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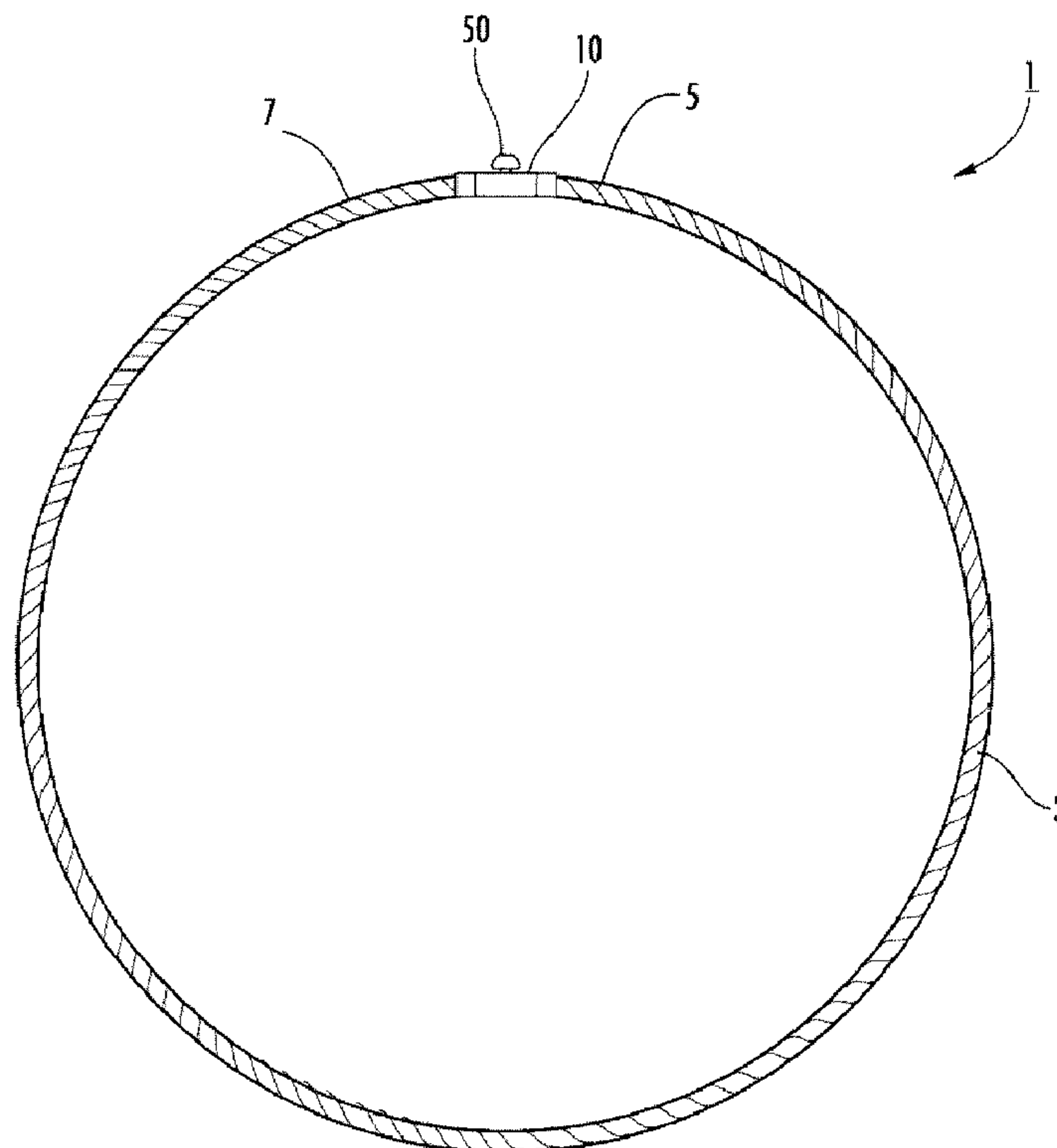
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(54) Title: THREADED REBAR HOOP AND METHOD OF FORMING AND USE THEREOF



(57) Abrégé/Abstract:

Threaded rebar with substantially continuous threads formed using a rolling process, wherein a majority of the circumference of the threaded rebar is covered by discontinuous threads, and wherein no additional steps are required to remove longitudinal ribs in the

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

threaded rebar. The threaded rebar may be used to form threaded rebar hoops that utilize one or more threaded rebar sections and one or more couplings to mechanically couple the ends of the various threaded rebar sections. In such threaded rebar hoops, the external threads are able to engage a coupling, which has internal threads that engage the external threads on the threaded rebar. The mechanically coupled threaded rebar hoops are an improvement over the welded rebar hoops because the mechanically coupled threaded rebar hoops are easier and cheaper to manufacture, ship, and/or install on site, and/or may provide improved strength and/or manufacturability when compared to welded rebar hoops.

ABSTRACT

Threaded rebar with substantially continuous threads formed using a rolling process, wherein a majority of the circumference of the threaded rebar is covered by discontinuous threads, and wherein no additional steps are required to remove longitudinal ribs in the threaded rebar. The threaded rebar may be used to form threaded rebar hoops that utilize one or more threaded rebar sections and one or more couplings to mechanically couple the ends of the various threaded rebar sections. In such threaded rebar hoops, the external threads are able to engage a coupling, which has internal threads that engage the external threads on the threaded rebar. The mechanically coupled threaded rebar hoops are an improvement over the welded rebar hoops because the mechanically coupled threaded rebar hoops are easier and cheaper to manufacture, ship, and/or install on site, and/or may provide improved strength and/or manufacturability when compared to welded rebar hoops.

THREADED REBAR HOOP AND METHOD OF FORMING AND USE THEREOF

CLAIM OF PRIORITY UNDER 35 U.S.C §119

[0001] The present Application for a Patent claims priority to Provisional Application No. 62/377,348, entitled “Threaded Rebar Hoop and Method of Forming and Use Thereof,” filed August 19th, 2016, and assigned to the assignee hereof and hereby expressly incorporated by reference herein.

FIELD

[0001] The present invention is related to the field of threaded rebar, and more particularly threaded rebar hoops and methods of manufacturing and using the threaded rebar hoops.

BACKGROUND

[0002] Reinforcing metal bars (hereinafter “rebar”) are bars, often made of steel, having protruding ribs, which are typically used to reinforce concrete structures. The protruding ribs can take a number of shapes or geometries, including diamond shaped, X-shaped, V-shaped, and the like. During the construction of bridges, buildings, and similar structures the rebar is often placed in a concrete form and concrete is poured around the rebar. The ribs in the rebar help to anchor the rebar within the concrete and add strength to the structures in which the rebar is used. In some applications of rebar, such as in columns (for example, columns for bridges, foundations for buildings, or the like), the rebar is formed into a hoop and welded to other rebar structures. In this regard, the rebar hoops may be tied to or affixed to longitudinally extending rebar (e.g., vertically or generally vertically rebar extending transverse to the rebar hoops) in order to form the columns.

[0003] In typical rebar manufacturing, heated bar stock is fed through rolls to form the cylindrical shaped rebar and protruding ribs. In some applications the ribs on the rebar can be manufactured and processed after forming the rebar in the rolls to create

threads that extend around the periphery of the rebar. In one example, rebar may be formed, and after forming the rolled ribs may be machined, grinded, or otherwise removed in order to create the threaded ribs. Alternatively, threaded rebar can also be formed by rolling billets using three or more rollers (e.g., non-standard equipment), which does not require subsequent machining. In some embodiments threads (e.g., machined threaded, not ribbed threads formed from rolling) may actually be machined into standard rolled rebar. However, all of these methods of forming threaded rebar result in increased processing steps and/or non-standard equipment that increases the costs of forming threaded rebar products.

[0004] Standard rebar and threaded rebar can be manufactured by cold rolling or hot rolling metal billets. In both processes a billet is fed between two cylindrical rolls that form the billet into the rebar. The cylindrical rolls have grooves with notches (e.g., knurls) formed therein to receive a bar and form the core rebar shape and protruding ribs as the bar passes through the rolls. In some rebar manufacturing processes flat dies can replace the cylindrical rolls. The flat dies also have grooves with notches formed therein, and are spaced apart to receive a bar that is rotated between them in order to create threads or ribs along the length of the rebar or a portion thereof.

[0005] When threaded rebar is manufactured using cold rolling, the bar is passed through the rolls at temperatures below the recrystallization temperature of the metal, which increases the strength of the metal, improves the surface finish, and results in tighter tolerances on the rebar core and threaded ribs. However, cold rolling also causes work hardening of the metal, which results in the metal becoming brittle, and hence, more susceptible to cracking at the base of the formed threaded ribs. These cold rolling problems are exacerbated when threaded rebar is used with a coupling, and in these applications the cold rolled threaded rebar is susceptible to premature thread failure. In a hot rolling process the bar is passed through the rolls at temperatures above the recrystallization temperature of the metal, which prevents work hardening. Threaded rebar made from hot rolling results in threaded rebar having uniform tensile strength and elongation characteristics, as well as ribs that are less likely to crack because they are an integral part of the bar and not work hardened. Furthermore, hot rolling allows for the use of steels with higher tensile strength, and hot rolling processes do not require additional bar peeling or swaging of the threaded rebar. However, potential problems with

threaded rebar manufactured through hot rolling include the formation of ribs that are coarse and that are unable to be used in applications requiring tight thread tolerances.

[0006] There are a number of problems associated with manufacturing threaded rebar using cylindrical rolls in a hot rolling process. Cylindrical rolls are used to form square, cylindrical, or other shaped bars into circular rebar with transverse threads formed into opposite sides of the circular rebar. The transverse threads formed are discontinuous and in some cases not aligned if the cylindrical rolls are not properly synchronized. Moreover, in these processes, two longitudinal ribs are formed along the length of the threaded rebar, which is a result of the excess metal from inconsistencies in the shape of the bar as well as the gap between the cylindrical rolls used to form the threaded rebar. The gap between the rolls is necessary so that the rolls do not rub against each other during the rolling process, since such rubbing may result in frictional heat that could damage the rolling system. The longitudinal ribs that result from processing prevent the threaded rebar from being freely rotatable within a nut or other mating internally threaded coupling. In order to manufacture threaded rebar without longitudinal ribs, additional steps are necessary that machine or shear off the longitudinal ribs. In some processes only the longitudinal ribs are machined off, however, in other processes the entire face of the bar with the longitudinal rib is machined into a flat surface. In still other processes the longitudinal ribs are sheared off using saw-tooth rotary dies, which are spaced apart to shear off sections of the longitudinal ribs located between the transverse ribs on the threaded rebar. In other processes the longitudinal ribs are ground off using a smooth groove rotary die that grinds down the longitudinal ribs. All of these methods present significant drawbacks, including additional processing steps, additional processing time, and additional processing equipment, all of which increase the cost of manufacturing the threaded rebar.

[0007] Alternatively, machined threads result in tight tolerances; however, machined threads are weaker than cold rolled threads. Moreover, manufacturing threaded rebar by machining the threads significantly increases the manufacturing costs associated with the threaded rebar, as it requires multiple processing steps, as well as being time consuming and resulting in higher handling expenses.

[0008] Therefore, there is a need to improve upon the formation of threaded rebar and the products made therefrom.

BRIEF SUMMARY

[0009] Embodiments of the present invention address the above needs and/or achieve other advantages by providing systems and methods that are used to create threaded rebar with substantially continuous threads using a rolling process, wherein a majority of the circumference of the threaded rebar is covered by the discontinuous threads; and wherein no additional steps are required to remove longitudinal ribs in the threaded rebar. Moreover, the threaded rebar may be used to form threaded rebar hoops that utilize one or more threaded rebar sections and one or more couplings to mechanically couple the ends of the various threaded rebar sections. In such threaded rebar, the external threads are able to engage a coupling (e.g., a nut, collar, or other apparatus), which has internal threads that engage the external threads on the threaded rebar. The mechanically coupled threaded rebar hoops are an improvement over the welded rebar hoops because the mechanically coupled threaded rebar hoops are easier and cheaper to manufacture, ship, and/or install on site, and/or may provide improved strength and/or manufacturability when compared to welded rebar hoops or other types of hoops.

[0010] Embodiments of the invention comprise a threaded rebar hoop. The threaded rebar hoop comprises a threaded rebar having a first end and a second end, wherein the threaded rebar is formed from a rolling process, wherein the threaded rebar is bent into a hoop shape, and wherein the threaded rebar is void of longitudinal ribs along at least the first end and the second end of the threaded rebar, and a coupling operatively coupling the first end and the second end of the threaded rebar to form the threaded rebar hoop.

[0011] In further accord with embodiments of the invention, the threaded rebar hoop comprises a stop operatively coupled to the coupling, the first end of the threaded rebar, or the second end of the threaded rebar.

[0012] In other embodiments of the invention, the coupling comprises a stop aperture, wherein the stop is operatively coupled to the stop aperture to reduce or prevent rotation of the coupling on the first end or the second end of the threaded rebar.

[0013] In still other embodiments of the invention, the coupling comprises an alignment feature, wherein the alignment feature is configured for aligning the first end and the second end within the coupling using the alignment feature.

[0014] In yet other embodiments of the invention, a first coupling end on the first end of the threaded rebar hoop is at least approximately the same length as the second coupling end on the second end of the threaded rebar hoop.

[0015] In further accord with embodiments of the invention, the first end or the second end has at least a straight portion on which the coupling is operatively coupled.

[0016] In other embodiments of the invention, the threaded rebar is formed without longitudinal ribs directly from the hot rolling process.

[0017] In still other embodiments of the invention, the hot rolling process comprises providing a lead pass bar comprising a body extending along a longitudinal axis, wherein at least one portion of the body has a cross-section defining a plane that intersects the longitudinal axis, wherein a first part of the plane has a first width, a second part of the plane has a second width, and a third part of the plane has a third width, wherein the first width is less than the second width and the third width, wherein the first part of the plane is located adjacent to the longitudinal axis, and the second part of the plane and third part of the plane are located distal from the longitudinal axis on opposite ends of the first part of the plane, wherein the lead pass bar has a X-axis through the first part of the plane, the second part of the plane and the third part of the plane, and a Y-axis through only the first part of the plane, and wherein the lead pass bar is formed in a first orientation along the longitudinal axis of the lead pass bar in one or more lead pass bar roll sets in which the X-axis is substantially parallel to and the Y-axis is substantially perpendicular to lead pass rolls of the one or more lead pass bar roll sets. The hot rolling processing further comprises forming the threaded rebar having substantially continuous threads from the lead pass bar by hot rolling the lead pass bar in one or more threaded rebar roll sets, wherein forming the threaded rebar comprises forming the threaded rebar from the lead pass bar in a second orientation along the longitudinal axis that is different from the first orientation in which the X axis is substantially perpendicular

to and the Y-axis is substantially parallel to threaded rolls of the one or more threaded rebar roll sets, and wherein the threaded rebar is formed without having to remove longitudinal ribs along at least a portion of the body.

[0018] In yet other embodiments of the invention, the threaded rebar hoop is formed in a shape of a circular hoop, a square hoop, a rectangular hoop, an oval hoop, or a triangular hoop.

[0019] In further accord with embodiments of the invention, the threaded rebar is formed from two or more threaded rebar sections having at least one bend and two or more couplings, each of the two or more sections having the first end and the second end, wherein the first end of each section is operatively coupled the second end of each adjacent section through the coupling from the two or more couplings.

[0020] In other embodiments of the invention, the rebar has substantially continuous threads.

[0021] Another embodiment of the invention comprises a method of forming a threaded rebar hoop. The method comprises forming a threaded rebar from a rolling process, bending the threaded rebar, wherein the threaded rebar has a first end and a second end, and threading a coupling onto the first end of the threaded rebar hoop. The method further includes drawing the second end of the threaded rebar hoop adjacent to the first end of the threaded rebar hoop, and threading the coupling on the second end of the threaded rebar hoop.

[0022] In further accord with embodiments of the invention, the method comprises operatively coupling a stop to the coupling, the first end of the threaded rebar, or the second end of the threaded rebar.

[0023] In other embodiments of the invention, the coupling comprises a stop aperture, and wherein the method further comprises operatively coupling the stop within the stop aperture to reduce or prevent rotation of the coupling on the first end or the second end of the threaded rebar.

[0024] In still other embodiments of the invention, the rebar hoop comprises an alignment feature, wherein the method further comprising aligning the first end and the second end within the coupling using the alignment feature.

[0025] In yet other embodiments of the invention, threading the coupling on the second end of the threaded rebar hoop comprises threading the coupling until a first

coupling end on the first end of the threaded rebar hoop is at least approximately the same length at the second coupling end on the second end of the threaded rebar hoop.

[0026] In further accord with embodiments of the invention, the threaded rebar is formed without longitudinal ribs directly from the hot rolling process.

[0027] In other embodiments of the invention, the threaded rebar is formed from two or more threaded rebar sections having at least one bend and two or more couplings, each of the two or more sections having the first end and the second end, wherein the first end of each section is operatively coupled the second end of each adjacent section through the coupling from the two or more couplings.

[0028] In still other embodiments of the invention, the rebar has substantially continuous threads.

