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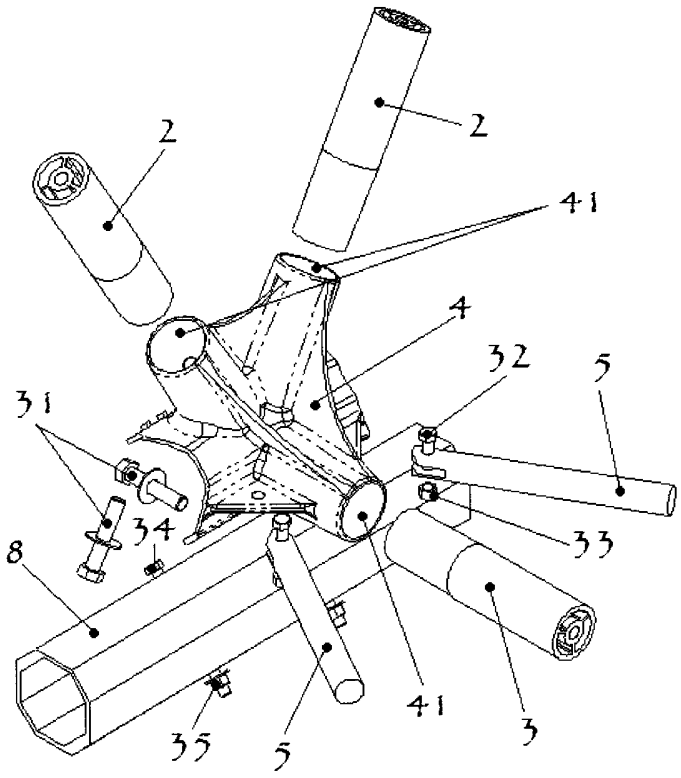
(54) Title: MOMENT-RESISTING JOINT AND SYSTEM



(57) Abstract: The present invention is directed toward a novel moment resisting connection system, for use, but not limited to, with a pony-truss bridge system. The connection system comprises multi-hollow sections that can be, but are not limited to, extruded aluminum and a joint or node connector that can be casted, milled, forged or made by any other means.

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Title of the Invention

[0002] Moment-Resisting Joint and System

Cross-Reference to Related Applications

[0003] The present application claims the right of foreign priority with respect to Application No. US60/679,884, filed 05/12/2005, in United States of America, the disclosure of which is incorporated herein by reference.

Field of the Invention

[0004] The present invention relates to a non-welded, structural connection system with moment resisting capability that can be used in a pony-truss bridge system or in diverse areas of architectural design, engineering, fabrication, and field erection structures using tubular members.

Background of the Invention

[0005] Transportable and assemblable bridges are known which can provide a path for pedestrian, bicycles, light or heavy vehicles, across and over obstacles such as rivers and ravines. Some example of previous invention of prefabricated unit construction modular bridging systems may be found in U.S. Pat. Nos. 4,912,795 / 5,414,885 / 6,009,586 / 4,965,903 / 6,308,357 / 6,631,530 and 5,924,152.

[0006] Most of the time, fusion welding is employed to assemble such structures. However, it is well known in literature that aluminum fusion welding partially anneals the weld zone by creating a heat-affected-zone on the base metal which decreases its ultimate and yield strengths (example can be read in Dispersoid-Free Zones in the Heat-Affected Zone of Aluminum Alloy Welds - B.C. MEYER, H. DOYEN, D. EMANOWSKI, G. TEMPUS, T. HIRSCH, and P. MAYR). The present invention allows

the fabrication of such structure using the full strength of aluminum because no welding for the main bearing structure would be required anymore. As an additional feature, the invention could allow anodizing, bake paint finished and easy transportation of all components to the erection site. The fabrication of all components could also be made by numerically controlled technologies that could increase accuracy as well as minimizing the fabrication time. Most of these additional features are not always possible for conventional aluminum welded structures since large structures request special transportation or would not fit into anodizing baths or on automated bake paint lines.

[0007] Another important advantage is that the invention allows all elements to be joined quickly together on site with a minimum of fasteners to form a bridge of the required length and strength within the overall limitations of the system wether it is made of aluminum, steel or other suitable material.

Objects of the Invention

[0008] It is an object of the present invention to provide a mean to build transportable bridges which can be easily and readily transported in pieces by, for example, trucks, boats, aircrafts or helicopters.

[0009] It is a further object of the present invention to design such bridge pieces so that they may be carried or parachuted into the desired location.

[0010] It is yet another object of the present invention to allow for the bridge to be assembled as a self-supporting, projecting structure by relatively few people without using special equipment.

[0011] The invention can achieve one or more of the following advantages:

- Avoiding the creation of a heat-affected-zone for the main bearing elements;
- No certified welders are required to assemble the structure;

- Very long span possible due to the light weight of aluminum;
- Allowing architectural finishes such as anodizing, bake paint finishes and others;
- Pre-engineered structures that minimize the engineering design costs;
- Off-the-shelf elements that allow a structure to be shipped within few working days compared to weeks or months for a regular welded structure;
- Pre-fabricated elements with numeric controlled technologies reduces labour costs and poor accuracy;
- Decreasing assembly costs because the structure can be assembled quickly with minimal labour as well as a minimum number of fasteners;
- Ease of transportation (or exportation) allows all elements to be shipped on regular bundles or pallets independently of the final size of the complete structure.

[0012] The invention is especially advantageous for use in the construction of structures made from aluminum.

[0013] Other and further objects and advantages of the present invention will be obvious upon an understanding of the illustrative embodiments about to be described or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

Summary of the Invention

[0014] There is, therefore, provided in the practice of this invention a connection system with moment resisting capability, a novel framing element and a method of assembling same.

[0015] The present invention relates to a novel connection system with moment resisting capability being used, but not limited to, in a pony-truss bridge which can be assembled from individual prefabricated or off-the-shelf components.

[0016] Such structure may be constructed quickly to meet variation of spans or widths as well as to provide temporary or permanent access to all individuals, light vehicles and bicycles between two areas of different elevation or across and over obstacles or may be used as a walkway system to be cantilevered from the existing bridge structure, thereby providing suitable walkway widths on both sides of a bridge without reducing the width of existing traffic lanes.

[0017] The connection system can be attached to the tension chord of a pony-truss bridge to resist bending moment such as required for the top chord stability (top chord stability criteria utilizing elastic lateral restraints - TV Galambos, Timoshenko). To assemble the connection system, three or more multi-hollow members are slid into female node cavities and preferably locked in place utilizing a fastener, usually a bolt, that goes through their neutral axis. The framing elements are positioned accurately into the node's cavities according to fabrication accuracy which may be done by numeric controlled technologies. The framing member attachment or fastener means is preferably done within the area of its neutral axis by typically, but not limited to, a bolt that acts to absorb the tensile forces exerted on to the system without compromising the node connection. Once the member is in place, it can be secured by a bolt, a threaded rod or any other means that will keep the member into place ideally, but not limited to, within the neutral axis region. The external wall of the element has a friction contact with the internal side cavity which will resist the compression forces or bending moments exerted onto the element therefore it can transfer such forces or moment to the node without compromising the node connection.

[0018] A given connection system is comprised of a joint or node and associated interlinked members to be used in pony-truss bridges system or any other applicable engineered structures. A preferred embodiment of the connection system employs custom aluminum extruded hollow elements and a node and bolts or rods to secure elements to the node.

[0019] Pony-truss bridge or other structures may be wholly or partially constructed using the moment resisting connectors in accordance with the invention. Such a structure is comprised of a plurality of framing elements, joint or node connectors, and attachment means.

[0020] To assemble a structure with the use of the invention, some members are positioned into the node's cavities given at the same time the final alignment due to the perfect fit inside the cavity while another member, generally a chord, is liked onto the channel's node. Ideally, all members are secured with fasteners while some have only one fastener that goes through their neutral axis and another one, generally the chord, has at least two bolts that secure it through the node's channel. For ease of reference, every time the word «cavity» is used hereinafter, it is to be understood a cavity with a specific depth to confer moment resisting capability. This depth can be determined with calculation, benchmark tests or other known means.

[0021] An example of a structure using the invention is a transportable bridge or other similar structure having two longitudinal vertical trusses, comprising: plural bridge elements connected to each other by rigid nodes on a chord. The structure includes: a decking extending across a width of the bridge and having an horizontal triangular or Vierendeel truss depending on the lateral forces being acting on the structure (usually created by wind loads). Each vertical truss of the structure (main carrying members) resists gravity live and dead loads and brings sufficient stiffness to limit the deflection in conjunction of acting as a guard-rail. When the invention is being used for a pony-truss bridge system both vertical trusses have a bottom chord and an oppositely disposed top chord, the lower chord portion of the truss being connected to the transversals usually also made of a multi-hollow beams and multi-hollow diagonal struts by the rigid node herein named connection system.

[0022] The bridge vertical trusses, and thus the main load carrying members of the bridge, has essentially five different components: the top and bottom chords, the diagonals struts and/or vertical posts, the top connector (superior node) and the bottom

connector (inferior node) which one connect both vertical trusses by horizontal floor members. These horizontal members can support what is called stringers located underneath a decking. The decking can be however made of different type of material but preferably, it could be made of a material having a low specific mass, for example composites or aluminum. The triangular trusses are dimensioned to reduce their size and corresponding weight. Consequently, the decking and the triangular trusses can be made so light that eventually the bridge structure could land on floating dock without the necessity to add additional buoyancy to it. Eventually the reduced weight of the individual components could allow the bridge to be manually assembled and carried by relatively few people.

[0023] When assembled, the bridge has a half-through shape, and consists essentially of longitudinally extending main support vertical trusses, and a decking.

[0024] The connection system being used as a moment resisting connector for the half-through bridge structure that can be eventually used to construct footbridges, golf course bridges, skywalks, overpasses, vehicular access bridges, bicycle path bridge, trail bridges, recreational bridges, walkways and so.

[0025] Further, freeway overpasses and underpasses built in the last decades frequently lack adequate walkways in situations where pedestrians or bicycles are permitted. In many communities, such barriers prevent pedestrian/bicycles access between neighborhoods, schools, and employment centers. In such cases the invention could serve to construct bridges that can be placed on the side of existing narrow bridges to give better access to the communities.

[0026] To eliminate excessive free play between the connected components when the bridge is assembled, the triangular trusses are interlockingly connected with each other. The interlocking connection includes at least one fastener that goes through the neutral axis of the diagonal and/or vertical struts, transversal beams as well as a minimum of fasteners to hold the connector to the bottom chord of the truss. Fasteners that secure the

struts to the connector act in tension while fasteners that hold the connector to the chords act in shear. Further, the top chord is linked to the diagonal and/or vertical struts with the mean of a pin connection working in shear.

