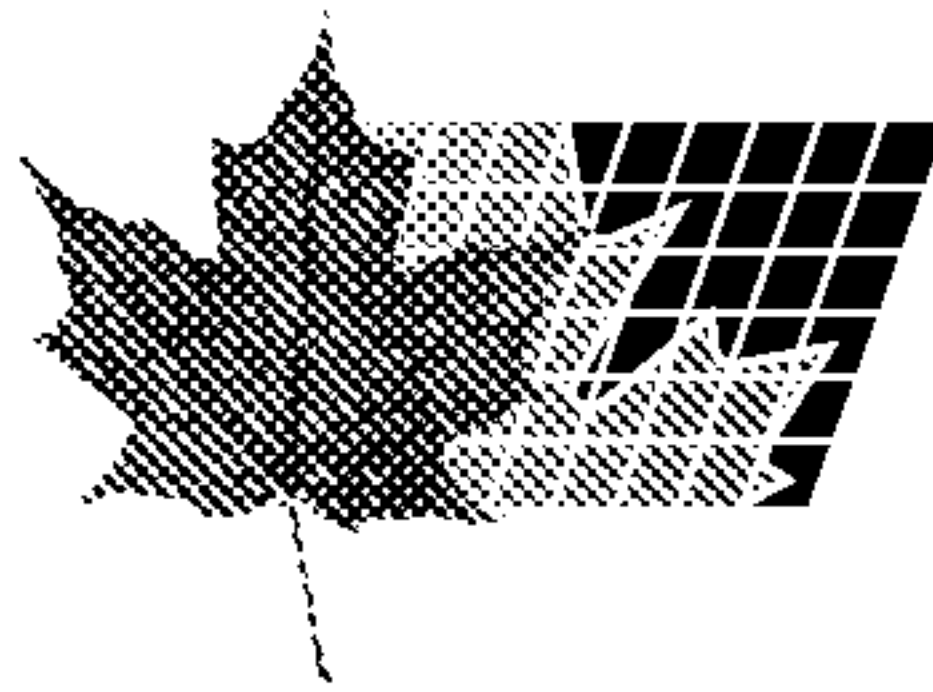




(72) CHAPMAN, WILLIAM A., US

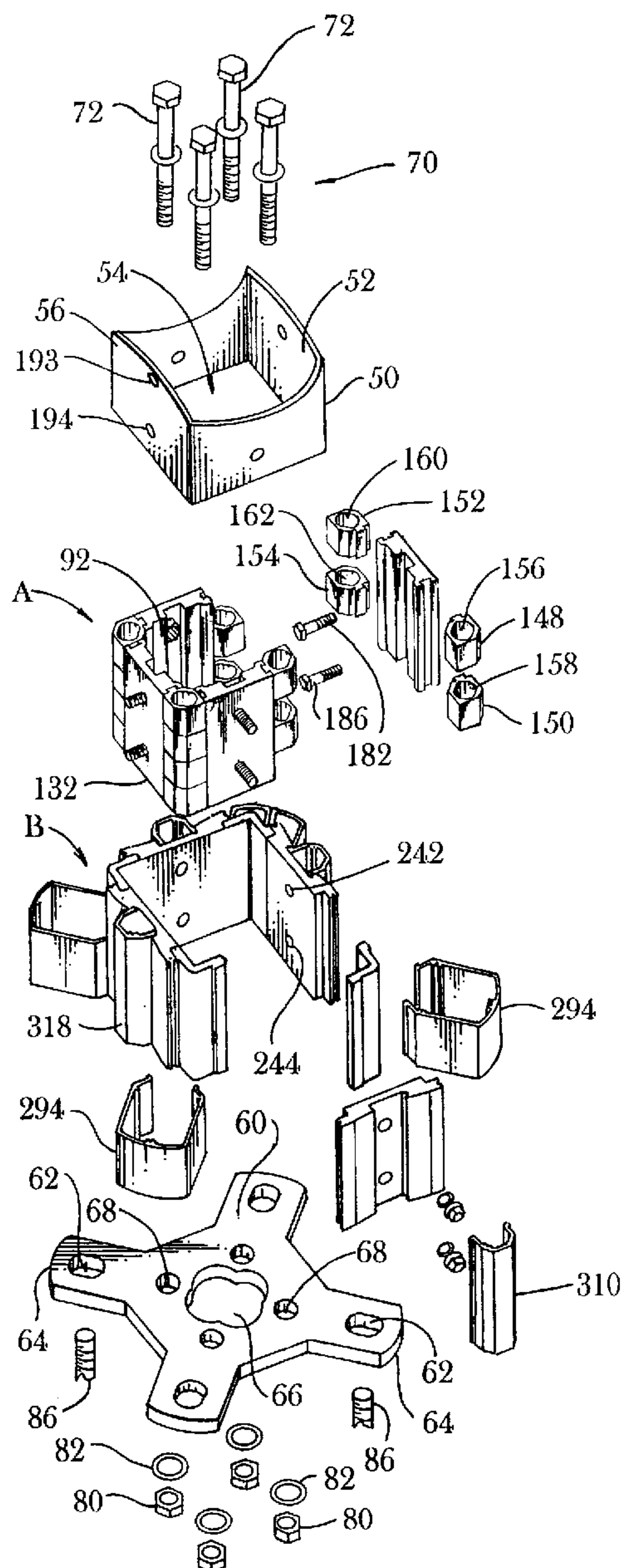
(71) CHAPMAN, WILLIAM A., US

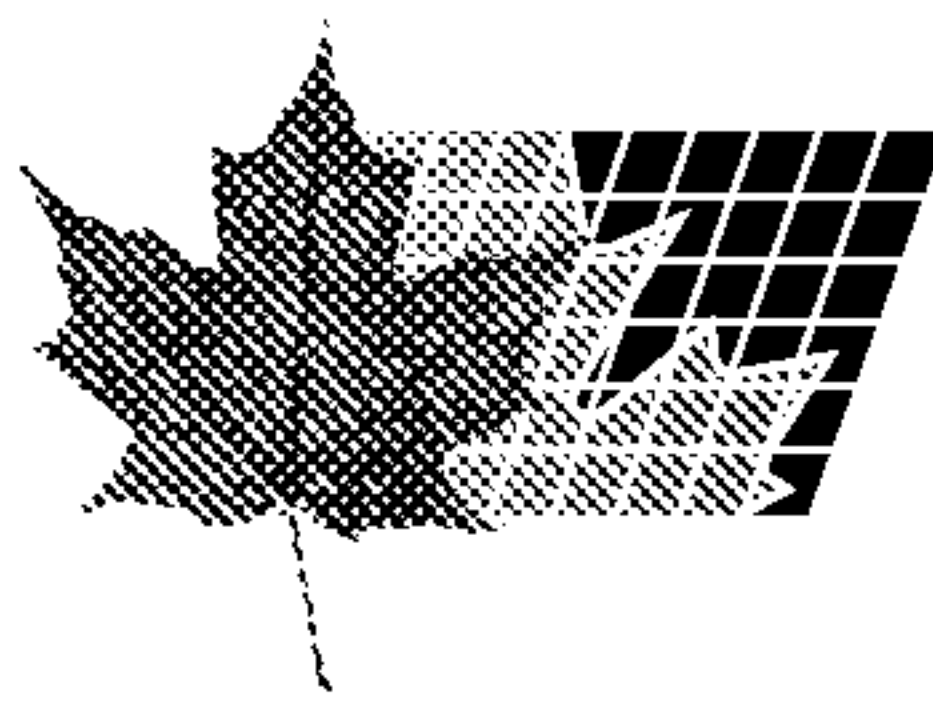
(51) Int.Cl.⁷ E04H 12/22, E02D 27/42, F16B 7/00

(30) 1997/05/08 (60/045,952) US

(54) **PROCEDE ET APPAREIL D'ASSEMBLAGE DE COMPOSANTS
STRUCTURELS**

(54) **METHOD AND APPARATUS FOR JOINING STRUCTURAL
COMPONENTS**





(21) (A1) **2,289,059**
(86) 1998/05/08
(87) 1998/11/12

(57) L'invention concerne un dispositif de couplage, dans lequel des éléments indépendants et un mécanisme de raccordement à emboîtement coulissant, permettant de raccorder des tenons à la paroi d'un module d'assemblage, présentent plusieurs avantages. Tout d'abord, les tenons peuvent être ajustés individuellement sur ladite paroi, permettant ainsi d'obtenir un dispositif d'imbrication plus flexible. Ainsi, au lieu d'avoir à fabriquer plusieurs modules d'assemblage indépendants pour obtenir différents dispositifs d'imbrication, il n'est plus nécessaire que de fabriquer une seule paroi standard et un seul type de tenons standard, de sorte que l'imbrication est possible simplement par assemblage des tenons et des parois. On a pu obtenir une telle flexibilité en développant le raccordement à emboîtement coulissant des tenons à la paroi, sans perte de résistance ou diminution de la facilité d'utilisation. On peut utiliser les tenons sur n'importe laquelle des extrémités des parois, simplement en les détachant de l'une de ces extrémités, puis en les retournant pour les fixer sur une autre extrémité. Dans une variante, un dispositif de couplage peut, conformément à cette invention, être pourvu de modules dont chacun présente une paroi pourvue d'extrémités. Les extrémités d'au moins une partie de ces modules comprennent des tenons qui s'étendent parallèlement à un axe du dispositif de couplage, des fentes à mortaise étant ménagées dans au moins une partie desdites extrémités, et ces fentes s'étendant parallèlement à un axe du dispositif de couplage. Ainsi, lorsque lesdits modules peuvent sont assemblés à l'intérieur de ce dispositif de couplage, les parois à tenons viennent s'insérer dans les fentes à mortaise correspondantes.

(57) A coupling device (A), wherein separate individual elements (142) and a sliding interlocked connection mechanism (170a, 166) for connecting individual tenons (148) to a wall portion of a link module provide several advantages. The tenon members (148) are individually adjustable on the wall portion to give various intermeshing arrangements. Therefore, instead of manufacturing several individual different link modules to obtain a variety of different intermeshing arrangements, one needs only to manufacture a standard wall portion (142) and a standard type of tenon means (148), so that any intermesh can be provided by simply assembling tenon means and wall portions. The tenon members may be used on either wall end portion by simply detaching from one wall end, inverting, and reattaching to the other wall end.



PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification⁶ : E02D	A2	(11) International Publication Number: WO 98/50639 (43) International Publication Date: 12 November 1998 (12.11.98)
(21) International Application Number: PCT/US98/09419 (22) International Filing Date: 8 May 1998 (08.05.98) (30) Priority Data: 60/045,952 8 May 1997 (08.05.97) US (71)(72) Applicant and Inventor: CHAPMAN, William, A. [US/US]; 2706 South Horseshoe Drive, Naples, FL 33942 (US). (74) Agent: OLDHAM, Scott, M.; Oldham & Oldham Co., L.P.A., Twin Oaks Estate, 1225 W. Market Street, Akron, OH 44313 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>Without international search report and to be republished upon receipt of that report.</i>
(54) Title: METHOD AND APPARATUS FOR JOINING STRUCTURAL COMPONENTS (57) Abstract The invention is directed to a coupling device, wherein separate individual elements and a sliding interlocked connection mechanism for connecting individual tenons to a wall portion of a link module provide several advantages. First, the tenon members are individually adjustable on the wall portion to give more flexibility in providing various intermeshing arrangements. Therefore, instead of having to manufacture several individual different link modules to obtain a variety of different intermeshing arrangements, one needs only to manufacture a standard wall portion and a standard type of tenon means, so that any intermesh can be provided by simply assembling tenon means and wall portions. The key to this flexibility was the development of the sliding interlock connection between the tenon members and a wall portion, without the loss of strength and function. The tenon members may be used on either wall end portion by simple detaching from one wall end, inverting and reattaching to the other wall end portion by simply detaching from one wall end, inverting and reattaching to the other wall end. Alternatively, a coupling device according to this invention, may have each module of a plurality of modules which includes a wall portion with wall end portions on each end. The wall end portions of at least some of the modules have tenon wall members extending parallel to an axis of the coupling device, and at least some of the wall end portions have slot mortise members formed therein which extend parallel to an axis of the coupling device whereby when the modules are assembled into the coupling device the tenon wall members are received into corresponding slot mortise members.		

METHOD AND APPARATUS FOR JOINING STRUCTURAL COMPONENTS

BACKGROUND OF THE INVENTION

1. Field of the Invention.

5 This invention relates to method and apparatus for joining structural components generally and, in particular, to joining first and second structural components when the first component is a tubular type element having an inner wall surface defining an internal duct and an outer wall surface surrounding the internal duct.

2. Description of the Prior Art.

10 This invention is an improvement over the invention disclosed in U.S. Patent No. 5,499,885, (referred to herein as '885), issued to William A. Chapman on March 19, 1996, and in corresponding PCT Application No. PCT/US94/05058, filed May 6, 1994 by William A. Chapman. The disclosures of the above-noted U.S. Patent and the PCT Application are incorporated herein by reference thereto. Further, the prior art patents
15 cited and discussed in the above-noted U.S. Patent and PCT Applications are also incorporated herein by reference thereto.

There are a number of applications where a tubular type component needs to be joined, connected or otherwise attached to another component. For example, vertical building modules use hollow vertical columns which must have their lower ends
20 connected to a base. Further, in such building application, tubular type components can be used as beams extending between the vertical columns, which again require joining methods and apparatus.

Other applications include building frames or other structures from tubular type elements, such as truck beds or trailers for semi-trailer trucks. If the tubular elements are
25 formed from aluminum, then important weight reductions can be achieved which translate directly into increased payloads and improved profits.

One of the most extensively used of such connections are utility pole assemblies for street and highway lighting, electric wire carriers, and for other vertical standard uses.

These poles may be made from many materials which are suitable for their
30 intended application, e.g., steel, aluminum, industrial reinforced plastic, or other materials. Most are elongated and tubular. Aluminum is very popular because of its light

weight and corrosion resistant qualities.

The most common method of attaching a tubular pole is to weld the lower end of the pole to a base plate which is then connected to an anchor structure. In such a construction, if the yield strength of an aluminum pole is 25,000 psi, welding will
5 decrease the loading capacity by as much as 57 percent. Therefore, it is preferable to mechanically fasten the pole to a base plate to retain the yield strength and loading capacity. Then a lighter pole can be used which will have the same loading capacity as a larger and more expensive pole which has been attached by welding, particularly since the quality of a weld can vary from piece to piece.

10 The most popular mechanical fastening method is to use a fixed size inner sleeve which the tubular pole fits over. The inner sleeve may be previously attached to a base plate with provisions for attaching the base plate to an anchor means. The problem with this method is in controlling the size tolerance of both the fixed size inner sleeve and the size tolerance of the internal duct, which must be very close. Unfortunately, in the
15 manufacturing process the desired tolerance cannot be maintained without adding considerable expense to the process, and/or the discarding of out-of-tolerance parts.

When the inner sleeve is too small, the pole fit is loose and a hinge effect will occur. This not only reduces the initial load capacity, but permits additional reductions in capacity if the pole metal is fatigued with the pole motion as time passes. If the inner
20 sleeve is too large and is jammed into the tube duct, a shear problem may occur. In any event, the stretching of the pole by an oversized inner sleeve will stress the pole, and may actually cause a rupture, hairline crack, or the like.

Since the problems in this general area are most readily apparent in the joining of a tubular pole to an anchor base, and since most of the pertinent prior art is related to a
25 tubular pole or similar structural components, this invention will be set forth in that context. While the invention is particularly well suited for and advantageously used with tubular poles, it must be kept in mind that protection is sought in all of the applications for this invention, including those discussed above and hereinafter and in which the invention may be used whether specifically discussed herein or not.

30 The method and apparatus in the above-referenced Patent '885 was and is a substantial advance over the existing prior art. For example, the method and apparatus of

'885, relative to the concept of a non-welded utility standard base in the lighting industry, has met with significant enthusiasm by the nationwide lighting agency representative network. The engineering community has accepted the '885 invention as a viable option to "brittle-break" welded posts in high stress as well as normal applications. This method and apparatus provides the only nonferrous post or standard that will meet the engineering requirements in Dade County, Florida, in the aftermath of Hurricane Andrew and the resulting new, tougher Dade County codes. The '885 invention is the only approach that can meet all the elements in the demand for low maintenance, lower cost, and longer life. Further, the '885 invention is a deterrent to earthquake driven utility standard failures in areas such as California in the United States, and internationally in Japan and other areas with high earthquake probabilities.

However, as with all new innovations, further development and research has provided a method and apparatus that is new and unique, and which can perform and improve on the functions of the '885 invention by using a combination of different components and different method steps, and which provide advantages over the '885 invention.

In the '885 invention, casting of the link members appeared to be the best way to manufacture the apparatus. However, such casting techniques have been found to not consistently provide a quality product in an effective manner.

Therefore, research was initiated to develop a new method and combination of components which would perform and improve on the functions of the '885 invention, wherein the new components would be stronger with higher material strengths, would have virtually no component failures, and would provide significantly higher production rates. This also turned out to significantly lower the production costs. Further, the production lead times are substantially reduced.

SUMMARY OF THE INVENTION

Based upon the foregoing, it is an object of this invention to provide an improved method and apparatus for joining a first component to a second component. Such first component may be a tubular wall forming an elongated tubular element having an inner wall surface extending along and defining an internal passageway or duct, and an outer wall surface surrounding the inner wall surface and the internal duct or passageway. Such

second component may be another structural component, an anchor means, a frame structure, a support element, or other element.

It is a further object of this invention to provide an improved method and apparatus for joining such a first component to a second component, which utilizes link
5 modules which may be moved with respect to each other into supporting and engaging contact with an inner passageway or internal duct wall, or with an outer wall surface surrounding the inner wall or duct, or both. After such engagement and supporting contact, the link modules are secured into a unitary structure.

It is a still further object of this invention to provide the method and apparatus
10 described above which utilizes components which are unique, and thus forms a unique combination, and which can be manufactured at the lower cost, have the highest material strength, and can be extruded to maximize the advantages thereof.

Thus, there has been developed a new combination of unique components and a new method for joining structural components to provide new results and advantages over
15 prior structures and methods.

In a first embodiment of a coupling device, separate individual means and a sliding interlocked connection means for connecting individual tenons to a wall portion of a link module provide several advantages. First, the tenon members are individually adjustable on the wall portion to give more flexibility in providing various intermeshing
20 arrangements. Therefore, instead of having to manufacture several individual different link modules to obtain a variety of different intermeshing arrangements, one needs only to manufacture a standard wall portion and a standard type of tenon means, so that any intermesh can be provided by simply assembling tenon means and wall portions. The key to this flexibility was the development of the sliding interlock connection between the
25 tenon members and a wall portion, without the loss of strength and function. The tenon means may be used on either wall end portion by simply detaching from one wall end, inverting, and reattaching to the other wall end.

The tenon means and the wall portion can be manufactured in any length or height. Different wall portions can be provided which, in combination with adjustable
30 individual tenons, can be assembled to provide engaging contact support and mate with the interior or exterior surfaces of any type of tubular element, whether square,

rectangular, polygonal, tapered or the like, examples of such tubular elements being disclosed in Patent '885, incorporated herein by reference.

The various new components of the new combination may be formed from metals, such as steel or aluminum, or from heavy duty and strong industrial reinforced plastics.

5 The components may be formed by machining, casting, or other such approaches. However, part of the discoveries herein was to design the individual components so that they can be manufactured by extrusion, whether metal or plastics.

While other materials can be used in extrusion manufacturing, the preferred material is aluminum, because of its light weight, corrosion resistance qualities, and
10 excellent strength to weight ratio when extruded, with a guaranteed material strength as opposed to inconsistent strengths when casting, for example.

Further, extrusion of the components enables cost reductions in the manufacturing process. For example, extrusion reduces die and mold costs by seventy percent. Still, further, production is faster. Lead times for the combination components shown herein
15 are shorter than the lead times on a pole shaft itself.

The above-described individual tenon means can be used with coupling devices which can engage either inner or exterior support surfaces of components to be joined together.

In a second embodiment of a coupling device useful in this invention, each
20 module of a plurality of modules in the coupling device includes a wall portion with wall end portions on each end.

The wall end portions of at least some of the modules have tenon wall means extending parallel to an axis of the coupling device, and at least some of the wall end portions have slot mortise means formed therein which extend parallel to an axis of the
25 coupling device whereby when the modules are assembled into the coupling device the tenon wall means are received into corresponding slot mortise means.

Some of the wall end portions of each wall portion have a slot formed therein which opens inwardly toward the center of the coupling device and extends parallel to an axis of the coupling device, the other of the wall end portions having a slot formed therein
30 which opens outwardly from the center of the coupling device and ends parallel to an axis of the coupling device.

Each slot has an outermost slot wall at the end of each wall portion which forms the tenon wall means, whereby when the modules are assembled together into a coupling device the tenon wall means on a wall end portion is received in a slot formed on a wall end portion of an adjacent module.

5 The slots advantageously have a width enabling a tenon wall to be moved therein to permit expansion or reduction of the size of the coupling device to engage support surfaces with all modules of the coupling device. The tenon walls cooperate with slot walls to form guide ways to receive a means for securing the modules of the coupling device into a unitary structure.

10 The securing means may include rod means with screw threads formed on one end. The rod means may have a configuration on the other end shaped to be engaged and captured by the tenon wall and slot sides, to prevent the rod means from rotating when a nut is tightened on the screw thread end.

15 The modules may have outer and inner wall surfaces configured to mate with inner and exterior wall surfaces, respectively.

As in the first embodiment of the coupling device, the second embodiment is specifically designed so that the modules can be manufactured by an extrusion process in order to obtain all of the advantages set forth hereinbefore for extrusions.

20 Also, as in the first embodiment, the modules may be used with coupling devices which can engage either inner or exterior support surfaces of components to be joined together.

25 Thus, the method and apparatus of this invention can be used to join two tubular elements together to form a horizontal beam. Further, this method and apparatus can be used to joint two tubular elements to replace a broken tubular element by joining a tubular element to a tubular element still left in the ground with the top portion is broken off or is bent (and cut off). This avoids having to tear up streets, sidewalks, etc. to bury a new pole. Further, this can be used for repair of a broken tubular mast or the like without having to return to port or a ship yard for total mast replacement.

30 While the above-described first and second embodiments of coupling devices are unique and novel, and have advantages over the coupling devices disclosed in Patent '885, this invention is also directed to method and apparatus for joining first and second

components to provide a stronger and more stable apparatus and method. Thus, such apparatus and method can be used to join a first component to a second component, such as a base anchor device or the like. This apparatus and method can also be used to join first and second components when each has a passageway formed therein which opens to the exterior of the component, such as first and second tubular elements. Further, the apparatus and method can be used to join first and second components by engaging the exterior surfaces of the two components. The key to this effort is to preferably use the improved coupling devices described herein, secure the modules thereof together into first and unitary structures, and then connecting the first and second unitary structures together, after the customized fit for each coupling device is obtained by module adjustment with the associated separate support surfaces of the component involved with each coupling device.

