PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :		(11) International Publication Number:
F16B 7/04, E04B 1/58, 1/19 F16L 37/12	A2	WO 88/ 05136
		(43) International Publication Date: 14 July 1988 (14.07.88)

(21) International Application Number: PCT/US87/03132

(22) International Filing Date: 25 November 1987 (25.11.87)

(31) Priority Application Number: 946,980

(32) Priority Date: 29 December 1986 (29.12.86)

(33) Priority Country: US

(71) Applicant: INTERLOCK STRUCTURES INTERNATIONAL, INC. [US/US]; 420 North Fifth Street, Minneapolis, MN 55401 (US).

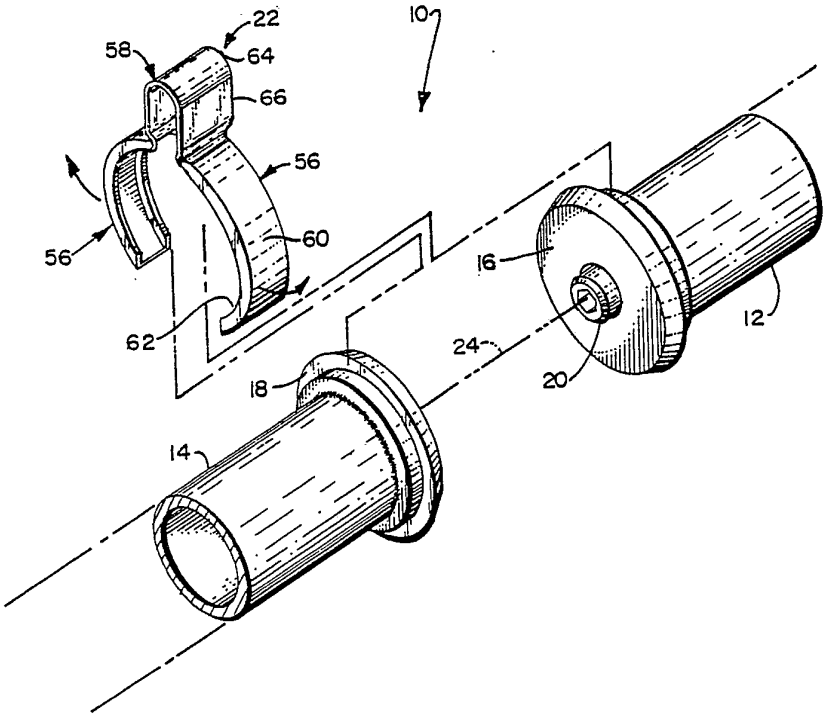
(72) Inventor: LANGE, Fredric, A. ; 13690 Elm Creek Road, Osseo, MN 55369 (US).

(74) Agent: HAMRE, Curtis, B.; Merchant, Gould, Smith, Edell, Welter & Schmidt, 1600 Midwest Plaza Building, Minneapolis, MN 55402 (US).

(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).

Published
Without international search report and to be republished upon receipt of that report.

(54) Title: CONNECTING APPARATUS



(57) Abstract

The application is directed to a quick connect/disconnect mechanism (10) for fastening structural members (12, 14) together. The apparatus includes flanges (32) with non-facing ringular surfaces (38) on each structural member (12, 14). A bolt (20) or other mechanism aligns the structural members (12, 14) and prevents movement in shear of one with respect to the other. A resilient clip (22) having end portions (56) which are U-shaped in cross section and which extend around more than one half the circumference of the flanges (32) fits onto the flanges (32) to hold and clamp the structural members (12, 14) together. Application in the field of trusses, space frames and similar structural members.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**FR**	France	**ML**	Mali
AU	Australia	**GA**	Gabon	**MR**	Mauritania
BB	Barbados	**GB**	United Kingdom	**MW**	Malawi
BE	Belgium	**HU**	Hungary	**NL**	Netherlands
BG	Bulgaria	**IT**	Italy	**NO**	Norway
BJ	Benin	**JP**	Japan	**RO**	Romania
BR	Brazil	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CF	Central African Republic			**SE**	Sweden
CG	Congo	**KR**	Republic of Korea	**SN**	Senegal
CH	Switzerland	**LI**	Liechtenstein	**SU**	Soviet Union
CM	Cameroon	**LK**	Sri Lanka	**TD**	Chad
DE	Germany, Federal Republic of	**LU**	Luxembourg	**TG**	Togo
DK	Denmark	**MC**	Monaco	**US**	United States of America
FI	Finland	**MG**	Madagascar		

CONNECTING APPARATUS

Field of the Invention

The present invention is directed to a quick connect/disconnect fastening assembly for a pair of structural members, said fastening assembly being operable without special tools.

Background of the Invention

Space frames, trusses, and similar structural members are known. Usually, truss members are attached to one another or to some other structural member, such as a wall, using nut and bolt combinations. In the case of a space frame, it is common to have a multi-face node with threaded openings in each face for receiving a threaded rod fastened to the end of a tube. Nuts, bolts and various other threaded fastening designs have long been the usual fastening mechanism.

Truss members and space frames are used, not only in a structural sense, but also in a decorative sense. Oftentimes, it is desirable to assemble and thereafter disassemble truss or space frame structures rapidly. Usually, a number of workers must work as a team in order to satisfy such time constraints.

The present invention is intended to replace the necessity for conventional nut and bolt combinations and provide a quick connect/disconnect fastening mechanism for truss members, space frame structures and other structural members so that structures may be rapidly assembled and disassembled without compromising structural strength.

Summary of the Invention

In this regard, the present invention is directed to interconnect apparatus for fastening first and second structural members together, said structural members

including first and second ringular surfaces, respectively, facing generally away from one another. The first and second ringular surfaces are generally aligned by an aligning mechanism along the axes of the structural members, the aligning mechanism also prevents significant radially directed or shear movement. Clamping mechanism contacts the ringular surfaces in the opposing relationship, thereby clamping the structural members together.

More particularly, in the preferred embodiment the ringular surfaces are surfaces facing away from one another on buttons having disk-like heads with shanks which extend into tubular end portions of the first and second structural members. The aligning mechanism preferably includes an axial protrusion on one of the buttons and a mating axial recess on the other. An inexpensive design for achieving such aligning mechanism, while also preventing significant radially directed movement, includes threaded cavities centered on the axis of each button. The end of the cavity is bored to a larger diameter to receive a portion of the head of a bolt. The bolt is then threaded into one of the cavities such that the head of the bolt protrudes beyond the end of the first button into the cavity of the second button.