[0027] A lubricant can be disposed at the interface of the connection of framing elements and node connectors to allow an easier disassembling if the bridge is temporarily installed.

[0028] The invention will be described below in greater detail in connection with embodiments thereof that are illustrated in the drawing figures.

[0029] The features of the present invention which are believed to be novel are set forth with particularity in the appended claims.

Brief Description of the Drawings

[0030] A preferred embodiment of the present invention will be described in greater detail below with reference to the following drawings, in which:

[0031] Fig. 1 is a perspective view of a fully assembled modular bridge in accordance with the present invention.

[0032] Fig. 2 is a perspective view of the main carrying members of the bridge shown in Fig. 1 prior to installation of floor boards, fencing and stringers;

[0033] Fig. 3 is an exploded perspective view of the bridge understructure shown in Fig. 2;

[0034] Fig. 4 is an exploded perspective view of the bridge shown in Fig. 1 including floor boards, fencing and stringers;

[0035] Fig. 5 is a perspective view of a splice in the bridge of Fig. 2;

[0036] Fig. 6 is a exploded perspective view of the connection system with moment resisting capability shown in all previous figures (Fig. 1, 2, 3, 4 & 5);

[0037] Fig. 7 is an elevation view of the connection system shown in Fig. 6 when fully assembled;

[0038] Fig. 8 is a section view along lines A--A in Fig. 7 when fully assembled;

[0039] Fig. 9 is a section view along lines B--B in Fig. 7 when fully assembled;

[0040] Fig. 10 is a section view of along lines C--C in Fig. 9 when fully assembled;

[0041] Fig. 11 is a exploded perspective view of the compression chord connector shown in Fig. 1, 2, 3, 4 & 5;

[0042] Fig. 12 a section view of the superior connector shown in Fig. 11 when fully assembled;

[0043] Fig. 14 is a section view along lines D--D in Fig. 12 when fully assembled.

[0044] Fig. 15 is an elevation view of the inferior node connector with moment resisting capabilities;

[0045] Fig. 16 is an elevation view of the superior node connector;

[0046] Fig. 17 is a section view of the diagonal/vertical struts and transversals;

[0047] Fig. 18 is an alternative for the inferior connector element. It is therefore possible that the struts to be made of a hollow section, usually circular, and the tension forces can be taken by a rod that is independently located near the strut neutral axis.

[0048] Fig. 19 is a section view along lines E-E in Fig. 18 when fully assembled;

[0049] Fig. 20 is another alternative for the inferior connector element. It is therefore possible that the struts to be made of a hollow section, usually circular, and the tension forces can be taken by an insert located inside the hollow section.

[0050] Fig. 21 is a section view along lines F-F in Fig. 20 when fully assembled;

Detailed Description of the Preferred Embodiment

[0051] Turning to Fig. 1, a modular pedestrian bridge 1 is shown comprising a plurality of individual elements connected to each other by the mean of node connectors 4 and 7. Fencing 20 connect to the vertical trusses on the inside as shown or eventually on the outside. A decking 21, or eventually floor boards, is placed on top of the stringers (not shown) and acts as a floor to be walked on. Ends of the bridge, when installed, are connected to respective end footings (not shown) via respective anchors (not shown).

[0052] The modular sections of fencing 20 may be fabricated to any suitable length. Typical sections contemplated are 5 feet, 10 feet, 15 or 20 feet in length.

[0053] Fig. 2 shows the bridge in Fig. 1 prior to installation of the decking and stringers. As can be seen from Fig. 2, both vertical trusses are linked to each other via a plurality of transversals 3 and diagonals 5 extending there between.

[0054] Fig. 3 illustrates an exploded view of the main bearing structure comprising a plurality of linear elements such as two tension chords 8, two compression chords 1, a

plurality of diagonals 2, transversals 3, floor diagonals 5 all connected to each other by the mean of top node connectors 7 and bottom node connectors 4.

[0055] Next, as shown with reference to Fig. 4, longitudinal stringers 22 are placed and secured on top of the transversals 3. A decking is secured to the stringers via fasteners (not shown). A fencing system 20 (optional) can be attached to the vertical main load carrying trusses.

[0056] Turning to Fig. 5, successive ones of the vertical trusses are shown comprising top and bottom chord members 1 and 8 connected via splices 30 and 31. Diagonal members 2 provide additional support.

[0057] The bottom node connector is shown in greater detail with reference to Fig. 6 comprising diagonals 2, tension chord 8, floor diagonals 5, transversals beams 3 and a node connector 4 that have the ability to transfer bending moments. The diagonals and transversals are inserted into corresponding cavities thereby 41 at the distal ends of the diagonals and transversals members 2 and 3. Ideally, the diagonals and transversals have tapered ends for insertion into corresponding ones of the cavities. Their ends can be milled, turned, swaged or bring to this particular shape by the mean of any way. The cavities however could be or not to be of a similar corresponding shape depending on temporary or permanent use of the structure (vertical or tapered inside wall of cavities). The best way to secure such diagonals and transversals inside the node connector could be done by the use of a bolt that is screwed inside the internal region 42 of the multi-hollow cavity extruded tube as shown in fig. 17 and as shown in greater detail with reference to Figs. 8 and 10. The node connector is attached to the tension chord by a pair of bolts 34 and nuts 35 through two like pairs of holes adapted to align the node 4 and the chord 8. Both floor diagonals attach to the node connector with bolts 32 and nuts 33.

[0058] The node connector form a solid and extremely stable connection between the hollow tubing chord members 8, the transversal beam 3 and the diagonals 2 for maintaining structural integrity throughout the chord members 8, thereby overcoming

lateral stability problems inherent in half through (pony) bridge. As shown with reference to Fig. 6, bolts that are used to secure diagonals and transversals are hidden so they cannot be unscrewed while the node is attached to the chord providing additional safety against thief or sabotage. Additionally, anti thief nuts can be used instead of regular nuts to secure the node connector to the chord 35. The resulting connector is in a visually attractive appearance.

[0059] Turning now to Figs. 7, 8, 9 and 10, the first figure is an elevation view from the inside of the bridge. Element 3 is the transversal hollow beam and elements 5 are the diagonal bracings to resist any horizontal loading act on the projected area of the bridge structure. Elements 2 are the diagonals that support the compression chord (not shown). They mainly resist tension and compression forces but they also transfer some bending moment to the floor beams as well as they transfer torsion to the tension chord 8 since they stabilize the compression chord which one tend to buckle. Fig. 8 shows a view along lines A-A in Fig. 7. As it can be seen a fastener 36, generally a bolt, secures the floor beam 3 into the node 4 cavity. Bolt 34 secure the node 4 to the tension chord 8. Fig. 9 shows a view along lines B-B in Fig. 7. Fig. 10 shows a view along lines C-C in Fig. 9. Once again we find two fasteners, generally bolts, to secure both diagonal members 2 into the node 4 cavities.

[0060] As shown best with reference to Fig. 11, the exploded view of the compression node connector shows two diagonals 2, two superior node connectors 7, a compression chord 1 and their associated fasteners 36, 37 and 38, generally bolts. The diagonals 2 are linked to the superior nodes generally by the mean of one bolt 36 screwed into their neutral axis. The superior node connectors are however linked to the compression chord by the mean of a bolt 37 that fits into a hole in the compression chord 1. The bolt 37 is secured in place with a nut 38 or preferably with an antitheft nut (not shown).

[0061] Fig. 12 shows a sectional view from the compression chord 1. It is therefore acknowledge that the bolt 37 works in shear while the fasteners (not shown) that secure the diagonal 2 on the superior node 7 works in tension.

[0062] Fig. 14 shows a view along lines D-D in Fig. 12. As it is shown fasteners, generally bolts 36, secure the diagonals 2 on the superior node 7. A fastener 37 goes through a hole in the compression chord 1.

[0063] Fig. 15 shows the moment resisting node connector 4 while fig. 16 shows the superior node connector which one are generally liked to a multi-hollow extruded shape as it is shown in fig. 17. Even if the cylindrical framing element 2, 3 has been shown having a circular section, it is to be noted that the section of the framing element could have any other suitable section such as, for example curved section (e.g. ellipsoidal) or polygonal section (e.g. square, triangular or else).

[0064] Fig. 18 shows a possible alternative to the use of a multi-hollow section shown in figure 17. It is therefore possible to use, but not preferred, a regular hollow shape that could be secured into the node cavities by the mean of a rod partially or completely threaded. Fig. 19 shown a view along lines E-E in Fig. 18. A rod 39 can run on or near the neutral axis of a tube. A nut 40 can give a pre-tension to maintain the tube inside the cavity with adequate pressure.

[0065] In addition to the alternative shown in fig. 18, Fig. 20 shows another alternative that could be possible, but not necessary desired, as it could allow the element 9 (a hollow section) to be secured into place with the mean of a threaded insert 44 as shown in Fig. 21 that would fit the inside of the element 9. The insert 44 could be maintained inside the element 9 by the mean of welding or by any other mean.

[0066] Fig. 21 is a view along lines F-F in Fig. 20 and it shows the insert that could be achieved to secure in place the element 9 into place with a fastener 43, generally a bolt.

[0067] Thus, in final assembly the center load of diagonals or verticals are supported equally by horizontal or tapered wall when the elements work in compression or by the mean of the fasteners, generally bolts, when the diagonals or verticals work in tension.

The transversals however transfer their moment to the node with the friction applied along the internal walls.

[0068] Accordingly, a maximum dimension of transversals 3 and diagonals 2 may be accommodated irrespective of the width and length of the bridge. By way of contrast, know prior art transversals or diagonals connections require multiple welds, generally fillet weld type, which one are not desired since it weak the base material when aluminum is employed for such structure.

[0069] Accordingly, an important aspect of the present invention is the improved mechanical properties because of avoiding welding of the main structural members. The connector acts as a rigid node able to carry and transfer tension, compression, torsional and bending moments provided by usually only one interlocking fastener running through the neutral axis of diagonals/verticals and transversals.

[0070] Preferably, all metallic structural components of the pedestrian bridge in fig. 1 in accordance with present invention are made of aluminum with the possibility to hard anodize each individual element, for forming an aesthetically pleasing and scratch resistant surface.

[0071] Other embodiments and variations of the present invention are contemplated.

[0072] For example, the connector of the present invention may be advantageously applied to virtually any structures using standard or custom hollow tubing. To that end, the inventive moment resisting connector could be used in such diverse applications as furniture construction, building construction, fencing, bridges, towers, flag post bases, gantry of motorway etc., any of which may be fabricated from stainless steel, plastic, steel or other suitable material.

