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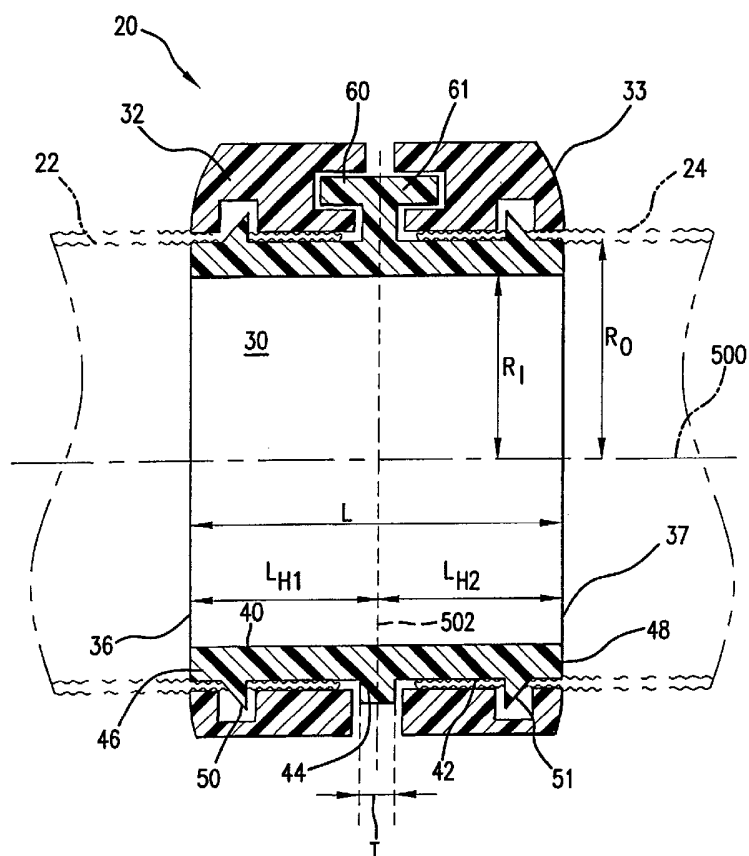
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[Continued on next page]

(54) Title: PROSTHETIC VASCULAR GRAFT CONNECTOR



(57) Abstract: Two prostheses (22, 24) each have a tubular sidewall with a terminal portion extending to a connection end. A connector body (20) has first (46) and second (48) terminal portions extending to first (36) and second (37) ends. The connector body terminal portions (46, 48) are respectively surrounded by the prostheses terminal portions. First (32) and second (33) straps respectively circumscribe the prostheses terminal portions to bias the prostheses into engagement with the connector body (20). The connector body (20) has first and second strap engagement projections respectively captured by apertures in the straps. (Drawing Figure 2)



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PROSTHETIC VASCULAR GRAFT CONNECTOR

[0001] This invention relates to a connector for interconnecting a first prosthetic vessel to a second prosthetic vessel, such as during reconstructive surgery. More particularly, the connector facilitates the rapid durable joining of a prosthetic graft to a bodily vessel or organ thereby reducing cross-clamp time to enhance recovery.

[0002] Vascular reconstructive surgery is utilized to replace portions of blood vessels damaged by aneurismal and occlusive diseases. One such type of replacement is an end-to-end anastomosis where a blood vessel is cut on either side of a diseased or damaged portion.

Prosthetic devices are joined to the cut ends of the healthy portions of the blood vessel and a connector joins the prosthetic devices completing a vessel for the flow of blood that by-passes the damaged portion. Among the objectives of vascular reconstructive surgery is to minimize exsanguination at interfaces between the blood vessels and the prostheses and at interfaces between the prostheses, to minimize cross-clamp time (the time that the blood vessel is externally deprived of blood flow) and to minimize thrombogenicity (the formation of blood clots). The rate of the formation of blood clots tends to increase when flowing blood contacts different materials and when turbulence is introduced into the blood flow.

[0003] Exsanguination is minimized by a tight seal between the vessel and the prosthesis and between interconnected prostheses. Sutures and surgical staples are effective to achieve a tight seal between a prosthesis and a blood vessel and are widely used in vascular reconstructive surgery. Sutures and surgical staples are less efficient to form a tight seal between two prostheses.

[0004] As a replacement to sutures and surgical staples, it is known to interconnect a prosthesis to a blood vessel with an external clamp. Such clamps are disclosed in United States patents numbered 3,357,432; 3,435,823 and 6,402,767. Generally, the prosthesis is inserted into the end of the vessel. The prosthesis has a locking structure on an external surface, such as detents or barbs. An external clamp or ring then closes about the vessel portion overlying the locking structure to thereby hold the vessel firmly in place. Due to the small scale of the vessels, manipulation and accurate placement of the locking structure has, to date, proven difficult.

[0005] Another vascular prosthesis connector is disclosed in FR2683141 by Thierry Richard and Eric Perouse entitled "Connection device for organ vessel prostheses."

[0006] Accordingly, there remains a need for an effective mechanism to rapidly seal a first vascular prosthesis to a second vascular prosthesis that does not have the disadvantages recited above.

5 [0007] In one aspect, the invention is directed to a vascular prosthesis and connector assembly. Two prostheses each have a tubular sidewall with a terminal portion extending to a connection end. A connector body has first and second terminal portions extending to first and second ends. The connector body terminal portions are respectively surrounded by the prostheses terminal portions. First and second straps respectively circumscribe the prostheses terminal portions to bias the prostheses into engagement with the connector body. The
10 connector body has first and second strap engagement projections respectively captured by apertures in the straps.

[0008] In one embodiment of this aspect, the vascular prosthetic surface is everted about a connector.

15 [0009] In another embodiment of this aspect, a connector is pre-attached to either one or both ends of vascular prostheses.

[0010] Other aspects relate to methods of use and kits containing the subject connectors.

20 [0011] The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

[0012] FIG. 1 is a view of a vascular prosthesis connector.

[0013] FIG. 2 is a longitudinal sectional view of the connector of FIG. 1.

[0014] FIG. 3 is a view of a body of the connector of FIG. 1.

[0015] FIG. 4 is a side view of the body of FIG. 3.

25 [0016] FIG. 5 is an end view of the body of FIG. 3.

[0017] FIG. 6 is a view of a strap of the connector of FIG. 1.

[0018] FIG. 7 is a connector end view of the strap of FIG. 6.

[0019] FIG. 8 is a cross sectional view of the strap of FIG. 7 taken along line 8-8.

[0020] FIG. 9 is a sectional view of the strap of FIG. 7 taken along line 9-9.

30 [0021] FIG. 10 is a longitudinal sectional view of a prosthesis.

[0022] FIG. 11 is a view of the prosthesis installed on the connector body.

[0023] FIG. 12 is a view of the installed prosthesis of FIG. 11 circumscribed by a strap.

[0024] FIG. 13 is a view of a modular aorto-biiliac bypass.

[0025] FIG. 14 is an exploded view of the bypass of FIG. 13.

[0026] FIG. 15 is a cross-sectional representation of a connector body in accordance with a second embodiment of the invention.

[0027] FIG. 16 is a cross-sectional representation of an assembled vascular prosthesis utilizing the connector body of FIG. 15.

5 [0028] Figure 17 is a perspective view of the connector body of FIG. 15.

[0029] Like reference numbers and designations in the various drawings indicate like elements.

[0030] FIG. 1 shows a connector 20 for connecting a first end of a first vascular prosthesis 22 to a first end of a second vascular prosthesis 24 to by-pass a diseased or damaged portion of a blood vessel. Opposing second ends 26, 28 of the first 22 and second 24 vascular prostheses are joined to cut ends of healthy portions of the blood vessel on either side of the diseased or damaged portion. The opposing second ends may be joined to the blood vessels by conventional methods such as sutures or surgical staples. Further, use of the connector is not limited to human reconstructive surgery and may be used in veterinary applications as well.

15 [0031] An exemplary connector 20 is shown in cross-sectional representation in FIG. 2 and includes a connector body 30, a first strap 32 and a second strap 33. The connector body 30 is manufactured from any biocompatible material, including metals, plastics and carbon compounds, for example polyethylene or a pyrolytic carbon compound. Preferably, the connector body 30 is formed as a unitary molding from an injection molded plastic. The connector body 30 has a generally tubular structure configuration and extends for a length L along a central longitudinal axis 500 between first rim 36 and second rim 37 that define respective first and second ends of the connector body. The length "L" is dependent on the application. For an exemplary aortic anastomosis, "L" is from about 12 millimeters to about 14 millimeters. The connector body 30 has an inner (interior) surface 40 with a principal radius R_I and an outer (exterior) surface 42 with a principal radius R_O . For the exemplary aortic anastomosis, R_I is from about 18 millimeters and R_O is from about 20 millimeters to about 24 millimeters. Typically, R_O is about 10% greater than R_I .

25 [0032] A flange 44 extends radially outward from the connector body 30 along a central transverse plane 502 that divides the body into two halves. The exemplary flange has an outer radius R_F (FIG. 5) that is from about 1.5 millimeter a thickness T of from about 0.5 millimeter. As shown in FIG. 2, central transverse plane 502 bisects the flange 44 and separates first connector body portion 46 from second connector body portion 48 with each tube portion having a respective length, L_{H1} or L_{H2} . L_{H1} is typically, but not necessarily equal to L_{H2} .