[0029] In yet other embodiments of the invention, forming the threaded rebar comprises providing a lead pass bar comprising a body extending along a longitudinal axis, wherein at least one portion of the body has a cross-section defining a plane that intersects the longitudinal axis, wherein a first part of the plane has a first width, a second part of the plane has a second width, and a third part of the plane has a third width, wherein the first width is less than the second width and the third width, wherein the first part of the plane is located adjacent to the longitudinal axis, and the second part of the plane and third part of the plane are located distal from the longitudinal axis on opposite ends of the first part of the plane, wherein the lead pass bar has a X-axis through the first part of the plane, the second part of the plane and the third part of the plane, and a Y-axis through only the first part of the plane, and wherein the lead pass bar is formed in a first orientation along the longitudinal axis of the lead pass bar in one or more lead pass bar roll sets in which the X-axis is substantially parallel to and the Y-axis is substantially perpendicular to lead pass rolls of the one or more lead pass bar roll sets. Forming the threaded rebar further comprises forming the threaded rebar having substantially continuous threads from the lead pass bar by hot rolling the lead pass bar in one or more threaded rebar roll sets, wherein forming the threaded rebar comprises forming the threaded rebar from the lead pass bar in a second orientation along the longitudinal axis that is different from the first orientation in which the X axis is substantially perpendicular to and the Y-axis is substantially parallel to threaded rolls of the one or

more threaded rebar roll sets, and wherein the threaded rebar is formed without having to remove longitudinal ribs along at least a portion of the body.

[0030] The features, functions, and advantages that have been discussed may be achieved independently in various embodiments of the present invention or may be combined in yet other embodiments, further details of which can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0031] Having thus described embodiments of the invention in general terms, reference will now be made to the accompanying drawings, wherein:

[0032] FIG. 1 provides a top view of a threaded rebar hoop with a single section and coupling, in accordance with embodiments of the present invention;

[0033] FIG. 2 provides a top view of a threaded rebar hoop with multiple sections and couplings, in accordance with embodiments of the present invention;

[0034] FIG. 3 provides an enlarged view of the threaded rebar hoop coupling illustrated in Figures 1 or 2, in accordance with embodiments of the present invention;

[0035] FIG. 4A provides a cross-sectional view of assembling the coupling on a first end of the threaded rebar hoop, in accordance with one embodiment of the present invention;

[0036] FIG. 4B provides a cross-sectional view of the coupling assembled on the first end of the threaded rebar hoop, in accordance with one embodiment of the present invention;

[0037] FIG. 4C provides a cross-sectional view of the coupling assembled on the first end and the second end of the threaded rebar hoop, in accordance with embodiments of the present invention;

[0038] FIG. 5A provides a perspective view of a threaded rebar circular column cage, in accordance with embodiments of the present invention;

[0039] FIG. 5B provides a cross-sectional or top view of a threaded rebar circular column cage, in accordance with embodiments of the present invention;

[0040] FIG. 5C provides a cross-sectional sectional or top view of a threaded rebar circular column cage, in accordance with embodiments of the present invention;

[0041] FIG. 6A provides a side view of a threaded rebar square column cage, in accordance with embodiments of the present invention;

[0042] FIG. 6B provides a cross-sectional or top view of a threaded rebar square column cage, in accordance with embodiments of the present invention;

[0043] FIG. 6C provides a cross-sectional sectional or top view of a threaded rebar square column cage, in accordance with embodiments of the present invention;

[0044] FIG. 7 provides a process flow illustrating the manufacturing process of forming and installing the threaded rebar hoop, in accordance with embodiments of the present invention;

[0045] FIG. 8 provides a perspective view of a lead pass rolling system for forming a lead pass bar used to create the threaded rebar, in accordance with embodiments of the present invention;

[0046] FIG. 9 provides a cross-sectional view of the lead pass rolling system for forming a lead pass bar used to create the threaded rebar, in accordance with embodiments of the present invention;

[0047] FIG. 10A provides a perspective view of the lead pass bar used to create the threaded rebar, in accordance with embodiments of the present invention;

[0048] FIG. 10B provides a cross-sectional view of the lead pass bar used to create the threaded rebar, in accordance with embodiments of the present invention;

[0049] FIG. 11 provides a perspective view of a threaded rebar rolling system for forming the threaded rebar from a lead pass bar, in accordance with embodiments of the present invention;

[0050] FIG. 12 provides a cross-sectional view of the threaded rebar rolling system for forming the threaded rebar from a lead pass bar, in accordance with embodiments of the present invention;

[0051] FIG. 13 provides a perspective view of the threaded rebar formed form the lead pass bar, in accordance with embodiments of the present invention;

[0052] FIG. 14 provides a cross-sectional view of the threaded rebar formed from the lead pass bar, in accordance with embodiments of the present invention; and

[0053] FIG. 15 provides a cross-sectional view of rebar formed with longitudinal ribs.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0054] Embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all, embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like numbers refer to like elements throughout.

[0055] Figures 1 through 3 illustrate embodiments of a threaded rebar hoop 1 of the present invention. The threaded rebar hoop 1 comprises one or more threaded rebar sections 3 and one or more couplings 10. The threaded rebar hoop sections 3 comprise a first end 5 and a second end 7. As illustrated in Figure 1, in one aspect of the invention the threaded rebar hoop 1 comprises a single section 3 having a first end 5 and a second end 7, and wherein the first end 5 is operatively coupled to the second end 7 through the use of a coupling 10, as will be described in further detail with respect to Figures 4 through 7. In other aspects of the invention the threaded rebar hoop 1 comprises two or more sections 3, such as a first section 30, a second section 32, and third section 34 as illustrated in Figure 2. As illustrated in Figure 2, a first end 5 of the first section 30 is operatively coupled to a second end 7 of the second section 32; a first end 5 of the second section 32 is operatively coupled to a second end 7 of the third section 34; and a first end 5 of the third section 34 is operatively coupled to a second end 7 of the first section 30.

[0056] Figure 3 illustrates an enlarged view of the coupling 10 and the connection between the first end 5 and second end 7 of a threaded rebar section 3, while Figure 4 illustrates a cross-sectional view of assembling the coupling. It should be understood that the coupling has a first portion 12 that is operatively coupled to the first end 5 of a threaded rebar section, and a second portion 14 that is operatively coupled to a second end 7 of a threaded rebar section, as will be discussed in further detail below. Moreover, the coupling comprises an internal cavity 16 there through in which the first end 5 and second end 7 of the threaded rebar section 3 is installed when assembled into a threaded rebar hoop 1. It should be understood that the internal cavity 16 of the coupling 10 has threads 18 that are configured to mate with the threads 9 on the surface of the threaded rebar sections 3 to operatively couple the first end 5 and second end 7 of the one or more

threaded rebar sections 3 together. In some embodiments the internal cavity 16 is an enclosed cavity; however, in other embodiments the cavity may be partially open (e.g., an opening in a portion of the coupling, an opening extending along the length of the coupling, such as a slot, or the like).

[0057] It should be understood that as illustrated in Figures 1 and 2, the size of the threaded rebar hoops 1 may vary based on the needs of the customer. For example, the threaded rebar hoops 1 may be of a size that allows for the formation of a threaded rebar hoop 1 using a single threaded rebar section 3 as illustrated in Figure 1. However, as illustrated in Figure 4 multiple threaded rebar sections 3 may be used to form larger threaded rebar hoops 1. For example, the threaded rebar hoops may be 6, 8, 10 12, 14, 16, 18, 20, or more feet in diameter (or any size less than, between, or greater than these sizes) and as such may require multiple threaded rebar sections 3 to form threaded rebar hoops 1 having these sizes. Furthermore, it should be understood that existing rebar hoops are typically shipped to a customer in a configuration in which they have already been assembled, since the assembly is often of a permanent nature, such as a welded configuration. As will be described in further detail later, since the threaded rebar hoops 1 of the present invention may be formed through the use of multiple threaded rebar sections 3, the threaded rebar sections 3 may be shipped in a bundle and assembled on site using couplings 10 to reduce shipping costs associated with shipping assembled threaded rebar hoops 1.

[0058] It should be further understood that the shape of the threaded rebar hoops 1 in Figures 1 through 3 are illustrated as circular hoops. However, in the construction industry rebar hoop also describes shapes other than circular, such as rectangular, square, oval, or other like shape. As such, as described with respect to Figures 1 and 2, like the circular hoop shapes, these other shapes may have two or more sections that are coupled together through the use of two or more couplings 10.

[0059] It should be understood that the threaded rebar hoops 1 illustrated herein, specifically the circular threaded rebar hoops 1, may have a portion at the ends 5, 7 that is straight (e.g., not bent with a radius of curvature). Depending on the size of the threaded rebar hoops 1, the size of the couplings 10 (e.g., the length of the couplings 10), and the distance of travel of the couplings 10 along the threaded rebar sections 3 during assembly, the threaded rebar hoop ends 5, 7 may not be required to have a portion that is straight. In

these cases the coupling 10 is sized for tolerances that would allow it to be coupled to slightly bent ends 5, 7 of the threaded rebar hoop 1. However, it is likely that at least a portion of the ends 5, 7 will not be bent so as to allow the couplings 10 to operatively couple the ends 5, 7 between one or more sections 3 of the threaded rebar hoop 1 together.

[0060] Figures 4A through 4C illustrate assembling a first end 5 and second end 7 of one or more threaded rebar sections 3 of a threaded rebar hoop 1, while Figures 5A-6C illustrate different rebar hoops installed in rebar cages 500, 600. Figure 7 illustrates a process flow for assembling a threaded rebar hoop 1 and installing it in a rebar cage 100. As illustrated by block 102 in Figure 7, a threaded rebar is formed, which may be used as a threaded rebar section 3, or which may be cut into a threaded rebar section 3. In some aspects of the invention the threaded rebar is formed from a rolling process, such as a cold rolling process or hot rolling process. In other embodiments of the invention, the threaded rebar product may be formed without longitudinal ribs extending along at least a portion of the first 5 end and/or second end 7 of the threaded rebar, or the entire length of the threaded rebar product. In some aspects of the invention the threaded rebar is formed by rolling a lead pass bar, rotating the lead pass bar, and rolling the lead pass bar into the threaded rebar, as will be discussed in further detail later with respect to Figures 8 through 15. However, it should be understood that the threaded rebar product may be formed through any type of forming process including, but not limited to, rolling the threaded rebar product and machining the longitudinal ribs off of the threaded bar after rolling, rolling the threaded rebar using three or more rollers (non-standard rolling equipment), rolling the threaded rebar product using rolling sets that are offset 90 degrees (e.g., a lead pass rolling set and a threaded roll set that is rotated 90 degrees from the lead pass rolling set).

[0061] Block 104 of Figure 7 illustrates that the one or more threaded rebar sections 3 are bent into an arc. In some aspects of the invention, a single threaded rebar section 3 is used to create the threaded rebar hoop 1, and as such the threaded rebar section 3 is bent into a circular hoop shape, as illustrated in Figure 1. In other aspects of the invention, two or more threaded rebar sections 3 are bent into arced shapes, such as two half circle sections, or other arced shapes based on the size of the threaded rebar hoop 1 and the number of sections 3 being used. For example, as illustrated in Figure 2 there is a single half circle section 30, and two quarter circle sections 32, 34, which are all bent or

curved to form the desired circular threaded rebar hoop 1. In other embodiments of the invention the two or more sections of the rebar hoop 1 may be equal. It should be understood that although the rebar hoops 1 are illustrated as being generally circular, the threaded rebar sections 3 may be bent into any shape in order to form a threaded rebar hoop 1 of any contour or shape, such as but not limited circular, oval, square, rectangular, triangular, polygonal, any non-uniform shape, or any other curvilinear shape.

[0062] Figure 7 further illustrates in block 106 that a coupling 10 is threaded onto the first end 5 of a threaded rebar section 3. In one example of block 106, Figures 4A and 4B illustrate that a coupling 10 is rotated onto the first end 5 of a threaded rebar section 3. Block 108 of Figure 7 illustrates drawing (e.g., pulling or otherwise moving) the second end 7 of the threaded rebar section 3 adjacent the first end 5 of the threaded rebar section 3, as illustrated in Figure 4B. In some aspects of the invention the ends of the threaded rebar section(s) 3 may touch, while in other aspects of the invention the ends of the threaded rebar section(s) 3 may have a gap between them as they are operatively coupled using the coupling 10.

[0063] Figure 7 further illustrates in block 110, that the coupling 10 is partially unthreaded off of the first end 5 of the threaded rebar section 3 to at least partially on the second end 7 of the threaded rebar section 3, as illustrated by Figure 4C. In some aspects of the invention, this includes threading the coupling 10 onto the second end 7, such that a first portion 12 of the coupling 10 is located around the first end 5 of the threaded rebar section 3, while a second portion 14 of the coupling 10 is located around the second end 7 of the threaded rebar section 3. It should be understood that the rebar hoop 1 may include an alignment feature, which may include a viewing aperture 40 in the coupling, a marking feature on the threaded rebar section 3, or the like. It should be understood that the coupling 10 may have one or more viewing apertures 40 (e.g., hole, slot, void, window, notch within or at an edge of the coupling) that allows a user during assembly to view the location of the first end 5 and/or second end 7 within the coupling 10 in order to determine if the coupling 10 is positioned correctly on the first end 5 and second end 7 of the threaded rebar hoop 1. That is, to allow a user to determine that the first end 5 and second 7 of the threaded rebar section(s) 3 meet at least generally in the middle of the coupling 10. For example, the first portion 12 of the coupling 10 covers a length of the first end 5 of the threaded rebar section that is generally the same length as the second end 7 of the

threaded rebar section that is covered by the second portion 14 of the coupling 10. In other embodiments of the invention the threaded rebar section(s) 3 may be marked (e.g., colored, embossed, notched, or the like) to illustrate the location to which the coupling 10 should be assembled. For example, portions of the threaded rebar 3 may be marked on the first end 5 and the second end 7, such that when assembled both markings on the threaded rebar 3 may be seen on either side of the coupling 10.

[0064] Block 112 of Figure 7 further illustrates that one or more stops 50 are operatively coupled to the threaded rebar first end 5, the threaded rebar second end 7, and/or the coupling 10 to reduce or prevent movement of the coupling 10 (i.e., there may be small movement and/or rotation of the coupling 10). In some aspects of the invention, as illustrated in Figures 3 through 4C, the one or more viewing apertures 40 may also be the one or more stop apertures 42 through which a stop 50 is used to reduce or prevent movement of the coupling 10. However, it should be understood that the one or more viewing apertures 40 may be different from the one or more stop apertures 42 (e.g., hole, slot, void, window, notch within or at an edge of the coupling). As illustrated in Figure 4C, at least a portion of the stop 50 may be located between the first end 5 and the second end 7 within the cavity 16 of the coupling 10. In some embodiments the stop 50 may extend from a first stop aperture through the cavity 16 of the coupling 50 and into a second stop aperture. The stop 50 is illustrated as being located through the coupling; however, it should be understood that the stop 50 may be located at the end of the first portion 12 or the end of the second portion 14 of the coupling 10. As such, in some embodiments of the invention the stop may not extend into or through the cavity 16 of the coupling 10. For example, the stop may be operatively coupled to the threaded rebar sections that are exposed outside of the coupling 10 (e.g., inserted into an aperture in the threaded rebar, coupled to the external surface of the threaded rebar, or the like apart from the coupling 10). The stop 50 may be any type of feature, such as but not limited to a fastener (e.g., screw, bolt, pin, or the like), a wire, flange, collar, clamp, lever, or any other like feature that prevents or limits the movement of the coupling 10 once assembled.

[0065] The stop 50 may be utilized to not only reduce or prevent movement of the coupling 10 during installation on site, but also during transportation, during which the vibrations from the transport could potentially cause the coupling 10 to rotate off (e.g., back-off, or the like) the first end 5 and/or second end 7 of the threaded rebar section 3. In

some embodiments, the stop 50 is a self-drilling, self-threading and/or self-tapping fastener (e.g., screw, or the like), such that the fastener may form threads within the stop aperture 42 during assembly, in order to reduce or prevent the stop 50 from backing out of the stop aperture 42.

[0066] Block 114 of Figure 7 further illustrates that one or more threaded rebar hoops 1 may be shipped to a site for use within a construction product, such as a support column within a bridge, other like support structure. As such, it should be understood that the threaded rebar hoop 1 may be sent to its destination for installation in the assembled form, in which it can be used along with other threaded rebar, or other types of rebar, for creating a rebar cage for concrete fill for supporting a structure. Alternatively, instead of shipping the threaded rebar hoop 1 in its assembled form, the one or more rebar sections 3 may be delivered uncoupled (e.g., bundled together, or the like), such that the threaded rebar hoops 1 may be assembled on site during installation of a rebar cage. By not having to weld rebar to make a hoop, the coupling of the rebar sections 3 may be done on site using the coupling 10, and thus potentially hazardous and time consuming welding processes are not required to be performed on site or before shipping to the site. Moreover, by installing the threaded rebar hoops 1 on site, the installation process may be sped up and/or improved because of the flexibility of the threaded rebar sections 3 before they are formed into a hoop may ease the assembly of the rebar cage. For instance, with respect to welded hoops, the hoops are typically rigid and operatively coupling (e.g., tying) the hoops to transverse rebar (e.g., vertical rebar within a column, or the like) may be difficult and time consuming. Unlike the welded hoops the uncoupled threaded rebar hoops 1 are more easily manipulated before the coupling 10 is used to create the threaded rebar hoop 1. Moreover, pre-welded hoops may have tolerance issues because the pre-welded hoops are shipped to a construction site and might not fit properly in the rebar cage. Alternatively, the couplings 10 allow for tolerance differences in the rebar cage because the couplings 10 allow for slight adjustments in the sizes of the rebar hoops 3. For example, the distances between the ends of the sections may be spaced apart or brought closer together to account for tolerance differences. Welded rebar hoops do not allow for the slight adjustments (e.g., in welded applications the ends of the hoops have to be welded together, and thus the size of the rebar hoop is static).

