PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : **F16F 1/34** | **A1**

(11) International Publication Number: **WO 87/ 06664**

(43) International Publication Date: 5 November 1987 (05.11.87)

(21) International Application Number: PCT/US87/00976

(22) International Filing Date: 30 April 1987 (30.04.87)

(31) Priority Application Number: 858,103

(32) Priority Date: 1 May 1986 (01.05.86)

(33) Priority Country: US

(71)(72) Applicant and Inventor: FULLERTON, Robert, L. [US/US]; 4635 Rio Encantado Lane, Reno, NV 89502 (US).

(74) Agent: RUSSELL, Reid, M.; 559 East South Temple, Salt Lake City, UT 84102 (US).

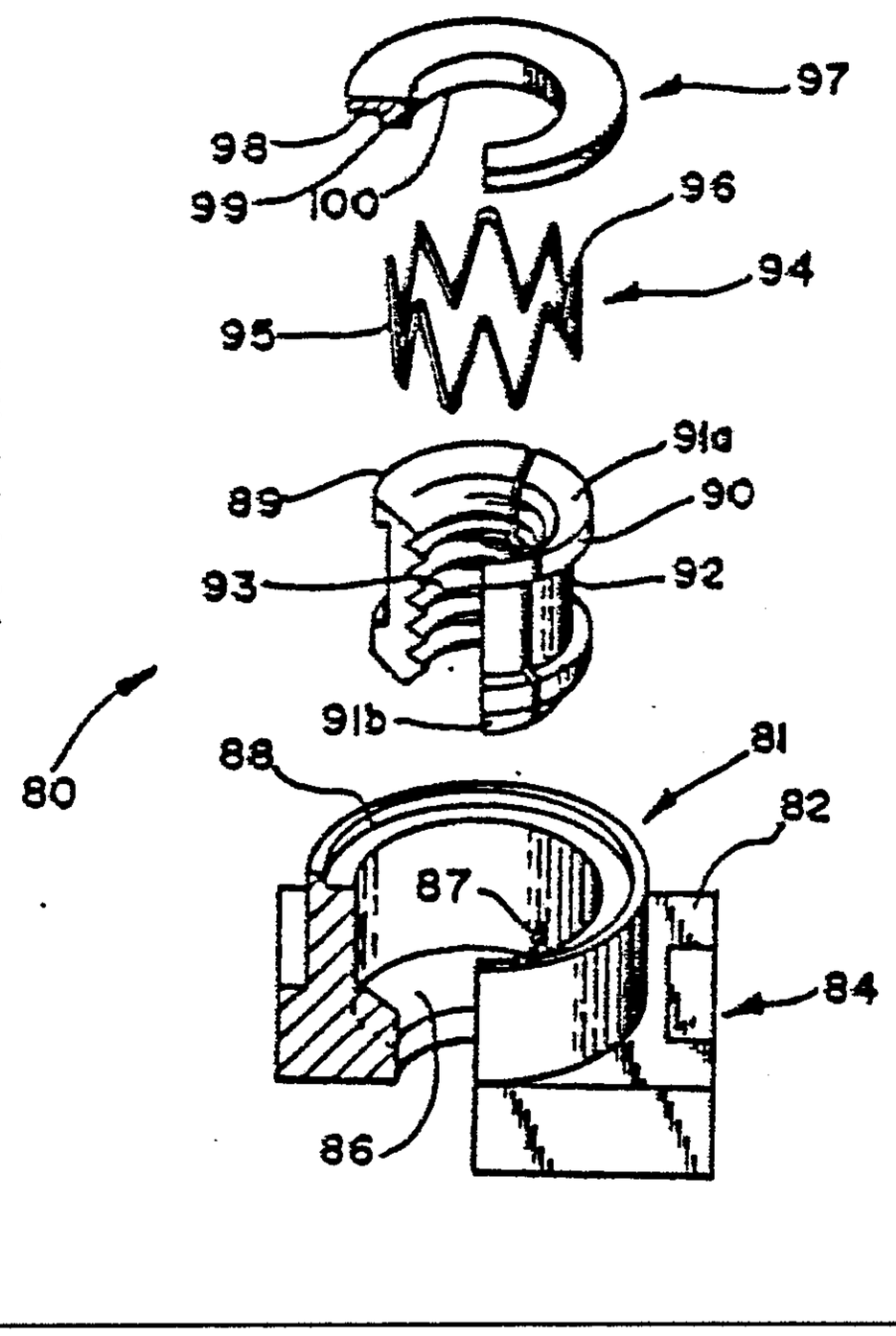
(81) Designated States: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent).

Published
With international search report.

(54) Title: QUICK ACTING SPEEDNUT AND SPRING THEREFOR

(57) Abstract

A quick acting nut assembly and a process for manufacture of certain embodiments thereof that includes a nut body (41) formed by magnetically shrinking a thin wall steel tube to have a multi-sided exterior and interior cavity shape, laterally cutting that tube to leave remainder sections that are bent at an angle to the horizontal that is the thread angle of threaded segments (45) supported thereon that are biased towards a vertical center axis therethrough. In another embodiment, the nut components are preferably formed from plastic and include a housing (81) that has a cylindrical inner cavity that terminates in a step (86) that is a lower slide surface to receive an assembly of arcuate threaded segments (93) contained therein by a cap (97) that has, as its undersurface, an upper slide surface (99), a wave tension retainer (49, 70, 94) for fitting in a continuous groove formed around the assembled threaded segments.



FOR THE PURPOSES OF INFORMATION ONLY

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

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

S P E C I F I C A T I O N

QUICK ACTING SPEEDNUT AND SPRING THEREFOR

BACKGROUND OF THE INVENTION

Field Of The Invention

This invention relates to threaded fasteners and a process for their manufacture, and is particularly directed to a quick acting nut assembly adapted to be telescoped onto a threaded shank without relative rotary movement.

Prior Art

Threaded fasteners have generally involved nuts for turning on a threaded shaft or shank, the nut turned over the full shaft length to bring a face thereof into registry with a work piece. Additionally, in tightening of such conventional nut into registry, because of the nut thread configuration, results in only a few of the nut threads actually being in stressed engagement with the threaded shank. In fact, in such tightening, the two or three thread flights or revolutions proximate to the work piece tend to be distorted while the remaining threads are largely ineffective and do not significantly contribute to either the locking action or the holding power of the nut.

Heretofore, various attempts have been made to provide a nut that could be slid onto a threaded shaft or shank up to a point of loading so as to avoid a necessity for turning it over the full length. Such devices, however, have all had numerous disadvantages and shortcomings that are sought to be avoided by the present invention. A most common problem with earlier devices has been an excessive number of components and their complex interaction, that resulted in a nut configuration that was difficult and costly to manufacture. An example of such a complex nut configuration that incorporates stepped wedges as nut segments is shown in the patent by Beswick, U.S. Patent No. 2,489,613. A similarly complicated arrangement is shown in a patent by Jansen, U.S. Patent No. 2,896,496 that includes a tension force member for operating a plunger portion thereof that is arranged within the nut body. Vertical movement of that plunger moves a wedge thereon that contacts, to move outwardly, threaded segments into engagement with an internally threaded nut body. Another such complicated nut assembly is shown in a patent by Schertz, U.S. Patent No 3,352,341, that also includes a wedging of threaded segments that bring threads thereof into meshing engagement with a threaded shaft or

shank. This nut assembly also involves a plunger configuration for manually moving the threaded segments into such meshing engagement with shank threads. Similar to the wedging action of the Schertz patent, a patent by Desbrueres, U.S. Patent No. 2,021,051, shows an arrangement for wedging threaded segments into engagement with a threaded shank and is operated as a safety nut. Also, a patent by Hiroshoiokada, U.S. Patent No. 4,083,393, shows a wedging nut that includes segments arranged within a nut body that are spring biased for engaging a threaded shank.

The threaded segments of the present invention, distinct from the cited prior patents, are spring biased to travel along at least one sloping surface or track so as to bring threads thereof into uniform engagement with threads of a shaft or shank. A nut utilizing arcuate segments that functions similarly to the threaded segments of the present invention is shown in an earlier patent by the present inventor for a "Quick Acting Nut Assembly", U.S. Patent No. 4,378,187. This patent shows a nut that incorporates threaded segments that are arranged to slide along and between parallel track surfaces for providing positive movement of all the threads into meshing engagement with the threads of a shaft or shank whereon the nut is slid.

While the present invention also incorporates threaded segments their manufacture and use is distinct from the earlier patent, as is a spring configuration of the present invention that urges segment threads into uniform meshing engagement with the threads of the shaft or shank.

SUMMARY OF THE INVENTION

It is, therefore, a general object of the present invention to provide a quick acting nut assembly to telescope over a threaded shank or shaft, sliding thereover without relative rotation, into registry with a work surface whereat, with limited wrenching or turning, the nut can be tightened on that threaded shank against the work piece.

Another object of the present invention is to provide, as a threaded segment, a unit that has like parallel sloping top and bottom faces that conform to the slope of a nut body slide surface, which threaded segments, when fitted together, have an exterior surface for installation within an open central cavity of the nut body.

Another object of the present invention is to provide a spring arrangement for uniformly biasing an assembly of threaded segments within a nut body into uniform meshing engagement of the threads thereof with the threads of a shaft or shank installed through that nut body.

Still another object of the present invention is to provide a continuous tension retainer to fit around the assembled threaded segments as the spring biasing arrangement for fitting within the nut body to bias the threaded segments towards a center vertical axis.

Still another object of the present invention is to provide, in one embodiment, a process for fabricating a nut body for a quick acting nut assembly from a thin walled magnetically attractive tubular material.

Still another object of the present invention is to provide a process for fabricating a quick acting nut assembly body by magnetically shrinking a thin wall tube formed of a magnetically attractive material into a hexagonal shape and appropriately cutting and folding top and bottom ends thereof into slide surfaces wherebetween the threaded segments are arranged to travel.