[0073] Furthermore, whereas the preferred embodiment of the tapered end element which may usually be milled, swaged or turned by numeric controlled technologies, it is contemplated that end portions of the elements 2 and 3 may also be strait.

[0074] As a further alternative, the node configuration may be fabricated via specialized machining tools from a solid block or cast from metal or eventually made of composites.

[0075] Moreover, whereas the preferred embodiment discloses a structural connection for use with multi-hollow cross-sectional elements 2 and 3 in Fig. 17, it is contemplated that the cooperating element and cavity aspect of the present invention may be applied equally to hollow tubing sections having square, circular or other cross-section.

[0076] All such embodiments or variations are believed to be within a sphere and scope of the present invention as defined by the claims appended hereto.

[0077] Although preferred embodiments of the invention have been described in detail herein and illustrated in the accompanying figures, it is to be understood that the invention is not limited to these precise embodiments and that various changes and modifications may be effected therein without departing from the scope or spirit of the present invention. For example, the node resisting joint and system of the invention may be used to construct roofs and other structures using nodes to join elongated members.

Claims

1. A moment transferring node connector for joining a plurality of elongated framing elements each having a neutral axis, said node connector comprising a plurality of cavities having fastener holding means at or near their center and adapted to closely mate with one extremity of said framing member.

2. The node connector of claim 1, further comprising a channel adapted to be mounted on another structure with attachment means.

3. The node connector of claim 1, wherein said framing elements are held in said cavities by said fasteners.

4. The node connector of claim 3, wherein said fasteners are disposed along to said neutral axis.

5. The node connector of claim 4, wherein said fasteners are bolts, threaded rods or any other means that acts to absorb the tensile forces exerted on the system disposed along said neutral axis.

6. The node connector of claim 5, wherein said cavities are tapered.

7. A framing element for use with a node connector as claimed in claim 1, wherein the cross-section of said framing element comprises a central core, an external wall and a plurality of openings between the core and the exterior wall.

8. The framing element of claim 7, wherein the extremities of said framing element are tapered.

9. A connection system comprising:

a. at least one node connector itself comprising a plurality of cavities having fastener holding means at or near their center;
b. at least one framing element having a neutral axis matingly attached to one said cavity by fastening means disposed in said neutral axis.

10. The connection system of claim 9, wherein said cavities are tapered.

11. The connection system of claim 9, wherein extremities of said framing element are complementary tapered to engage said cavities.

12. A connection system as claimed in claim 9, wherein a lubricant, a sealant or glue is disposed at the interface of the connection of said framing elements and said node connectors.

13. A structure forming at least one module comprising:

a. a plurality of node connectors having cavities;
b. a plurality of framing members joined to said node connectors through their neutral axis.

14. The structure of claim 13, wherein said structure is a modular pedestrian bridge.

15. The structure of claim 13, wherein the extremities of said framing elements and the cavities of said node connectors are precisely worked to provide a predetermined gap between said framing elements and said node connectors.

16. The structure of claim 13, further comprising a least one chord wherein said node connectors further comprises at least one channel to be fixed to said chord.

17. The structure of claim 16, wherein two adjacent modules are joined by splice means.

18. The structure of claim 15, wherein said node connectors and said framing members are assembled to form vertical and horizontal trusses.

19. The structure of claim 18, further comprising side railings connected to said vertical trusses.

20. The structure of claim 14, further comprising a decking extending across a width of the bridge.

21. An extruded structural element having a neutral axis comprising;

a. an external wall;
b. an internal closed core section, disposed along said neutral axis;
c. at least one portion extending outwardly from said internal core section to said external wall.

22. The element of claim 21, wherein said wall is cylindrical.

23. The element of claim 21, wherein said framing element has a cross-section and wherein said cross section is curved or polygonal.

24. The element of claim 23, wherein said framing element has a cross-section and wherein said cross-section core section comprises a circular opening adapted to receive a fastener.

25. The element of claim 23, wherein the extremities of said framing element are tapered.

26. The element of claim 25, wherein said fastener is a bolt, a threaded rod or any other means that acts to absorb the tensile forces exerted on the element.

Fig. 1

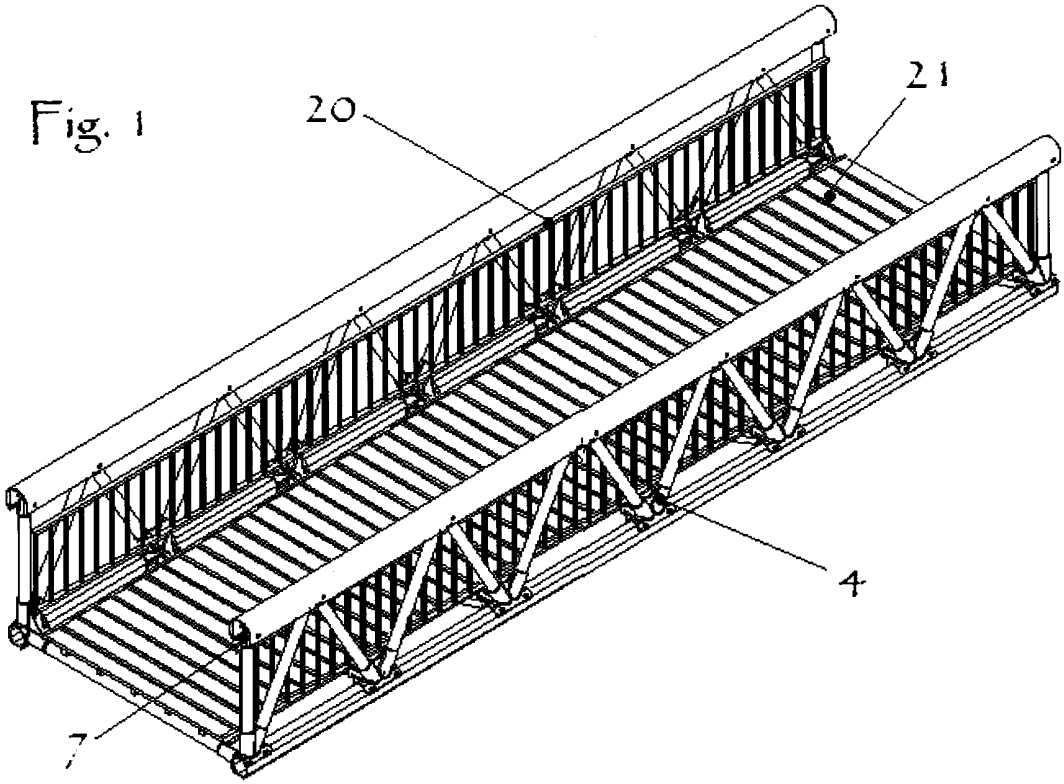
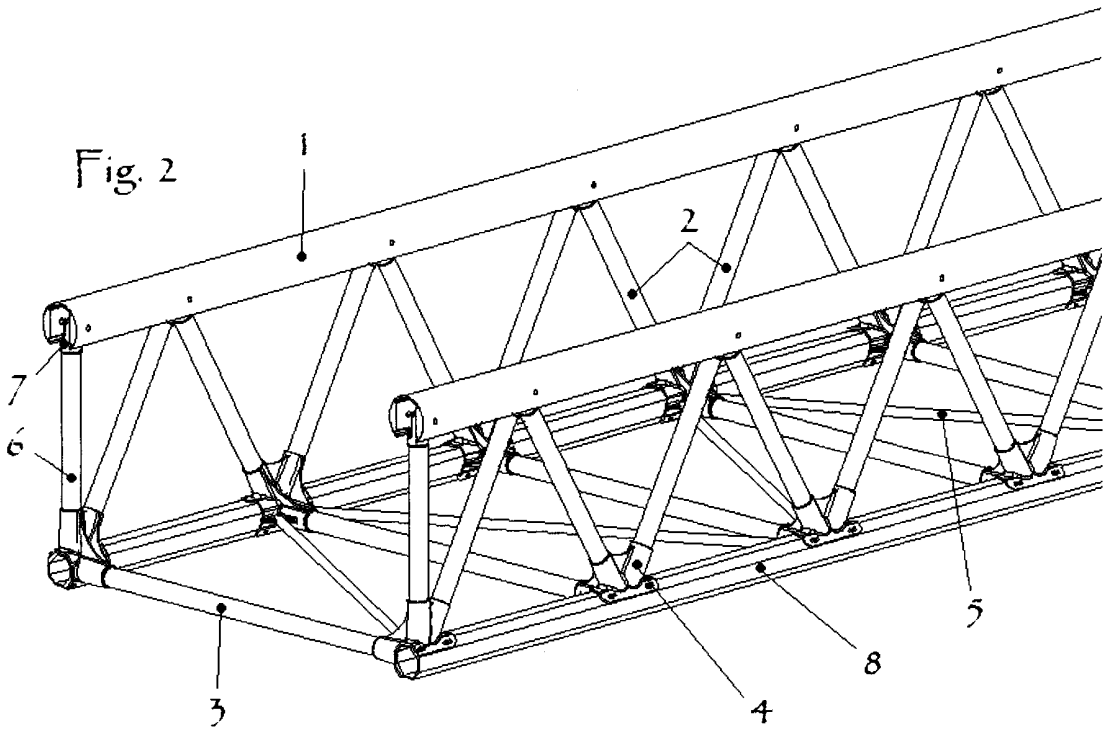