[0067] It should be further understood that performing a welded connection between ends of rebar may be a difficult process to repeat, and thus, the strength of welded rebar hoops are dependent on the strength of the welds. As such, welded rebar hoops may require destructive testing by engineers, construction entities, or regulators before they can be utilized within a project. In some cases, 20 percent (or more or less depending on regulations) of the welded hoops may be required to undergo destructive testing in order to satisfy safety requirements for construction products, and thus, the threaded rebar undergoing destructive testing is useless for the construction product, which adds additional costs to the project. The threaded rebar hoops 1 of the present invention may provide improved strength and/or improved repeatability of the strength of the hoop at the coupling location, such that the destructive testing of the threaded rebar hoop 1 is not required, or at least the amount of testing may be reduced. As such, the improved strength and/or improved repeatability of the strength at the coupling location reduces the costs associated with the construction project.

[0068] It should be understood that the threaded rebar hoop 1 of the present invention may have improved strength of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 20, 25, 30, 35, 40, 45, 50, 70, 90, 100, 125, 150, 175, 200, 300, 400, 500, 600, 700, 800, 900, 1000, or more percent (or any range of percent improvement that falls within, overlaps, or is outside of these values) when compared to welded hoops.

[0069] Figures 5A and 6A illustrates views of rebar columns 500, 600, in some embodiments of the present invention. Moreover, Figures 5B and 5C, and 6B and 6C illustrate different cross-sectional views and/or top views of threaded rebar cage columns. Figures 5B and 6B illustrate rebar cages in which the rebar hoops 1 are located on the outside of the longitudinal bars 500, 600, while Figures 5C and 6C illustrate rebar hoops 1 located both outside and inside of the longitudinal bars 500, 600. Figures 5A-5C illustrate a circular column rebar cage 400 that utilizes circular rebar hoops 1, while Figures 6A-6C illustrate a square column rebar cage 500 that utilizes square rebar hoops 1. However, it should be understood that any type of column rebar cage, non-uniform rebar cage, or the like may incorporate different rebar hoops 1 of different shapes and sizes.

[0070] It should be understood that typical rebar cage column construction may include operatively coupling longitudinal bars to the welded rebar hoops. The welded rebar hoops may be tied or welded to the outside and/or inside of longitudinal bars (e.g.,

vertical bars in the columns) of the rebar cage. The rebar cage columns may be formed on the ground and hoisted into place. For example, the hoops may be placed in frames and the longitudinal bars may be attached thereto. In some embodiments the rebar cages are formed in facilities and transported on site to be hoisted into place. In other embodiments the rebar hoops may be added to the structure as it is being built in the installed position. It should be understood that if the rebar hoops are not properly secured to the longitudinal bars the strength of the rebar cage could be greatly reduced before it is encapsulated in concrete, and thus portions of the rebar cage could fail and/or deform (e.g., which could cause structural problems if not identified before the concrete is added).

[0071] As previously discussed the threaded rebar hoops 1 of the present disclosure not only result in improved strength, but the rebar hoops may allow for improved installation processes that reduce costs. As such, the rebar hoops 1 may be used in the same way as welded rebar hoops (e.g., cages built at the factory or built on site, and hoisted into place), or the rebar hoops 1 of the present invention may partially or completely replace the welded rebar hoops 1. The rebar hoops 1 of the present disclosure may also be particularly useful when installing the rebar cages in place. For example, as the longitudinal rebar 502, 602 is being installed in the columns, the rebar hoops 1 may be placed around the longitudinal rebar 502, 602 at the desired locations. Moreover, regardless of the number of sections 3 used in the threaded rebar hoop 1 (e.g., one, two, three, or the like) the present invention may allow for adjusting the size of the hoops by making the ends of the sections 3 closer together and/or farther apart as the multiple sections are being assembled (e.g., in the rebar cage in the installed position, as a pre-assembly on site or at a manufacturing facility). In some cases, when installing the rebar hoops 1 on the outside of the longitudinal bars of a rebar cage column the ends of the rebar hoops 1 may be pulled together to provide a tighter fit around the longitudinal bars. Alternatively, when installing the rebar hoops 1 within the longitudinal rebar of the rebar cage, the ends of the sections 3 may be spaced apart (e.g., moved away from each other) when the one or more couplings 10 are used to provide a tighter fit within the rebar cage.

[0072] With respect to threaded rebar hoops having two or more sections 3 and two or more couplings 10, utilizing multiple sections 3 and assembling the rebar cages on site reduces shipping costs because the sections 3 may be bundled and shipped in smaller spaces and/or packages. The improved shipping costs may be especially true for large

support columns for buildings and bridges, which may require oversized rebar hoops that may be difficult to transport to the construction site due to the limits of road clearances, and/or may be required to be assembled in the installed position because the pre-assembled columns may be not be able to be lifted into place. As such, in this way the threaded rebar sections 3 may be transported to the site in the bundles and assembled using couplings 10, and thereafter tied and/or welded to longitudinal bars.

[0073] While Figures 5A-6C illustrate perspective and top view of circular and square column rebar cages 500, 600, it should be understood that different shapes of the column rebar cages (e.g., rectangular, oval, or the like) may be formed using the threaded rebar hoops 1. Moreover, the combinations of rebar hoops 1 may be used in any type of rebar cage, such as wind tower bases, bridge floors, or other structural or non-structural components of any type of structure.

[0074] Moreover, not only may the couplings 10 described herein be utilized with the rebar hoops 1 of the rebar cages, but the couplings 10 may also be utilized to operatively couple the longitudinal bars of the rebar cages together and/or to operatively couple other portions of the rebar cages together, where one end of a first threaded rebar meets another end of a threaded rebar. As such, the couplings 10 and/or the rebar hoops 1 described herein may be utilized in combination with other rebar cage elements to create a rebar cage system that is cheaper to manufacture (e.g., through the threaded rebar forming process described below), cheaper to ship (e.g., components may be more easily bundled and shipped), stronger (e.g., the couplings 10 provide a more reliable strength determination over the plurality of rebar hoops), cheaper and faster to assemble (e.g., less destructive testing is needed, can be more quickly installed, and because it is stronger less rebar hoops 1 are need because they can be spaced farther apart), and/or more flexible installation (e.g., the rebar hoops 1 can be assembled as the structure is being built instead of pre-assembled).

[0075] With respect to forming the threaded rebar sections 3 described herein, the threaded rebar sections 3 may be formed by first rolling (e.g., cold rolling or hot rolling) a billet 200 into a lead pass bar 220, rotating the lead pass bar 220 to a different orientation, and rolling the lead pass bar 220 into the threaded rebar 240, as illustrated in Figures 8-14. The lead pass bar 220 may have a cross-section with upper and lower width dimensions (see A in Figure 10B) and a reduced dimension (see B in Figure 10B)

approximate the center of the lead pass bar 22 that is less than the upper and lower width dimensions. In one embodiment of the invention, the billet 200 can be formed into a lead pass bar 240 with a cross-section in the shape of an hourglass (i.e., the hourglass/peanut shaped lead pass bar depicted in Figures 10A and 10B) by feeding the billet through a first set of rolls (i.e., lead pass roll set 300) that forms the hourglass shape. As explained in further detail below the hourglass cross-section aids in the production of a substantially continuous threaded rebar 240 with little to no longitudinal ribs 262, which is used to create the threaded rebar sections 3 described above. After the lead pass bar 200 is formed it is passed through a second set of rolls (i.e., threaded pass roll set 350) in order to form the substantially continuous threaded rebar 240 with little to no longitudinal ribs 262. The billet 200, the lead pass bar 220, and the threaded rebar 240 are typically processed consecutively at the same mill, however, it is understood that in some embodiments they may be processed at different mill sites.

[0076] In the present invention, the threaded rebar sections 3 can be produced using conventional rebar processing equipment and without the additional steps and tooling that are used for removal of the longitudinal ribs 262. Therefore, it is generally not necessary to use more than two rolls or more than two dies at a time to create the substantially continuous threaded rebar 240, or to use little to no additional machining, grinding, or shearing operations to remove a portion of the longitudinal ribs 262. The present invention results in threaded rebar 240 that can be used to create the threaded rebar sections 3 for the threaded rebar hoops 1 described herein utilizing standard rebar manufacturing tooling and equipment in less time and for less cost than conventional threaded rebar products made utilizing more complex manufacturing processes and equipment.

[0077] It should be understood that after the cross-sectional area of the billet 200 is reduced to the proper size, the hot roll lead pass rolls 300 shapes the billet 200 into a lead pass bar 220 with the proper cross-sectional area for producing a threaded rebar product without longitudinal ribs. The type of cross-sectional area of the lead pass bar 200 will impact the surface quality and circular cross-section of the final threaded rebar 240. If a lead pass bar 220 with the proper cross-sectional area is not used, excess material can build up between the gaps in the rolls and create longitudinal ribs 262 in the threaded rebar 240, as illustrated by the rebar product 260 in Figure 15.

[0078] In order to create threaded rebar 240 with little to no longitudinal ribs 262, a bar with a reduced width (see B of Figure 10B) along or approximate to the y-axis is helpful in reducing or eliminating the material that spreads into the gaps between the rolls. The greater the width of the cross-sectional area along the y-axis of the lead pass bar 220 the larger the longitudinal ribs 262 might be along the length of the threaded rebar 240. A longitudinal rib 262 prevents the threaded rebar 240 from being used in conjunction with a coupling 10 or other type of mating threaded part 24 because the longitudinal ribs 262 prevent the threaded rebar 240 from turning within the coupling 10 or other mating part.

[0079] It should be understood that typical threaded rebar 260 that includes longitudinal ribs 262, as illustrated in Figure 15, requires additional stages of manufacturing to machine, file, shear, chip, or otherwise remove the longitudinal ribs 262 in order to allow the threaded rebar to be used with a threaded coupling. These additional process steps add increased tooling, man-hours, manufacturing time, and floor space costs that ultimately increase the overall cost of manufacturing typical threaded rebar 260. Alternatively, not having enough cross-sectional material along the y-axis of the lead pass bar 220 prevents the formation of a circular threaded rebar with threads that span the majority of the circumference of the threaded rebar 240 because the material will not properly flow into the grooves and knurls in the opposing rolls. This can lead to a threaded rebar product with less tensile holding strength, weakened threaded rebar that is more apt to fail, deformed threaded rebar that cannot be secured to a coupling, etc. Therefore, it is important to create a lead pass bar 220 with a cross-sectional area that results in a threaded rebar 240 product having the proper shape for tensile strength, but with little to no longitudinal ribs 262.

[0080] The dimensions and shape of the cross-sectional area of the lead pass bar 220 play a role in producing threaded rebar 240 with little to no longitudinal ribs 262. Figures 10A and 10B illustrate one embodiment of a lead pass bar that has an hourglass or peanut shaped cross-section. The lead pass bar 220 has a body extending along a longitudinal z-axis. At least a portion of the body has a cross-section defining a plane 222 in the vertical x-axis and horizontal y-axis that intersects the longitudinal z-axis as illustrated in 10A. The first part 224 of the plane 222 has a first width (see A) and the second part 226 of the plane 222 has a second width (see B) that is different than the first width of the first part 224. In other embodiments of the invention, the plane 222 has a

height dimension (see C) substantially centered along the longitudinal z-axis. The first part 224 of the plane 222 is located vertically adjacent to the longitudinal z-axis and the first width is smaller than the second width of the second part 226 of the plane 222 located vertically distal from the longitudinal z-axis. In other embodiments of the invention, the first part 224 of the plane 222 is vertically adjacent to the longitudinal z-axis and the first width is smaller than the second width of the second part 226 of the plane 222, and the third width of the third part 228 of the plane 222, wherein the second part 226 of the plane 222 and third part 228 of the plane 222 are located vertically distal from the longitudinal z-axis. In some embodiments, the first part 224 of the plane 222 is rectangular in shape (see D) and the second part 226 of the plane 222 and third part 228 of the plane 222 are at least approximately circular, wherein the second part 226 of the plane 222 is located vertically above the first part 224 of the plane 222 and the third part 228 of the plane 222 is located vertically below the first part 224 of the plane 222. In other embodiments of the invention, the x-axis may be in the horizontal position and the y-axis may be in the vertical position dependent on the position of the lead pass bar 222.

[0081] As previously discussed the shape of the lead pass bar 220 illustrated in Figures 10A and 10B may be described as having an hourglass and/or peanut shape. These shape descriptions may only generally describe the shape that the lead pass bar 220 may take in a given embodiment. For example, a traditional peanut or hourglass shape has circular opposed ends connected by a vertical shaft. In general terms, the lead pass bar 222 of various embodiments has two opposed ends with a wider dimension than a central connecting section that generally resembles a peanut or hourglass, but the lead pass bar does not have to necessarily include circular opposed ends and a flat vertical connecting section. For example, in some embodiments of the invention, the lead pass bar 222 may have flat sections in the first part 224 of the plane 222 (see D), as illustrated in Figures 10A and 10B. However, in other embodiments of the invention the flat sections may have a curved surface with an associated radius of curvature (e.g., convex or concave). In still other embodiments of the invention, the flat sections may have a v-shape or have another shape that provides a reduced cross-sectional area along or near the y-axis (i.e., mid-section of the lead pass bar) illustrated in Figures 10A and 10B.

[0082] In the embodiment illustrated in Figures 10A and 10B the lead pass bar 220 has rounded top edges and bottom edges. In some embodiments of the invention, the

top edge and bottom edge of the lead pass bar 220 are a rectangular shape. In other embodiments the top edge and bottom edge can have various shapes and the shape of the lead pass bar 220 may only need to be a reduced width (e.g., the first width) that runs approximate to the y-axis of the cross-sectional area for at least a part of the length of the longitudinal z-axis of the body of the lead pass bar 220. In some embodiments, the shape of the lead pass bar 220 may be hyperbolic, notched, or have some other type of geometry that has a reduced cross-sectional area in the midsection (i.e. y-plane or near the y-plane) of the bar.

[0083] In order to create the hourglass lead pass bar 220, the rectangular billet 200 is fed through a lead pass roll system 300 that has opposing rolls, as illustrated in Figures 8 and 9. As an aid to understanding the figures, Figure 9 illustrates the gap between the opposing lead pass rollers 302 and 304. In one embodiment of the invention the lead pass roll system 300 comprises a first lead pass roll 302 and a second lead pass roll 304 (collectively the “lead pass roll set”), a transmission 306, and a bar guide 308. The first lead pass roll 302 and the second lead pass roll 304, have grooves 310 machined or formed in the shape of half of the hourglass lead pass bar 220 (e.g., if the lead pass bar was cut along the x-axis). The grooves 310 and roll surfaces 312 define the shape of the lead pass bar.

[0084] The rectangular billet 200 as illustrated in Figure 9, is fed into the hot rolled lead pass system 300 in an orientation where the x-axis of the lead pass bar lies horizontal and the y-axis of the lead pass bar is in the vertical direction with respect to the first lead pass roll 302 and second lead pass roll 304. The transmission 306 drives the first lead pass roll 302 in a counter-clockwise direction, while driving the second lead pass roll 304 in a clockwise direction. In this way, the lead pass bar 220 will exit the rolls, and thus the bar guide 308, with the x-axis in the horizontal direction and the y-axis in the vertical direction, as illustrated in Figure 8.

[0085] A threaded pass roll system 350, which has two opposing rolls, is used in order to manufacture the threaded rebar 240, as illustrated in Figures 11 and 12. As illustrated in Figure 11, in one embodiment of the invention, the threaded pass roll system 350 comprises a first threaded pass roll 352 and a second threaded pass roll 354 (collectively the “threaded pass roll set”), a transmission 356, and bar guide 358. The first threaded pass roll 352 and the second threaded pass roll 354, as illustrated in Figure

11, have grooves 360 and knurls 362 machined or formed in the shape of a semi-circle. As illustrated in Figure 12, the lead pass bar 220 is fed through the hot rolled threaded pass system 350 in order to produce the threaded rebar 240 product. The lead pass bar 220 as illustrated in Figure 12 is fed into the hot rolled threaded pass system 350 in an orientation where the x-axis is in the vertical direction and the y-axis is in the horizontal direction with respect to the first threaded roll 352 and second threaded roll 354. The transmission drives the first threaded roll 352 in a counter-clockwise direction, while driving the second threaded roll 354 in a clockwise direction. In this way, the substantially continuous threaded rebar 240 will exit the rolls and the bar guide 358, with the x-axis in the vertical direction and the y-axis in the horizontal direction, as illustrated in Figure 11. It is important to note that, unlike other threaded rebar processes, little to no additional machining or forming steps are necessary after the threaded rebar 240 exits the threaded rebar pass to remove longitudinal ribs 262, due to the fact that the threaded rebar 240 has little to no longitudinal ribs 262 along at least a portion of the length of the threaded rebar 240. In some embodiments, the threaded rebar 240 that is produced after the hot rolled threaded rebar pass need only be cooled, bent into the desired threaded rebar sections 3, and/or coupled together using the coupling 10, as described above, before it is shipped to the customer (or shipped to the customer then assembled).