In accordance with the above objects, the present invention, in one embodiment, involves a quick acting nut assembly that includes a thin wall body that is formed by a process of the present invention involving magnetically shrinking a thin wall tube into a sided nut body shape preferably, a hexagonal outer and inner cavity shape to accommodate an assembly of sided threaded segments fitted therein. To provide such shrinking, a mandrel is arranged to receive a thin walled magnetically attractive pipe fitted thereover, which mandrel can include sections that are electrically separated. Each such section is for separate attachment to a power source to provide current to the section to provide pipe shrinkage at that location. In another embodiment the nut body is round and includes a stop therein to interact with, so as to block rotation of, arcuate threaded segments fitted therein. For both round or sided nut body configurations appropriate threaded segments are provided that, when assembled, will also have a shape like the nut body interior. The assembled segment threads are arranged to travel between sloping side surfaces in the nut body to mesh with threads of a threaded shaft or shank fitted axially therethrough.

In the hexagonal embodiment, the tube, after shrinking to the hexagonal shape, has the bottom end portion thereof cut appropriately to form outwardly extending wing sections. The wing sections are thereafter folded appropriately into the body to form a first or lower slide surface that extends into the body cavity at an angle with respect to the horizontal that is approximately the thread angle of the threaded segments and shaft whereover the nut is to be turned. The hexagonal tube is cut thereacross to form a nut body lip area that can be rolled over appropriately to contain a cap fitted therein. The cap has, as its undersurface, a slide surface that is essentially like and is

parallel to the nut body first or lower slide surface. In another arrangement of this thin wall body embodiment, the tube is cut to leave outwardly extended wings at the top thereof that can then be bent into the nut body cavity to form the upper slide surface. In this arrangement, the threaded segments are contained between the parallel slide surfaces.

In another embodiment that is suitable for providing a limited holding strength, the components of the quick acting nut can be formed from plastic by conventional molding methods. In this embodiment the nut body is preferably formed to have a large central cavity that terminates in a first or lower slide surface that is open centrally to accommodate a threaded shaft or shank fitted therethrough. The central cavity is preferably round to accommodate arcuate threaded segments fitted therein that form a disk that has a central opening and is threaded therethrough. The nut body is stepped around the open top and inner circumference to accommodate a lid fitted thereto and can be grooved above the step to accommodate an expansion ring fitted therein, sandwiching the lid against the step. The lid includes an undersurface that is flat and, when assembled to the body, will be parallel to the nut body first or lower slide surface. So arranged, the threaded segments are maintained between the lower slide surface and the lid under surface to slide back and forth thereon. The embodiment further includes a spring arrangement for biasing the threaded segments towards the center opening; and a preferred spring arrangement is set out below.

The invention preferably includes as a preferred spring arrangement a wave tension retainer for biasing the threaded segments towards a vertical center axis through the nut body such that each segment will tend to slide along a slide surface into meshing engagement with a threaded shank fitting therethrough. The wave tension retainer is arranged to encircle the threaded segments that are all grooved appropriately around their outer circumference to receive the wave tension retainer fitted therein. The wave tension retainer will act to apply a uniform biasing force over the segment outer surface so as to urge the segments towards that center longitudinal axis. The wave tension retainer is suitable for arrangement with both the described nut embodiments and can also be employed as the spring biasing arrangement for the quick acting nut assembly of my earlier patent, U.S. Patent No. 4,378,187, or the like.

The invention also includes a process of the invention for manufacture of the quick acting nut assembly that incorporates a body formed by shrinking a thin wall magnetically attractive tube that involves; first telescoping a

conventional round, thin wall magnetically attractive tube to fit snuggly over an electrode that can have separate electrically isolated sections and, thereafter applying sufficient electrical current to the electrode or to the separated electrode sections to provide a magnetic force of attraction therebetween that is sufficient to collapse or shrink the tube to the electrode shape. Which current can vary with the amount of shrinkage required. Whereafter, the formed shrunken tube can be cut appropriately thereacross to form the described nut body ends that include wing sections on the top and bottom ends thereof. The wing sections are to be bent appropriately into the nut body to form one or more of the nut body slide surfaces. So arranged, the nut body will accommodate the threaded segments therein positioned such that the assembled segment faces will fit into the nut body interior cavity walls.

A quick acting nut assembly formed, as set out above, will accommodate a threaded shaft or shank telescoped therethrough. During which travel, the threaded segments are forced by the shaft threads against the biasing of the wave tension retainer, or similarly functioning spring biasing arrangement, such that the thread flights will ratchet over one another. The nut assembly thereby accommodates travel of the shaft or shank through the nut assembled until an undersurface or face of the nut body is brought into registry with a work surface. Whereat, using a conventional wrench, the nut assembly is turned into binding engagement. Preferably, an elastic stop washer segment or the like is provided as the lower thread flight of each threaded segment that will squash appropriately when turned against the work surface. Such washer arrangement deforms into the threads of the shank, locking the nut to that shank. Removal of the nut off of the threaded shaft or shank requires it to be rotated fully over the length of the shank.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, is shown that which is presently regarded as the best mode for carrying out the invention:

Fig. 1 shows a hexagonal shaped electrode with a pair of wires extending therefrom for connection to a power supply, not shown, the electrode shown aligned with, a thin wall tube formed of a magnetically attractive metal that is for telescoping thereover;

Fig. 2 shows the thin wall tube of Fig. 1 shrunk to the shape of the electrode;

Fig. 3 shows a section of the hexagonal shaped thin wall tube of Fig. 2 fitted over a mandrel, the lower tube end having been cut to leave wings as remainders that are for folding into the tube as lower slide surfaces, as illustrated by arrow A, and shows broken lines thereacross identified as arrows B and C that are optional lateral cuts to provide tube end sections for bending into the nut body to form top surfaces;

Fig. 4 shows an exploded view of a first embodiment of a quick acting nut assembly that incorporates a cap for fitting within a nut body for containing threaded segments within the nut body, showing sections of the nut body bottom end bent upwardly from the horizontal to form an upwardly sloping slide surface for supporting threaded segments thereon;

Fig. 5 shows the sections of the nut of Fig. 4 assembled into the quick acting nut assembly and turned onto a threaded portion of a bolt fitted therethrough;

Fig. 6 shows an exploded view of another embodiment of quick acting nut assembly showing a nut body thereof as including bottom slide surfaces that are arranged to slope downwardly from the horizontal and a wave tension retainer of the present invention shown for fitting therein to urge threaded segments along the slide surfaces;

Fig. 7 shows the nut components of Fig. 6 assembled together into the quick acting nut assembly with a threaded portion of a bolt fitted therethrough;

Fig. 8 shows an exploded view of still another embodiment of the quick acting nut assembly, showing the nut body thereof as including lower slide surfaces bent below the horizontal and spaced apart upwardly extending wings that are arranged for bending appropriately into the nut body to form upper slide surfaces and shows a wave tension retainer of the present invention aligned for installation within the nut body for biasing the threaded segments towards the nut body longitudinal center;

Fig. 8A shows a cross-section of the assembled nut of Fig. 8;

Fig. 9 shows the assembled quick acting nut of Fig. 8A turned onto a bolt;

Fig. 10 shows an exploded view of another embodiment of a quick acting nut assembly that includes a cylindrical nut body housing aligned to receive arcuate threaded segments fitted therein wherearound a wave tension retainer is aligned to be positioned, and shows a cap aligned for fitting thereover.

Fig. 11 shows a cross-sectional view of the components of Fig. 10 assembled together and fitted onto a threaded shaft or shank; and

Fig. 12 shows a top plan view of the arcuate threaded segments of Fig. 10 showing how the individual segments are marked, respectively, with (0, -, and +) for identifying the particular segments and for positioning them within the nut body.

DETAILED DESCRIPTION

Heretofore, quick acting nut assemblies have generally involved a nut body whose fabrication has involved a number of machining steps to form a proper interior cavity wherein threaded arcuate segments are arranged. For example, such arrangements, to provide a proper meshing of threads of the arcuate segments with the threads of a shank or shaft, have involved forming slide or wedge surfaces therein to close angular tolerances thereby necessitating a use of expensive precision machinery techniques. The present invention either fabricates the nut body from a conventional thin wall of magnetically attractive tube that is shrunk to have, preferably, a hexagonal shape or forms the nut components from plastic by conventional molding methods. The quick acting nut of the present invention can therefore be formed without the heretofore required machining steps. Current manufacturing practices can easily be adapted to manufacture the hexagonal shaped threaded segments from metal or plastic for fitting within such nut body and using such conventional methods allows the components of the nut assembly to be economically manufactured.

Fig. 1 shows a schematic of a wall steel tube 10, formed of a magnetically attractive metal hereinafter referred to as tube, aligned for telescoping over a hexagonal or hex-shaped bar electrode 11, hereinafter referred to as electrode. Electrode 11 is shown to include wires 12a and 12b that extend from out of the electrode top that, it should be understood, connect the electrode to a conventional source of electrical current that will produce a magnetic force of attraction between that electrode and tube. Though, not shown and dependent upon the power required to properly shrink different points or sections along the tube, different locations along the electrode can be separately connected to different or variable power sources within the scope of this disclosure.

Fig. 2 shows the tube 10 installed over the electrode 11 that has been collapsed or shrunk to the hexagonal shape of that electrode as a consequence of the force of magnetic attraction generated at that electrode. In practice, a thin wall steel tube having a tube wall thickness that is approximately 2-5% of the nut overall diameter, which diameter is selected to be in direct proportion

to the anticipated design load, is selected for installation over the electrode 11. The electrode is electrically connected so as to receive a voltage that is in direct proportion to the tube wall thickness to produce a sufficient force of magnetic attraction to induce the collapse of the tube to the mandrel shape, taking into account the tube material strength. The voltage input will vary in relation to the particular tube wall thickness and strength of the tube material to produce the desired shrinkage. The process of the present invention can therefore be practiced over a range of sizes and strengths of thin wall magnetically attractive tubes to an upper limit to obtain proper shrinkage to the electrode shape for a malleable tube of approximately a wall thickness of 1/8 of an inch.