Such a method (and comparable apparatus) can be used for joining first and second components when at least one of the components may have a passageway formed therein with inner support surfaces extending along the length of and defining the passageway, and when at least one of the components may have an outer or exterior support surface extending around the exterior of that component.

A first plurality of modules is assembled into a first coupling device. At least one of the first plurality of modules is moved with respect to the other modules so that the first plurality of modules is in engaging and support contact with one of the support surfaces of the first and second components. The modules of the first coupling device are secured into a first unitary structure when the modules are in the engaging and support contact with the said one of the support surfaces of the first and second components to prevent movement of those modules with respect to each other in response to changing load conditions and to maintain the modules and the first unitary structure in a customized exact fit in a stable engaging and support contact position with said one of the first and second components.

A second plurality of modules is assembled into a second coupling device. At least one of the second plurality of modules is moved with respect to the other modules so that the modules are in engaging and support contact with another of said support surfaces of the first and second components.

The modules of the second coupling device are secured into a second unitary structure when the modules are in said engaging and support contact with said other of the support surfaces of one of the first and second components to prevent movement of said modules with respect to each other in response to changing load conditions and to
5 maintain said modules and said second unitary structure in a stable engaging and support position with said other support surfaces of said one of the first and second components.

The first and second unitary structures are connected together, whereby the individual sizing of each of the unitary structures with respect to said one and said other support surfaces by module movement before being secured into first and second unitary
10 structures providing a customized fit for each unitary structure and a stronger joining method and apparatus.

Other objects, advantages, and features of this invention will become apparent when the following description is taken in conjunction with the accompanying drawings.

15 BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, where like numerals are employed to designate like parts throughout:

Fig. 1 is an exploded view in perspective illustrating a first embodiment of this invention;

20 Fig. 2 illustrates an enlarged view in perspective of subassembly A from Fig. 1;
Fig. 3 is an enlarged plan view of a subassembly A from Fig. 1;

Fig. 4 is an enlarged plan view of an individual tenon and an associated wall end portion of an adjacent module;

25 Figs. 5 and 6 is an enlarged plan view and side elevational view of a bolt head restraint;

Fig. 7 is a plan view of an individual tenon and an associated wall end portion, with the bolt head restraint position indicated in dotted lines thereon;

Fig. 8 is an enlarged view in perspective of subassembly B from Fig. 1;

30 Fig. 9 is an exploded view in perspective illustrating a second embodiment of this invention;

Fig. 10 is an enlarged view of subassembly D from Fig. 9;

Figs. 11 and 12 are plan views of the first of subassembly D with different sizes of tubular elements;

Fig. 13 is an enlarged view in perspective of subassembly C from Fig. 9;

5 Figs. 14, 15 and 16 are plan view graphical illustrations of how the subassembly C assembles with inner support surfaces of various dimensions;

Fig. 17 is an exploded view in perspective of a subassembly E, for use with outer support surfaces of a component having an arcuate cross-section;

Figs. 18, 19 and 20 are plan view graphical illustrations of how the subassembly E assembles with outer support surfaces of various dimensions;

10 Fig. 21 is an exploded view in perspective of subassembly F;

Figs. 22 and 23 are graphical representation of how the subassembly F assembles with outer support surfaces of various dimensions; and

15 Fig. 24 is an exploded view in perspective of two joining or coupling devices illustrating the joining of two tubular components, with Figs. 24a and 24b illustrating hand holes.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to Fig. 1, there is shown an exploded view in perspective of a first embodiment of the joining apparatus of this invention, which also illustrates the method of this invention.

20 A tubular element 50 represents a first component to be joined to a second component such as a base plate or an anchor means 60. Such a tubular element 50 may be a utility standard or pole to support transmission lines, light fixtures, etc. Other examples of the first and second components to be joined together are discussed elsewhere herein. In this embodiment the tubular element may rest on the base plate 60, which in this
25 embodiment is connected to an anchor means by anchor bolts 86 which extend upwardly from an anchor base (not shown) through bores 62 in ears 64 of the base plate by appropriate nuts, lock washers or lock nuts on the threaded upper ends of the anchor bolts.

The base plate 60 also may have bores 68 formed therein which are located to be aligned with securing bores 156, 158 and 160, 162 formed in tenons 148, 150 and 152,
30 154, respectively, (best seen in Fig. 2) so that the joining device or unitary structure indicated generally at 132 can be connected directly to base plate 60 with the same bolt

and nut combination that secures an expanded coupling device together into a existing unitary structure. A wire-way 66 may be formed in base plate 60, which is aligned with a wire-way 92 formed by assembled link modules or sets in subassembly A in Fig. 1.

When the assembly of link modules of subassembly A is nested inside of the tubular element 50 as a joining device in this embodiment, the size of the joining device is enlarged or expanded as will be described in the discussion of Fig. 2 hereinafter. This expanded coupling device then has the link modules secured together into a unitary structure by means indicated generally at 70, which includes bolts 72 inserted through aligned bores 156, 158 and 160, 162 in the tenon means of the assembled link modules or sets. In this embodiment, the bolts 72 are long enough to also extend through the bores 68 formed in base plate 60. Washer's 82, plate and/or lock types, are placed on the threaded ends of bolts 72, and then nuts or lock nuts 80 are expanded assembly of link modules into a unitary structure, and may also connect the unitary structure to base plate 60. Under lighter loading conditions the base pate 60 may be omitted and the unitary structure connected directly to anchor bolts.

The bolt means 70 utilized in this embodiment are representative of a number of different ways for securing the assembly 132 into a unitary structure. The bolts are the preferred embodiments, because they are standard, off-the-shelf parts, which are relatively inexpensive. Moreover, they serve another important function. That is, the bolts 72 can be inserted through the aligned bores in the link modules together for shipping and handling purposes, as when nesting the assembly inside the tubular member. Loss of loose parts is thus avoided.

While bolts and nuts are readily available, they are representative of rod or other means insertable through the aligned bores for retaining the link modules assembled together. For example, threads may be formed on both ends of a rod, and nuts screwed on both ends. Alternatively, threads may be formed in the top or bottom bore of link modules. The rod means may then be screwed into the threaded bores. The other end of the rod means may have a regular bolt or thread-nut combination enabling the securing of the link modules into a unitary structure.

The aligned bores in the tenons are sized with respect to the size of the rod means or bolts to permit movement of the link modules with respect to each other while the rod

means or bolts are inserted in the aligned bores. Thus, the link modules may be moved into the desired inner wall or external wall engaging contact and support position.

Referring now to Fig. 2, there is illustrated a subassembly A (enlarged from Fig. 1) which shows a first embodiment of a coupling or joining device, indicated generally at 132, which may be employed in this invention. The coupling device 132 in this embodiment includes four sets of link members or modules, each indicated generally at 134, 136, 138 and 140. Since each of those sets are identical in this embodiment, only the set 140 will be described in detail, which is shown in a disassembled, exploded fashion separate from the other three sets 134, 136 and 138, which are shown assembled together into the coupling or joining device 132.

The module set 140 includes a wall portion 142 having wall ends 144, 146, which are opposed in this embodiment. In this embodiment, projecting or tenon means 148, 150 are associated with wall end portion 144, while projecting or tenon means 152, 154 are associated with wall end portion 146. Examples of other wall portion shapes are disclosed in the referenced U.S. Patent No. 5,499,885.

Bores 156, 158 are formed in tenon means 148, 150 respectively, and bores 160, 162 are formed in tenon means 152, 154 respectively. In this embodiment the bores 156, 158 and 160, 162 have axes formed parallel to the wall end portions 144, 146. Bores 156, 158 are located so that when the tenon means 148, 150 are connected to wall end portion 144, the bores will be axially aligned with each other. Similarly, bores 160, 162 are located so that when tenon means 152, 154 are connected to wall end portion 146, the bores will be aligned with each other.

Means are provided to respectively slidably engage and connect the tenon means to the wall end portions 144, 146 in an interlocking fashion, to prevent them from being pulled away from the wall end portions. In this embodiment, each tenon means carries a dovetail shaped projection 166, 168 and 172, 174 thereon, which has a width diminishing toward the root where it is connected to the tenon means. A groove 170 is formed in wall end portion 144 having a cross-section which is complementary with and mates with dovetail projections 166, 168 formed on tenon means 148, 150, respectively. Similarly, a groove 176 having the same type of cross-section is formed in wall end portion 146, which is complementary with and mates with dovetail projections 172, 174 formed on

tenon means 152, 154, respectively.

The dovetail projections can be slipped into the grooves from either end of the groove. The dovetail/groove combination prevents the tenon means from being pulled away from the wall end portions, and provides an interlocked connection.

5 Conversely, the dovetail projections may be formed on the wall end portions, while the grooves are formed in the tenon means to receive the dovetail projections formed on the wall end portions, and hold them in the interlocking relationship discussed above.

10 While the dovetails shown in Fig. 2 diminish on each side, a dovetail configuration may be used in which only one side is angled inwardly toward the root and the other side is perpendicular to the connection of the dovetail to the tenon, sometimes called a "sliding dovetail."

15 Also, while dovetail structures are a preferred method of forming interlocking joints, other interlocking structures can be used. For example, an interlocking joint can be obtained by extruding or forming a cylindrical bead attached to a tenon by a tongue. In this instance, the slot is then formed with a complementary and mating bore forming in the wall end portion to receive the cylindrical bead. This slot further includes an opening between the bore in the wall end portion and the wall end to receive and accommodate the tongue which connects the bead to the tenon. The tongue opening is smaller in width than
20 the cross-section of the cylindrical bead, to prevent the bead from being pulled out of the slot. Thus, this structure is also interlocking. Other such interlocking structures are also known to accomplish the desired interlocking in this invention.

25 Assembly of a link member or module is also illustrated by viewing module set 140 in Fig. 2. As noted above, tenon means 148, 150 are assembled with wall portion 142 by sliding dovetails 166, 168 into groove 170 formed in wall end portion 144. Tenon means 152, 154 are assembled with wall portion 146 by sliding dovetails 172, 174 into groove 176 formed in wall end portion 146.

30 The tenon means 148, 150 are spaced from each other with the bottom tenon means 150 being aligned with the bottom of the wall portion 142, while tenon means 148 is to be located halfway between tenon means 150 and the top of wall end portion 144, in this embodiment.

Tenon means 152, 154 are also spaced from each other, with the top of the tenon means 152 being aligned with the top of the wall portion 142, while tenon means 154 is to be located halfway between tenon means 152 and the bottom of wall end portion 146, in this embodiment.

5 The separated position of the tenon means 148, 150 and 152, 154 permits and enables module set 140 to be assembled with modules 134 and 138, with offset tenons 148, 150 to be intermeshed with the similarly offset tenons extending from module set 134, and with offset tenons 152, 154 to be intermeshed with the similarly offset tenons extending from module set 138.

10 As described herein, bolts or other securing means are inserted through the aligned bores in the tenons to secure the assembly 132 into a unitary structure. Such bolts can also be used in preliminary assembling of the links or modules 134, 136, 138 and 140 into the coupling or joining device 132. Plastic assembly jigs can be used to properly to position the tenon means in the spaced positions discussed.

15 It should be noted that the term tenon means includes an individual tenon or a plurality of tenons or projections.

 Projection or tenon receiving spaces are formed on wall end portions by the spacing of the tenon means assembled therewith. Thus, tenon receiving spaces are formed and defined by spaced tenon means 148, 150 and wall end portion 144, and
20 spaced tenon means 152, 154 on wall end portion 146. Therefore, the tenon means extending from modules 134, 138 are inserted into those tenon receiving spaces. Different arrangements of tenon locations for intermeshing are disclosed in Patent '885.

 In any of the link member or module embodiments of this invention, assembly of the link members into a coupling device is accomplished by inserting tenon means on a
25 wall end portion into tenon means receiving space formed on or in a wall end portion of another link member.

 In summary, as shown in Figs. 1, 2 and 3, when identical link modules of this type are assembled together, the tenon means associated with one wall end of one link module are offset from the tenon means associated with a wall end of an adjacent link
30 module, so that when such link modules are assembled into a joining or coupling device such tenon means are intermeshed. However, this invention does not require that the

offsets of the tenon means at each of two adjacent wall end portions (at a corner of a square assembly as shown) have to be the same as the offsets at other so-called corners.

It should also be noted that while the disclosed link members or modules are unique and specifically designed to give this method and apparatus advantageous assembly and functional properties, other types of members may be used and different methods of assembly may be used as long as they fall within the unique overall method and general apparatus disclosed herein. That is, the method includes, assembly of a plurality of modules into a joining device, and nesting the device in an internal duct or passageway (or against an external surface surrounding the duct or passageway) of a first structural member. At least one of the assembly of members is moved with respect to the others to enlarge the size or expand the joining device (or to nest the member on the outside or external surface), so that the members engage the inner wall or external surface in supporting contact therewith. The members are then secured together into a unitary support block or structure with the members in supporting contact with the first structural member. The support block is then connected to a second structural member or structural element, anchor means, or the like.

Referring now to Fig. 3, a plan view of an assembly 132 of four sets of link members or modules 134, 136, 138 and 140 is illustrated, which was shown in an exploded view in Fig. 1. As shown in Fig. 3, at least one of the sets 134, 136, 138 and 140 has been moved outwardly with respect to the other sets in order to enlarge or expand the assembly 132 so that the link members or modules are engaged in supporting contact with an inner wall means of a passageway or internal duct of a first structural component.

As will be shown hereinafter, a second embodiment of such an assembly is disclosed in which link members or modules are moved inwardly in an assembly arranged around the outer or exterior surface of a first structural component. This will place those link members or modules in engagement in supporting contact with the outer or exterior surface.

As disclosed herein, the "wall means" of a passageway or internal duct 54, when using the embodiment illustrated in Fig. 1, refers to the inner walls 52 or internal opposing surfaces of a first component which extend along the length of the passageway or duct 54, and which define the passageway or duct 54. The term "surfaces" describes

components with a plurality of inner or outer walls and cylindrical or other curved inner walls. In the latter instance, curved inner or outer walls may comprise a plurality of arcuate or curved surfaces.

Another embodiment to be described hereinafter will include a plurality of link members or modules which will be arranged around and nested against an outer surface of a first structural element, the outer surface 56 surrounding the first element, the outer surface 56 surrounding the first element and the passageway 54 of the internal duct formed therein. In that embodiment, at least one of the link members or modules will be moved with respect to the others in an inward direction so that the assembly will be nested around the outer or external surface with the link members in engagement in supporting contact with the outer surface.

In the embodiment disclosed in Fig. 2, the means for moving the link members or modules with respect to each other may include a slot 180 formed on the inner wall of a wall portion, e.g., wall portion 142. Two bores 190, 192 are formed in the bottom of slot 180 and extend through the wall portion. Bolts 182, 186 are inserted through bores 190, 192 and extend out of the other side of wall portion 142, and then through corresponding bores 193, 194 through an inner wall 52 of a passageway 54. Nuts are applied to the threaded ends of the bolts 182, 180 and tightened. This moves or pulls the wall portion 142 outwardly against the inner wall 52 of the passageway 54, along with the tenon means associate with the wall end portion 144, 146. This insures that all of the link members or modules will be pulled or moved into engagement in supporting contact with the inner walls 52 of the passageway 54.

The width of the slots 180 are sized so that bolt heads 184, 188 are received in the slots and are engaged by the sides of the slots. This insures that the captured bolt heads will not turn when lock nuts are screwed on. Thus, there will be no need to use a wrench on the bolt heads to prevent turning when nuts are tightened.

Referring now to Fig. 4, there is illustrated an enlarged plan view of tenon 148 and an associated wall end portion 144 of the link or module set 140. The dovetail 166 will slide into slot 170 as described hereinbefore. The enlargement illustrates a preferred cross-section of the dovetail 166. The various parts of the assembly 132 are advantageously extruded. As a die ages as it is used to form the parts, the extrusion tends

to enlarge as the die wears. Thus, the dovetail cross-section may enlarge to an extent where the dovetail may have difficulty in fitting or sliding into the slot 170.

The configuration of the cross-section of dovetail 166 may be formed as shown in Fig. 4. As noted hereinbefore, the dovetail protection 166 has a width which diminishes
5 along the sides 196, 198 toward the root, with an outer surface 200 connecting sides 196, 198. In order to be able to make quick dimensional changes to allow the dovetail to fit into groove 170, sides 196, 198 and outer surface 200 are concave. Thus, there are edges
10 202, 204 where the sides 196, 198 and surface 200 meet or intersect that have a reduced cross-section. This enables use of a file, grinding wheel, or the like to quickly remove excess material at those intersections or permit an oversized dovetail to smoothly and
easily fit into a groove 170. Thus, extruded parts at the end of the life of a die do not need to be discarded and can be quickly and easily modified to fit.

Referring now to Figs. 5 and 6, there is illustrated a plan view and a side
elevational view of a bolt head restraint indicated generally at 206, which includes a
15 washer-shaped body 208 having an opening 210 formed therethrough, and a first solid tab 212 and a second open or perforated tab 214 with opening 216 formed therein extending outwardly from the circumference of the washer-shaped body 208.

The bolt head restraint 206 is used in association with the top of a tenon means, such as 148U in Fig. 6, which extends from an upper portion of a wall portion set 134 in
20 Fig. 1 to be positioned on top of a tenon 148 in the set module 140. The restraint 206 is shown in phantom lines in Fig. 6, and is placed on top of the tenon 148U as shown, with the opening 210 being concentrically located with respect to the bore 156 in tenon 148U. A bolt 218, (shown in phantom lines in Fig. 6) with a hexagonal head as shown, may then have the shaft thereof inserted through opening 210 of the restraint 206, bore 156 in
25 tenon 148U (and through bores of tenons aligned therewith), and has a lock nut screwed on the threaded shaft thereof in order to secure the link members or modules into a unitary structure as discussed hereinafter.

In this embodiment, as shown in Fig. 2, at each corner of assembly 132 there is at least one of the dovetail slots 170 that is open at the top. This occurs because the
30 intermeshing tenons are vertically offset with respect to each other and are not normally all going to be at the top or bottom of the wall portions (or at the same level as the top or

bottom of a wall portion.) Thus, there will be only one dovetail available to fit into one of the two slots formed in the two wall end portions adjacent to a tenon, while the other slot will be open. Thus slots 170 that are open at the top of assembly 132 in Figs. 2 and 3, are noted at 170a, 170b, 170c and 170d in Figs. 2 and 3.

5 Referring again to Fig. 6, the side elevational view of the restraint 206 is shown with the open or perforated tab 214 bent upwardly from body 208 with respect to the tenon 148U, while the solid tab 212 is shown as bent downwardly with respect to the tenon 148U. This enables solid tab 212 to extend downwardly into the open upper end 170a of slot 170 in tenon 148U, where the tab 212 engages the side of slot 170 to prevent
10 the restraint 206 from rotating as the nut is tightened on the threaded shank of bolt 218.

The opening 216 in tab 214 is shown in Figs. 5, 6 and 7 as rectangular, to enable the tab 214 to be bent toward and engage the hexagonal head at the corner of the hexagon with the sides of opening 216 to prevent rotation of the bolt head, and thus the bolt 218 when a lock nut is being screwed or tightened on the threaded shank of the bolt.

15 The tab 214 may have other forms and shapes to accomplish the same function. For example, the tab 214 could be larger and/or longer, to enable the opening 216 to completely surround the bolt head and restrain against rotation. It is advantageous to either size the bolt restraint or use an additional washer which extends outwardly past the junction of a tenon and a wall end portion, so that there can be no relative movement
20 upwardly between a tenon and a wall portion.

The link modules wall portion 142 has an outer wall surface defined between and intersecting with wall end portions 144, 146 (see Fig. 2). The outer wall surface is preferably configured in this embodiment to substantially mate with an inner wall surface 52 (see Fig. 2) of the tubular element shown in Fig. 1.

25 Link module sets are shown in Patent '885 which have arcuate outer wall surfaces for the wall portions of a module, to mate with the inside of a cylindrical pole or standard. However, the embodiment shown in Figs. 1, 2 and 3 can also be used with cylindrical poles having arcuate inner surfaces. This is taught in Fig. 17 with assembly 280 of Patent '885 along with the accompanying description in the specification of Patent '885.
30 To provide the most wall contact surface for the inner wall of round poles the corners of the tenons are chamfered or beveled.

As shown in Figs. 1, 2 and 3 when the link modules are assembled, the thickness of the wall portions of individual link modules are substantially thinner than those shown in Patent '885. This is a designed result obtained by designing the manufacturing of components by extrusion. Thus, the wire-way 92 is substantially larger and easier to
5 work with when placing wires connecting between the base and top of a utility standard. As disclosed in Patent '885 a hole in the tubular element 50 which coincides with a hand hole formed in a link module, may be formed to permit access to the wire-way 92 after the joining device is installed and the tubular element is in its final desired position. This hand hole is preferably formed in an extension of one wall module above the other wall
10 modules, to increase the working room. A cover plate may be used to keep out dirt and moisture. Similar hand hole arrangements may set up for all of the embodiments discussed herein.

A key part of the method and apparatus of this invention is securing or fastening the link modules of the joining or coupling devices described, after they have been moved
15 with respect to each other (either inwardly or outwardly) into engaging and support contact with either the inner or exterior walls. The link modules when thus fastened or secured become a unitary support block to maintain the link modules in the desired contact support positions with inner or outer walls. As will be described herein, this allows custom fitting of each of two or more unitary structures with the support surfaces
20 respectively engaged.

In the first embodiment shown in Figs. 1, 2 and 3, the link modules 134, 136, 138 and 140 are moved outwardly with respect to each other by the four sets of bolts 182, 186 (two bolts for each link module). Each bolt 182, 186 is inserted through bores 190, 192 formed through the wall portions 142 at the bottom of slots 180. The bolts 182, 186 then
25 extend on through bores 193, 194 formed in the tubular element walls 56. Nuts are then screwed onto the threaded ends of the bolts 182, 186 on the outside of the tubular element 50, which when tightened pull the link modules outwardly into engagement and support contact with the inner walls or support surfaces 52 of the tubular element 50.

Under lighter loading conditions this is an adequate connection of the coupling
30 device 132 to the tubular element 50. The bolts 72 and nuts 80 are then used to fasten and secure the link modules together into a unitary structure to support the tubular element 50,

and to join or connect the tubular element 50 to the base plate 60 or other anchor means, base or other second component.

The just-discussed method and apparatus for moving the link modules with respect to each is shown is preferred since it provides the strongest joining apparatus.

5 However, other means for moving the link modules with respect to each other can be used, including those described in Patent '885.

In such other module moving means the link modules are not necessarily connected to the tubular element, and do not need to be. This is, the most common method of mechanically attaching a tubular element is to slide the bottom of the tube over
10 a fixed size inner sleeve, which is preferably sized to accept a press fit inside of the tube. As noted hereinbefore, such a mechanical attachment in the prior art is not acceptable because of the tolerance variations in manufacturing both the tube and the fixed size inner sleeve.