As indicated, the buttons preferably include circular or disk-like flanges at the ends which are spaced outwardly from the structural members to which they are attached. The clamping mechanism preferably includes a resilient clip having end portions with a U-shape cross section which fit over the pair of abutting flanges and together extend around more than one half the circumference of the flanges thereby clamping and holding the flanges together. A center portion between the end portions is shaped in an inverted U-shape to extend away from the flanges thereby providing a handle for the clip, as well as providing spring-like resiliency for the end portions with respect to the

center portion for easy installation and removal of the clip with respect to the flanges.

In an alternate embodiment, the end portion of first and second structural members may be tubular and flared so as to provide ringular surfaces facing away from one another when the flared ends are facing one another. In this situation, the aligning mechanism may be a hollow tubular member having a cylindrical wall and a flange-like portion extending radially outwardly from the wall. The wall of the tubular member fits within the end portions of the first and second structural members, while the flange-like portion fits between the flared ends. The resilient clip as previously described clamps the parts together at the ringular surfaces.

In a further alternative, the aligning mechanism may be a tubular end portion on one of the first or second structural members which end portion has a diameter slightly less than the inside diameter or the end portion of the other of the structural members. In this case, only the latter of the structural members is flared at the end; the former of the structural members is formed to have a flange-like portion extending radially outwardly from the wall of the structural member to provide an element for butting against the flared end of the other structural member. Again, a resilient clip is used to clamp the oppositely facing ringular surfaces of the flared end of the one structural member and the flange-like portion of the other structural member.

It is noted that the resilient clip need not have a center portion. In that case, the clip is usually a permanent installation. Alternatively, a mechanism for rigidifying the center portion has a similar result. A rivet, nut and bolt combination or other fastening mechanism may be passed through the opposite walls of the center portion to hold them at a constant separation thereby limiting the resilience of the clip and making it difficult to remove from a

clamping configuration.

A further advantageous feature of the present mechanism is to flare the ends of the resilient clip to minimize what tends to be the weakest region of the clip when the connection is overstressed. That is, the opposite walls of the free ends of the clip are flared outwardly, as is the connecting wall. In this way, a rib is formed at each of the free ends thereby strenghtening the clip in that region.

The present invention is advantageously applicable for each of the tubes of a structural truss. Each tube of each truss has buttons, in the preferred case, attached to it such that one set of buttons includes an aligning bolt while the other set of buttons includes an empty cavity for receiving the head of the bolt. One truss and the buttons attached thereto is thereby aligned with the other truss and the buttons attached thereto so that clips may be installed onto the aligned pairs of buttons. The bolts serve the additional purpose of preventing significant movement in shear of the aligned buttons.

The present invention is of further advantage with respect to a space frame. A node having a plurality of faces includes buttons attached to at least some of the faces. Individual tubes with buttons attached to the ends are aligned, in the fashion previously indicated, with the buttons on the nodes. Clips are installed to hold the tubes to the nodes to form a framework.

The present fastening mechanism is of even further advantage in that a button may be attached directly to a wall or to any of a variety of other structural members. A second button may be attached, for example, to an electronic chassis or some other item which is to be held to the first structural member. When the two buttons are aligned, the clip is installed to provide an easy and quick connect/disconnect fastening mechanism.

It is understood that the preferred and alternate embodiments can be used in similar applications. The embodiments which maintain a hollow passage through the connection may as well be used in applications which require the passage of a wire, a fluid, light or other such material, substance or energy form.

In addition, it is apparent that the method of using the present connecting apparatus is distinguished from the usual threading type fastening mechanism. Rather than requiring tools and a rotation movement, the present apparatus simply requires aligning and an installation of the clip. The present apparatus is, therefore, easy to install, yet the present apparatus has been found to be structurally efficient and strong when made from materials known to those so skilled.

Brief Description of the Drawings

FIGURE 1 is a perspective view of the interconnecting apparatus of the present invention relative to first and second tubes;

FIGURE 2 is an axial cross-sectional view of the apparatus of FIGURE 1 when it is connected together;

FIGURE 3 is a cross-sectional view, taken along line 3-3 of FIGURE 2;

FIGURE 4 is a perspective view of a pair of truss members connected together with the apparatus of the present invention;

FIGURE 5 is an exploded side view, in partial cross section, showing a miscellaneous item connected to a wall;

FIGURE 6 is a perspective view of a space frame using the connecting apparatus of the present invention;

FIGURE 7 is a side view of an alternate embodiment of a clip;

FIGURE 8 is a front view of a free end of the clip of FIGURE 7;

FIGURE 9 is an exploded perspective of an alternate embodiment of the interconnect apparatus of the present invention;

FIGURE 10 is a cross-sectional view of the alternate embodiment of FIGURE 9;

FIGURE 11 is an exploded perspective of a pair of structural members showing yet another alternative embodiment of alignment mechanism;

FIGURE 12 is a cross-sectional view of the embodiment of FIGURE 11;

FIGURE 13 is a perspective view of the clip of FIGURES 7-8, except the central portion is not present.

Detailed Description of the Preferred Embodiment

Referring then to the drawings wherein like reference numerals designate identical or corresponding parts throughout the several views, and wherein like reference numerals, only primed, designate identical or corresponding parts in views of alternate embodiments, and referring more particularly to FIGURE 1, interconnecting apparatus in accordance with the present invention is designated generally by the numeral 10. Apparatus 10 is shown relative to first and second structural members 12 and 14 which are shown in the form of cylindrical tubes. Apparatus 10 includes first and second buttons 16 and 18 welded or otherwise attached to the ends of tubular members 12 and 14. Bolt 20 is both a shear pin and provides an alignment mechanism for buttons 16 and 18. Clip 22 holds buttons 16 and 18 together.