[0033] Along a peripheral surface of the first 46 and second 48 connector body portions, offset from the associated rim 36 and 37, a first circumferential array of detents 50 and a second circumferential array of detents 51 extend radially exterior from the outer surface 42 to an apex 52 at a radius R_T (see FIGS. 4 and 5). Described in further detail below, the detents 50, 51 extend upward from the exterior surface 42 (see FIG. 2) for a distance effective to engage and retain the prostheses 22, 24. Typically, the detents extend upward from the exterior surface 42 for a distance of about 1 millimeter when formed from plastic. Somewhat smaller detents are effective when formed from metal.

[0034] A pair of opposed shafts 60 and 61 shown in FIGS. 2 and 3 extend from the flange 44 along an axis 504 shown parallel to the axis 500. Exemplary shafts are of circular section of diameter D_S and length L_S (as shown in FIG. 4). Each shaft is spaced radially outboard from its associated portion 46, 48 of the connector body 30. Described in further detail below, the shafts 60, 61 may serve as a handle for maneuvering the connector body and may serve to position the associated straps 32 and 33. The shafts enable the prosthesis to be easily and accurately manipulated even during laparoscopic surgery and other procedures with limited access for the surgeon. The shafts may be formed to be removable from the connector body, integral with the connector body, or unitary with the connector body, such as when formed as part of the same molded piece.

[0035] FIG. 6 shows an exemplary strap 32. Depending on positioning circumstances, such a strap or a mirror image thereof could be utilized as either of the straps 32 and 33. The strap extends from a proximal end 70 to a distal end 72 and has generally inner (interior) and outer (exterior) surfaces 74 and 76. The strap inner surface has a channel 78 dimensioned to accommodate the associated detents, (e.g., 50 or 51 of FIG. 2) and portions of the associated prosthesis (e.g., 22 of FIG. 2) pushed into the channel by such detents. Advantageously, at an inboard side of the strap, there is a generally radial surface 80 joining the surfaces 76 and 78. At an outboard side of the strap, the strap largely tapers, with the outer surface 76 tapering inward to meet the inward surface 74. A blind longitudinal hole or compartment 90 extends from the surface 80 and for receiving the associated shaft 60, 61.

[0036] A channel 100 is provided in the outer surface 76 slightly recessed from the compartment 90. A complementary projection 102 is provided extending radially inward from the inner surface 74 near the distal end 72. In an engaged condition (described below), the channel 100 receives the projection 102 to lock the strap in a ring-like state. When locked, the strap prevents relative movement between the prostheses and the connector body. The locking of the strap is reversible. The strap may be disengaged by separating the projection from the

channel. When the strap is unlocked, the connector may be further manipulated or replaced. Alternatively, other locking methods may be employed.

[0037] FIG. 7 is an end view of a strap while FIGS. 8 and 9 illustrated selected portions of the strap in cross-sectional representation.

5 [0038] FIG. 10 shows an exemplary vascular prosthesis 22 having a generally tubular body 120 extending from a first end 122 to an opposing second end 26. The exemplary body is formed of woven or knitted polyester or other suitable fabric. One preferred polyester is poly (ethylene terephthalate), such as Dacron (manufactured by DuPont of Wilmington, DE). A major portion of the tubular body 120 has an internal radius R_B . The illustrated embodiment
10 includes an enlarged terminal portion 126 adjacent the first end 122. The exemplary terminal portion extends over length L_T and, over a major portion thereof, has an internal radius R_E . The terminal portion is provided for coupling to the connector 20 with an associated portion of the connector body 30 being received within the enlarged terminal portion 126. The radius R_E may be chosen relative to the radius R_O to provide insertion of the connector with appropriate
15 snugness. The radius R_B may be chosen relative to the radius R_I so that, when the prosthesis is installed and carrying blood, the connector does not provide an undue flow restriction (e.g., R_I is chosen to be equal to R_B).

[0039] In one application of the connector of the invention, a vascular reconstructive surgical procedure entails coupling the second ends 26 of two prostheses to healthy portions of
20 the patient's cardiovascular system on either side of a diseased or damaged portion and securing the connector to both first end 122 enlarged terminal portions 126 to couple the two prostheses. The connector may be pre-secured to one of the prostheses before the surgeon installs such prosthesis. The surgeon may so pre-secure (pre-install) or the packaged prosthesis may come with the connector pre-installed. To install each half of the connector to its
25 associated prosthesis, the surgeon inserts a connector body portion (46, 48 in FIG. 2) into the enlarged terminal portion 126. This may be done by holding the connector body with a surgical instrument. For example, with reference to FIG. 11, the connector 20 may be held by one or both of the shafts 60, 61. The prosthesis enlarged terminal portion is then drawn over the tube portion 46 or 48, advantageously with a slight degree of stretch so as to firmly engage the
30 detents 50. Advantageously the detents are pointed and point outward from the connector body to pierce the terminal portion and resist its retraction. With reference to FIG. 12, when the terminal portion is installed, the surgeon then installs the associated strap 32. This is done by manipulating the strap 32 with the associated shaft 60 and wrapping the strap around the

terminal portion 126, finally inserting the projection 102 into the channel 100 (as illustrated in FIG. 6) to lock the strap 32 in its installed condition.

[0040] The connector body is advantageously formed of an appropriate plastic having sufficient rigidity to withstand the pressure envelope of the patient's viscera and is further biologically inert within the human body. Such plastics are dimensioned to a size effective to withstand arterial pressures of up to 300 millimeters. Preferred plastics include polyurethane and polyethylene. Other biocompatible materials such as metals and carbon compounds are also suitable. The connector may be dimensioned for particular applications. Size may be conveniently designated by an appropriate diameter or associated radius such as the interior diameter or its associated radius R_I . In an exemplary 20 mm embodiment, the radius R_I is 10 mm and the radius R_O is 11 mm. The 20 mm embodiment is near the large end of a size spectrum. Near the small end of that spectrum, an exemplary 6 mm embodiment has a radius R_I of 3 mm and a radius R_O of 4 mm. The scaling of connector body wall thickness relative to size will be largely influenced by structural integrity considerations. Accordingly, the wall thickness may increase less than proportionately.

[0041] The detent height is $R_T - R_O$ and is influenced principally by the material and thickness of the prostheses. Exemplary woven polyester prostheses have a wall thickness of 0.3-0.4 mm. for such material, exemplary detent height is about twice the prosthesis wall thickness (e.g. about 1-3 times) or approximately 1 mm. The length L_H will be influenced by structural integrity considerations and by considerations relating to the ease of assembling the prosthesis and strap to the body weighed against compactness considerations. An L_H of about 2.5 mm may be a practical minimum. For the relatively small exemplary 6 mm size, an L_H of about 3 mm may be appropriate. For the relatively large exemplary 20 mm size, an L_H of about 5 mm may be appropriate. An exemplary flange thickness T is 1 mm. The detents advantageously fall along the outboard half of the length L_H . The handle shaft length L_S is advantageously about half L_H to avoid clearance problems relative to the detents.

[0042] An exemplary strap is molded of an appropriate plastic that is biologically inert within the body. Suitable plastics include polyethylene or polyurethane with a thickness of about 3 millimeters. An exemplary principal thickness T_S is about 2 mm and an exemplary width W_S is equal to L_H . Advantageous values of T_S may be relatively insensitive to size. The flange radius R_F is advantageously the same as the outer radius of the installed straps.

[0043] FIG. 13 shows a flow-splitting prosthesis ("flow splitter") 200 installed in an aorto-biiliac bypass establishing communications between a patient's aorta 600 and iliac arteries 602 and 604. The flow splitter 200 is generally Y-shaped, having a leg or trunk 202 and

a pair of first and second arms or branches 204 and 206. The flow splitter 200 is coupled to the arteries by respective connection prostheses 202, 204, and 206. The flow splitter 200 is coupled to the prostheses 202, 204, and 206 via respective couplers 208, 210, and 212. Except as otherwise described, these couplers may be otherwise similar to the connector (illustrated in either FIG. 2 or FIG. 15 as described below) and have similar interaction with the associated prostheses.

[0044] Prior to surgery, the sizes of the prostheses 202, 204, and 206 will be selected based upon medical imaging. Most key is the cross-sectional area characterized by a diameter or radius. Length may also be relevant and may be used to either select a particular prosthesis or cut a prosthesis to a particular length. By way of example, the prostheses 202, 204, and 206 may have nominal diameters of eighteen, eight and ten mm, respectively in one common size combination.

[0045] With reference to FIG. 14, in an exemplary surgical procedure, the bodies of the couplers 208, 210, and 212 are preinstalled on associated ends of the prostheses 202, 204, and 206. They may be so installed with respective straps 214, 216, and 218. Alternatively, they may be secured by other means for example when only the other half of each connector body is adapted for receipt of such straps.

[0046] The components illustrated in FIG. 14 may be provided in kit form. For example, Prostheses 202, 204 and 206 are supplied from a medical supply house with connectors 208, 210 and 212 pre-attached. The kit would further include a required prostheses 200 and a number of locking straps 222, 224 and 226. It is preferred, but not required, that the connectors 208, 210 and 212 would be of similar configuration such that locking straps 222, 224 and 226 are interchangeable.

