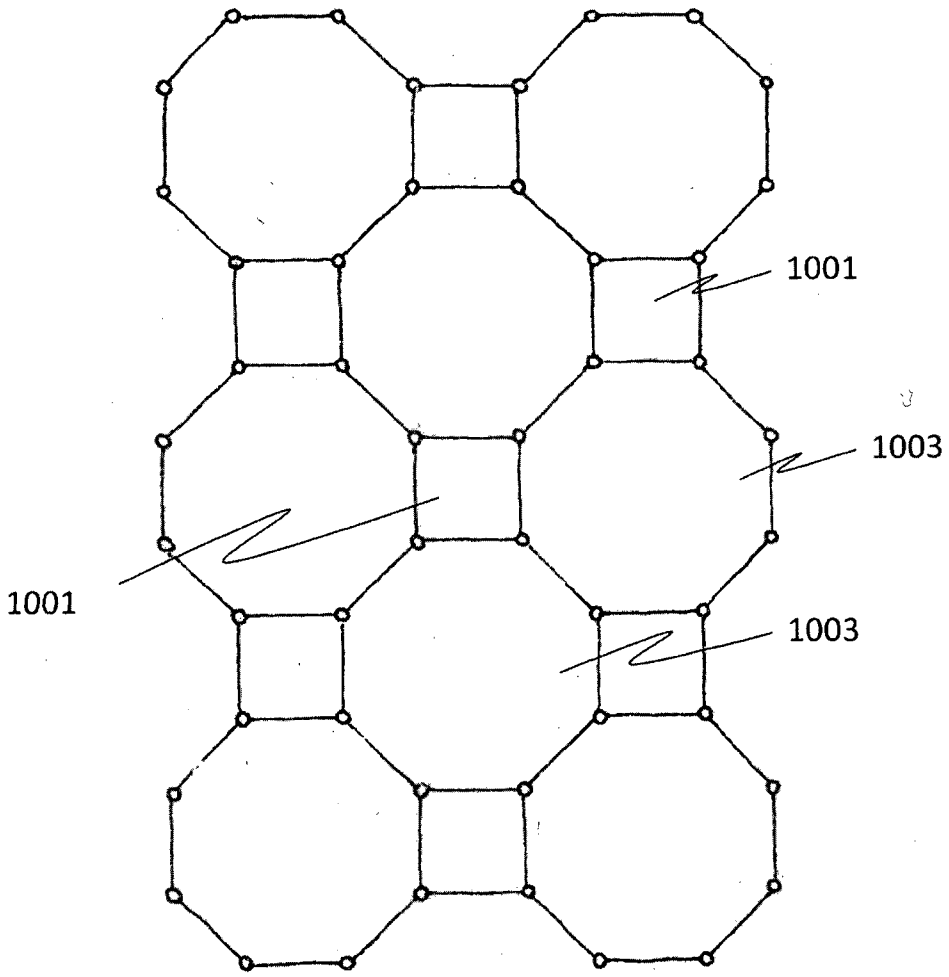


Figure 10B

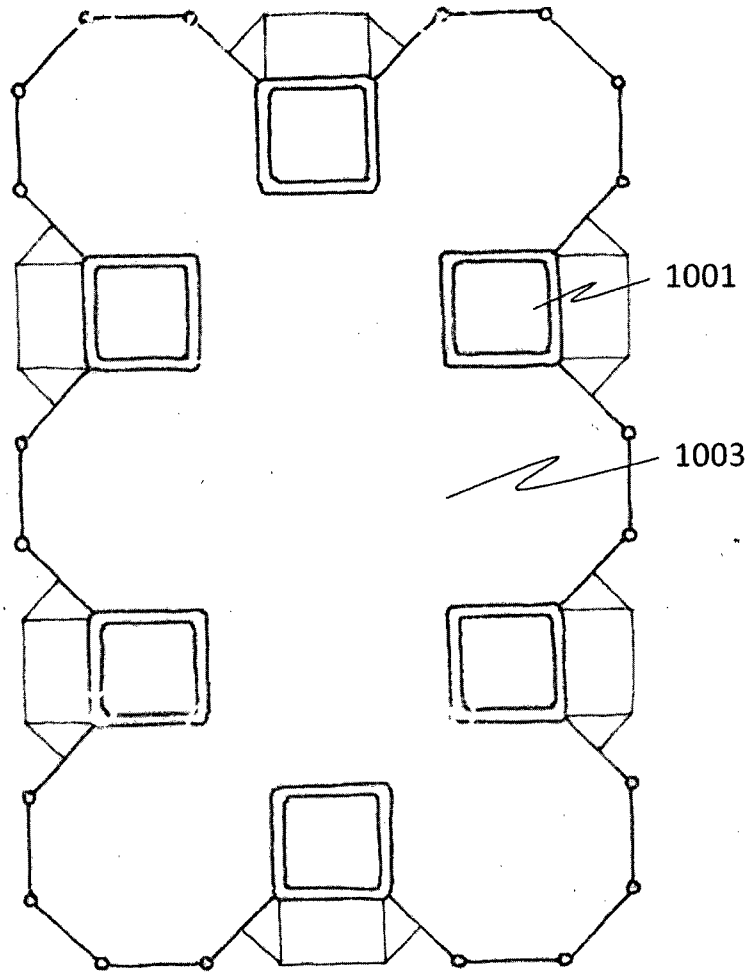


Figure 10C

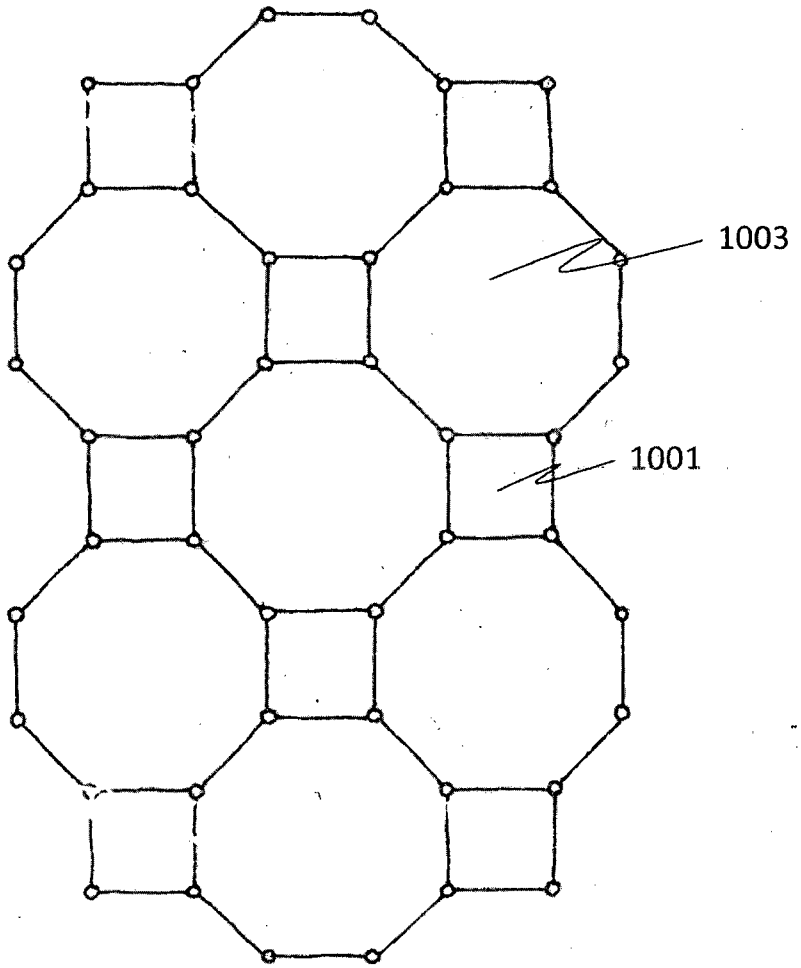