With this invention, the mechanical attachment achieves the ideal results intended
15 for a fixed size inner sleeve. That is, by moving the link modules with respect to each other into contact engaging position, and then securing those modules together into a unitary structure in that contact engaging position, a customized fixed size inner sleeve type device is obtained which has a zero tolerance fit between the tube and the coupling device. This method and apparatus removes all of the objections to the fixed inner sleeve
20 utilized in the prior art.

In some applications it is desirable to have an even stronger joining or coupling device, with additional support for the tubular element 50. Referring now to Fig. 8, there is illustrated subassembly B, which is enlarged from the view of this subassembly shown in Fig. 1.

25 Subassembly B is a face support plate assembly indicated generally at 228. This embodiment includes four sets of components at 228. This embodiment includes four sets of components generally indicated at 230, 232, 234 and 236. Since those sets are identical in this embodiment, only the set 236 will be described in detail. Set 236 is shown in an exploded view, disassembled and separate from the sets 230, 232 and 234.

30 Set 236 includes an outer face support plate 240 having bores 242, 244 formed therethrough, which are aligned with bores 190, 192 formed in slot 180 in wall portion

142, and further aligned with bores 193, 194 in the tubular element 50 (see Fig. 1). Thus, when bolts 182, 186 (first shown in Fig. 2) are inserted through bores 190, 192 in slot 180 of wall portion 142, bores 193, 194 in tubular member 50 and through bores 242, 244 of face plate 240, the tightening of nuts 222, 224 on bolts 182, 186 will not only move
5 wall portion 142 outwardly with respect to the other link modules against and into contact support engagement with inner wall 52 of element 50, but will also secure the face plate 240 against outer wall 56 of tubular element 50.

The face plate 240 has an outer surface 245 in which a vertical slot 246 with spaced sides 248, 250 is formed. Side 248 has a vertical groove 252, and side 250 has a
10 vertical groove 254, respectively, formed therein. The face plate 240 also has opposing end walls 258, 260, with grooves 262, 264, respectively, formed therein. The face plate 240 also has rabbet notches 266, 268 formed respectively in end walls 258, 260. Each notch has inside surfaces 269, 270 at right angles with respect to each other.

Assembly 228 also includes four corner angle members 272. Each angle member
15 has two walls 274, 278 extending at a right angle with respect to each other in this embodiment for use with a tubular element 50 having a square or rectangular cross-section. Each wall 274, 276 has butt surface 284, a first sliding surface 286 and a second sliding surface 288 extending away from the butt surface 284. When the face plate 240 is secured to the outside wall of the tubular element 50, the notch surfaces 269, 270
20 cooperate with the outside wall of tube 50 to form a channel to receive the butt end of wall 274 against rabbet surface 269. The first and second sliding surfaces 286, 288 of wall 272 then slide on and between botch surface 270 and the external wall 56 of tubular element 50.

Thus, walls 274 and 276 of each angle corner member 272 are received in the two
25 channels formed as described above at each corner of tubular element 50. Each angle corner member thus services to make an adjustment for the tolerance variations in the dimensions of the periphery of the outer wall 56 of the tubular element 50. This allows the walls of the corner angle members to be moved inwardly or outwardly in the channels to adjust for peripheral dimensional variations of element 50.

30 In addition to the tolerance variation characteristics of the corner angles 274, the corner angles cooperate with the base face plates 240 to restrict pole sway. When the

walls 274, 276 of the angle members are seated in the channels formed by the notch surfaces 269, 270 and the outside wall 56 of tubular element 50, the butt surface 284 of wall 274 is adjacent to and abuts against the notch wall 269. Since pole 50, and internal and external assemblies 132, 228, are resting on the top of base plate 60, and are held there by the weight of the pole and the connection between bolts 72 through bores 68, the butt surfaces are held in a perpendicular position. If the pole 50 tries to sway in any one direction, abutting contact with the bottom of the corner angles 274 with base plate 60, and the side contact between notch surface 269 and butt surface 284 (plus the two bolt 182, 196 connection) resists and restricts movement that would tend to take the corner angles 274 and plates 240, and that would take the sides of all such components, out of the perpendicular relationship with base plate 60.

It is to be noted that only one bolt 182 or 186 can be used to connect a wall portion 142 to a wall of tubular element 50 and to an outer face support plate 240, especially for lighter loading conditions. However, it is advantageous to use two bolts 182, 186 for connecting wall portion 142, element 50 and plate 240 as shown in the drawings. It assures that the joining device 132 is open at the top and bottom, thus eliminating problems with installation and resulting hinge effect problems.

In the past, bolts such as 182, 186 were inserted from the outside to inside, and it was difficult to tighten the nuts 222 and 224 on the inside of an assembly 132, especially after the assembly was already nested inside the passageway. However, the slot 180 engages the bolt heads 184, 188 to prevent the heads from turning when nuts 222, 224 are tightened. Further, the slot 180 allows the bolt heads 184, 188 to be recessed into wall portion 142, which frees up even more working space and room for more cables, etc. in wire-way 92. In addition, with the nuts 222, 224 on the outside of the tubular element 50 and face plate 240, the assembly 236, etc. is easier to work with, install, and allows easier inspection and maintenance. Also, the bolts 182, 186 can be made shorter than the comparable bolts in Patent '885, and can be zinc coated against corrosion, (instead of stainless steel), because the bolts are located internally and are not exposed to weather induced corrosion. This again reduces the cost of the assembly.

It should also be noted that in cases of very, very heavy loading conditions, both the internal assembly and external assembly can be extended upwardly for additional

strength and pole support, particularly with taller poles.

Referring to Figs. 1 and 8, there is illustrated anchor bolt covers 294. While there are four such covers 294 in this embodiment, they are identical so only one will be described in detail. A U-shaped wall 296 extends outwardly from tongues 298, 300
5 formed on the ends of wall 296, to encircle and enclose the anchor bolts 86 (Fig. 1) and associated nuts and washers extending upwardly through bores 62 formed in ears 64 of base plate 60.

The tongues 298, 300 of cover 294 are insertable in and slidable downwardly in grooves 264, 262 formed in vertical end walls 260 and 258 of adjacently disposed outer
10 face support plates 240 of subassembly B. The covers 294 are moved downwardly until they rest on base plate 60. The covers 294 are advantageously formed so that the gap in the U-shaped cover between tongues 290, 300 slightly exceeds the distance between grooves 264, 262 when face support plates 240 are secured against the outer wall 56 of the tubular element 50. The material of the U-shaped wall 296 preferably has spring-type
15 characteristics, so that when the tongues 298, 300 are forced toward each other in order to get the tongues 298, 300 in grooves 264, 262, the wall will be spring-biased outwardly to retain or secure the tongues in the grooves by the spring force exerted thereon.

Pairs of vertically extending reinforcing ribs 302, 304, 306 are formed on the U-shaped wall 296 of covers 294. The open top of the U-shaped wall 294 is to be covered
20 with a preferably plastic snap-cap to prevent dirt, moisture, or other debris from getting inside the covers. The snap-caps may be formed with depending cap retainers which extend downwardly between each pair of reinforcing ribs 302, 304 and 306 to hold the snap-caps in place by the press-fit of the depending retainers between the reinforcing ribs.

The anchor bolt covers 294 and the snap-caps do not contribute to the strength of
25 the coupling assemblies, so they may be formed from suitable plastic material. However, both the covers 294 and 310 (to be described next) and their associated snap-caps may be formed from metal (preferably extruded aluminum) if greater protection from vandalism is desired.

Also, shown in Fig. 8 are assembly bolt covers 310. Once again, although there
30 are four of the covers 310 shown, they are identical in this embodiment so only one will be described in detail. A U-shaped wall 312 extends outwardly from tongues 314, 316

formed on the ends of wall 312 to encircle and enclose the threaded ends of bolts 182, 186 and the nuts 222, 224 screwed thereon, which extend out of bores 242, 244 of outer face support plate 240.

5 The tongues 314, 316 of cover 310 are insertable in and slidable downwardly in grooves 252, 254 formed in sides 248, 250 of vertical slot 246 formed in face plate 240. The covers 310 are moved downwardly until they rest on base plate 60. As with covers 294 the gap between tongues 314, 316 is such so that the wall 312 is spring-biased outwardly to retain or secure the tongues 314, 316 in grooves 252, 254.

10 Pairs of vertically extending reinforcing ribs 318, 320 are formed on the U-shaped wall 312 of cover 310. Again the open top of the U-shaped wall 312 is to be covered with a plastic snap-cap to prevent dirt, moisture and debris from getting inside the cover. Such a cap may be formed with depending cap retainers, of plastic or other material, which extend downwardly between each pair of reinforcing ribs 318, 320 to hold the snap-caps in place by the press-fit of the depending retainers between the ribs.

15 Referring now to Fig. 9, there is illustrated an exploded view in perspective of a second embodiment of this invention, which also illustrates the method. The first embodiment was directed to a joining or coupling device which is nested inside of a tubular element, with square, rectangular, or other cross-section with a plurality of planar walls or surfaces, and then expanded into contact support engagement with the inner wall
20 of the tubular elements.

This second embodiment is directed to a joining or coupling device nested around the outer surface or wall of a tubular element. Further, the tubular element in this instance has a circular cross-section, enabling the illustration of modifications within the scope of this invention that are needed to work with interior and exterior arcuate surfaces. While
25 the arcuate surfaces shown herein are arcs of circular cross-sections, the invention is equally applicable to non-circular arcuate surfaces, such as oval, elliptical, or other arcuate surfaces.

Further, the apparatus and method shown in Fig.9, also illustrates the use of an interior joining or coupling device, and the use of an exterior joining or coupling device.
30 Both of these joining devices each have link module sets which may be moved with respect to each other into engaging and contact support with an exterior wall support

surface or an inner wall support surface. Each also has means for securing the wall engaging link modules into a unitary structure.

Fig. 9 also illustrates that two unitary structures may be employed at the same time. This is particularly useful when higher loading conditions require additional joining
5 strength.

A tubular element 330 represents a first component to be joined to a second component, such as base plate 340, or an anchor means, etc. Such a tubular element 330 may be a utility standard or pole to support transmission lines, light fixtures, etc. Other examples are discussed elsewhere herein.

10 In this embodiment, the tubular element 330 may rest directly on the base plate 340, which in this embodiment may be connected to an anchor means by anchor bolts 374, which extend upwardly through bores 342 formed in ears 344, by appropriate nuts, lock washes, lock nuts, etc. on the threaded upper ends of bolts 374.

The base plate 340 also may have bores 348 aligned to receive bolts 354 after they
15 are threaded through bores 404, 406 in tenon means 396, 398, and after they are threaded through bores 408, 410 in tenon means 400, 402, as shown in Fig. 10, so that the joining device indicated generally at 380 can be connected directly to plate 340 with the same bolt and nut combinations that secures a reduced size coupling device 380 together into a unitary structure. A wire-way 346 may be formed in base plate 340, which is aligned
20 with a wire-way 376 formed by assembled link module sets in subassembly C in Figs. 1 and 13.

When the assembly of link modules of subassembly D is nested around the outer wall surface 336 of tubular member 330, the size of the joining device 380 will be reduced as will be described in the discussion of Fig. 10 hereinafter. Thus reduced size
25 coupling device 380 then has the link module sets secured together into a unitary structure by means indicated generally at 350, which includes bolts 354 inserted through aligned bores 404, 406 and aligned bores 408 and 410 in the tenon means of this assembled link module sets in subassembly D. In this embodiment the bolts 354 are long enough to also extend through bores 348 in base plate 340. Washers 356, plate or lock type, are placed
30 on the threaded ends of bolts 354, and then nuts or lock nuts 358 are screwed on bolts 354. The nuts are tightened to secure the reduced size assembly of link module sets into a

unitary structure, and may also connect the unitary structure to base plate 340. Under lighter loading conditions, the base plate 340 may be omitted and the unitary structure connected directly to anchor bolts.

5 The bolt means 350 are representative of a number of different ways for securing an assembly of link modules together into a unitary structure. Alternatives of such securing means are discussed hereinbefore in the description of bolt means 70 in Fig. 1.

10 Once again, the aligned bores in the tenons are sized with respect to the securing bolts 354 to permit movement of the link module sets with respect to each other while the bolts 354 are inserted in the bores. Thus, the link module sets in subassembly D may be moved inwardly into the desired external wall surface contact and wall engaging support position.

Referring now to Fig. 10, there is illustrated the subassembly D which shows a second embodiment of a coupling or joining device indicated generally at 380. The coupling device 380 includes four sets of link modules, each indicated generally at 382, 15 384, 386 and 388. Since each of those sets are identical in this embodiment, only the set 388 will be described in detail, which is shown in a disassembled, exploded fashion separate from the other three sets 382, 384 and 386 which are shown assembled together into the coupling or joining device 380.

20 The module set 388 includes a wall portion 390 having wall end portions 393, 394, which are opposed in this embodiment. Further, wall portion 390 has an inner face 391 which is formed in a concave fashion to enable the inner face 391 to be complementary and mate with the outer arcuate surface or wall 336 of tubular element 330. Wall portion 390 also has an outer wall surface 392.

25 In this embodiment, projecting or tenon means 396 and 398 are associated with wall end portion 393. Tenon means associated with wall end portion 394 cannot be seen in Fig. 10, except for the piece of tenon 401(i) peeking out from behind wall end portion 394, because the perspective view shields those two tenons from full view. However, those two shielded tenons are identical to those indicated at 400, 402 associated with a wall end portion of a wall portion of module set 382 in Fig. 10, except that their dovetail 30 connections 416, 418 are slid out of the interlocking groove 420 in the wall end portion in module set 382 and the tenons are inverted and slid into groove 420(i) on wall end portion

394 of module set 388.

Therefore, the tenons associated with wall end 394 will be designated by the same reference numerals as shown for the module set 382, except that each reference numeral will be followed by an (i) to indicate the inverted position when used with wall end
5 portion 394.

Thus, there are tenons 400(i), 402(i) associated with wall end portion 394. Bores 408(i), 410(i) are formed in tenons 400(i), 402(i). In this embodiment, the bores 404, 406 and 408(i), 410(i) have axes formed parallel to the wall end portions 393, 394. Bores 404, 406 are located so that when the tenon means 396, 398 are connected to wall end portion
10 393, the bores will be axially aligned with each other. Similarly, bores 408(i), 410(i) are located so that when tenon means 400(i), 402(i) are connected to wall end portion 394, the bores will be axially aligned with each other.

The description of the tenon means 400(i), 402(i) use in an inverted fashion serves to underscore another advantage of the components, combination and method of this
15 invention. That is, only one type of tenon means needs to be manufactured, but that type may be used in different positions simply by inverting the standard type tenon as required. This reduces manufacturing costs, saves time, requires storage and shipping of fewer types of tenons with less sorting required, etc. Yet, all of the configurations desired can still be assembled to perform the functions of this invention by selectively inverting and
20 interlocking the standard tenon with wall end portions. This flexibility of the uniquely formed individual tenon means provides substantial advantages over the prior art. The tenons, wall means and other components can be extruded in any length, and then cut to any length required, by using only one extruder mold.

Means are provided to slidably engage and connect the tenon means to the wall
25 end portions 393, 394 in an interlocking fashion, to prevent the tenons from being pulled away from the wall end portions. In this embodiment, each tenon means carries a dovetail shaped projection thereon, which has a width diminishing toward the root where it is attached to the tenon means. A groove 415 formed in wall end portion 393 has a cross-section which is complementary and mates with the cross-section of dovetail
30 projections 412, 414 formed on tenon means 396, 398, respectively. Similarly, a groove 420(i) formed in wall end portion 394 has the same type of cross-section, which is

complementary and mates with dovetail projections 416(i), 418(i) formed on tenon means 400(i), 402(i), respectively.

The dovetail projections can be slipped into the grooves from either end of the groove. The dovetail/groove combinations prevents the tenon means from being pulled
5 away from a wall end portion and thus provides an interlocked connection.

As noted hereinbefore, the dovetail projections may alternatively be formed on the wall end portion, while the complimentary grooves are formed in the tenon means to receive the dovetail projections, and hold them in the interlocked relationship discussed above.

10 Assembly of the link member or module sets is also illustrated in Fig. 10. As noted above, tenon means 396, 398 are assembled with wall end portion 393 by sliding the dovetails 412, 414 into the groove 415 in wall end portion 393. Similarly, tenon means 400(i) and 402(i) are assembled with wall end portion 394 by sliding dovetail projections 416(i), 418(i) into groove 420 in wall end portion 394. Spacing and locating
15 of the tenon means on wall end portion is described earlier in the discussion of subassembly A in Fig.2.

In any of the link member or module set embodiments, assembly into a coupling device is accomplished by inserting tenon means on one wall end portion into tenon means receiving space formed on or in an adjacent wall end portion of another set as
20 described hereinbefore in the discussion of subassembly A in Fig. 2. After the link module sets have been moved into engaging and supporting contact with the outer wall or surface 336 of tubular element or first component 330, the modules are then secured together into a unitary support block or structure. Such block or structure is then connected to a second structural component, anchor means or the like.

25 A vertical slot 422 is formed in the outer face 392 of wall portion 390. The slot sides 424, 246 are spaced on each side of bores 428, 430 formed though wall portion 390 to receive bolts to be described later. Each set of bores 428, 430 are aligned with bores 436, 438 formed in tubular element 330. Vertical grooves 432, 434 are form din slot sides 424, 426, respectively. A bolt cover such as shown in Fig. 8 generally indicated at
30 310 and having a U-shaped wall 312 with tongue 314, 316 formed thereon, can be used to protect the bolts from dirt, debris and moisture. The tongues 314, 316 are inserted into

grooves 432, 434, as described for subassembly B.

Referring now to Figs. 11 and 12 there is illustrated how the coupling device 380 can be nested around and against the outer wall 336 of tubular element 330. In Fig. 11 the circle 440 represents the smallest tolerance circumference of tubular element 330 that the coupling device 380 will be designed for. In that situation, the link module sets 382, 388 will nest against the outer wall 336 very snugly, without having to move the individual module sets 382, 388 with respect to each other, except during initial assembly.

In Fig. 12, the circumference 442 is larger than circumference 440. Therefore, the tenon means, such as 400 on a wall portion of set 382, will be moved slightly apart from tenon 400 (i) below tenon 400 on a wall means of set 388. This is shown by the dotted lines of tenon 400 (i) below tenon 400. As noted, bores 408 and 408 (i) do not coincide identically, but there is space left in the bores 408, 408 (i) to accommodate a bolt 354 to allow adjustment of coupling device 380 to accommodate a range of circumference sizes for tubular element 330.

Referring now to Fig. 13, there is illustrated subassembly C, which illustrates a coupling or joining device indicated generally at 450 and which has four module sets 452, 454, 456 and 458. Since all these module sets are identical, only set 458 will be described in detail.

Subassembly C is designed to be nested inside of a tubular element 330 having an arcuate cross-section, in this instance a circular cross-section corresponding to the exterior wall surface. When this assembly of module sets is nested inside of tubular element 330, the size of the joining device 450 will be enlarged or expanded by moving at least one of the modules with respect to the others so that the outer walls of the modules are in engaging and support contact with the inner support surfaces of the inside wall 332 of element 330.

The module 452, 454, 456 and 458 are then secured into a unitary structure by means generally indicated at 360, when the modules are engaging and support contact with the inner support surfaces of element 450 to prevent movement of the module with respect to each other in response to changing load conditions and to maintain the unitary structure in a stable engaging and supporting contact position with the inner support surfaces of element 330. This is accomplished by a plurality of bolts 364 of the securing

means 360.

Each of the identical module sets has a wall portion 460 with wall end portions 462, 464 at each end. Each wall end portion of at least some of the modules has tenon wall means 468 extending parallel to an axis of the coupling device 450, and at least some
5 of the wall end portions 462, 464 have a slot mortise means 470 formed therein which extend parallel to an axis of the coupling device. Therefore, when the modules are assembled together into a coupling device the tenon wall means 468 are received into corresponding slot mortise means 470 in an adjacent module set.

Alternatively, this structure can be described as some of the wall end portions
10 having a slot 472 which opens inwardly toward the center of the coupling device 450 and extends parallel to an axis device 450. The other wall end portion also has a slot 470 formed therein which opens outwardly away from the center of device 450 and extends parallel to an axis of device 450.

Each slot has an outermost wall 468, 474 at the end of the wall end portion which
15 forms a tenon wall, whereby when the modules are assembled together into devices 450 the tenon wall on a wall end portion of an adjacent module.

The slots 470, 472 in this embodiment advantageously have a width enabling a tenon wall 468, 474 to be moved therein to permit expansion and reduction of the size of device 450 to engage inner support surfaces with all of the modules of device 450.

20 The tenon walls 468, 474 cooperate with the walls of slots 470, 472 to form guide ways 476, 478 (see the assembled modules 452, 454 and 454, 456) to receive means for securing the modules of device 450 into a unitary structure. In this embodiment, the bolts 364 are inserted through guide ways 476, 478, through bores 370 in base plate 340, and secured in place by the washer 366, nut 368 combination.

25 Since device 450 is nested inside of element 330, tightening nuts 368 on bolts 364 may present some difficulties and slow the assembly and securing process. Therefore, it would be very advantageous to provide means and a method to prevent the securing rod means or bolts 364 from rotating when nuts 368 are being tightened, or when the nuts 368 are being removed in a disassembly.

30 Such means were shown in Figs. 5, 6 and 7 for the first embodiment, using a bolt restraint. In this embodiment an alternative approach includes the use of rod means, such

as carriage bolts, having a configuration on one end shaped to be engaged and captured by the cooperation of the tenon wall and slot sides, to keep the rod means or carriage bolt from rotating when a nut is tightened or is loosened, on the screw thread end. The square neck of a carriage bolt provides a configuration which can be engaged or captured.

5 In the embodiment disclosed in Fig. 13, the means for moving the modules with respect to each other may include a slot 480 formed between spaced, vertically extended reinforcing ribs 482, 484 extruded on the inside wall 486 of the module. Two bores 488, 490 are formed in the bottom of slot 480 and extend through the wall portion of the module.

10 Bolts 492, 494 are inserted through bores 488, 490, extend through bores 436, 438 in the inner and outer wall surfaces 332, 336 of element 330, and through bores 428, 430 formed in slot 422 in the outer face 392 of wall portion 390 of module set 388 of coupling or joining device 380 on the outer wall surface 336 of tubular element 330. (See Fig. 10) The ribs 482, 484 are spaced to receive the heads of bolts 492, 494 to engage and capture
15 the heads to prevent bolt rotation. Nuts or lock-nuts 496, 498 are screwed on the threaded ends of bolts 492, 494 on top of washers or lock washers 500, 502.

Tightening of nuts or lock-nuts 496, 498 accomplishes three different tasks at the same time. First, modules of the inner coupling device are moved outwardly into engaging and supporting contact with inner support surfaces of tubular element 330.