[0047] The surgeon secures the connection prostheses 202, 204, and 206 to their associated arteries. In the illustrated example, the connection prosthesis 202 is surgically stapled to the aorta 600 in an end-to-end anastomosis. Suturing is an alternative. The connection prosthesis 204 is also secured to its iliac artery 602 via an end-to-end anastomosis such as via stapling or suturing. The connection prosthesis 206 is connected to its iliac artery 604 via an end-to-side anastomosis such as via suturing or stapling.

[0048] After installation of the connection prostheses 202, 204, and 206, the surgeon may install flow splitter 200. If the coupler bodies are preinstalled at the factory to their associated connection prostheses 202, 204, and 206, rings 222, 224, and 226 may be prepackaged with such connection prostheses. Alternatively, such rings may be prepackaged with the flow splitter 200 or otherwise provided. With the connection prostheses 202, 204, and

206 installed, the surgeon may finally size the flow splitter 200 by removing distal lengths of one or more of the trunk 192, first branch 194, and second branch 196 to define final ends 230, 232, and 234, respectively. Terminal portions adjacent to these ends are in turn placed by the surgeon over associated end portions of the bodies of connectors 208, 210, and 212 and secured
5 with straps 222, 224, and 226. Blood flow is then reestablished and the surgery site closed.

[0049] In accordance with another embodiment of the invention, an alternative connector 20' is illustrated in cross-sectional representation in FIG. 15. A first prosthesis 22 extends through an interior bore 302 of connector body 300. An end portion 303 of the first prosthesis 22 is everted 304 and folded back over a first rim 306 of the connector body 300 and
10 engaged along an exterior surface of the connector body, such as by detents 308. As illustrated in FIG. 16, a second prosthesis 24 intended to be joined to the first prosthesis 22 has an enlarged terminal portion 309 extended over the end portion 303 of the first prosthesis and engaged on detents 308. When properly positioned, strap 310 is circumscribed about the connector body 300 to firmly retain the connector in place. Throughout the assembly, handle
15 312 is used to manipulate the connector body.

[0050] The embodiment of FIG. 15 is further illustrated in perspective representation in FIG. 17 where first prosthesis 22 has been extended through the interior bore of connector body 300 and an end portion 303 everted and engaged on detents 308. Handle 312 provides ease of manipulation.

20 [0051] In the embodiment illustrated in FIGS. 15-17, the surface contacting the blood remains that of the prostheses, rather than a transition to the interior bore of the connector. Avoiding the changing of surface chemistry reduces the risk of thrombosis inherent when the chemistry of the surfaces contacted by the blood changes. Thrombogenicity is further reduced by a reduced turbulence imparted into the blood flow.

25 [0052] One or more embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, the connectors may be tailored for a variety of general or specific applications. Accordingly, other embodiments are within the scope of the following claims.

CLAIMS

What is Claimed is:

1. A connector 20 for joining a first tubular vessel 22 to a second tubular vessel 24, comprising:
 - 5 a connector body 30 with a first connector body portion 46 for engaging a first end of said first tubular vessel 22 and a second connector body portion 48 for engaging a first end of said second tubular vessel 24;
an extension 60 projecting outward from said connector body 30;
a first locking strap 32 that circumscribes said first connector body portion 42 and said
10 extension 60 thereby preventing movement of said first tubular vessel 22 relative to said connector 20; and
a second locking strap 33 for circumscribing said second connector body portion 48 thereby preventing movement of said second tubular vessel 24 relative to said connector 20.
- 15 2. The connector 20 of claim 1 wherein a first radial array of detents 50 extends outward from an exterior surface 42 of said first connector body portion 46 and a second radial array of detents 51 extends outward from an exterior surface 42 of said second connector body portion 48.
- 20 3. The connector 20 of claim 2 wherein detents 50 of said first radial array of detents outwardly terminate at an apex and said detents are effective to pierce and retain a wall of said first tubular vessel 22.
4. The connector 20 of claim 2 wherein said extension 60 has a length effective for
25 grasping to facilitate manipulation of said connector body 30.
5. The connector 20 of claim 4 wherein said extension 60 is integral with said connector body 30.
- 30 6. The connector 20 of claim 5 wherein said extension 60 is unitary with said connector body 30.
7. The connector 20 of claim 4 wherein said extension 60 is removable from said connector body 30.

8. The connector 20 of claim 4 wherein said second connector body portion 48 is a mirror image of said first connector body portion 46.

5 9. The connector 20 of claim 4 wherein said first locking strap 32 is locked by engaging a first end 70 thereof into a second end 72 thereof.

10. The connector 20 of claim 9 wherein said locking is non-permanent and said first end 70 thereof may be disengaged from said second end 72 thereof.

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11. The connector 20 of claim 10 wherein said first end 70 thereof includes a projection 102 that engages a channel 100 formed in a second end thereof.

12. The connector 20 of claim 9 wherein said first tubular vessel 22 and said second tubular
15 vessel 24 are both vascular prostheses.

13. The connector 20 of claim 10 wherein said first locking strap 32 is removable from said connector 20 when unlocked.

20 14. A connector 20' for joining a first tubular vessel 22 to a second tubular vessel 24, comprising:

a tubular connector body 300 terminating at first 306 and second rims thereof and having an interior bore 302 and an exterior surface 303;

a first end of said first tubular vessel 22 for extending through said interior bore 302,
25 being everted 304 about said first rim 306 and engaging said exterior surface 303 of said connector body 300;

a first end 309 of said second tubular vessel 24 for extending over said first rim 306 and over said first end of said first tubular vessel 22 and engaging said exterior surface 303 of said connector body 300;

30 an extension 312 projecting outward from said connector body 300; and

a locking strap 310 for circumscribing said connector body 300, said first end of said first tubular vessel 22, and said first end 309 of said second tubular vessel 24 thereby preventing movement of said first tubular vessel 22 and said second tubular vessel 24 relative to said connector 20'.

15. The connector 20' of claim 14 wherein a radial array of detents 308 extends outward from said exterior surface 303 of connector body 300.

5 16. The connector 20' of claim 15 wherein said detents 308 outwardly terminate at an apex and are effective to pierce and retain both a wall of said first tubular vessel 22 and a wall of said second tubular vessel 24.

10 17. The connector 20' of claim 16 wherein said extension 312 has a length effective for grasping to facilitate manipulation of said connector body 300.

18. The connector 20' of claim 17 wherein said extension 312 is integral with said connector body 300.

15 19. The connector 20' of claim 18 wherein said extension 312 is unitary with said connector body 300.

20 20. The connector 20' of claim 17 wherein said extension 312 is removable from said connector body 300.

21. The connector 20' of claim 17 wherein said locking strap 310 is locked by engaging a first end 70 thereof into a second end 72 thereof.

25 22. The connector 20' of claim 21 wherein said locking is non-permanent and said first end 70 thereof may be disengaged from said second end 72 thereof.

23. The connector 20' of claim 22 wherein said first end 70 of said locking strap 310 includes a projection 102 that engages a channel 100 formed in said second end 72 thereof.

30 24. The connector 20' of claim 22 wherein said first tubular vessel 22 and said second tubular vessel 24 are both vascular prostheses.

25. The connector 20' of claim 22 wherein said locking strap 310 is removable from said connector 20' when unlocked.

26. A kit for vascular reconstructive surgery comprising:
a first vascular prosthesis 22 having opposing first and second ends;
a second vascular prosthesis 24 having opposing first and second ends;
5 a connector body 30 for affixing to said first end of said first vascular prosthesis 22 and
to said first end of said second vascular prosthesis 24; and
at least a first locking strap 32 effective to prevent movement of said first vascular
prosthesis 22 and said second vascular prosthesis 24 relative to each other and to said
connector body 30.

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27. The kit of claim 26 wherein a radial array of detents 50 extend outward from an exterior
surface 42 of a first connector body portion 46.

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28. The kit of claim 27 wherein detents 50 of said radial array of detents outwardly
terminate at an apex and said detents 50 are effective to pierce and retain a wall of said first
tubular vessel 22.

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29. The kit of claim 27 wherein an extension 60 projects outward from said connector body
30 and has a length effective for grasping to facilitate manipulation of said first tubular
connector body portion 46.

30. The kit of claim 29 wherein said extension 60 is integral with said connector body 30.

25

31. The kit of claim 30 wherein said extension 60 is unitary with said connector body 30.

32. The kit of claim 29 wherein said extension 60 is removable from said connector body
30.

30

33. The kit of claim 29 wherein a second connector body portion 48 is a mirror image of
said first connector body portion 46.

34. The kit of claim 29 wherein said first locking strap 32 has a first end 70 with a
projection 102 for reversibly engaging a channel 100 formed in an opposing second end 72 of
said locking strap 32.

35. The kit of claim 34 wherein said locking strap 32 is removable from said connector 20 when unlocked.

5 36. The kit of claim 26 wherein said connector 20 is affixed to one of said first vascular prosthesis 22 or said second vascular prosthesis 24.

37. A method for forming a vascular graft comprising the steps of:

- 10 (a). providing a first tubular prosthetic vessel 22 having first and second opposing ends, providing a second tubular prosthetic vessel 24 having opposing first and second ends, and providing a tubular connector 20 having opposing first 36 and second ends 37;
- (b). fixedly inserting said first end 36 of said tubular connector into said first end of first tubular prosthetic vessel 22;
- 15 (c). fixedly inserting said second end 37 of said tubular connector 20 into said first end of said second tubular prosthetic vessel 24; and
- (d) reversibly locking said first tubular prosthetic vessel 22 and said second tubular prosthetic vessel 24 to prevent relative motion between all of said first tubular prosthetic vessel 22, said second tubular prosthetic vessel 24 and said tubular connector 20.