Figure 10D

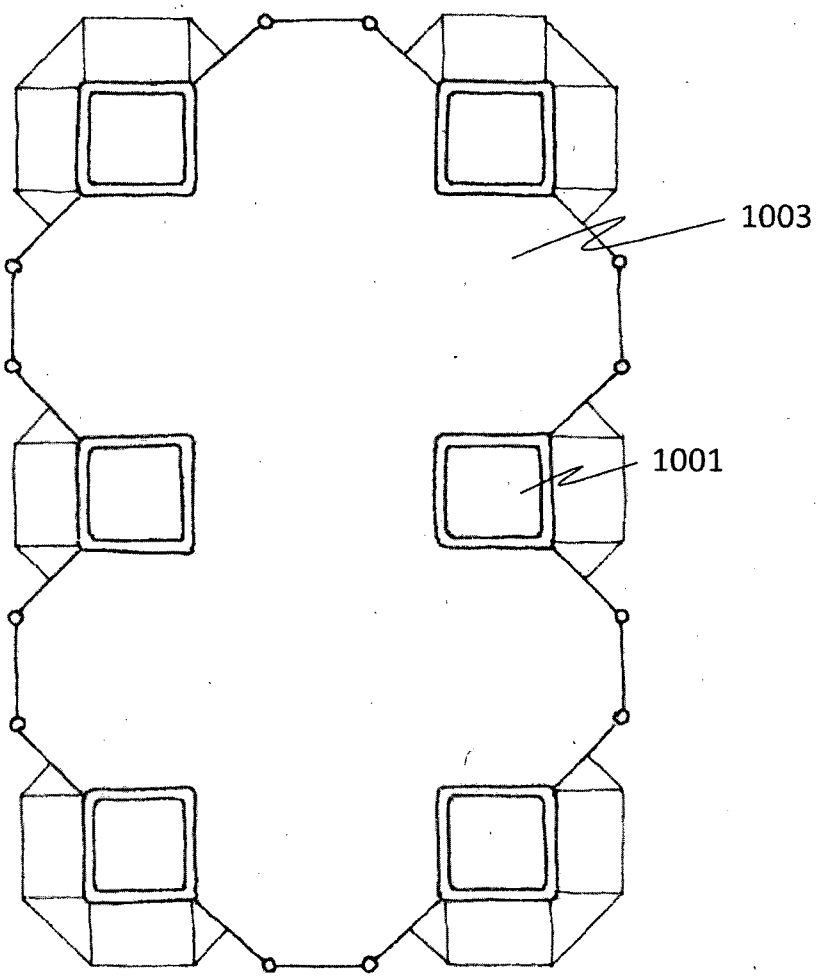


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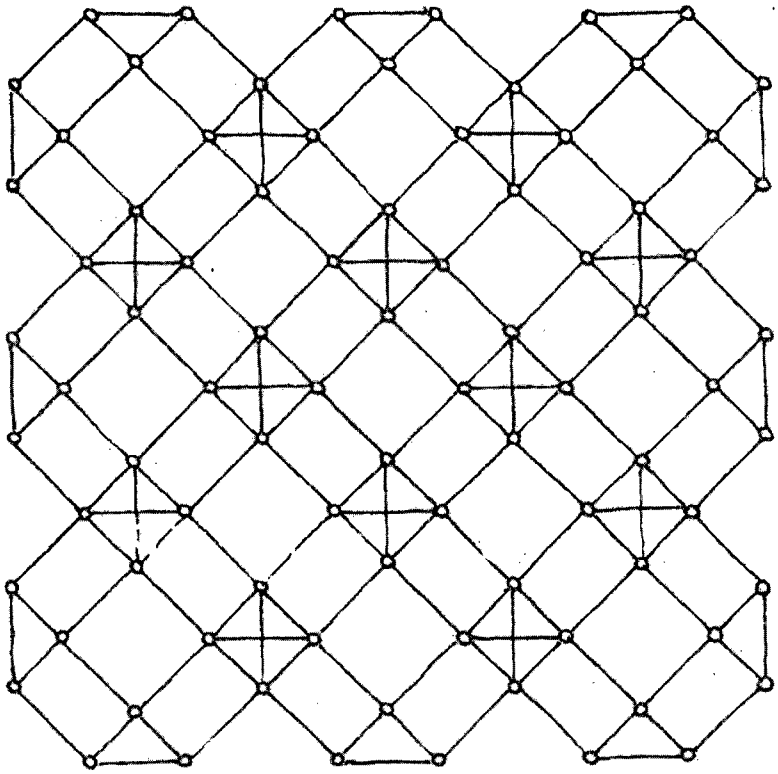


