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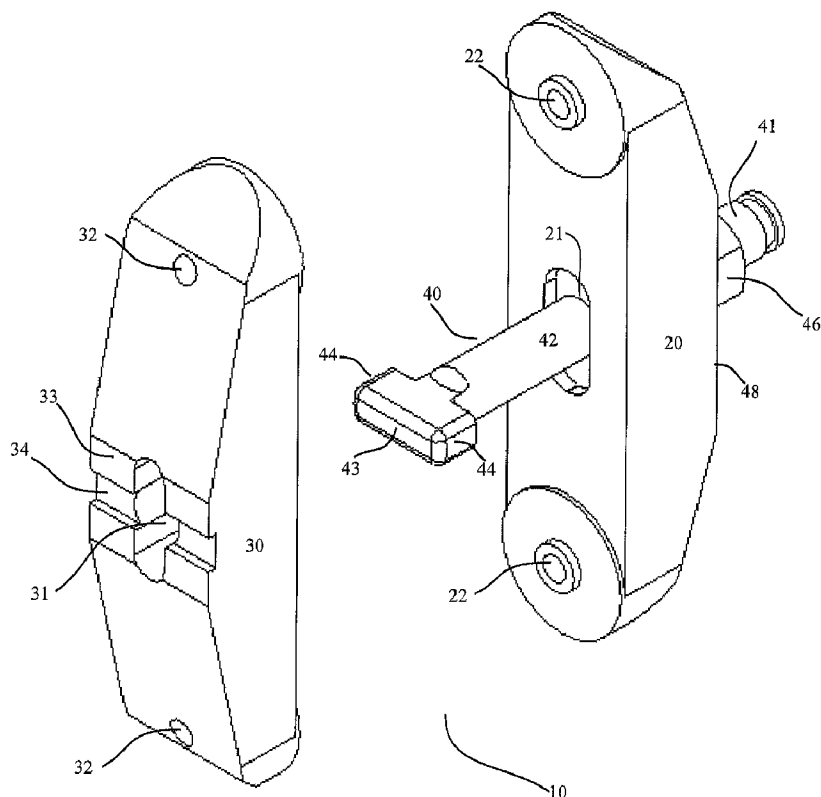
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(54) Titre : APPAREIL DE CONNEXION

(54) Title: CONNECTION APPARATUS



(57) Abrégé/Abstract:

A connection apparatus may be used to connect truss sections or other objects. A connection segment is mounted on each truss to be connected. Each of a first and second connection segment has an opening, in alignment with each other to receive a

(57) **Abrégé(suite)/Abstract(continued):**

fastener. The opening of the first connection segment allows the fastener to pivot. The second connection segment has a side opening which allows the fastener to pivot inside and outside the body of the second connection segment. The fastener has a threaded end and a locking end. The locking end may be secured against an outer surface of the second connection segment. In the locked position the locking end of the fastener engages the outer surface of one the second connection segment and the fastener is prevented from rotational or axial movement. The connection segments are thus fixed relative to each other as are the truss sections on which the connection sections may be mounted.

Abstract

A connection apparatus may be used to connect truss sections or other objects. A connection segment is mounted on each truss to be connected. Each of a first and second connection segment has an opening, in alignment with each other to receive a fastener. The opening of the first connection segment allows the fastener to pivot. The second connection segment has a side opening which allows the fastener to pivot inside and outside the body of the second connection segment. The fastener has a threaded end and a locking end. The locking end may be secured against an outer surface of the second connection segment. In the locked position the locking end of the fastener engages the outer surface of one the second connection segment and the fastener is prevented from rotational or axial movement. The connection segments are thus fixed relative to each other as are the truss sections on which the connection sections may be mounted.

CONNECTION APPARATUS

Field of the Invention

[0001] The present invention generally relates to an apparatus and method for connecting two objects. For example, the apparatus and method may be used to connect objects such as truss sections to provide a single truss structure. Truss structures may be used to support displays, lighting systems, or sound systems for concerts, festivals, trade shows or in theatres. Each time they are used, truss structures are assembled from individual truss sections. Once a concert, festival, or trade show has concluded the truss structures are disassembled and the truss sections are transported to other venues or to storage facilities.

Background of the Invention

[0002] Connection apparatus may be used in a variety of applications and industries. In one application, connection apparatus may be used to interconnect truss sections. Truss sections may be used in a variety of industries, including the entertainment industry, where they are used for the construction of truss structures for mounting lighting, cameras, displays, and speaker systems. Truss structures are commonly used in entertainment (and in particular concert) venues for this purpose.

[0003] Although some means are needed to secure lighting, sound, camera, and display equipment for concerts, not all entertainment venues are equipped with such means. Accordingly, in some cases truss sections are transported to the venue and a truss structure is assembled on site. Because renting of a venue is costly, it is desirable for truss structures to be assembled and disassembled quickly to minimize rental costs. Assembling such a truss structure can be large and complex job.

[0004] Truss structures are typically constructed by placing truss sections adjacent to one another and joining them together using connection apparatus. In order to form a single unitary whole, each truss section comprises means for connecting with other truss assemblies. For example, the connecting means may comprise a set of connection openings that may be aligned as between separate truss sections and through which connection hardware, such as pins or bolts, may be inserted to create firm connection points.

[0005] Truss sections are normally shipped out to venues from a central storage facility or possibly from a number of disparate storage facilities. Connection hardware must be present at the venue in order for the truss sections to be assembled.

[0006] Connection hardware and fasteners are quite small relative to the truss sections and as a result may be stored separately from the truss sections. Alternatively, the disassembler may choose to attach the connection hardware to individual truss sections for storage. However, there is no guarantee that the connection hardware is stored in a consistent manner such that truss sections that are delivered to a site arrive with an appropriate amount of connection hardware. The lack of appropriate connection hardware may lead to delays and increase in the time required to assemble the truss structure.

Brief Description of the Drawings

[0007] The following drawings illustrate examples of the components of the invention disclosed herein, and are for illustrative purposes only. Other embodiments that are substantially similar can use other components that have a different appearance.

[0008] **Figure 1** is an isometric view of an embodiment of the connection apparatus depicting a first connection segment, a bolt with a T-shaped locking end and a second connection segment.

[0009] **Figure 2** is an exploded isometric view of the first connection segment shown in Figure 1 including, a bolt with a T-shaped locking end, washers, a nut and two stoppers.

[0010] **Figure 3** is a schematic of an embodiment of a truss section depicting an end thereof with an attached first connection segment and a second connection segment.

[0011] **Figure 4** is an isometric view of a truss structure depicting two truss sections, each having mounted a first connection segment and a second connection segment and further depicting the first and second connection sections of the truss connection apparatus in a locked position.

[0012] **Figure 5** is an isometric view of the embodiment illustrated in Figure 2, further illustrating a pin retainer O-ring and beam retainer bolts.

[0013] **Figure 6** is an exploded isometric view of a further embodiment of the connection apparatus.

[0014] **Figure 7** is an isometric view of the embodiment in **Figure 6** showing the bolt extending through the first connection segment.

[0015] **Figure 8** is a further isometric view of the embodiment in **Figure 7** showing the nut threaded on the bolt, and the retainer ring on the end of the bolt.

[0016] **Figure 9** is a further isometric view of the embodiment in **Figure 8** showing the bolt extending through the first connection segment and the bolt pivoted on an angle from Axis A.

[0017] **Figure 10** is a further isometric view of the embodiment in **Figure 9** showing the first connection segment and second connection segment in close proximity.

[0018] **Figure 11** is a further isometric view of the embodiment in **Figure 10** showing the bolt positioned parallel to Axis A and the locking end of the bolt being spaced from the outer surface of the second connection segment.

[0019] **Figure 12** is a further isometric view of the embodiment in **Figure 11** showing the locking end of the bolt being engaged with the securing means of the second connection segment.

[0020] **Figure 13** is an isometric view of a first connection segment and a second connection segment of **Figure 6** attached to a truss section.

[0021] **Figure 14** is an isometric view of first connection segment and a second connection segment of **Figure 6** attached to another truss section..

[0022] **Figure 15** is an isometric view of the truss section of **Figure 13** and the truss section of **Figure 14** in close proximity, and the bolts positioned on an angle from Axis A.

[0023] **Figure 16** is a further isometric view of the truss structure in **Figure 15** showing the bolts positioned parallel with Axis A and the locking end of the bolt spaced apart from the outer surface of the second connection segment.

[0024] **Figure 17** is a further isometric view of the truss structure of **Figure 16** showing the locking end of the bolt engaged with the securing means on the outer surface of the second connection segment.

[0025] **Figure 18** is an exploded isometric view of the first connection segment and the rotatable joint of **Figure 6**.

[0026] **Figure 19** is an isometric view of the first connection segment 80 and the rotatable joint 108 of **Figure 6**.

[0027] **Figure 20** is an isometric view of a further embodiment of the connection apparatus depicting a first connection segment, second connection segment, bolt, and nut.

[0028] **Figure 21** is a plan view of the second connection segment of the embodiment shown in **Figure 20**.

[0029] **Figure 22** is a side view of the second connection segment of the embodiment shown in **Figure 21**.

[0030] **Figure 23** is an isometric view of the bolt of the embodiment shown in **Figure 20**.

Detailed Description

[0031] The present invention relates to a connection apparatus and method to allow efficient assembly of structures.

[0032] In an embodiment of the present invention, provided is a connection apparatus that has a first fastener, a threaded end, a locking end opposite the threaded end, and a shaft between the locking end and the threaded end. Also provided is a second fastener adapted to receive the threaded end of the first fastener. Also provided is a first connection segment, the first connection segment has a first opening dimensioned to receive the threaded end and the shaft of the first fastener, the first opening is further adapted to allow the first fastener to pivot radially within the opening between a first position and a second position, whereby the first position is at an angle relative to the second position. Also provided is a second connection segment that has a body. The body has a side opening adapted to receive the shaft of the first fastener and allows the

first fastener to pivot between the first position and the second position. The second connection segment also has an outer surface and a securing means on the outer surface which is adapted to fixably secure the locking end. When the first fastener extends through the first connection segment in the first position and the first and second connection segments are aligned and brought in proximity, the first fastener is aligned with the side opening of the second connection segment and outside the body of the second connection segment. When the first fastener is in the second position, the first fastener is inside the body of the second connection segment. When the second fastener is threaded and tightened to the threaded end of the first fastener and the locking end of the first fastener engages the outer surface of the body of the second connection segment, the first fastener is prevented from rotational or axial movement and the first and second connection segments are fixed relative to each other.

[0033] In another aspect, the first opening of the first connection segment has a rotatable joint, the rotatable joint comprising an opening for receiving the first fastener. When the first fastener is received through the opening of the rotatable joint, the first fastener is pivotable radially between the first position and the second position.

[0034] In a further aspect, the outer surface of the second connection segment has a securing means. When the second fastener is threaded and tightened to the threaded end of the first fastener and the locking end of the first fastener engages the securing means, the first fastener is prevented from rotational or axial movement and the first and second connection segments are fixed relative to each other.

[0035] In yet a further aspect, the securing means has a cavity corresponding in shape to the locking end of the first fastener.

[0036] In another aspect, the first fastener is a bolt and the second fastener is a nut.

[0037] In a further aspect, the threaded end of the first connection segment has a stopper. The stopper is wider than the inner diameter of the second fastener wherein the second fastener is prevented from removal from the first fastener.

[0038] In yet a further aspect, the stopper is a retainer ring and wherein the threaded end of the first fastener further comprises a channel for receiving the retainer ring.

[0039] In another aspect, the locking end of the first fastener is dimensioned such that it is prevented from passing through the first opening of the first connection segment.

[0040] In a further aspect, the connection apparatus interconnects a first object and a second object. The first connection segment is integral with the first object, and the second connection segment is integral with the second object.

[0041] In yet a further aspect, the first object is a first truss section and the second object is a second truss section.

[0042] In an embodiment of the present invention, a truss section is provided with at least one first connection segment for connection to a corresponding second connection segment on a second truss section. Each of the at least one first connection segments comprises an aperture dimensioned to receive therethrough the threaded end and the shaft of a first fastener. The aperture is adapted to allow the first fastener to pivot radially within the aperture between a first position and a second position. The first position is at an angle relative to the second position. The corresponding second connection segment comprises a body, comprising a side opening adapted to receive the shaft of the first fastener and further adapted to allow the first fastener to pivot between the first position and the second position, and an outer surface comprising a securing means adapted to fixably secure the locking end of the first fastener. When the first fastener extends through the aperture of the first connection segment in the first position and the first and second connection segments are aligned and brought in proximity, the first fastener is aligned with the side opening of the second connection segment and outside the body of the second connection segment. When the first fastener is in the second position inside the side opening, the first fastener is inside the body of the second connection segment. When the second fastener is tightened to the threaded end of the first fastener and the locking end of the first fastener engages the outer surface of the body of the second connection segment, the first fastener is prevented from rotational or axial movement and the first and second connection segments are fixed relative to each other.

[0043] In a further aspect, the aperture of the first connection segment of the truss section further comprises a rotatable joint which is rotatably fixed to the first connection segment, the rotatable joint comprising an aperture for receiving the first fastener. When the first fastener is received

through the aperture of the rotatable joint, the first fastener is pivotable radially between the first position and the second position.

[0044] In yet a further aspect, the outer surface of the corresponding second connection segment comprises a securing means. When the second fastener is threaded and tightened to the threaded end of the first fastener and the locking end of the first fastener engages the securing means, the first fastener is prevented from rotational or axial movement and the first and second connection segments are fixed relative to each other.

[0045] In another aspect, the securing means comprises a cavity substantially corresponding in shape to the locking end of the first fastener.

[0046] In yet another aspect, the locking end of the first fastener is dimensioned such that it is prevented from passing through the aperture of the first connection segment.

[0047] While the present invention is described below primarily in relation truss sections and truss structures, it will be apparent to one of ordinary skill in the art that the present invention may be used to interconnect other objects and structures.

[0048] Reference will now be made to **Figure 1**, which provides an isometric view of an embodiment of the connection apparatus **10** of the present invention.