[0086] Figure 13 illustrates one embodiment of the threaded rebar 240. As illustrated in Figure 13, the top threads 242 are formed by the first threaded pass roll 352 and the bottom threads 244 are formed by the second threaded pass roll 354. It is important that the top threads 242 are substantially lined up with the bottom threads 244 in order for the threaded rebar 240 to work properly within various applications (e.g., be able to mate with a coupling, etc.). In some embodiments, the first threaded roll 352 and the second threaded roll 354 may have to be properly aligned with each other so the knurls 362 of each roll produce top threads 242 and bottom threads 244 that are substantially aligned with each other.

[0087] As illustrated in Figures 13 and 14 the alignment of the top threads 242 and the bottom threads 244 produce a discontinuous threaded rebar 240. However, a single discontinuous thread covers substantially the entire circumference of the threaded rebar 240 thereby creating a substantially continuous thread. In some embodiments of the

invention a single substantially continuous thread, made up of a top thread 242 and bottom thread 244, can span over ninety (90) percent (or more or less, such as 60, 65, 70, 75, 80, 85, 95, or the like percent, or within a range of any of the forgoing) of the circumference of the threaded rebar 240. The circumference of the threaded rebar 240 that the substantially continuous threads cover may be changed by altering the dimensions of the knurls 362 in the grooves 360 of the first threaded roll 352 and second threaded roll 354.

[0088] Another feature of the threaded rebar 240 produced using this lead pass bar 220 is that there are little to no longitudinal ribs 262 that run along the surface of the threaded rebar 240 in the longitudinal direction, or at least along a partial length of the threaded rebar 240. As illustrated in Figure 15, typical threaded rebar 260 manufactured using a rolling process has a cross section with pronounced longitudinal ribs 262 that run the length of or at least a portion of the body of typical threaded rebar 260. The longitudinal ribs 262 are due to the excess material that fills the gaps 370 between the first threaded roll 352 and the second threaded roll 354, as illustrated in Figure 12. In a typical threaded rebar manufacturing process, these pronounced longitudinal ribs 262 are of sufficient dimension so as to obstruct threading a coupling onto the threaded rebar without subsequent post-forming machining, grinding, shearing, etc. of the longitudinal ribs 262 of the threaded rebar. In the embodiments of the present invention where a little or slight longitudinal rib may exist on the threaded rebar 240, the little or slight longitudinal rib is not of sufficient dimension so as to obstruct threading a coupling onto the threaded rebar. Moreover, in the embodiments when the area of the longitudinal ribs are slightly concave, the slightly concave shape does not have an effect on the couplings. As such, when the area of the longitudinal ribs are slightly concave or convex, the threaded rebar will still be considered to have no longitudinal ribs as long as the coupling is able to be threaded on the bar without having to perform additional manufacturing on area of the longitudinal ribs. Therefore, subsequent post-forming machining, grinding, shearing, etc. of the longitudinal ribs of the threaded rebar is not necessary.

[0089] Along with the dimensions of the lead pass bar 220, the gap distance (see G), may also play an important role in preventing longitudinal ribs from forming along the length of the threaded rebar 240. The shape of the lead pass bar 220, as well as the gap distance, helps to prevent the metal from filling the gaps 370 between the

first threaded roll 352 and the second threaded roll 354, thus preventing longitudinal ribs 262 from forming in the present invention. If the gap is too small, material may fill the gap and form longitudinal ribs 262, or alternatively, if the gap is too large the threaded rebar 240 may not form the proper cylindrically shaped core or threads.

[0090] As illustrated by Figures 13 and 14, the threads 242, 244 may be substantially continuous. Furthermore, the outer circumference of the threads may provide a circular or substantially circular cross-section, such that if a line was extended around the outer circumference of the threads 242, 244, the outer circumference may be circular or substantially circular, as illustrated by the thread diameter TD. Additionally, the core of the threaded rebar 240 may also be circular or substantially circular, as illustrated by the core diameter CD. As illustrated by Figure 14 there are material voids 246 where there is a lack of metal material in the outer edges of the threaded rebar 240. The material voids 246 create the appearance that the threaded rebar 240 is not circular or substantially circular, however, as discussed the top threads 242 and bottom threads 244 have a diameter TD that is circular or substantially circular and will mate with a circular or substantially circular coupling 10.

[0091] Different types of threaded rebar 240 can be produced by simply changing the dimensions of the grooves 310, 360 and knurls 362 in the lead pass rolls 302, 304 and threaded pass rolls 352, 354, as well as the gaps between the rolls. These changes can be made to create customized lead pass bars 220 that result in customized threaded rebar 240 with little to no longitudinal ribs 262 based on the individual requirements of each customer, through an interchangeable and cost effective process utilizing standard rebar forming tooling and equipment.

[0092] In some embodiments as previously discussed above, instead of changing the orientation of the lead pass bar in order to roll the lead pass bar through the threaded pass roll set to form the threaded rebar, the threaded pass roll set may be oriented 90 degrees with respect to the lead pass bar roll set. Alternatively, three or more rollers may be utilized instead of two rollers to form the threaded rebar product. In still other embodiments, threads may be machined into the rebar.

[0093] It should be understood that “operatively coupled,” when used herein, means that the components may be formed integrally with each other, or may be formed separately and coupled together. Furthermore, “operatively coupled” means that the

components may be formed directly to each other, or to each other with one or more components located between the components that are operatively coupled together. Furthermore, “operatively coupled” may mean that the components are detachable from each other, or that they are permanently coupled together.

[0094] Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation. In addition, where possible, any terms expressed in the singular form herein are meant to also include the plural form and/or vice versa, unless explicitly stated otherwise. Accordingly, the terms “a” and/or “an” shall mean “one or more.”

[0095] Specific embodiments of the invention are described herein. Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which the invention pertains, having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments and combinations of embodiments are intended to be included within the scope of the appended claims. As such, it will be understood that, where possible, any of the advantages, features, functions, devices, and/or operational aspects of any of the embodiments of the present invention described and/or contemplated herein may be included in any of the other embodiments of the present invention described and/or contemplated herein, and/or vice versa.

WHAT IS CLAIMED IS:

1. A threaded rebar hoop, the threaded rebar hoop comprising:
 - a threaded rebar having a first end and a second end, wherein the threaded rebar is formed from a rolling process, wherein the threaded rebar is bent into a hoop shape, and wherein the threaded rebar is void of longitudinal ribs along at least the first end and the second end of the threaded rebar; and
 - a coupling operatively coupling the first end and the second end of the threaded rebar to form the threaded rebar hoop.
2. The threaded rebar hoop of claim 1, further comprising:
 - a stop operatively coupled to the coupling, the first end of the threaded rebar, or the second end of the threaded rebar.
3. The threaded rebar hoop of claim 2, wherein the coupling comprises a stop aperture, wherein the stop is operatively coupled to the stop aperture to reduce or prevent rotation of the coupling on the first end or the second end of the threaded rebar.
4. The threaded rebar hoop of claim 1, wherein the coupling comprises an alignment feature, wherein the alignment feature is configured for aligning the first end and the second end within the coupling using the alignment feature.
5. The method of claim 3, wherein a first coupling end on the first end of the threaded rebar hoop is at least approximately the same length at the second coupling end on the second end of the threaded rebar hoop.
6. The threaded rebar hoop of claim 1, wherein the first end or the second end has at least a straight portion on which the coupling is operatively coupled.
7. The threaded rebar hoop of claim 1, wherein the threaded rebar is formed without longitudinal ribs directly from the hot rolling process.

8. The threaded rebar hoop of claim 7, wherein the hot rolling process comprises: providing a lead pass bar comprising a body extending along a longitudinal axis, wherein at least one portion of the body has a cross-section defining a plane that intersects the longitudinal axis, wherein a first part of the plane has a first width, a second part of the plane has a second width, and a third part of the plane has a third width, wherein the first width is less than the second width and the third width, wherein the first part of the plane is located adjacent to the longitudinal axis, and the second part of the plane and third part of the plane are located distal from the longitudinal axis on opposite ends of the first part of the plane, wherein the lead pass bar has a X-axis through the first part of the plane, the second part of the plane and the third part of the plane, and a Y-axis through only the first part of the plane, and wherein the lead pass bar is formed in a first orientation along the longitudinal axis of the lead pass bar in one or more lead pass bar roll sets in which the X-axis is substantially parallel to and the Y-axis is substantially perpendicular to lead pass rolls of the one or more lead pass bar roll sets; and forming the threaded rebar having substantially continuous threads from the lead pass bar by hot rolling the lead pass bar in one or more threaded rebar roll sets, wherein forming the threaded rebar comprises forming the threaded rebar from the lead pass bar in a second orientation along the longitudinal axis that is different from the first orientation in which the X axis is substantially perpendicular to and the Y-axis is substantially parallel to threaded rolls of the one or more threaded rebar roll sets, and wherein the threaded rebar is formed without having to remove longitudinal ribs along at least a portion of the body.

9. The threaded rebar hoop of claim 1, wherein the threaded rebar hoop is formed in a shape of a circular hoop, a square hoop, a rectangular hoop, an oval hoop, or a triangular hoop.

10. The threaded rebar hoop of claim 1, wherein the threaded rebar is formed from two or more threaded rebar sections having at least one bend and two or more couplings, each of the two or more sections having the first end and the second end, wherein the first end of each section is operatively coupled the second end of each adjacent section through the coupling from the two or more couplings.

11. The threaded rebar hoop of claim 1, wherein the rebar has substantially continuous threads.
12. A method of forming a threaded rebar hoop, the method comprising:
forming a threaded rebar from a rolling process;
bending the threaded rebar, wherein the threaded rebar has a first end and a second end;
threading a coupling onto the first end of the threaded rebar hoop;
drawing the second end of the threaded rebar hoop adjacent to the first end of the threaded rebar hoop; and
threading the coupling on the second end of the threaded rebar hoop.
13. The method of claim 12, further comprising:
operatively coupling a stop to the coupling, the first end of the threaded rebar, or the second end of the threaded rebar.
14. The method of claim 12, wherein the coupling comprises a stop aperture, wherein the method further comprising:
operatively coupling the stop within the stop aperture to reduce or prevent rotation of the coupling on the first end or the second end of the threaded rebar.
15. The method of claim 12, wherein the rebar hoop comprises an alignment feature, wherein the method further comprising:
aligning the first end and the second end within the coupling using the alignment feature.
16. The method of claim 12, wherein threading the coupling on the second end of the threaded rebar hoop comprises threading the coupling until a first coupling end on the first end of the threaded rebar hoop is at least approximately the same length at the second coupling end on the second end of the threaded rebar hoop.

17. The method of claim 12, wherein the threaded rebar is formed without longitudinal ribs directly from the hot rolling process.

18. The method of claim 12, wherein the threaded rebar is formed from two or more threaded rebar sections having at least one bend and two or more couplings, each of the two or more sections having the first end and the second end, wherein the first end of each section is operatively coupled the second end of each adjacent section through the coupling from the two or more couplings.

19. The method of claim 12, wherein the rebar has substantially continuous threads.

20. The method of claim 12, wherein forming the threaded rebar comprises:

providing a lead pass bar comprising a body extending along a longitudinal axis, wherein at least one portion of the body has a cross-section defining a plane that intersects the longitudinal axis, wherein a first part of the plane has a first width, a second part of the plane has a second width, and a third part of the plane has a third width, wherein the first width is less than the second width and the third width, wherein the first part of the plane is located adjacent to the longitudinal axis, and the second part of the plane and third part of the plane are located distal from the longitudinal axis on opposite ends of the first part of the plane, wherein the lead pass bar has a X-axis through the first part of the plane, the second part of the plane and the third part of the plane, and a Y-axis through only the first part of the plane, and wherein the lead pass bar is formed in a first orientation along the longitudinal axis of the lead pass bar in one or more lead pass bar roll sets in which the X-axis is substantially parallel to and the Y-axis is substantially perpendicular to lead pass rolls of the one or more lead pass bar roll sets; and

forming the threaded rebar having substantially continuous threads from the lead pass bar by hot rolling the lead pass bar in one or more threaded rebar roll sets, wherein forming the threaded rebar comprises forming the threaded rebar from the lead pass bar in a second orientation along the longitudinal axis that is different from the first orientation in which the X axis is substantially perpendicular to and the Y-axis is substantially parallel to threaded rolls of the one or more threaded rebar roll sets, and wherein the

threaded rebar is formed without having to remove longitudinal ribs along at least a portion of the body.