Figure 10F

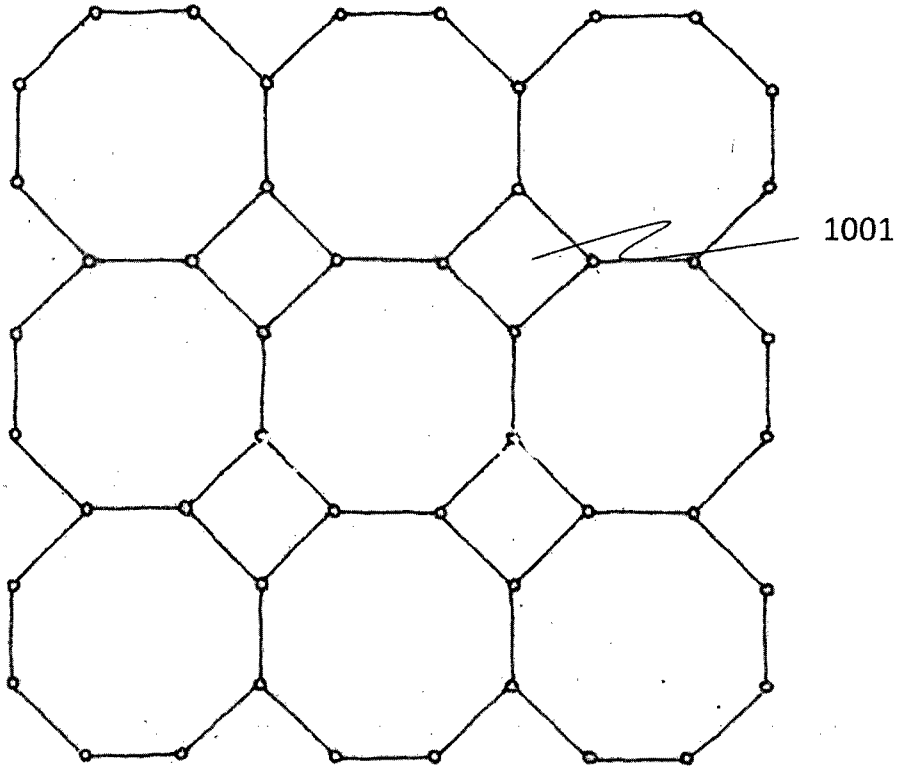


Figure 10G

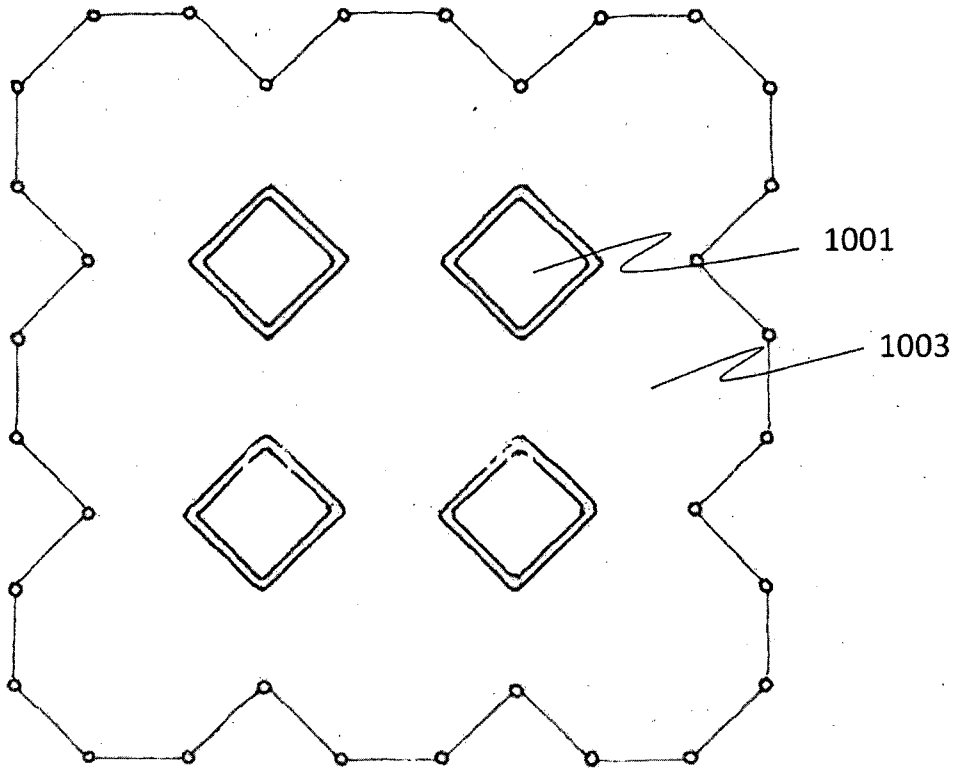


Figure 10H

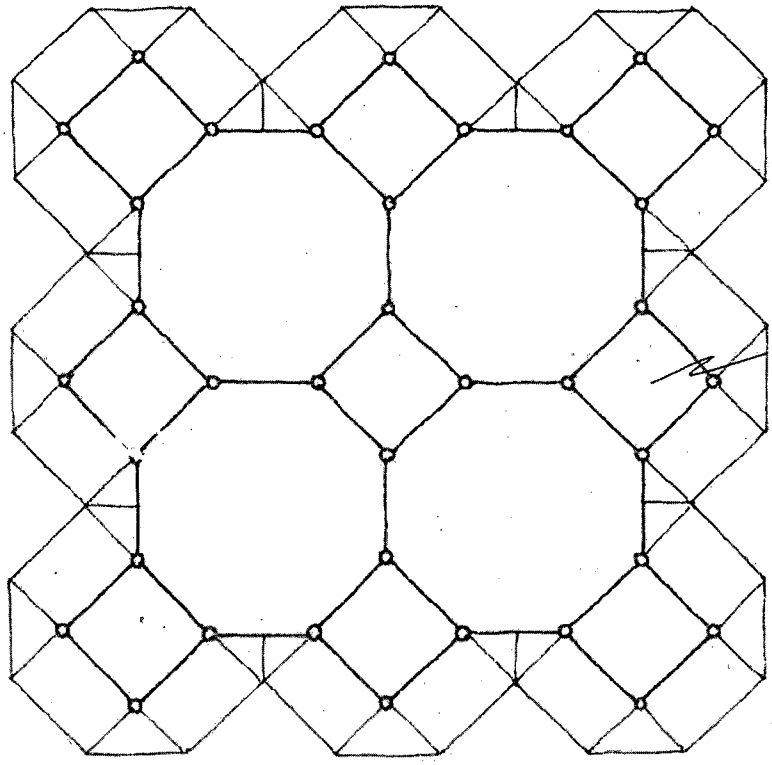


Figure 10I

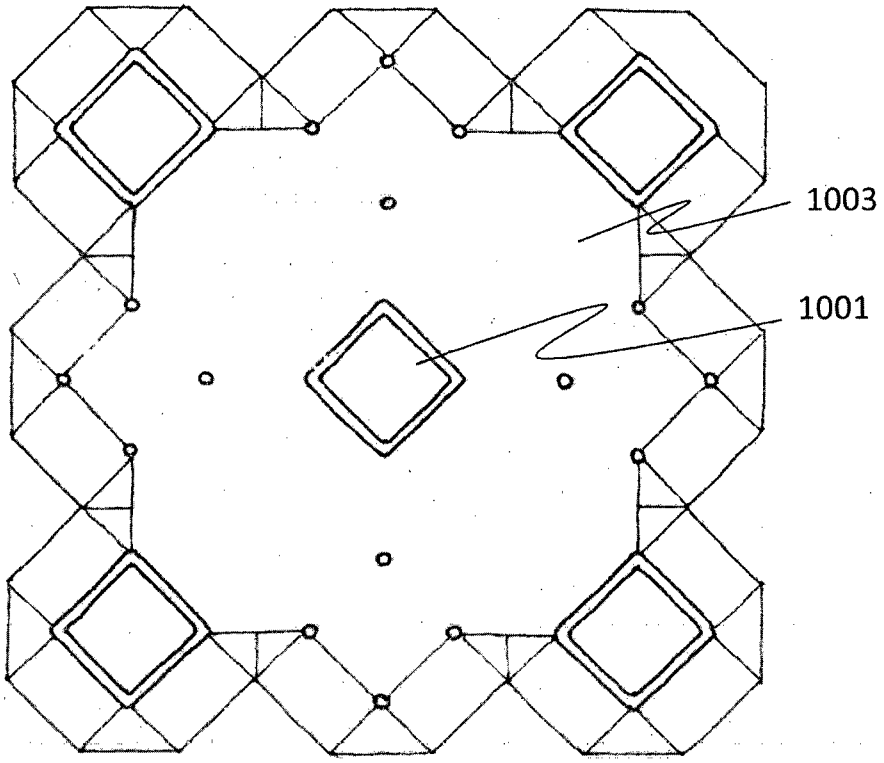


Figure 10J

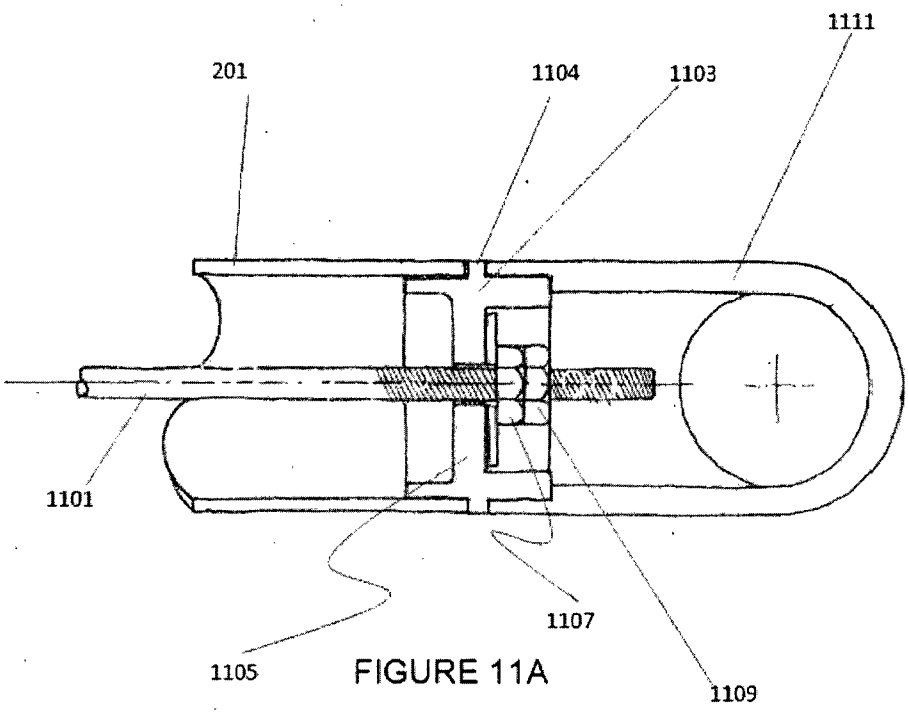


FIGURE 11A

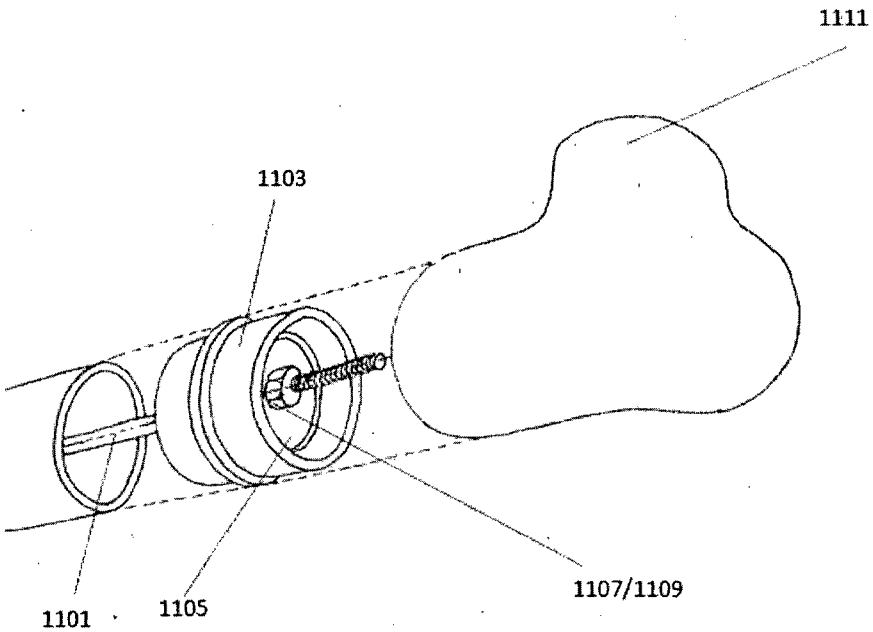


FIGURE 11B

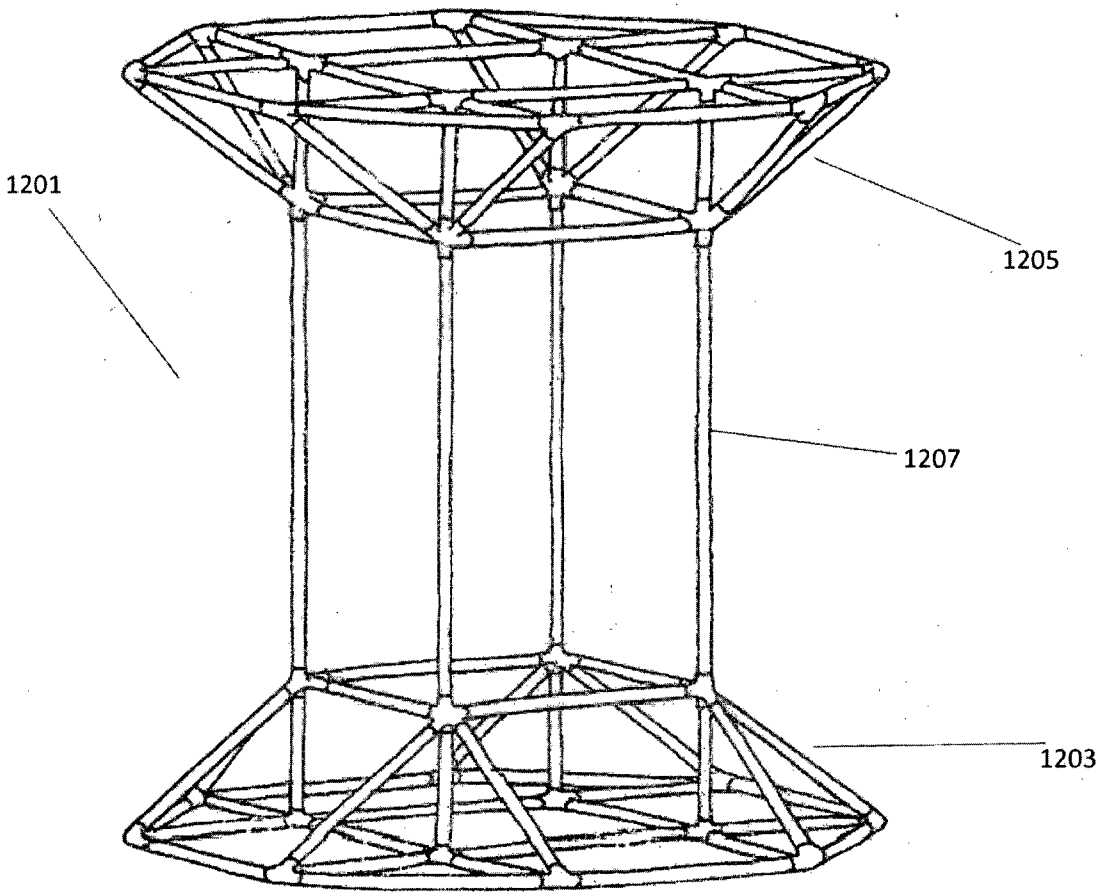


FIGURE 12A

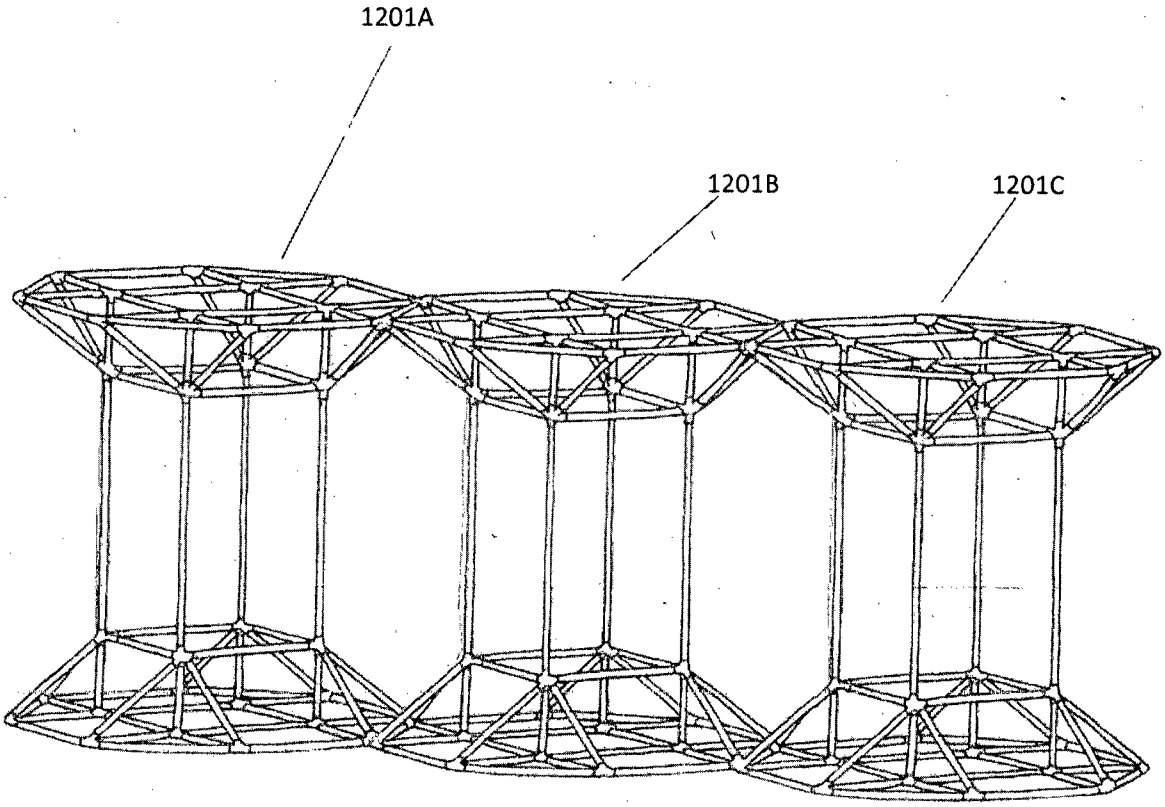


FIGURE 12B

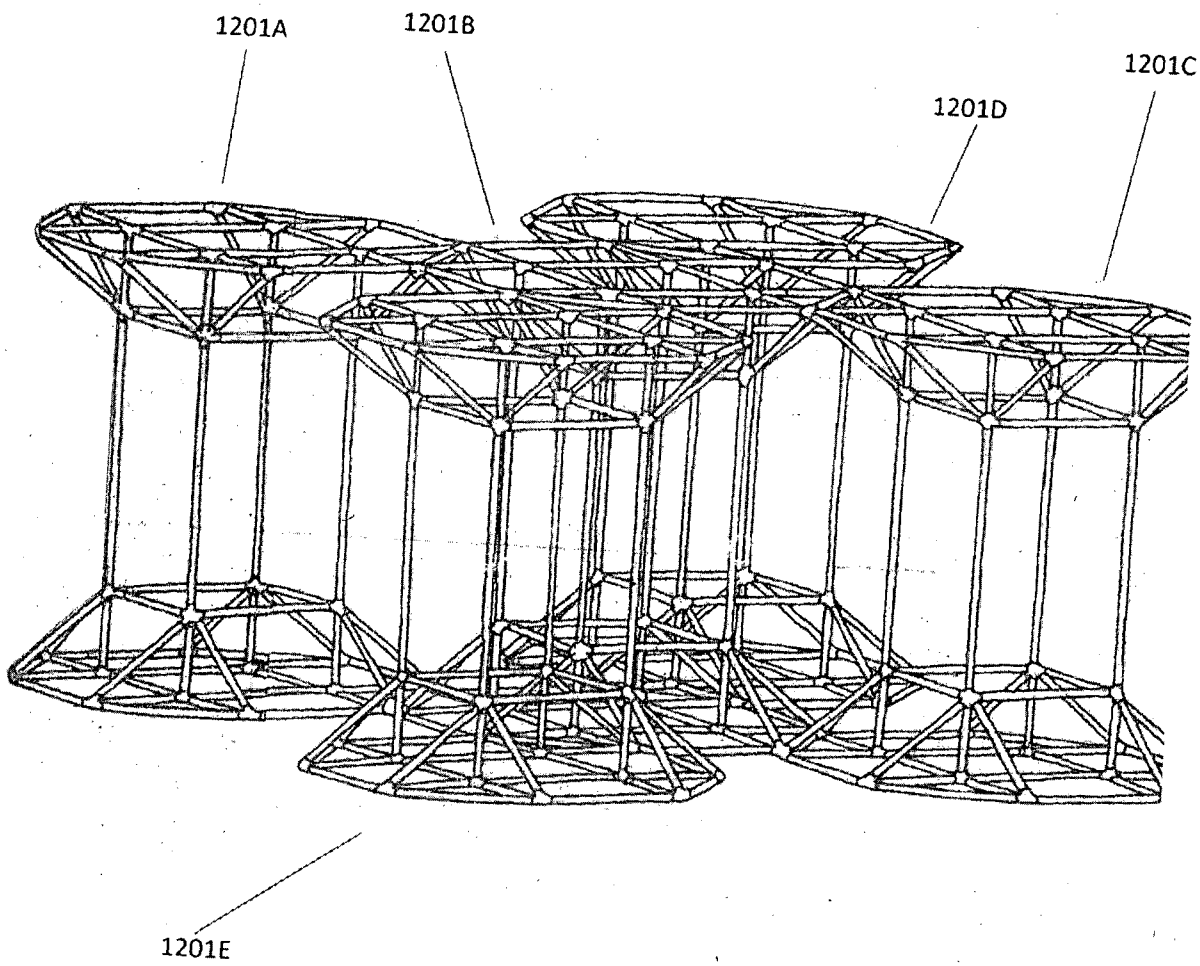


FIGURE 12C

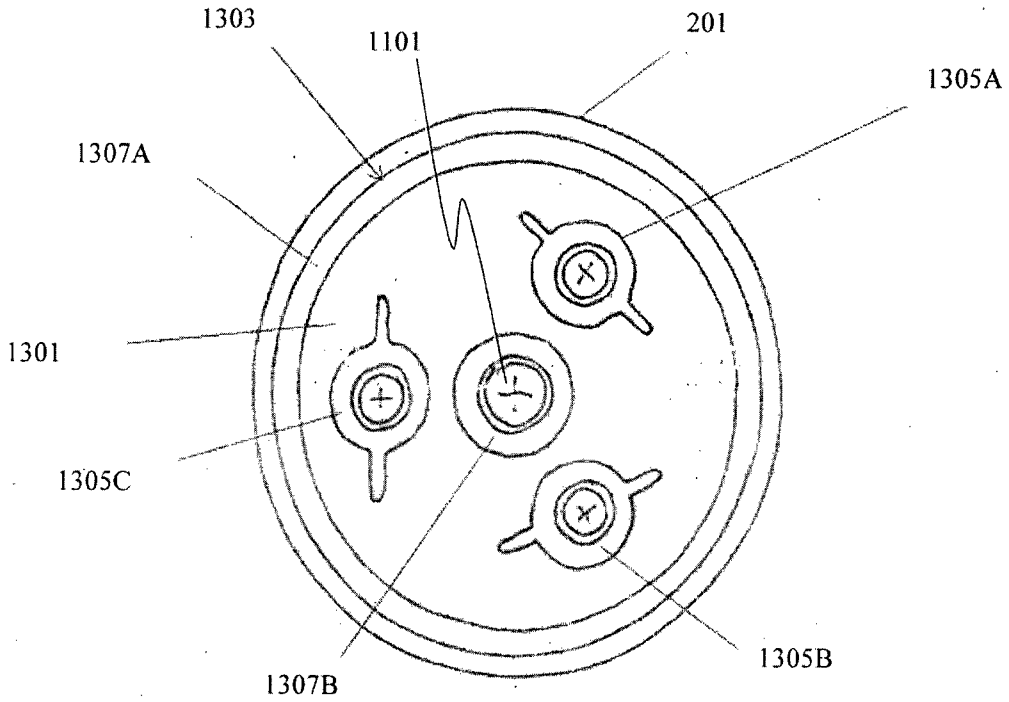


Figure 13A

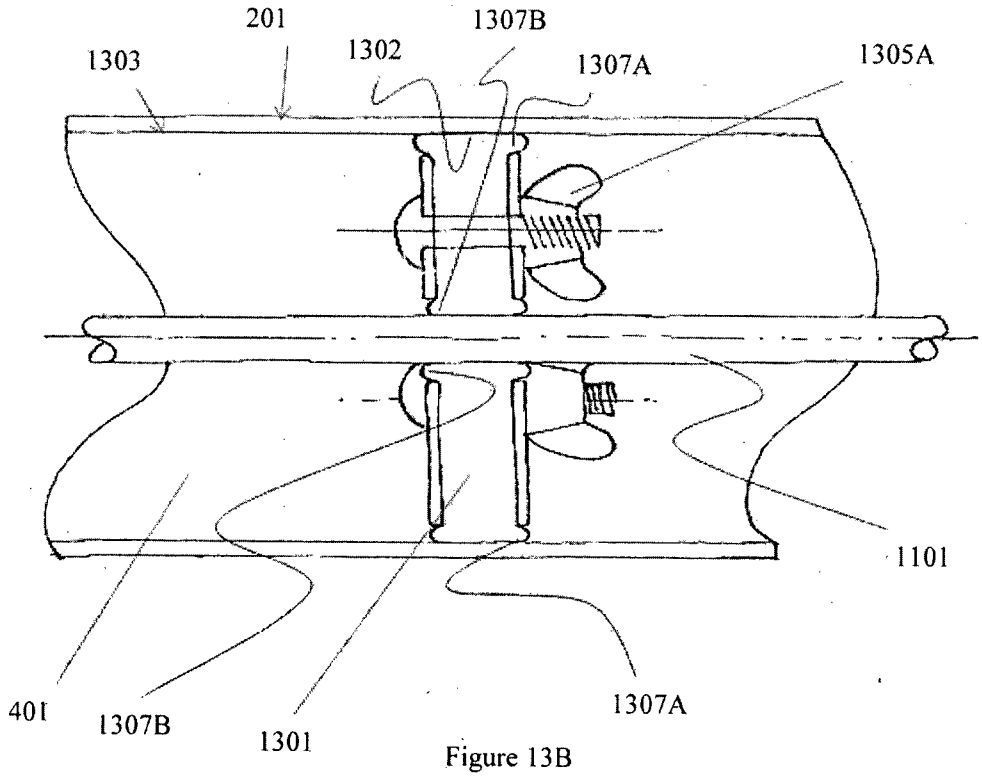


Figure 13B

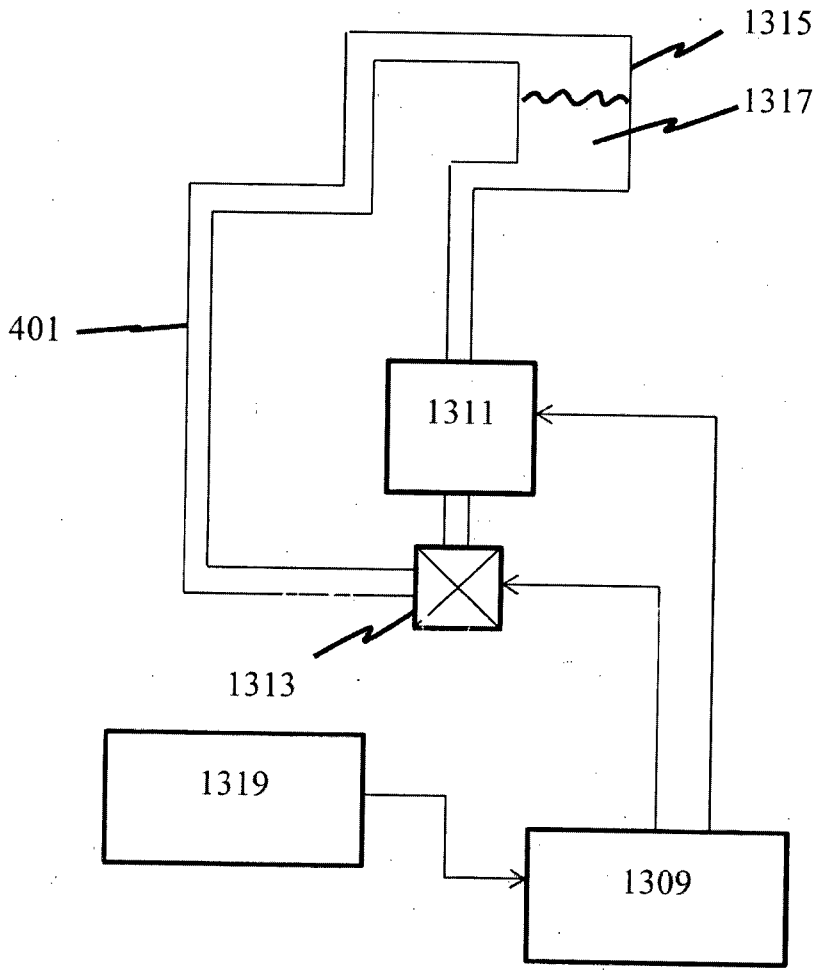


Figure 13C

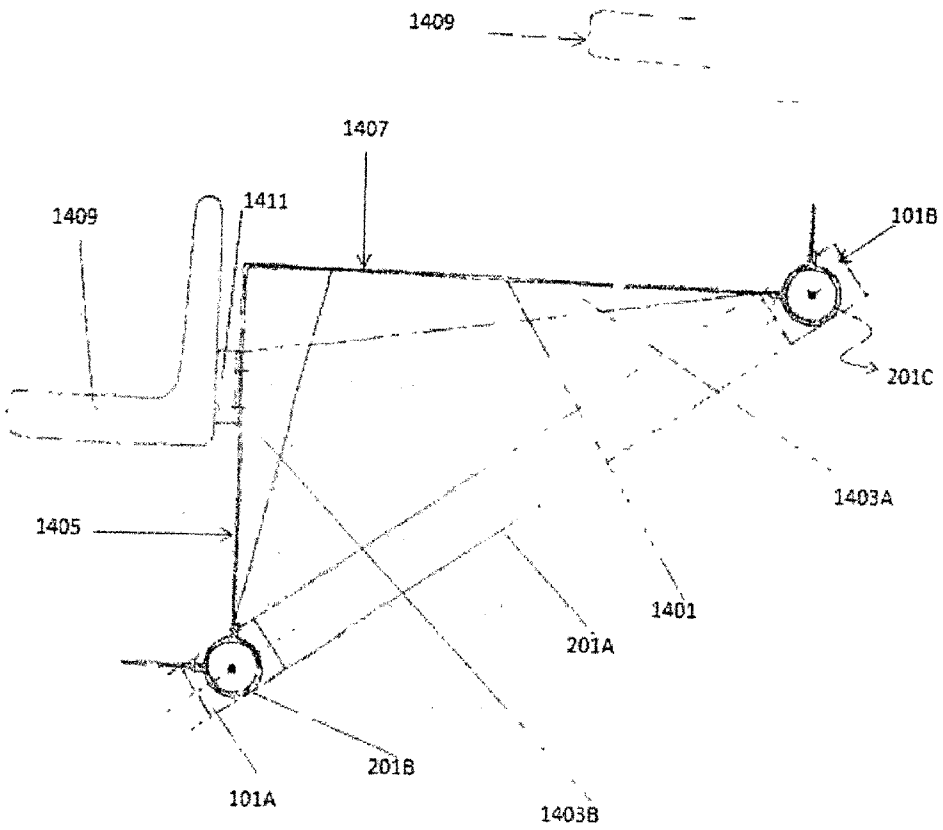

1409
1407
1409
1411
101B
201C
1403A
1405
1401
201A
201B
101A
1403B

FIGURE 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2013/000723

A. CLASSIFICATION OF SUBJECT MATTER

E04B 1/19 (2006.01) E04C 2/292 (2006.01) E04H 1/02 (2006.01) E04B 5/00 (2006.01) E04F 15/02 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI & EPODOC – IPC & CPC E04B 1/-, E04H 1/-, E04B 5/00, E04B 5/02/LOW, E04B 5/43, E04B 5/46, E04B 5/48, E04C 2/-, E04F 15/- and keywords (FLOW+, CONVEY+, CIRCULAT+, AIR_CON+, SEAL+, GASKET+, NODE?, NODAL, HUB?, COUPL+, CONNECT+, FRAM+, SKELET+, LATTICE+, DIMENSIONAL+, TRUSS+, PIPE?, PIPING+, TUB+, HOLLOW+, +TENSION+, TIGHT+, TAUT, TENDON+, CABL+, PLATFORM+, FLOOR+, DECK+, WALK+, PANE+, BOARD+, CONNECT+, ATTACH+, MOUNT+, SUPPORT+, SECUR+, CIRCULAR+, RADIAL+, CIRCUMFER+, DIAMET+, FLANGE+, FIN, TAB, PLANAR, ROUND+, CIRC+, BEAM+, JOIST+, SHEET+, METAL+, STEEL+, ALUMIN+, LAYER+, SKIN+, CLAD+, FACING+, SANDWICH+, FOAM+, LIGHTWEIGHT+, EXPAND+, BOND+, GLUE+, ADHE+, PORTION+, SECTION+, SECOND+, MULTIPL+, STACK+, TWO, OVERLAY+, OVERLAP+) and like terms;

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 October 2013	03 October 2013

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INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2013/000723**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1515014 A (MANNESMANNROEHREN-WERKE AG) 21 June 1978 Fig. 1, page 1 lines 34-44, page 2 lines 23-35	1-5
X	GB 1497576 A (MANNESMANNROEHREN-WERKE AG) 12 January 1978 Figs. 1 & 2, page 2 lines 56-60	6-12
X	JP 2000-220208 A (SANKYO ALUM IND) 08 August 2000 Figs. 3-5 & 10	13-18, 23-28 & 40
X	DE 3710230 A1 (HÜTZEN) 06 October 1988 Figs. 1 & 2, col. 4 lines 8-12 & 58-60	19-22