[0049] The connection apparatus **10** comprises a first connection segment **20** and a second connection segment **30** and a bolt **40**. The first connection segment **20** is adapted so that it can be securely attached to a first truss section (not shown in **Figure 1**) and similarly, the second connection segment **30** is adapted so that it can be attached to a second truss section (not shown in **Figure 1**). The first and second connection segments **20** and **30** can be attached to truss sections through a variety of means such as through welding, bolting, or fastening. Also, first and second connection segments **20** and **30** can be integral with a truss section. In the present embodiment, the first and second connection segments **20** and **30** are each equipped with two truss attachment holes **22** and **32**, which correspond to holes in the truss (item **55** in **Figure 3**) and are adapted to receive a bolt (not shown in **Figure 1**) for attachment to the respective trusses.

[0050] The first connection segment **20** and second connection segment **30** can be securely connected together using bolt **40**. Bolt **40** has a threaded end **41**, a shaft **42** and a locking end **43**. In the embodiment of **Figure 1** the locking end **43** is depicted as a T-shaped portion comprising a pair of protrusions **44** extending radially outwards from the shaft **42**. The locking end **43** need not be configured as a T-shape and may be configured in other shapes suitable for locking an adjacent truss section. The locking end is provided with at least one protrusion from the shaft such that it can be received by and run through an opening in a second connection segment, for example borehole **31**, while bolt **40** is in a first orientation. When the bolt **40** is rotated to a second orientation, it is “locked” in that it can no longer be received by or run through borehole **31**. Moreover, the protrusions **44** are adapted to slot into a securing means **34** such that the bolt **40** may not be rotated when the locking end **43** is slotted into said securing means **34**. Once slotted, the threaded nut **46** may be tightened to secure bolt **40** in place so as to not allow movement along the bolt’s axis. The first and second connection segments (**20** and **30**) are thus locked in place relative to one another until the nut **46** is loosened.

[0051] The first connection segment **20** has an opening, for example borehole **21**, dimensioned to receive the shaft **42** of the bolt **40**. In the embodiment of **Figure 1**, the borehole **21** is dimensioned such that the locking end **43** with protrusions **44** cannot pass through the borehole **21**, thus maintaining one end of the bolt **40** in the borehole **21** as long as nut **46** is on the threaded end **41**. The dimensions of borehole **21** can be more clearly seen in **Figure 2** and are further described below.

[0052] Also depicted in **Figure 1** is the second connection segment **30** which has a borehole **31** dimensioned to receive the shaft **42** of the bolt **40**. The borehole **31** must also be dimensioned to allow the locking end **43** to pass through the borehole **31** in a first orientation but prevent it from passing through when the bolt **40** is rotated to another orientation. The second connection segment **30** has an outer surface **33** comprising a securing means **34**. In the embodiment depicted in **Figure 1**, securing means **34** is shaped as a linear slot and adapted to receive protrusions **44** of locking end **43** of bolt **40**. Other shapes and dimensions may be provided as a means of securing the locking end **43** of bolt **40**. Shaft **42** of bolt **40** must be of a sufficient length to, at least, allow the locking end **43** to pass through borehole **31** to the outer surface **33** for interaction with securing means **34** while allowing the threaded end **41** to protrude from borehole **21** on the outer

surface 48 of the first connection segment 20 such that the nut 46 may be threaded but not tightened. When the locking end 43 of the bolt 40 passes through borehole 31, it can be rotated to an orientation where the pair of protrusions 44 prevent it from being able to pass back through the borehole 31. **Figure 1** shows bolt 40 rotated to an orientation whereby locking end 43 is not be able to be received by borehole 31.

[0053] In the embodiment of **Figure 1** the securing means 34 takes the form of a linear slot. The slot 34 corresponds with the shape of the pair of protrusions 44 such that the protrusions 44 fit into the slot 34 as the nut 46 is tightened onto the threaded end 46 of the bolt 40 and the bolt 40 is prevented from rotating to the first orientation by the edges of the slot 34 interacting with the protrusions 44 on the locking end 43. Thus, once the nut 46 is tightened and the protrusions 44 are engaged with the securing means 34, the bolt 40 remains in place to secure the truss sections. The slot 34 depicted in **Figure 1** is one embodiment of a securing means and embodiments of different shapes or sizes would perform similarly. Such other embodiments could include a pair of protrusions extending outwards from the outer surface 33 in a manner that allows them to secure the locking end 43 and prevent it from rotating.

[0054] In an alternate embodiment from that depicted in **Figure 1**, the borehole in the first connection segment may be dimensioned to receive not only the shaft of the bolt but also the locking end. In this embodiment the bolt is not securely maintained within the opening in the first connection segment even when a nut is secured onto the threaded end. While this embodiment does not provide the advantage of maintaining the connection hardware within the first connection segment for ease of storage, it has the alternative advantage that the first connection segment and the second connection segment may be identical and thus used interchangeably. There would be fewer parts to manufacture and assembly may be simplified as there would be no need to align a first connection segment with a complementary second connection segment if they may both be used with either the locking end or the threaded end of a fastener.

[0055] In a further embodiment, the opening in either the first or second connection segment can be equipped with a gasket. During operation, when the bolt is disposed within the opening, the gasket abuts the surface of the shaft of the bolt. In one embodiment, the gasket may be a rubber or

plastic O-ring. The gasket operates to fill the space between the opening and the bolt, creating friction that resists rotational or axial movement of the bolt. This prevents the bolt fastener from sliding freely within the first opening and provides for more controlled operation and a more secure connection between truss sections.

[0056] **Figure 2** is an isometric exploded view providing more detail of the parts of the first connection segment **20**. **Figure 2** shows bolt **40** prior to insertion into borehole **21**. In this embodiment, the inside of borehole **21** comprises a ridge **23** for receiving a retaining means, such as an O-ring (which is shown in **Figure 5** and labelled “Pin retainer O ring”). This retaining means may be used to limit the amount that the bolt **40** slides within the borehole **21** and may help in reduce the likelihood of the bolt **40** inadvertently sliding out of the borehole **21** during assembly or disassembly of a truss structure, or while the various truss components are in transit. In this embodiment, the threaded end **42** will fit into borehole **21** but the protrusions **44** of locking end **43** prevent it from passing the whole way through. Once the threaded end **42** is received by borehole **21**, the washers **45**, nut **46** and stopper **47** can be secured to the threaded end **42** thus securing bolt **40** within borehole **21** such that bolt **40** can slide the length of shaft **41** within borehole **21** but is retained by the protrusions **44** at locking end **43** and nut **46** and stopper **47** at threaded end **42**.

[0057] **Figure 2** shows bolt **40** rotated to an orientation whereby locking end **43** would be able to be received by borehole **31** as shown in **Figure 1**.

[0058] The threaded end **41** of bolt **40** may comprise a stopper **47** (depicted in **Figure 2**). Stopper **47** can prevent the bolt **40** from sliding out from the borehole **21**, or the nut **46** from sliding off of the bolt **40** if unthreaded. The skilled person will appreciate that providing a stopper **47** provides at least the advantage of having the bolt **40** and all the connection hardware (nut, washers, etc.) securely captured by the first connection segment **20** such that it is less likely to get lost during assembly/disassembly, transit, or storage. In the embodiment depicted in **Figure 2**, stopper **47** comprises a pair of O-rings which may be fitted on the threaded end **41** of bolt **40**. In this embodiment, a retaining ridge **48** is provided for holding the O-rings **47** in place.

[0059] In certain circumstances, it may be preferable to allow bolt **40** to be removed from the first connection segment **20**. This can be achieved by omitting the stopper **47** or providing a

removable stopper **47** from the threaded end **41**, thus allowing the nut **46** to be removed from the bolt, and the bolt **40** to be removed from the borehole **21**. This can also be achieved through a different configuration of the borehole **21** in the first connection segment **20** whereby it is dimensioned to allow the locking end **43** to pass through the borehole **21** in one orientation but prevent locking end **46** from passing through when the bolt **40** is rotated to another orientation.

[0060] **Figure 3** shows the end portion of truss section **50** with a first connection segment **20** and second connection segment **30** attached. Truss section **50** is made from four tubes **51** connected at each end by four end beams **52** to form a rectangular prism shape. The embodiment shown in **Figure 3** has diagonal braces **53** to provide additional rigidity. Truss sections come in many shapes and sizes. The truss connection apparatus of the present invention can be adapted to connect truss sections of various different shaped tubes and beams to achieve a truss structure of the desired shape and strength depending on the specific application.

[0061] As depicted in **Figure 3**, the end of truss section **50** is equipped with four attachment plates **54**. Each attachment plate **54** has a hole **55** to allow for first or second connection segments **20** and **30** to be attached to the truss section **50**. Holes **55** are positioned and dimensioned to correspond with the respective truss attachment holes **22** and **32** of the first and second connection segments **20** and **30**.

[0062] **Figure 4** depicts truss section **50** attached to a second truss section **60**. Second truss section **60** has similar structure as truss section **50** but is equipped with first and second connection segments **20** and **30** in a way that correspond with the first and second connection segments **20** and **30** of truss section **50**. In particular, the first connection segment **20** attached to truss section **50** should be aligned with the second connection segment **30** of truss section **60** such that the borehole **21** of first connection segment **20** aligns with the borehole **31** of second connection segment **30**. The first connection segment **20** of truss section **60** is similarly aligned with its counterpart, second connection segment **30** of truss section **50**. When assembling a truss structure, the ends of truss section **50** and second truss section **60** are brought together and abut against each other creating a close fit.

[0063] The truss sections depicted in **Figures 3 and 4** are but one example and the ends of the truss sections can be adapted in many different ways to allow truss sections to abut or interlock.

[0064] To assemble a truss structure using the truss connection apparatus, the following method may be used. If a first connection segment **20** does not already have a bolt **40** passing through borehole **21**, the threaded end **41** of bolt **40** is passed through borehole **21** of first connection segment **20**. Washers **45**, nut **46**, and O-rings **47** are then secured to the end of bolt **40**.

[0065] The first truss connection segment **20** is attached to a truss section **50** while a second connection segment **30** is secured to a second truss section **60**. If the first and second connection segments (**20** and **30**) are integral with said truss sections, then this step is not needed. The ends of truss section **50** and second truss section **60** are then brought together such that the ends of the truss sections abut one another, and such that the borehole **21** of first connection segment **20** and borehole **31** of second connection segment **30** are aligned. The locking end **43** of bolt **40** of the first connection segment **20** can be inserted through the borehole **31** of the second connection segment **30**. The bolt **40** must be inserted such that the protrusions **44** extend past the outer surface **33** of second connection segment **30**, such that bolt **40** may be rotated. Bolt **40** can then be rotated to an orientation whereby its locking end **43** cannot be received by borehole **31**. As nut **46** is tightened, bolt **40** is put into tension and the protrusions **44** of locking end **43** are drawn into slot **34** to prevent rotation of bolt **40** back to an orientation whereby it can be received by borehole **31**. As nut **46** is tightened to an appropriate torque on each bolt **40**, it creates a secure connection between the respective first and second connection segments **20** and **30**, which in turn creates a secure connection between truss section **50** and second truss section **60**.

[0066] Truss sections can be shaped and dimensioned differently. The number and placement of truss connection apparatus **10** required to create an appropriate connection will vary based on a number of factors including the type, shape dimension, material and weight of the truss section, the loads that will be applied to the truss, the interface between trusses being connected and the overall geometry of the truss structure being assembled.

[0067] **Figures 6-19** illustrate a further embodiment of truss connection apparatus **70**.

[0068] **Figure 6** illustrates an exploded view of truss connection apparatus **70**. The apparatus comprises a first truss connection segment **80**, a second truss connection segment **90**, and a first fastener **100**. In this embodiment, the first fastener is a bolt. The first connection segment **80** is adapted so that it can be securely attached to a first truss section (not shown in **Figure 6**) and

similarly, the second connection segment **90** is adapted so that it can be attached to a second truss section (not shown in **Figure 6**). The first and second connection segments **80** and **90** can be attached to truss sections through a variety of means such as through welding, bolting, or fastening. In this embodiment, the first and second connection segments **80** and **90** are each respectively equipped with two truss attachment holes **82** and **92**, which correspond to holes in the truss (items **131** and **132** in **Figures 13** and **14**) and are adapted to receive a screw **84**. Screws **84** secure the first and second connection segments **80** and **90** to respective trusses. Also, first and second connection segments **80** and **90** can be integral with a truss section (not depicted).

[0069] The first connection segment **80** and second connection segment **90** can be securely connected using bolt **100**. Bolt **100** has a threaded end **101**, a shaft **102** and a locking end **103**. In the embodiment of **Figure 6** the locking end **103** is depicted as an oblong shaped flanged portion extending radially outwards from the shaft **102**. The locking end **103** need not be configured as an oblong shaped flange and may be configured in other shapes suitable for locking an adjacent truss section.

[0070] The oblong shaped flange portion of the locking end **103** is adapted to slot into a securing means **94** such that the bolt **100** is restricted from movement when the locking end **103** is slotted into said securing means **94** to restrict the bolt from rotational movement. Once slotted, a threaded nut **106** may be tightened to secure bolt **100** in place so as to restrict movement along the bolt's axis (**Axis A**). The first and second connection segments (**80** and **90**) are thus locked in place relative to one another until the nut **106** is loosened.

[0071] The first connection segment **80** has a borehole **81**, dimensioned to receive the threaded end of the shaft **102** of the bolt **100**. In the embodiment of **Figure 6**, the borehole **81** is dimensioned such that the locking end **103** cannot pass through the borehole **81**.

[0072] The nut **104** is also dimensioned such that it cannot pass through the borehole **81**. Thus, when the shaft **102** of bolt **100** is passed through the borehole **81**, and the nut **106** is threaded to the threaded end **101** of the bolt **100**, the bolt **100** is captured by the borehole **81** and may not be separated from the first connection segment **80** unless the nut **106** is taken off of the bolt **100**.

Those skilled in the art will appreciate that the use of a threaded shaft and a threaded nut is one means for securing a first fastener to a second fastener, and that other means may also be used.