20 Second, modules of the outer coupling device 380 are moved inwardly into engaging and supporting contact with outer support surfaces of tubular element 330. Third, the bolts, washers and nuts serve to connect the unitary structures together after each structure has been individually sized for custom fit with their respective support surfaces, and then secured together into unitary structures.

25 Further, the unitary structures are also connected together by their connections to base plate 340 by bolts 354, 364 (See Fig. 9). This dual connection of the unitary structures together by the horizontal and vertical bolts puts the bolts under tension, both vertically and horizontally. The module parts and the unitary structure are placed under compression, both horizontally and vertically. These tension and compression forces
30 combine to provide the strongest possible mechanical joint.

The use of two bolt pairs 492, 494 further adds to the joining strength of the

apparatus, as opposed to the single horizontal bolt Patent '885. The single bolt was adequate for most loading conditions, but unusual loading conditions such as hurricanes and earthquakes (and extra tall tubular elements) would sometimes permit a hinge effect problem, i.e., an attempt by the tubular member to rotate around a single bolt.

5 In addition, some installers would enlarge the original bores, rather than taking the time to obtain proper alignment of bores. In the present embodiments, the tubular members are placed in drilling jigs to ensure that the bores therein are equally spaced around the periphery or outer surface of the tubular members. The improved tolerance adjustments of the present invention then allow each module to be automatically centered
10 in the desired position in engaging and contact support with the desired support surfaces, and with respect to the other modules in a coupling or joining device.

As noted herein, the new modules have been designed, so that they can be manufactured by extrusion. These new, unique components provide substantial advantages over casting methods, such as better strength-to-weight ratios, faster and less
15 expensive manufacturing, more working room inside the tubular elements for connection conduits and electrical wiring, the ability to extend the height of at least one of the wall portions to provide more pole support or a hand hole entry, more flexibility in putting modules together, individual tenon means and tenon wall means and corresponding tenon and tenon wall receiving spaces, unique features such as forming reinforcing ribs that also
20 serve other purposes like capturing bolt heads and permitting use of depending snap cap parts, reducing the dimensions of at least some of the parts or components, more consistent quality of component production, and other features noted throughout herein.

The coupling device 450 is superior to internal support plates, because the plates cannot be individually adjusted to provide an exact customized fit in the same fashion as
25 the adjustable modules. Two or more of those coupling devices can be stacked in the manner disclosed in Fig. 24. While a round version is shown in Fig. 13, a square version can also be made using the same structural interlocks (See Fig. 21). The height of the module walls may be increased or decreased to adapt to different applications. For example, increased height provides support for a taller tubular element. Only one module
30 wall will need to have a greater height, if it is desired to have reinforced hand hole section above the coupling device.

Referring now to Figs. 14, 15 and 16, there is illustrated how the coupling device 450 can be nested around and against the inner wall surface 332 of tubular element 330. In Fig. 14, the circle 506 represents the smallest inside tolerance circumference of element 330 that the coupling device 450 will be designed for. In that situation, the module sets 452, 454, 456 and 458 will nest against the inner wall surface 332 very snugly, without having to move the modules with respect to each other very much, except during initial assembly.

In Fig. 15, the circumference 508 is somewhat larger than circle 506 in Fig. 14. Therefore, the tenon wall 474 will be moved in slot mortise 472 slightly apart from the intermost slot wall of mortise 472, to enlarge or expand the coupling device 450 outwardly against the larger inner wall support surface.

In Fig. 16, the circumference 510 is somewhat larger than circle 508 in Fig. 15. Therefore, the tenon wall 474 will again be moved in slot mortise 472 slightly further apart from the innermost slot wall of mortise 472, to further enlarge or expand the coupling device 450 outwardly against the larger inner wall support surface.

As noted in Figs. 14, 15 and 16, even though the guide ways 476, 478, formed by tenon walls 468, 474 cooperating with the walls of slots 470, 472 to receive securing means bolts 364, vary in cross-section there is still space in the guide ways 476, 478 to receive bolts 364 to secure the coupling device into a unitary structure.

Since this embodiment of coupling device 450 features bolt or rod means restraint against rotation while nuts are being tightened or removed, it is critical for the guide ways 476, 478 to have two opposed cooperating walls that define means for engaging and capturing the configuration of the rod means (such as the square neck of a carriage bolt). During the size adjustment of the coupling device 450, the tenon walls 468, 474 ride on the bottom walls of slot mortises 470, 472, thus maintaining surfaces 514, 516 the same distance apart at all times during the size adjustment. This distance apart engages the configuration, e.g., a square neck of a carriage bolt, to capture the rod or bolt and prevent rotation.

Two of the subassembly C coupling devices may also be used in a "stacked" arrangement, with each subassembly C being nested in the end of a tubular element. Then, each subassembly is secured into a unitary structure, and the two unitary structures

are connected together, in the same manner as the two coupling devices shown in Fig. 24 to connect the two tubular elements together.

Referring now to Fig. 17 there is illustrated on exploded view of a coupling or joining device 520, which is an outer support surface version for use with round or arcuate tubular members of the type of inner surface coupling device 450 shown in Fig. 13. While device 520 can be used with an inner surface coupling device 450, it can also be used with the inner surface coupling devices 132 in Fig. 2, and with coupling device 280 in Fig. 17 in Patent '885, etc.

The coupling device 520 has four module sets 522, 524, 526 and 528. Since all of these modules sets in this embodiment are identical, only the set 528 will be described in detail.

Device 520 is designed to be nested around outer or exterior support surfaces of tubular elements, such as shown in Fig. 9 at 336 on tubular element 330 in Fig. 9 which has an arcuate or round cross-section. When assembly 520 is nested around an outside surface, the size of device 450 will be reduced by moving at least one of the module sets with respect to the others so that the inner walls 530 of the module sets are in engaging and supporting contact with the outer wall support surface of the tubular element (e.g., 336, 330 respectively in Fig. 9).

The module sets 522, 524, 526 and 528 are then secured into a unitary structure by means generally indicated at 532, which includes rod means or bolts 534, washers or lock-washers 536, and nuts or lock nuts 538, after the module sets are in engaging and support contact with the outer support surface of the tubular element. This prevents movement of the module sets with respect to each other in response to changing load conditions and to maintain the unitary structure in a stable engaging and support contact position with the outer support surfaces of the tubular element. Thus, the coupling device 520 had a customized exact fit with those outer support surfaces.

Each of the identical module sets has a wall portion 540 and wall end portions 542, 544, which are opposed in this embodiment. Each wall end portion 542, 544 of at least some of the modules has tenon wall means 546 extending parallel to an axis of the coupling device 520, and at least some of the wall end portions 542, 544 have a slot mortise means 548 formed therein which extend parallel to an axis of the coupling device

520. Therefore when the modules are assembled into a coupling device, the tenon wall means 546 are received into corresponding slot mortise means formed in an adjacent module set.

Alternatively, this structure can be described as some of the wall end portions
5 having a slot 550 which opens outwardly away from the center of the coupling device 520 and extends parallel to an axis of device 520. The outer wall end portion also has a slot 548 which opens inwardly toward the center of device 520 and extends parallel to an axis of device 520.

Each slot has an outermost wall 546, 552 at the end of the wall end portions 542,
10 544 which forms a tenon wall. When the module sets are assembled into a device 520, the tenon wall on a wall end portion is received in a slot formed in a wall end portion of an adjacent module set.

The slots 548, 550 in this embodiment advantageously have a width enabling tenon walls 546, 552 to be moved across the width to permit expansion and reduction of
15 the size of device 520 to engage outer support surfaces with all of the modules of device 520.

The tenon walls 546, 552 cooperate with the walls of slots 548, 550 to form guide ways 554, 556 (see the assembled module sets 522, 524 and 524, 526) to receive means for securing the modules of device 520 into a unitary structure. In this embodiment, bolts
20 534 are inserted through guide ways 554, 556, through bores 558 in base plate 560, and secured in place by washer or lock-washers 536 and nuts or lock nuts 538.

Bolts, such as shown at 492, 494 in Fig. 13, extend out through bores in an inner coupling device such as 450 in Fig.13, and out through bores in a tubular element such as 436, 438 in Fig. 9, and through bores 562, 564 in module set 528. Appropriate washers,
25 lock-washers 566 and nuts, lock nuts 568 as shown in Fig. 17 are used with the bolts just described to connect the first unitary structure or device 450 (of Fig. 13) to the second unitary structure 520 in Fig. 17. Further, those bolt, nut combinations are used to move the modules of each device 450 and 520 into engaging and support contact with inner and outer support surfaces, respectively, of the tubular element. As noted herein before, the
30 use of the two-bolt pairs adds to the joining strength and reduces hinge-effect problems. Once again, the vertically and horizontally extending bolts are under tension, both

vertically and horizontally. The components of the joining devices and the unitary structures are under compression both horizontally and vertically along the wall of the tubular element. This provides additional strength, and additional resistance to any relative movement of the components with respect to each other, or relative movement of the tubular element with respect to the components, as in "uplift" resistance.

While device 520 is not on the inside of a tubular element, the same carriage type bolts and engaging, capturing surfaces in the guide ways 554, 556 may be used to prevent rotation of bolt or rod means when being tightened. Alternatively, since device 520 is on the outside of the tubular element, bolts such as those shown at 354 in Fig. 9 may be used along with appropriate washers and nuts to secure device 520 into a unitary structure.

Once again, the device 520 is designed to be produced by extrusion, with all of the advantages noted above. Since device 520 is used on the outer surface, there is no concern about obtaining working room in the middle of the device. Therefore, the wall portions may be made thicker and longer to extend support up the tubular member.

The tolerance adjustments are obtained in the same manner, and with the same type of structure, as is used in adjusting device 450 and is shown in Fig. 13, 14, 15 and 16. Figs. 18, 19 and 20 show how the device 520 adjusts to first, second and third tolerance sizes from smallest, to somewhat larger, to even larger outside circumferences.

It should be noted that slots have been formed on the outside face of each module, with vertical grooves in each slot side wall to accept the same bolt covers 310 as shown in and described for Figs. 1 and 8. Further, grooves have been provided in the modules so that the same anchor bolt covers 294 shown and described in Figs. 1 and 8 can be used.

Two of the coupling devices 520 may be used in a "stacked" arrangement on the outer surface of tubular elements. Use of two devices 520 on the outside of a single tubular element provides improved joining strength. The use of a first device at the end of a first tubular element, and the use of a second device at the end of a second tubular element, enables joining of the first and second tubular elements. To stack two of the coupling devices, the bolts used to secure the devices into unitary structures are made longer so that the bolts extend entirely through a first guide way of the first coupling device and also through a second guide way in the second guide way, and are connected together by nut and bolt combinations to connect the resulting first and second unitary

devices together.

A coupling device for the outside of tubular elements that have a square, rectangular or polygonal cross-section will use the same structure to interlock the modules together, as shown in Fig. 12. However, the interlock structure will be formed in beveled
5 corners to provide the same tolerance adjustments in the same way as the round embodiment has in Fig. 17. For such an embodiment, refer to Fig. 21.

In Fig. 21, there is illustrated an exploded view of a coupling device 580, which is an outer support surface version for square, rectangular, or polygonal cross-section tubular elements. The coupling device can be used with the coupling device 132 in Fig. 1
10 and in place of the base face plate support assemblies 230, 232, 234 and 236 shown in Fig. 8. The apparatus shown in Fig. 21 is superior to the face plates, because the face plates cannot be adjusted to obtain a customized fit that is identical to the exterior surface of a tubular element 50 shown in Fig. 1, for maximum joining strength.

The coupling device indicated generally at 580 has four module sets 582, 584, 586
15 and 588. Since these module sets in this embodiment are identical, only the set 558 will be described in detail.

Device 520 is designed to be nested around outer or exterior support surfaces of a tubular element such as the element 50 shown in Fig. 1. When assembly 580 is nested around an outside or exterior surface, the size will be reduced by moving at least one of
20 the module sets with respect to the others so that the inner wall surfaces 590 of the modules are in engaging and supporting contact with the outer wall surfaces of a tubular element.

The module sets 582, 584, 586, 588 are moved with respect to each other by bolts, such as 182, 186 which extend out from an inner coupling device through bores 193, 194
25 in element 50 (all in Fig. 1), and through the bores 598, 600 in module sets in Fig. 21. This positions each module set 582, 584, 586 and 588 in engaging and supporting contact with outer support surfaces of the tubular element in the customized fit desired.

The module sets 582, 584, 586 and 588 are then secured into a unitary structure by means indicated generally at 594, which includes bolts or rod means 595, washers or lock
30 washers 596, and nuts 597. Threaded ends of rod means 595 may be extended through bores 593 in base plate 592 to also connect the unitary structure to the base plate if

desired. Thus, movement of the module sets with respect to each other in response to changing load conditions is prevented, and the unitary structure is maintained in a stable engaging and support contact position with the outer support surfaces of the tubular element, to provide the exact customized fit. The same means may be used to prevent
5 bolt rotation as described hereinbefore.

Each of the module sets has a wall portion 604 and wall end portions 606, 608, which are opposed in this embodiment. Each wall end portion 604, 608 of at least some of the modules has tenon wall means 610 extending parallel to an axis of the coupling 580, and at least some of the wall end portions have a slot mortise means 612 formed
10 therein which extends parallel to the axis. Therefore, when the modules are assembled into a coupling device, the tenon wall means 610 is received into a corresponding slot mortise means of an adjacent module.

Alternatively, this structure could be described as some of the wall end portions having slot 614 which opens outwardly away from the center of the coupling device 580
15 and extends parallel to an axis of device 580. The other wall end portion also has a slot 614 which opens inwardly toward the center of device 580 and extends parallel to the axis.

Each slot 614, 612 has an outermost wall 610, 616 which forms tenon walls 610, 616. When the module sets are assembled into device 580, the tenon wall is received in a
20 slot formed in a wall end portion of an adjacent module.

The slots 612, 614 advantageously have a width enabling tenon walls 610, 616 to be moved across the width to permit expansion and reduction of the size of device 580 to engage outer support surfaces will all of the modules of device 580.

The walls 610, 616 cooperate with the walls of slots 612, 614 to form guide ways
25 618, 620 (see assembled modules 582, 584 and 584, 586) to receive rod means for securing the modules of 520 into a unitary structure. That means is indicated generally at 594 and may be carriage bolts 595.

Modules 580 also may be "stacked" as described elsewhere herein, with the rod means extending through the guide ways in each module to connect those two unitary
30 structures together. Once again these modules are designed to permit manufacture by extrusion, with the advantages noted hereinbefore.

The tolerance adjustments for Fig. 21, are made by the same principles discussed hereinbefore with respect to Figs. 13 and 17. Figs. 22 and 23 graphically illustrate the tolerance adjustment between a smaller, minimum size cross-section 624, and a larger cross-section 626.

5 Again, slots and grooves are formed in the outer faces of the modules to accept anchor bolt covers and the module, moving bolt covers described hereinbefore.

Referring now to Fig. 24, there is illustrated another embodiment of this invention, which discloses uses for "stacked" combinations of the coupling method and apparatus of this invention.

10 There are a number of applications for stacking that have been discussed herein. Fig. 234 is directed to so-called retrofit applications. One such application is where utility standards have been installed in streets, parking lots, etc., but now need new standards, either for appearance changes, pole height changes, or damage to the poles by wind, hurricanes, earthquakes and the like. It is very expensive to tear up streets,
15 sidewalks, parking lots, etc., to remove the previous pole base structure, install new bases in the ground and put up new utility standards. Not only is this expensive, but the job takes a long time and interrupts vehicle and pedestrian traffic.

A second application is when vehicles strike the utility standards and bend or knock them down.

20 Another application is when a tubular element such as a boat or ship mast is broken or bent.

In all of the above situations, a quick replacement can be made by cutting off the undamaged bottom portion of the tubular element that is extending upwardly from its original base position, leaving a clean tubular element stub. If the total overall height of
25 the tubular element is not critical, then the damaged section at the bottom of the undamaged upper portion can be cut off. Then, the upper part of the tubular portion can be coupled to the lower tubular element stub with the apparatus shown in Fig. 24.

If the total overall height is critical, then a new upper portion which brings the total overall height to the desired critical height can be connected to the element stub.

30 Similarly, a new or replacement mast may be coupled by this method and apparatus. Further, a vehicle known-down can be replaced quickly.

Finally, this apparatus can be used to join two tubular elements together to form beams for construction purposes.

In the exploded view in Fig. 24 there is shown a first assembly of link modules 640 and a second assembly of link modules 650. In this embodiment the assemblies 640 and 650 are identical to subassembly A shown in Fig. 2 as a coupling device indicated generally at 132. The coupling device 132 is described in detail hereinbefore.

In Fig. 2 herein, device 132 is shown as being used with a square or rectangular tubular element 50. In Fig. 24 the two assemblies 640 and 650 are being used with upper and lower tubular elements 642 and 652, respectively, that have round or arcuate cross-sections. The use of a single assembly with a reference numeral of 280 is shown in Fig. 17 of Patent '885 (cited above) with a round cross-section, and that description is incorporated herein by reference thereto. However, the single assembly 280 is not the same as assemblies 640 and 650 in Fig. 24, which is an improved apparatus with many advantages over assembly 280 in Patent '885. Further, there is not teaching in Patent '885 of the novel method of using two assemblies together or the novel apparatus necessary to provide the unexpected and novel functions achieved by the use of two assemblies together.

There have been previous disclosures and descriptions in this application of the use of two coupling devices together to obtain much higher joining strengths. In Fig. 9, a subassembly C is used as an inner assembly in combination with an outer subassembly D. In Fig. 17 where is disclosed an outer assembly 520 which may be used with inner subassembly C from Fig. 9. In Fig. 21 an outer assembly 584 is disclosed which may be used with an inner subassembly A in a combination. There are also permutations of combinations of the various assemblies listed in this paragraph, which can be used together, but which are specifically listed together.

However, in Fig. 24 there is the first illustration of using two assemblies to join two tubular elements, or two components which each have a passageway formed therein which opens to the exterior of the component. Mention has been made herein of using two assemblies in a "stacked" configuration.

For example, two subassembly C devices from Fig. 9 can be "stacked" inside two tubular elements to join those two tubular elements together. Similarly, two subassembly

D devices can be stacked on the outer or exterior surfaces of two tubular elements to join those two elements. Further, two assemblies 520 may be used on the outer or exterior surfaces of two tubular elements to join them. Two of the assemblies 584 in Fig. 21 may be used on the exterior or outer surfaces of two tubular elements to join them.

5 The listings above of combinations are not intended to limit the breadth of this invention, but merely to provide examples of the various uses and of the teachings of this invention.

Referring again to Fig. 24, the assembly 640 is nested inside of tubular element 642. In the manner described for subassembly A in Fig. 1, the module sets are expanded
10 by bolts 182a, 186a, moving the modules with respect to each other so that the chamfered corners of the individual tenon means are in engaging and support contact with inner wall or support surface 644 of element 642.

Similarly, the assembly 650 is nested inside of tubular element 652. The module sets are expanded by bolts 182b, 186b, moving the modules with respect to each other so
15 that the chamfered corners of the individual tenon means are in engaging and support contact with inner wall or support surfaces 654 of element 652.

In some instances, the bottom tubular element 652 can be removed from its base plate or anchor means by normal disassembly procedures. If so, the open lower end of element 652 will tighten the washer/lock-washers 644 and nuts/lock-nuts 666 on the
20 threaded lower ends of bolts 662. This will enable the two assemblies 640, 650 to be secured into two abutting unitary structures after each assembly has received its own individual customized fit with the inner support surfaces 644, 654 of tubular upper and lower elements 642, 652, respectively.

If access through the lower end of element 652 is not possible or convenient, then
25 one or more of the module walls of an assembly can be extended upwardly or downwardly to provide additional support for both the tubular element and a reinforced hand hole to provide access to the inside of one of the tubular elements to enable tightening of the nut/washer combinations on the threaded ends of the bolts 662.

Such a hand hole is shown in Fig. 21 of the referenced Patent '885 designated by
30 the reference numeral 348, and is formed in a module wall of link module or member 344.

Fig. 24a illustrates in dotted lines an upward extension 646 of a wall module of an

assembly that is identical to device 640, which has a hand hole opening 648 formed therethrough. As in the hand hole apparatus 348 in the preceding paragraph the tubular element may be attached to the extension 646 above and below the access hole formed in the tubular element adjacent the hand hole, to reinforce the tubular element in that area.

5 This application is most useful with a tubular element that has a square or rectangular cross-section.

Fig. 24b illustrates in dotted lines a downward extension 668 of a wall module of an assembly such as shown in Fig. 13, which has a hand hole opening 670 formed therethrough. As noted above the extension 668 can be attached to the tubular element
10 for reinforcement purposes. Fig. 24b also illustrates in dotted lines an upward extension 668a of a wall module of an assembly such as shown in Fig. 13, which has a hand hole opening 670 formed therethrough. This application is most useful when a tubular element has a round or arcuate cross-section.

In the apparatus shown in Fig. 24, assembly 650 will be nested and expanded in
15 the upper end of tubular element 652. Assembly 640 will be nested and expanded in the lower end of tubular element 642. The two assemblies 640, 650 will preferably abut each other at the juncture of the upper and lower tubular elements 642, 652, respectively. The bores or guide ways which receive hex head bolts 662 or carriage type bolts are aligned with each other, so that bolts can extend through both assemblies, to secure the assemblies
20 into unitary structures and to connect the two unitary structures together in the strongest joining apparatus.

To further add to the joining strength a multi-segment outer collar indicated generally in Fig. 24 at 680, has segments 682, 684, 686, 688. Pairs of bores 193c, 194c are formed in the upper half of the collar segments, and pairs of bores 193d, 194d are
25 formed in the lower half of the collar segments.

As noted, assembly 640 has four pairs of bolts 182a, 186a extending outwardly. The bores 193c, 194c of the collar segments, are aligned with bores 193a, 194a in the tubular element 642 to receive the threaded ends of bolts 182a, 186a.

Assembly 650 has four pairs of bolts 182b, 186b extending outwardly. The bores
30 193b, 194b in the tubular element 652 to receive the threaded ends of bolts 182b, 186b.

Nut and washer combinations 696 are applied to the ends of bolts 182a, 186a

extending through bores 193a, 194a in the upper tubular element and bores 193c, 194c in the upper half of the collar segment. Similarly, nut and washer combinations 698 are applied to the ends of bolts 182b, 186b extending through bores 193b, 194b in the lower tubular element 652 and bores 193d, 194d in the lower half of the collar segment.

5 The tightening of nut and washer combinations 696 and 698 will not only secure the collar segments in reinforcing positions around the tubular elements 642, 652, but will also move the modules with respect to each other of both assemblies 640, 650 into engaging and contact support with inner walls 644 and 654.

10 Finally, tightening of nut and washer combinations 666, 664 on the threaded ends of bolts 662 will secure both assemblies 640, 650 into abutting unitary structures.