Fig. 2



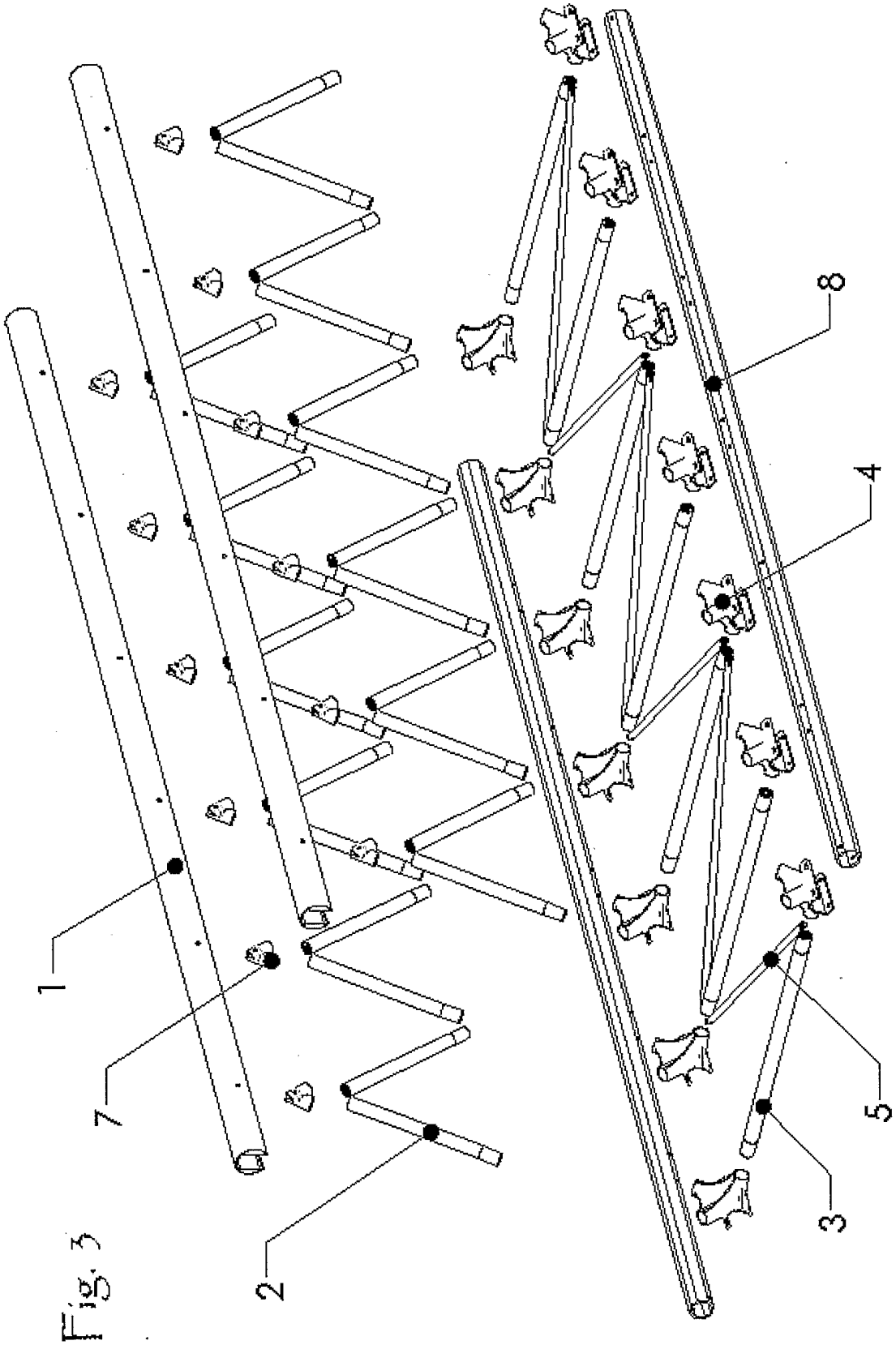


Fig. 3

Fig. 4

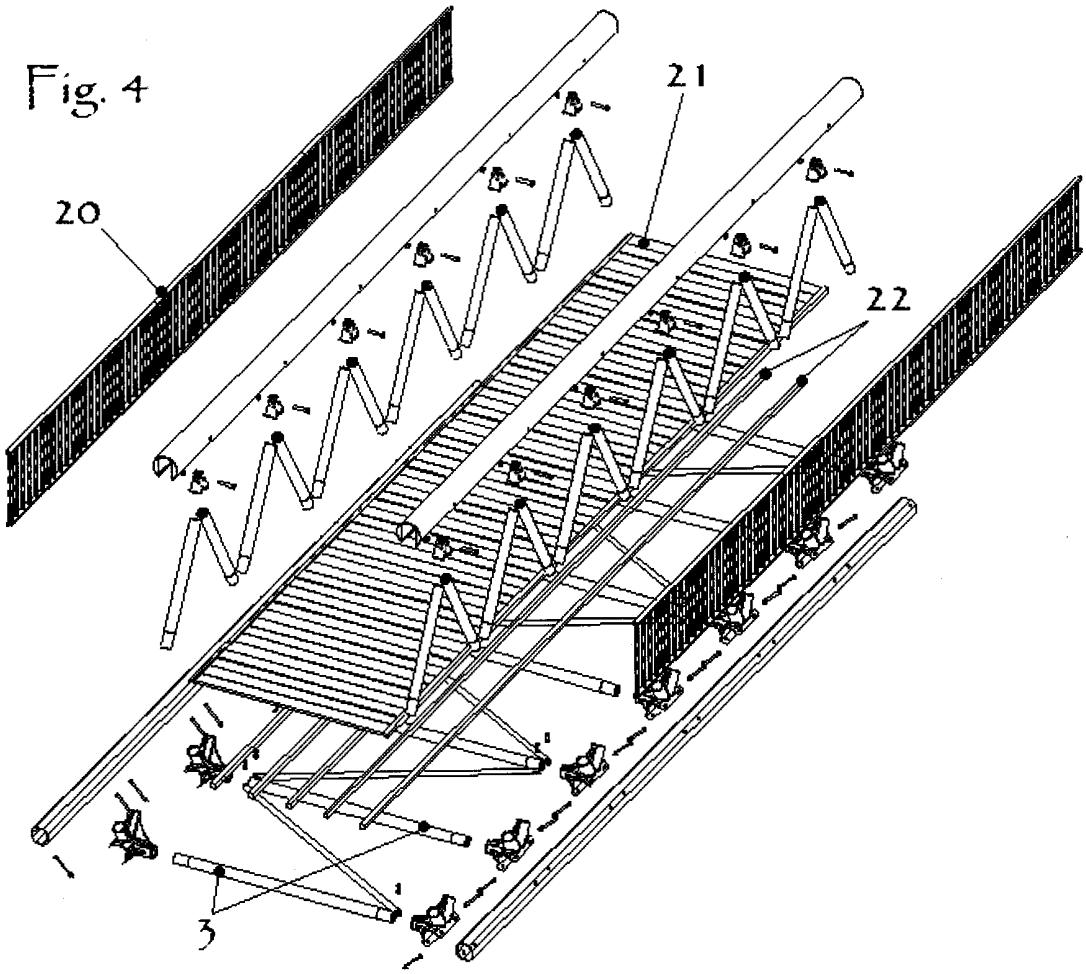


Fig. 5

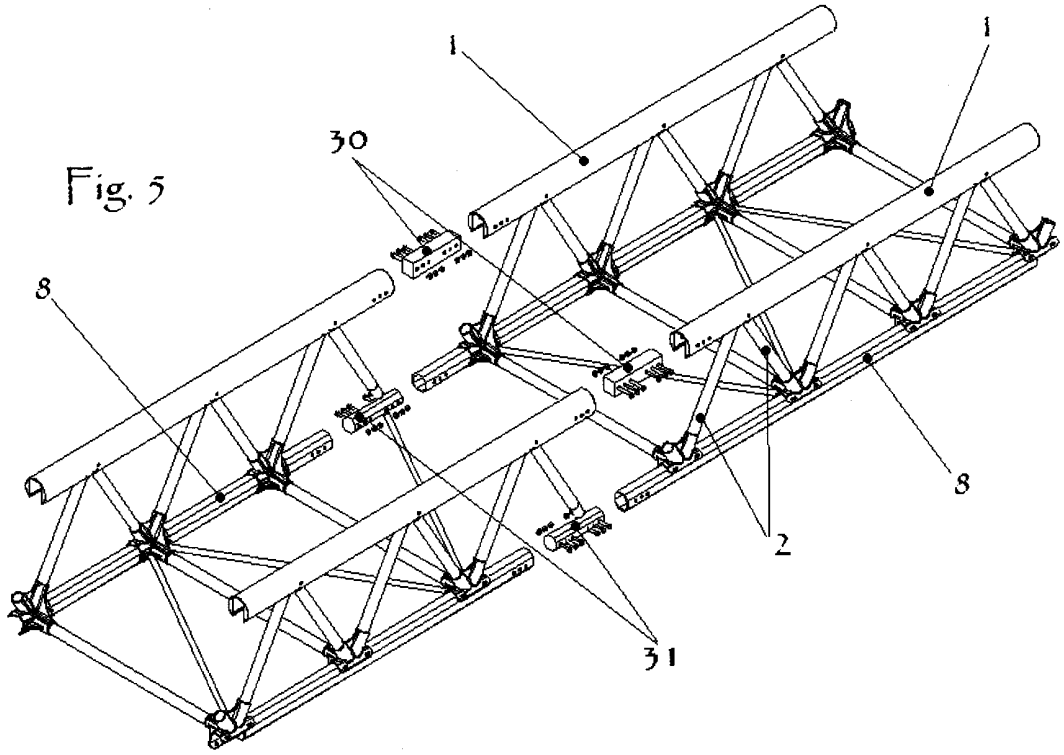


Fig. 6

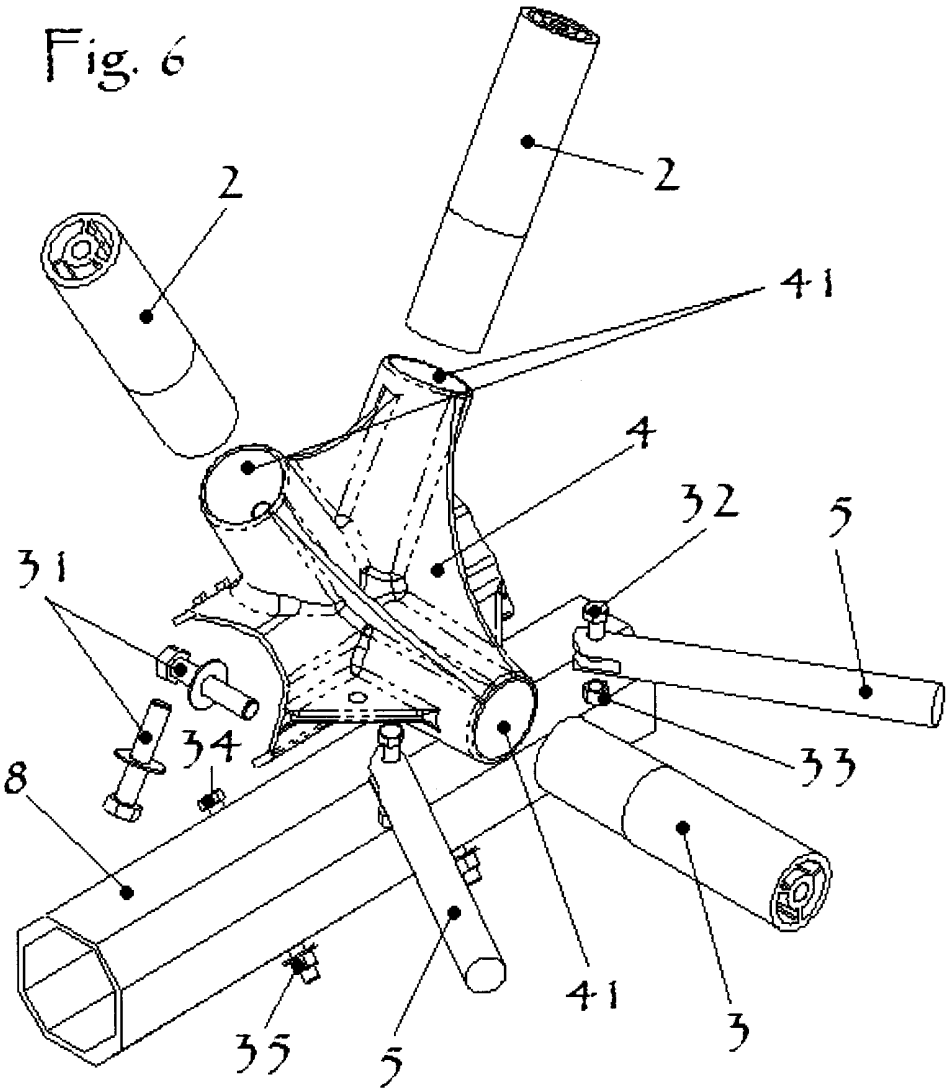