20 38. The method of claim 37 including manipulating said first tubular connector 30 with an outwardly projecting handle 60.

39. The method of claim 37 including the step of attaching at least one of said second end of said first tubular prosthetic vessel 22 and said second end of said second tubular prosthetic vessel 24 to a bodily vessel prior to step (b).

25

40. The method of claim 39 wherein said step of attaching said second end of said first tubular prosthetic vessel 22 includes stapling.

41. A method for forming a vascular graft comprising the steps of:

(a). providing a first tubular prosthetic vessel 22 having first and second opposing ends, a second tubular prosthetic vessel 24 having opposing first and second ends, and a
5 tubular connector 20' having first and second opposing ends;

(b). passing said first tubular prosthetic vessel 22 through an interior bore 302 of said tubular connector 20' from said first end thereof to said second end thereof and everting 304 said first tubular vessel 22 about said second end of said tubular connector;

(c). fixedly attaching both said first prosthetic vessel and said second prosthetic
10 vessel to an exterior surface of said connector portion 20; and

(d). reversibly locking said first tubular prosthetic vessel 22 and said second tubular prosthetic vessel 24 to prevent relative motion between all of said first tubular prosthetic vessel 22, said second tubular prosthetic vessel 24, and said tubular connector 20'.

15 42. The method of claim 41 including affixing said first prosthetic vessel 22 and said second prosthetic vessel 24 to said connector body 20' by piercing with a radial array of detents 308 extending outwardly from said connector body 20'.

43. The method of claim 41 including manipulating said first tubular connector 20' with an
20 outwardly projecting handle 312.

44. The method of claim 40 including the step of attaching at least one of said second end of said first tubular prosthetic vessel 22 and said second end of said second tubular prosthetic vessel 24 to a bodily vessel prior to step (b).

25

45. The method of claim 44 wherein said step of attaching said second end of said first tubular prosthetic vessel 22 includes stapling.

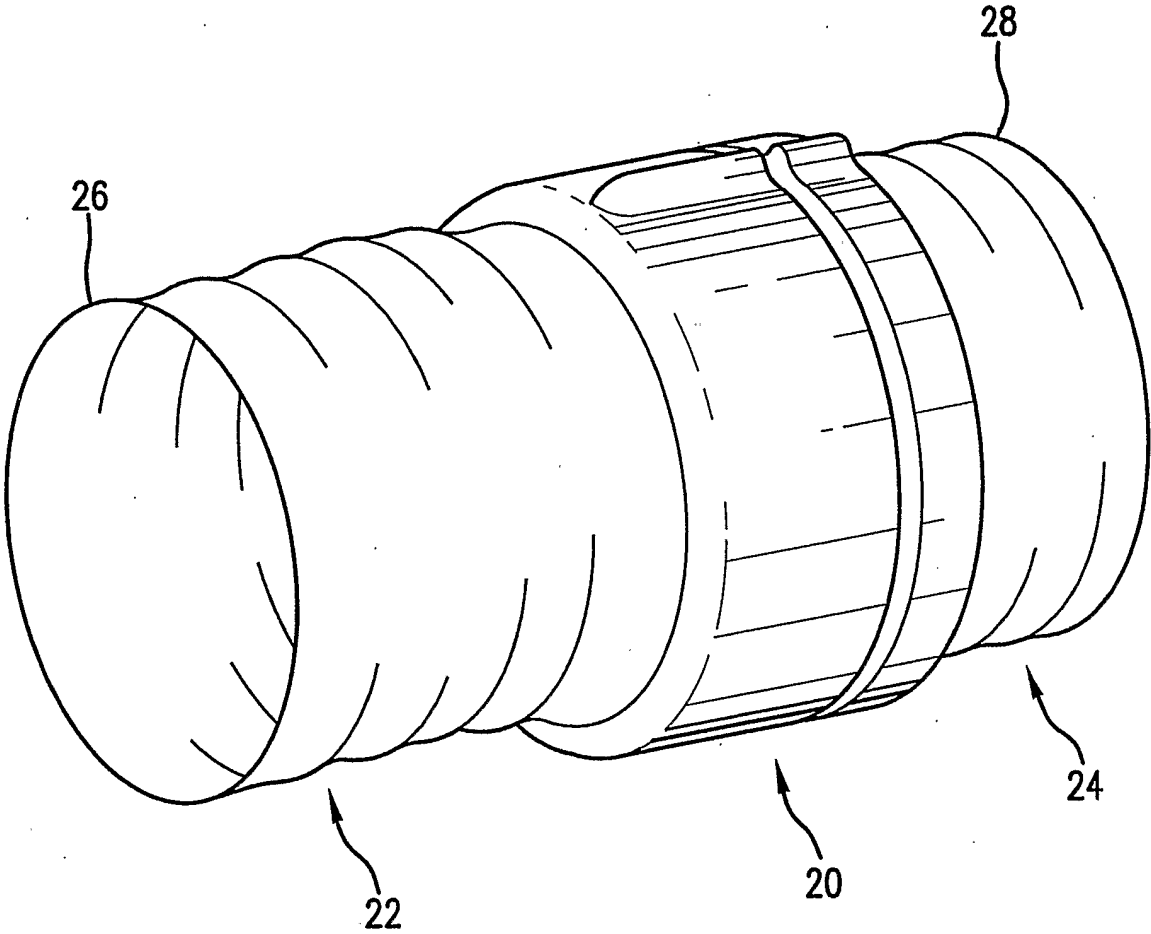


FIG. 1

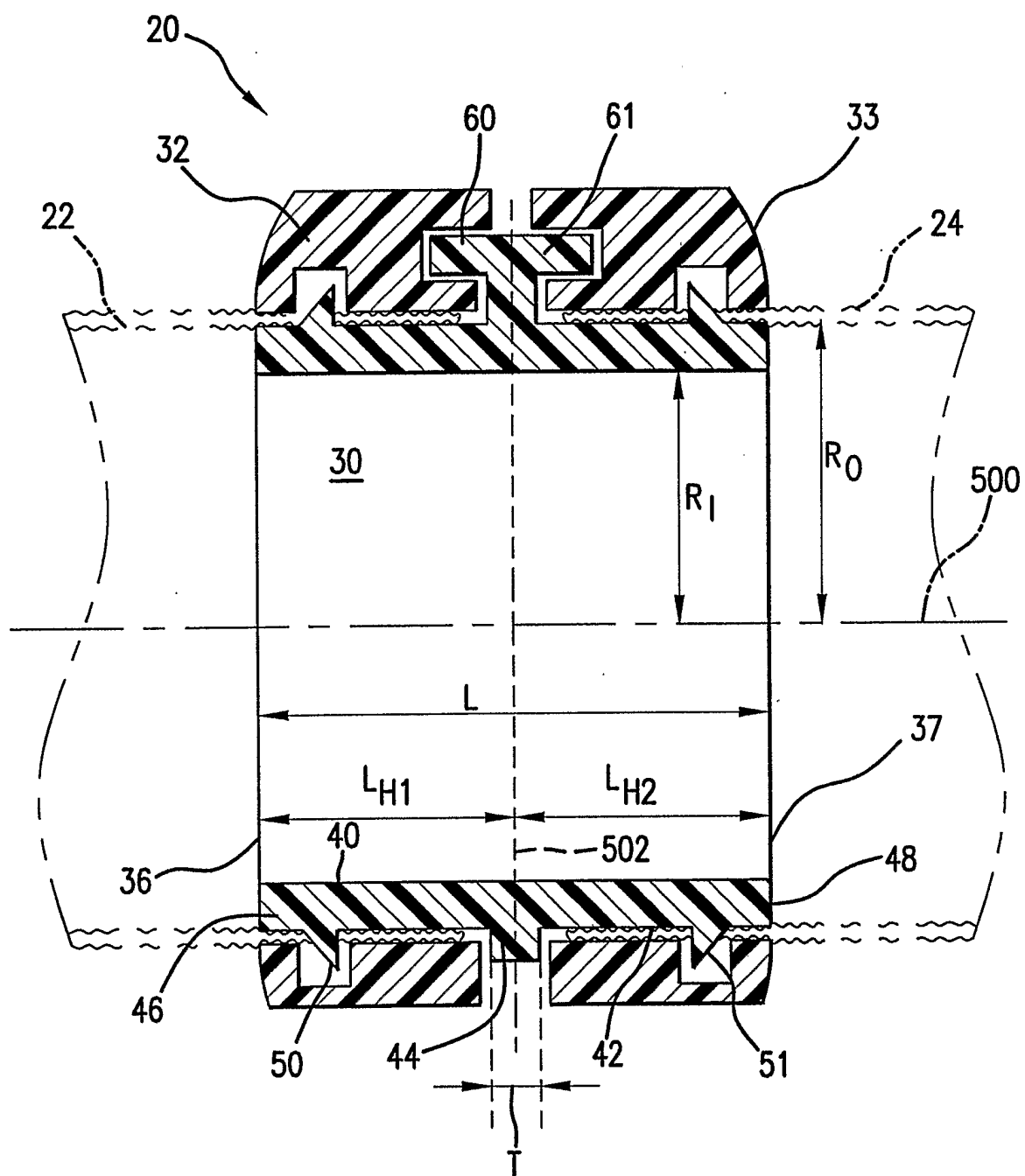
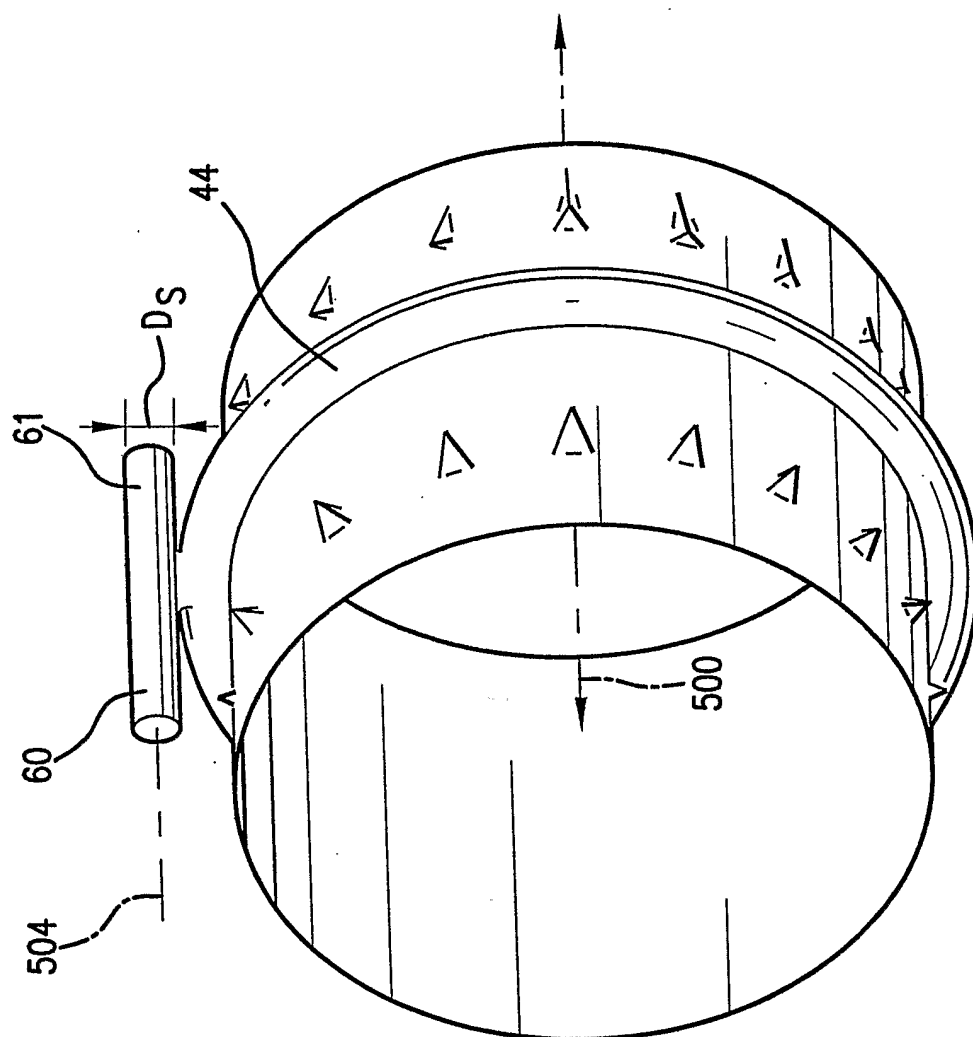