As shown more clearly in FIGURE 2, both buttons 16 and 18 are preferably identical. The only difference is that a bolt 20 is threaded into one of the buttons, in this case button 16. Consider button 16 as exemplary. Button 16 is symmetric about an axis 24. Button 16 has opposite ends 26 and 28. End 26 faces into tube 12 to which button 16 is

attached, while end 28 faces away from tube 12. Button 16 has a cylindrical portion 30 adjacent to face 26. Portion 30 has a diameter so as to just fit within the inner diameter of hollow tube 12. A flange 32 is adjacent to face 28. Flange 32 extends radially beyond the outer diameter of tube 12. Flange 32 has an outer wall 34 slanted inwardly in the direction toward face 28 to form a frusto-conical shape. A stepped portion 36 is formed between the inside wall or ringular surface 38 of flange 32 and portion 30. Step portion 36 provides a wall 40 parallel to face 26 against which end 42 of tube 12 abutts. Portion 36 is cylindrical with a diameter preferably greater than the outer diameter of tube 12 so that a fillet weld 44 may be used between tube 12 and wall 40. If a different type of weld were used or if a different attachment mechanism between button 16 and tube 12 were used, portion 36 would be unnecessary. It is also understood that flange 32 could be the same or of a smaller diameter than portion 30. In that case, flange 32 and portion 30 would be separated by a neck of smaller dimension than flange 32.

An axially aligned cavity 46 is bored into and preferably through button 16. Cavity 46 has a smaller diameter inner portion toward face 26 and a larger diameter outer portion 50 toward face 28. Inner portion 48 is threaded to receive the threaded shank 52 of bolt 20. Outer portion 50 has sufficient diameter to receive head 54 of bolt 20. Outer portion 50 has depth such that some but no more than one half the depth of head 54 protrudes beyond the plane of face 28. In this way, head 54 may extend into the facing outer portion 50 of button 18 to aid in aligning buttons 16 and 18 generally along axis 24 and to prevent movement in shear of buttons 16 and 18 with respect to one another. It is apparent that if buttons 16 and 18 are identical, bolt 20 may be threaded into either button and still serve its aligning and shear pin functions.

As shown most clearly in FIGURE 1, clip 22 is a unitary member and includes opposite end portions 56 separated by a center portion 58. Each end portion 56 has a U-shaped cross-section. The U-shaped end portions 56 include a cylindrical connecting wall 60 with radial side walls 62 extending inwardly therefrom. Radial walls 62 are separated by a distance so as to just fit against ringular surfaces 38 and 39 of buttons 16 and 18 when buttons 16 and 18 are abutted against one another. Radial walls 62 extend inwardly so as to approach stepped portions 36, without contacting them. Cylindrical wall 60 has a diameter slightly larger than the greatest diameter of flanges 32 so that end portions 56 fit about and mate with flanges 32. End portions 56 together fit about more than one half the circumference of flanges 32, and preferably fit about approximately three quarters of the circumference of flanges 32.

In this regard, clip 22 has its greatest width along a line passing generally through axis 24, while the free ends of end portions 56 are unconnected and spaced-apart a distance less than the indicated greatest width.

Center portion 58 is U-shaped to extend in an inverted fashion away from end portions 56. That is, the rounded base 64 of center portion 58 is spaced outwardly from end portions 56 while legs 66 extend from base 64 to connect with end portions 56. In this fashion, end portions 56 are separated from one another by approximately the distance of separation of legs 66.

Clip 22 is preferably made from a spring steel. The U-shape of center portion 58 provides a resiliency which allows end portions 56 to separate during installation on and removal from flanges 32. It is noted that clip 58 may be rotated when once installed on flanges 32 so that center portion 58 may extend outwardly at any location around the circumference of flanges 32. In this regard, center portion 58

functions also as a handle to aid in rotating clip 22, as well as to make installation and removal easier.

A center portion, however, is not necessary in all cases as shown in alternate embodiment clip 102 in FIGURE 13. Clip 102 is generally used when a connecting installation is permanent, since clip 102 is much less resilient and would be difficult to grasp for removal. Even if a center portion 58' is present, clip 104 as shown in FIGURE 9 may be rigified for a more permanent installation by fastening opposite legs 66' with respect to one another. A rivet 106 may be used to hold legs 66' rigid and at a constant spacing. It is also understood that other fastening mechanisms such as nuts and bolt combinations may be used.

As shown in FIGURES 7-9, clip 104 is similar to clip 22 except for the shape of the free ends 108 of end portions 56'. Each free end 108 is flared to provide a rib-like strength and also to aid in installing a clip on flanges 32 or flared ends 124 and 126. More particularly, side walls 62' flare gradually outwardly so that when clip 104 is installed, flared walls 110 near the tip 112 of each free end 108 are approximately perpendicular to ringular surfaces 38' and 39'. Similarly, at free end 108 connecting wall 60 is also gradually flared outwardly to maintain the connecting flared wall 114 between side flared walls 110 (see FIGURE 8). Since connecting flared walls 114 are arcuately directed to point at least slightly away from one another, they more easily receive the larger cylindrical shape of flanges 32. In addition, whereas a pair of structural members held together by a clip 22 act as levers and apply significant force on side wall 62 and can rip side wall 62 from connecting wall 60 near the free ends of clip 22, flared walls 110 and 114 form essentially a rib and strengthen a region which may otherwise be somewhat weak.

Alternate embodiments of an alignment mechanism are shown in FIGURES 9-12. In FIGURE 9, tubular end portions 116 and 118 of structural members 120 and 122 are shown to have outwardly flared ends 124 and 126. At flared ends 124 and 126, ringular surfaces 128 and 130 facing away from one another are the surfaces which make contact with side walls 62' when clip 104 clamps structural members 120 and 122 together. Preferably, each of surfaces 128 and 130 form angles no greater than 90 degrees with axes 132 and 134, respectively, when viewed in the axial direction away from the other of the ringular surfaces.

The alignment mechanism shown in FIGURE 9 is formed with a hollow tubular member 136 having a wall 138 and a flange-like portion 140 which extends radially outwardly from the wall. Flange-like portion 140 is preferably formed as a unitary part of tubular member 136 and extends circumferentially completely around wall 138. Wall 138 has an outer diameter slightly smaller than the inner diameters of structural members 120 and 122 so that tubular member 136 on each side of flange-like portion 140 may readily fit within end portions 116 and 118 as flange-like portion 140 fits between flared ends 124 and 126. In this way, tubular member 136 aligns axis 132 and 134 of structural members 120 and 122 and yet maintains a hollow passageway through which materials, substances, or something other may be directed to pass. Clip 104 fits over and clamps together flared ends 124 and 126 with flange-like portion 140 therebetween.