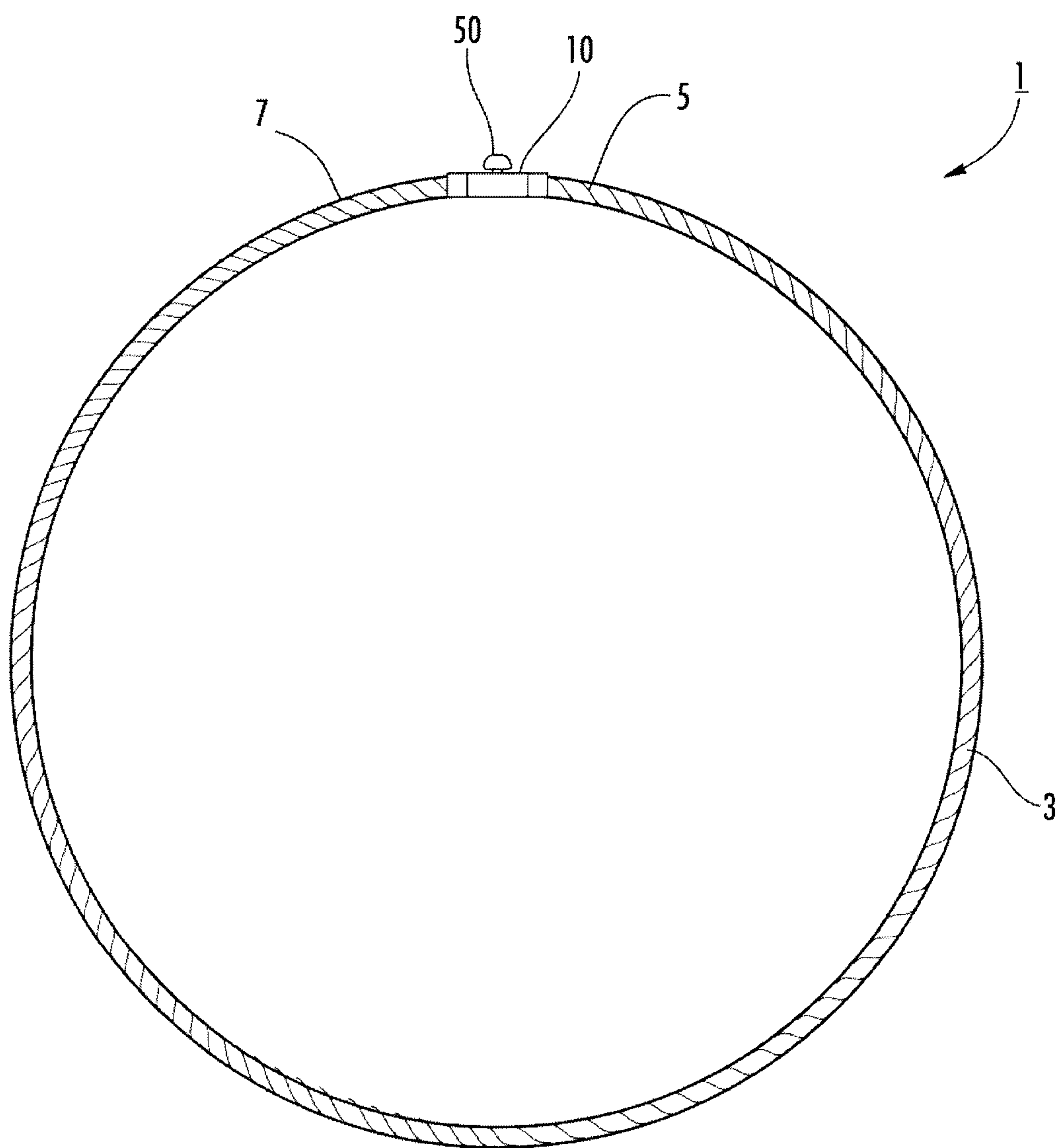


FIG. 1

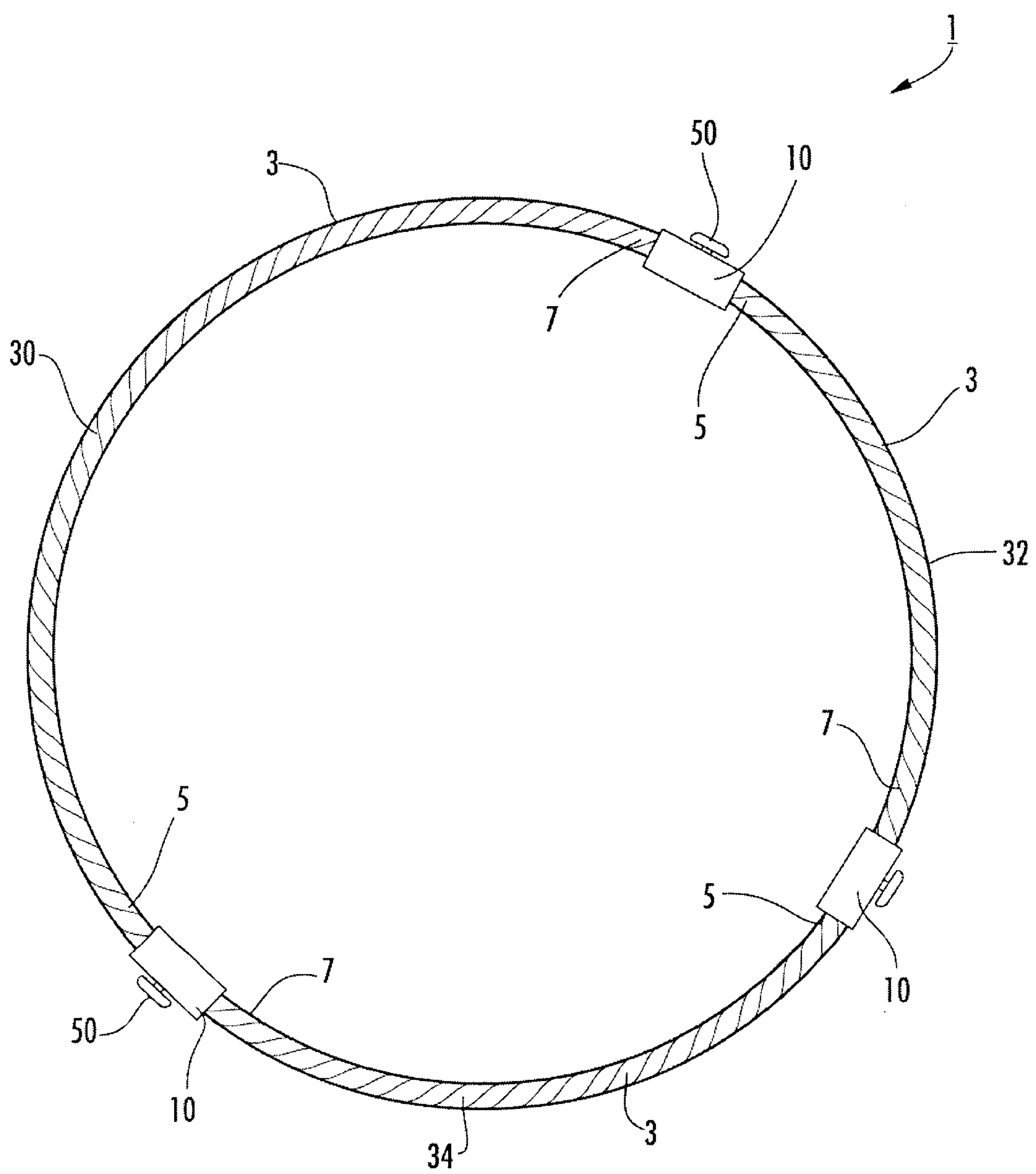


FIG. 2

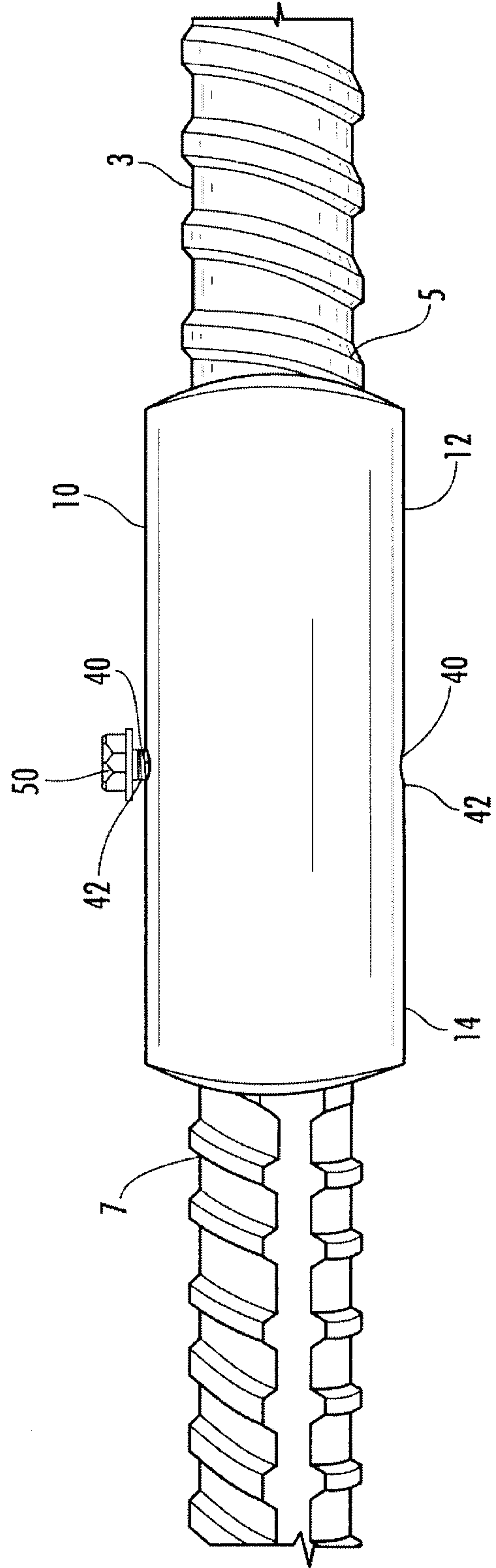


FIG. 3

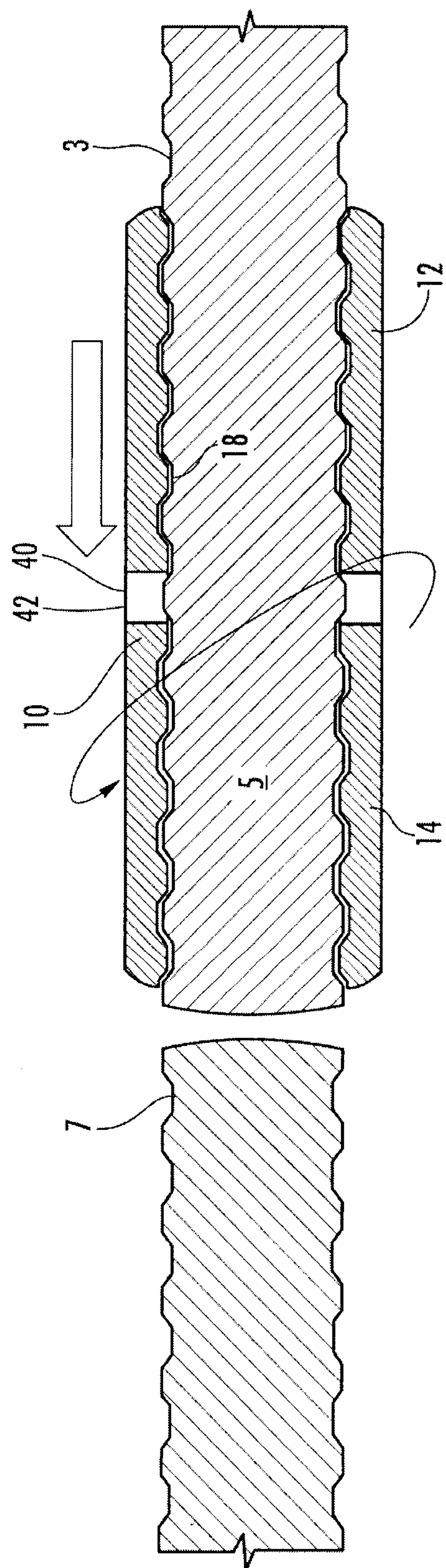


FIG. 4B

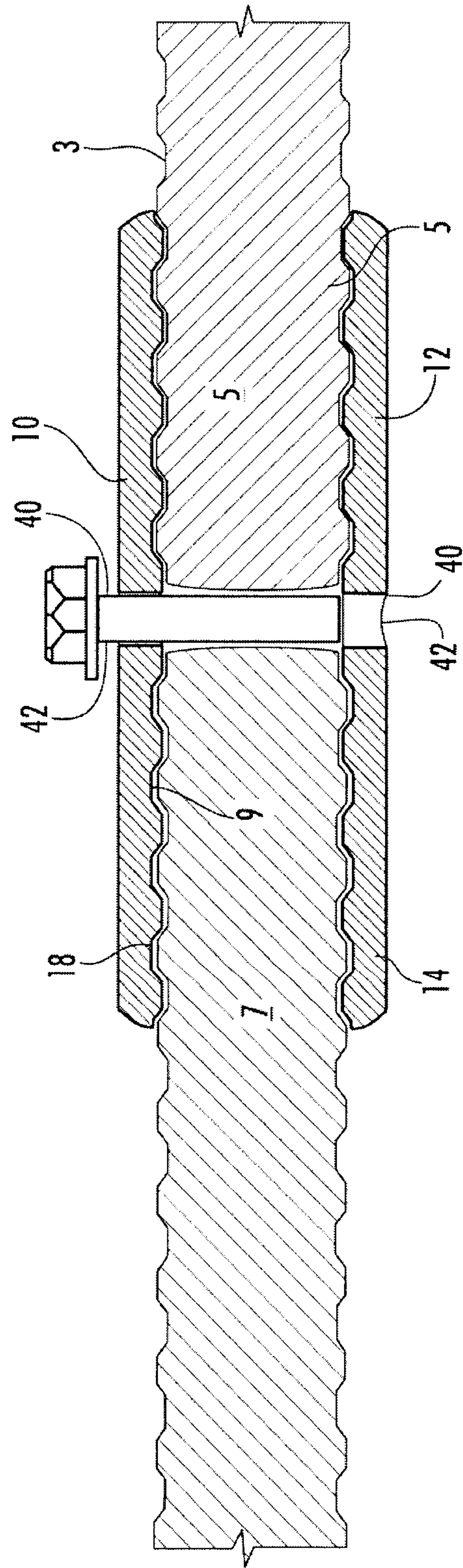


FIG. 4C