X	DE 1928840 A1 (MERO AG) 23 December 1970 Figs. 1, 4, 5 & 10	29-39
X	CA 1259467 A (MARSH) 19 September 1989 Figs. 4-6	6-12
A	WO 2001/051741 A1 (NOWACK et al) 19 July 2001	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2013/000723

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

Supplemental Box

Continuation of: **Box III**

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

1. Claims 1 to 5 are directed to a building system comprising a plurality of tubes and connection nodes with a continuous cavity and further comprising fluid tight seals between the tubes and connection nodes to enable fluid to flow through the continuous cavity. The feature of the fluid tight seals between the tubes and connection nodes to enable fluid to flow through the continuous cavity is specific to this group of claims.
2. Claims 6 to 12 are directed to a building system comprising a plurality of tubes and connection nodes with a continuous cavity and further comprising the cavity being arranged to receive the at least one tensile element for countering tension in the frame. The feature of the tensile element for countering tension in the frame is specific to this group of claims.
3. Claims 13 to 18 are directed to a building system comprising a plurality of tubes and connection nodes wherein the tubes comprise at least one planar portion for the attachment of a platform structure. The feature of a planar portion for the attachment of a platform structure is specific to this group of claims.
4. Claims 19 to 22 are directed to a composite panel. These features of the panels comprising a first metal outer layer, a second metal outer layer, and a foam core positioned in between the first and second metal outer layers, are specific to this group of claims.
5. Claims 23 to 28 and 40 are directed to a flooring system comprising a plurality of tubes with planar portions (claim 13) for the attachment of composite panels as claimed in claim 19.
6. Claims 29 to 39 are directed to a building system comprising a plurality of connection nodes and tubes with planar portions (claim 13) for the attachment of panels and wherein the nodes further comprise at least two extending portions positioned at an angle of 135 degrees to form a frame having an octagonal plan cross-section. The feature of the at least two extending portions positioned at an angle of 135 degrees to form a frame having an octagonal plan cross-section is specific to this group of claims