FIG. 2



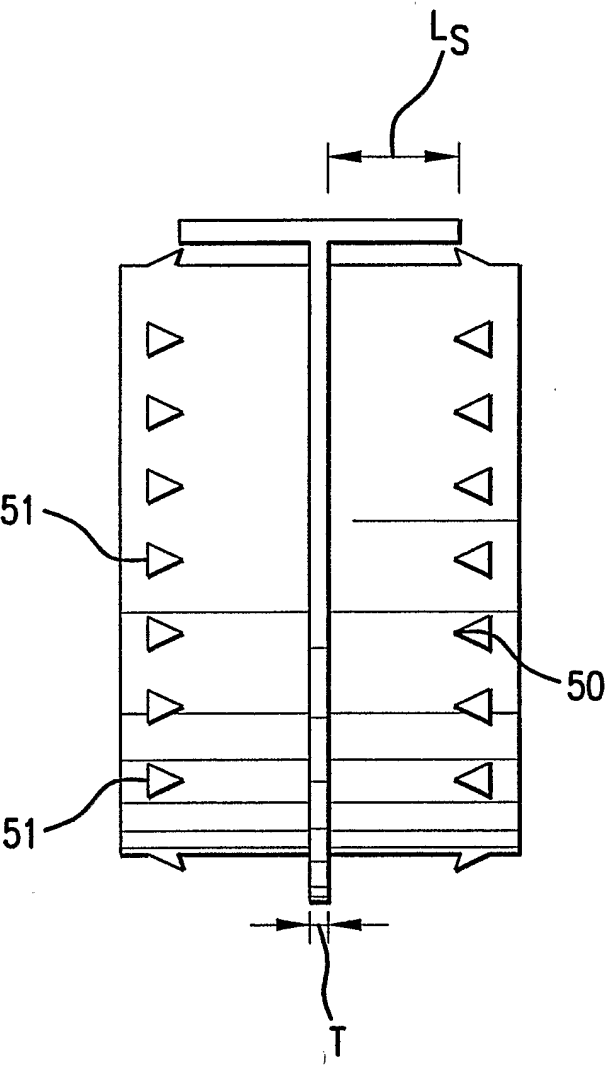


FIG.4

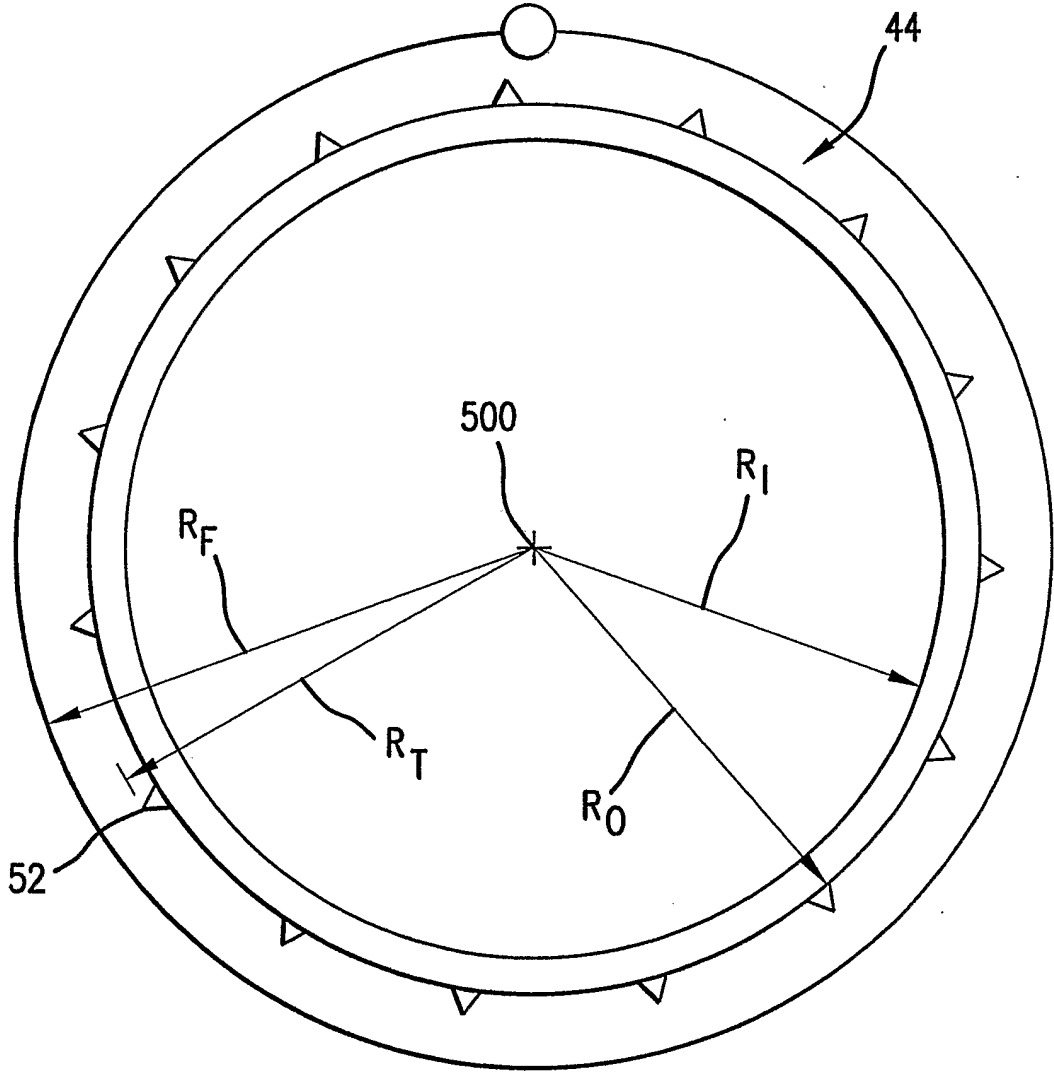


FIG.5

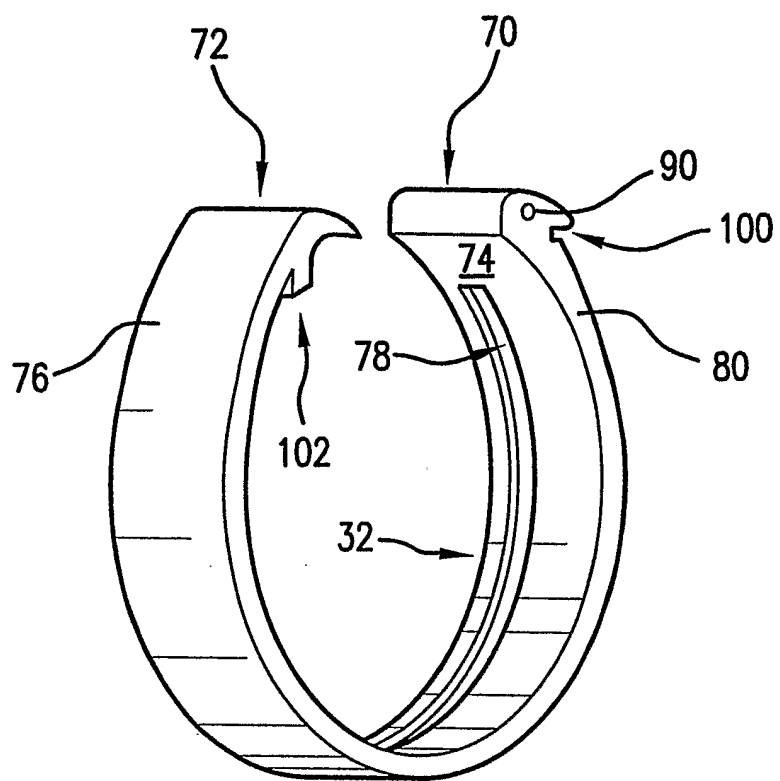


FIG. 6