Fig. 7

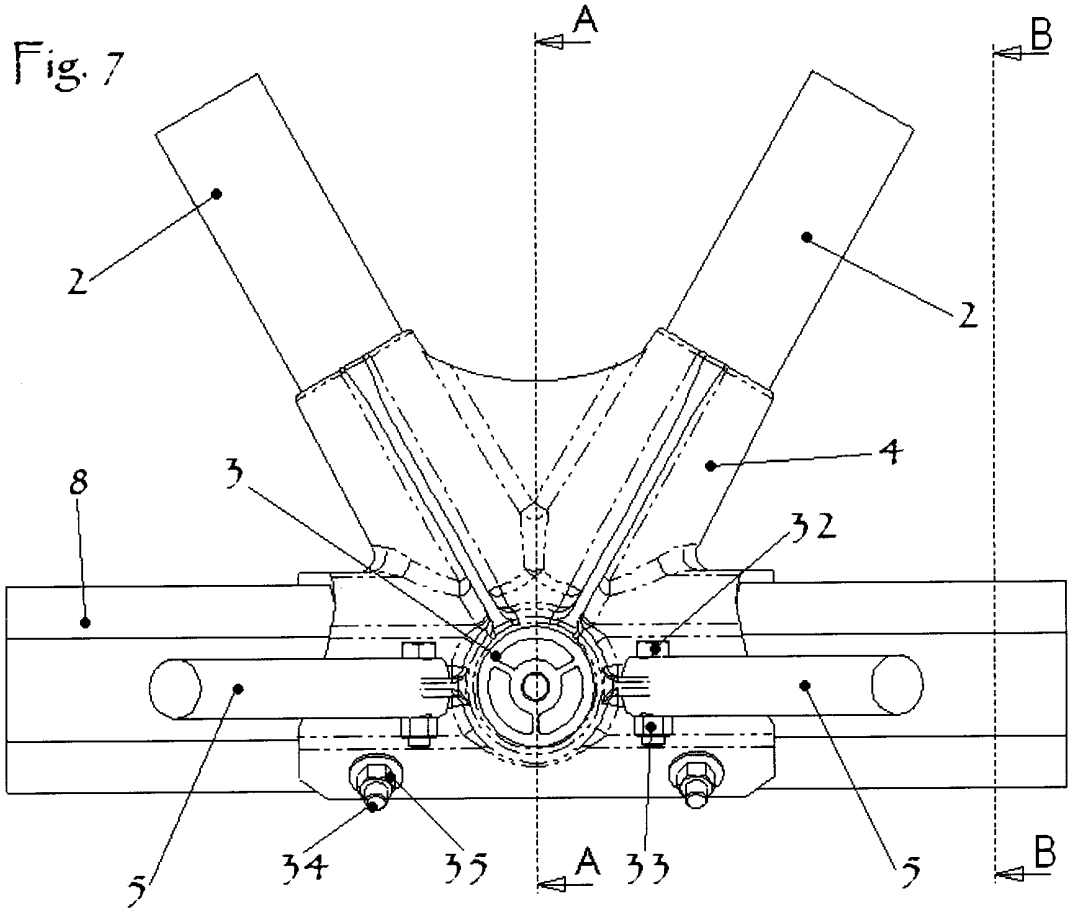


Fig. 8

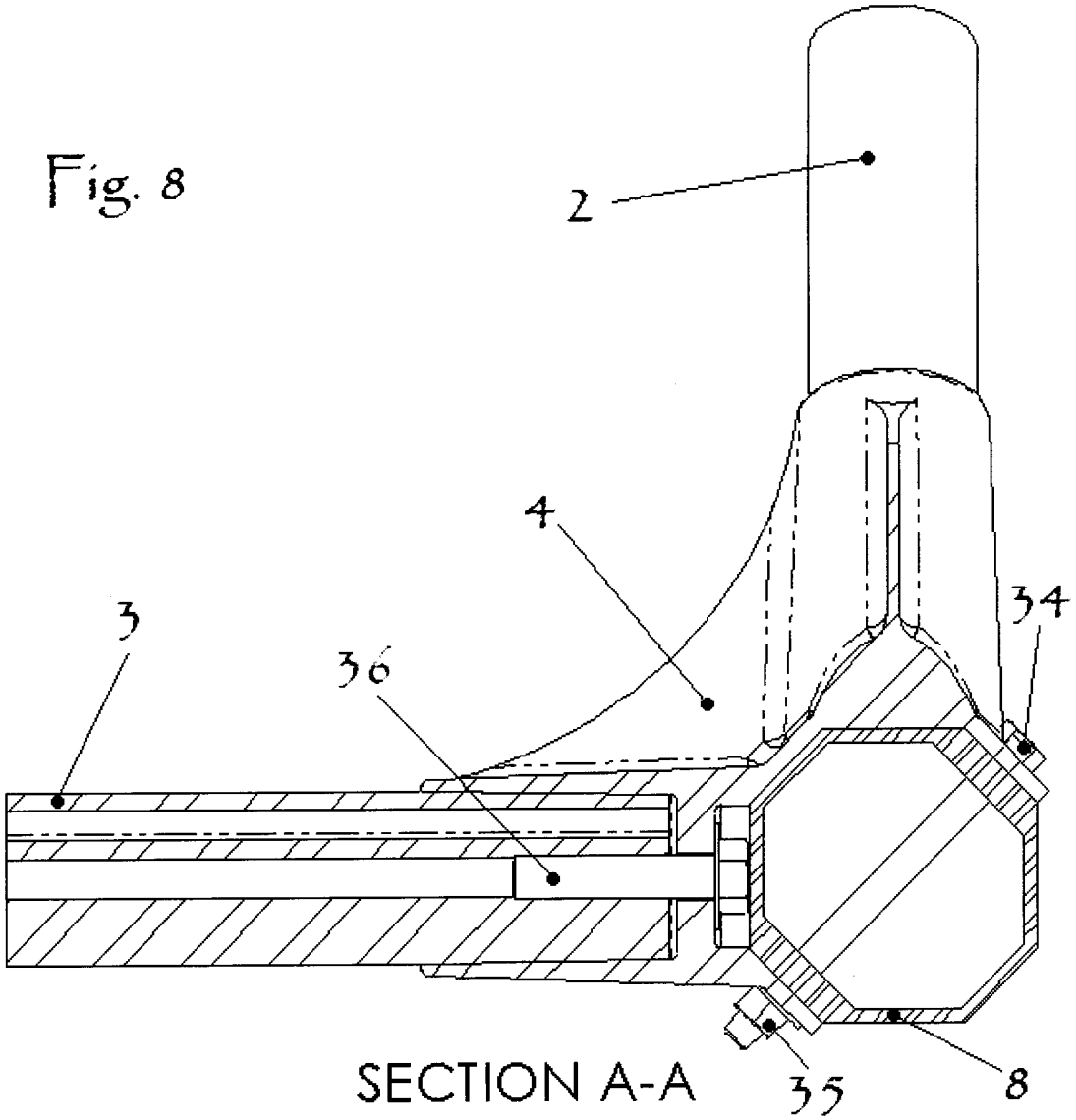
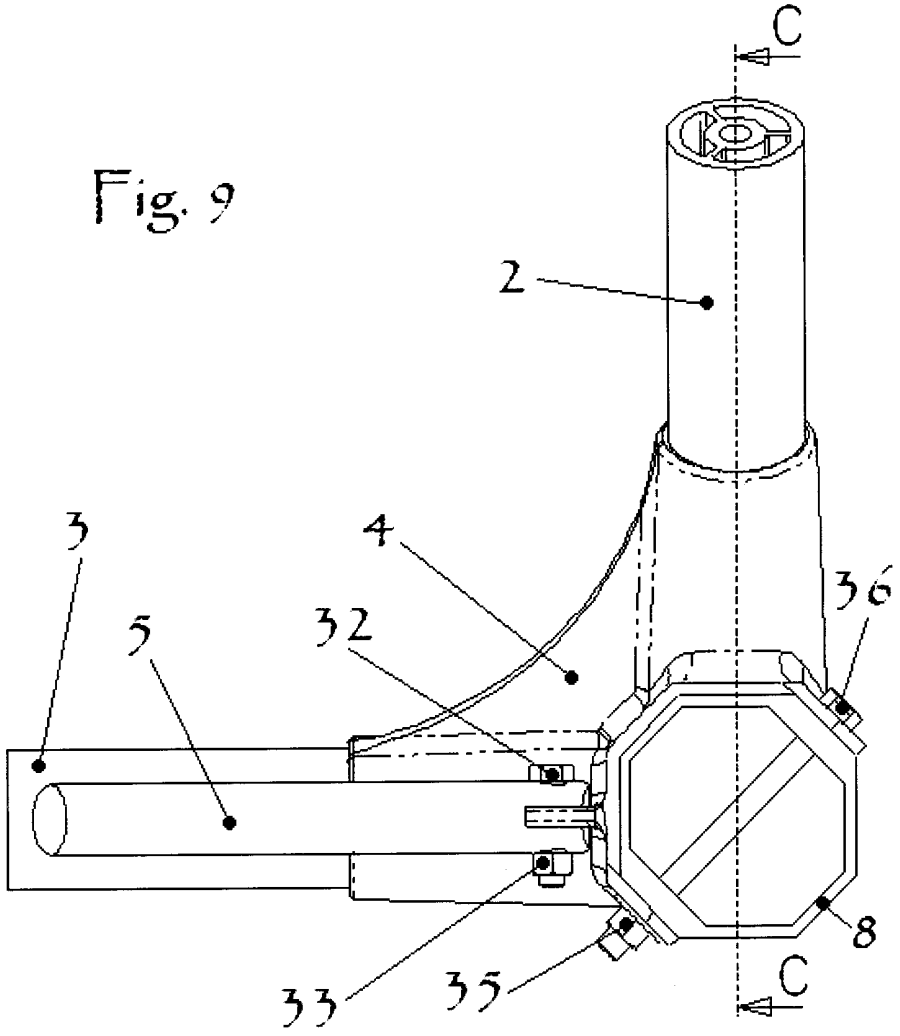
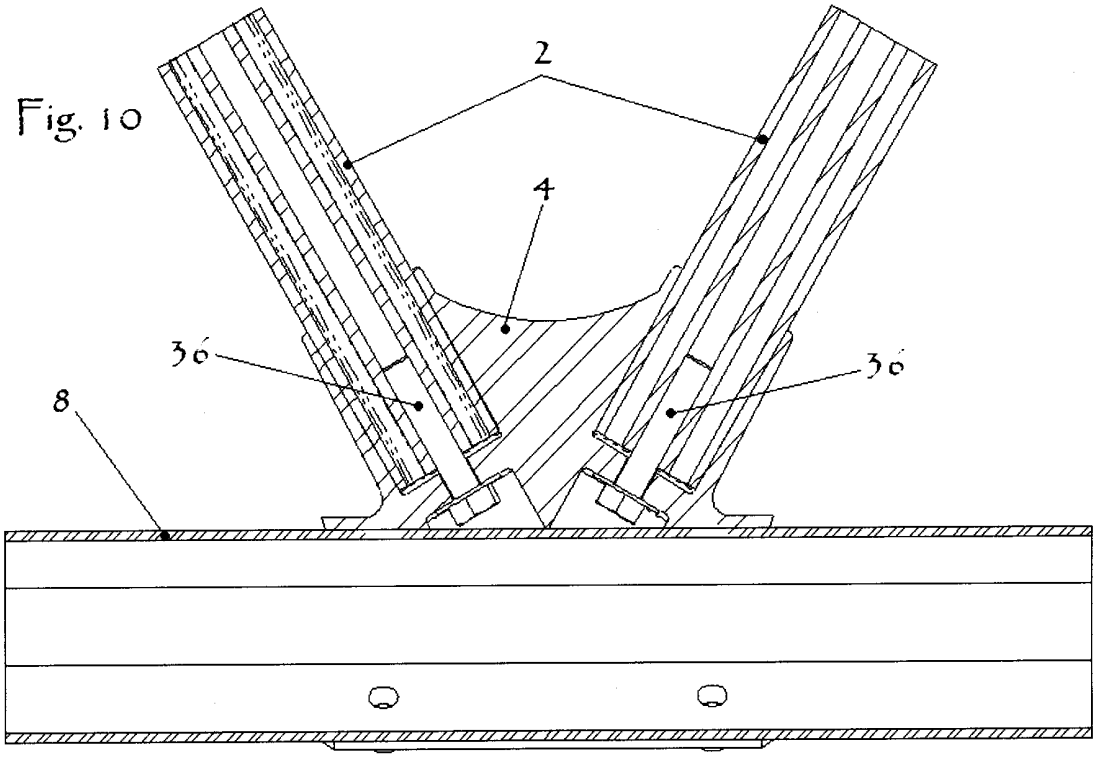