15 While Fig. 24 shows the bolts 662 with their thread ends extending downwardly through assemblies 640, 650, it should be noted that means can be used to retain the bolts in the assemblies 640, 650 if the threaded ends are extended upwardly to hold the bolts in place against the pull of gravity. For example, a double nut approach on each bolt would accomplish this, with the second nut being added for the final tightening. This approach would allow the use of a hand hole either above or below the two assemblies to provide the most convenient access for tightening.

20 While the choice of the specific components and their arrangement in the preferred embodiments described herein illustrate the results and advantages obtained by the choice of those specific components over the prior art, the invention is not limited to those components and their arrangement. Thus, the forms of the invention shown and described herein are to be taken as illustrative, and changes in the components of their arrangement may be made without departing from the spirit and scope of this invention, there has been disclosed method and apparatus which differs from, provides functions not
25 performed by, and has clear advantages over the prior art.

What is Claimed is:

1. Apparatus for joining first and second components when at least one of the components may have a passageway formed therein with at least one inner support surface extending along the length of and defining the passageway, and when at least one
5 of the components may have at least one outer support surface extending around the exterior of that component, comprising;
 - (a) a first plurality of modules assembled into a first coupling device,
 - (b) mechanism for moving at least one of said first plurality of modules with respect to the other modules so that said modules are in engaging and support contact
10 with at least one of the support surfaces of the first and second components,
 - (c) means for securing said modules of said first coupling device into a first unitary structure when said modules are in said engaging and support contact with said at least one of the support surfaces of one of the first and second components to prevent movement of said modules with respect to each other in response to changing load
15 conditions and to maintain said modules and said first unitary structure in a stable engaging and supporting contact position with said one of the first and second components,
 - (d) a second plurality of modules assembled into a second coupling device,
 - (e) a mechanism for moving at least one of said second plurality of modules with
20 respect to the other modules so that said modules are in engaging and support contact with another of said support surfaces of the first and second components,
 - (f) means for securing said modules of said second coupling device into a second unitary structure when said modules are in said engaging and support contact with said other of the support surfaces of one of the first and second components to prevent
25 movement of said modules with respect to each other in response to changing load conditions and to maintain said modules and said second unitary structure in a stable engaging and support contact position with said other support surface o said one of the first and second components, and
 - (g) a connecting mechanism for coupling said first and second unitary structure
30 together, whereby the individual sizing of each of said unitary structures with respect to said one and said other support surfaces by module movement before being secured into

said first and second unitary structures provides a stronger joining apparatus.

2. Apparatus as defined in claim 1, in which

(a) each module of said first plurality of modules has a wall portion with wall end portions at each end,

5 (b) said wall end portions of at least some of said modules having at least one tenon associated therewith, and at least some of said wall end portions of said modules having tenon receiving space, whereby when said modules are assembled into a coupling device said at least one tenon on a wall end portion are intermeshed with said tenon receiving space in a wall end portion of an adjacent module.

10 3. Apparatus as defined in claim 2, in which a coupling device has at least one elongated continuous wall for use with components which have dimensions that would require module sizes that would exceed the capabilities of the most efficient and least expensive manufacturing methods, including,

(a) a plurality of modules each having a wall portion and wall end portions,
15 aligned into an elongated continuous wall,

(b) said wall end portions of at least some of said modules in said continuous wall means having at least one tenon associated therewith, and at least some of said modules in said continuous wall means having at least one tenon receiving space, whereby when said modules are aligned into said continuous wall said at least one tenon on a wall end
20 portion are intermeshed with said at least one tenon receiving space in a wall end portion of an adjacent module, and

(c) means for securing said modules of said elongated continuous wall means together into a unitary elongated continuous wall structure.

4. Apparatus as defined in claim 1, in which

25 (a) each module of said first plurality of modules has a wall portion with wall end portions at each end,

(b) said wall end portion of at least some of said modules having tenon wall means extending parallel to an axis of said coupling device, and at least some of said wall end portions having slot mortise means formed therein which extend parallel to an axis of said
30 coupling device, whereby when said modules are assembled into a coupling device said tenon wall means are received into corresponding slot mortise means.

5. Apparatus as defined in claim 1, in which

(a) each module of said first plurality of module has a wall portion, with wall end portions at each end,

(b) some of said wall end portions of each wall portion having a slot formed therein which opens inwardly toward the center of said coupling device and extends parallel to an axis of said coupling device, the other of said wall end portions having a slot formed therein which opens outwardly away from the center of said coupling device and extends parallel to an axis of said coupling device,

(c) each slot having an outermost slot wall at the end of said wall end portion which forms a tenon wall, whereby when said modules are assembled together into a coupling device and tenon wall on a wall and portion is received in a slot formed in a wall end portion of an adjacent module.

6. Apparatus as defined in claim 5, in which said slots have a width enabling a tenon wall to be moved therein to permit expansion or reduction of one size of said coupling device to engage support surfaces with all modules of the coupling device.

7. Apparatus as defined in claim 6, in which said tenon walls cooperate with slot walls to form guide ways to receive said means for securing said modules of said first coupling device into a unitary structure.

8. Apparatus as defined in claim 7, in which

(a) said means for securing said modules into a unitary structure includes rod means with screw threads formed on one end,

(b) said rod means having a configuration on the other end shaped to be engaged and captured by said tenon wall and slot sides, to prevent said rod means from rotating when a nut is tightened or loosened on said screw thread end of said rod means.

9. Apparatus as defined in claim 1, in which

(a) each module of said first plurality of modules has a wall portion with wall end portions at each end,

(b) each wall end portion having at least one individual tenon associated therewith, and

(c) means for selectively attaching each tenon to an associated wall end portion in an interlocking relationship which prevents said tenon from being pulled away from its

associated wall end portion.

10. Apparatus as defined in claim 9, in which said selective attaching means for individual tenons includes,

5 (a) a projecting member extending from one of said individual tenons and said wall end portion of a module with which said tenon is associated, and

(b) a cavity formed in the other of said individual tenon means and said wall end portion to receive and capture said projecting member.

11. Apparatus as defined in claim 10, in which said cavity comprises a groove having a cross-section configured to slidably receive said projecting member to connect said
10 tenon and said wall end portion of said module in an interlocking relationship.

12. Apparatus as defined in claim 1, in which

(a) said first plurality of modules is secured into a first unitary structure which is in engaging and supporting contact with an inner support surface of a passageway of a first component,

15 (b) said second plurality of modules is secured into a second unitary structure which is in engaging and supporting contact with an outer support surface extending around the exterior of said first component, and

(c) means for connecting said first and second unitary structure together through said first component between said inner and outer support surfaces, thereby improving the
20 strength of the joining apparatus.

13. Apparatus as defined in claim 12 which further includes means for connecting said connected first and second unitary structures to a second component.

14. Apparatus as defined in claim 1, in which

25 (a) said first plurality of modules is secured into a first unitary structure which is in engaging and supporting contact with an inner support surface of a passageway of a first component,

(b) said second plurality of components is secured into a second unitary structure which is in engaging and supporting contact with an inner support surface of a passageway of a second component, and

30 (c) means for connecting said first and second unitary structures together to join said first and second components.

15. Apparatus as defined in claim 14, in which

(a) said first and second components are tubular modules which have aligned passageway openings and in which,

(b) said means for connecting said first and second unitary structures together
5 includes rod means which extend through both unitary structures to secure the modules in each coupling device in unitary structures and to connect said first and second unitary structures together, to provide a joining device with improved strength, for said first and second components.

16. A coupling device for use in joining first and second components where at least
10 one of the components has a passageway with at least one inner support surface extending along and defining the passageway, and when at least one of the components has an outer support surface extending around the exterior of that component comprising;

(a) a plurality of modules assembled into a coupling device,

(b) means for moving at least one of said plurality of modules with respect to the
15 other modules so that said modules are in engaging and support contact with one of the support surfaces of the first and second components, and

(c) means for securing said plurality of modules into a unitary structure when said modules are in said engaging and support contact with said one of the support surfaces of one of the first and second components to prevent movement of said modules with respect
20 to each other in response to changing load conditions and to maintain said modules and said unitary structure in a stable engaging and supporting contact position with said one of the first and second components.

(d) each module of said plurality of modules having a wall portion with wall end portions at each end,

25 (e) said wall end portion of at least some of said modules having tenon wall means extending parallel to an axis of said coupling device, and at least some of said wall end portions having slot mortise means formed therein which extend parallel to an axis of said coupling device, whereby when said modules are assembled into said coupling device said tenon wall means are received into corresponding slot mortise means.

30 17. Apparatus as defined in claim 16, in which

(a) some of said wall end portions of each wall portion have a slot formed therein

which opens inwardly toward the center of said coupling device and extends parallel to an axis of said coupling device, the other of said wall end portions having a slot formed therein which opens outwardly away from the center of said coupling device and extends parallel to an axis of said coupling device,

- 5 (b) each slot having an outermost slot wall at the end of said wall portion which forms said tenon wall means, whereby when said modules are assembled together into a coupling device said tenon wall means on a wall end portion is received in a slot formed in a wall end portion of an adjacent module.

18. Apparatus as defined in claim 17 in which said slots have a width enabling a tenon wall to be moved therein to permit expansion or reduction of the size of said coupling device to engage support surfaces with all modules of the coupling device.

19. Apparatus as defined in claim 18 in which said tenon walls cooperate with slot walls to form guide ways to receive said means for securing said modules of said coupling device into a unitary structure.

15 20. Apparatus as defined in claim 19, in which

(a) said means for securing said modules into a unitary structure includes rod means with screw threads formed on one end,

20 (b) said rod means having a configuration of the other end shaped to be engaged and captured by said tenon wall and slot sides, to prevent said rod means from rotating when a nut is tightened on said screw thread end of said rod means.

21. Apparatus as defined in claim 16 in which each wall portion of each module has an outer wall surface configured to mate with an inner support surface of a component.

22. Apparatus as defined in claim 16 in which each wall portion of each module has an inner wall surface configured to mate with an exterior support surface of a component.

25 23. A coupling device for use in joining first and second components when at least one of the components may have a passageway with inner support surfaces extending along and defining the passageway, and when at least one of the components may have an outer support surface extending around the exterior of that component comprising;

(a) a plurality of modules assembled into a coupling device,

30 (b) means for moving at least one of said plurality of modules with respect to the other modules so that said modules are in engaging and support contact with one of the

support surfaces of the first and second components,

(c) means for securing said plurality modules into a unitary structure when said modules are in said engaging and support contact with said one of the support surfaces of one of the first and second components to prevent movement of said modules with respect
5 to each other in response to changing load conditions and to maintain said modules and said unitary structure in a stable engaging and supporting contact position with said one of the first and second components,

(d) each module of said plurality of modules having a wall portion with wall end portions at each end,

10 (e) each wall end portion having at least one individual tenon means associated therewith, and

(f) means for selectively attaching each tenon means to an associated wall portion in an interlocking relationship which prevents said tenon means from being pulled away from its associated wall end portion.

15 24. Apparatus as defined in claim 23, in which said selective attaching means for individual tenon means includes,

(a) projection means extending from one of said individual tenon means and said wall end portion of a module with which said tenon means is associate, and

20 (b) a cavity formed in one in the other of said individual tenon means and said wall end portion to receive and capture said projection means.

25. Apparatus as defined in claim 24 in which said cavity means comprises a groove having a cross-section configured to slidably receive said projection means to connect said tenon means and said wall end portion of said module in an interlocking relationship.

26. Apparatus as defined in claim 23 in which said selective attaching means includes

25 (a) projection means having a dovetail shape, and

(b) cavity means having a groove with a cross-section configured to mate with and slidably receive said dovetail shape of said projection means.

27. Apparatus as define din claim 23 in which said selective attaching means includes

30 (a) projection means having an elongated bead connected to one of said tenon means and wall end portion by an elongated tongue, and

(b) cavity means having a groove with a cross-section configured to receive said

elongated bead and a slot to receive said elongated tongue.

28. Apparatus as defined in claim 23 in which said individual tenon means are identical and are formed with a cross-section whereby any said individual tenon means may be used with either wall end portion of a wall portion of a module by selectively
5 detaching an individual tenon means from one wall and portion of a wall portion, inverting the individual tenon means and attaching said inverted tenon means to the other wall end portion of said module.

29. Apparatus as defined in claim 23 in which each wall portion of each module causes an outer wall surface configured to mate with an inner support surface of a
10 component.

30. Apparatus as defined in claim 23 in which each wall portion of each module has an inner wall surface configured to mate with an exterior support surface of a component.

31. A method for joining first and second components when at least one of the components has a passageway formed therein with at least one inner support surface
15 extending along the length of and defining the passageway, and when at least one of the components has at least one outer support surface extending around the exterior of that component, comprising;

(a) assembling a first plurality of modules into a first coupling device,

(b) moving at least one of said first plurality of modules with respect to the other
20 modules so that said first plurality of modules are in engaging and support contact with one of the support surfaces of the first and second components,

(c) securing said modules of said first coupling device into a first unitary structure when said modules are in said engaging and support contact with said one of the support surfaces of one of the first and second components to prevent movement of said modules
25 with respect to each other in response to changing load conditions and to maintain said modules and said first unitary structure in a stable engaging and support contact position with said one of the first and second components,

(d) assembling a second plurality of modules into a second coupling device,

(e) moving at least one of said second plurality of modules with respect to the
30 other modules so that said modules are in engaging and support contact with another of said support surfaces,

(f) securing said modules of said second coupling device into a second unitary structure when said modules are in said engaging and support contact with said other of the support surfaces of one of the first and second components to prevent movement of said modules with respect to each other in response to changing load conditions and to
5 maintain said modules and said second unitary structures in a stable engaging contact and support position with said other support surfaces of said one of the first and second components, and

(g) connecting said first and second unitary structures together, whereby the individual sizing of each of said unitary structures with respect to said one and said other
10 support surfaces by module movement before being secured into said first and second unitary structures provides a customized fit for each unitary structure and a stronger joining method.

32. A method as defined in claim 31 which includes the step of extruding said modules from a material selected for the best strength-to-weight ratio in the desired
15 application to reduce at least some of the dimensions of said modules while maintaining the required strength, and to enable consistent production at a lower manufacturing cost.

33. A method as defined in claim 32 which includes the step of reducing the thickness of wall modules by extrusion in order to provide a large wire-way on the inside of a unitary structure which is in engaging contact and support with an inner support surface
20 of one of said first and second components.

34. A method as defined in claim 31 in which

(a) said first unitary structure is in said engaging and support contact with an inner support surface of one of said first and second components,

(b) said second unitary structure is in said engaging and support contact with an
25 exterior support surface of said one of said first and second components, and

(c) connecting said first and second unitary structures together through said inner and outer support surfaces of said one of said first and second components.

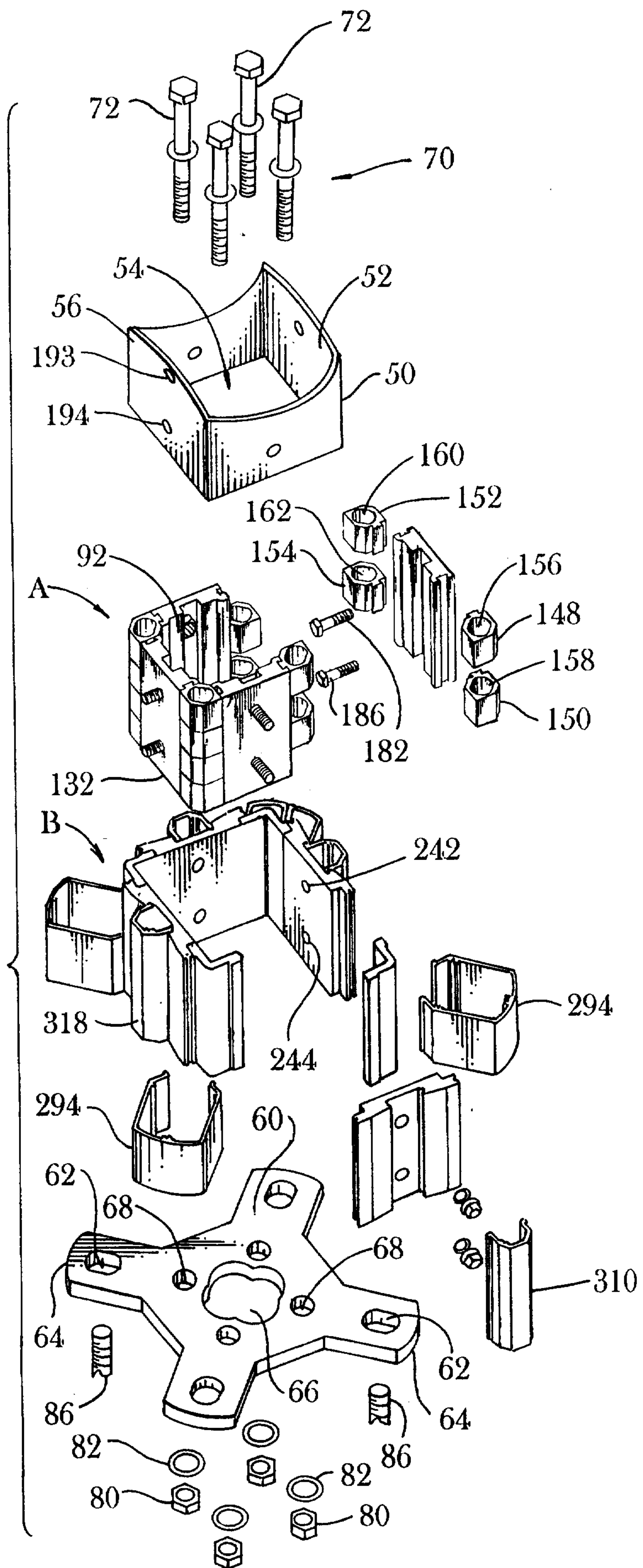
35. A method as defined in claim 31 in which said first unitary structure is in said engaging and support contact with one of said inner and outer support surfaces of a first
30 component, and said second unitary structure is in engaging and support contact with the same one of said inner and outer support surfaces of a second component as is said first

unitary structure is with said first component, which further includes,

(a) the step of connecting said first and second unitary structures together by extending means through both unitary structures and using said connecting means to also secure said modules into said first and second unitary structures.

