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(54) **Connection node for joining members of space structures**

(57) The invention pertains to the connection node for joining eight members of a space structure in particular structural space frames. The node is formed by interconnecting the individual members (10,20) to spacer plates (30) using overlapping bolt holes (40) at the ends of each member and on the plates. The main assets of the system are that it can be utilised for various space structures, can be fabricated using simple elements and enhances the use of relatively short sectional members.

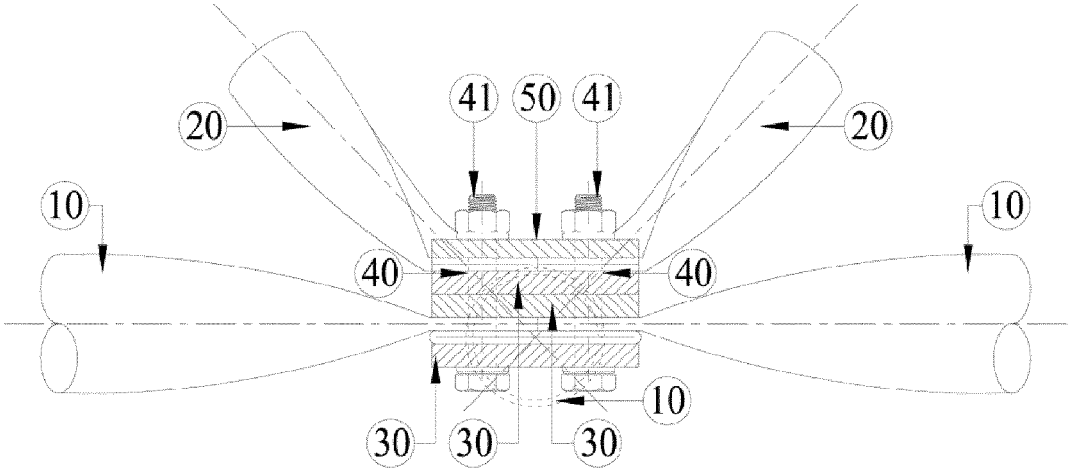

Fig. 2

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Description

BACKGROUND DESCRIPTION OF THE INVENTION

[0001] The invention is an effective node solution to successfully design and construct space structures made up of different sectional elements. The node was developed to be capable of connecting eight sectional members (per node) located in three dimensional space together to a single joint. The ability of connecting such an amount of sectional members enhances the use of short sectional members and thus facilitates the assembly and transportation processes. In order to be capable of transferring the complex forces, the node had to be designed as strong, stiff, structurally stable yet mechanically simple with minimum eccentricity. These characteristics were achieved considering that elements of the node could be fabricated easily without using extraordinary technology and thus opting for repetitive, mass production techniques.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The invention can be more fully understood by reading the subsequent detailed description with references made to the accompanying drawings, wherein:

[0003] FIG. 1 is a plan view showing the edges of the four boom and four diagonal elements assembled over the spacer plates with the bolt holes aligned.

[0004] FIG. 2 is a sectional elevation through the main boom elements showing all the elements assembled with the bolts tightened.

[0005] FIG. 3 is a side elevation showing an exploded view of the system.

[0006] FIG. 4 is a plan view showing a variation of the system where the spacer plates above and below the diagonal elements are rotated by 45 degrees.

[0007] FIG. 5 is a sectional elevation through the main boom elements showing the variation of the system where the spacer plates above and below the diagonal elements are rotated by 45 degrees.

DETAILED DESCRIPTION OF THE INVENTION

[0008] The invention is aimed towards spaceframe structures of up to approximately 20m clear span, employing an efficient, fast and clean design, manufacture and assembly of such structures, both for aesthetic and functional purposes.

[0009] These space structures are manufactured from any type of member of any material which is structurally adequate, and amenable to the method of manufacture.

[0010] Preferably the elements are made of steel. The size of the elements ***(10, 20)*** varies with the structural/aesthetic requirements of the project in hand. The elements are divided into 2 main groups - the *main booms* ***(10),*** those parallel to the direction of span, and the *diagonal* members ***(20).*** Welding is removed from the jointing system, implying the possibility of a cost-effective and if required a relocatable solution.