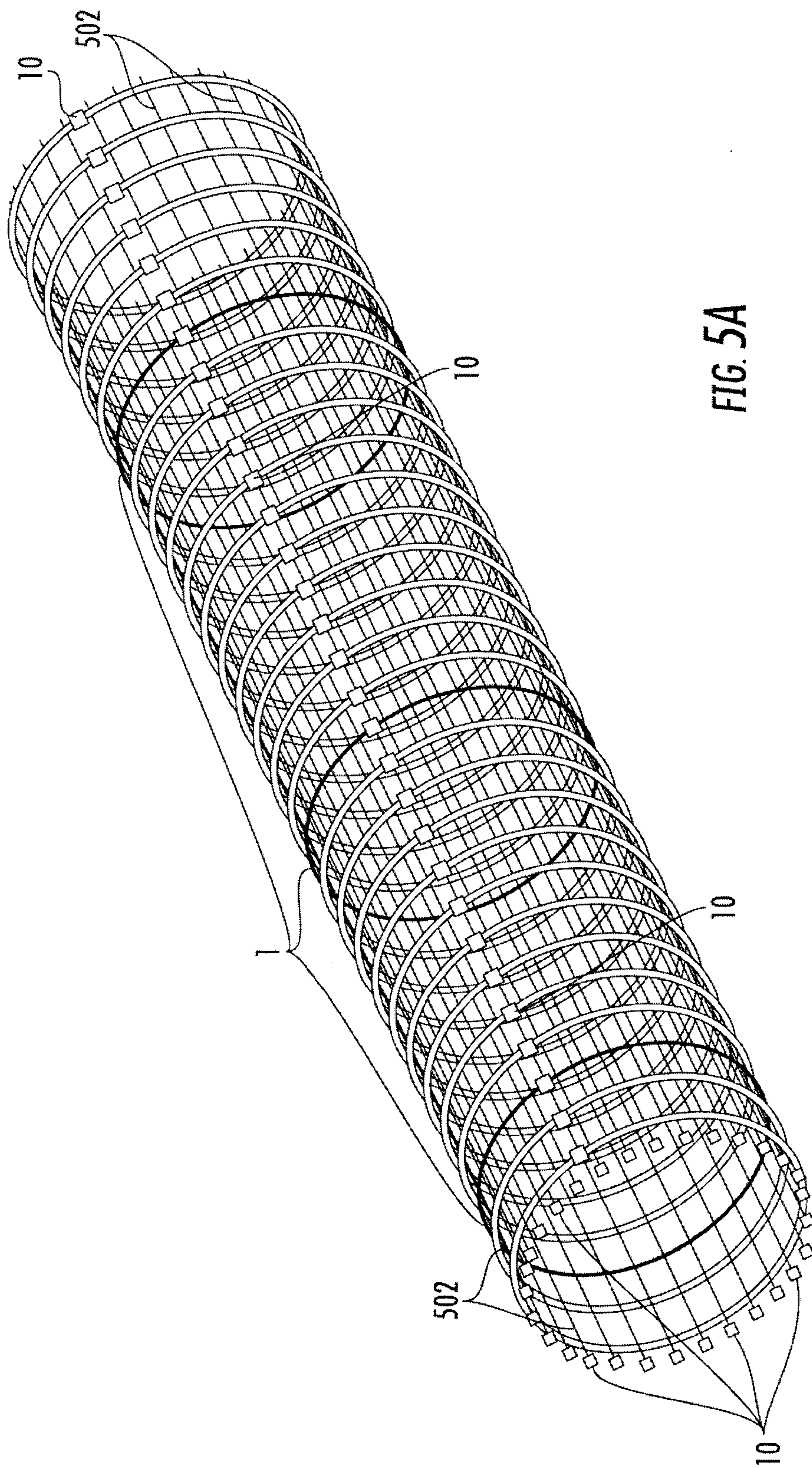


FIG. 5A

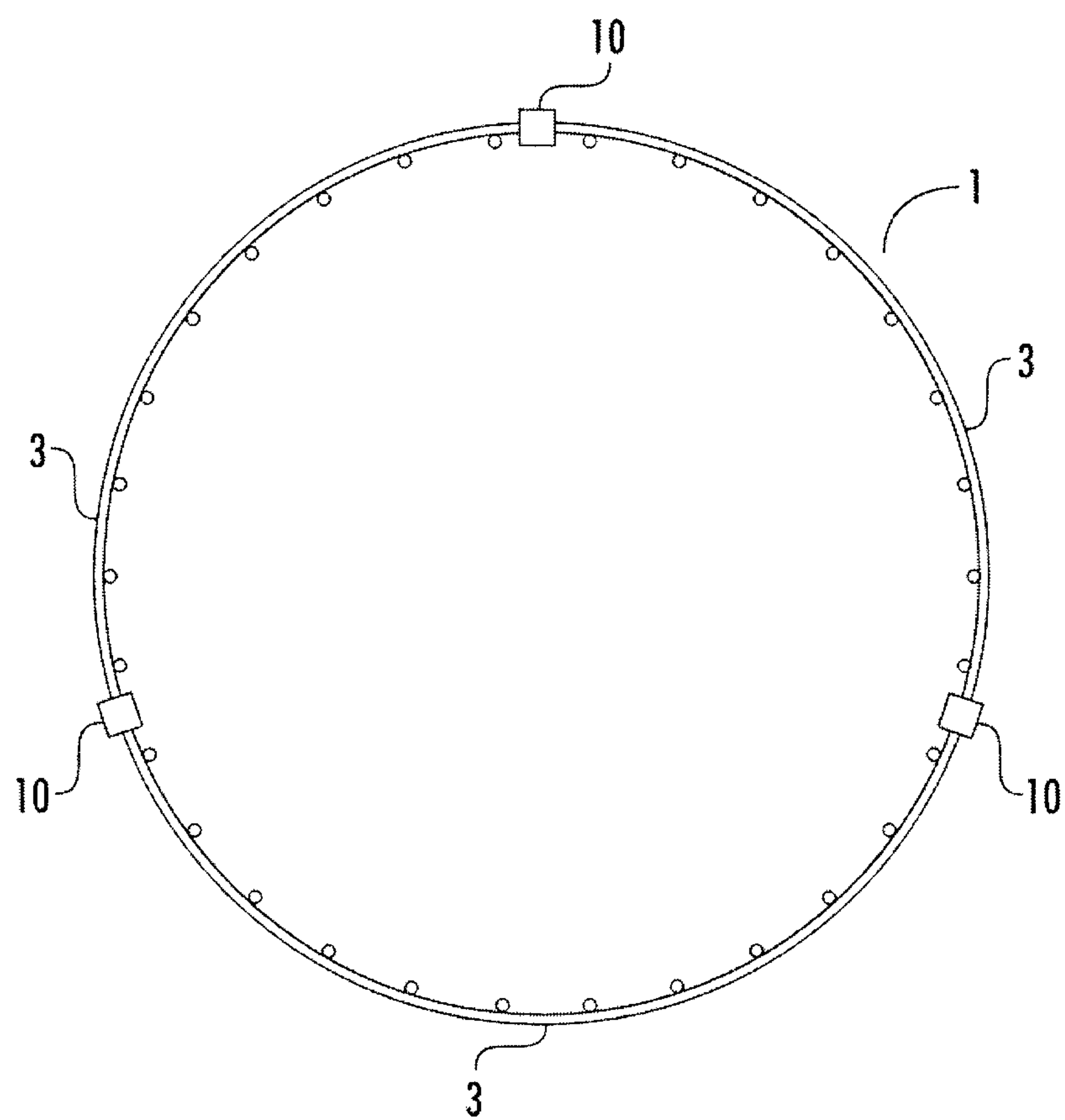


FIG. 5B

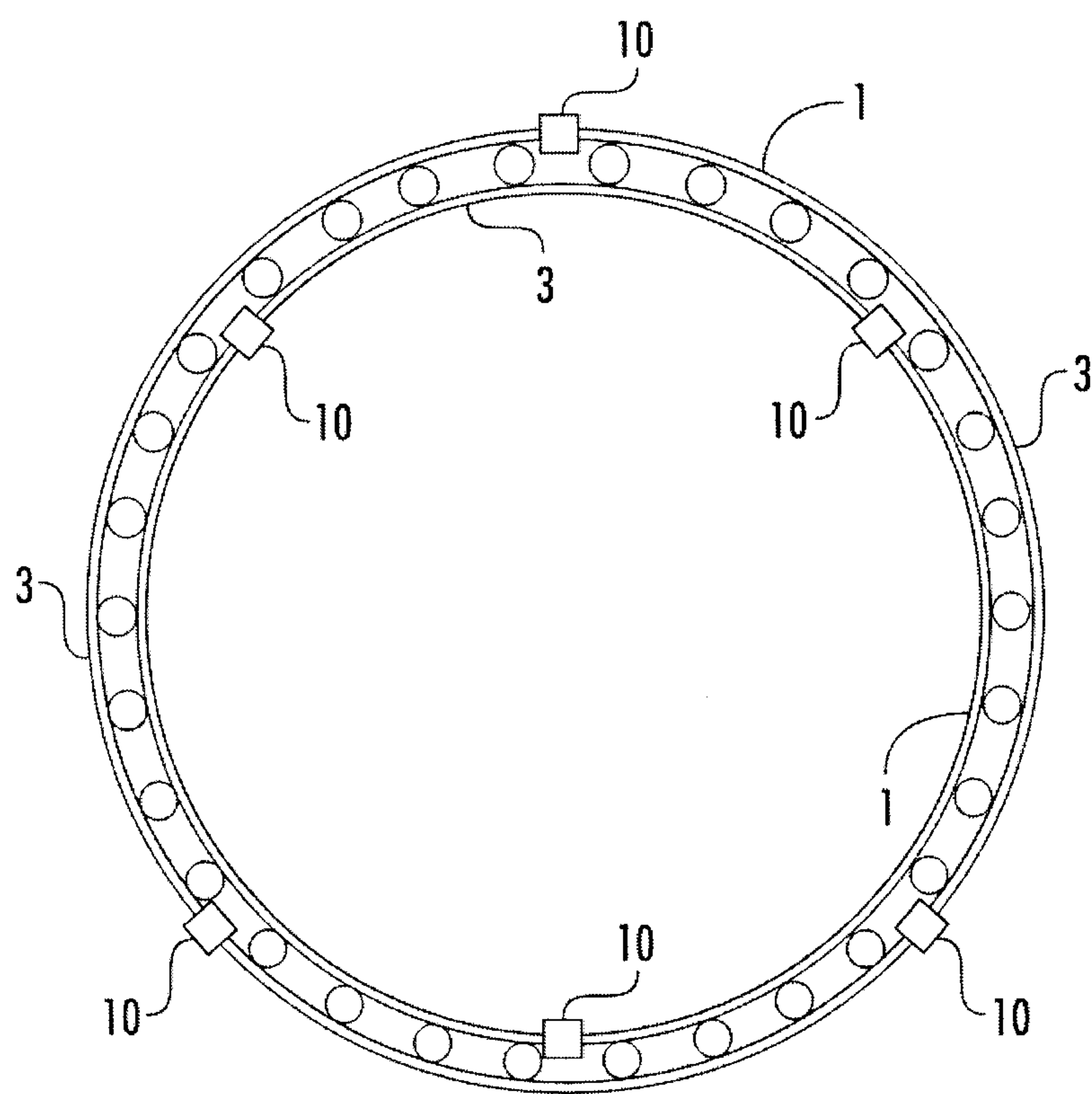


FIG. 5C

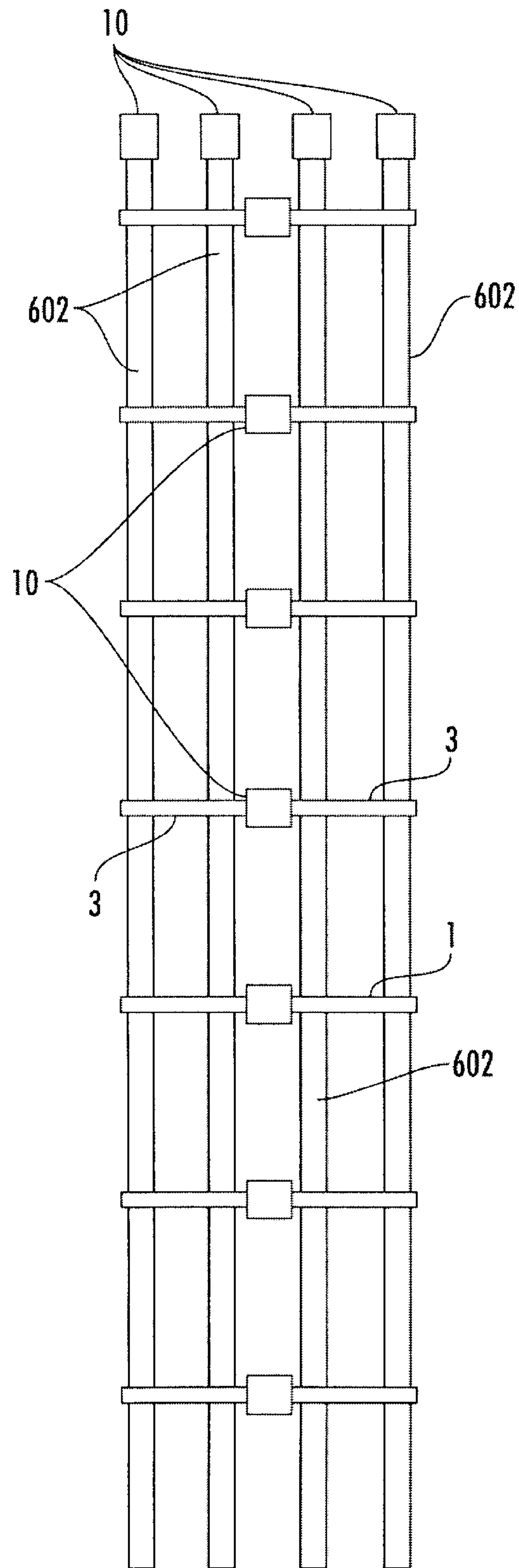


FIG. 6A

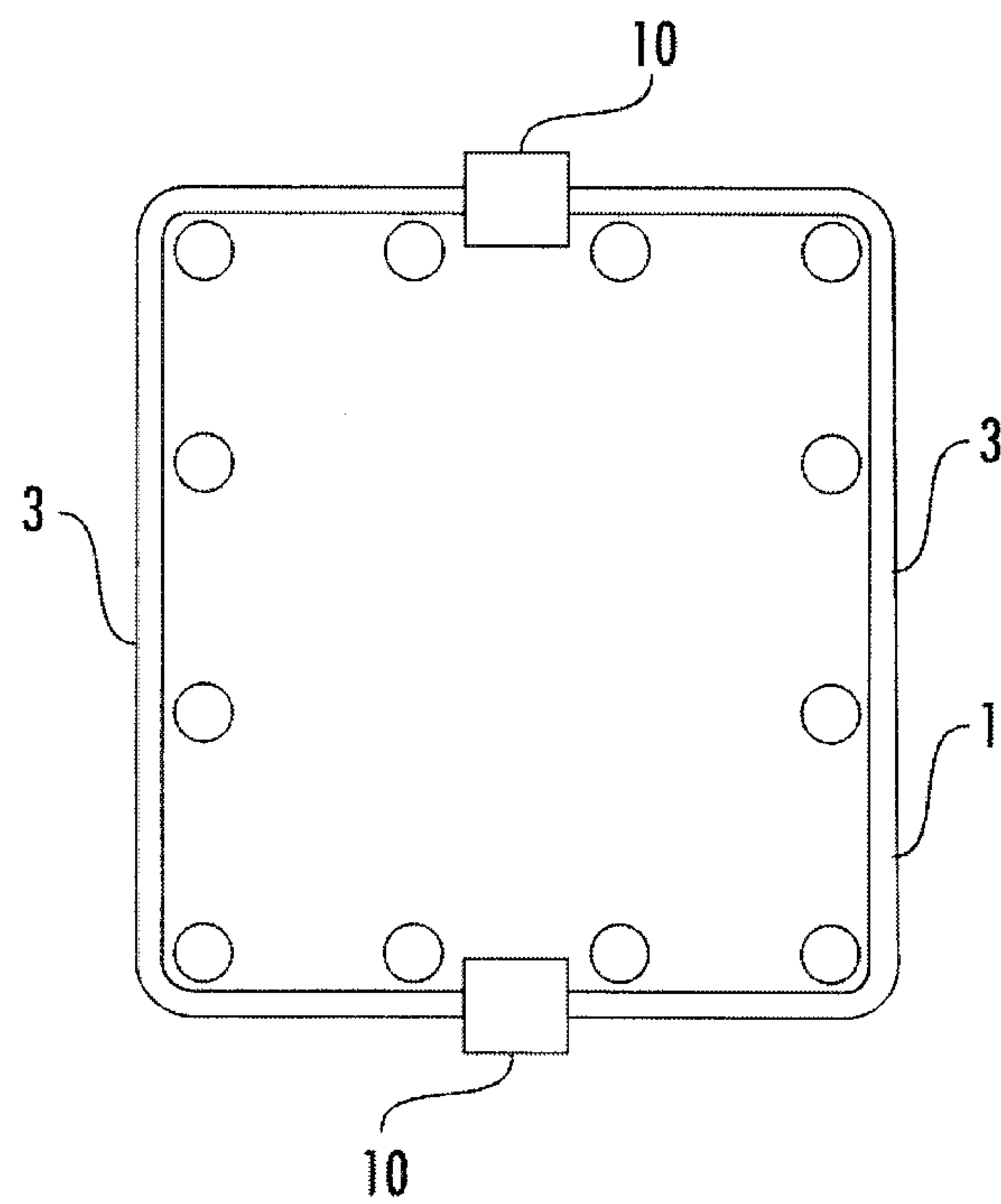


FIG. 6B

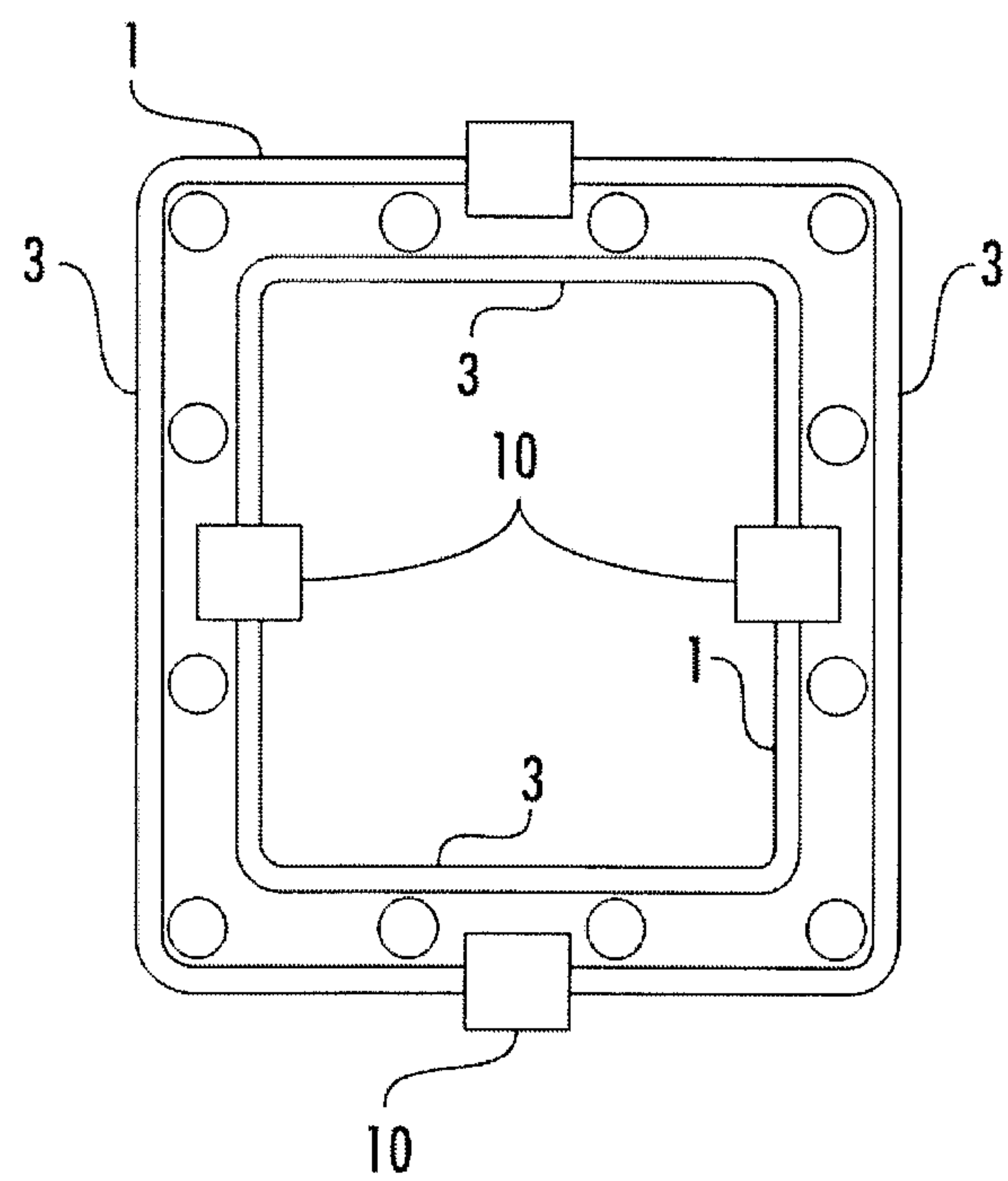