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Fig. 1



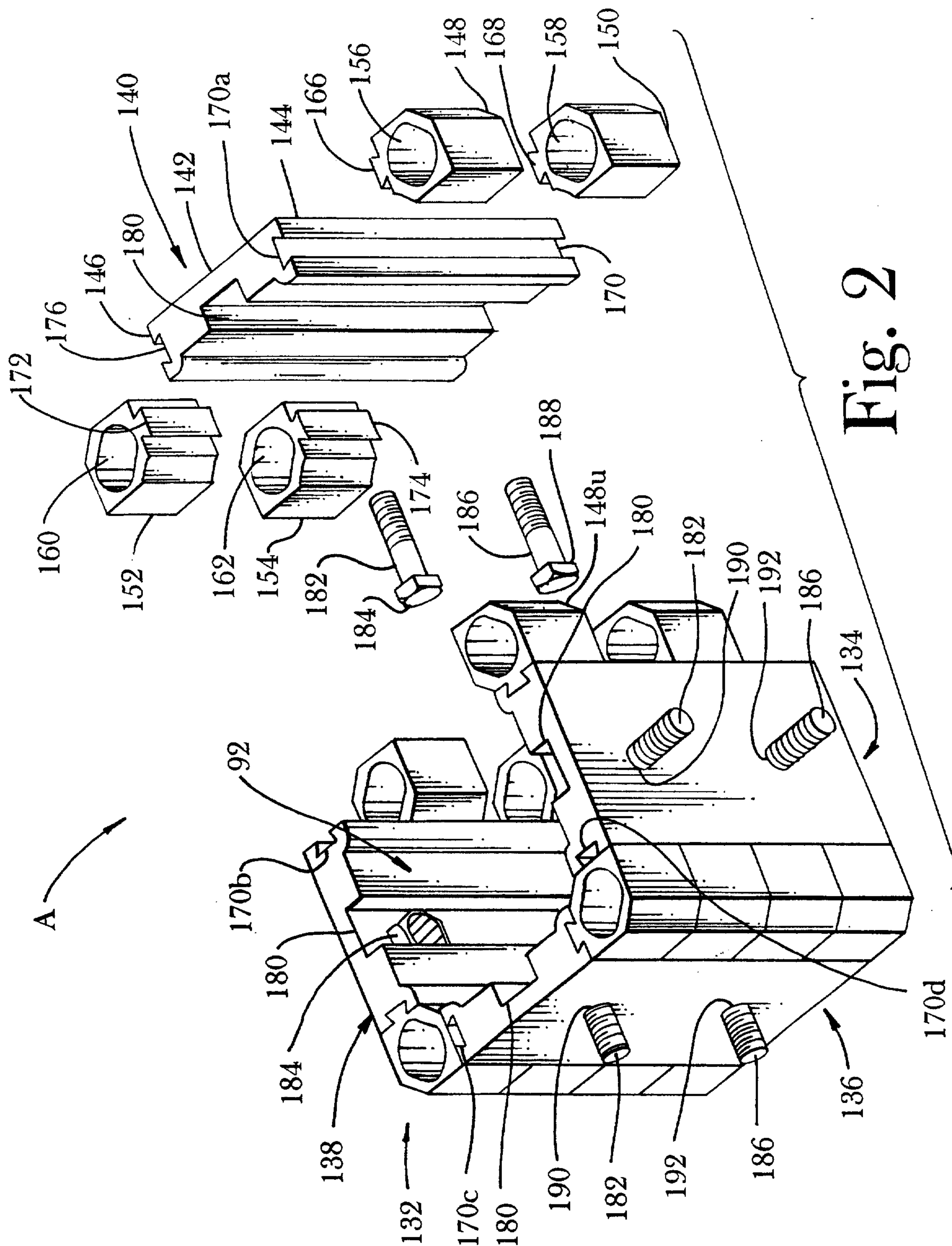


Fig. 2

Fig. 3

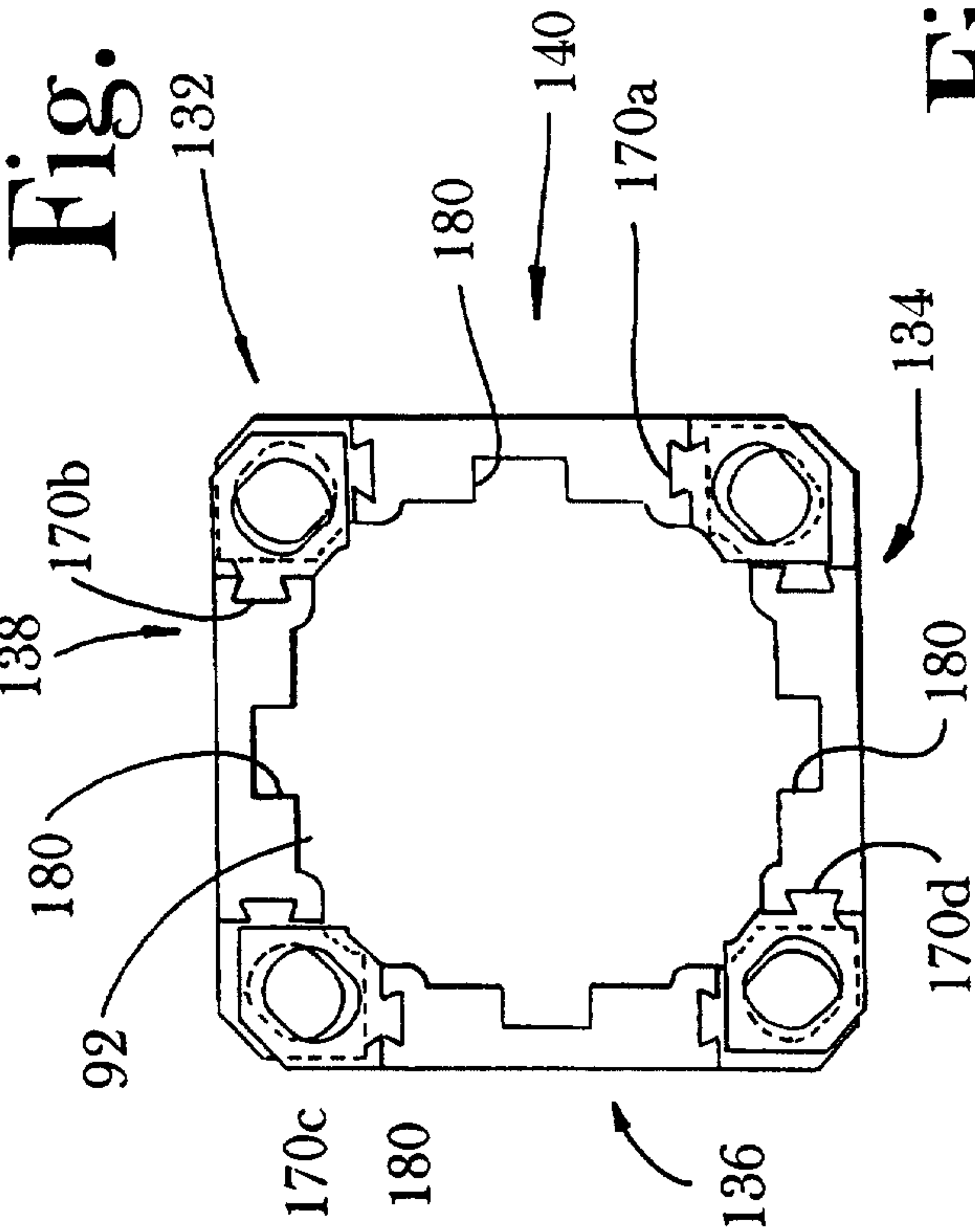


Fig. 6

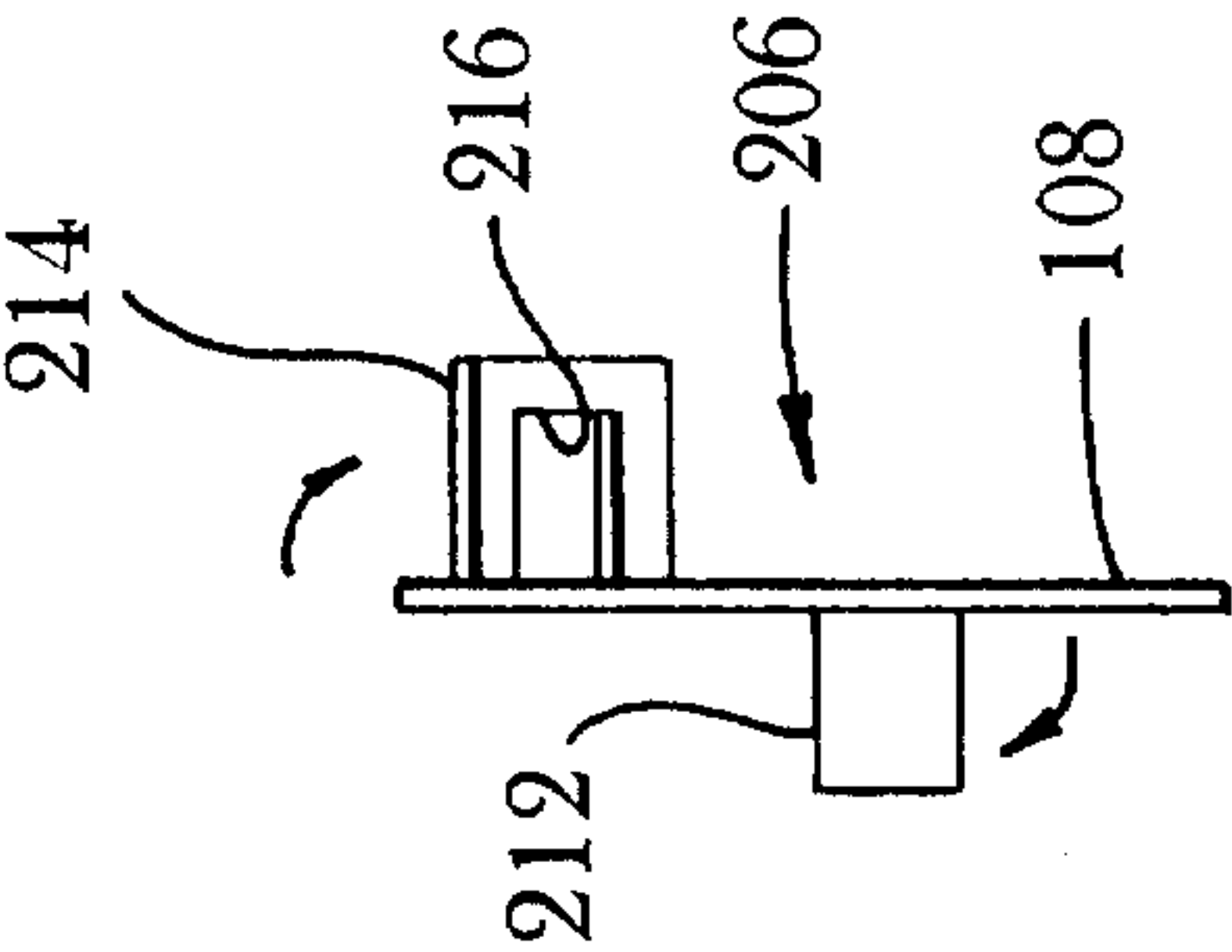


Fig. 5

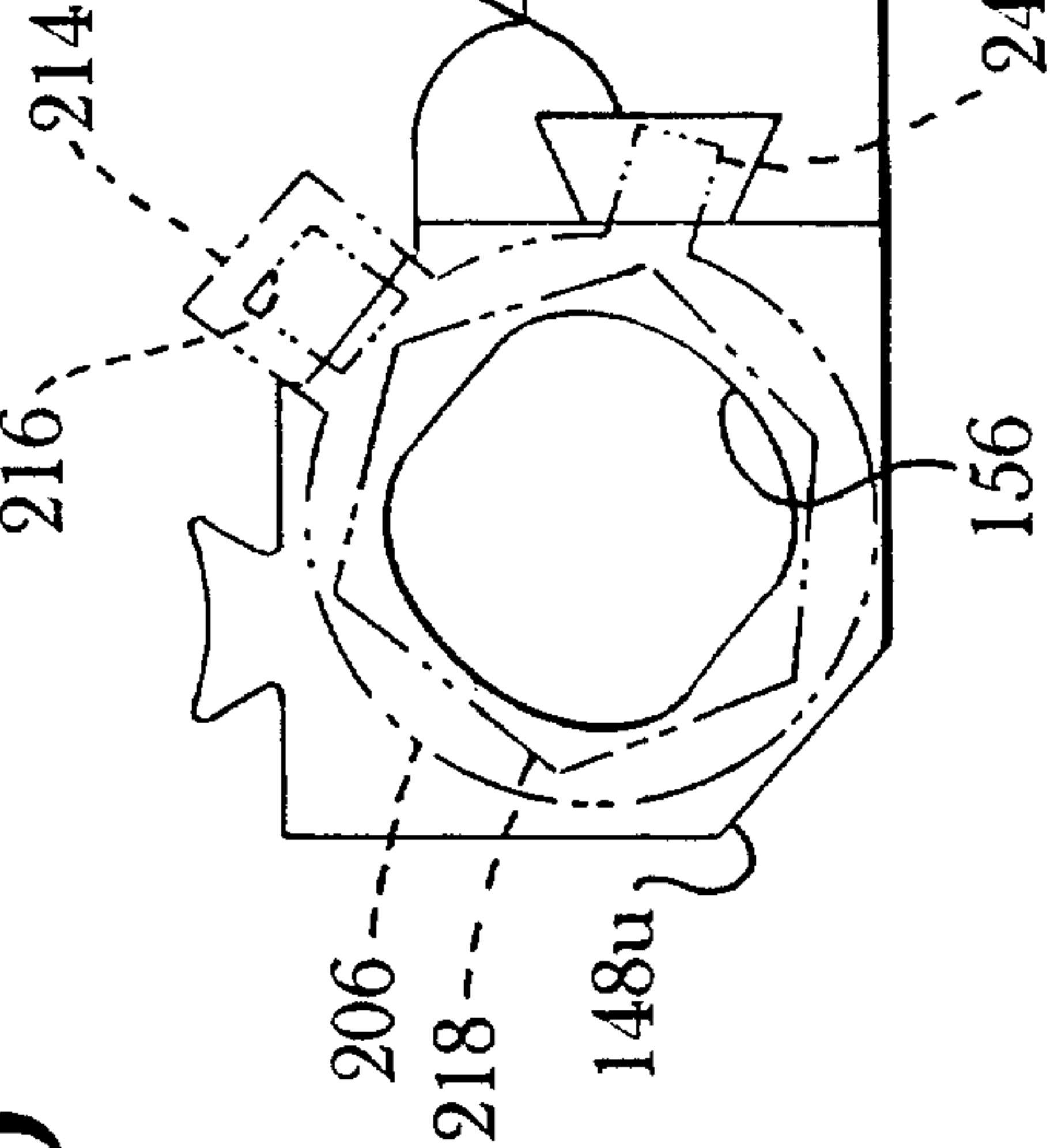
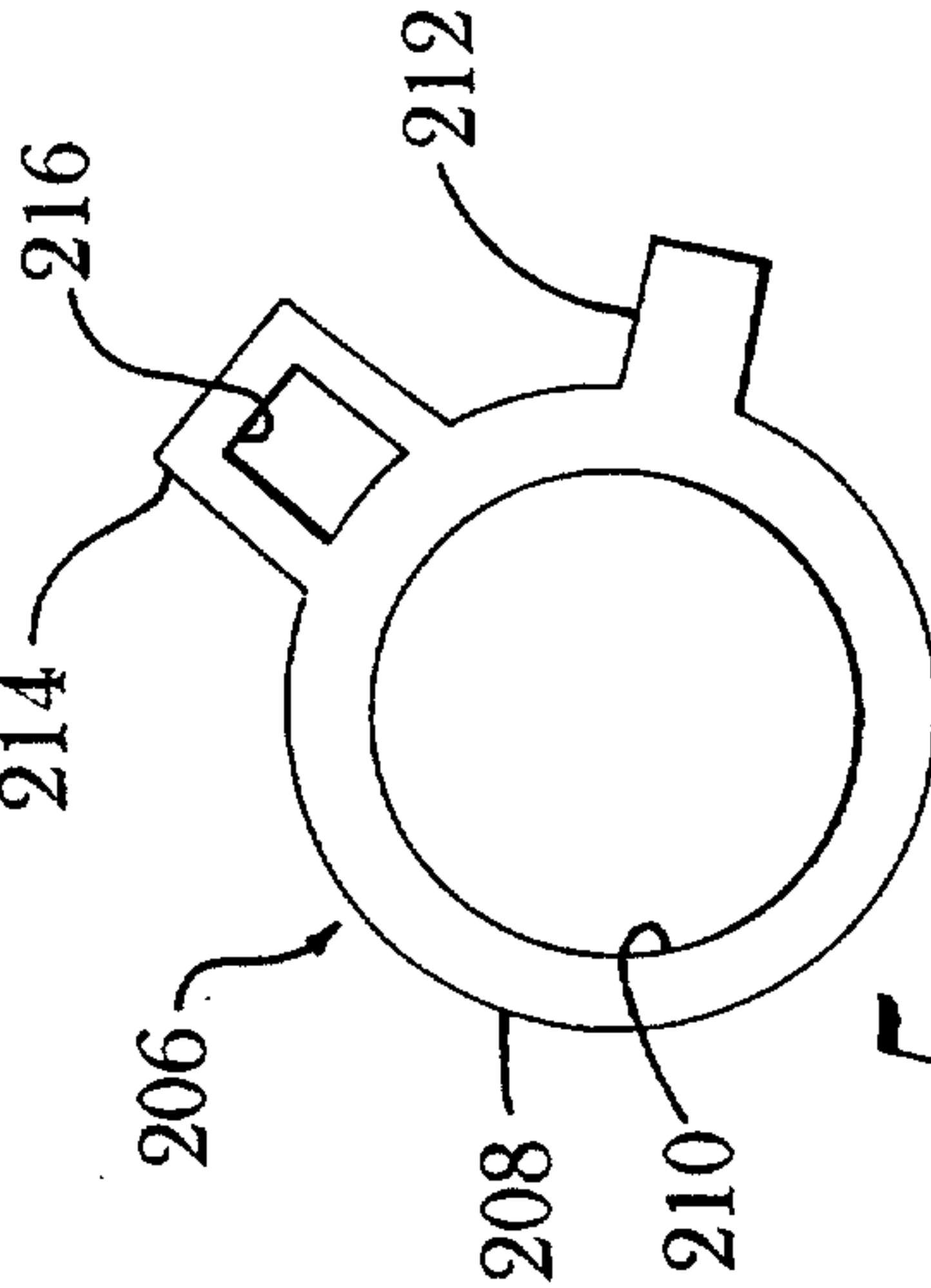


Fig. 7

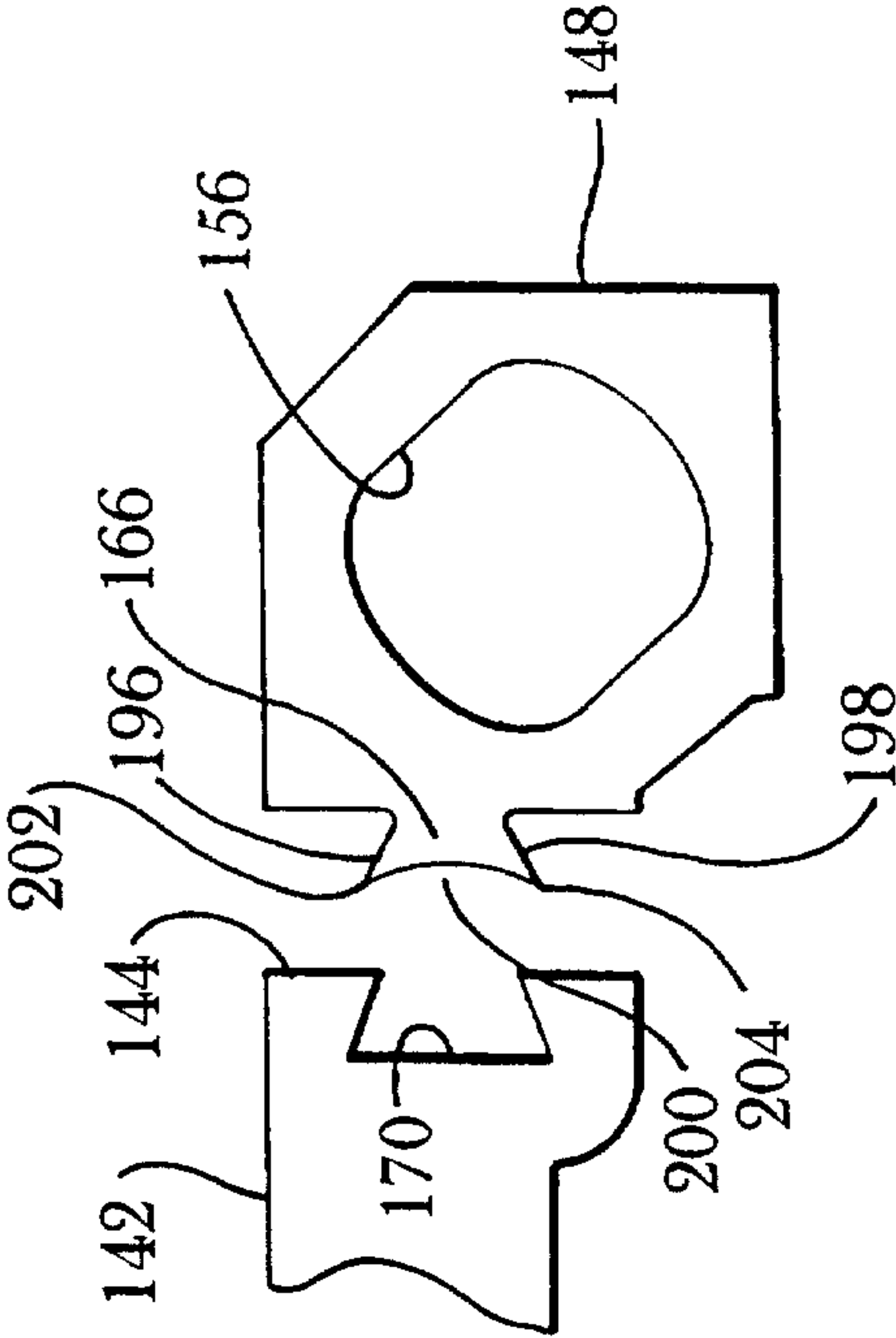


Fig. 4

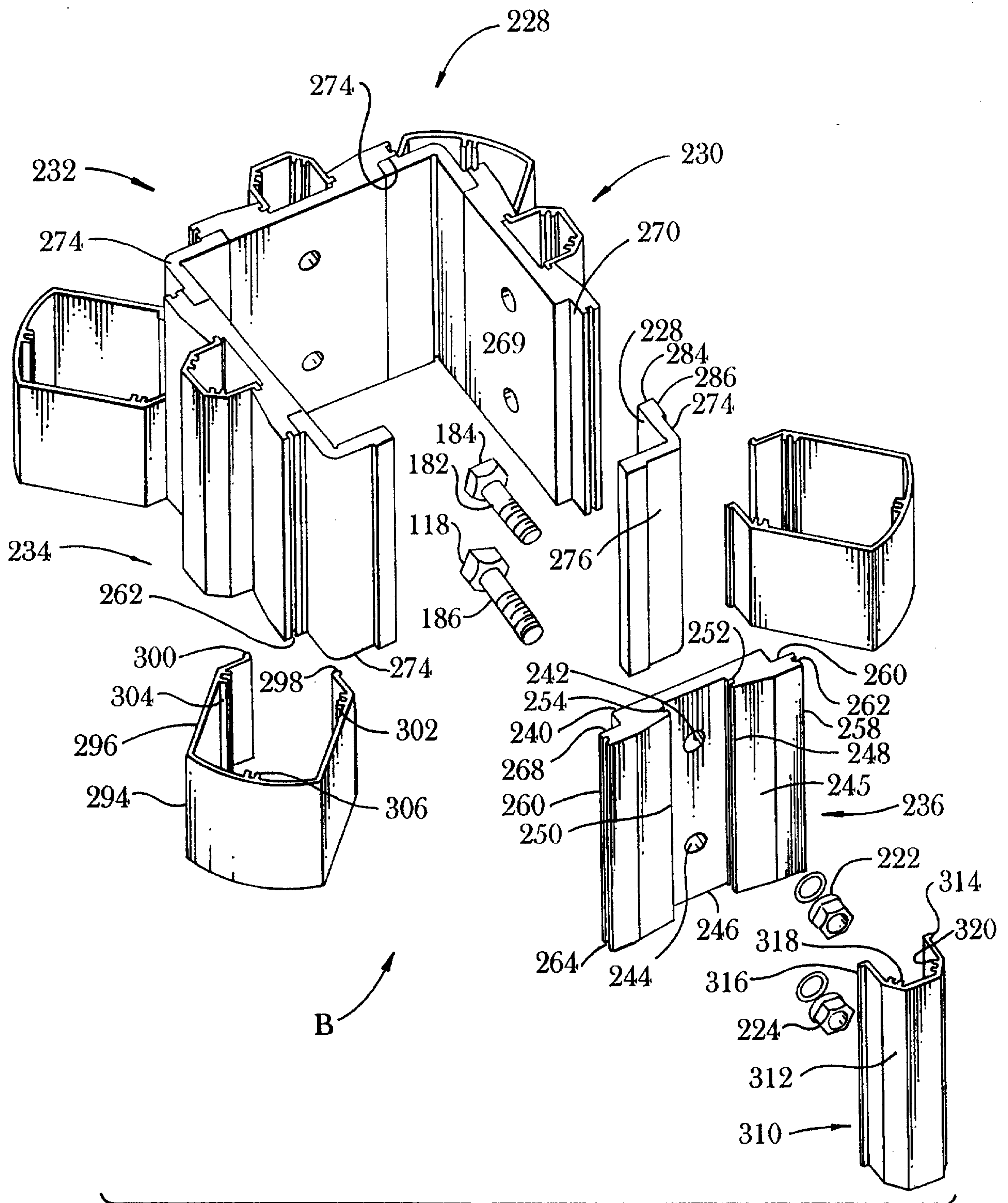


Fig. 8

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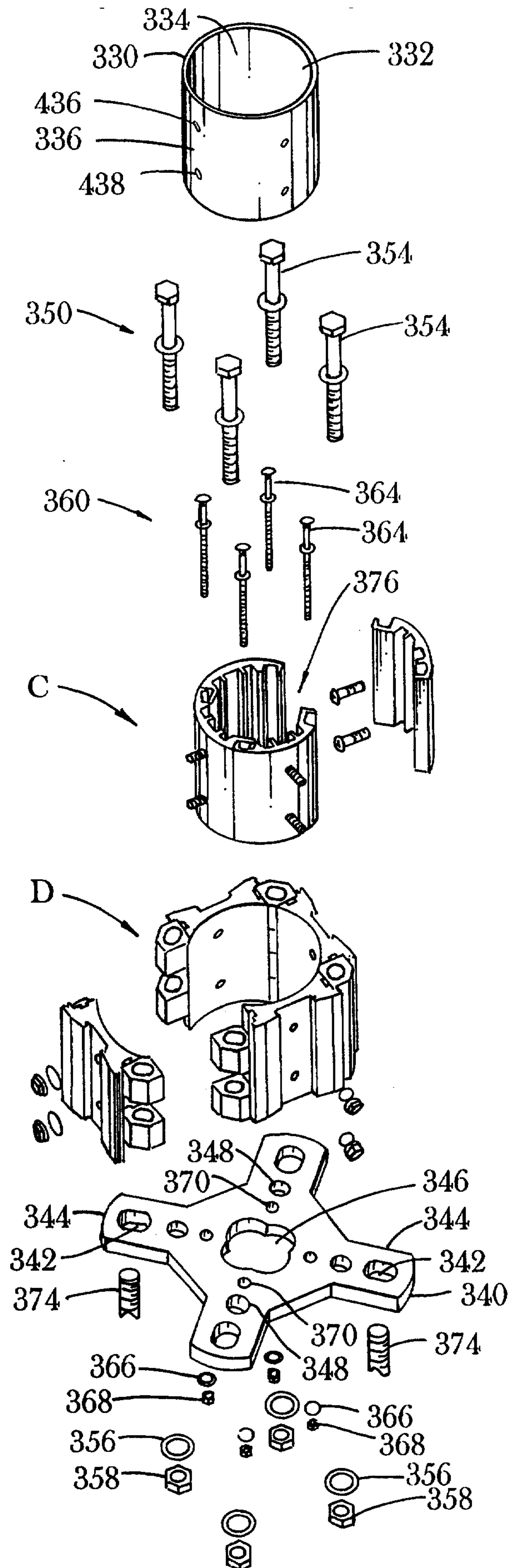