[0073] Also depicted in **Figure 6** is the second connection segment **90** which has a side opening **91**. The width of the side opening **91** is dimensioned to receive the shaft **102** of the bolt **100**. The diameter of the locking end **103** is wider than the width of the side opening **91**, thus preventing the locking end **103** from passing through the side opening **91** in a direction shown as **Axis A** in **Figure 6**. The side opening **91** is preferably dimensioned to closely fit around the shaft **102**. The second connection segment **90** has an outer surface **93** comprising a securing means **94**. In the embodiment depicted in **Figure 6**, securing means **94** is shaped as an oblong depression on the surface of the second connection segment **90** and is adapted to receive locking end **103** of bolt **100**. Other shapes and dimensions may be provided as a means of securing the locking end **103** of bolt **100**. Other means may also be provided to secure the locking end **103** to the first connection segment **90**.

[0074] Shaft **102** is of a sufficient length to allow, when the apparatus is assembled, the locking end **103** to protrude from side opening **91** past the outer surface **93** for interaction with securing means **94** while allowing the threaded end **101** to protrude from borehole **81** on the outer edge of the first connection segment **80**. When the shaft **102** is placed in the side opening **91** the locking end **103** prevents the bolt **100** from being able to pass back through the borehole side opening **91** in a direction perpendicular to the side opening **91**.

[0075] In the embodiment of **Figure 6** the securing means **94** takes the form of an oblong depression in the outer surface **93** of the second connection segment **90**. The oblong depression generally corresponds with the shape of the locking end **103** such that it fits into the oblong depression **94** as the nut **104** is tightened onto the threaded end **101** of the bolt **100**. When the nut **104** is tightened, the bolt **40** is prevented from movement because of the edges of the oblong depression **94** interacting with the locking end **43**. Thus, once the nut **104** is tightened and the locking end **103** is engaged with the securing means **94**, the bolt **100** remains fixed in place relative to the first connection segment **80** and the second connection segment **90**. The securing means **94** depicted in **Figure 6** is one embodiment of a securing means and embodiments of different shapes or sizes would perform similarly.

[0076] The embodiment illustrated in **Figure 6** also comprises a rotatable joint **108**. First connection segment **80** comprises an opening **89** on the outer surface **88**. The opening **89** is dimensioned to receive the rotatable joint **108** in a close fitting fashion. The rotatable joint **108** comprises pinholes **109** on an upper and a lower surface of the rotatable joint **108**. The first connection segment **80** also comprises pinholes **83** which may be aligned with the pinholes **109** of the rotatable joint **108**. When the rotatable joint **108** is fitted into opening **89** and the pinholes **83** are aligned with pinholes **109**, pins **107** may be inserted through both pinholes in both the rotatable joint **108** and the first connection segment **80** to secure the rotatable joint **108** to the first connection segment **80**. When secured, the rotatable joint **108** is only permitted to rotate about pins **107** but is otherwise restricted from movement relative to the first connection segment **80**. **Figures 18** and **19** are two additional perspective views of first connection segment **80** and rotatable joint **108**. In **Figure 18**, the outer surface **88** and opening **89** of first connection segment **80** are shown. A notch **85** may be provided to allow a tool (such as a screwdriver or the like) to lever the rotatable joint **108** out of the opening **89**. **Figure 19** illustrates how the rotatable joint **108** fits into opening **89**.

[0077] The rotatable joint **108** comprises a borehole **110** which is dimensioned to receive the threaded end **101** of bolt **100**. When the bolt **100** is in the borehole **110**, the bolt **100** is restricted to axial movement within the borehole **110**.

[0078] Washers **106** may be provided to prevent damage to the surface of the first connection segment **80** when the nut **104** is tightened on the bolt **100**. Moreover, washers **106** are also used to distribute the clamping force of the nut across the rotatable joint **108**. The washers **106** also acts as a bearing surface for the nut to minimize binding when the nut **104** is being tightened to bolt **100**.

[0079] Retainer ring **105** may be provided to prevent the nut **104** from being completely unthreaded from the bolt **100**. The retainer ring **105** is fixed to the bolt **100** after the nut **104** has been threaded. The retainer ring **105** prevents the nut from being removed from the bolt unless the retainer ring **105** is first removed.

[0080] **Figures 7-12** are further isometric views of the embodiment in **Figure 6**. **Figures 7-9** illustrate how the bolt **100** is secured to first connection segment **108**. In **Figure 7**, rotatable joint

108 is received in opening **89** of first connection segment **80**. The borehole **110** of the rotatable joint **108** is aligned with the borehole **81** of first connection segment **80**. Pins **107** rotatably fix the rotatable joint **108** to the first connection segment **80** (not shown). Bolt **100** is received through both borehole **81** of the first connection segment **80** and the borehole **110** of the rotatable joint. In this drawing, washers **106** are slidably fitted to the threaded end **102** of bolt **100**.

[0081] In **Figure 8**, the nut **104** is threaded to the threaded end **101** of bolt **100**. The retainer ring **105** has an opening on one side which allows it to be snap-fit to the end of bolt **100**. The retainer ring **105** comprises teeth which forms an inner circumference. The inner circumference of the retainer ring is somewhat less than the circumference of the shaft **102** of bolt **100**. Bolt **100** comprises a ridge **112**. The retainer ring **105** is somewhat flexible. When the opening of the retainer ring **105** is placed adjacent to the ridge **112** of bolt **100**, force may be applied to snap-fit the retainer ring **105** to bolt **100**. The retainer ring **105** prevents the nut from being separated from the assembly when it is unthreaded from the threaded portion of bolt **100**. Other means for preventing the nut from being separated may also be provided.

[0082] **Figure 9** illustrates how bolt **100** may swivel while it is captured in first connection segment **80**.

[0083] **Figures 10-12** illustrate how the various parts of the embodiment shown in **Figure 6** are assembled. When a first connection segment **80** and second connection segment **90** are brought together for assembly (**Figure 10**), bolt **100** may be pivoted away from the longitudinal **Axis A** (shown in **Figure 6**). Bolt **100** is able to pivot due to the dimensions of borehole **81**, which is preferably pie-shaped to allow one end of the borehole **81** to act as a pivot point.

[0084] Once the first connection segment **80** and second connection segment **90** are in close proximity, bolt **100** may swivel towards and be parallel to longitudinal **Axis A** (see **Figure 11**). Once the bolt **100** is parallel to longitudinal **Axis A**, nut **104** may be tightened onto bolt **100** such that the locking end **103** of bolt **100** engages the securing means **94** of second connection segment **90** (see **Figure 12**).

[0085] **Figures 13-17** illustrate how the embodiment shown in **Figure 6** is used to interconnect a pair of truss sections **130**.

[0086] **Figure 13** illustrates a first end of a truss section **130** which is provided with a first connection segment **80** and a second connection segment **90**. In this embodiment, truss section **130** is provided with four assembly attachment holes **131** and **132** for receiving bolts **84**. A pair of assembly attachment holes are provided for each connection segment. To attach a first connection segment, the truss attachment holes **82** are aligned with the assembly attachment holes **131** and bolts **84** are passed through both truss attachment holes **82** and assembly attachment holes **131**. The second connection segment is attached in the same way by passing bolts **84** through assembly attachment holes **132** and truss attachment holes **92**. Other means may be used to attach the connection segments to a truss section **130**. In another embodiment, connection segments may be integral with the truss section **130**, or may be built into the body of truss section **130**.

[0087] When the assembly is not in use, the nut **104** may be tightened to bolt **100** such that the bolt **100** is restricted from movement, such as shown in **Figure 13**. This prevents the bolt **100** from movement while the truss segment is being moved or transported. The bolt **100** and nut **104** may be transported with the truss section **130** so that there is no separate requirement to transport or locate parts to assemble the truss segments once they have been moved or transported. In this way, all the equipment needed to assemble the truss is transported with the truss segments.

[0088] **Figure 14** illustrates a second end of a truss section **130** which is provided with a first connection segment **80** and a second connection segment **90**. To assemble a truss structure, truss section **130** are attached end to end. A first connection segment **80** of a first truss section **130** is aligned with a second connection segment **90** of a second truss section **130**. Similarly, a second connection segment **90** of a first truss section **130** is aligned with a first connection segment **80** of a second truss section **130**.

[0089] **Figure 15** illustrates a pair of truss sections **130** which are each provided with the connection segments illustrated in **Figure 6**. In this embodiment, two pairs of the assembly are provided. Before the truss segments are brought together, nut **104** is sufficiently loosened to allow bolt **100** to swivel to a position diagonal to the length of the truss segment (shown in **Figure 15**) and away from opening **91** of the second connection segment **90**. The adjacent truss sections **130** are positioned end to end and the connection segments of a first truss section **130**

are aligned with their counterpart connection segments on a second truss section **130**. In **Figure 16**, bolts **100** are swivelled into opening **91** of the respective second connection segments **90** such that bolts **100** are aligned through opening **91** of second connection segment **90** and borehole **81** of first connection segment **80**. Once the bolt **100** is aligned, nut **104** is tightened to secure locking end **103** of bolt **100** to the securing means **94** of the second connection segment **90** (see **Figure 17**). The edges of the locking end **103** engage the walls of the oblong depression of the securing means **94** to prevent the bolt from rotating, particularly as the nut **104** is being tightened to the bolt **100**.

[0090] **Figures 20-23** illustrate a further embodiment of the present invention, comprising a first connection segment **220**, a second connection segment **230**, a first fastener **240** (for example, a bolt) and a second fastener **250** (for example, a nut).

[0091] In this embodiment, second connection segment **230** comprises a hexagonal-shaped indentation **235** on the outer surface along the outer edge of opening **231**. The profile of the opening **231** (shown in **Figure 21**, a plan view of the second connection segment **230**) is also hexagonal-shaped. In this embodiment, bolt **240** comprises a locking end **243**, a shaft **242**, and a threaded end **241** (threads not shown). The locking end **243** comprises an oblong shaped flange portion. Although depicted as oblong shape, the flange portion may be any suitable shape for ease of handling the bolt **240** provided that it is wider than the diameter of the openings in both the first and second connection segments.

[0092] The bolt **240** further comprises a hexagonal-shaped projection **244** (illustrated in **Figure 23**) on the underside of the oblong shaped flange portion. In this embodiment, the hexagonal-shaped projection **244** of the bolt **240** mates with the hexagonal-shaped indentation **235** of the second connection segment **230**. When the edges of the projections **244** engages the edges of indentations **235**, the bolt **240** is prevented from rotational movement relative to the second connection segment **230**.

[0093] Although embodiments of the present invention have been described above and are illustrated in the accompanying drawings in order to be more clearly understood, the above description is made by way of example and is not meant to limit the scope of the present invention. It is contemplated that various modifications apparent to one of ordinary skill in the

art could be made without departing from the scope of the invention which is to be determined by the following claims.

1. A connection apparatus comprising:

an elongated first fastener comprising:

a threaded end;

a locking end opposite the threaded end; and

a shaft between the locking end and the threaded end;

a second fastener adapted to receive the threaded end of the first fastener;

a first connection segment, the first connection segment comprising

an aperture dimensioned to receive therethrough the threaded end and the shaft of the first fastener, the aperture is further adapted to allow the first fastener to pivot radially within the aperture between a first position and a second position, whereby the first position is at an angle relative to the second position;

a second connection segment, the second connection segment comprising

a body, comprising

a side opening adapted to receive the shaft of the first fastener and further adapted to allow the first fastener to pivot between the first position and the second position;

an outer surface comprising a securing means adapted to fixably secure the locking end of the first fastener;

whereby when the first fastener extends through the aperture of the first connection segment in the first position and the first and second connection segments are aligned and brought in proximity, the first fastener is aligned with the side opening of the second connection segment and outside the body of the second connection segment;

whereby when the first fastener is in the second position inside the side opening, the first fastener is inside the body of the second connection segment; and

whereby when the second fastener is tightened to the threaded end of the first fastener and the locking end of the first fastener engages the outer surface of the body of the second connection segment, the first fastener is prevented from rotational or axial movement and the first and second connection segments are fixed relative to each other.

2. The connection apparatus of claim 1, wherein the aperture of the first connection segment further comprises a rotatable joint which is rotatably fixed to the first connection segment, the rotatable joint comprising an aperture for receiving the first fastener, wherein when the first fastener is received through the aperture of the rotatable joint, the first fastener is pivotable radially between the first position and the second position.
3. The connection apparatus of claim 1, wherein the outer surface of the second connection segment comprises a securing means, whereby when the second fastener is threaded and tightened to the threaded end of the first fastener and the locking end of the first fastener engages the securing means, the first fastener is prevented from rotational or axial movement and the first and second connection segments are fixed relative to each other.
4. The connection apparatus of claim 3 wherein the securing means comprises a cavity substantially corresponding in shape to the locking end of the first fastener.
5. The connection apparatus of claim 4 wherein the first fastener is a bolt and the second fastener is a nut.
6. The connection apparatus of claim 4 wherein the threaded end of the first connection segment further comprises a stopper, wherein the stopper is wider than the inner diameter of the second fastener whereby the second fastener is prevented from removal from the first fastener.
7. The connection apparatus of claim 4, wherein the connection apparatus interconnects a first object and a second object, wherein first connection segment is integral with the first object, and the second connection segment is integral with the second object.
8. The connection apparatus of claim 4, wherein the locking end of the first fastener is dimensioned such that it is prevented from passing through the aperture of the first connection segment.

9. The connection apparatus of claim 1 wherein the first fastener is a bolt and the second fastener is a nut.
10. The connection apparatus of claim 1 wherein the threaded end of the first connection segment further comprises a stopper, wherein the stopper is wider than the inner diameter of the second fastener whereby the second fastener is prevented from removal from the first fastener.
11. The connection apparatus of claim 10 wherein the stopper is a retainer ring and wherein the threaded end of the first fastener further comprises a channel for receiving the retainer ring.
12. The connection apparatus of claim 1, wherein the locking end of the first fastener is dimensioned such that it is prevented from passing through the aperture of the first connection segment.
13. The connection apparatus of claim 1, wherein the connection apparatus interconnects a first object and a second object, wherein first connection segment is integral with the first object, and the second connection segment is integral with the second object.
14. The connection apparatus of claim 13, wherein the first object is a first truss section, and the second object is a second truss section.
15. A truss section, comprising:
 - at least one first connection segment for connection to a corresponding second connection segment on a second truss section, each of the at least one first connection segments comprising an aperture dimensioned to receive therethrough the threaded end and the shaft of a first fastener, the aperture is further adapted to allow the first fastener to pivot radially within the aperture between a first position and a second position, whereby the first position is at an angle relative to the second position;
 - wherein the corresponding second connection segment comprises a body, comprising a side opening adapted to receive the shaft of the first fastener and further adapted to allow the first fastener to pivot between the first position and the second position, and an outer surface comprising a securing means adapted to fixably secure the locking end of the first fastener;

whereby when the first fastener extends through the aperture of the first connection segment in the first position and the first and second connection segments are aligned and brought in proximity, the first fastener is aligned with the side opening of the second connection segment and outside the body of the second connection segment;

whereby when the first fastener is in the second position inside the side opening, the first fastener is inside the body of the second connection segment; and

whereby when the second fastener is tightened to the threaded end of the first fastener and the locking end of the first fastener engages the outer surface of the body of the second connection segment, the first fastener is prevented from rotational or axial movement and the first and second connection segments are fixed relative to each other.