As shown in FIGURES 11-12, another alternate embodiment of an alignment mechanism essentially forms one end of one of the structural members to incorporate the features of tubular member 136. More particularly, structural member 142 is the same as either of structural members 120 and 122. Structural member 144, however, is cylindrically tubular and has a flange-like portion 146, similar to portion 140,

extending radially outwardly from the wall 148 of structural member 144. The tubular end portion 150 on a side of flange-like portion 146 facing structural member 142 is formed to have an outer diameter slightly less than the inner diameter of structural member 142. In this way, end portion 150 fits within structural member 142 and flange-like portion 146 fits against the flared end 152 of structural member 142. It is noted that the side of flange-like portion 146 facing away from structural member 142 forms a ringular surface, while flared end 152 also has a ringular surface facing away from structural member 144. A clip 104 or one of the other clips described is then used to fit about flared end 152 and flange-like portion 146 to contact the respective ringular surfaces to connect or hold structural members 142 and 144 together.

Apparatus 10 is applicable for fastening a variety of structural members together. First and second tubular members 12 and 14 are shown with respect to apparatus 10 in FIGURES 1-3. Structural members having at least cylindrically tubular ends are shown in FIGURES 9-12. In FIGURE 4, an apparatus 10 the same as discussed with respect to FIGURES 1-3 is used to connect each of aligned tubular members 68 and 70 for first and second truss members 72 and 74, respectively. Preferably, all center portions 58 are rotated so as to be directed toward the center of the truss members. Note that bolts 20 are needed in only two of the pairs of buttons to accomplish necessary alignment of the button pairs for the trusses. Bolts 20 are needed in all pairs of buttons, however, to accomplish the shear pin function.

In FIGURE 5, apparatus 10 is shown for fastening an assembly 76 to a wall 78. A conventional toggle bolt 80 is used to fasten button 16 to wall 78. The head 82 of toggle bolt 80 protrudes from button 16 to provide the aligning and shear pin functions as discussed hereinbefore. A second

bolt 88 is passed through washer 86 and wall 84 and threaded into button 18 to attach button 18 to assembly 76. With buttons 16 and 18 aligned, clip 22 fits over flanges 32 in the fashion discussed hereinbefore.

In FIGURE 6, a space frame is shown comprising nodes 90 and 92 fastened together by a tube 94 with an apparatus 10 at either end of tube 94.

Node 90 is exemplary of node 92 and includes a plurality of faces 96. Faces 96 are flat and are perpendicular to radial lines which are equiangularly spaced in each of three orthogonal planes passing through the center of node 90. Other symmetric and asymmetric nodes are also applicable for use with apparatus 10. A threaded opening 98 is bored into the center of each face 96. A button 18 is attached with bolt 20 to each face which is to receive a tube, of which tube 100 is representative. Button 16 is attached in the usual way to the end of tube 100. Tube 100 is aligned as discussed hereinbefore at buttons 16 and 18 and clip 22 is installed. Thus, a plurality of tubes 100 may extend in a variety of directions away from node 90, as also shown in FIGURE 6.

Apparatus 10 is preferably used with metallic structural members. In addition, it is preferable for clip 22 to be made from a spring steel. It is understood, however, that the present invention may be made from nonmetallic materials. The buttons or other alignment elements may be fastened to or used with the structural members in any acceptable fashion which provides the necessary structural strength. A clip made from a nonmetallic material may be used to hold the buttons or flared ends together as long as the clip is resilient to allow the end portions to separate during installation and removal.

In operation, a bolt 20 is installed in a cavity 46 of a button 16 in the preferred embodiment. Structural mem-

bers 12 and 14 are then brought together and aligned when the head of bolt 20 is received in the facing cavity 46. A clip 22 is fitted about flanges 32.

In the alternate embodiment of FIGURE 9, the structural members 120 and 122 are aligned by inserting tubular member 136 between them so that tubular member 136 is partially received in each of end portions 116 and 118 and so that flange portion 140 fits between flared ends 124 and 126. A clip 104 is then fitted about the flared ends and flange-like portion 140.

Similarly, in the alternate embodiment of FIGURE 11, end portion 150 is fitted into the end portion of structural member 142 until flange-like portion 146 contacts flared end 152. A clip 104 is then fitted about flared end 152 and flange-like portion 146.

Even though these details of the structure and function have been set forth with respect to a preferred and alternate embodiments, however, it is understood that other embodiments are encompassed by the present invention. Consequently, size, changes made, especially in matters of shape, size, materials, and arrangement, to the full extent extended by the general meaning of the terms in which the appended claims are expressed, are within the principle of the invention.

WHAT IS CLAIMED IS:

1. Interconnect apparatus, comprising:

first and second structural members having first and second end portions, respectively, said first and second structural members having first and second axes, respectively, said first and second end portions including first and second ringular surfaces, respectively, said first and second ringular surfaces facing generally away from one another, each of said first and second ringular surfaces forming angles no greater than 90 degrees with said first and second axes, respectively, in the axial direction away from the other of the ringular surfaces;

means for generally aligning the axes of said first and second structural members with respect to one another and for preventing significant radially directed movement of one of said first and second structural members with respect to the other;

means for clamping said first and second structural members together, said clamping means being formed as a unitary member having a generally U-shaped cross section with first and second walls on opposite sides for contacting said first and second ringular surfaces, respectively, said unitary member having a greatest width along a line passing generally through the aligned axes and having free ends unconnected from one another and spaced-apart a distance less than said greatest width when said unitary member clamps said first and second structural members together.

2. The apparatus in accordance with claim 1 wherein said unitary member includes end portions terminating at one end with said free ends and at another end with a center portion, said center portion being U-shaped for resiliency and extending away from said ringular surfaces and said end portions.

3. The apparatus in accordance with claim 2 including means for making said resilient center portion rigid.

4. The apparatus in accordance with claim 3 wherein said rigid making means includes a rivet.

5. The apparatus in accordance with claim 1 wherein said first and second walls of said unitary member include sections near said free ends which are flared outwardly from said first and second ringular surfaces, said unitary member having a connecting wall between said first and second walls of said U-shaped cross section, said connecting wall also being flared near said free ends, whereby said flared sections strengthen said unitary member at the free ends of said unitary member.