Fig. 9

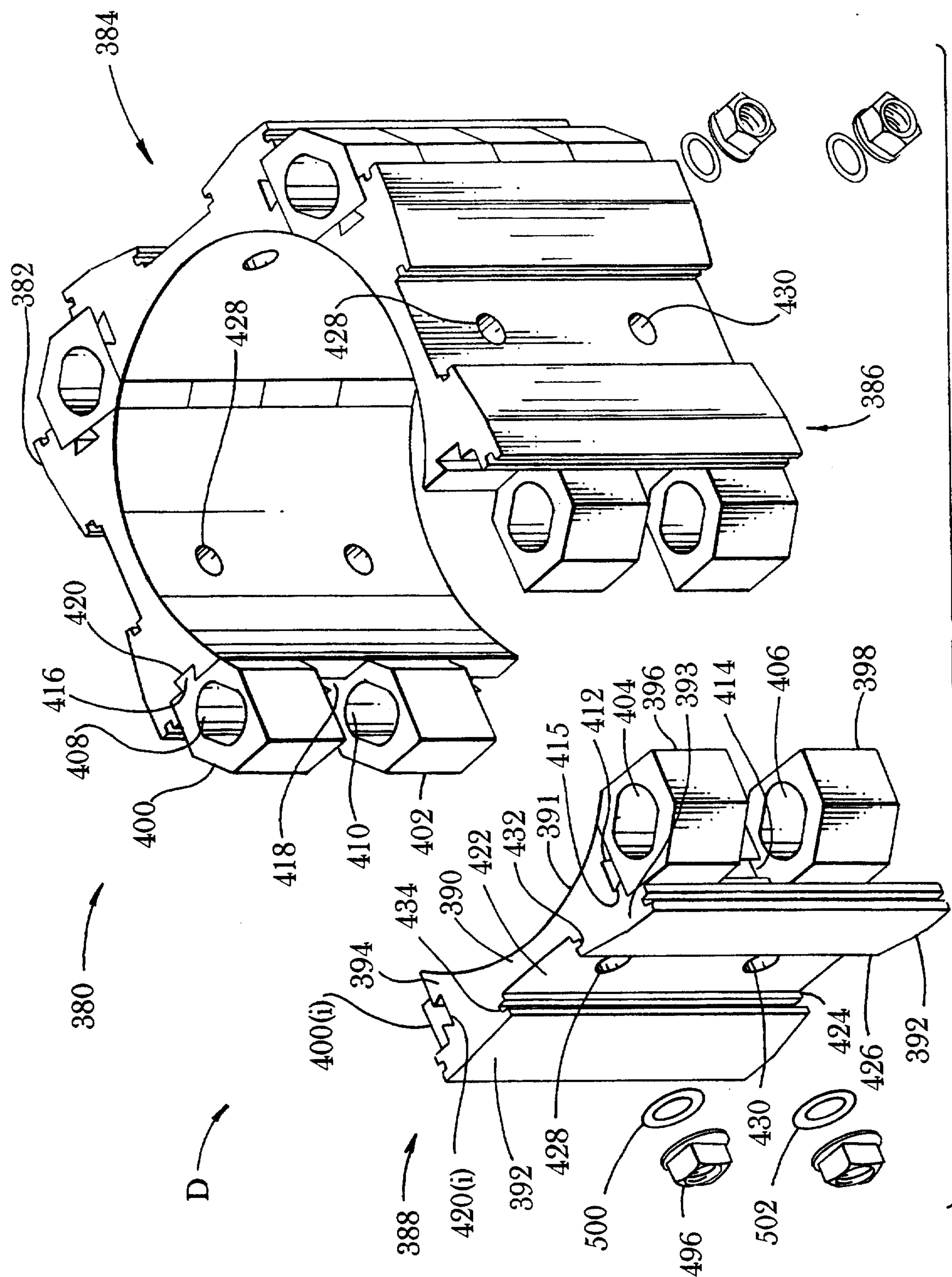


Fig. 10

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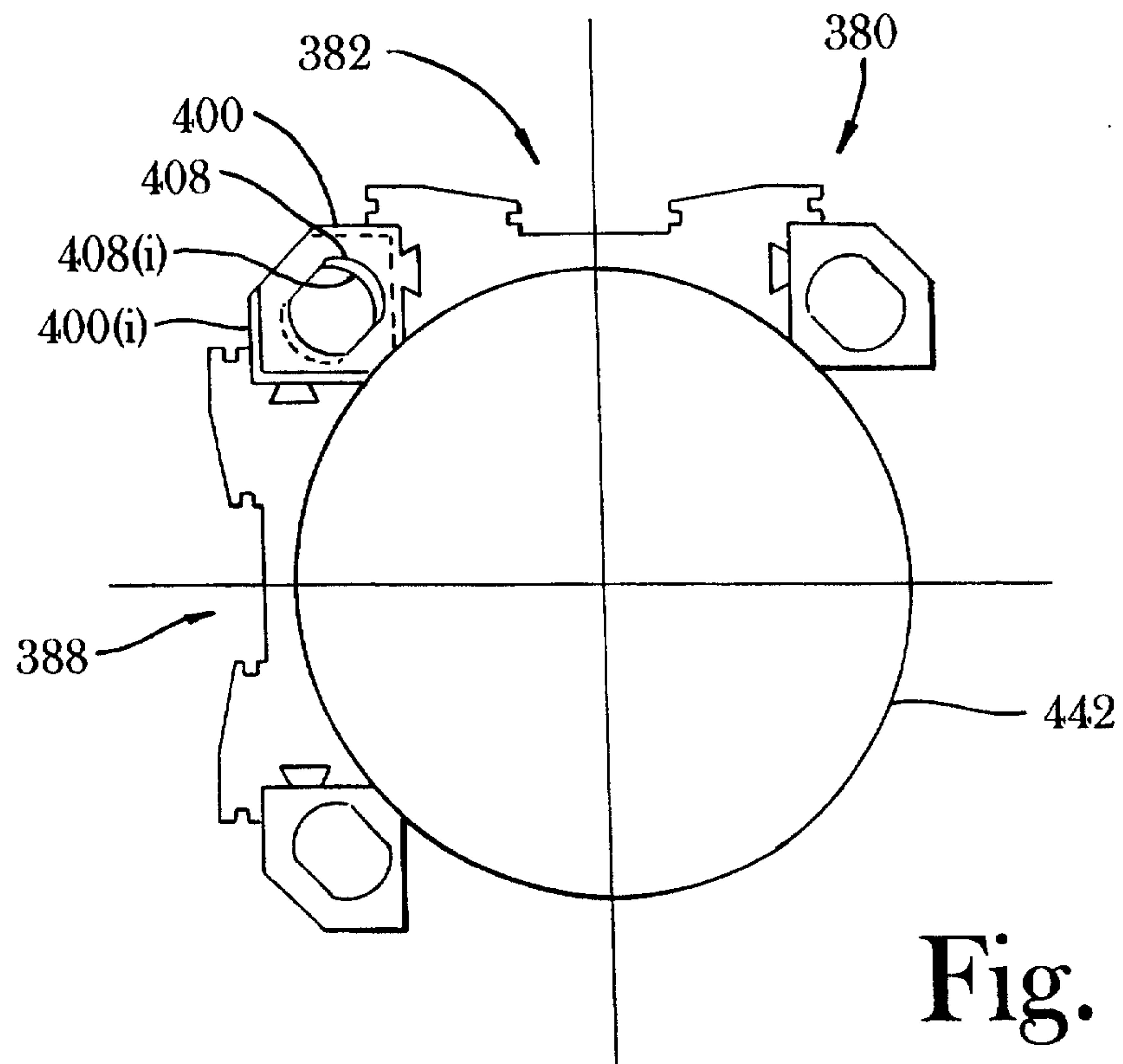


Fig. 12

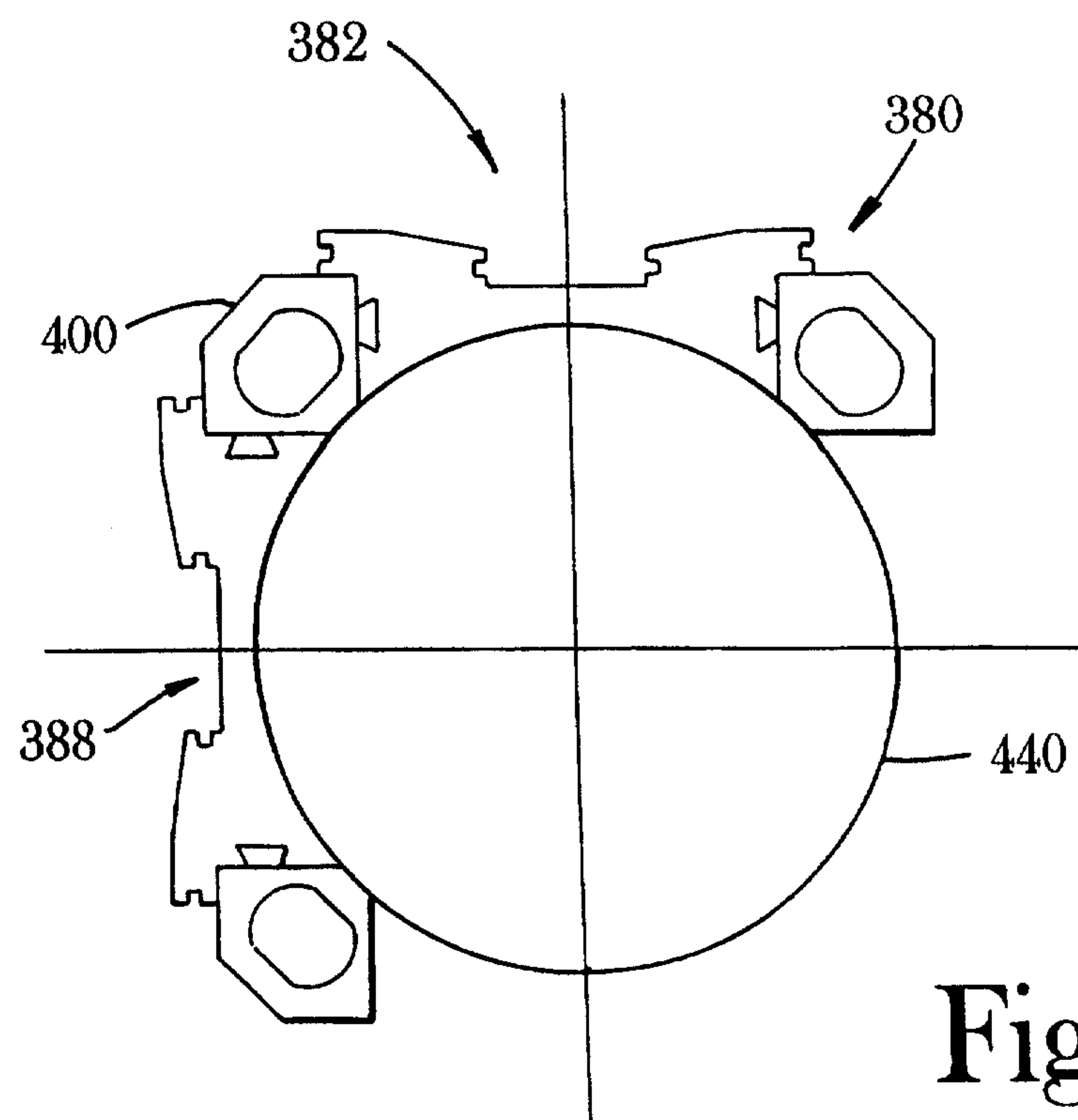


Fig. 11

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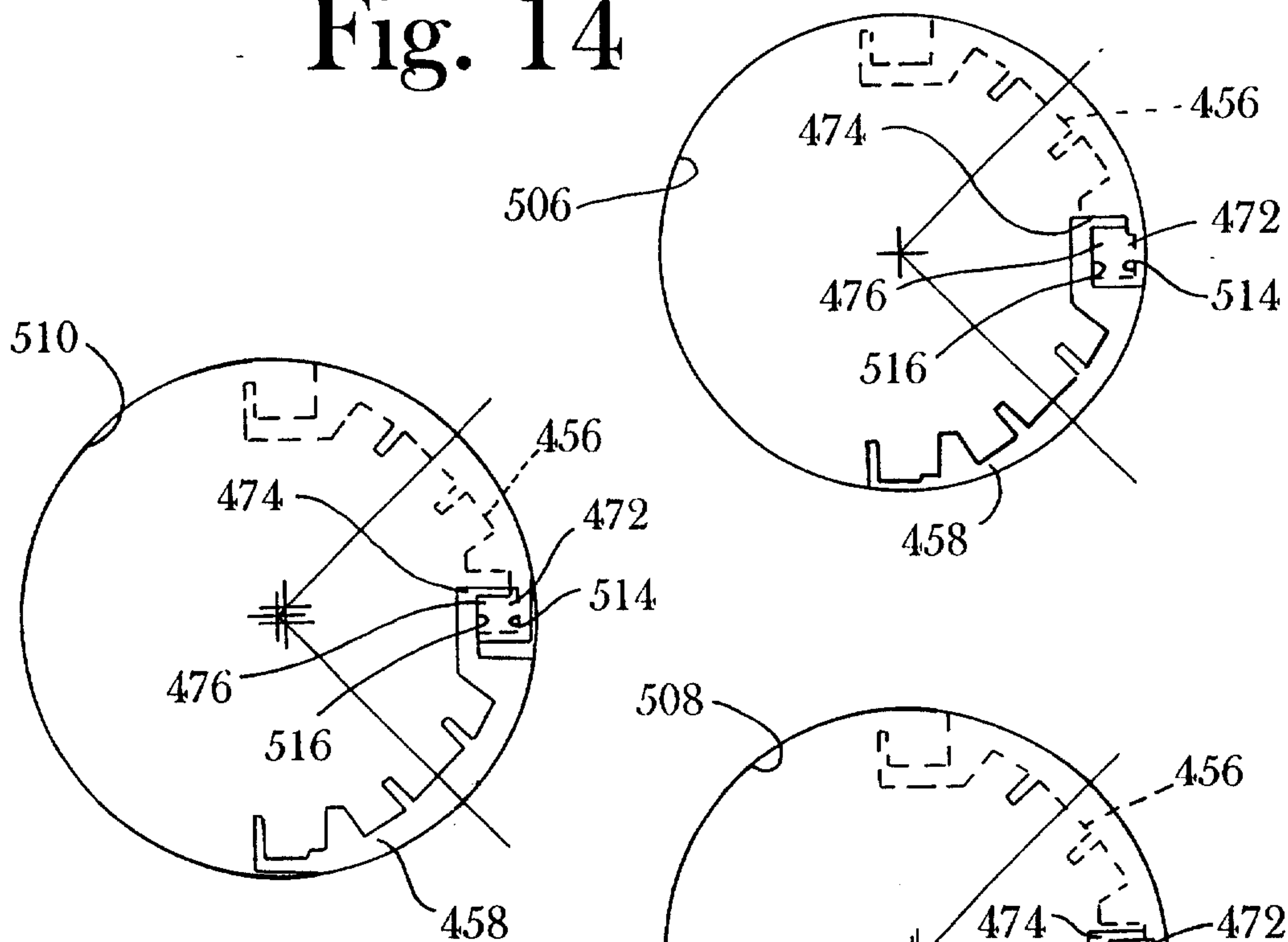
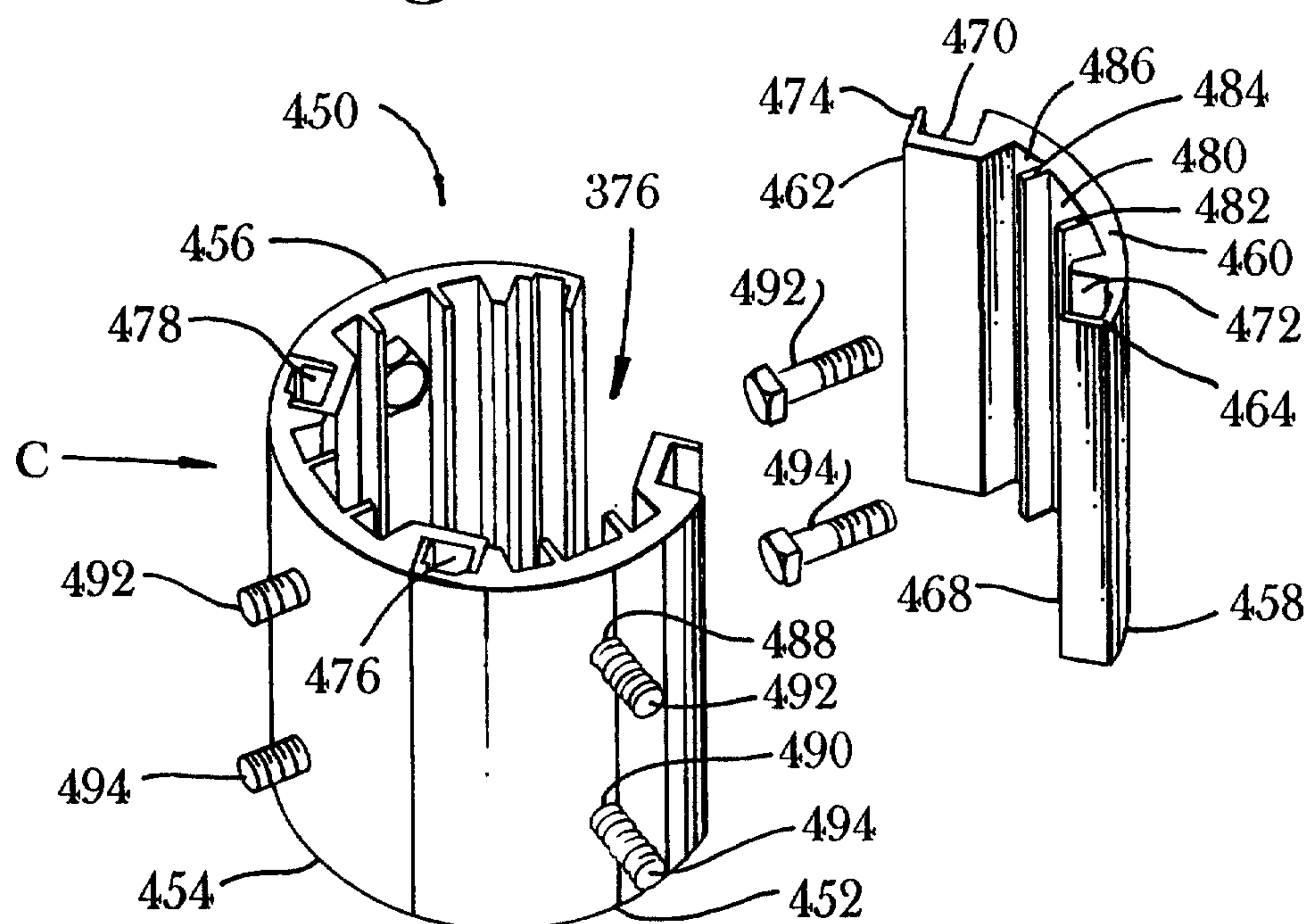
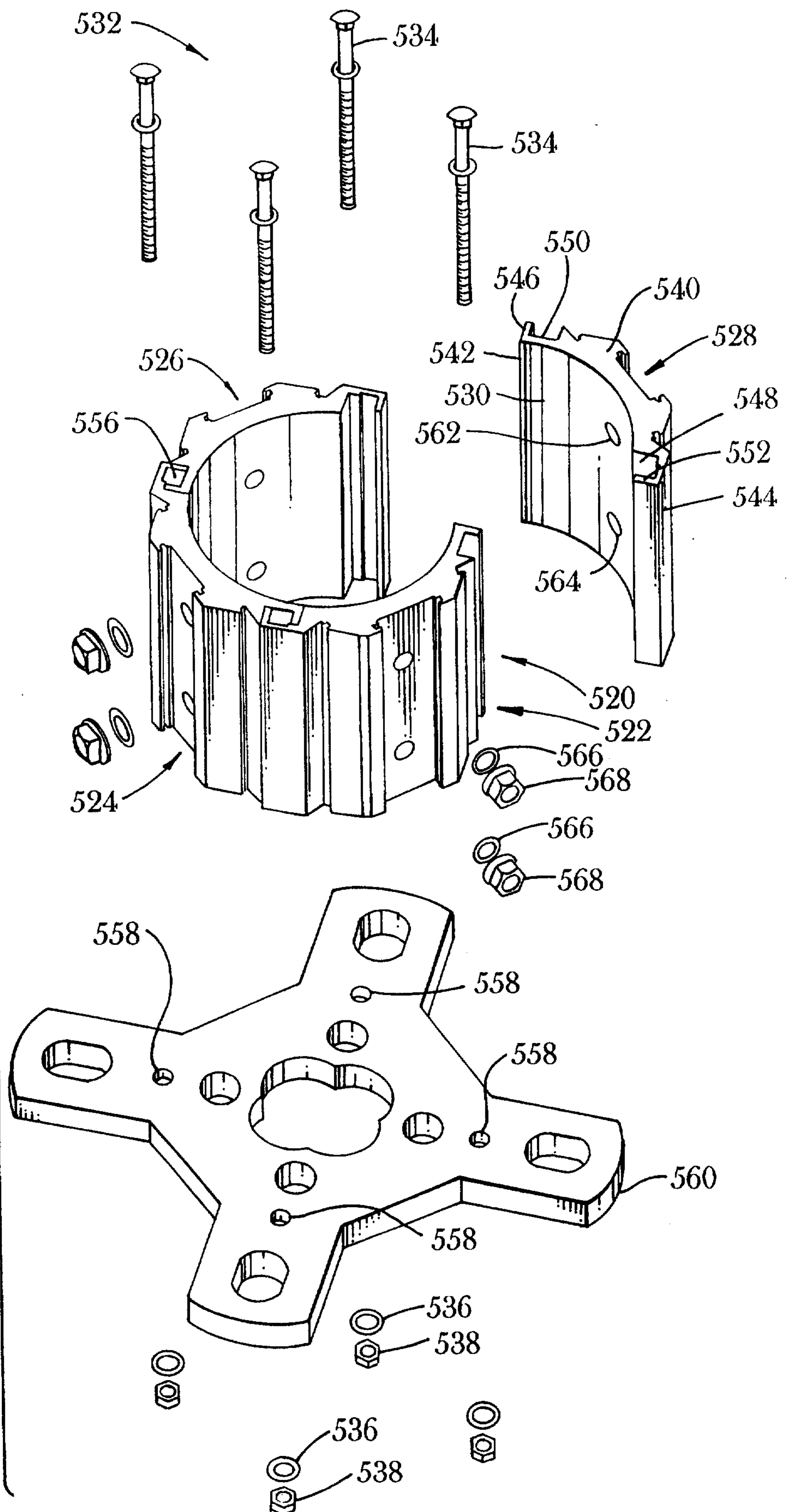
Fig. 14**Fig. 16****Fig. 15****Fig. 13**