Fig. 9



SECTION B-B

Fig. 10



SECTION C-C

Fig. 11

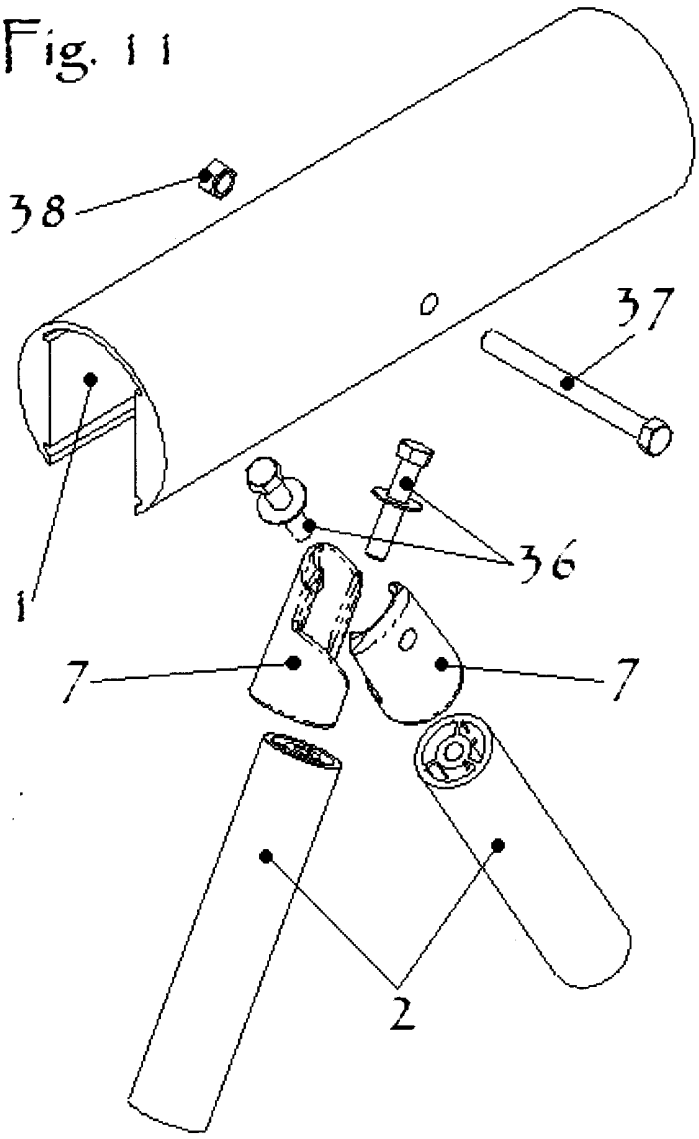
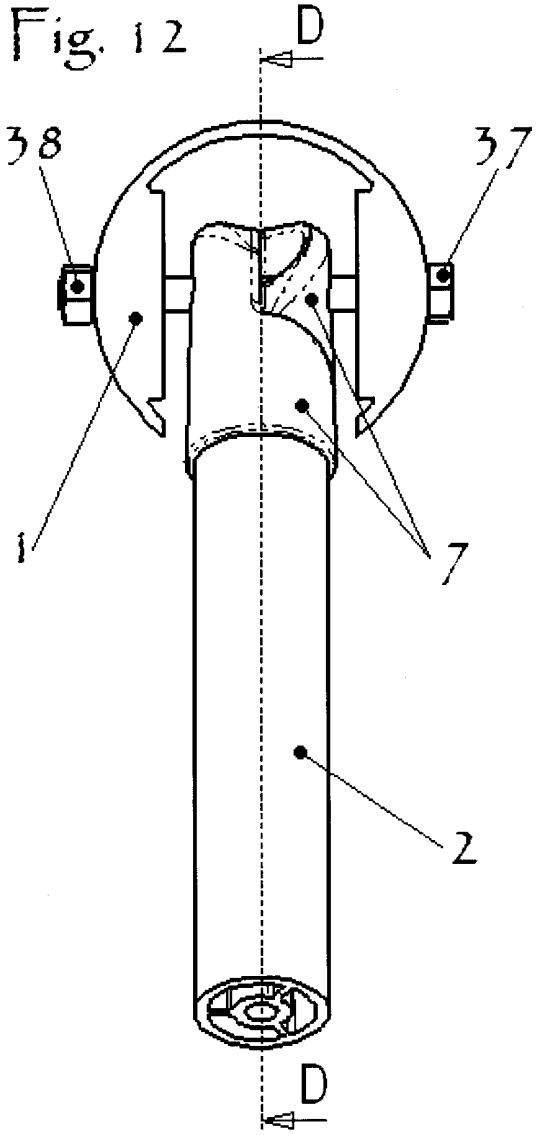