[0011] As shown in ***FIG 1 - 5*** the ends of the four main boom elements **(10)** and four diagonal elements **(20)** are cut to size and prepared in a pressing machine or other similar equipment to prepare the adequate jointing surface. When circular hollow sections are utilised, the edges are squashed to approximately half the flattened width, or one fourth of the pipe circumference. The ends of the *diagonal* members ***(20)*** are also bent to the required angle depending on the design height of the space frame and then cut or sheared to form the 45 degree rotated end shown in **FIG 1 and 4**. Two holes ***(40)*** are drilled or punched at the ends of the *main booms* ***(10),*** while one hole is drilled or punched at the ends of the *diagonal* elements ***(20).*** The size of these holes ***(40)*** depends on the size of the bolts ***(41)*** which in turn are related to the structural/aesthetic requirements of the project and on practical end distances required by the relative British Standards and Eurocodes. These elements are assembled together at the node as shown in **FIG 1-5**. Adequate spacers in the form of plates ***(30)*** with four holes ***(40)*** of a diameter and spacing similar to that of the rest of the node are placed between the *diagonal* elements ***(20)*** and the *main booms* ***(10),*** as shown in **FIG 1-5**, to enable the lines of force of the structural system to meet at one point. Therefore, the depth of these spacers ***(30),*** that is, the distance between the main booms ***(10)*** and the diagonals ***(20)*** at the node, will vary with the particular structural geometry of the specific project. A finishing plate ***(50)*** with four holes ***(40)*** of a diameter and spacing similar to that for the rest of the node is then placed over the diagonal members before final fixing with four adequate strength bolts ***(41).***

[0012] As shown in **FIG 1-5** the main booms and diagonal elements are not continuous at the node connection, therefore fabrication may be carried out as a series of mass production of individual main booms, diagonal elements and plates. The connection node is specifically designed to safely transfer the imposed stresses throughout the structure with minimum eccentricity. This is achieved by confirming that the maximum compressive and tensile forces do not exceed the bolt shear capacity, bolt bearing capacity and members' bearing capacity.

MAIN BENEFITS OF THE SYSTEM

[0013] Following is a list of the main benefits of this system over other similar space frame nodes such as those specified in international publication numbers WO 85/05650 and WO 2003/176733:

- All members are not continuous at the node connection therefore these may have a relatively short length which would be circa 1.80m. Therefore the assembly and transportation processes are facilitated since personnel would not need to handle large members and thus the use of lifting equipment is

minimised.

- Fabrication may be carried out as a series of mass production of identical main booms, diagonal elements and plates, thus the fabrication period is minimised since there would be no need to handle long members.

- The node proportions are specifically designed to enable sufficient bearing capacity of the connected part of the members to sustain the imposed tensile forces which are normally considered as a weak point when non continuous members are bolted at the edge.

Claims

1. A spaceframe node comprising of eight members cut to size with its edges prepared to form a flat joining surface, wherein the eight members four main boom elements (10) and four diagonal elements (20).

2. The node of claim 1 wherein the diagonal members (20) form a 45°C angle with the main boom elements, when viewed from a plan view.

3. The node in accordance with claims 1 or 2 wherein additional diagonal members and spacer plates are installed on the bottom part of the node such that these appear as a mirror image along the bottom booms when viewed from a sectional elevation. This is the case with a double layer spaceframe or other space structures.

4. The node according to claims 1-3 wherein two holes (40) are drilled or punched at the ends of the main booms (10), while one hole is drilled or punched at the ends of the diagonal elements (20).