6. The apparatus in accordance with claim 1 wherein said first end portion of said first structural member is cylindrically tubular having a first wall with a first inner diameter and said second structural member is cylindrically tubular having a second wall, and wherein said aligning means includes a flange-like portion extending radially outwardly from said second wall, said second end portion of said second structural member extending from said flange-like portion and having a second outer diameter slightly less than said first inner diameter, said second end portion of said second structural member fitting within said first end portion of said first structural member with said flange-like portion fitting between said first and second ringular surfaces.

7. The apparatus in accordance with claim 1 wherein said first and second end portions of said first and second structural members are tubular having first inner diameters, said first and second end portions having first and second ends, and wherein said aligning means includes a hollow tubu-

lar member having a wall and a flange-like portion extending radially outwardly from said wall, said wall having a second outer diameter slightly smaller than the first inner diameters of said first and second structural members, said wall of said tubular member fitting within said first and second tubular end portions of said first and second structural members with said flange-like portion fitting between said first and second flared end portions.

8. The apparatus in accordance with claim 7 wherein said first and second structural members are hollow and are each one of a plurality of interconnected spaced-apart tubular members of first and second truss members, respectively.

9. The apparatus in accordance with claim 7 wherein said first structural member is a node of a space frame, said node being hollow and having a plurality of faces, said first end portion extending away from one of said faces, said second structural member also being hollow.

10. The apparatus in accordance with claim 7 wherein said first and second structural members are both hollow tubes.

11. A method for interconnecting adjacent ends of first and second hollow structural members together, said first and second structural members having first and second end portions with first and second ends flared outwardly, respectively, said method comprising the steps of:

aligning said first and second structural members by installing a hollow tubular member partially in each of said first and second end portions, said tubular member having a wall and a flange-like portion extending radially outwardly from said wall, said wall of said tubular member fitting within said first and second end portions and said flange-like portion fitting between said first and second

flared ends; and

fitting a resilient clip about at least a portion of said first and second flared ends of said aligned first and second structural members and said flange-like member of said tubular member.