Fig. 12



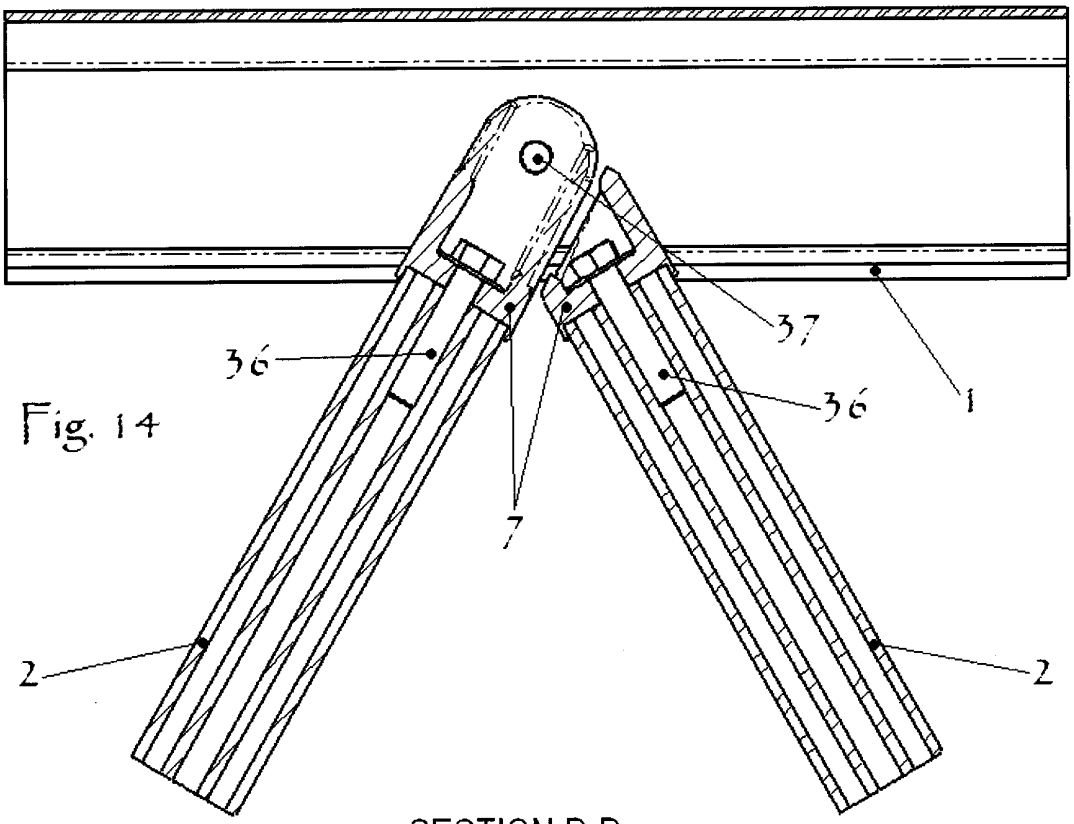


Fig. 14

SECTION D-D

Fig. 15

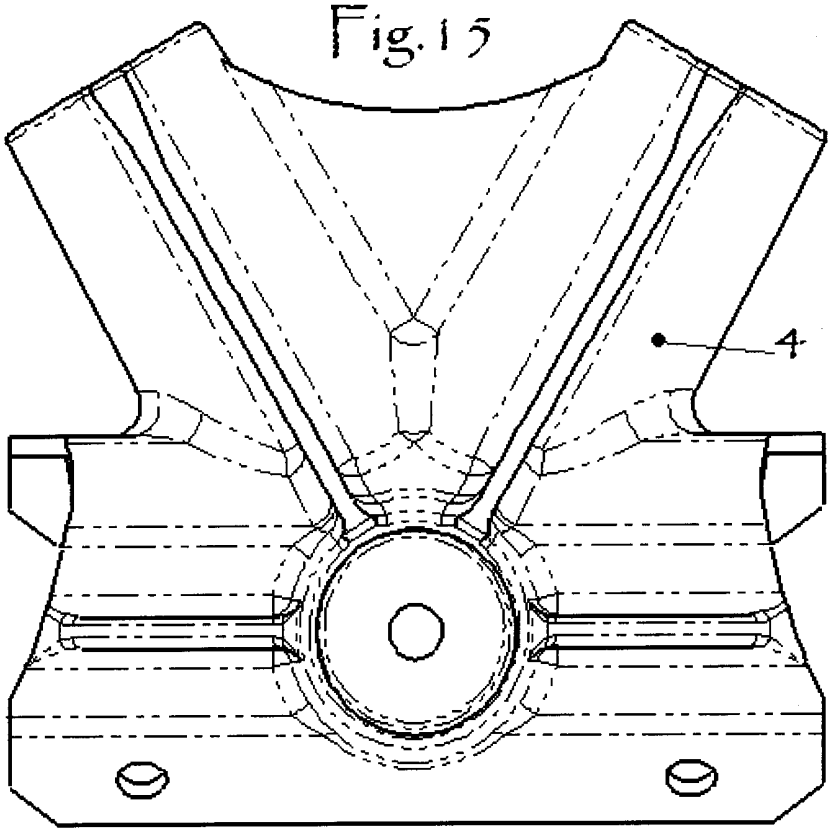


Fig. 16

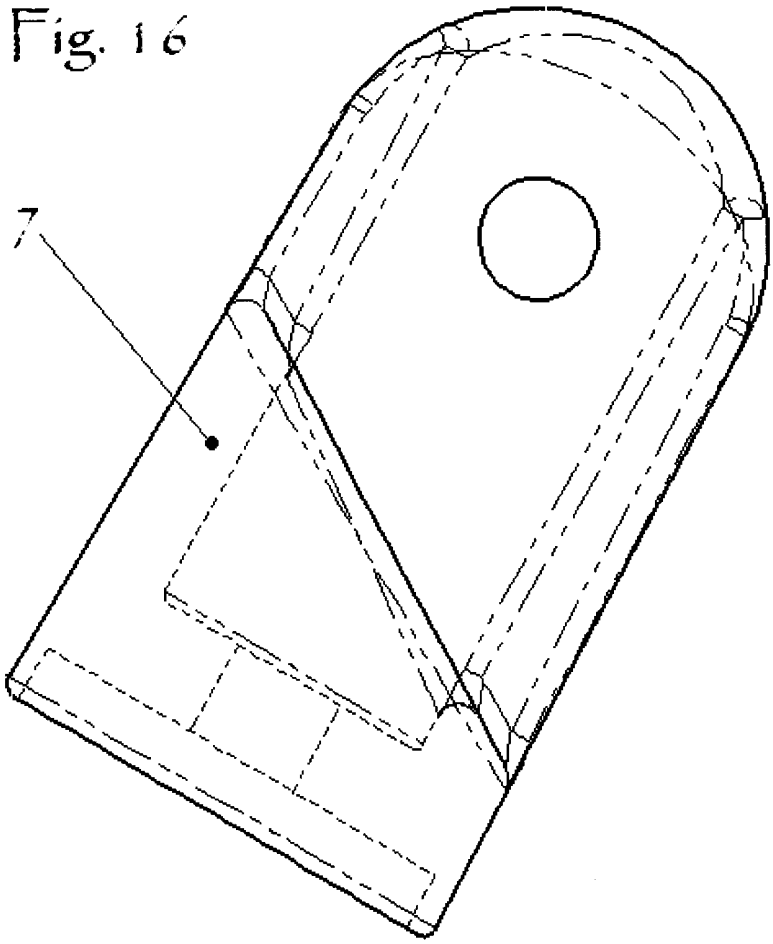
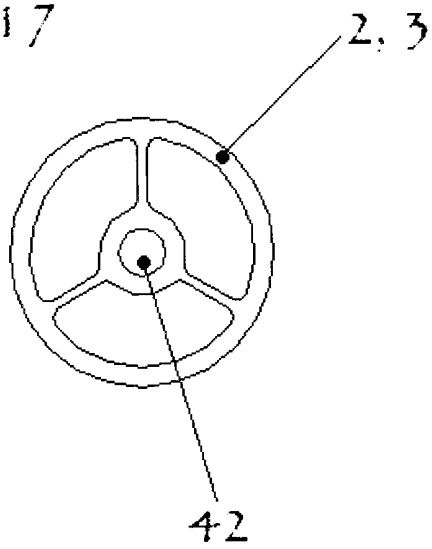


Fig. 17



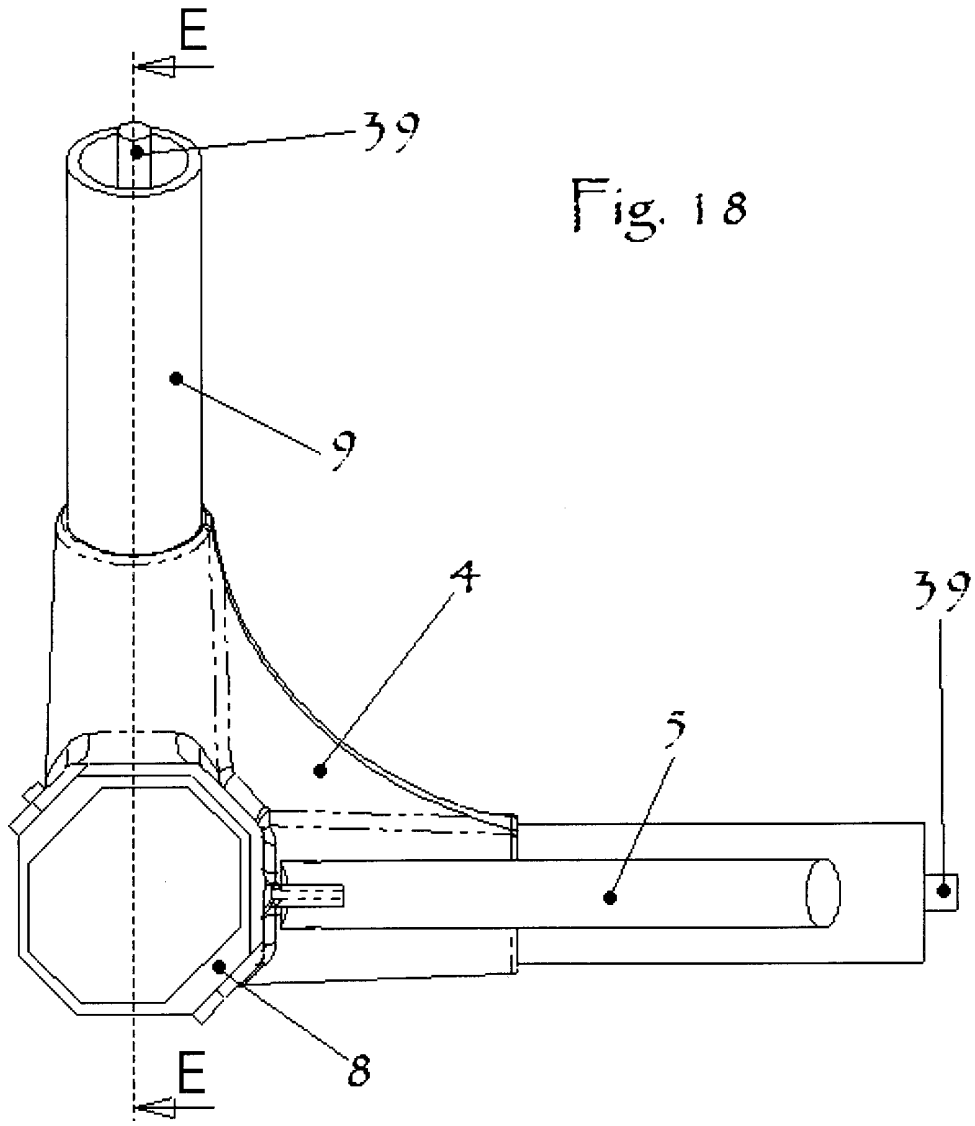
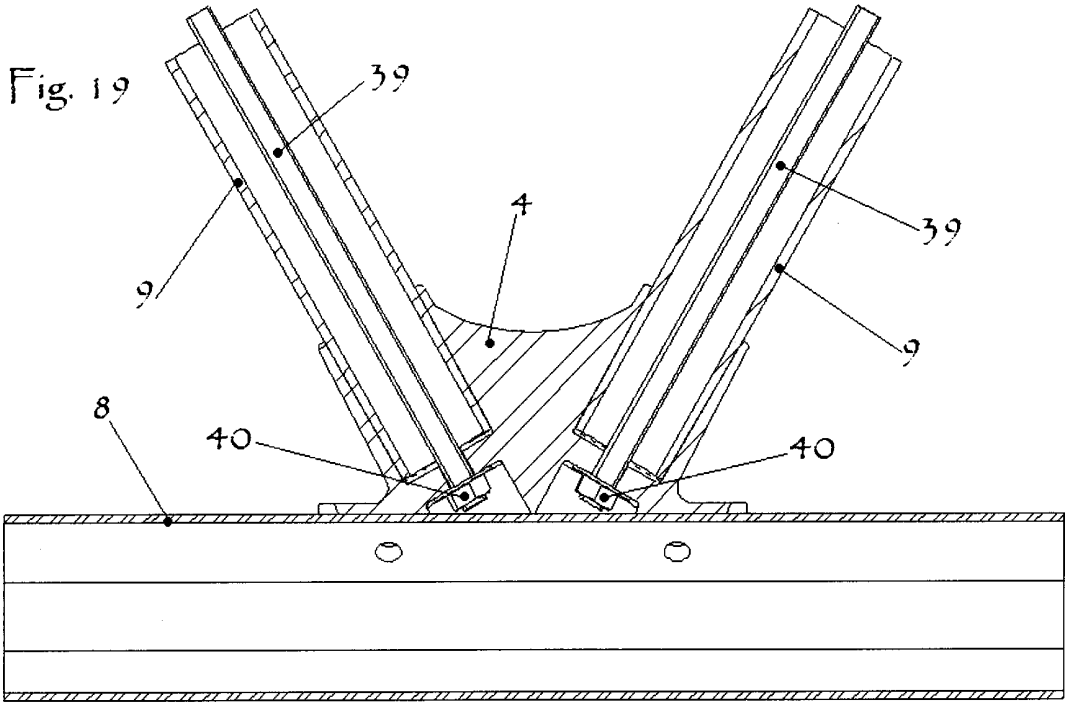