Shown in Fig. 2, the tube 10 has been shrunk, as described above, to the shape of the hexagonal electrode 11. Though, of course, shapes other than the hexagonal shape shown could be so used as could an electrode that is formed in sections that are electrically isolated from one another and connect to different electrical sources for providing appropriate forces of magnetic attraction exerted on the tube, as needed, to shrink it to the desired shape. After shrinking, as shown in Fig. 3, the tube is installed over mandrel 13 to where cross cuts can be made in that tube to form the nut body. Such cuts can be made with a conventional diamond saw or the like, not shown. The mandrel includes an upwardly sloping anvil end 14 whereagainst nut body end sections can be bent. The preferred cuts are shown in Fig. 3 identified by arrow A, to leave, as remainders, lower wing sections 15. Thereafter, the lower wing sections 15 are bent upwardly as by hammering them against anvil end 14, to form a nut body first or lower slide surface that will be described in detail later herein with respect to Fig. 4. As an alternative to bending the nut body end sections, said sections can be cut into the thin wall tube before shrinkage and the electrode formed to the desired shape to appropriately bend said tube ends to the electrode end. Also, other cuts that are shown in broken lines identified in Fig. 3 by arrows B and C, can be made across the tube to form alternative nut body embodiments that will be discussed later herein with respect to Figs. 4, 6, and 8. Cutting tube 10, as illustrated by the broken lines identified as arrow B provides a lip 16 that extends outwardly from around a top edge of the nut body. Lip 16 can be rolled inwardly as illustrated in the nut embodiments of Figs. 5 and 7 to contain a nut cap 29. Or, tube 10 can be cut, as illustrated by the broken lines shown as arrow C, to leave upper wing sections 17 that extend upwardly therefrom. These wing sections can then be

bent, as illustrated in the nut embodiment of Fig. 9, to form an upper slide of the nut body, which arrangement will be discussed more fully in detail later herein.

Fig. 4 shows an exploded view of a first embodiment of a quick acting nut assembly 20, hereinafter referred to as nut 20. Nut 20 is shown to consist of a nut body 21, that is preferably formed, as described above, from a section of tube 10, that has been cut, as illustrated by arrows A and B to form a nut body 21. The nut body has a hexagonal inner cavity with flat walls 21a and includes bending the lower wing sections 15 bent upwardly at 22a to form lower slide 22. This bending can be done using the mandrel 13, described above, or with an appropriate electrode 11 after the tube 10 end has been cut appropriately and subjected to sufficient electrical current to bend the wing sections 15 to form that lower slide 22. The lower slide 22 is bent to an angle above the horizontal that is approximately that of the helix or threaded angle of threaded segments hereinafter referred to as thread angle. The slide 22 thread angle is to a plane across said thread and, for a large nut that angle is generally approximately thirty degrees (30°).

Three threaded segments 23, that each are essentially pie shaped of approximately one hundred twenty degrees (120°) are fitted together to have the shape of a conventional hexagonal shaped nut and to provide continuous threads 25 therethrough shown in Fig. 5. Except, of course, such assembled nut is broken at gaps 23a that are, as set out above, spaced apart approximately one hundred twenty degrees (120°) of arc radially from a vertical center. The threaded segments top 28 and bottom 27 faces are parallel to each other and slope at the angle of the lower slide 22 to the horizontal. Though the shown three threaded segments 23 are preferred, it should be understood that more than three segments could be so arranged together to form the assembly of threaded segments 24 within the scope of this disclosure. So arranged, as shown in Fig. 5, movement apart of threaded segments 23 causes the gaps 23a therebetween to open, increasing the diameter of the vertical passage therethrough to allow a threaded shaft or shank 36 of a bolt 35 to travel past threaded segment threads 25. When, however, the threaded segments are moved into engagement with the threads of that shaft, closing the gaps 23a, the threaded segment threads 25 will mesh with the threads 36 of that threaded shank. To encourage this inward movement, a spring 26 is provided to fit within a groove 26a that is formed in each threaded segment to form a continuous groove around the outer circumference of the assembly of threaded segments

24 for biasing the segments together. Spring 26 is preferably a rubber band stretched to fit within groove 26a to provide a uniform biasing at all points therearound. The groove 26a is cut at a greater depth at the intersections of faces 23b of the threaded segments' outer surfaces than across the surfaces thereof such that the rubber band, when fitted therein, will not extend beyond the plane of the individual faces of the assembly of threaded segments 24. Such rubber band as spring 26 is, of course, suitable when the nut 20 is not subjected to a high torquing force. Where a greater holding force is required, the rubber band can be replaced with a wave tension retainer like that shown at 48 in Fig. 6 or another biasing arrangement, not shown, within the scope of this disclosure.

Fig. 5 shows that the threaded segments 23 each have a lower or bottom face 27 and a parallel top or upper face 28, both of which faces are parallel and are sloped at an angle to the horizontal to conform to the slope angle of lower slide 22 of the nut body. A cap 29 is arranged for fitting into the nut body 21 and includes a slide 30 as an undersurface thereof. Slide 30, when the cap is installed to the nut body as shown in Fig. 5, is parallel to the described upper and lower face 28 and 27 of the assembled threaded segments 24 and the lower slide 22 of the nut body. The cap has a center opening 31 wherethrough the threaded shank 35 will pass freely. The cap is preferably secured within the nut body across the nut body upper end by bending lip 16 of Fig. 3 inwardly at approximately a right angle.

In Fig. 5, the components of nut 20 of Fig. 4 are shown assembled together, with the individual threaded segments 23 fitted together into the assembly of threaded segments 24. The threaded segments are sandwiched between nut cap upper slide 30 and the nut body lower slide 22 leaving sufficient spacing between flat outer surfaces 23b and the nut body walls 21a to allow for segment travel back and forth along slides 22 and 30. Segment biasing towards the nut body longitudinal center is provided by spring 26. So arranged, a forcing of the threads 36 of the threaded shaft or shank 35 pushed or moved past segment threads 25 causes the one set of threads to travel over the other, overcoming the biasing force of spring 26. A ratcheting movement is thereby provided, the threaded segments moving back and forth along upper and lower slides 30 and 22 as the shank threads 36 move over the segment threads 25, until the nut body surface contacts a work piece 37. Thereat, with a minimum rotation or turning of the nut body 21, as with a conventional wrench fitted thereover, the engaged threads will be drawn into one another.

Shown in Fig. 5, an elastomer stop washer section 32, hereinafter referred to as washer section, is provided as a top flight of threads 25 that will be most proximate to the work piece when the nut 20 is installed to threaded shaft or shank 35. When the threaded segments are assembled the stop washer segments form a continuous washer that will be compressed or deformed when the nut 20 is tightened appropriately, the stop washer flowing into the threads 36, providing a locking thereto. Removal of the nut 20 off from the threaded shaft or shank 35 requires a full turning of the nut over the entire thread length. During such turning, the biasing of spring 26 continues to maintain the threaded segments in a meshing engagement.

Shown in Fig. 5, nut 20 has threaded shaft or shank 35 fitted downwardly therethrough such that the nut cap 29 is the surface that engages work piece 37. Obviously, this arrangement could be reversed with the nut end at bend 22a contacting and turned against a work surface. Such reversal would, however, require a repositioning of the washer section 32 to where it would then occupy the thread flight immediately next to lower slide 22. Of course, like the nut 20, all the embodiments of quick acting nut assemblies hereinafter shown and described could, with minor adjustments only, be reversed or turned over from the described use. Further, the functioning and operation of this and the following quick acting nut assemblies for turning against a work piece is essentially like the description of the functioning and operation of my earlier patent, U.S. Patent No. 4,378,187, in that the individual threaded segments are biased to move along parallel sloping surfaces within the nut body toward a center vertical axis therethrough, which axis will be occupied by a threaded shaft or shank.

Fig. 6 illustrates another embodiment of a quick acting nut assembly 40, hereinafter referred to as nut, that is similar in appearance and functioning to nut 20 except as to its slide arrangement and the preferred threaded segment biasing. Like nut 20, nut 40 also utilizes a nut cap 52 that is for fitting within a nut body 41 and is preferably maintained therein by rolling of nut body lip 41c over the cap edge as illustrated in Fig. 7. Further, the nut body 41 is also preferably formed by shrinking the thin wall steel tube, as described above, except the wing sections 15 that extend from the nut body bottom edge, as shown in Fig. 3, are to be bent twice. Shown in Fig. 6, a first bend 41a translates the wing section upwardly such that the section will extend alongside and essentially parallel to a nut body interior wall 41b. The second bend 42 is made downwardly to form a downwardly sloping lower slide 43. Additionally,

as will be set out in more detail hereinbelow, nut 40 preferably utilizes a wave tension retainer 48 for biasing individual threaded segments 44 shown as an assembly of threaded segment 45, for fitting within the nut body. However, both the rubber band 26 and wave tension retainer 48, and a wave tension retainer 70, set out later herein with respect to Figs. 8 and 9, could be used as the spring biasing of the individual threaded segments. The wave tension retainer 48 is preferably formed from a single wire 49 that is bent back and forth at 50 in serpentine fashion and is joined at its ends. In the bending process a torsional stress or twist is introduced into the wire over its entire length.