Fig. 17



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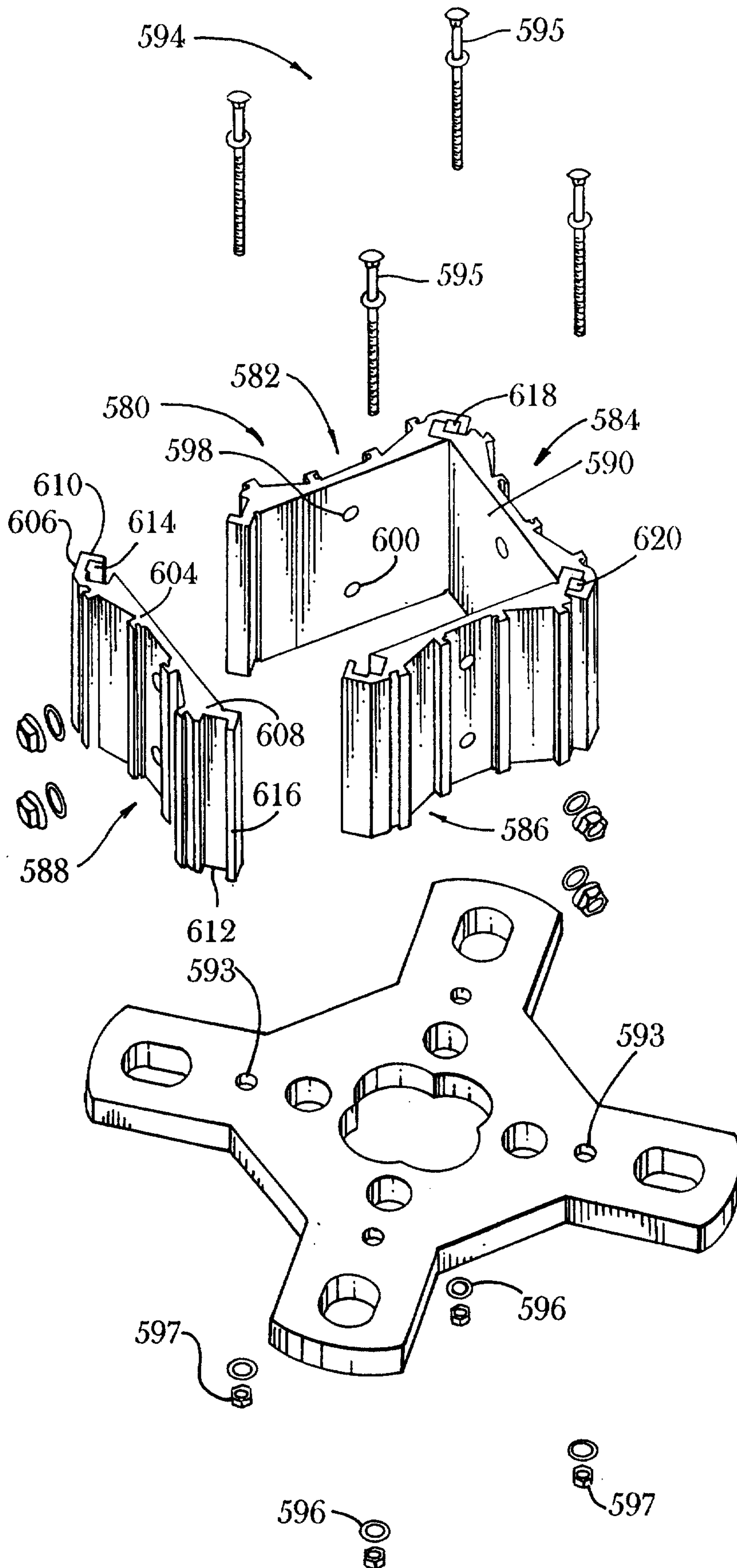


Fig. 21

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Fig. 23

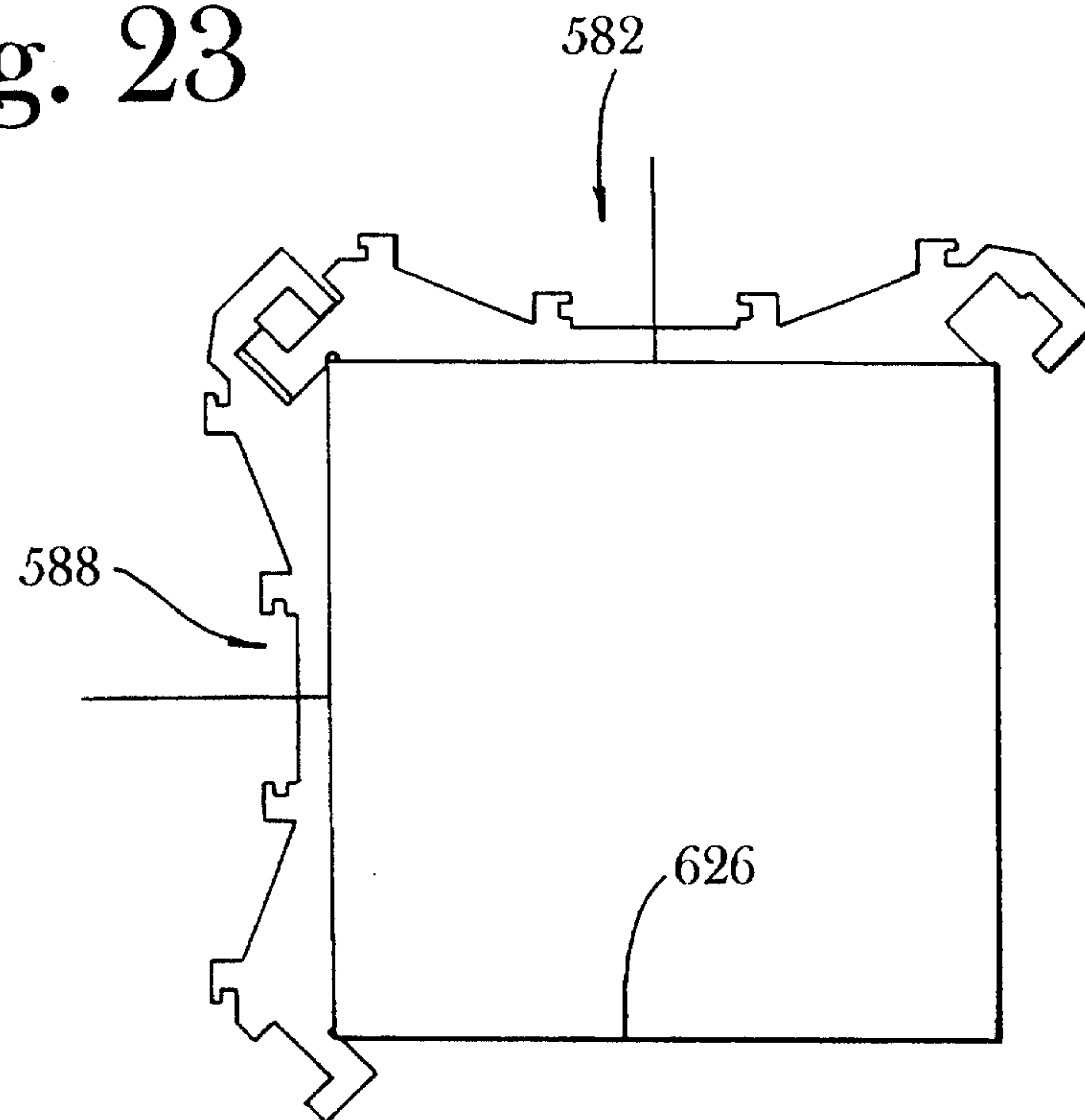
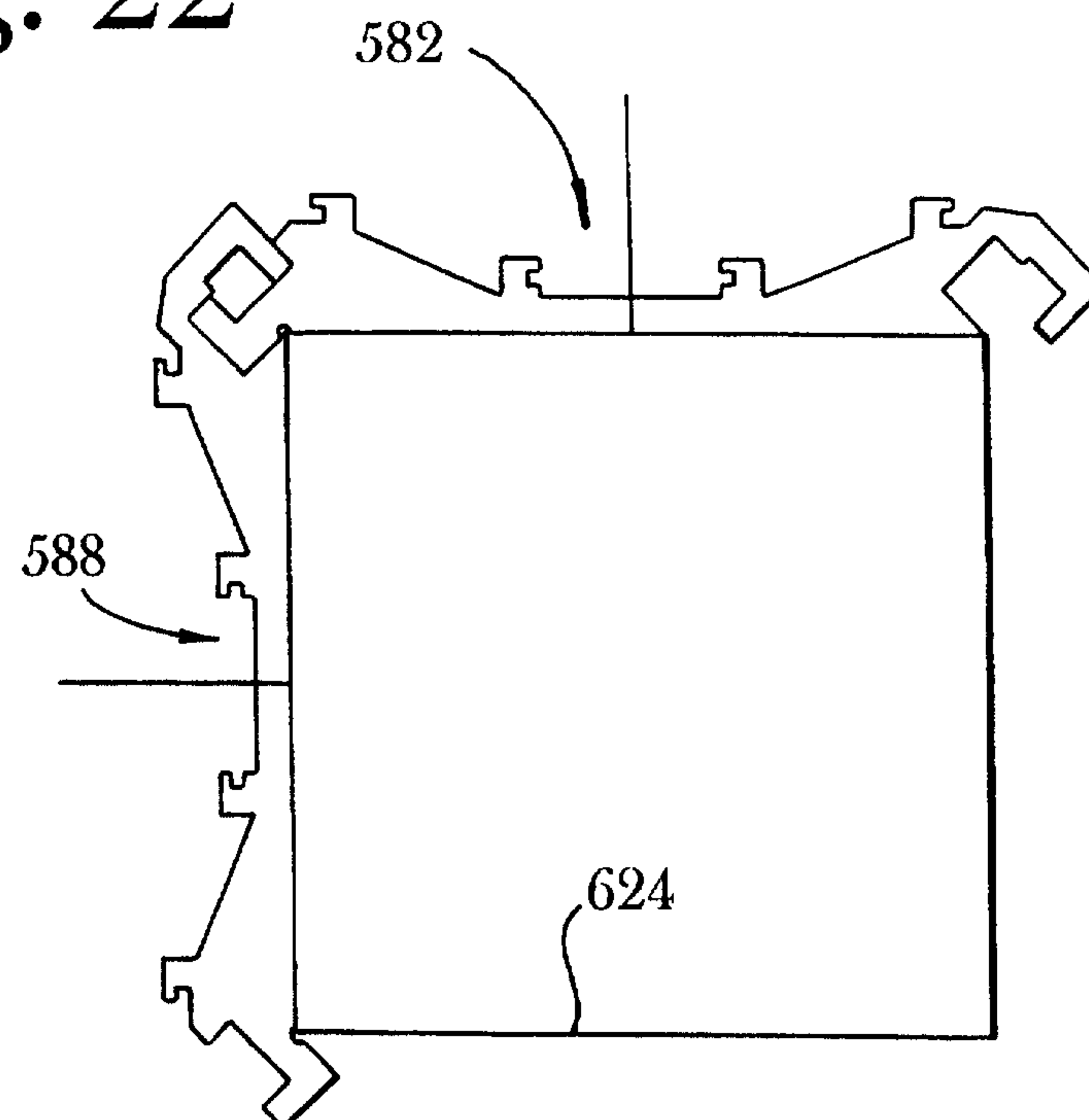


Fig. 22



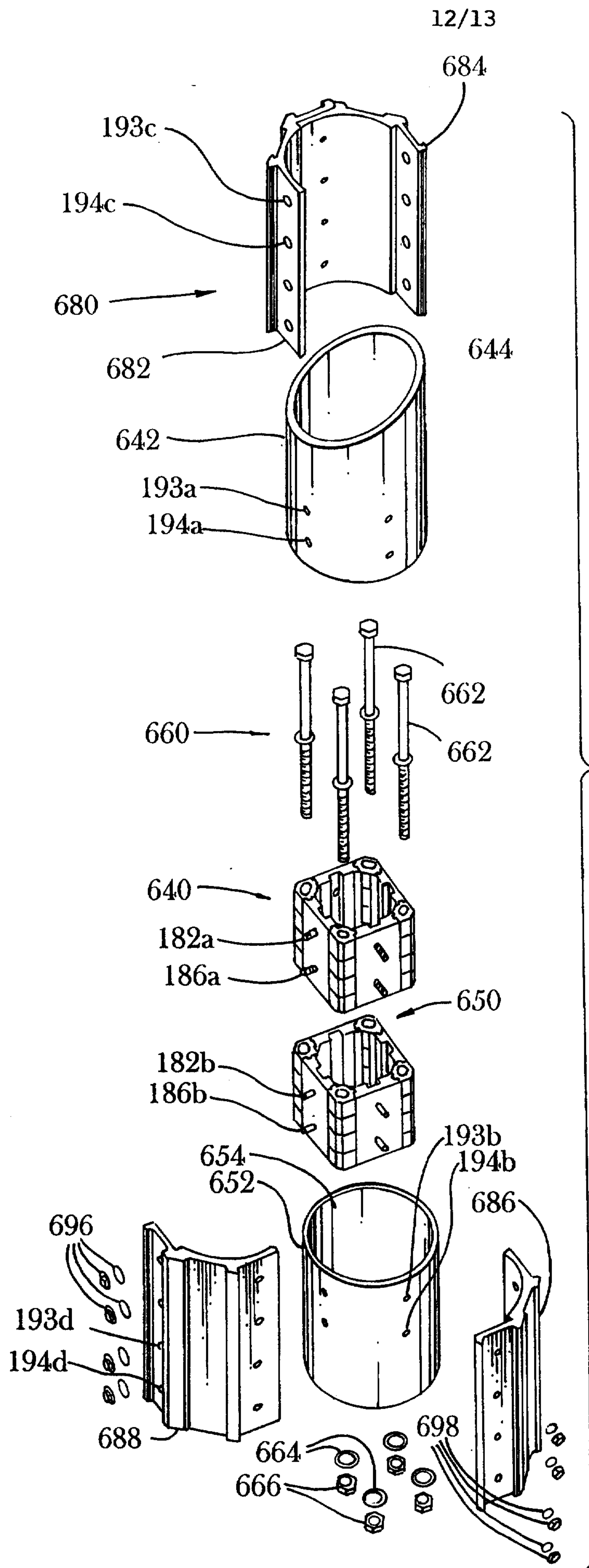


Fig. 24

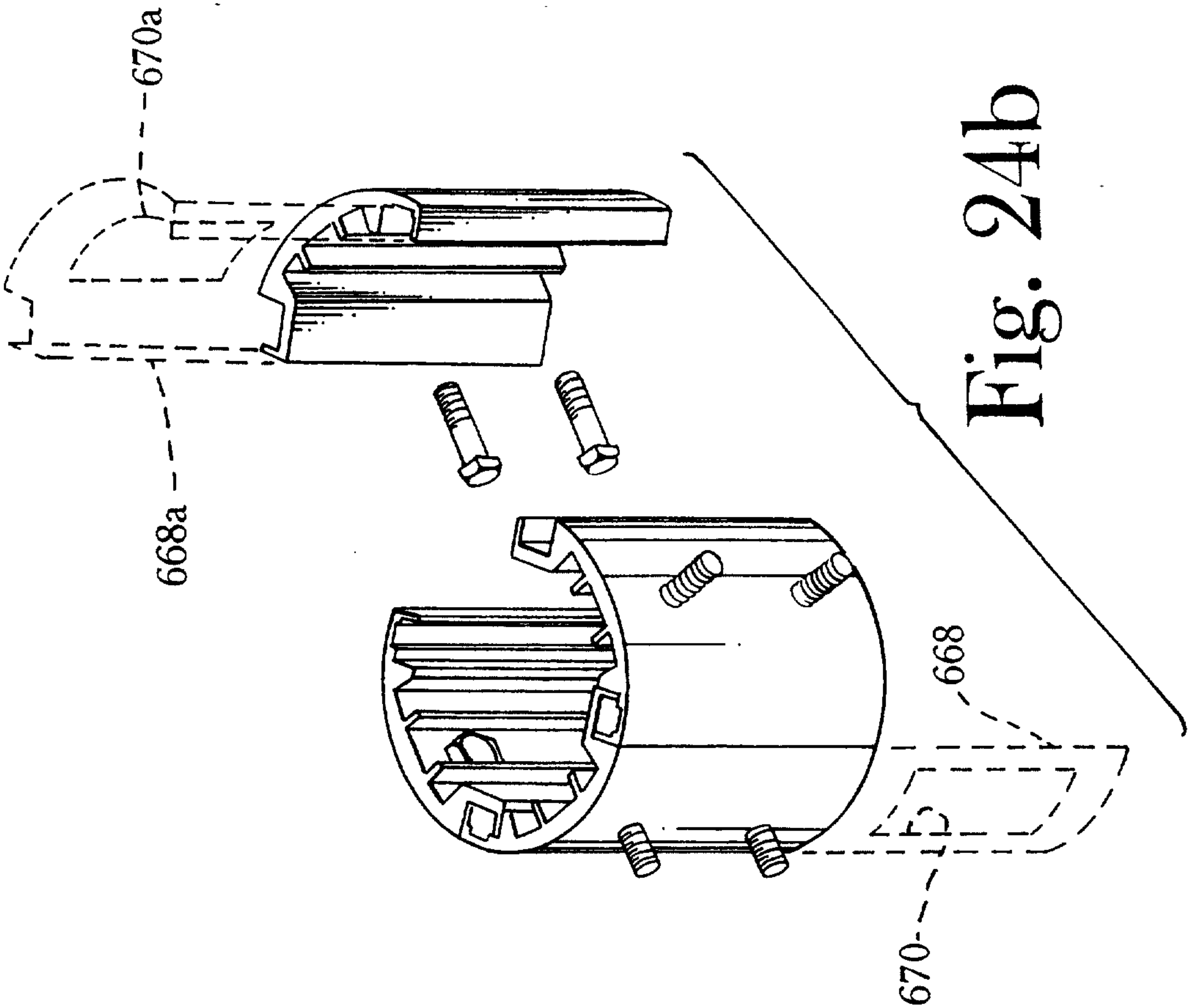


Fig. 24b

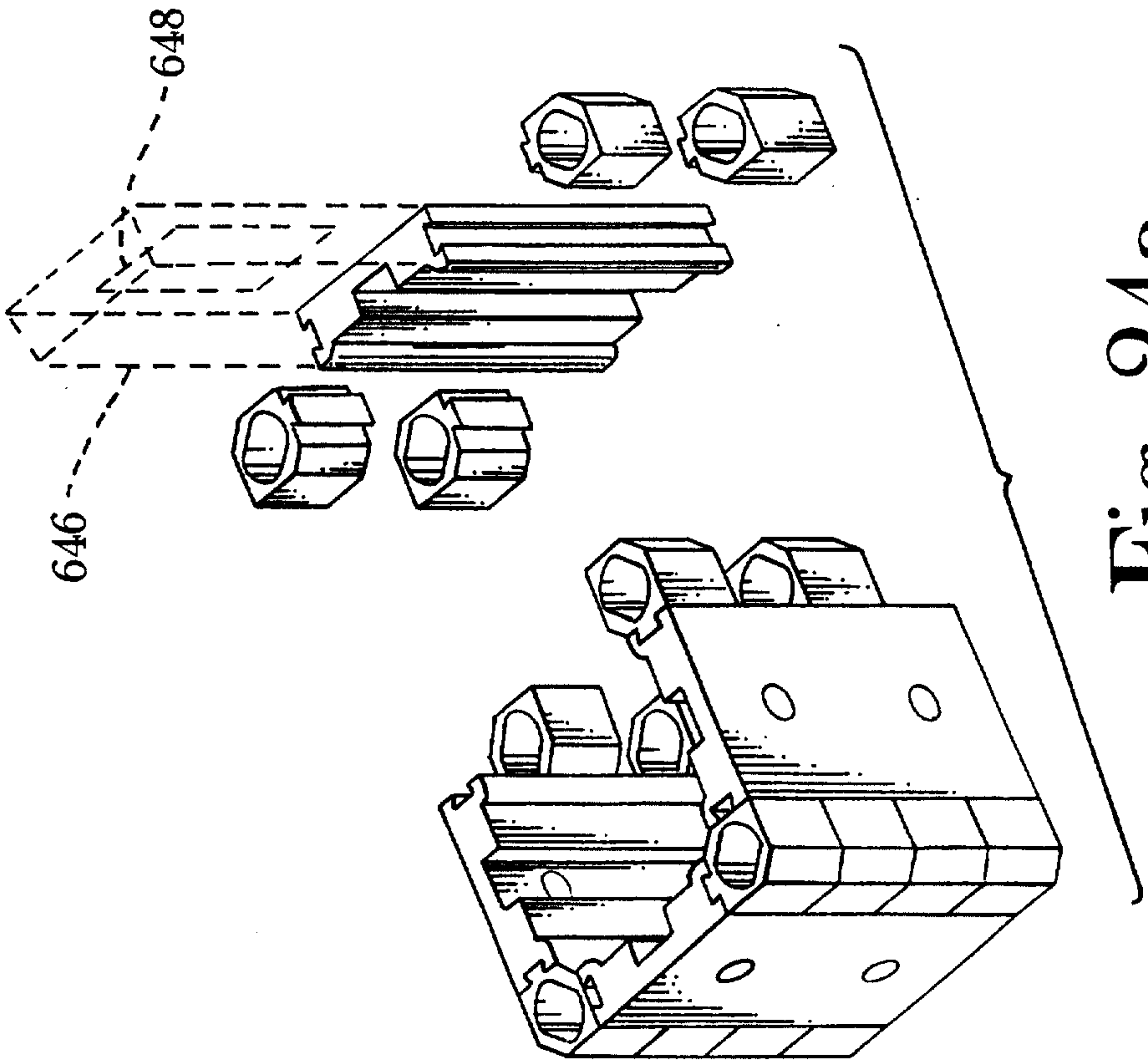


Fig. 24a