Fig. 18

Fig. 19



SECTION E-E

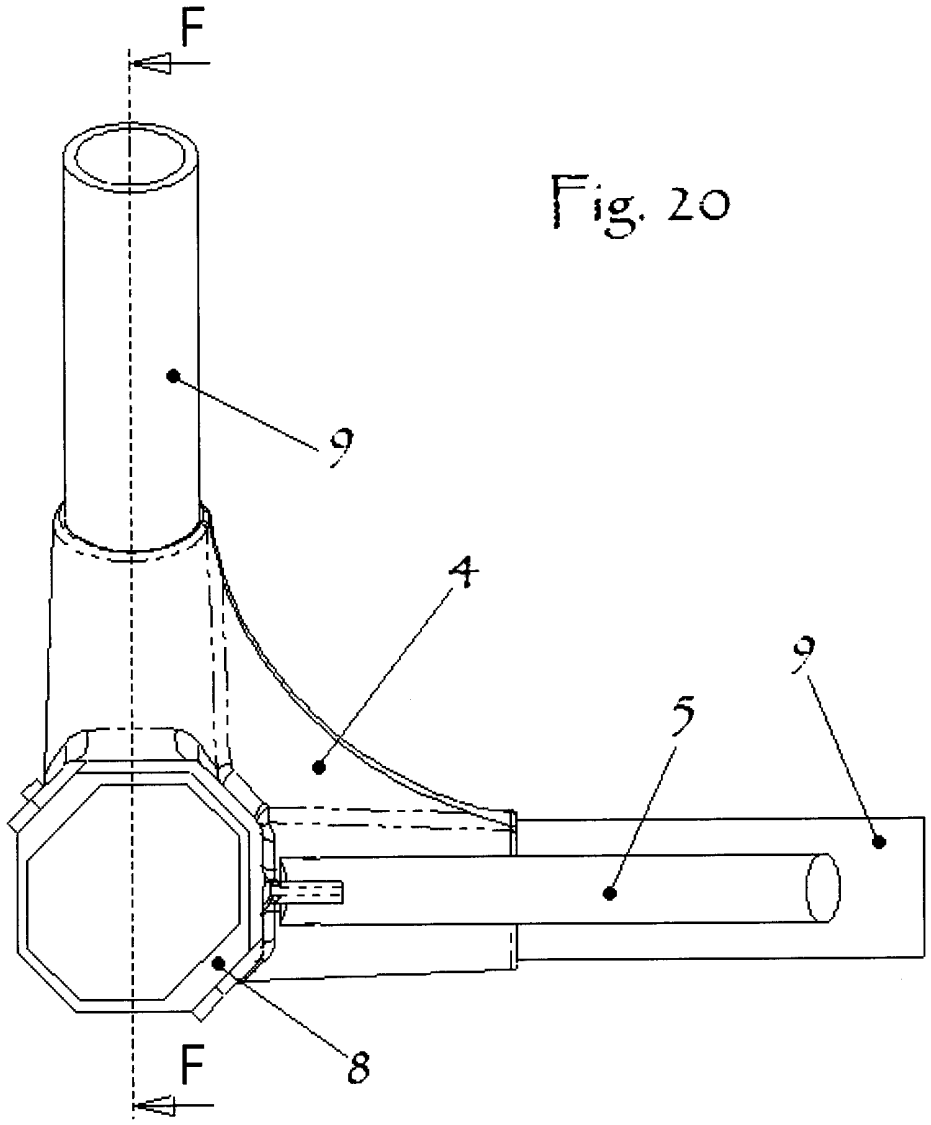
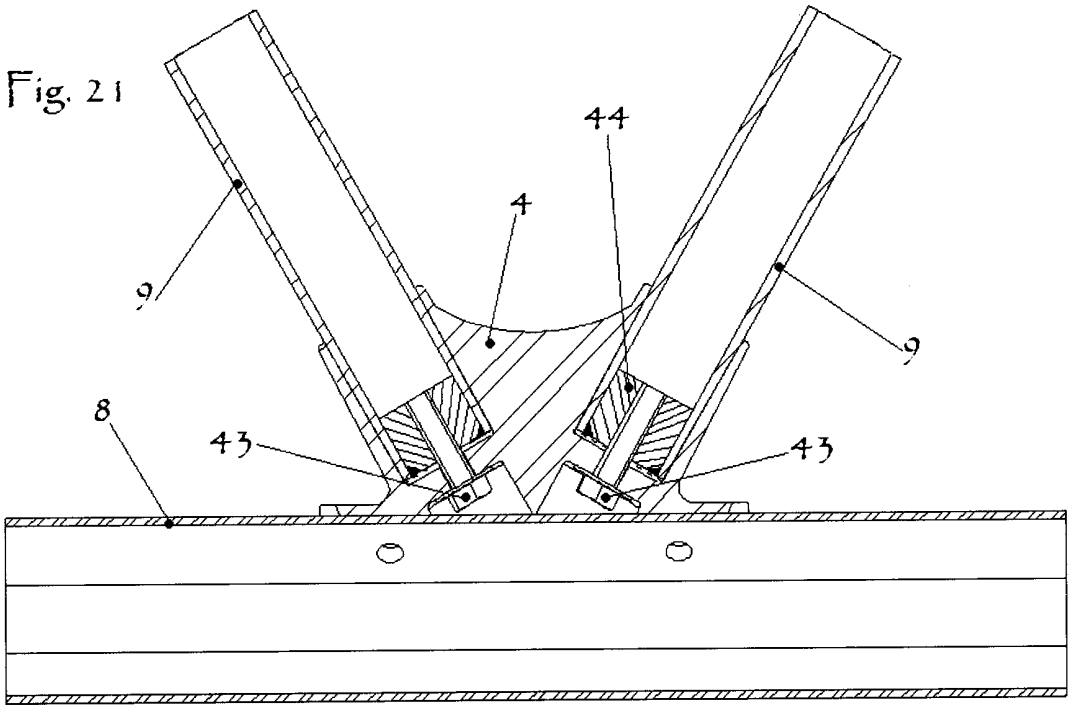


Fig. 20

Fig. 21



SECTION F-F

INTERNATIONAL SEARCH REPORT

International ap
PCT/CA2006/000778

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***E01D 19/00*** (2006.01) , ***E01D 15/133*** (2006.01) , ***E01D 15/00*** (2006.01) , ***E01D 19/10*** (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)

IPC (2006.01) E04C-3/30, 32, 36; E04H-12; E01D-19/00, 19/10, 15/133, 15/00
US Cl. 14/3, 13, 14, 77.1, 78; 52/600+, 655.1, 656.9, 720.1, 724.2, 731.2, 732.1, 738.1, 739.1; 403/202, 217, 218, 219, 266

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Canadian Patent Database, Delphion, PlusPat
Keywords: node, node connector, bridge, truss, frame, joint, modular, socket, cavity, extru*, core, aluminum, pultru*

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages				Relevant to claim No.
X	US 2839320	(HILL)	17-06-1958	entire document	1, 3, 4, 5, 9, 13, 15, 18
Y					7, 14, 19, 20
X	US 4136985	(TAUL)	30-01-1979	entire document	1, 3, 4, 5, 9, 13, 15
Y					7, 14, 18, 19, 20
Y	US 4912795	(JOHNSON)	03-04-1990	entire document	7, 14, 18, 19, 20
X	US 6672654	(YAMADA ET AL)	06-01-2004	entire document	21, 22, 23
Y					24, 26

[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
25 August 2006 (25-08-2006)	08 September 2006 (08-09-2006)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001(819)953-2476	Authorized officer William Byrne (819) 997-2565

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/0152715 (ROTHEROE) 24-10-2002 entire document	21, 22, 23, 25
Y		24, 26
Y	US 5956917 (REYNOLDS) 28-09-1999 entire document	24, 26
Y	US 3901613 (ANDERSON) 26-08-1975 entire document	24, 26

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the 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. [ ] Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :

2. [ ] Claim 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. [ ] Claim Nos. :
because they are dependant 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 :

Group A - 1-20 The claims of Group A comprise independent claims 1, 9 and 13, and dependent claims 2-8, 10-12, and 14-20. The above independent claims are directed to a node connector having a plurality of cavities for use with framing members each having a neutral axis.

Group B - 21-26 The claims of Group B comprise independent claim 21 and dependent claims 22-26. The above claims are directed to an extruded structural element characterized by its cross-section.

Continued on Supplemental Sheet

1. [X] 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 claim 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 claim 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.

[X] No protest accompanied the payment of additional search fees.

Continuation of Box III

As written the sole element common to all independent claims is the provision of a framing element having a neutral axis. However, such a provision is simply a recitation of a fundamental property of all prismatic structural members - and most evidently when they are under bending stress. As such the provision is in no way a definitive inventive feature and therefore cannot be relied upon to provide a link between all claims. The elements taught by the claims of either group are in no way exclusively adapted to be used with the elements of the other.

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
US2839320	17-06-1958	NONE	
US4136985	30-01-1979	BR7804103 A	06-03-1979
		CA1085431 A1	09-09-1980
		DE2829671 A1	25-01-1979
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		FR2396672 A1	02-02-1979
		GB1601912 A	04-11-1981
		IT1098659 B	07-09-1985
US4912795	03-04-1990	NONE	
US6672654	06-01-2004	CA2401060 A1	04-03-2003
		JP2003072587 A	12-03-2003
		JP2003072588 A	12-03-2003
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		US2005138885 A1	30-06-2005
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US3901613	26-08-1975	BE806009 A1	01-02-1974
		DE2351366 A1	25-04-1974
		FR2203451 A5	10-05-1974
		IT994825 B	20-10-1975
		JP49072917 A	15-07-1974
		NL7313992 A	16-04-1974
		SE368062 B	17-06-1974
		SE386488 B	09-08-1976