FIG. 1

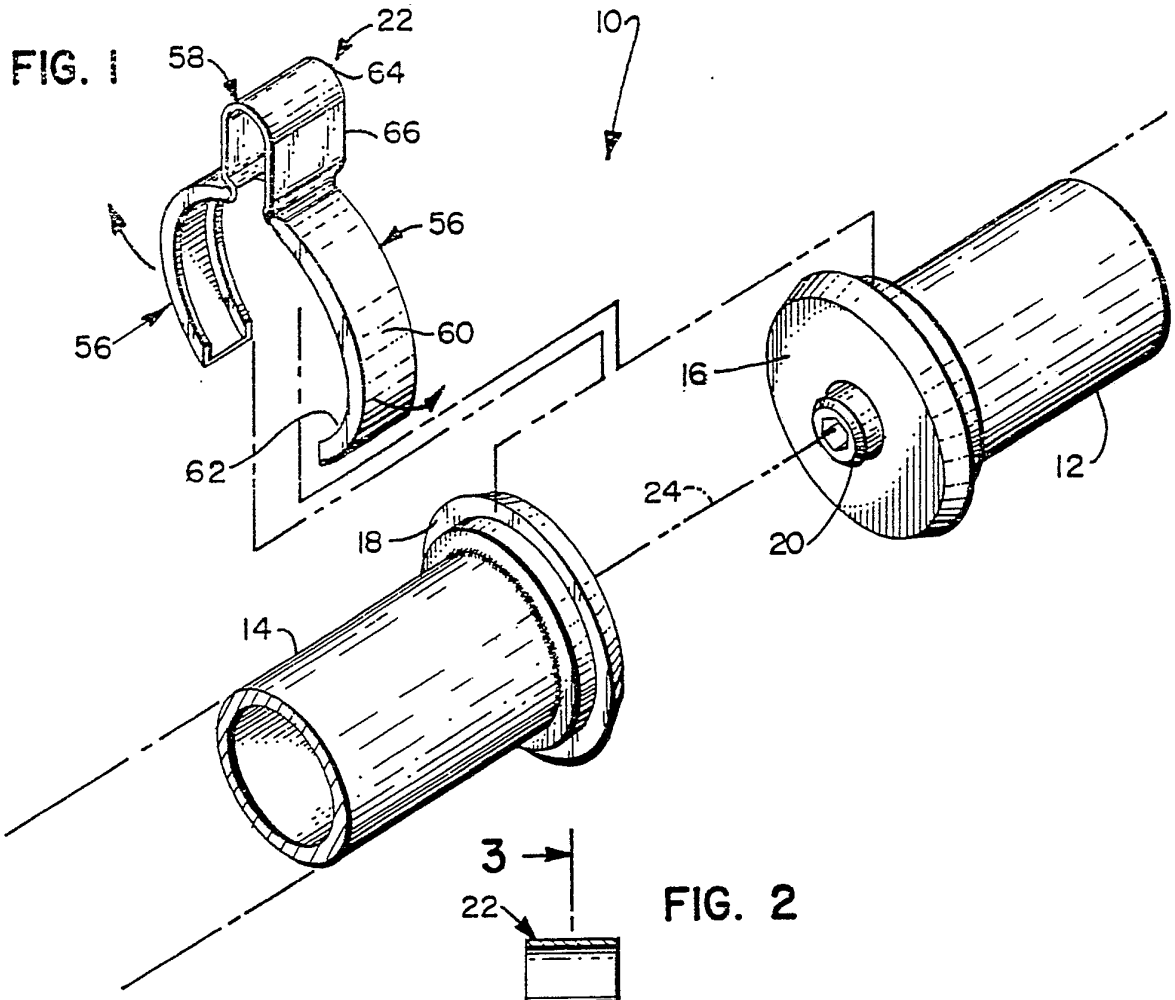


FIG. 2

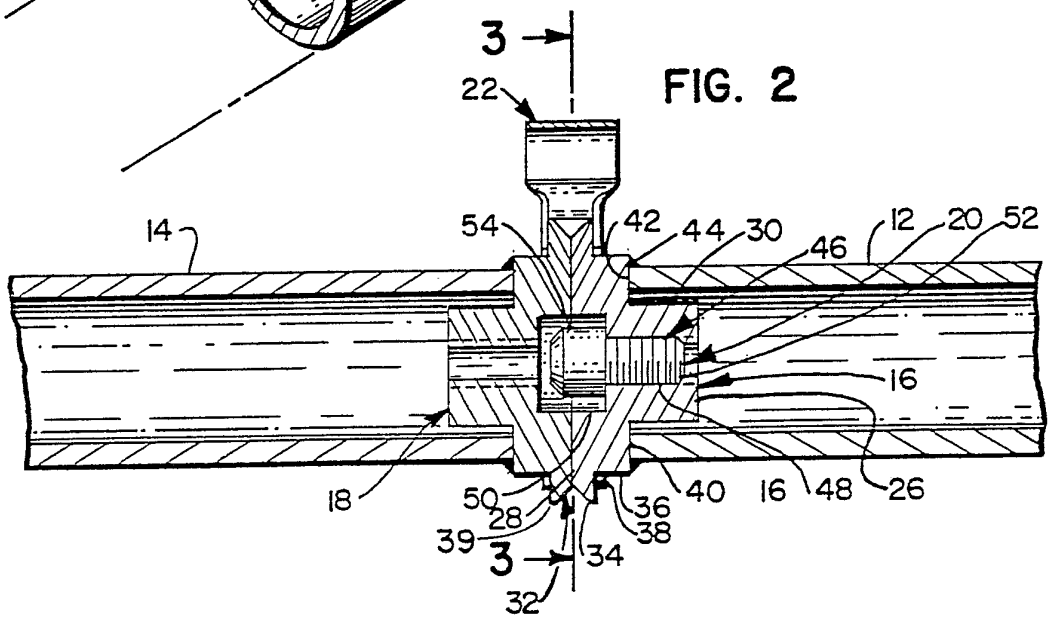


FIG. 3

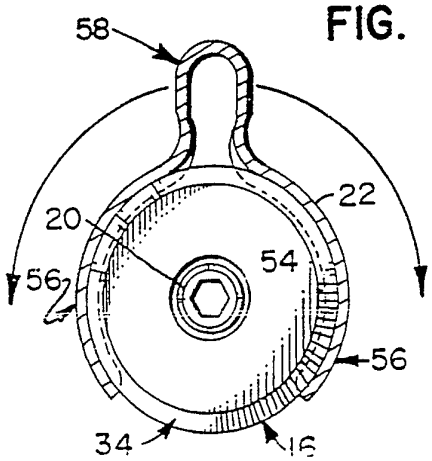


FIG. 4