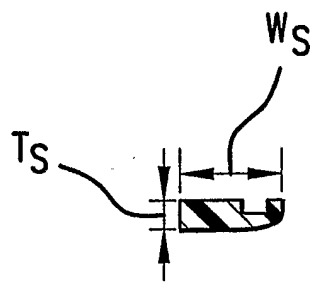


FIG. 8



FIG. 9

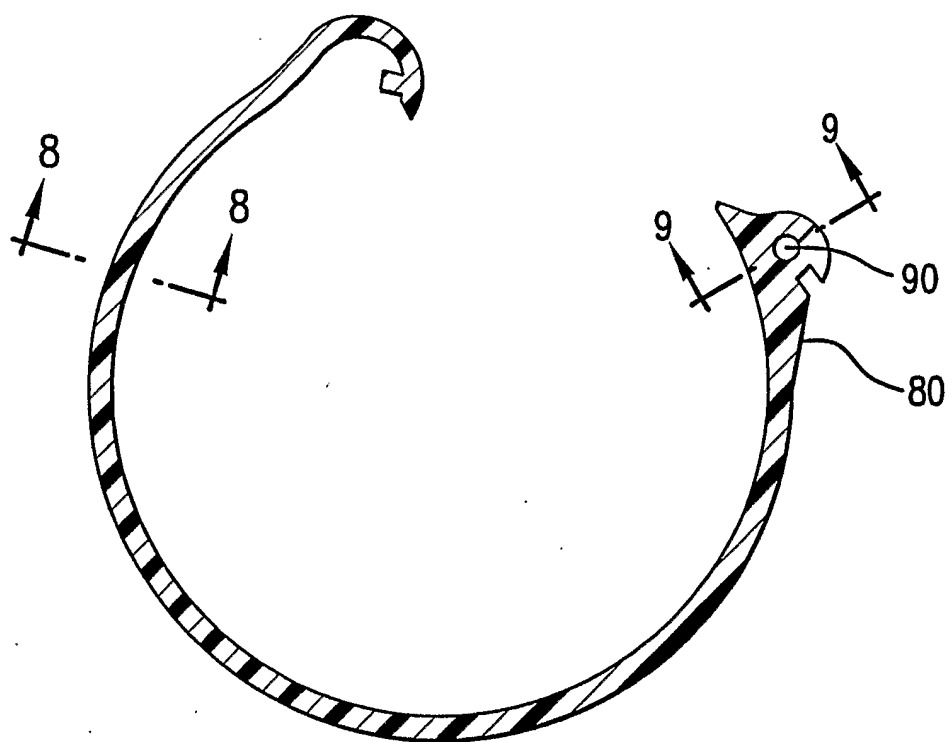


FIG. 7

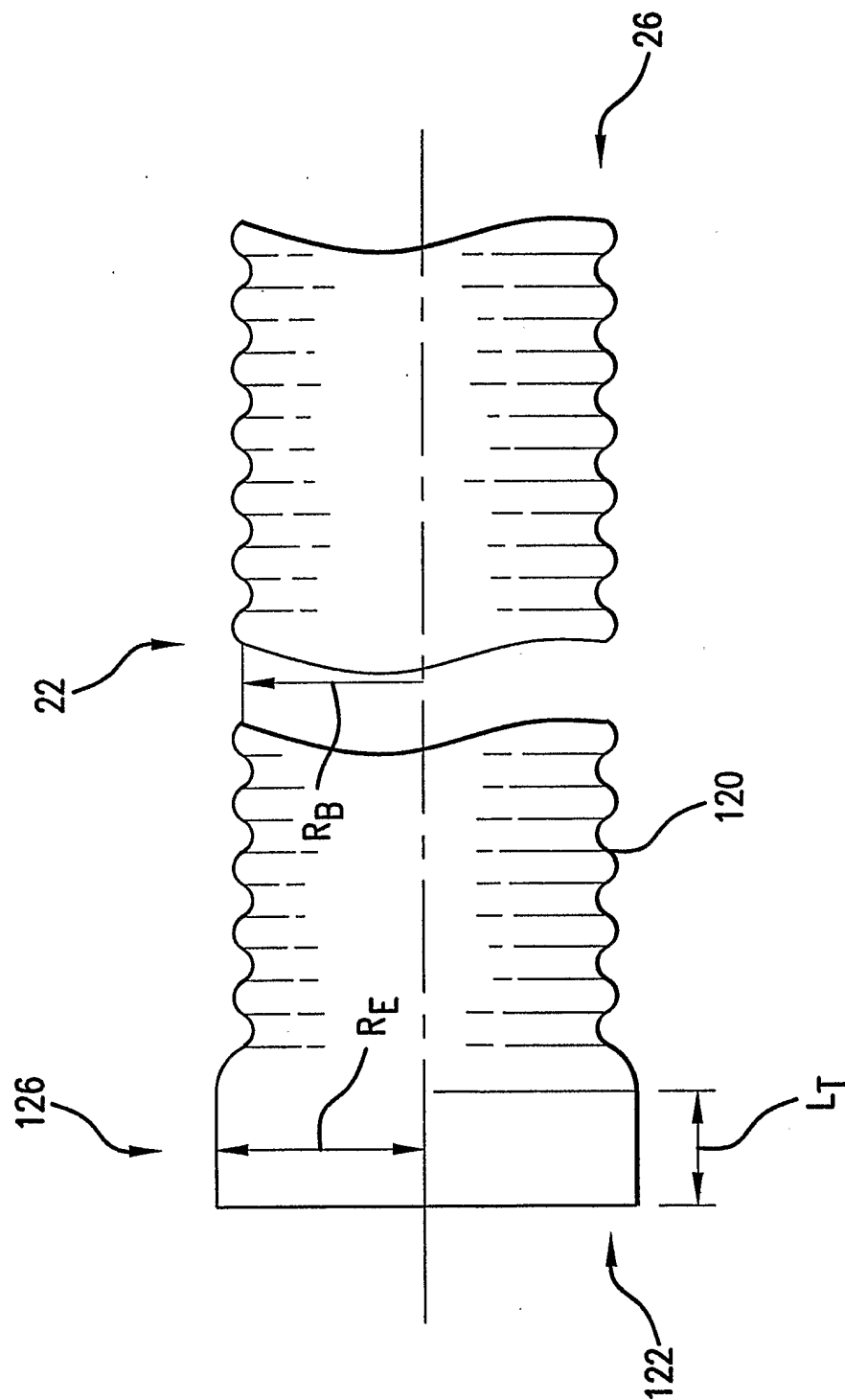


FIG. 10