5. The node according to claims 1-4 wherein the elements are made of steel.

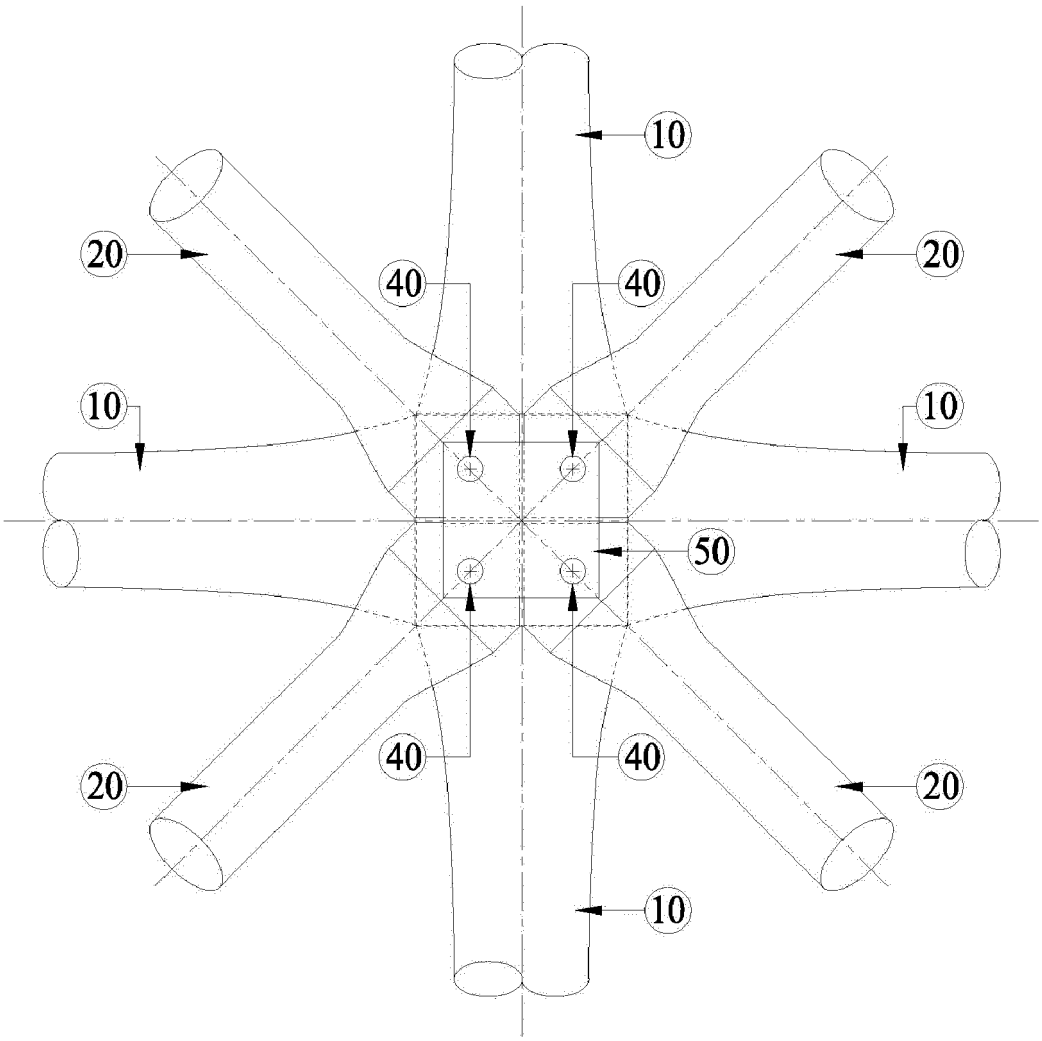

Fig. 1

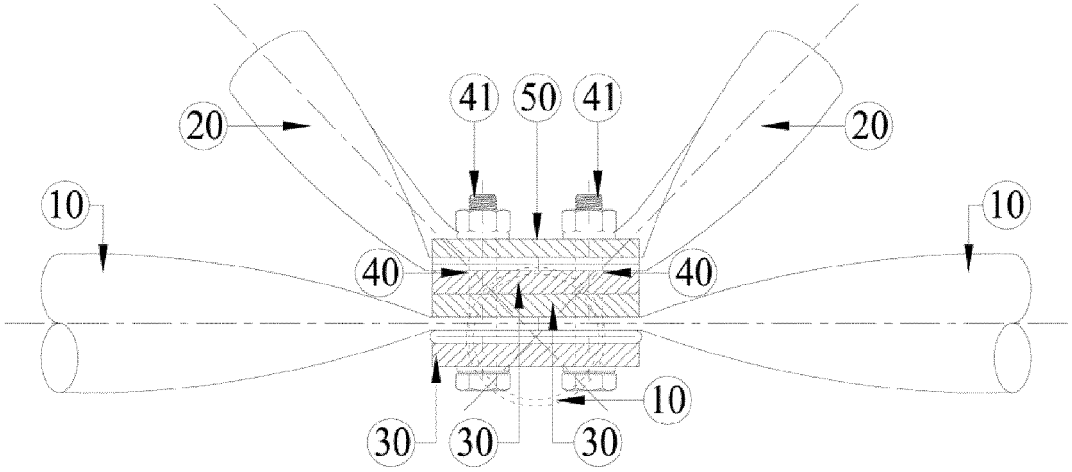

Fig. 2

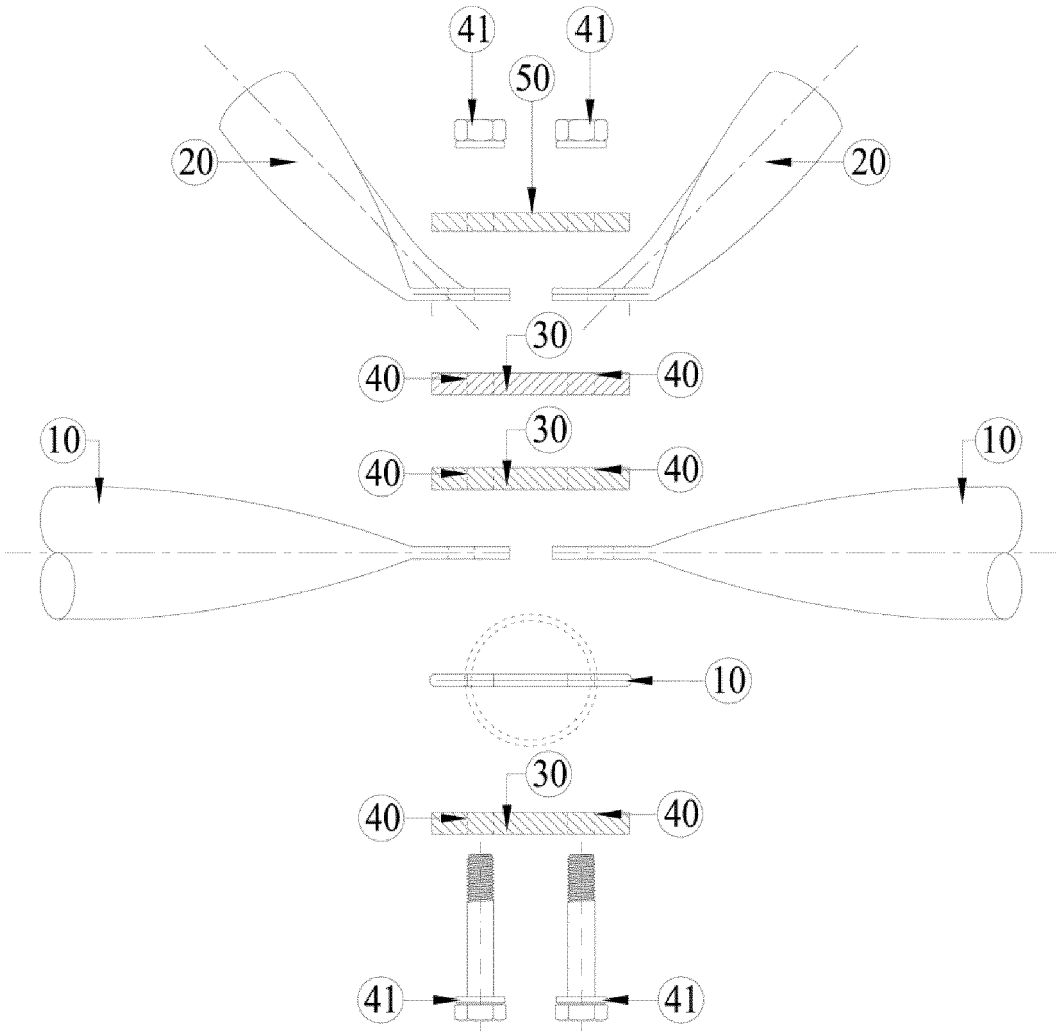

Fig.3

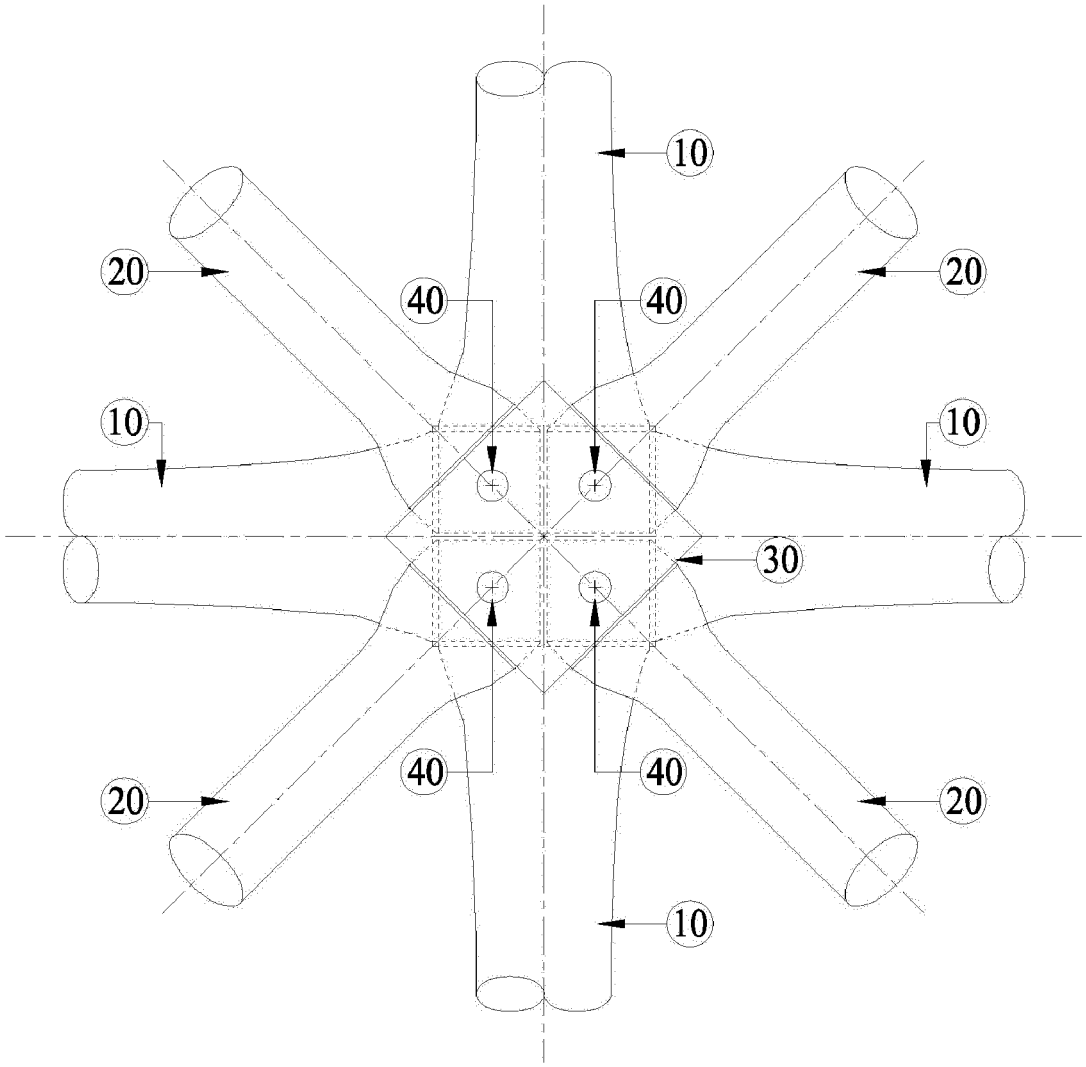

Fig. 4

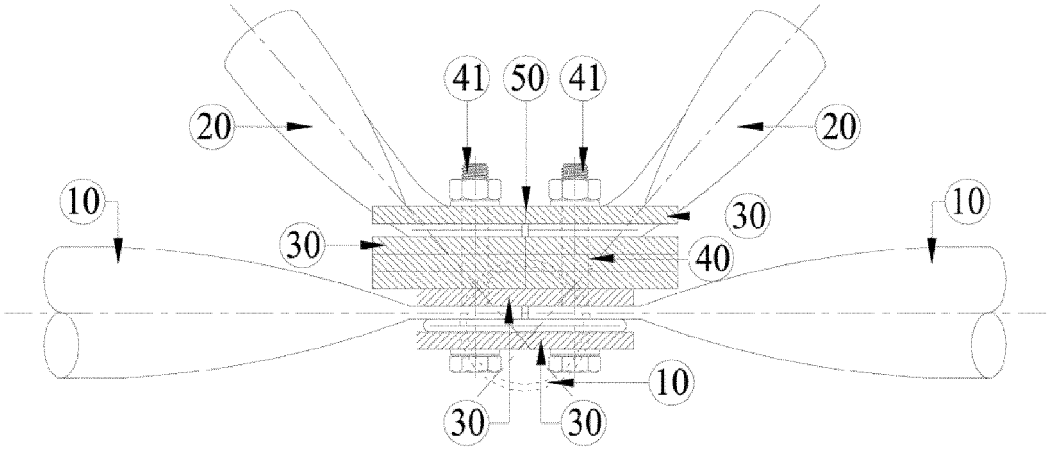

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 13 17 7255

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 85/05650 A1 (TULSERATE LTD [GB]; CODD EDWIN THOMAS [AU]) 19 December 1985 (1985-12-19) * page 3, line 14 - page 6, line 3; figures 1-6 * -----	1-5	INV. E04B1/19
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X	WO 85/01078 A1 (CODD EDWIN THOMAS) 14 March 1985 (1985-03-14) * page 3, line 6 - page 6, line 36; figures 1-6 * -----	1-5	
			TECHNICAL FIELDS SEARCHED (IPC) E04B

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	30 August 2013	Couprie, Brice

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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REFERENCES CITED IN THE DESCRIPTION

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