16. The truss section of claim 15, wherein the aperture of the first connection segment further comprises a rotatable joint which is rotatably fixed to the first connection segment, the rotatable joint comprising an aperture for receiving the first fastener, wherein when the first fastener is received through the aperture of the rotatable joint, the first fastener is pivotable radially between the first position and the second position.

17. The truss section of claim 15, wherein the outer surface of the second connection segment comprises a securing means, whereby when the second fastener is threaded and tightened to the threaded end of the first fastener and the locking end of the first fastener engages the securing means, the first fastener is prevented from rotational or axial movement and the first and second connection segments are fixed relative to each other.

18. The truss section of claim 17 wherein the securing means comprises a cavity substantially corresponding in shape to the locking end of the first fastener.

19. The truss section of claim 15, wherein the locking end of the first fastener is dimensioned such that it is prevented from passing through the aperture of the first connection segment.

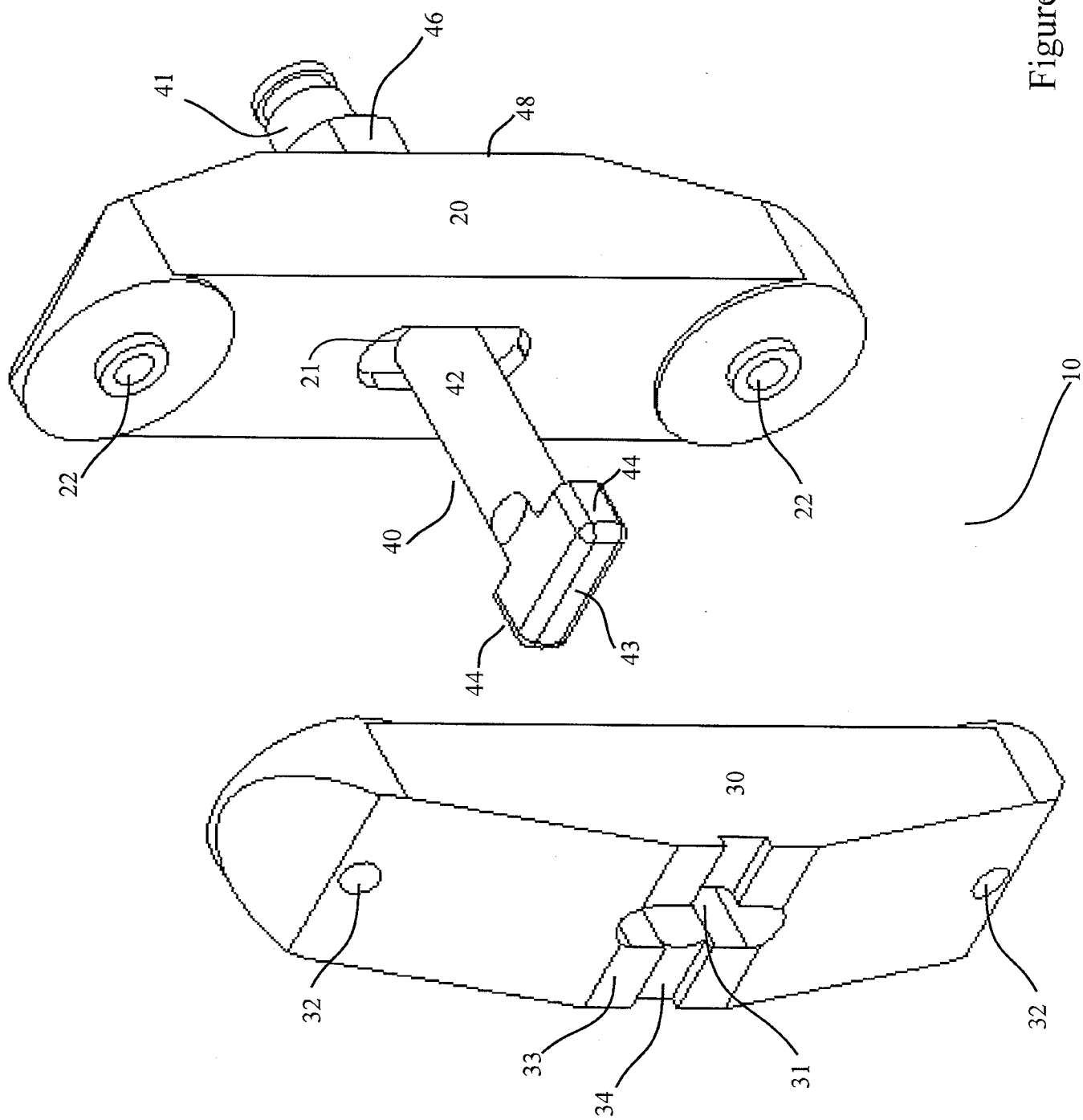


Figure 1

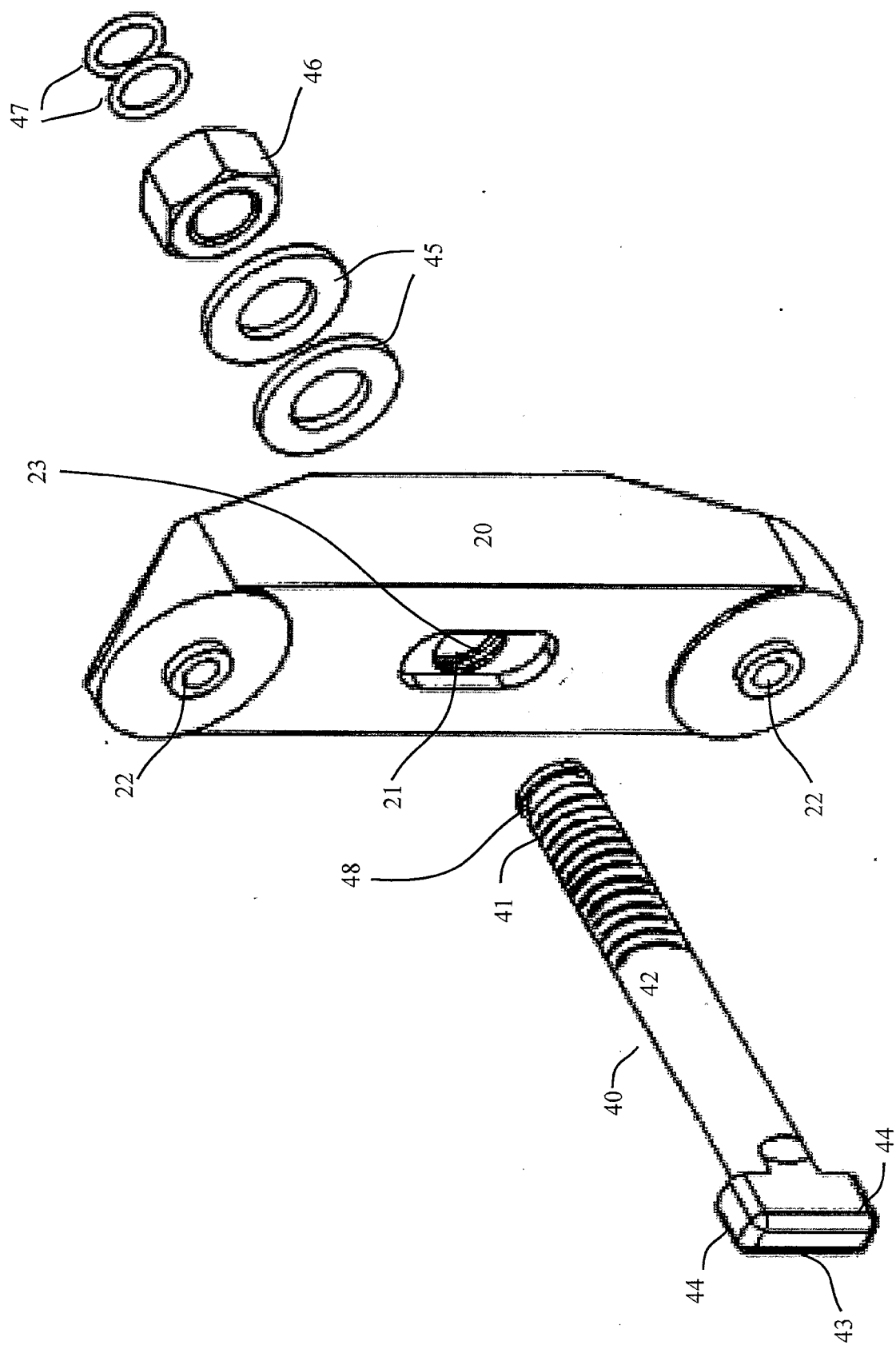
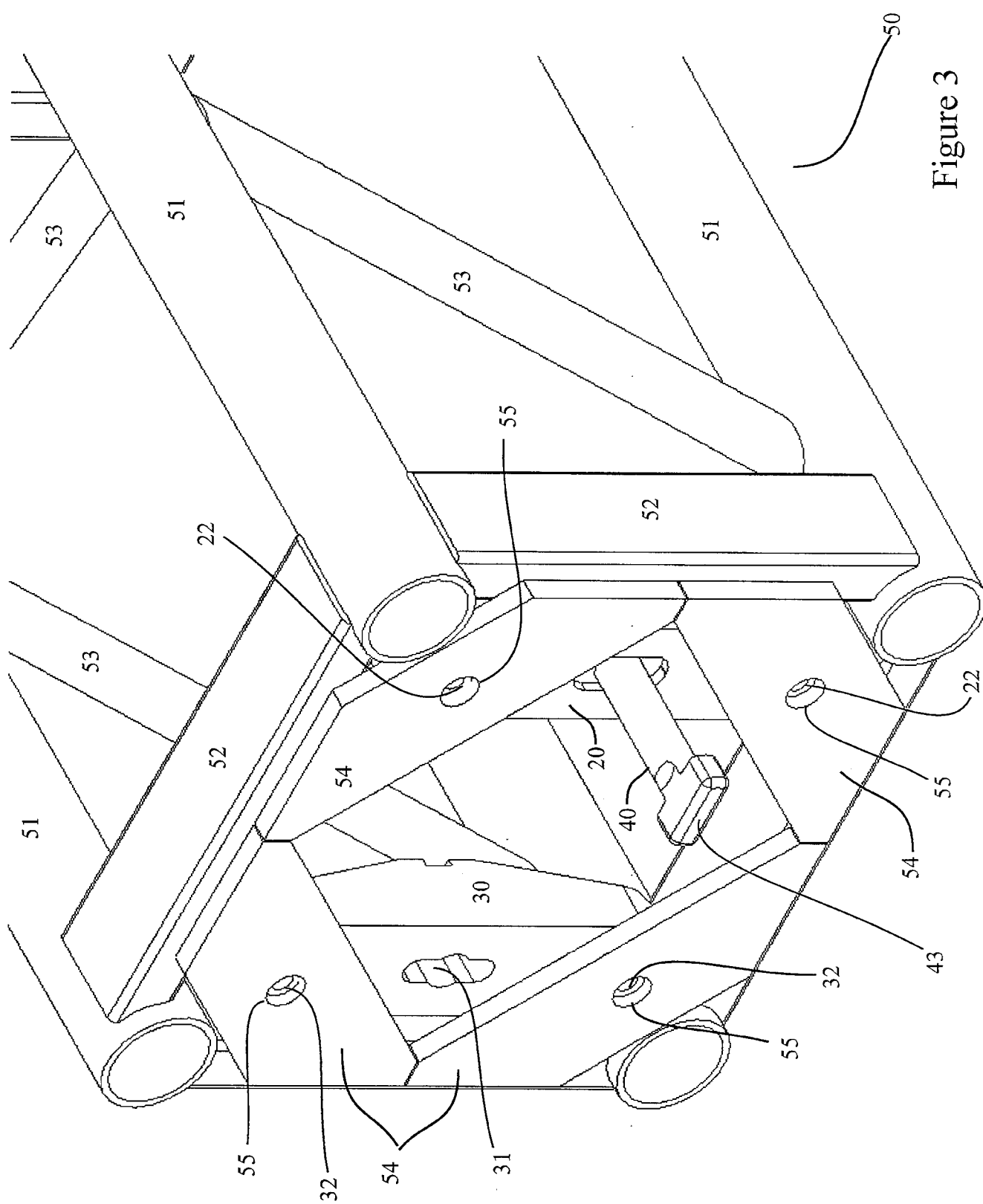
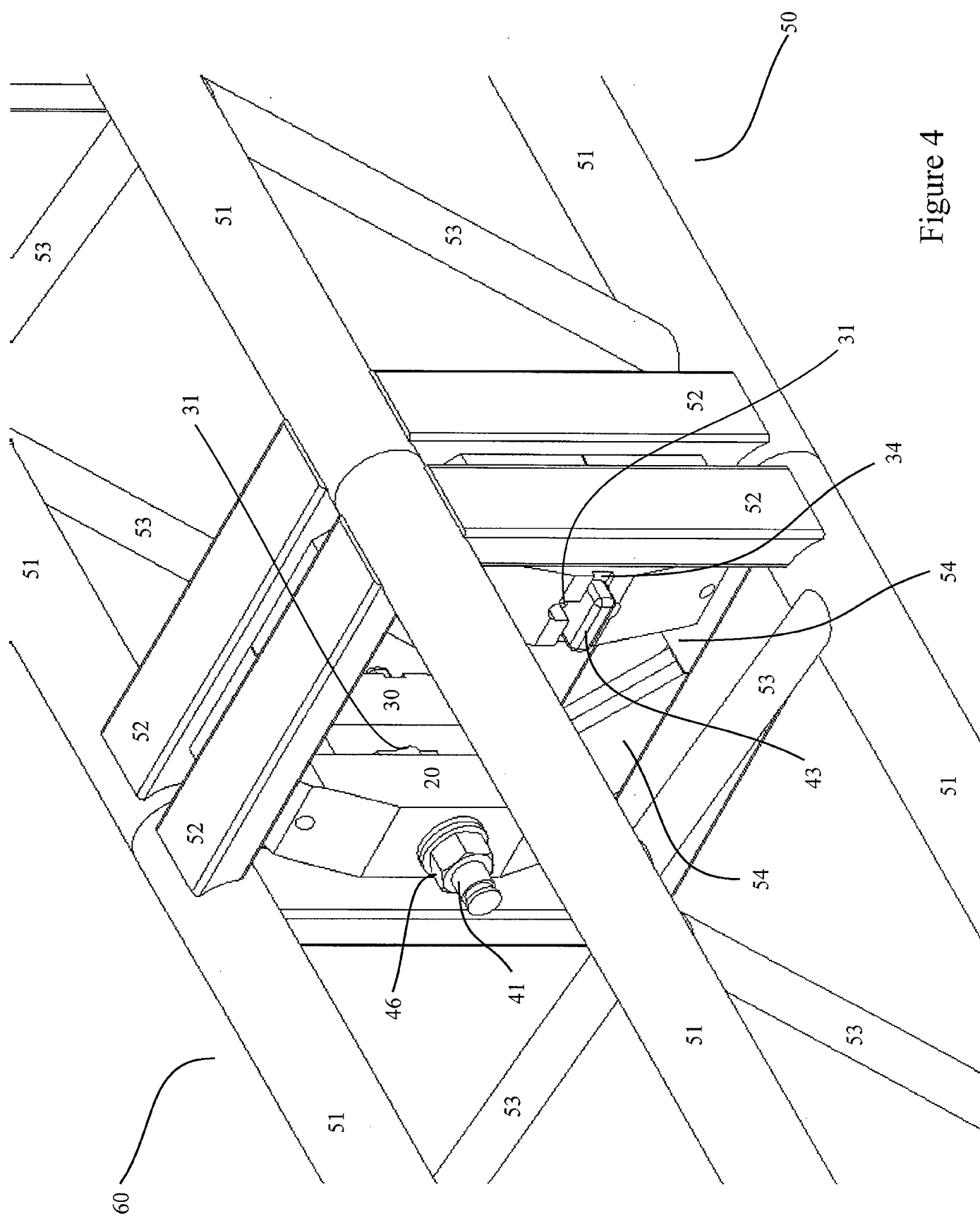