The wave tension retainer 48, between the bends 50 is of a height to fit in a groove 47 that is formed around the threaded segments 44 shown in Fig. 6. So arranged, the wave tension retainer tends to resist further twisting of the wire 49 as would occur when the assembled threaded segments 45 are each urged outwardly as the assembly is passed over and along a threaded shaft or shank. The tendency to resist twisting provides the required biasing to urge the threaded segments towards the longitudinal center and is uniformly applied across the groove 47. Of course, that resistance to twisting of the wire 47 is dependent upon wire thickness. Therefore, by a selection of a particular gauge or thickness of wire from which to construction of the wave tension retainer a desired force of spring biasing can be produced. The wave tension retainer can therefore be constructed for use with nuts like the nuts 20, 40 and 60 set out above, and as appropriate, can be fabricated of plastic, as set out hereinbelow, or can be fabricated from a thick wire for use in nuts holding many tons of force like the quick acting nut assembly of the earlier U.S. Patent, No. 4,378,187, of the present inventor, within the scope of this disclosure.

Like the above described operation of nut 20, shown in Fig. 7, as the threads 56 of a threaded bolt, shaft or shank 55 are pushed between segment threads 46 of nut 40, and shaft threads 56 will travel over, the segment threads, the segments ratcheting back and forth along slide 43 against the biasing of the wave tension retainer 48. The shank 55 travels through the threaded segments until the nut surface engages a work piece. Thereafter, by appropriately turning the nut, the threaded segments threads 46 engage and turn on the shank threads 56, tightening the nut against a work piece, and meshing an elastomer washer 57 that is shown in Fig. 7, to deform into a flight of shank threads 56 so as to provide a locking thereto. As with the nut 20

embodiment, this and the other nut embodiments set out herein will all include threaded segments that, after they are turned into locking engagement with the threads of a shank, will need to be turned fully off of that shank for removal.

As shown in Fig. 6, and as set out above, lower wing sections of the nut 40 embodiment are preferably cut somewhat longer than they are for the nut 20 embodiment to accommodate a first bending by rolling or like technique of each wing section into the nut body at 41a. Whereafter, the wing section is again bent downwardly at 42 to form lower slide 43. Slide 43 is at an angle below the horizontal that is approximately that of the thread angle of the threaded segments 44 and shank threads 56. In practice, this thread angle is approximately thirty degrees (30°) but, of course, can vary with the threads used within the scope of this disclosure. So arranged, lower slide 43 will support the assembled threaded segments 45 that, it should be understood, are like the above-described threaded segments 24 except that the slope of the top and bottom face thereof slants downwardly from the horizontal at an angle that is the angle of the lower slide and an upper slide surface. Like the assembly of threaded segments 24, the assembly of threaded segments 45 also preferably have a hexagonal outer shape to fit within the cavity of a nut body 41. Though, of course, the threaded segments could each be formed to have an arcuate shape to assemble into a flat cylindrical or disk shape for installation within a cylindrical nut body cavity within the scope of this disclosure. In either arrangement, the segment threads 46 form a continuous thread axially therethrough. Also, each threaded segment preferably includes the elastomer stop washer section 57 as a lower or bottom thread flight thereof. As with the elastomer stop washer sections 32 of Figs. 4 and 5, the stop washer that is assembled from fitting the washer sections 57 together will deform into the shank threads 56 when the nut 40 is installed thereover, as illustrated in Fig. 7.

With spring biasing preferably provided by the wave tension retainer 48, the threaded segments are urged towards the center vertical axis, as shown best in Fig. 7. So arranged, the grooves 47 within the flat exterior surfaces 44a of each nut segment 44 will receive and contain the serpentined wire 49 between bent ends 50. The wave tension retainer is thereby arranged to uniformily urge the threaded segments towards the vertical center axis. With assembly of nut segments 45 contained within the wave tension retainer 48 the assembly can be positioned within the cavity of nut body 41 and the nut cap 52 installed thereover, as shown best in Fig. 7. The nut cap 52, like the described nut cap 29, includes a lower face 54 that is sloped at an angle from

the horizontal that is at the same angle and is parallel to the lower slide 43. Shown in Fig. 7, the nut cap 52 is preferably retained over the nut body, to sandwich the threaded segments and wave tension retainer within the nut body cavity by rolling or pressing a nut body lip 41c over the nut cap edge.

The nut 40, as shown best in Fig. 7, and as described with respect to the nut 20 of Figs. 4 and 5, is installed over a bolt threaded shank 55, the threaded segments ratcheting over the shank threads against the biasing of wave tension retainer 49, until the nut contacts a work surface. Whereafter, with appropriate turning through usually less than one revolution of the nut, the nut 40 can be tightened thereagainst as illustrated in Fig. 7. In that tightening the elastomer washer segments 57 will be deformed into the threads 56.

Still another embodiment of a quick acting nut assembly 60 of the present invention, hereinafter referred to as nut 60, is shown in Figs. 8, 8A, and 9. Fig. 8 shows nut 60 as including a nut body 61 that includes a lower slide 62. The lower slide 62 is preferably formed, as has been described with respect to nut 40 of Fig. 6, by bending at 62a, wing sections like the wing sections 15 shown in Fig. 3. In such bending each wing section will come to rest at a vertical or essentially parallel attitude with respect to an inner wall 61a of the nut body 61. Thereafter, each wing section is bent downwardly at 63a to form lower slide 62. Lower slide 62, like the described lower slide 43 of nut 40 of Fig. 6 is angled relative to the horizontal at approximately the thread angle of threaded segments 67. Additionally, the nut body 61 top portion is preferably formed by bending wing sections 17, identified with arrow C in Fig. 3, to below the horizontal. An upper slide 66 is formed from the wing sections 17 by first bending each wing section at 64a to form a first section 65 that is essentially parallel to a nut body interior side wall 61a. Whereafter, that wing section is again bent at 64b to below the horizontal, as shown in Fig. 8A, to form an upper slide 66. Each upper slide 66 extends from bend 64b into the nut body cavity and is essentially parallel to, and at the same angle below the horizontal as is the lower slide 62. The bending of wing sections of Fig. 3 to form the upper and lower slides 66 and 62 is preferably accomplished by first rolling the wing section to form lower slide 62 into the nut body cavity forming lower slide 62, as described. Thereafter, the assembly of threaded segments 67 are fitted within the wave tension retainer 70, and the assembly passed into the nut body whereafter the upper wing section is likewise rolled into the nut body cavity to form the upper slide 66. The threaded segments 67, shown in Figs. 8 and 9, are preferably identical to the described threaded

segments 44, and the wave tension retainer 70 is like the described wave tension retainer 48, in that it is formed from a wire 71 that is bent at 72 upon itself in serpentine fashion with the wire ends joined together. So arranged, the wire 71 between the loop ends 72 is loaded with a torsional or twist stress to resist the threaded segments 67 being moved away from a vertical center axis through the assembly of threaded segments. It is this center axis, of course, that receives a threaded bolt shaft or shank 75 fitted therethrough. The wave tension retainer 70 thereby urges the threaded segments towards the vertical axis which force is uniform over the width of the groove 69 wherein the retainer is seated. Like the earlier described threaded segments, each threaded segment 67 preferably also includes an elastomer washer section 73. The washer sections, when the threaded segments are assembled together, provides a continuous washer that occupies the lower flight of thread 74 of the thread segments, and will deform into the threads 76 of shank 75 when the nut 60 is wrenched against a work surface.

In operation, as with the earlier described nuts, nut 60 and the nut threads 74 can be forced over the threaded shank 75, the threaded segments thereby ratcheting back and forth along slides 62 and 66 against the biasing of the wave tension retainer 70 until that nut reaches a work piece, as shown in Fig. 9. Whereafter, with minimum wrenching, the nut is tightened against that work piece. In that tightening the elastomer washer segments 73 deforms into the shank threads 76, providing a locking thereto.

The above description sets out preferred arrangements of nuts 20, 40, and 60 along with a process for their manufacture to include: shrinking a thin wall steel tube into a multi-sided shape, preferably a hexagonal shape, and either forming the nut body ends in that shrinking process or appropriately cutting portions therefrom so as to leave as remainders upper and lower sections projecting from the nut body. The lower section is then rolled, folded, bent, hammered, or the like, to form at least a lower slide surface. The described threaded segments and wave tension retainer are then installed in the nut body cavity to rest on the lower slide. Thereafter, in one embodiment a nut body lip is then rolled over to an edge of a nut cap securing that cap thereover. In another embodiment, the upper slide is formed from wing sections that are rolled, folded, bent, or the like, into the nut body to form the upper slide surface. The described procedures for cutting and forming the nut body ends are, of course, preferred, though it should be understood that other techniques or procedures could be used within the scope of this disclosure for forming the described nut body.

In Figs. 10 and 11 is shown still another embodiment of a quick acting nut assembly 80 that, preferably, is formed from a plastic suitable for conventional molding methods. Shown in the exploded view of Fig. 10, the quick acting nut assembly, hereinafter referred to as nut 80, includes a body 81 that consists of a foot portion 82 whereto is centrally mounted a cylinder 83 at a right or normal angle. The foot is notched at 84 to receive a tool, not shown, for fitting therein to hold or turn the nut 80. Fig. 10 shows the cylinder 83 as having had a section removed therefrom to expose a central longitudinal opening 85 therein that terminates in a step 86 that is shown to slope downwardly from the horizontal to form a lower slide surface 86. The angle to the horizontal of which slide surface 86 is preferably approximately the thread angle of a shaft or shank for fitting therethrough and is for receiving and guiding the travel of an assembly of threaded segments 93 thereon. Additionally, extending outwardly from which slide surface 86 is shown a pier 87 that is for fitting into a slot formed in the undersurface of a thread segment for prohibiting movement thereof around the slide surface 86. The slotted arcuate threaded segment 93 is preferably identified, as illustrated in Fig. 12, by scribing thereon during its manufacture an identifying mark, preferably on its upper face. Additionally, as shown in Fig. 12, the other arcuate threaded segments are also identified with marks on their upper faces during their manufacture to identify their preferred assembly arrangement. Shown therein, the preferred markings are +, - and 0.