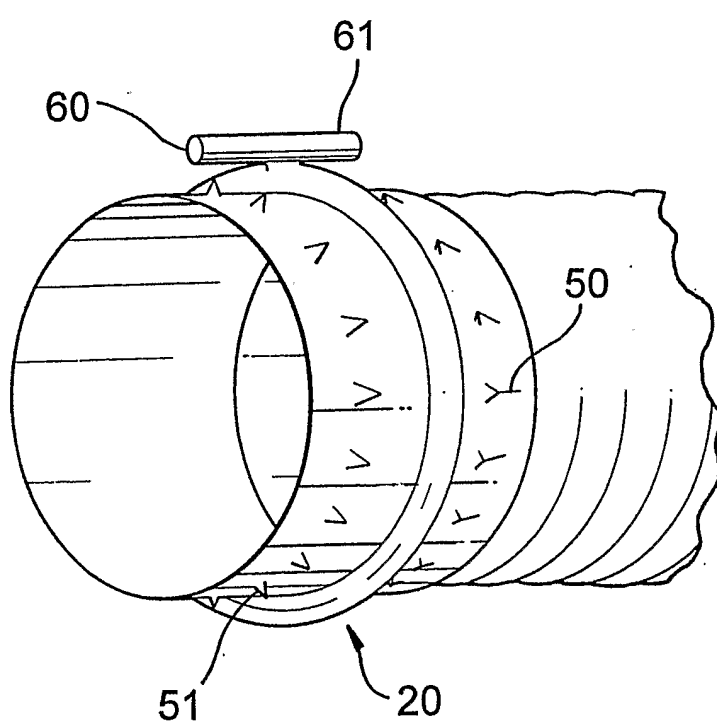


FIG. 11

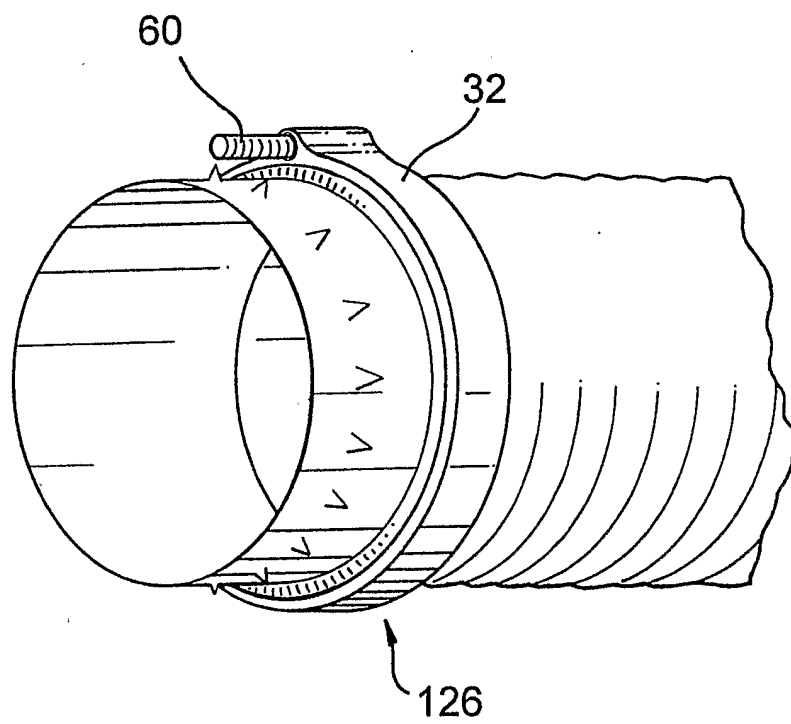


FIG. 12

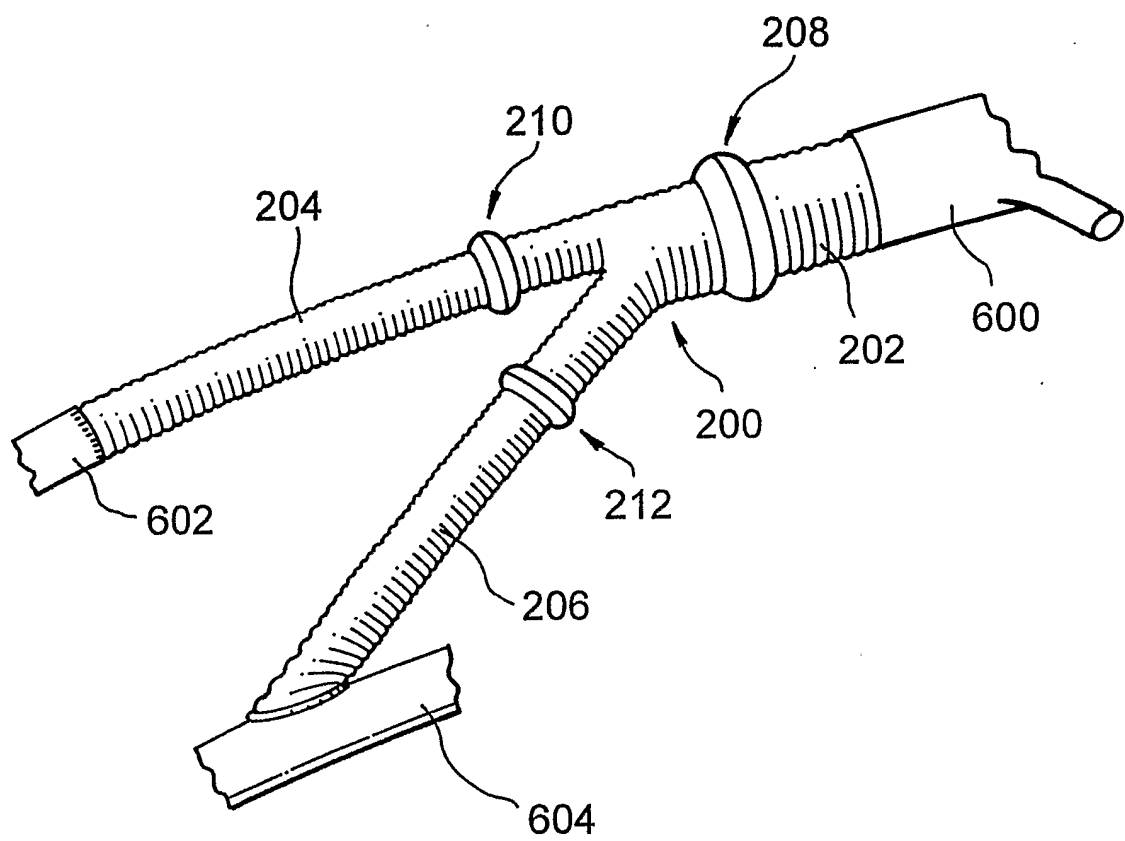


FIG. 13

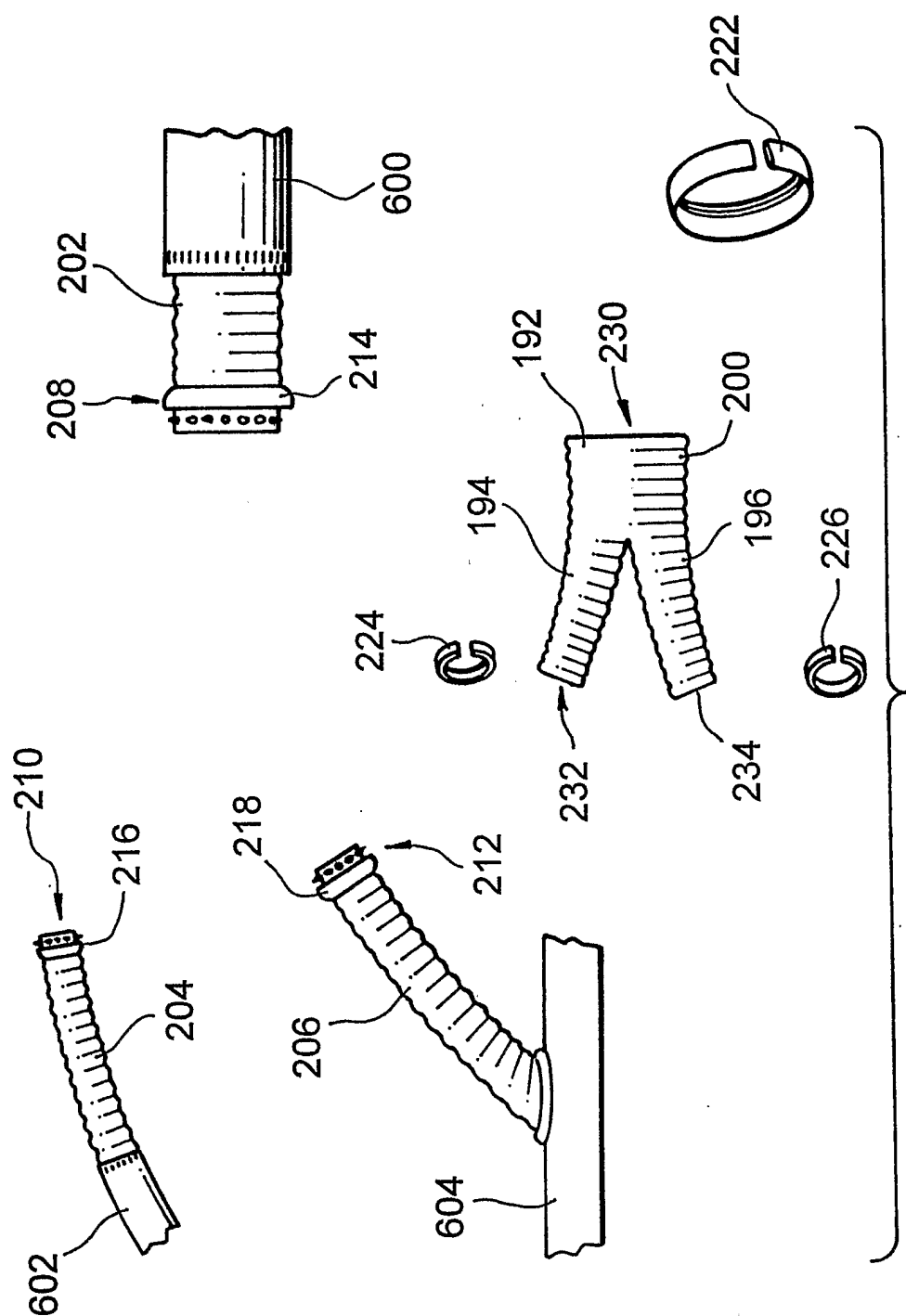