Figure 2





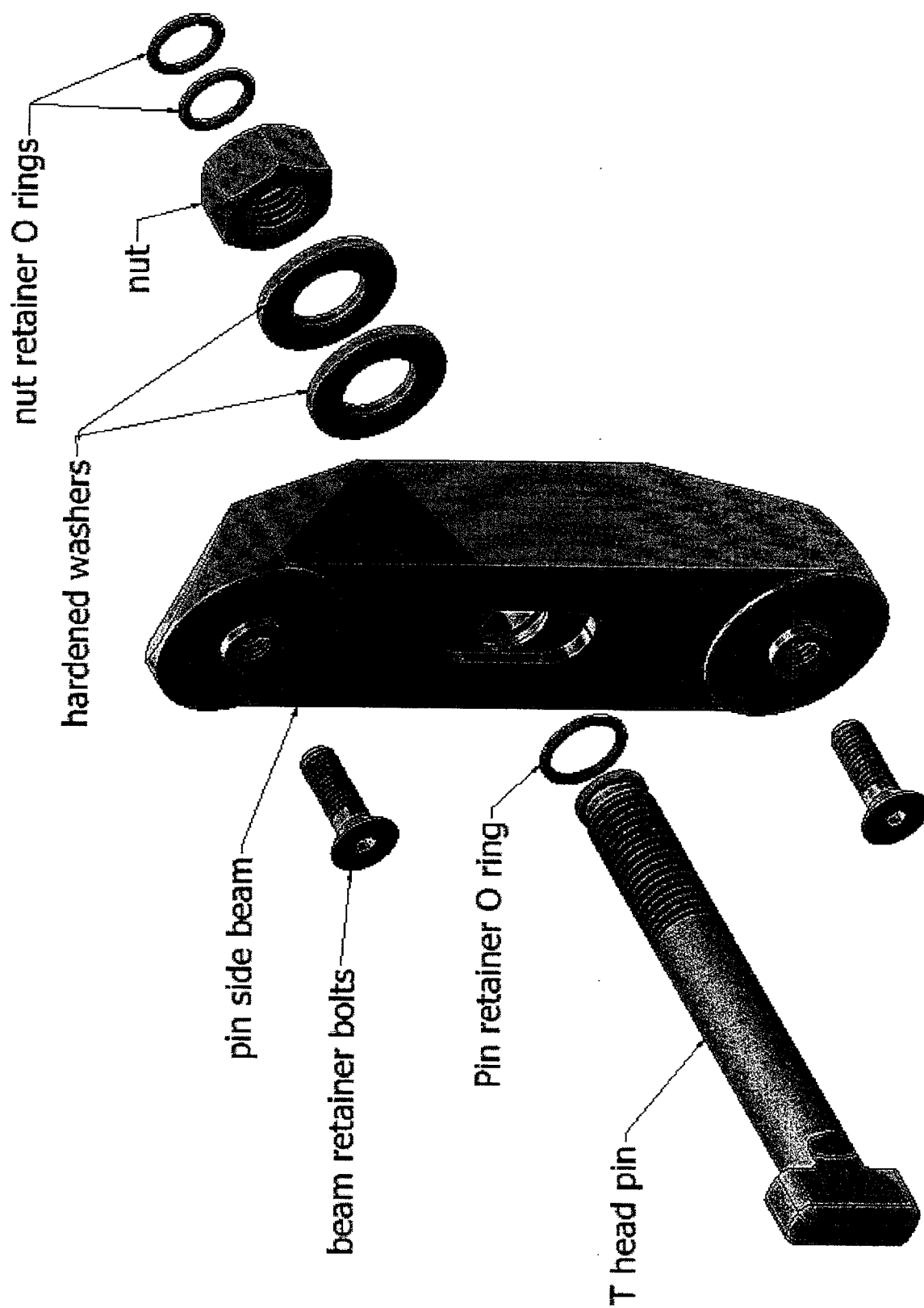


Figure 5

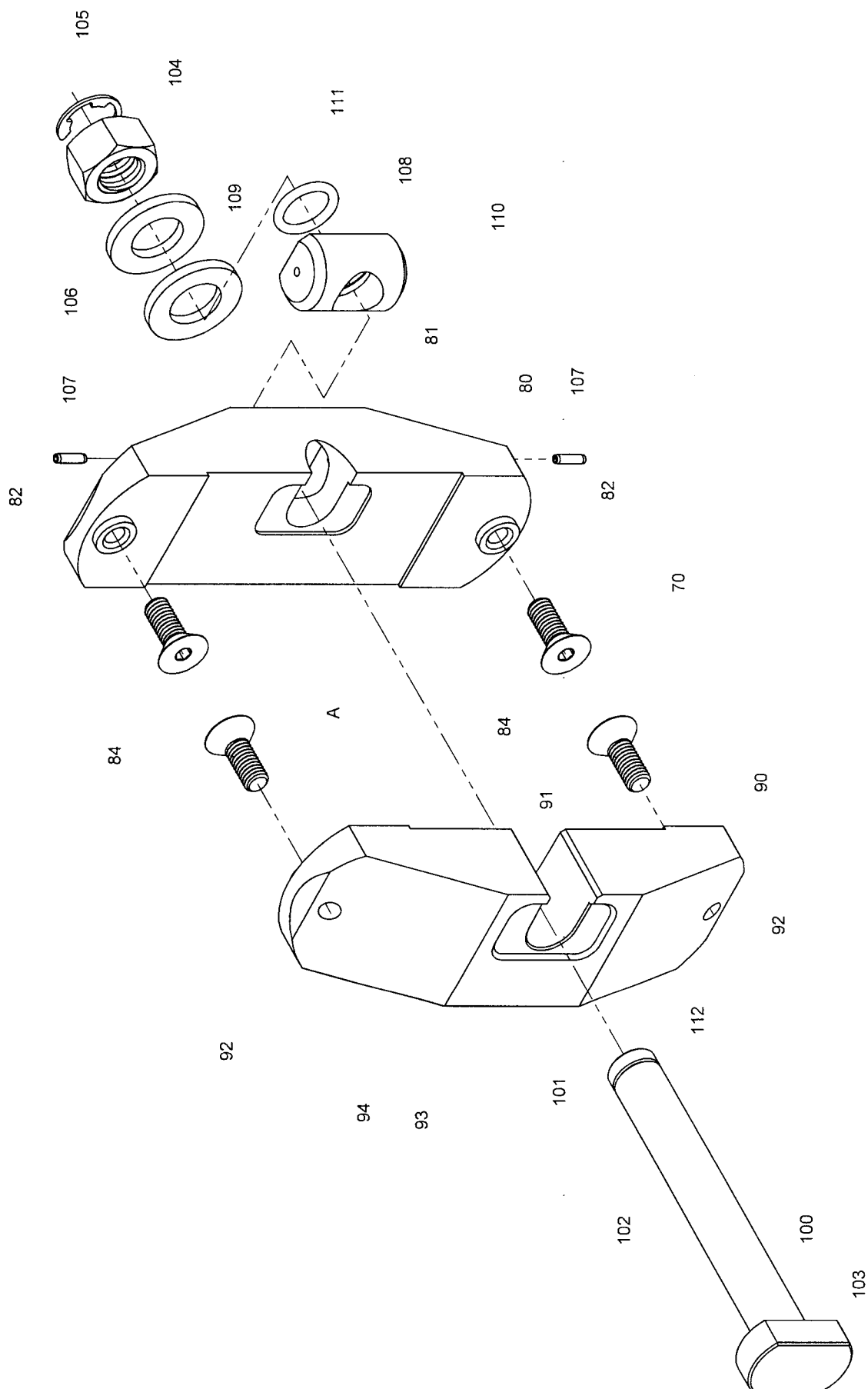


FIG 6

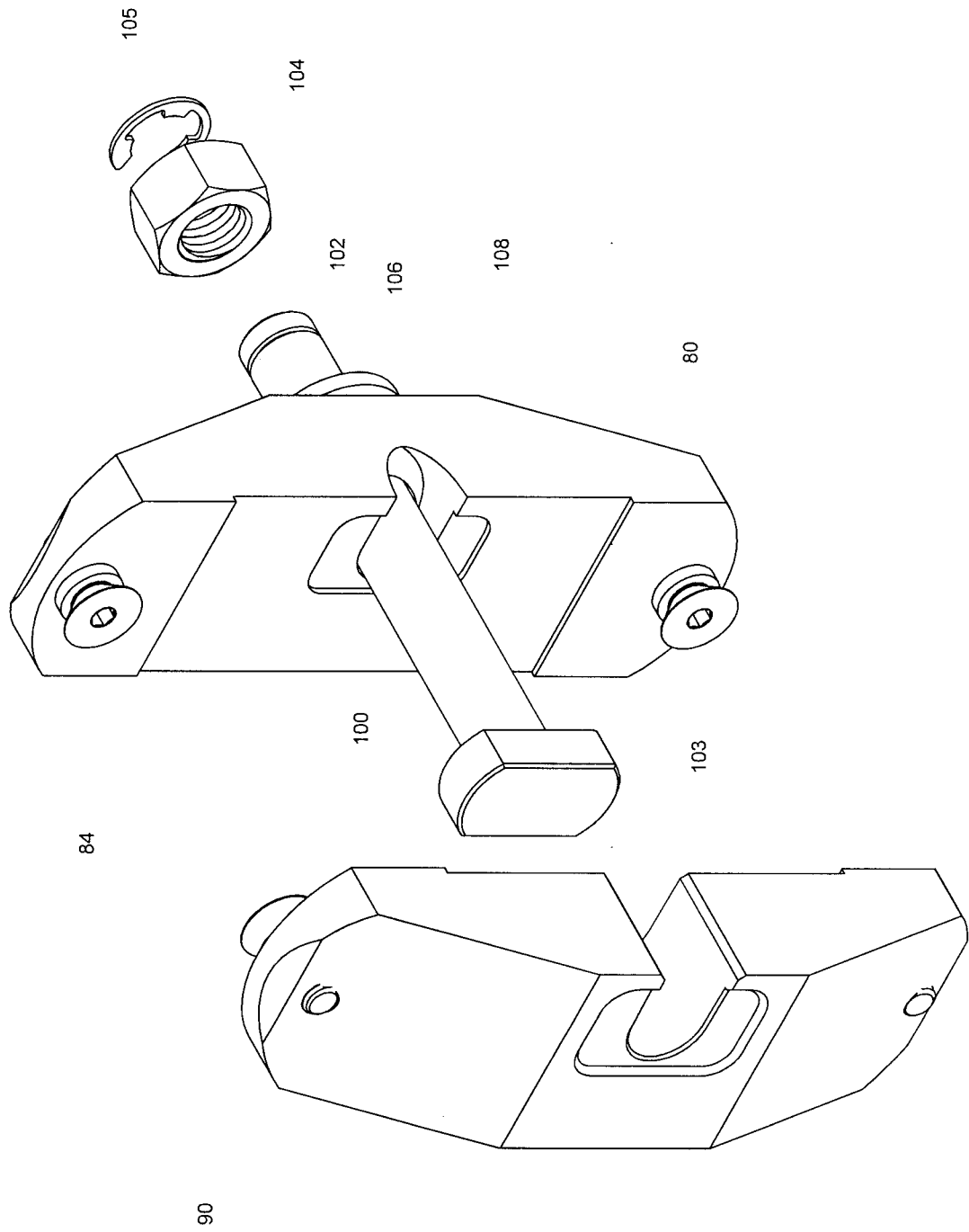
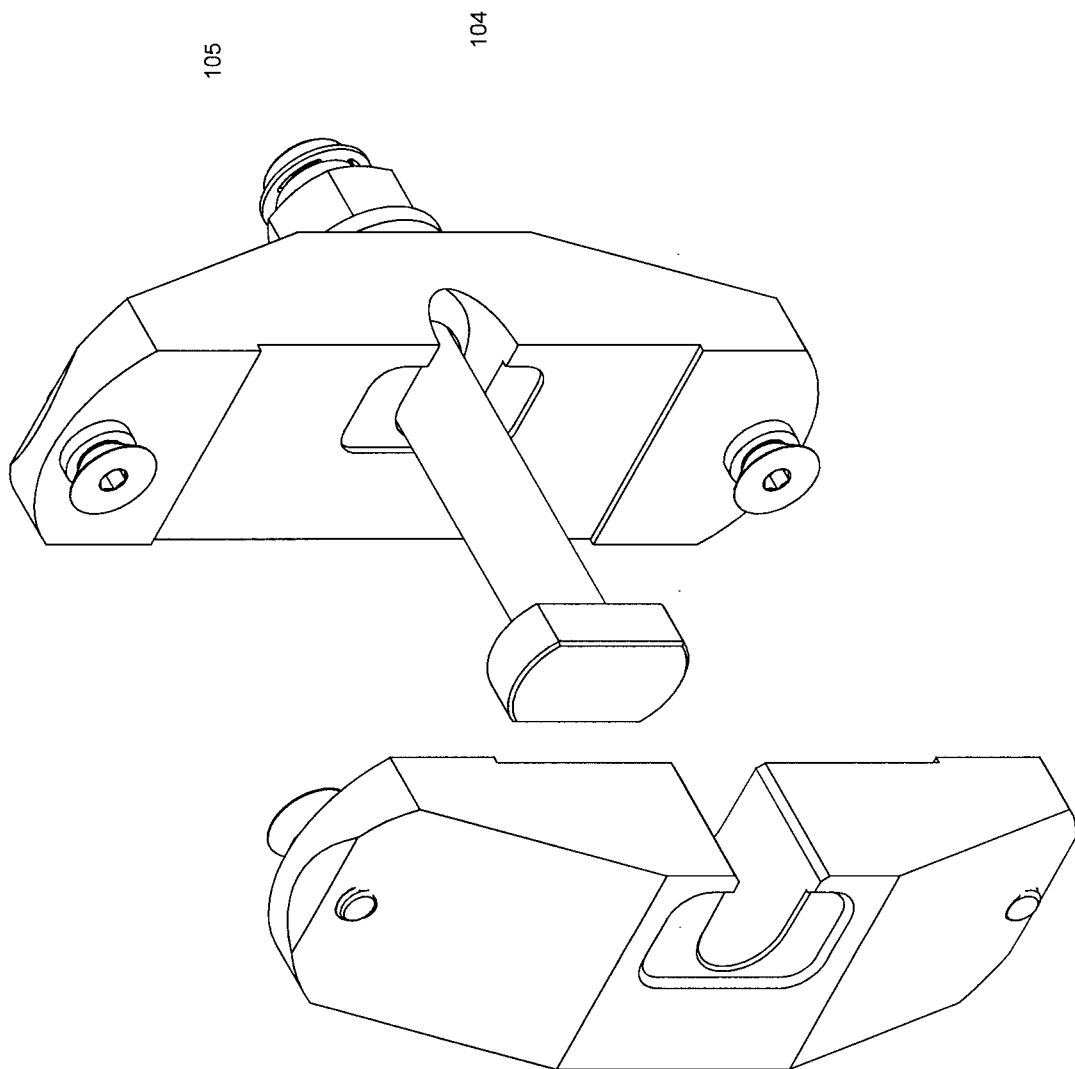