Shown best in Fig. 10, a groove 88 is provided around the cylinder top portion next to the central opening 85. Above the central opening 85 are shown aligned three threaded segments 89. Each of which threaded segments has somewhat of a pie section shape with an arcuate outer surface of approximately one hundred twenty degrees (120°) of arc. Opposite the arcuate surface is a threaded surface, and each threaded segment has parallel identically slopping upper and lower slide surfaces 91a and 91b that are formed as top and bottom faces. The slide surfaces 91a and 91b are at the same angle to the horizontal as is the body lower slide surface 86 and a top or upper slide surface 100. The threaded segments to be contained between the respective lower and upper slide surfaces. Each threaded segment 89 at its arcuate or rounded surface 90 has a wide groove or slot 92 inset therein with sections of threads 93 formed in the opposite surface. The sections of threads 93, when the segments are joined together align to form a continuous thread for encircling and turning on a threaded shaft or shank 101, shown in Fig. 11.

Shown in Fig. 10, aligned with the threaded segments 89 is a wave tension retainer 94 that consists of a length of material 95 that is bent on itself at bends 96 in serpentine fashion and is joined at its ends. The wave tension retainer, like the other components of nut 80, is preferably fabricated from plastic, but could be made of metal within the scope of this disclosure. The wave tension retainer 94 is for installation in slot 92 to urge or bias the threaded segments 89 towards a center vertical axis therethorugh. Functionally, the wave tension retainer 94 is like the wave tension retainers 48 and 70 described above. Whether made from metal or plastic the length of material 95 is subjected to torsional or twisting stress in the formation process so as to provide a consistent force resisting expansion exerted over its height to uniformly bias the threaded sections 89 inwardly.

A cap 97 is provided to close over the top over body 81. The cap includes a flange end 98 for fitting over the cylinder 83 top with a toe portion 99 of that cap for fitting into groove 88 formed around the cylinder top. The cap 97 includes slide surface 100 as the undersurface thereof that accommodates the threaded segment upper slide surface 91a traveling thereon. The cap 97 is preferably secured across the body cylinder 83 as by an application of an adhesive between the top flange end 98 and toe portion 99 and cylinder top and groove 88 therein.

Fig. 11 shows the assembled nut 80 turned onto a threaded shank 101 that extend outwardly from a work piece 102 surface whereagainst the nut 80 is turned. The positioning of which nut 80, as described with respect to nuts 20, 40, and 60, involves sliding the nut 80 onto the shank. The shank threads to urge the threaded segments 89 back along the upper and lower slides 100 and 86, against the biasing of the wave tension retainer 94 until the nut under surface engages the work piece. Whereat the nut can be turned into tight fitting engagement. In which turning, a lower flight of threads 93, which threads are preferably plastic, will somewhat deform to the shank threads, providing a locking thereto.

While a number of preferred quick acting nut assemblies of the present invention have been shown and described herein as has a preferred process for certain of their manufacture, it should be understood that the present disclosure is made by way of example only and that arrangements and modifications to the described process for forming the nut assembly, additional to those shown herein, are possible without departing from the subject matter coming from the scope of the following claims, which claims I regard as my invention.

CLAIMS

1. A quick acting nut assembly comprising a multi-faced nut body that is open through a center vertical axis and has a like multi-faced internal cavity that is defined by the nut body walls and parallel upper and lower slide surfaces which are sloped at an angle to a horizontal plane that is approximately the thread angle of a threaded shank arranged to occupy said open center vertical axis; threaded segment means that, when fitted together, have a like multi-faced shape to that of said nut body cavity for installation therein and present a threaded center vertical axis therethrough for turning on said threaded shank, each threaded segment means having upper and lower faces that are parallel to each other and are inclined to the horizontal to the slope of said slide surfaces and are in sliding engagement therewith; and spring biasing means arranged between said nut body walls and encircling said threaded segment means for uniformly biasing each said threaded segment along said slide surfaces towards the center vertical axis.

2. A quick acting nut assembly as recited in Claim 1, further including, a segmented elastomer washer means each segment for inclusion as a last thread flight of each threaded segment means for forming a continuous washer when said threaded segments are fitted together, said elastomer washer to deform into the threads of a threaded shank.

3. A quick acting nut assembly as recited in Claim 1, further including, cap means for arrangement over the nut body cavity, to contain the threaded segment means therein and provide the upper slide surface as a lower face thereof.

4. A quick acting nut assembly as recited in Claim 1, wherein the spring biasing means is a rubber band arranged to fit within a continuous groove formed around the assembly of threaded segment means multi-faced surfaces.

5. A quick acting nut assembly as recited in Claim 1, wherein the spring biasing means is a wave tension retainer means that consists of a section of material that is twisted to provide a tensile loading, is bent in serpentine fashion and is joined at its ends, the distance between opposite bends to be equal and somewhat less than the width of a continuous groove formed around the assembly of threaded segment means, said continuous groove to receive said wave tension retainer means fitted therein in close fitting engagement.

6. A quick acting nut assembly as recited in Claim 5, wherein the section of material is a metal.

7. A quick acting nut assembly as recited in Claim 5, wherein the section of material is a plastic.

8. A quick acting nut assembly as recited in Claim 1, wherein the nut body has a hexagonal exterior shape that is mirrored in its internal cavity and the threaded segment means consist of three threaded segments that, when fitted together, form a like hexagonal shape that is of lesser diameter than said internal cavity.

9. A method of manufacturing a quick acting nut assembly including the steps of installing a thin wall cylindrical tube formed of a magnetically attractive material over a multi-faced electrode and applying a sufficient current to that electrode to create a force of magnetic attraction between said electrode and said thin wall tube to shrink that tube to the electrode shape; cutting the shrunken tube to form a quick acting nut assembly body to leave upper and lower remainder sections that project outwardly from said nut body ends; bending the remainder sections of one end into the nut body interior as a first slide surface so as to leave a center opening therethrough which slide surface is sloped at an angle to the horizontal that is approximately the thread angle of the threads of a threaded shank for fitting axially through said center opening; installing, within the body cavity, an assembly of threaded segments and a biasing means for moving said threaded segments towards the nut body vertical center axis; and closing said nut body open end with a second slide surface that is parallel to the first slide and the upper and lower threaded segment faces.

10. A method as recited in Claim 9, wherein the thin wall steel tube has a wall thickness of than one eighth (1/8) of an inch or less.

11. A method as recited in Claim 9, wherein the second slide surface is formed as the undersurface of a cap for fitting within the nut body cavity and is maintained therein by rolling the remainder section of said nut body open end over the cap edge.

12. A method as recited in Claim 9, wherein the first slide surface is formed by first bending the lower remainder sections into the nut body cavity and then bending said remainder sections above that first bend towards the vertical center axis of the nut body to below the horizontal to form a slide surface.

13. A method as recited in Claim 12, wherein the first and second slide surfaces are each formed by bending the remainder sections at the junctions to within the nut body forming the parallel first and second slide surfaces that are at the desired angle to the horizontal.

14. A quick acting nut assembly comprising a nut body formed from a thin wall tube that is shrunk to a multi-faced, shape, is cut laterally to leave remainder sections projecting from ends thereof, which remainder sections that project from one end are bent into said tube leaving an opening through the center vertical axis of said tube forming a first slide surface that is at an angle to the horizontal that is approximately the thread angle to the threads of a shank; threaded segment means for arrangement within said nut body to have a threaded vertical center axis that include parallel upper and lower faces sloped to the angle to the horizontal that is the slope angle of the first slide surface; a second slide surface extending into said nut body cavity maintaining said threaded segment means therein that is at the angle to the horizontal of the first slide surface, and is open through a nut body center vertical axis; and means for biasing said threaded segment means toward the nut body vertical center axis.

15. A quick acting nut assembly as recited in Claim 14, wherein the thin wall steel tube has a wall thickness of one eighth (1/8) of an inch or less.

16. A quick acting nut assembly as recited in Claim 14, wherein the electrode has a hexagonal shape.

17. A quick acting nut assembly as recited in Claim 14, wherein the first slide surface is formed by bending the remainder sections that extend from one nut body end into the nut body cavity to extend therein at an angle that is below the horizontal and is approximately the thread angle.

18. A quick acting nut assembly as recited in Claim 14, wherein the second slide surface is an underface of a cap for installation over the open nut body end, which cap is open through its center.

19. A quick acting nut assembly as recited in Claim 18 wherein the cap is secured over the nut body open end by bending a lip of the nut body end over the cap edge.

20. A quick acting nut assembly as recited in Claim 14, wherein the second slide surface is formed after the threaded segment means and biasing means are installed in said nut body cavity by bending remainder sections that extend from the nut body open end into the nut body cavity to be parallel to and at the angle to the horizontal of the first slide surface.

21. A quick acting nut assembly as recited in Claim 14, wherein the threaded segment means consist of three threaded segments that, when fitted together, will have the exterior shape of the nut body cavity but are of lesser diameter to fit loosely therein.

22. A quick acting nut assembly as recited in Claim 21, wherein the threaded segments each include, as lower thread flight, a segment of an elastomer washer means, that, when said threaded segments are fitted together, forms a continuous washer to deform into the threads of a thread shank.

23. A quick acting nut assembly as recited in Claim 14, wherein the biasing means consists of a wave tension retainer means for arrangement within a continuous groove formed around the assembled threaded segment means.

24. A quick acting nut assembly as recited in Claim 23, wherein the wave tension retainer means is formed from a section of material that can be twisted to provide a tensile loading that is bent in serpentine fashion and joined at its end, the distance between opposite bends to be equal and somewhat less than the width of the continuous groove that receives said wave tension retainer means fitted therein in close fitting engagement.