FIG. 14

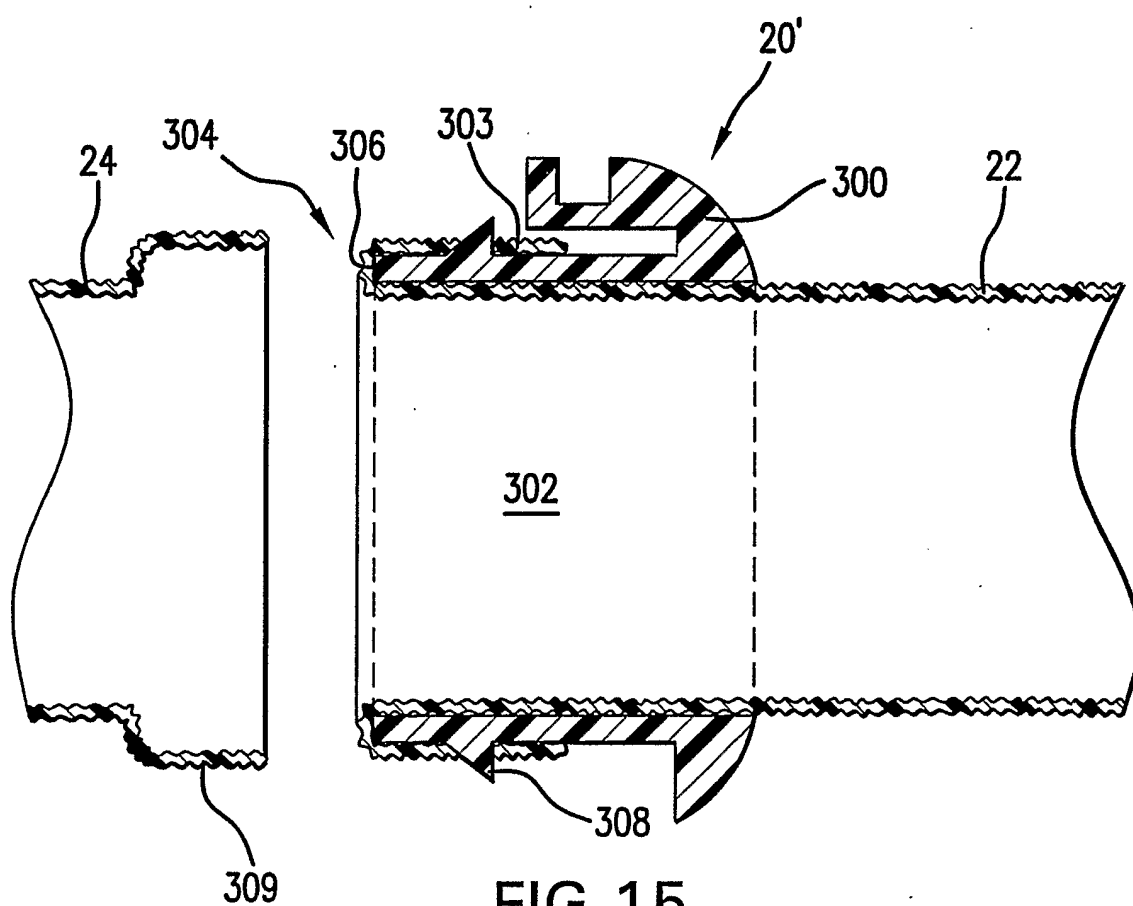


FIG. 15

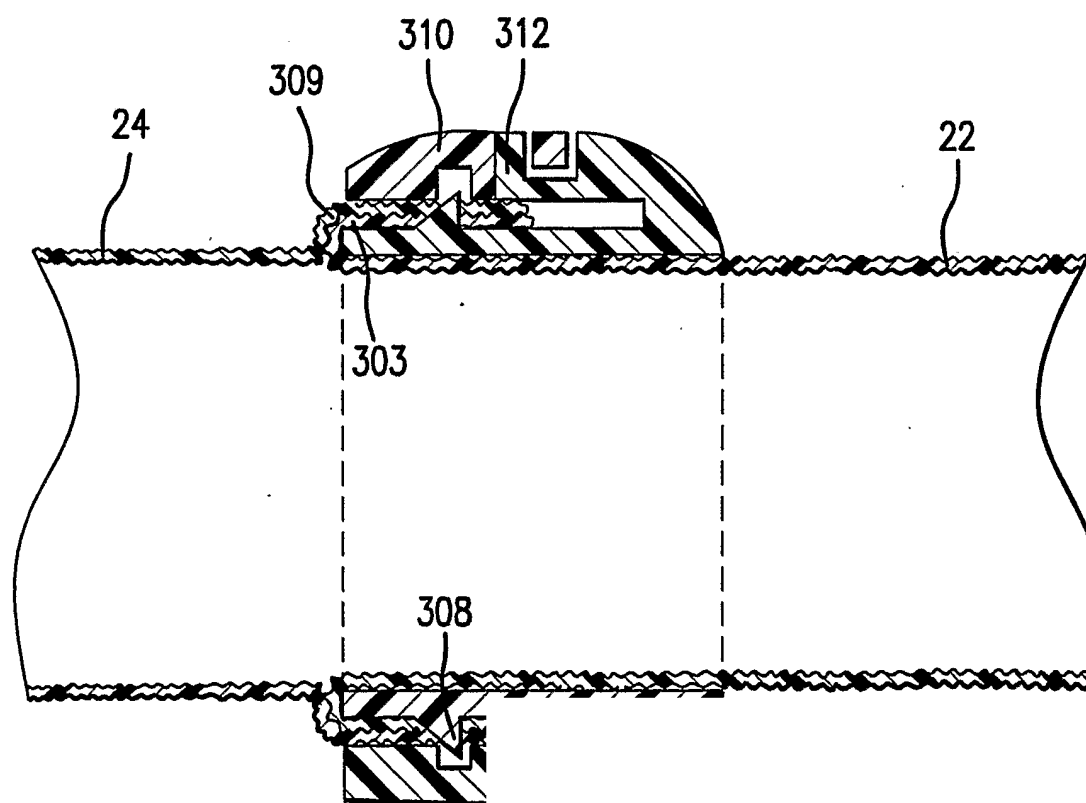


FIG. 16

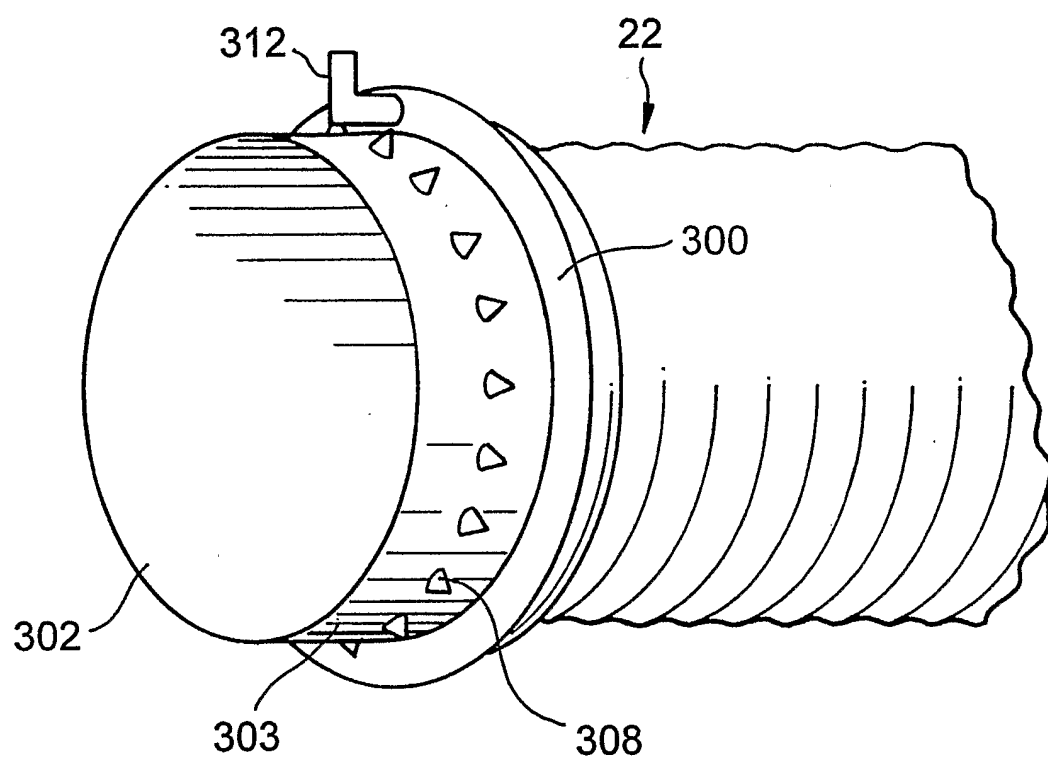


FIG. 17