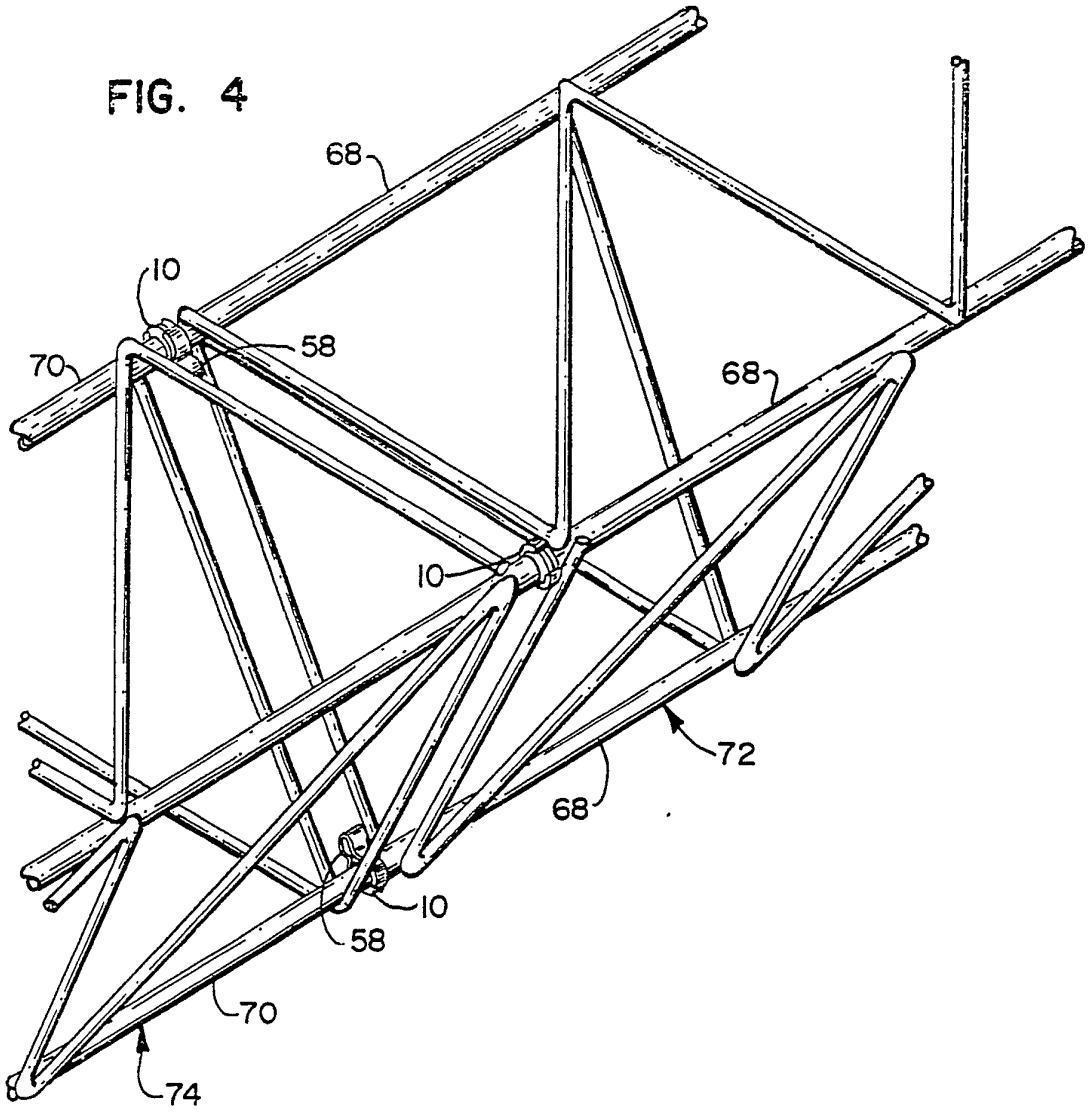


FIG. 5

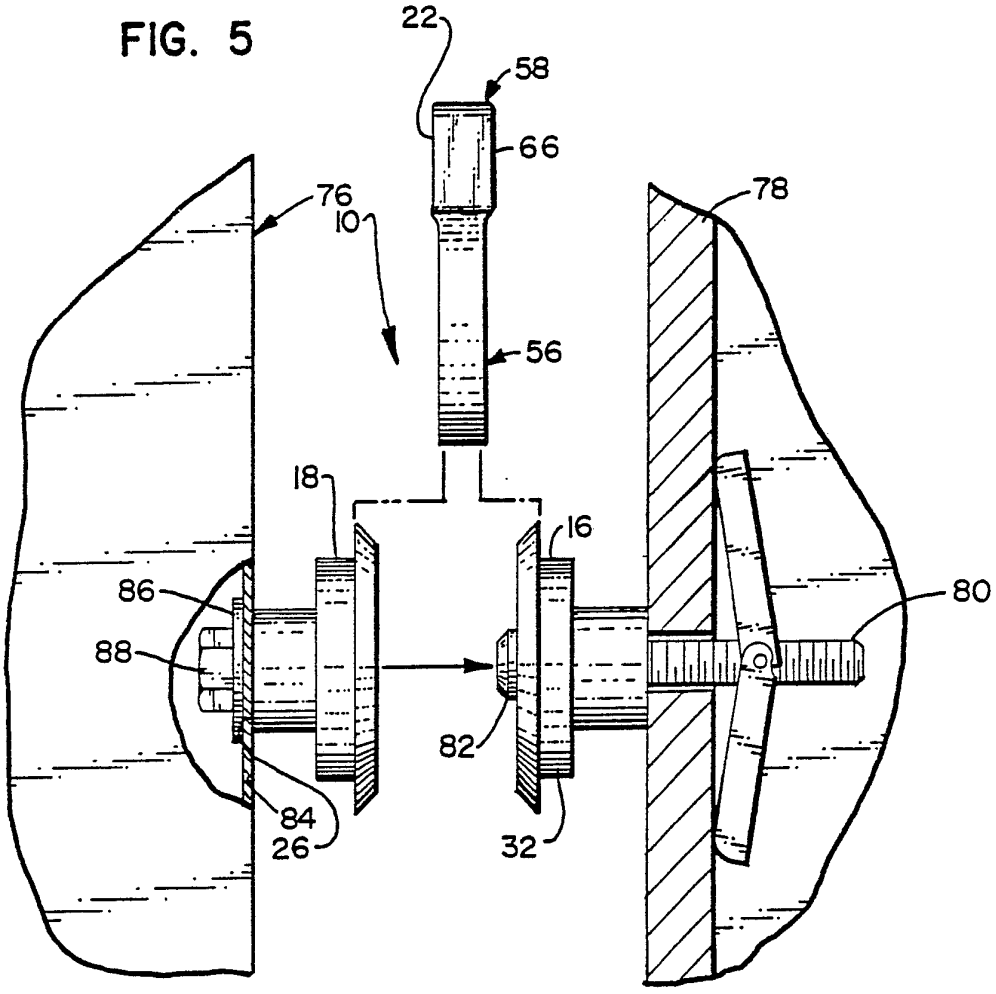
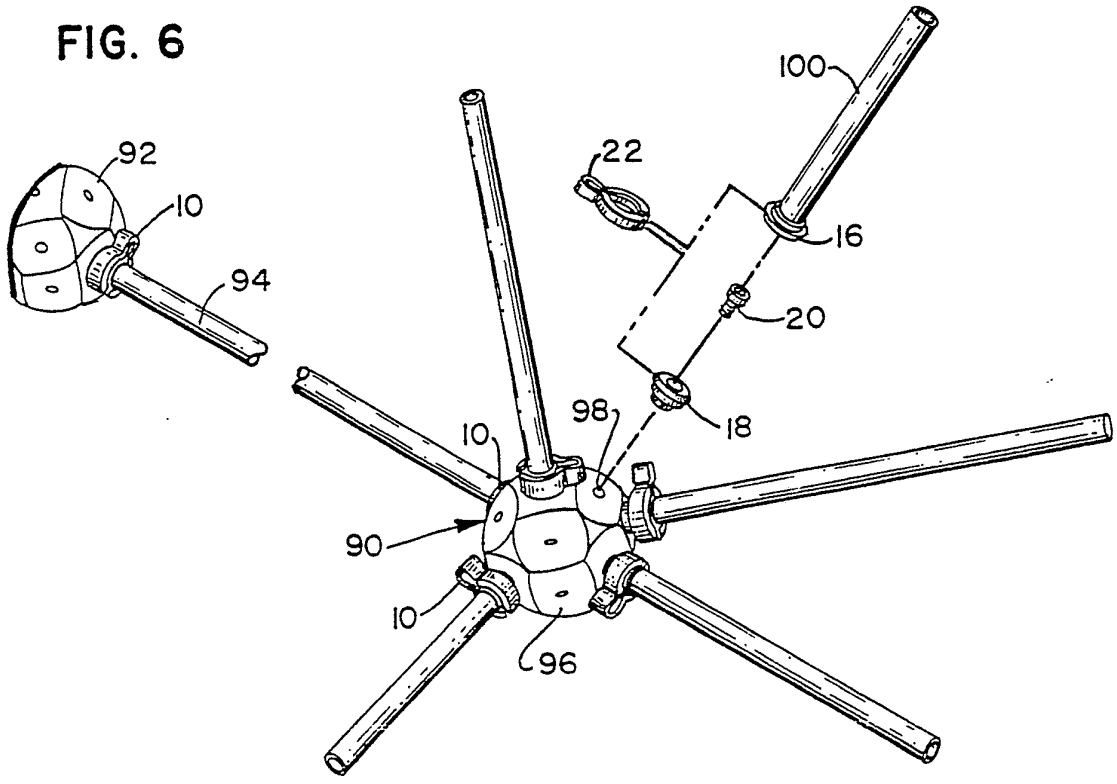
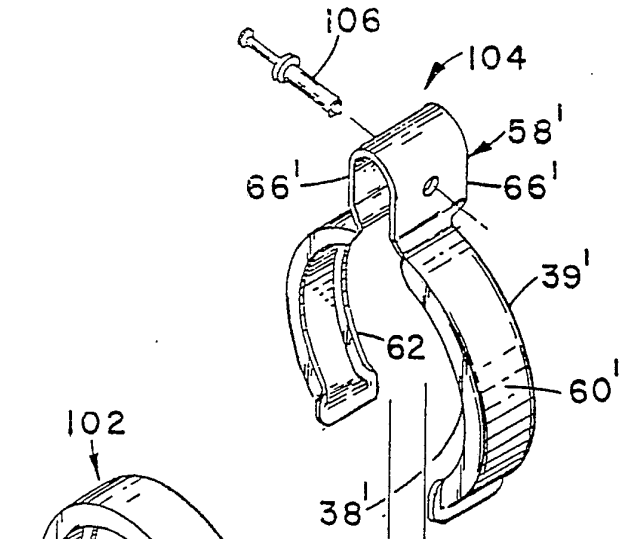