25. A quick acting nut assembly comprising a housing formed to have a cylindrical interior cavity that is open across a top end and terminates in a step across the opposite end, is centrally open therethrough and is internally stepped into a lower slide surface that is sloped to the horizontal at an angle that is approximately the thread angle of a threaded shank for insertion through said central opening; a plurality of arcuate threaded segment means for fitting in said housing central opening, that, when fitted together, present a threaded center vertical axis therethrough for turning on said threaded shank, each threaded segment means having upper and lower faces that are parallel to each other and are inclined to the slope of said slide surface, said arcuate threaded segment means each including a groove formed around the arcuate surface thereof that align to form a continuous groove when said threaded segment means are assembled together to receive a biasing means fitted therein for urging said arcuate threaded segment means towards the center vertical axis; a cap means for closing over said housing cylindrical interior cavity that includes, as the surface within said housing, an upper slide surface that is parallel to and at the angle to the horizontal of the lower slide surface; means for securing said cap means to said housing; and means for prohibiting rotation of said assembled arcuate threaded segment means when they are maintained within said housing cylindrical interior cavity.

26. A quick acting nut assembly as recited in Claim 25, further including means secured to said housing for receiving a turning tool means fitted thereto for turning said housing.

27. A quick acting nut assembly as recited in Claim 26,. wherein the housing is cylindrical and includes a foot portion on one end thereof that is notched appropriately as for means for receiving the turning tool means fitted thereto.

28. A quick acting nut assembly as recited in Claim 25, wherein the biasing means is a wave tension retainer means that consists of a section of material that is twisted to provide a tensile loading, is bent in serpentine fashion and is joined at its ends, the distance between opposite ends to be equal and somewhat less than the width of the groove formed around each threaded segment arcuate surface, said wave tension retainer means to fit closely within the continuous groove formed around the assembled arcuate threaded segments.

29. A quick acting nut assembly as recited in Claim 28, wherein the wave tension retainer means is formed from a plastic material.

30. A quick acting nut assembly as recited in Claim 25, wherein the cap means is disk shaped and is stepped from a lesser to greater thickness around its lower edge adjacent to the upper slide surface to fit closely within a notched formed around the housing open end; and adhesive means for securing said cap means to said housing open end at the fitted edges.

31. A quick acting nut assembly as recited in Claim 25, wherein the means for prohibiting rotation of said assembled arcuate threaded segments is a pier formed to extend upwardly from across the lower slide surface to fit within a slot formed in the undersurface of one of the arcuate threaded segments.

32. A quick acting nut assembly as recited in Claim 31, wherein the individual arcuate segments are separately marked to indicate their assembly order into the assembly of threaded segments.

33. A quick acting nut assembly as recited in Claim 25, wherein the housing and arcuate threaded segments are formed of a plastic material.

34. A wave tension retainer for a quick acting nut assembly comprising a section of material that is twisted to provide a tensile loading, is bent in serpentine fashion and is joined at its ends, the distance between opposite bends to be equal to fit closely within a continuous groove formed around an assembly of arcuate threaded segments.

35. A quick acting nut assembly as recited in Claim 34, wherein the wave tension retainer means is formed from a plastic material.