FIG. 6C

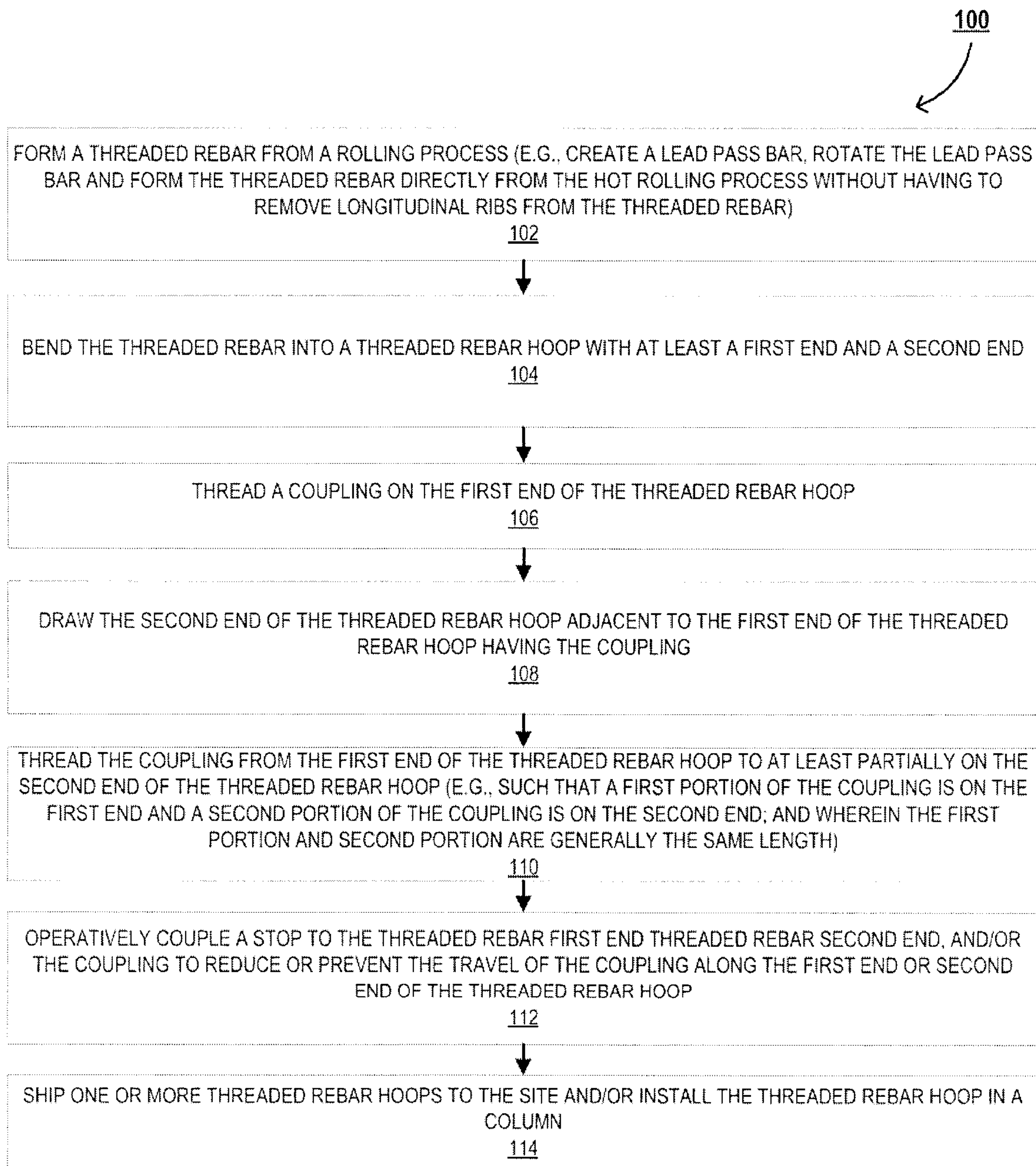


FIGURE 7

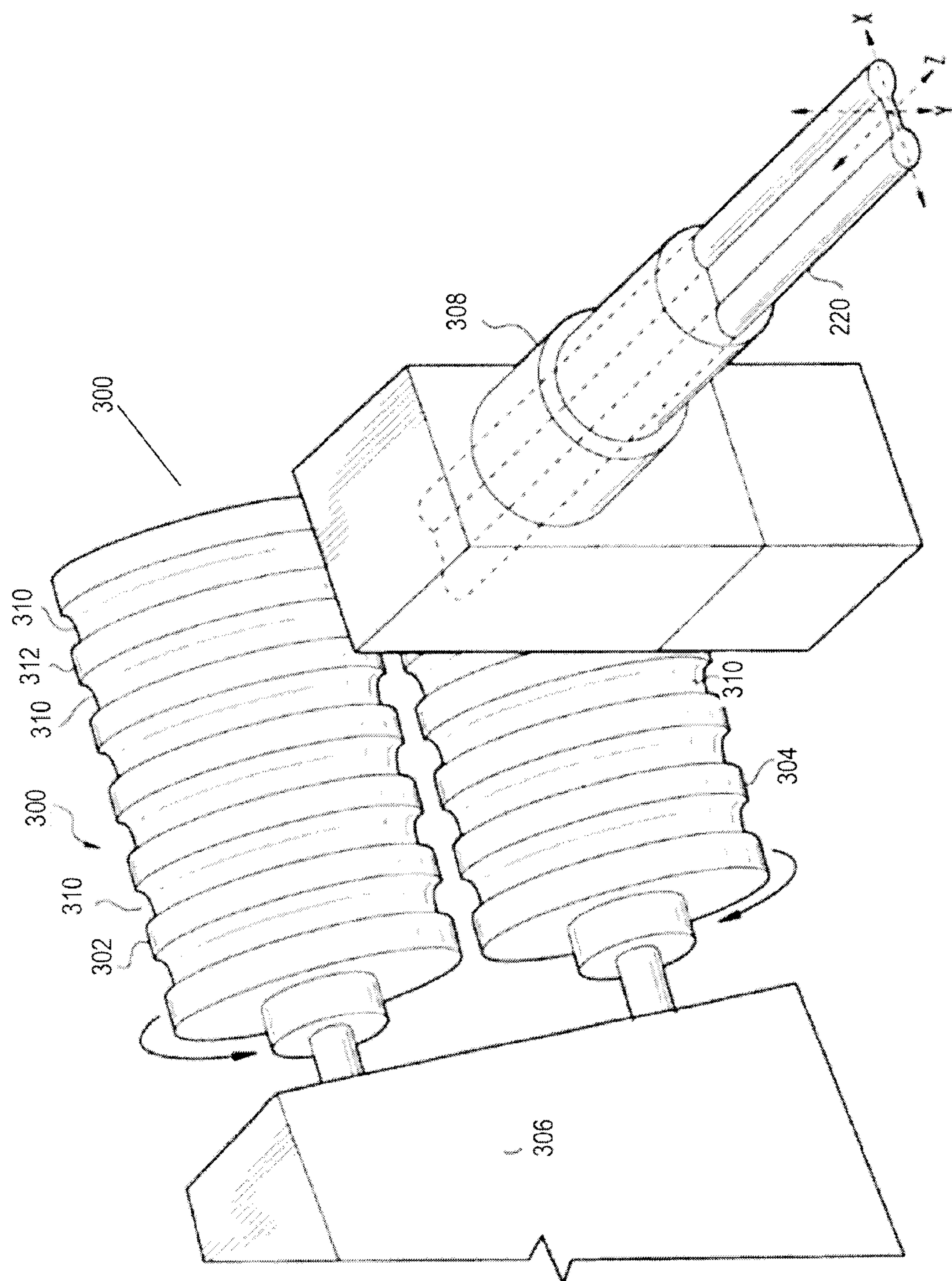


FIGURE 8

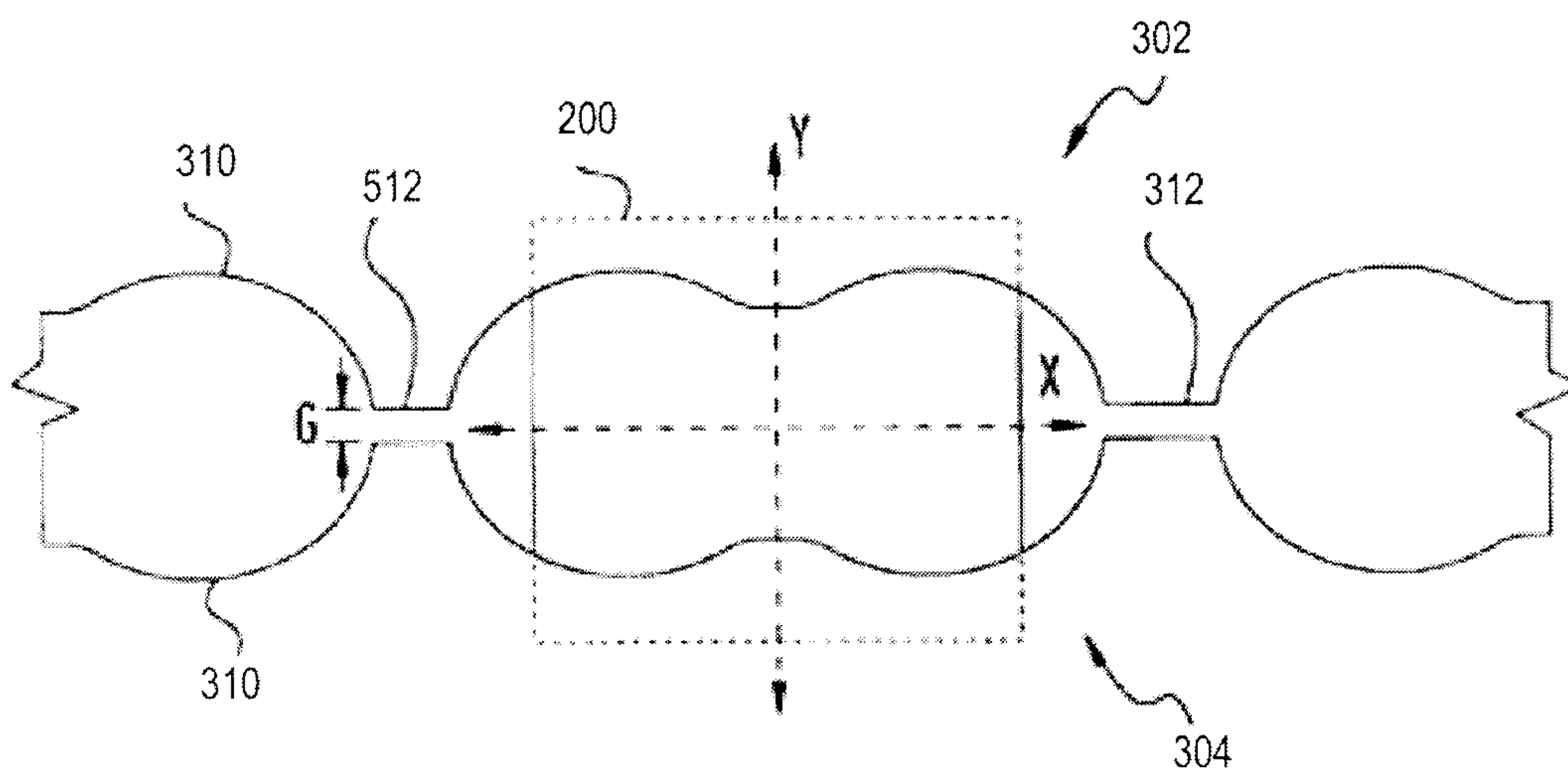


FIGURE 9

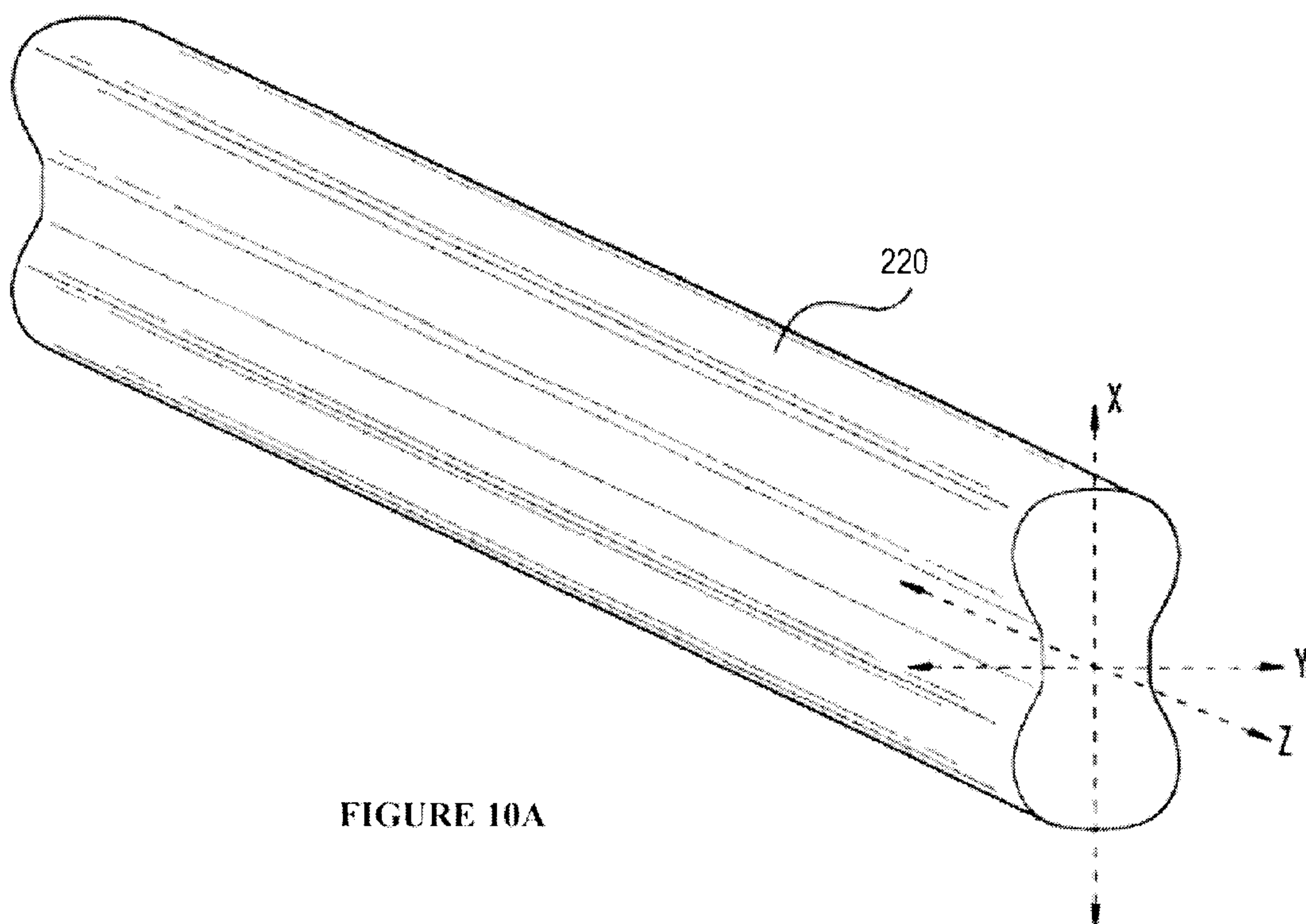


FIGURE 10A

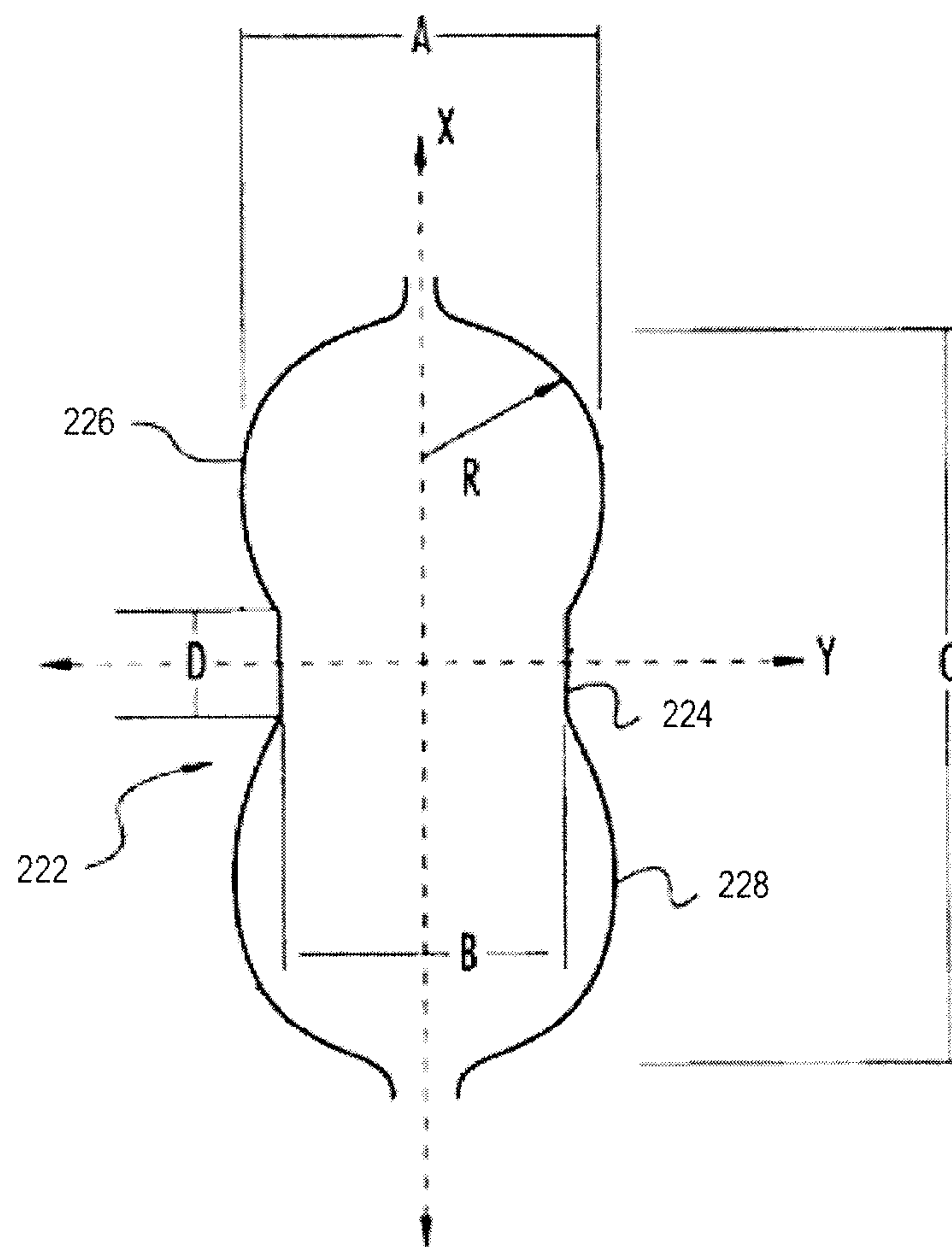