FIG 7



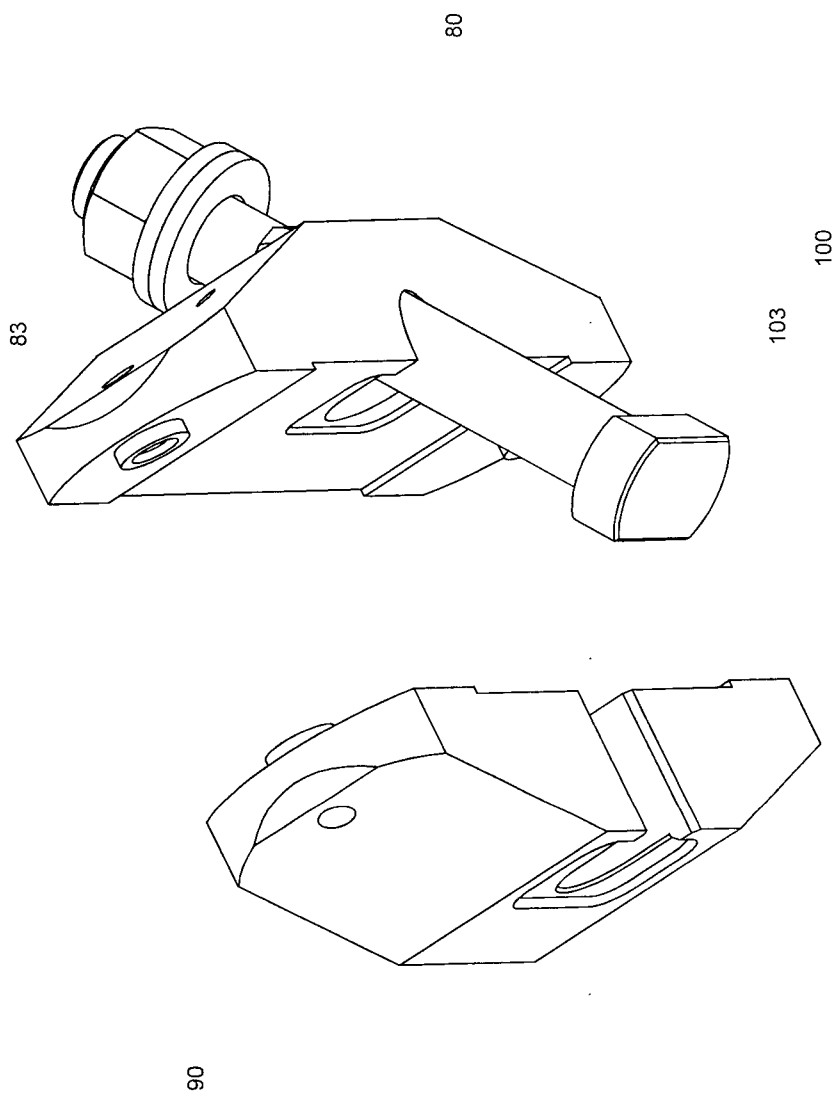


FIG 9

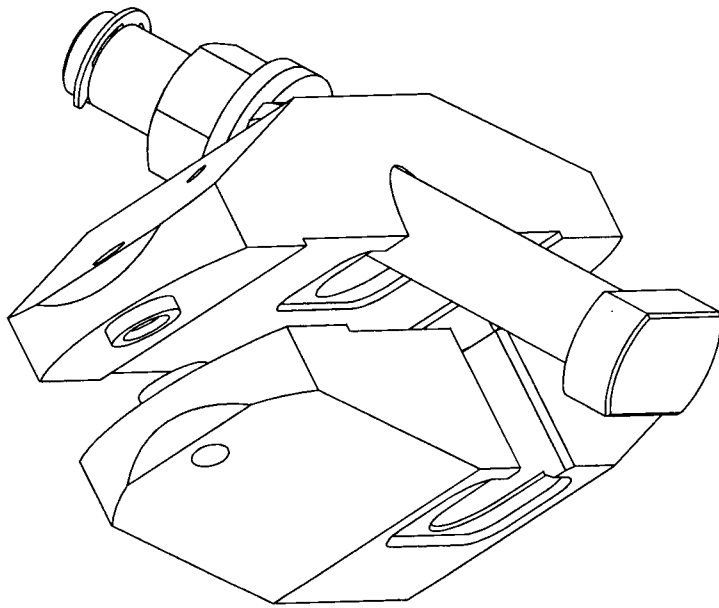


FIG 10

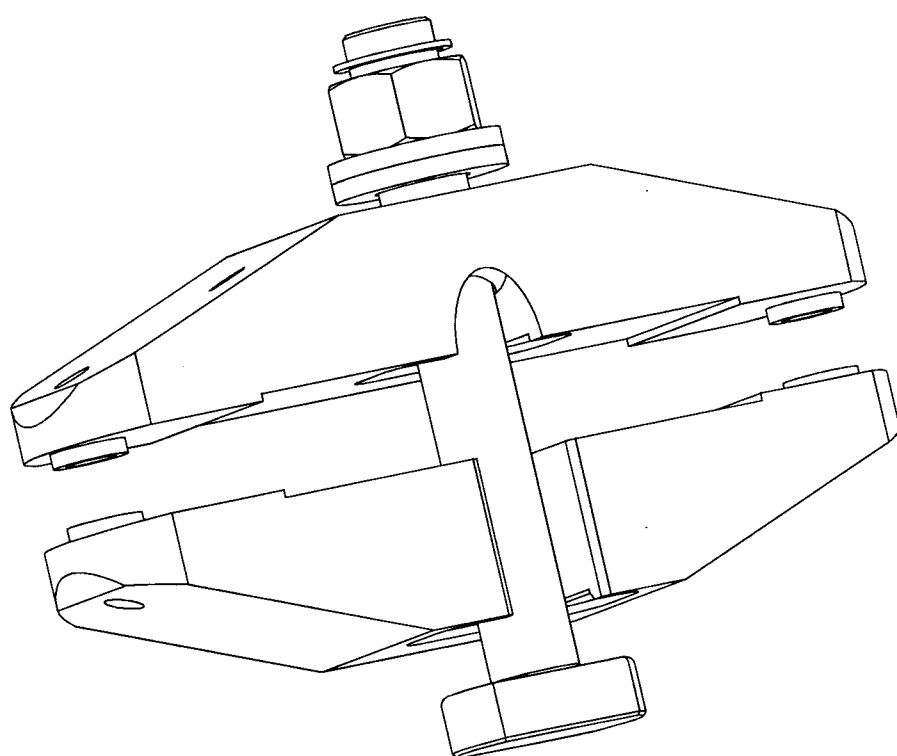


FIG 11

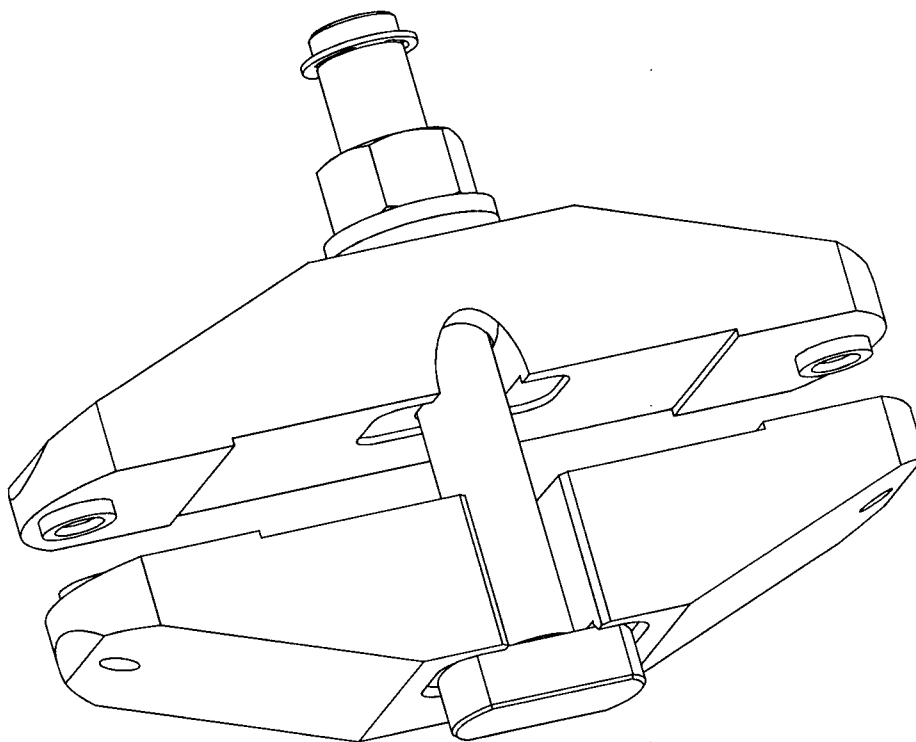


FIG 12

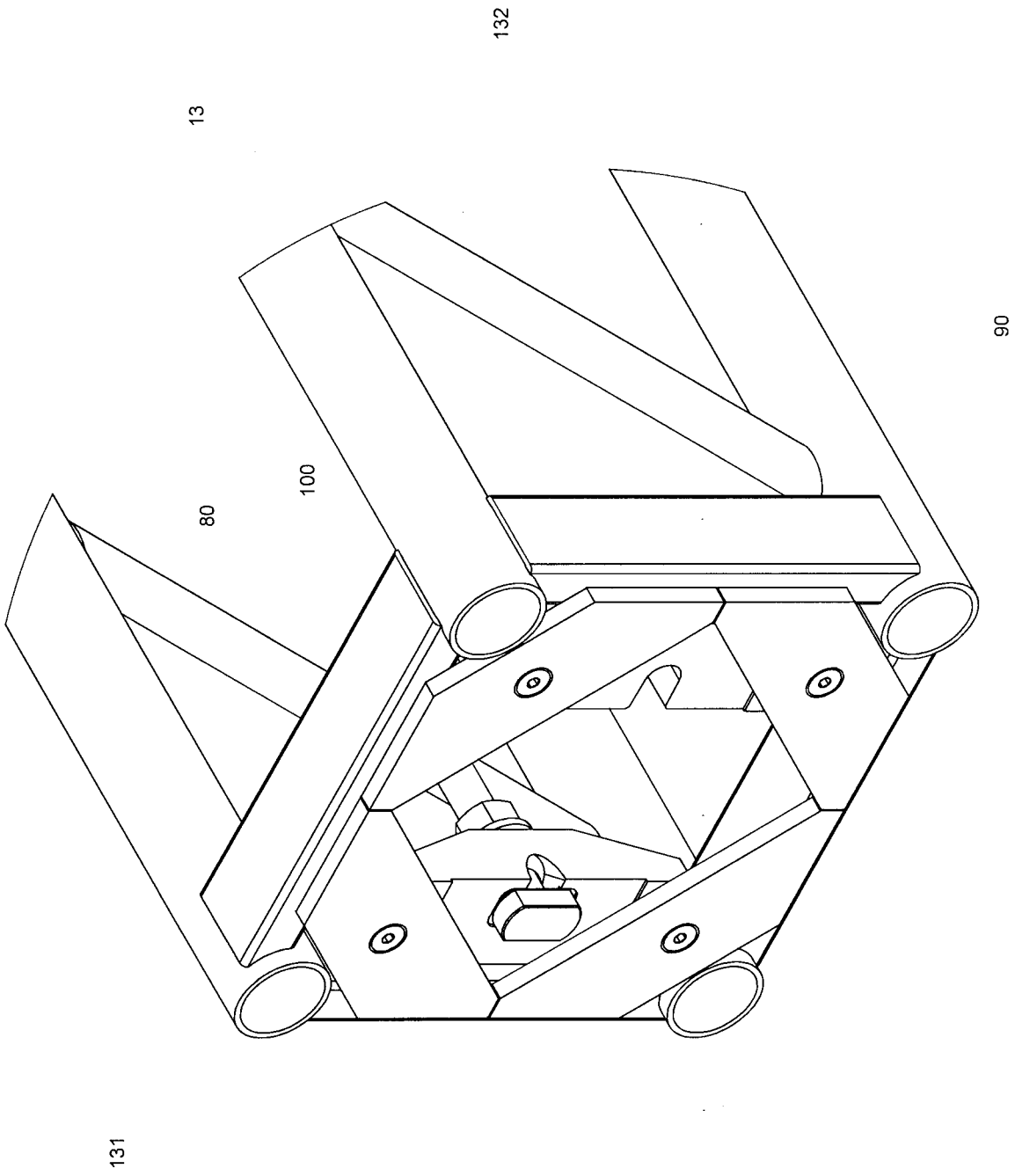


FIG 13