22
58
66
76
10
78
56
18
16
86
80
88
82
84
26
32

FIG. 6


100
92
22
10
16
94
20
18
98
10
90
10
96



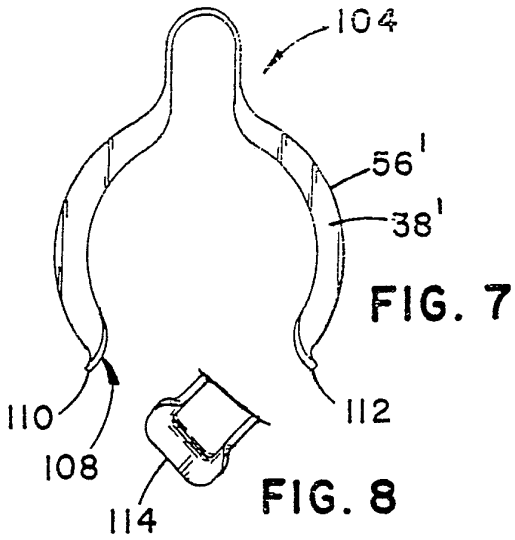


FIG. 7

FIG. 8

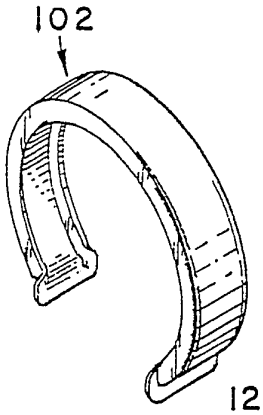


FIG. 13

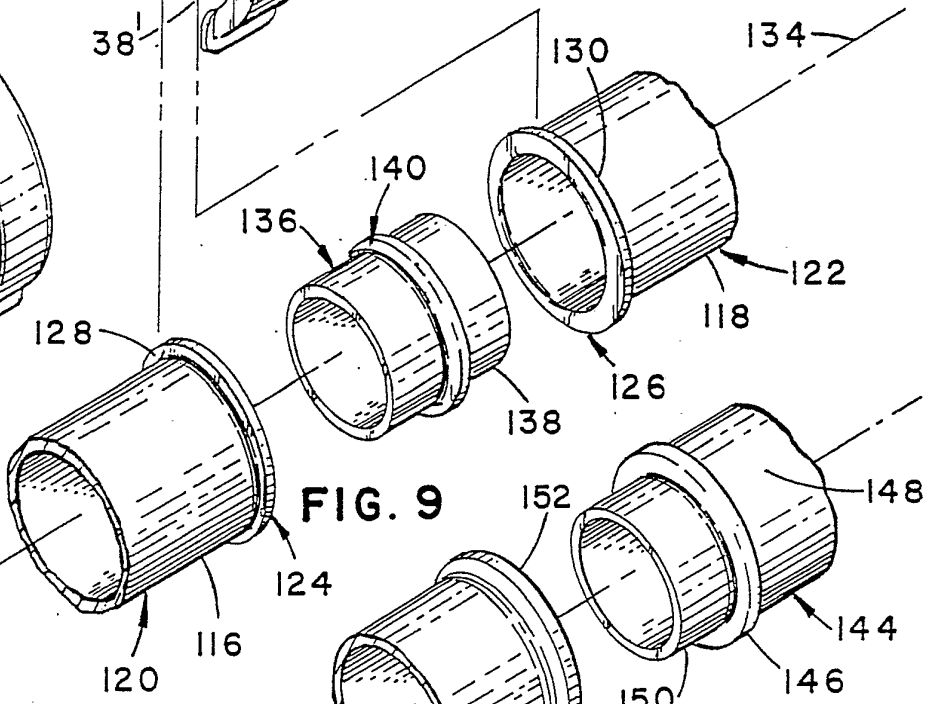


FIG. 9

FIG. 11

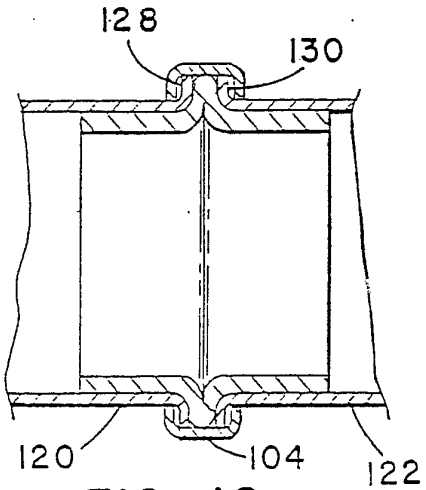


FIG. 10

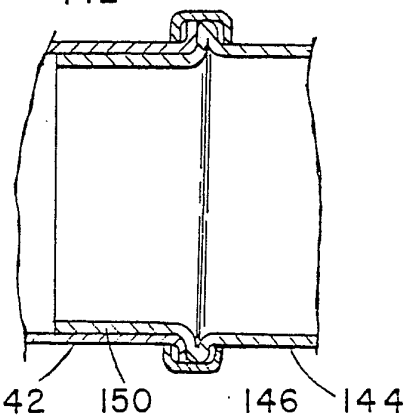


FIG. 12