FIGURE 10B

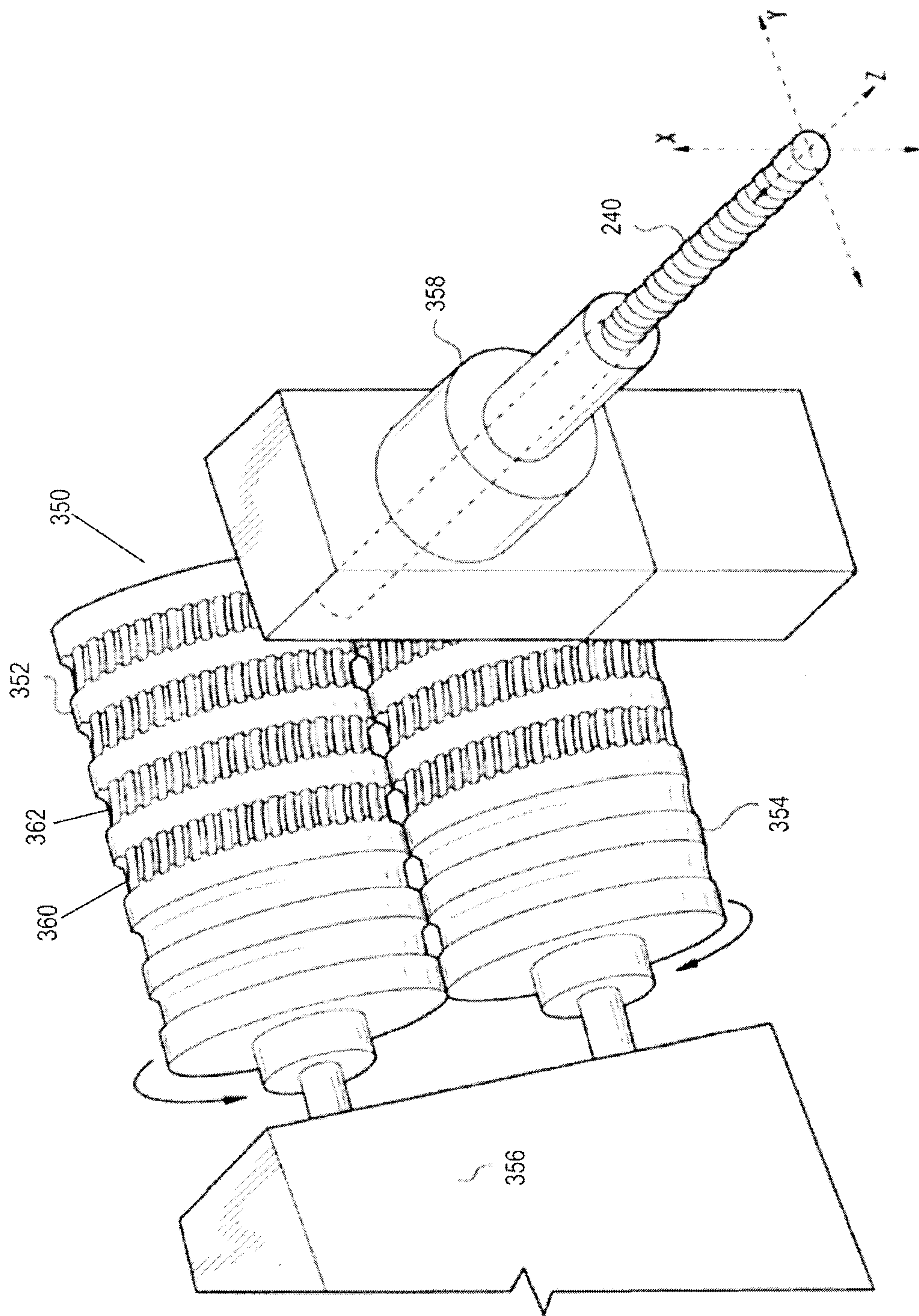


FIGURE 11

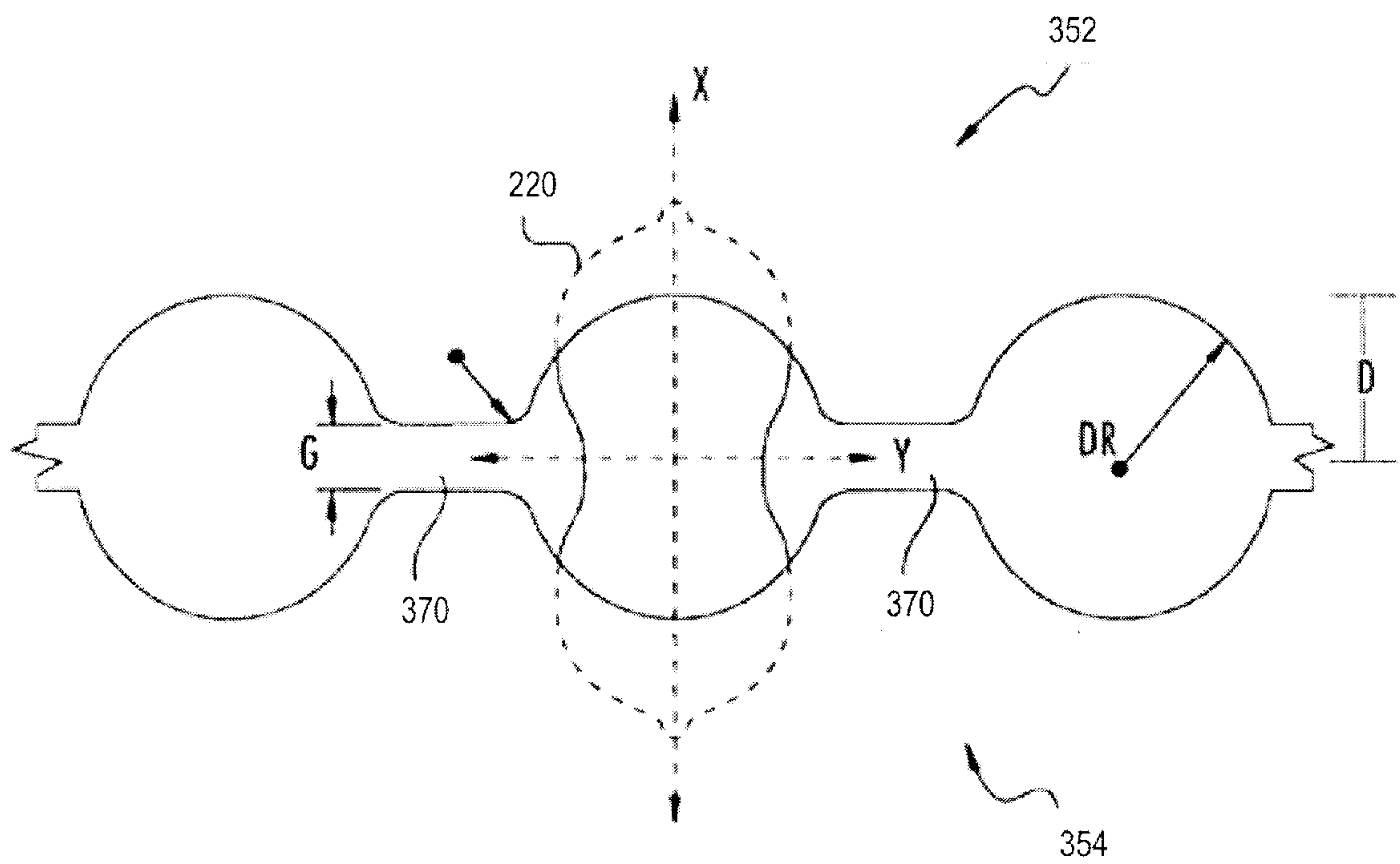


FIGURE 12

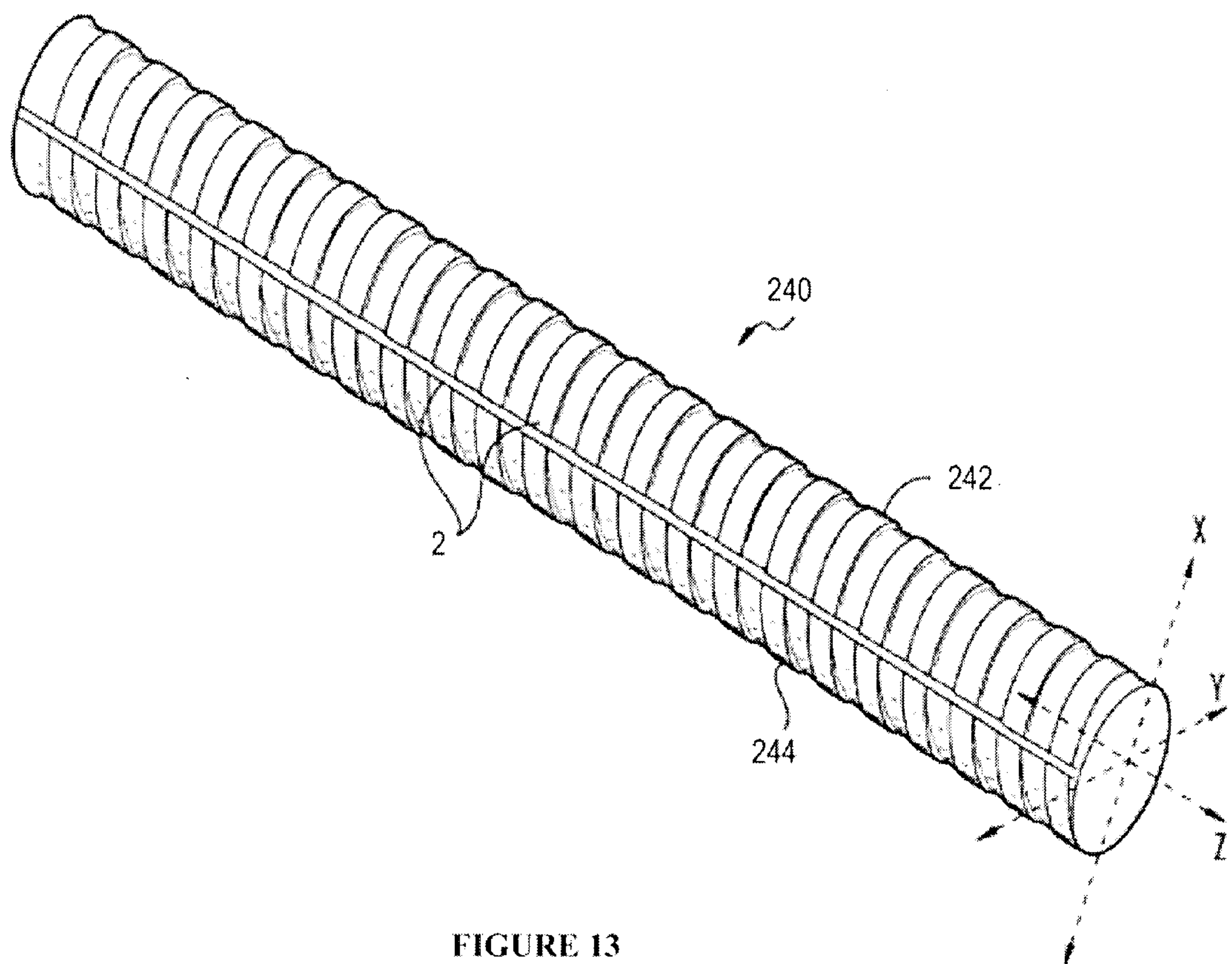


FIGURE 13

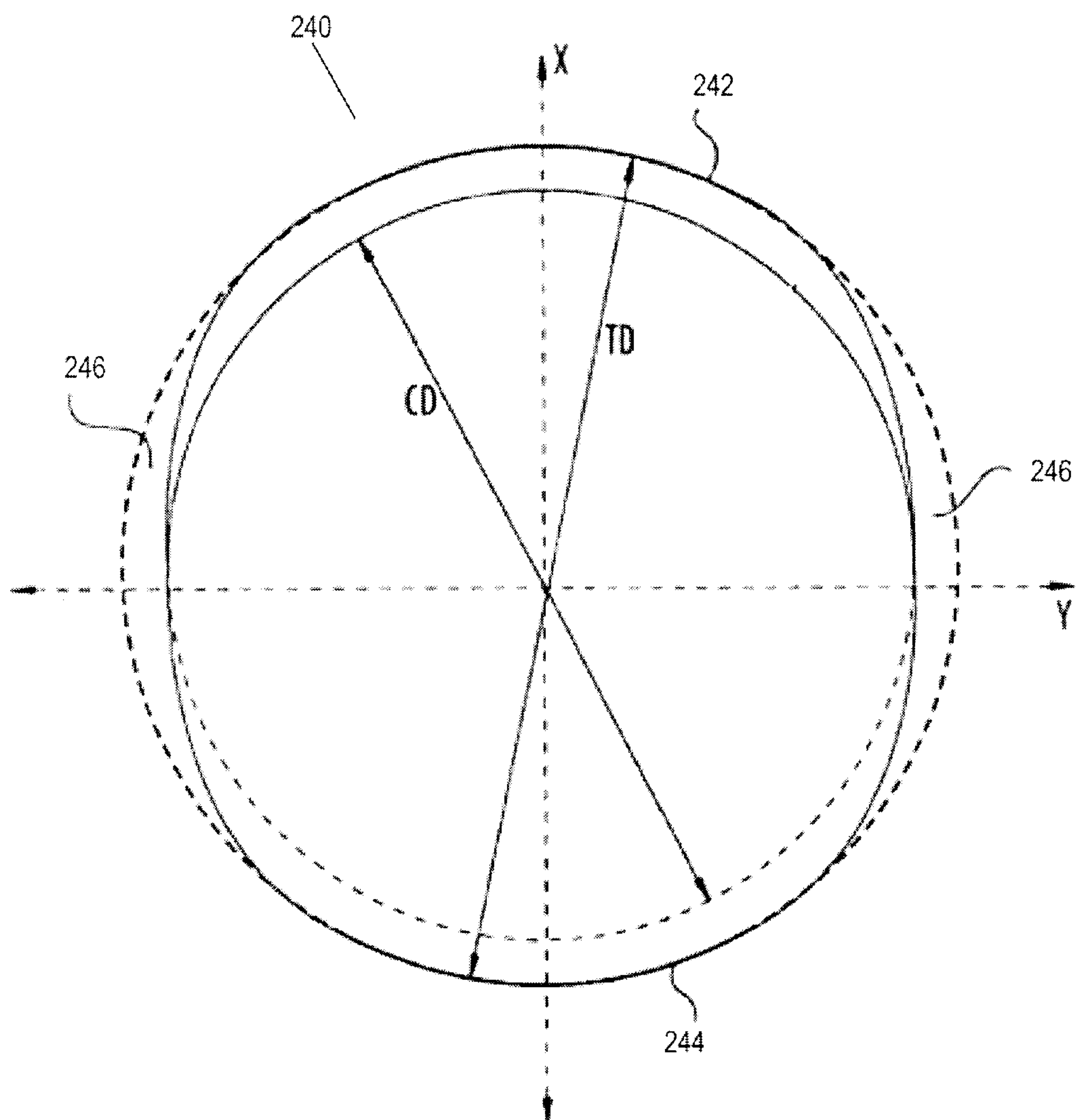


FIGURE 14

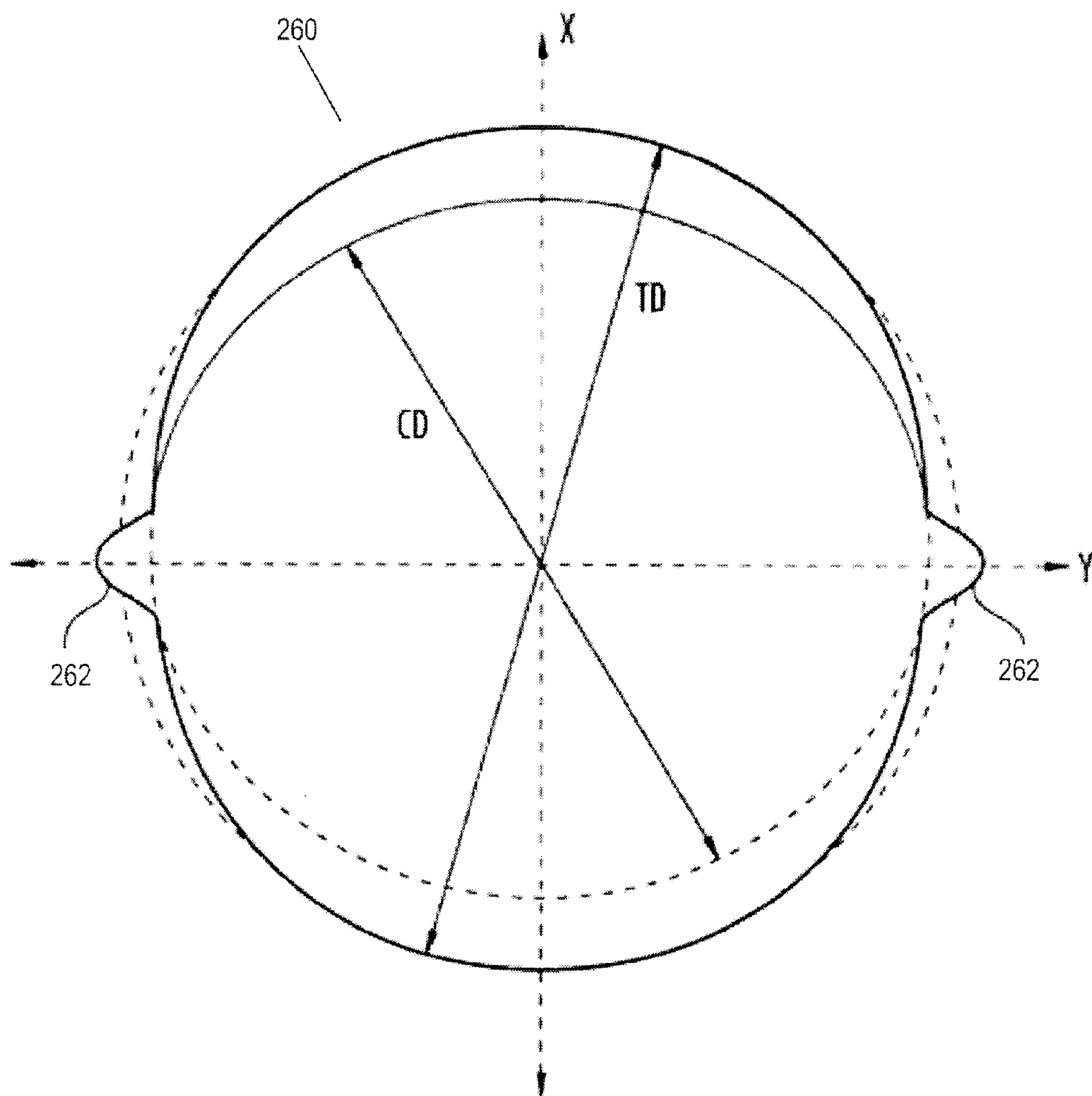


FIGURE 15