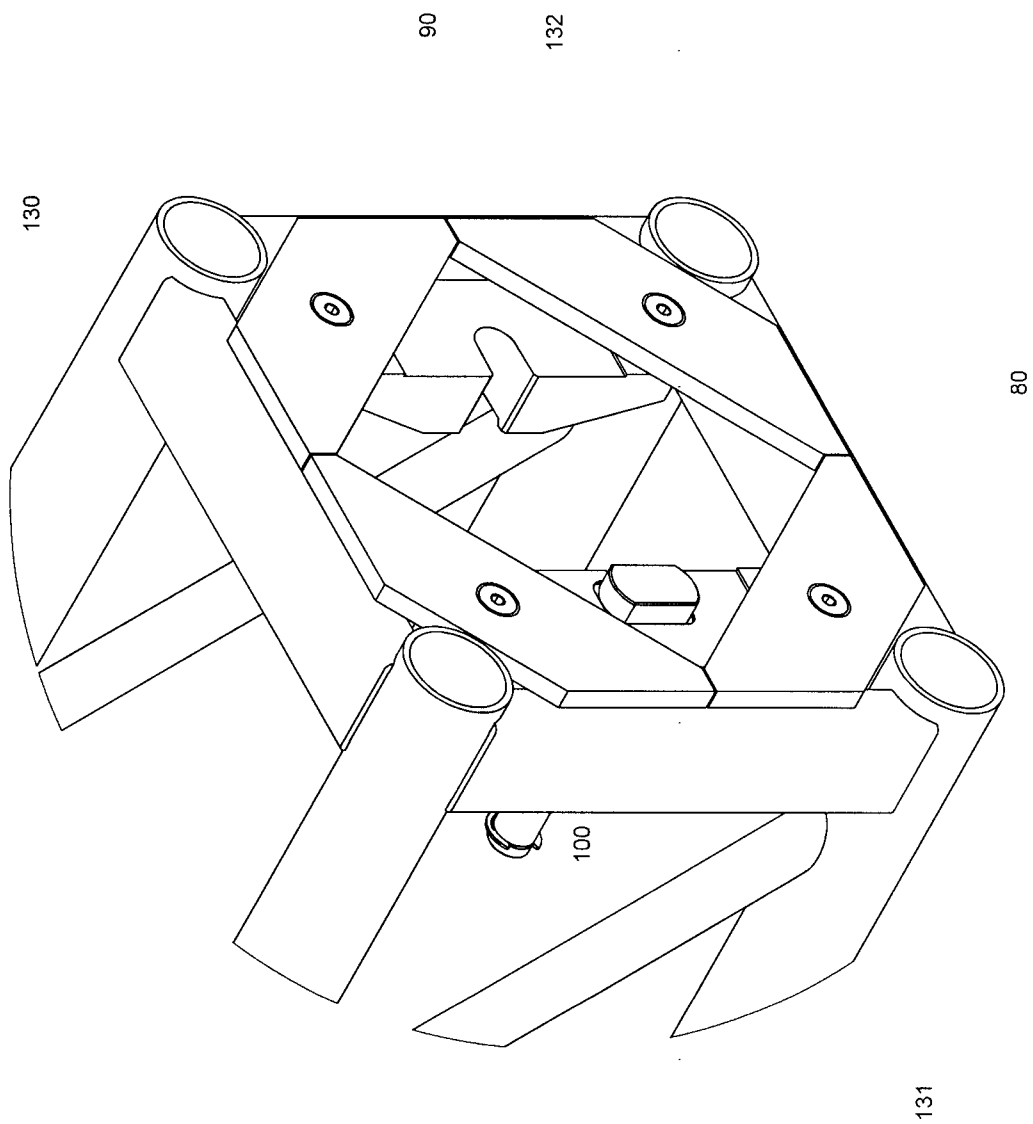


FIG 14

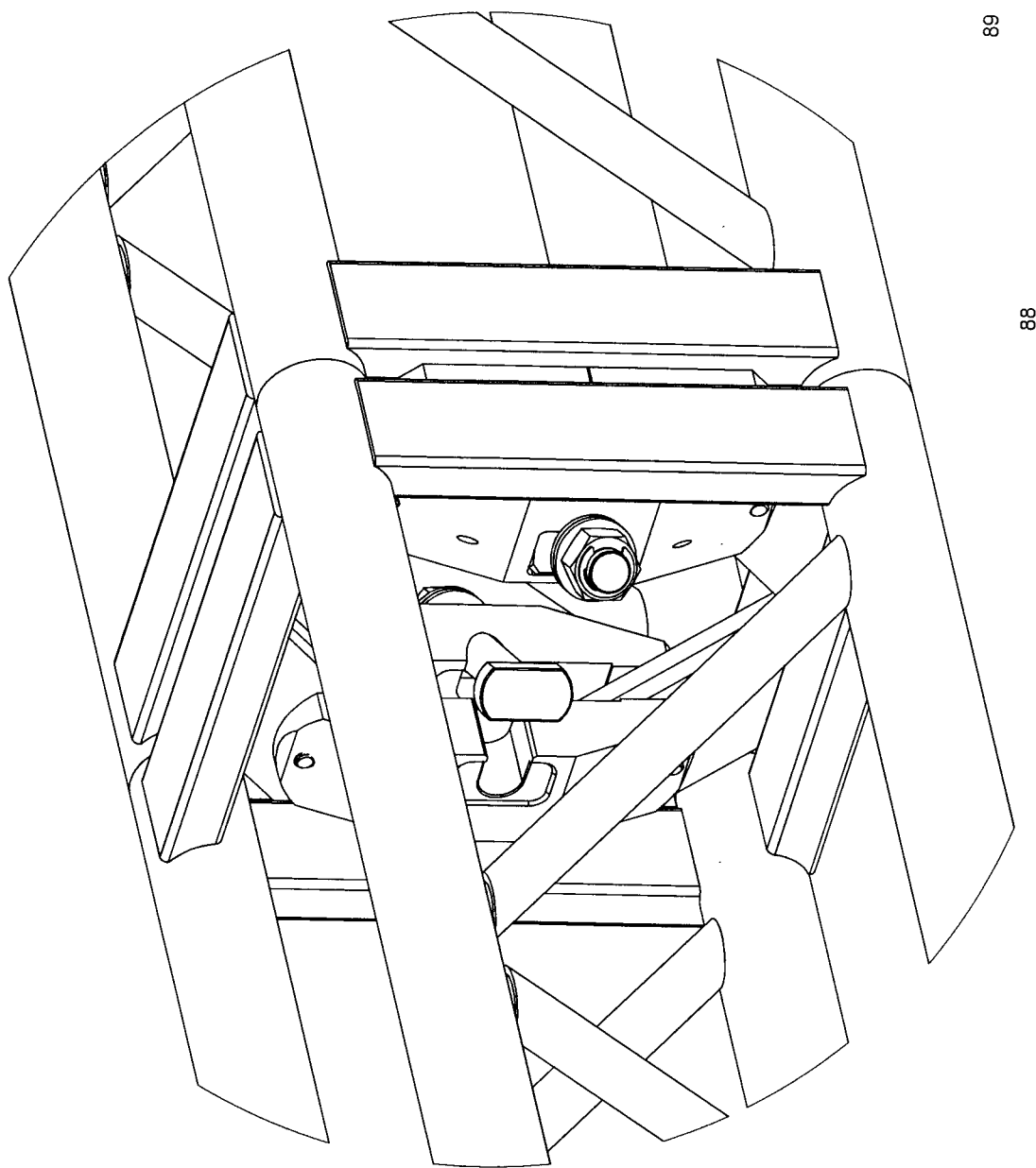


FIG 15

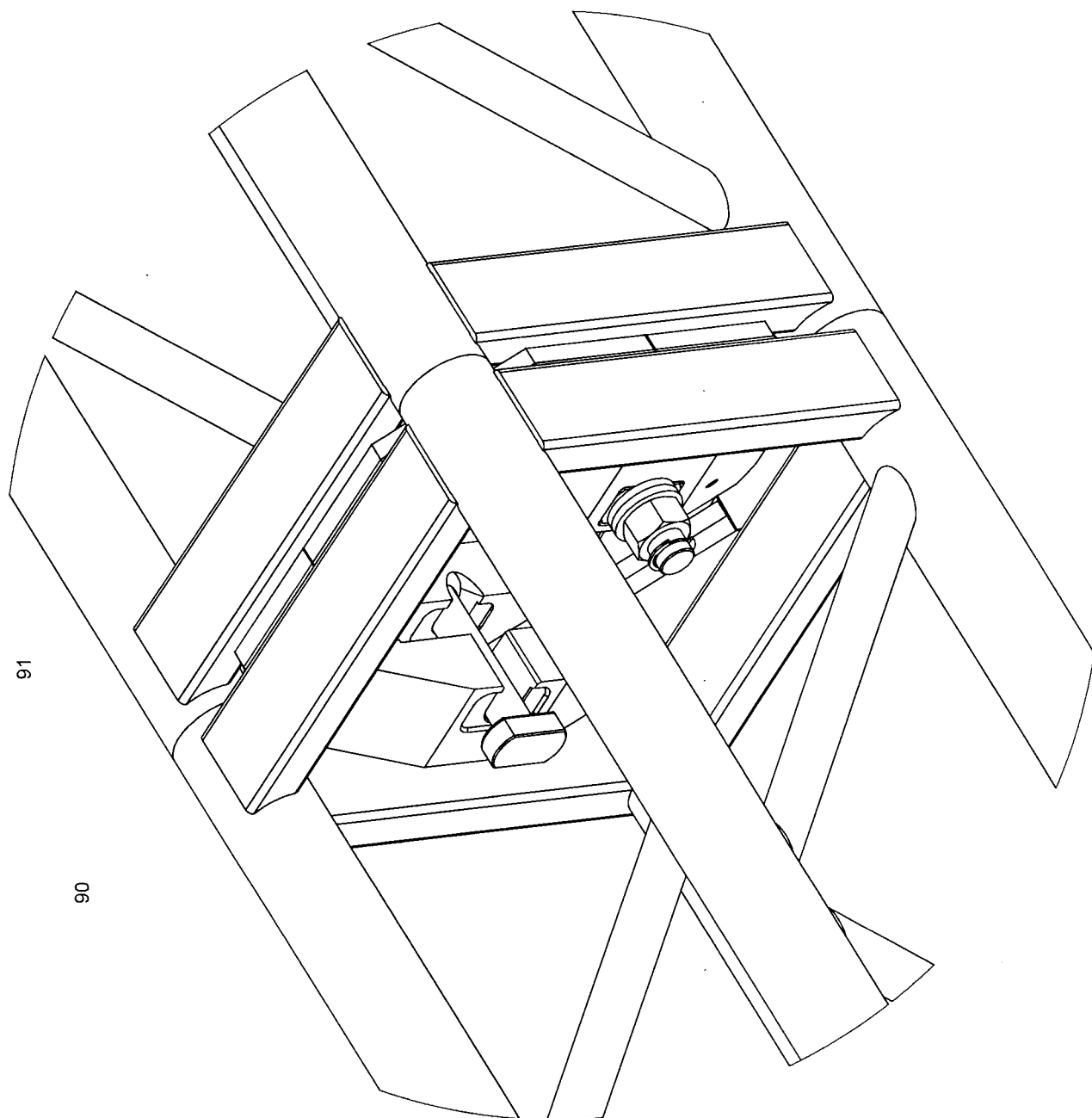


FIG 16

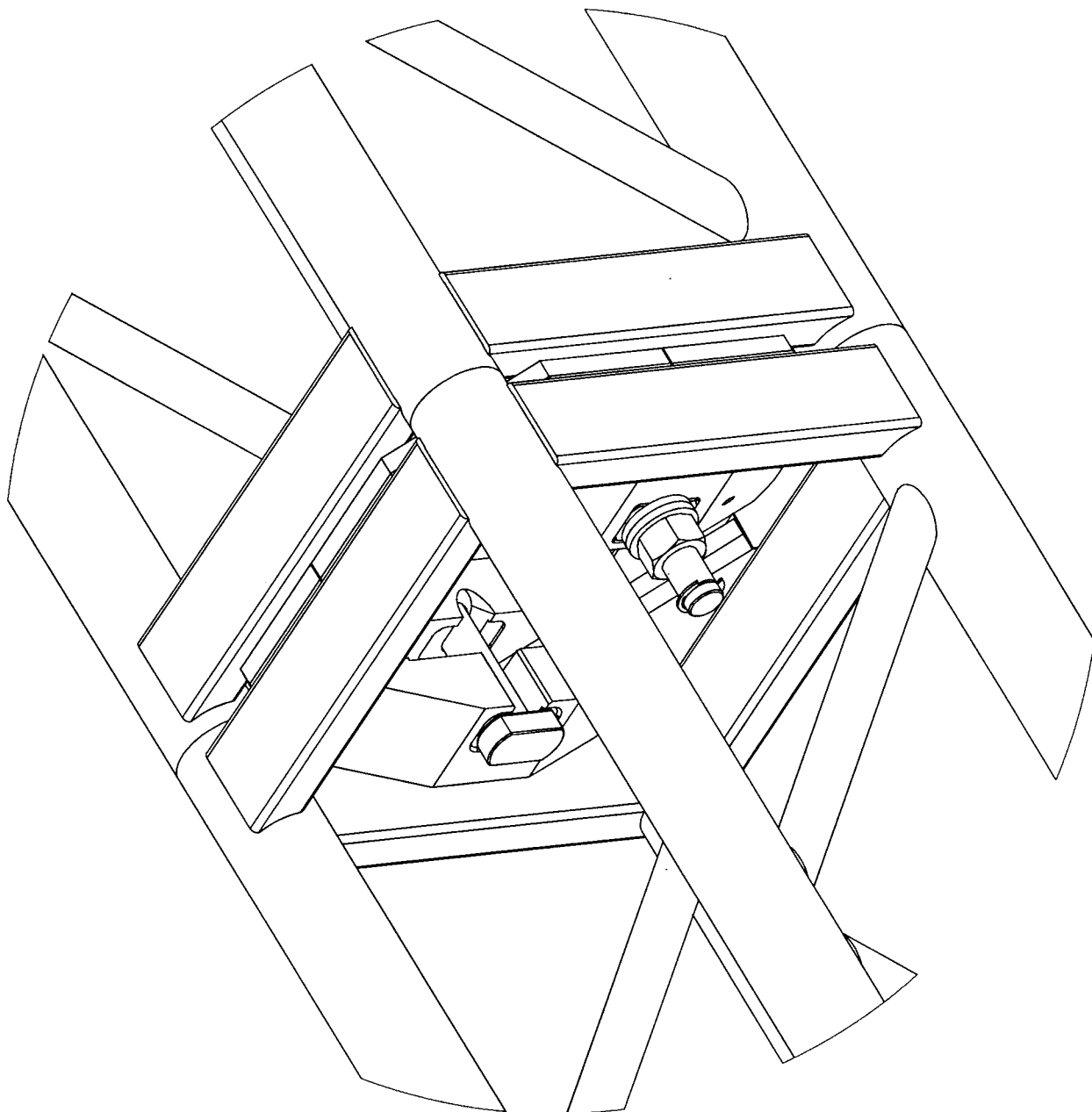


FIG 17

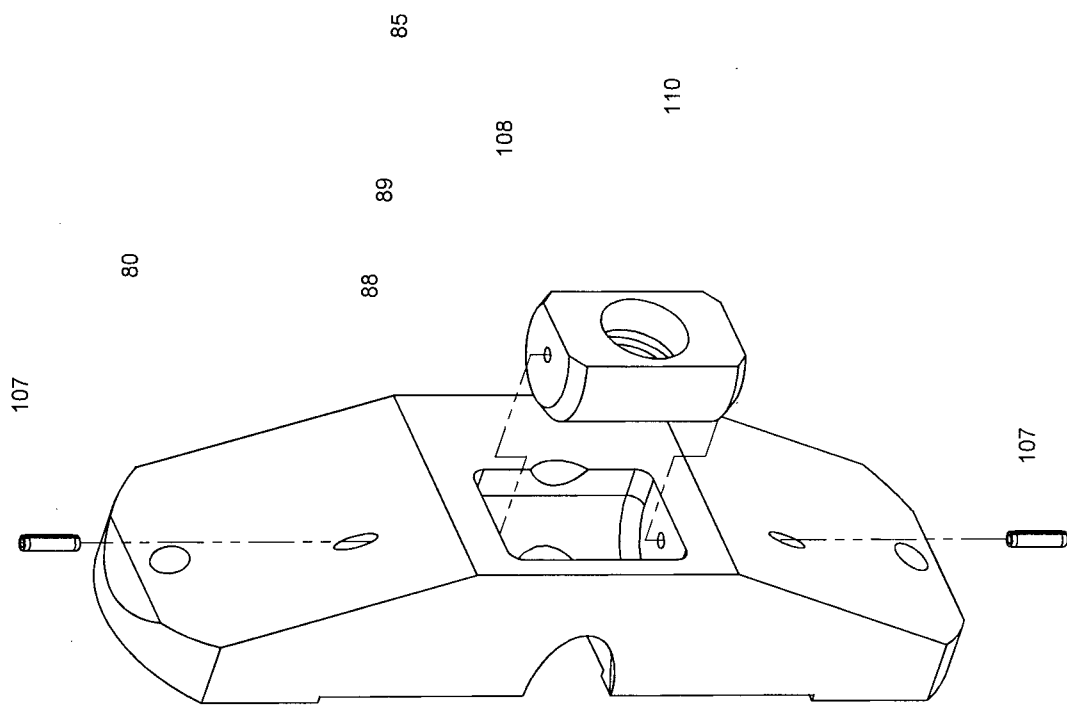


FIG 18