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a priori*.

It is further noted that the only feature common to the claimed inventions of groups 1, 2, 3 and 6 and which provides a technical relationship among them is a building system comprising a plurality of tubes and connection nodes. However this feature does not make a contribution over the prior art because it is disclosed in any one of the prior art documents D1 to D3 and D5 to D7.

Therefore in the light of this document this common feature cannot be a special technical feature. Therefore there is no special technical feature common to all the claimed inventions of groups 1, 2, 3 and 6 and the requirements for unity of invention are consequently not satisfied *a posteriori* for these groups.

The groups 1 to 4 and 6 do not share a common special technical feature and as such there are five distinct inventions. The invention of group 5 contains a dependency to the invention of group 4. Some claims introduce features from different inventions of the other groups. Where appended claims introduce features of one of the claimed inventions and yet are additionally appended to claims directed to any other of the claimed inventions, such claims will only be searched and reported on to the extent that additional search fees have been paid for all such claimed inventions.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2013/000723**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
GB 1515014 A	21 Jun 1978	CA 1036314 A1	15 Aug 1978
		DE 2428524 A1	18 Dec 1975
		DE 2428524 B2	14 Sep 1978
		FR 2274744 A1	09 Jan 1976
		FR 2274744 B1	01 Oct 1982
		GB 1515014 A	21 Jun 1978
		IT 1038880 B	30 Nov 1979
		JP S5111613 A	29 Jan 1976
		JP S5848699 B2	29 Oct 1983
GB 1497576 A	12 Jan 1978	AT 336235 B	25 Apr 1977
		BR 7503596 A	25 May 1976
		DE 2427426 A1	11 Dec 1975
		DK 251175 A	07 Dec 1975
		FR 2273914 A1	02 Jan 1976
		FR 2273914 B1	08 Jun 1979
		GB 1497576 A	12 Jan 1978
		JP S517715 A	22 Jan 1976
		NL 7506719 A	09 Dec 1975
		SE 7506503 A	08 Dec 1975
JP 2000-220208 A	08 Aug 2000	JP 3402241 B2	06 May 2003
DE 3710230 A1	06 Oct 1988	None	
DE 1928840 A1	23 Dec 1970	DE 1928840 A1	23 Dec 1970
		DE 1928840 B2	15 Jul 1976
CA 1259467 A	19 Sep 1989	None	
WO 2001/051741 A1	19 Jul 2001	DE 10001399 A1	16 Aug 2001
		WO 0151741 A1	19 Jul 2001

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.