36. A quick acting nut assembly as recited in Claim 34, wherein the wave tension retainer means is formed from metal.

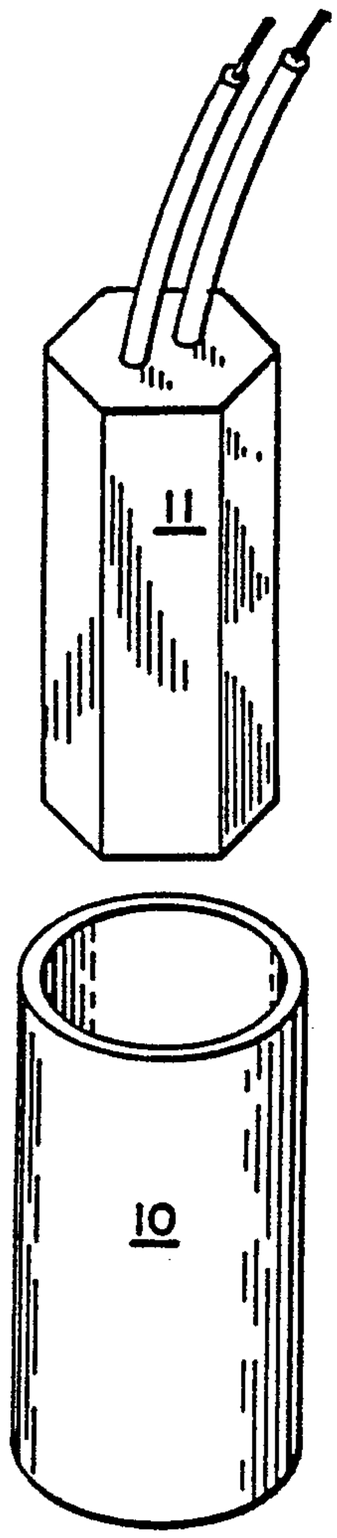


FIG. 1

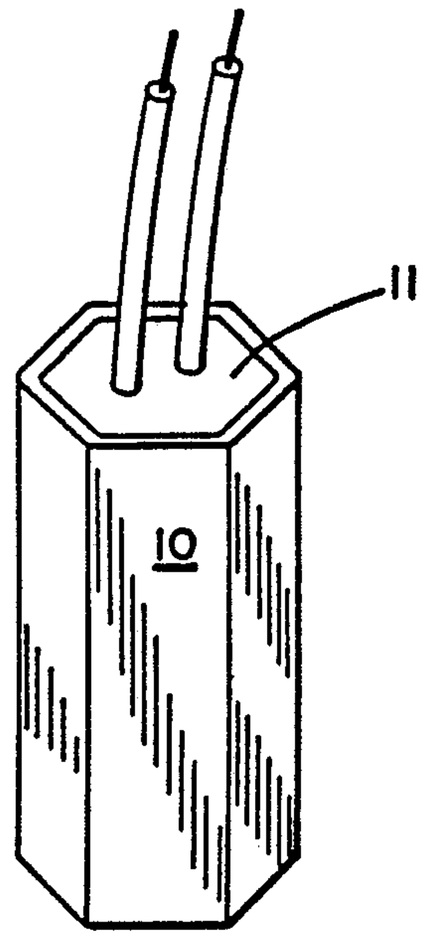


FIG. 2

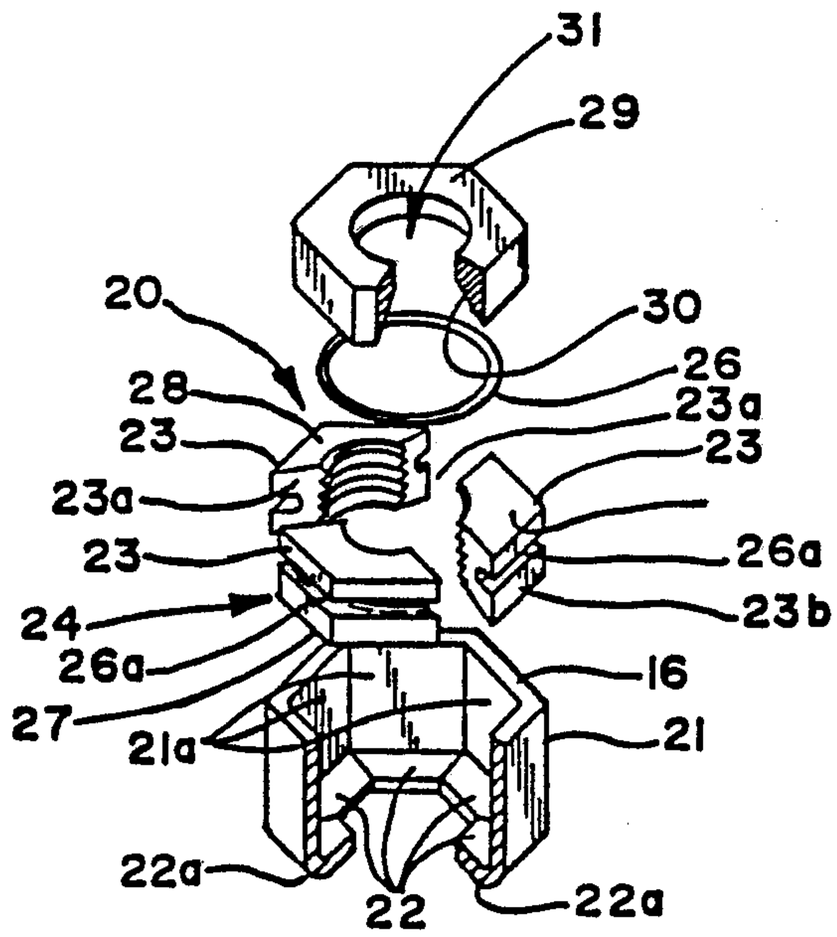


FIG. 4

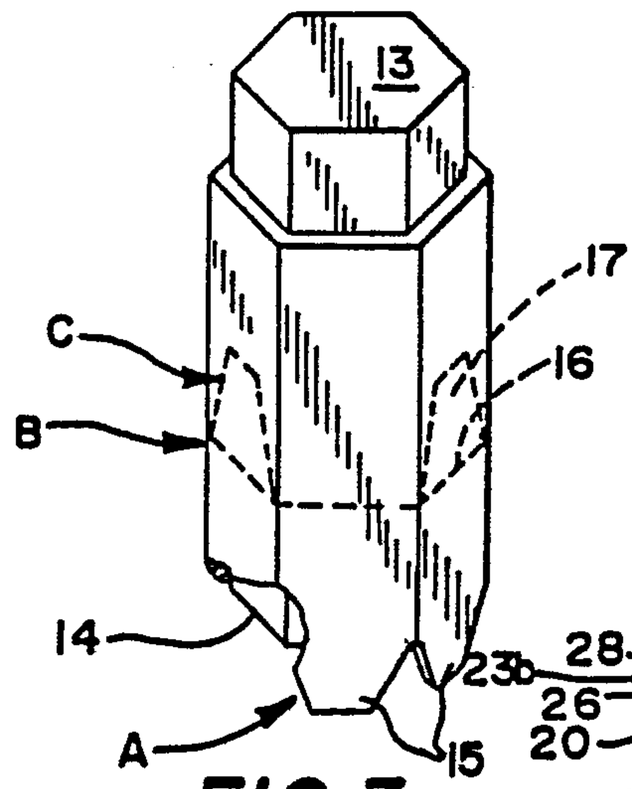


FIG. 3

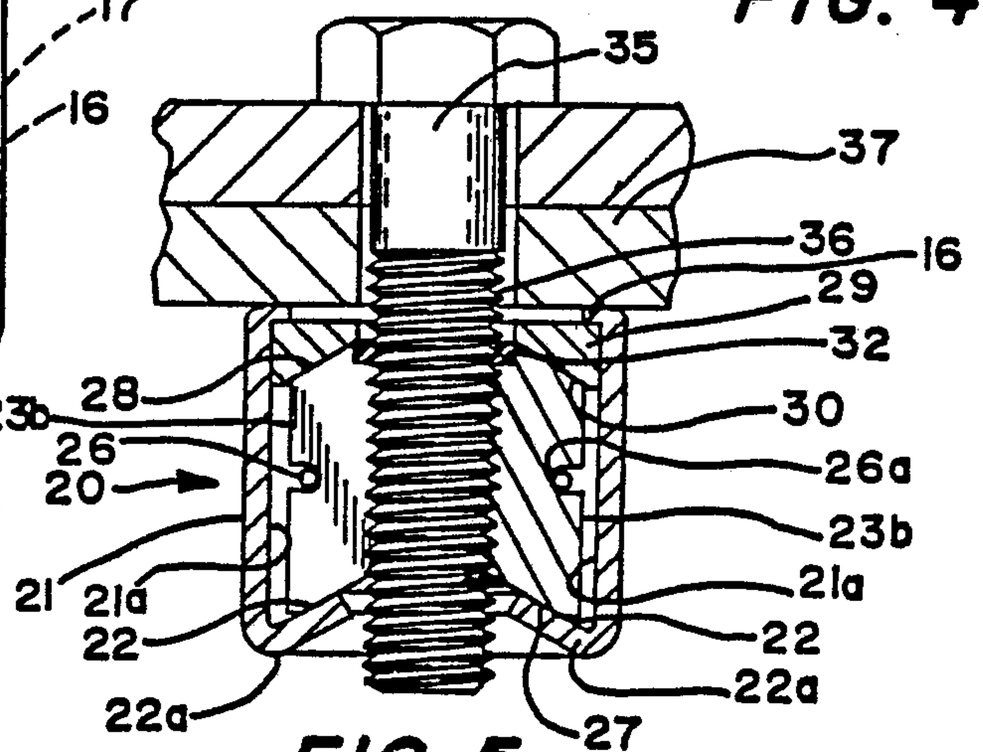


FIG. 5

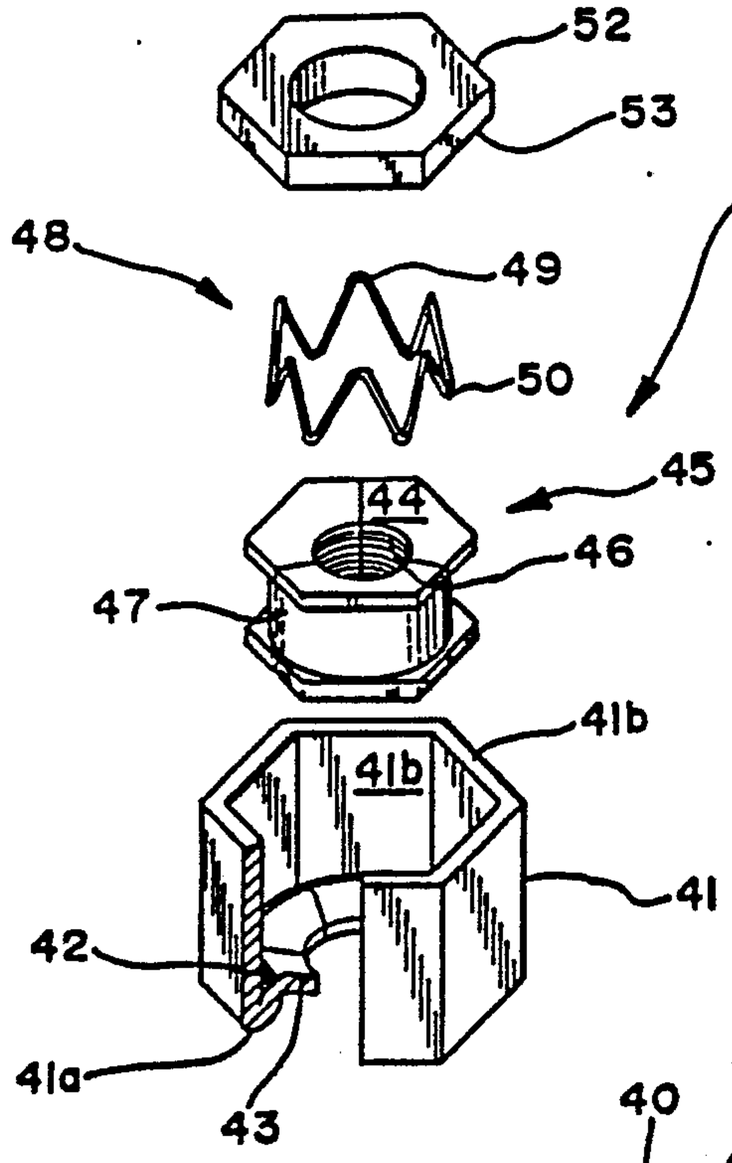


FIG. 6

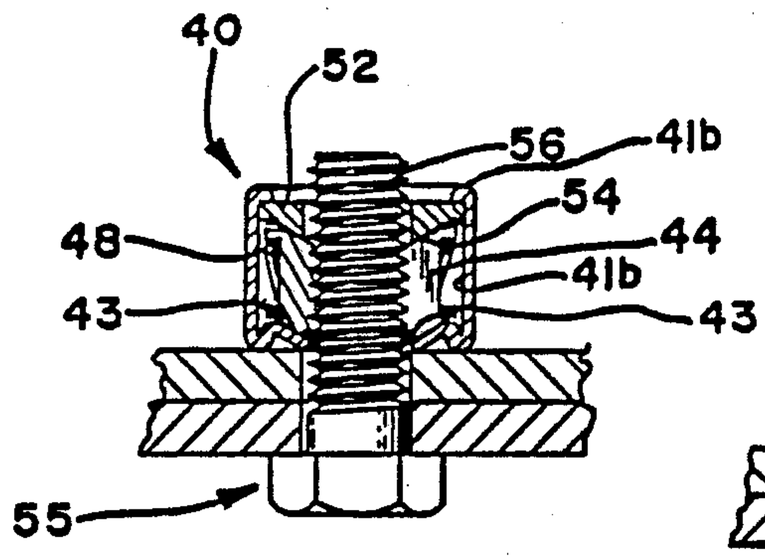


FIG. 7

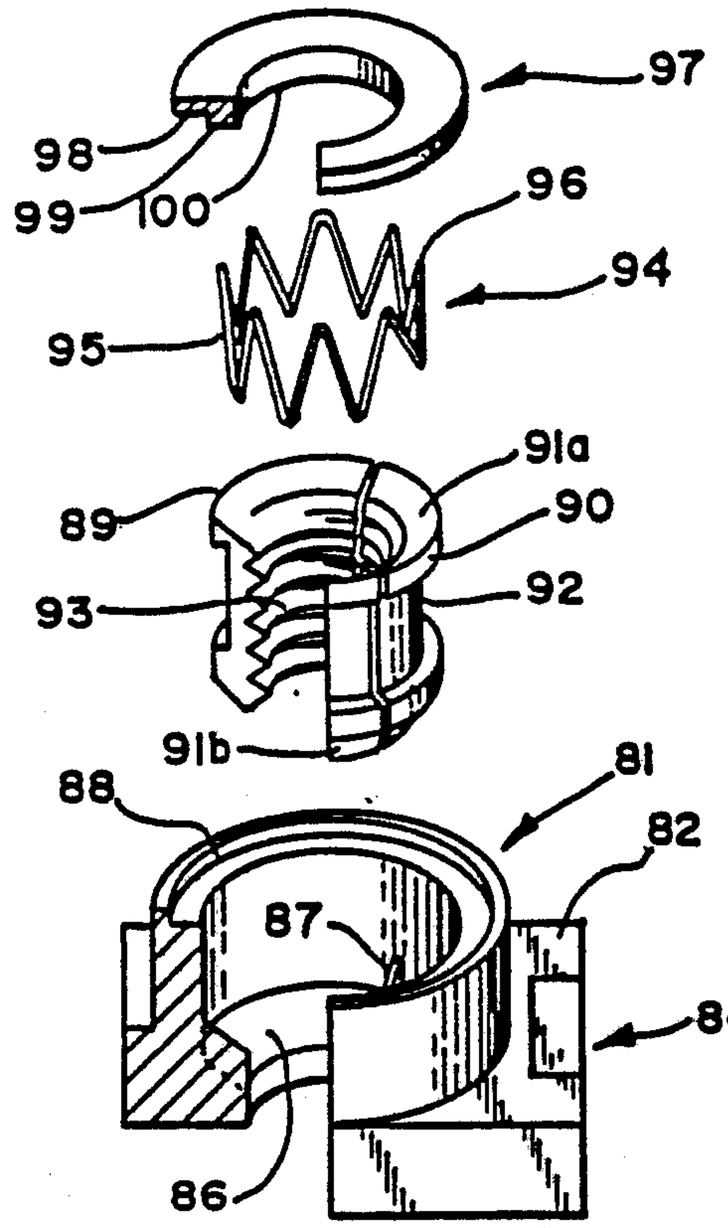


FIG. 10

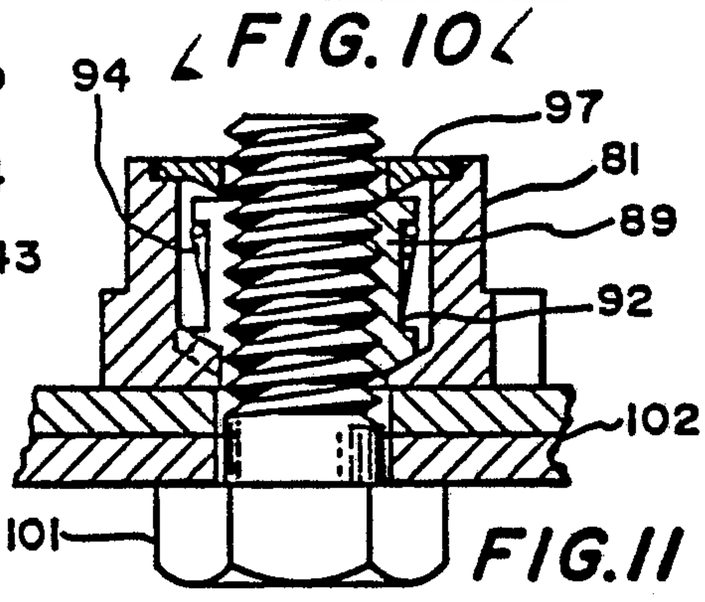


FIG. 11

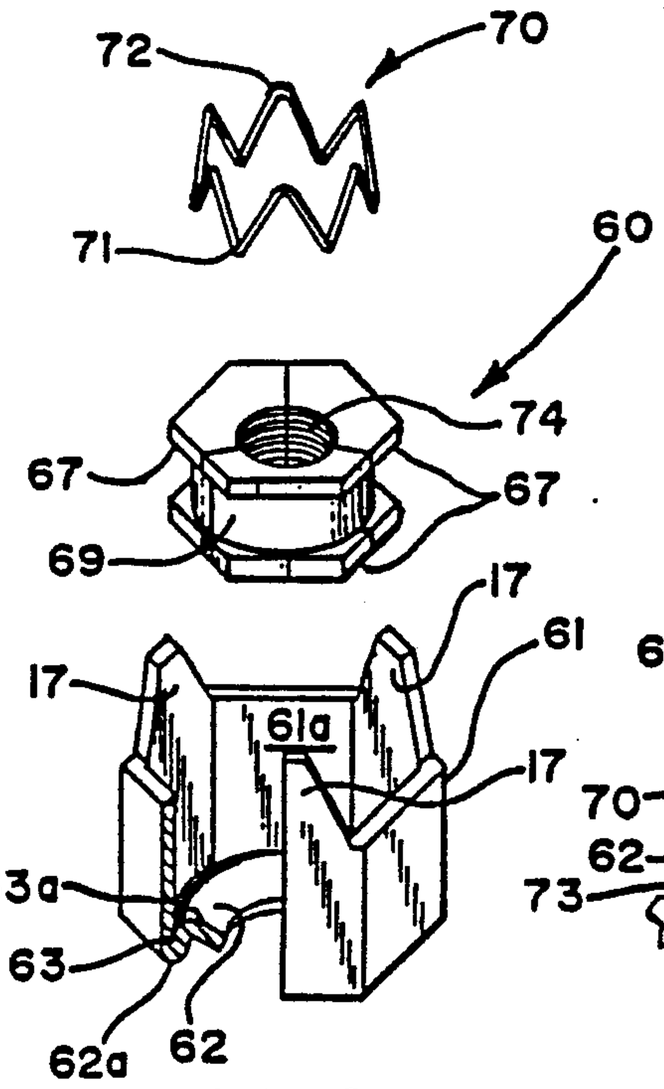


FIG. 8

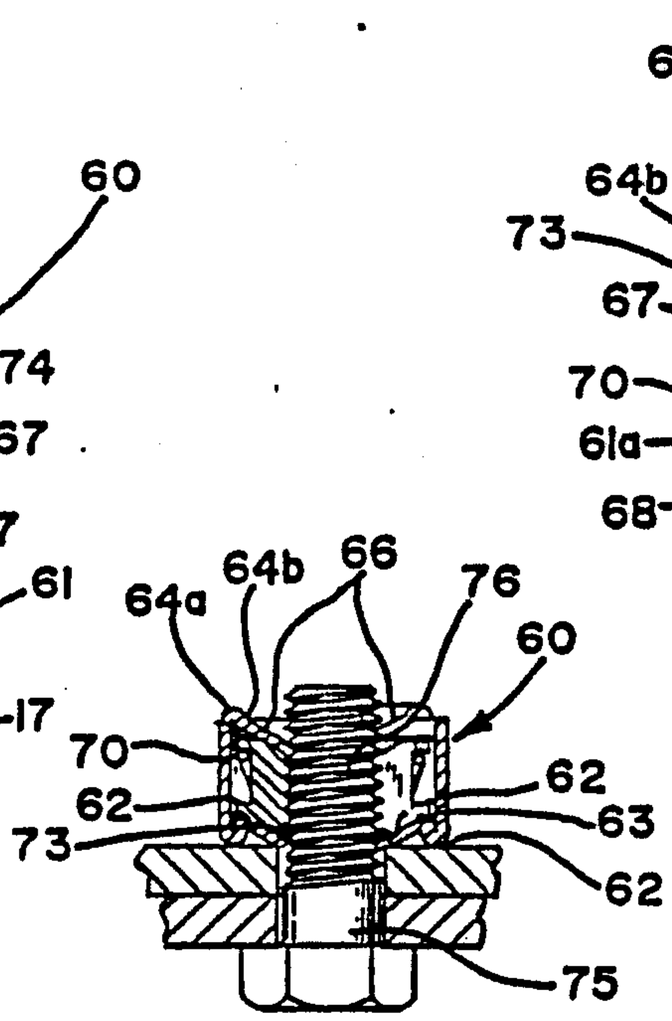


FIG. 9

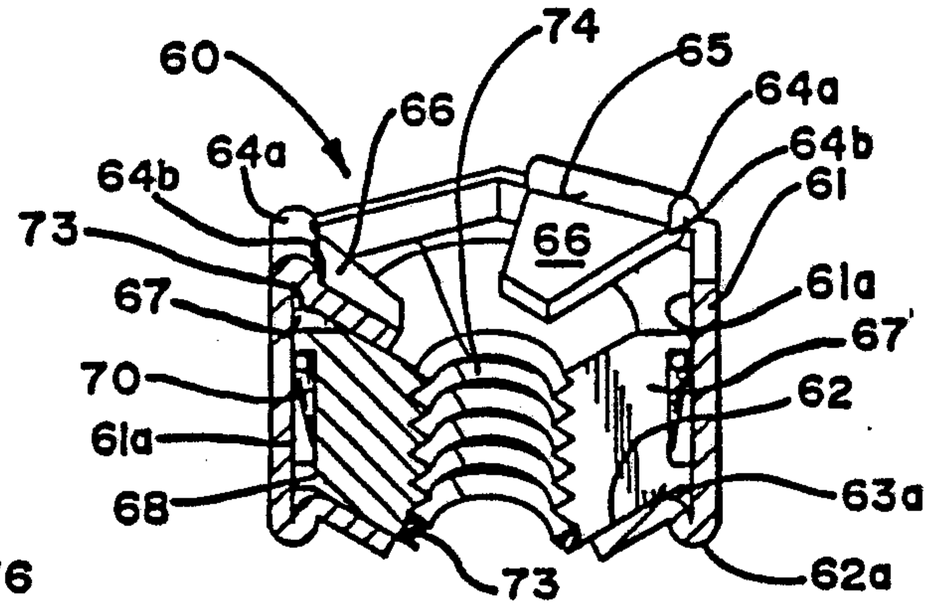


FIG. 8A

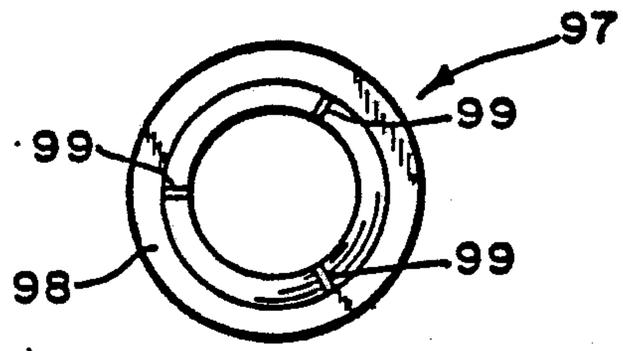


FIG. 12

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 87/00976

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC (4): F16F 1/34
U.S. Class. 267/73

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	267/73, 74, 154, 158, 160, 165, 167 10/72R,85, 86R, 86F; 29/447, DIG. 35 411/267, 303, 427 432, 433, 512, 935

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	U.S. A, 4,378,187 (FULLERTON) 29 March 1983, see entire document.	1-4,25-27
A	U.S.A, 3,352,341 (SCHERTZ) 14 November 1967, see entire document	1-3
A	U.S. A, 2,896,496 (JANSEN) 28 July 1959, see entire document	

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
16 July 1987	04 AUG 1987
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	Robert J. Oberleitner

Form PCT/ISA/210 (second sheet) (May 1986)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [10]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ...., because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [11]

This International Searching Authority found multiple inventions in this international application as follows:

I. Claims 1-33 are drawn to a nut assembly; class 411, subclass 432.

II. Claims 34-36 are drawn to a wave tension retainer; class 267, subclass 73.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers: 1-33

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.