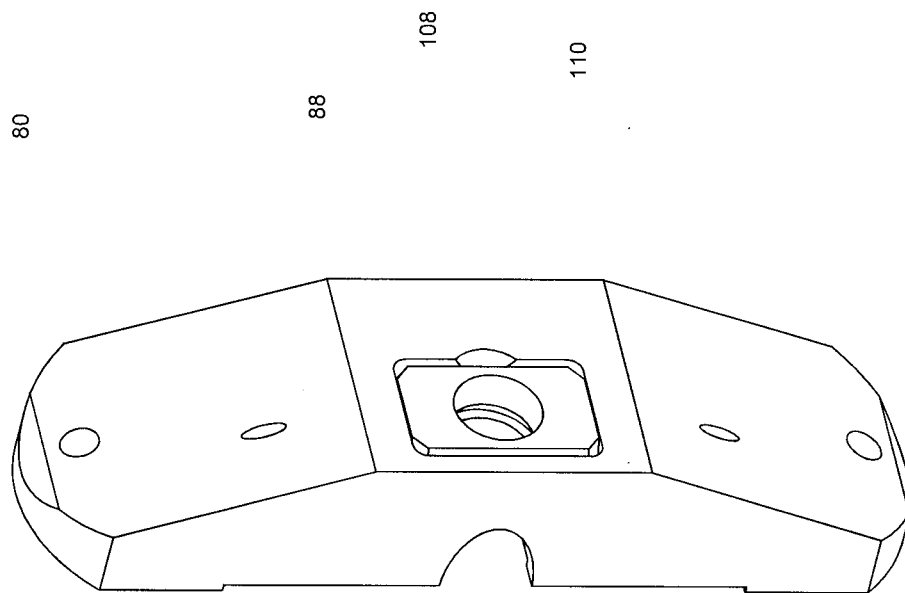


FIG 19

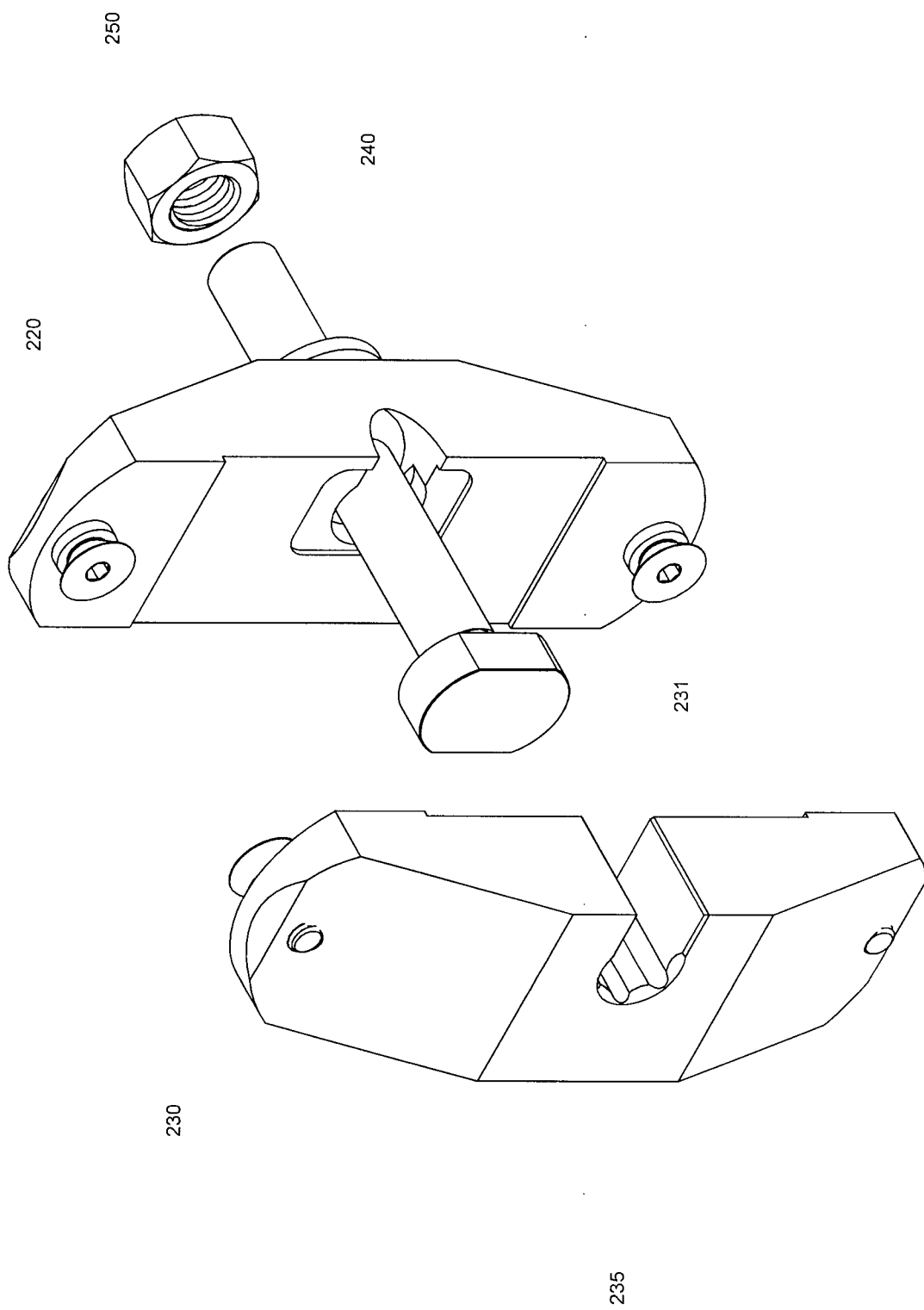
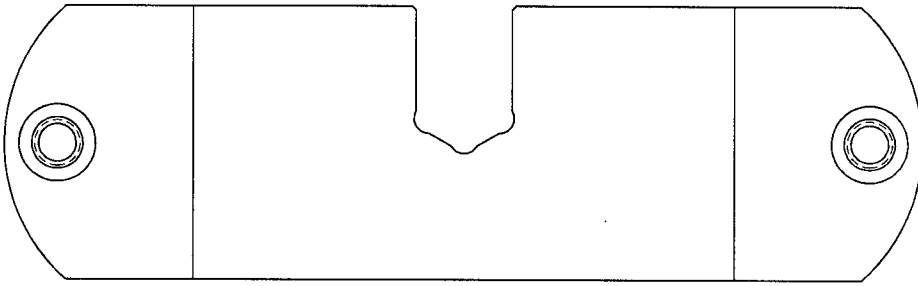


FIG 20

230



231

FIG 21

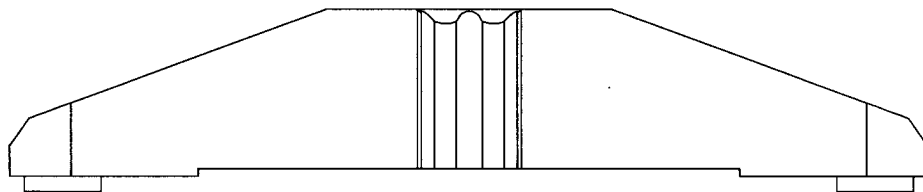


FIG 22

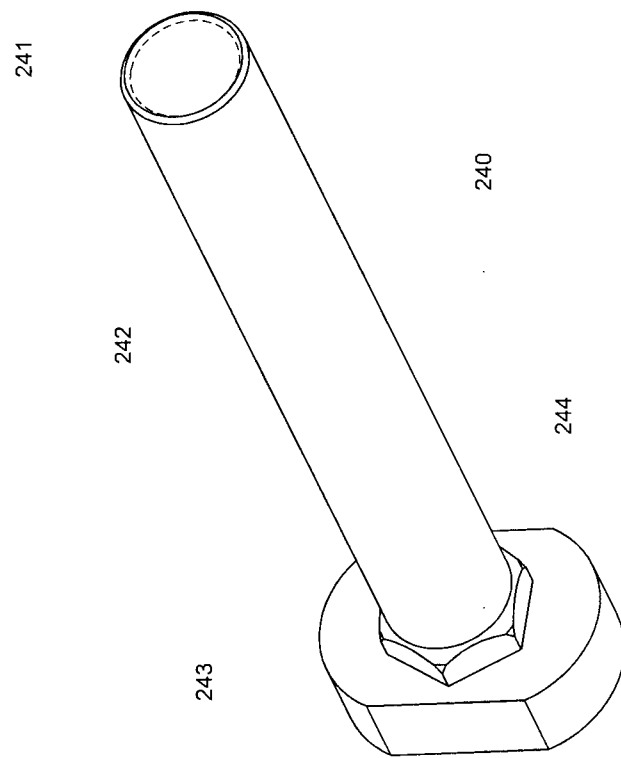


FIG 23

