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(54) **FREE LOOP KNOTLESS SUTURE ANCHOR ASSEMBLY**

KNOTENLOSE NAHTANKERZUSAMMENSTELLUNG MIT FREIER SCHLAUFE
ENSEMBLE ANCRE DE SUTURE SANS NOEUD A BOUCLE LIBRE

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(56) References cited:
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EP 1 161 184 B1

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Description**BACKGROUND OF THE INVENTION**5 **Field of the Invention**

[0001] The present invention relates to a process and device or assembly for use in tissue repair. More particularly, there is provided an enhanced assembly that enables the attachment together or repair of portions of biological tissue, such as tendons or ligaments, on a bone surface. Such device or assembly is used in a unique way with novel components to reattach or attach tissue to bone.

Description of the Background Art

15 [0002] Soft tissues, such as tendons and ligaments, generally are attached to bone by small collagenous fibers. These connections are strong but permit the tendons and ligaments to be flexible. When a tissue, or a portion of a tissue, is torn away from the bone and requires repair, a surgeon is often required to repair the detached soft tissue with sutures which are passed through bone tunnels and tied. A number of devices have been developed for securing a ligament or tendon to a bone mass. These devices can be used in place of bone tunneling techniques. These attachment devices are usually inserted through extensive surgical incisions and, in some circumstances, by arthroscopic surgical techniques. 20 The use of bone tunnels for repair can be difficult and generally require large open incisions. Recently, through the advent of endoscopic surgery, where the surgeon looks into a joint cavity with a telescope, there has been a trend to repair soft tissues back to bone through small incisions called portals. The unique free loop knotless suture anchor assemblies described herein facilitate this difficult and precise procedure.

25 [0003] A variety of devices are available for attaching objects to bone, such as screws, staples, cement, suture anchors, and sutures alone. These devices have been used to attach soft tissue, such as ligaments, tendons, muscles, as well as objects such as prostheses, to bone. A suture anchor assembly is a device which utilizes small anchors with suture materials attached thereto. A device, such as a screw, is inserted into the bone mass and anchored in place. After insertion of the anchor, the attached suture is passed through the tissue to be repaired. The tying of a knot in the suture is then required to secure the tissue to the bone. The process of passing the anchored suture through the soft tissue and tying a knot is time consuming and difficult to undertake in the tight space encountered during endoscopic surgery and sometimes even in conventional open surgery. 30

[0004] One example of a suture anchor assembly is disclosed in U.S. Patent No. 5, 370, 662, wherein an anchor assembly includes a pre-threaded suture positioned at its posterior. First the anchor is inserted into the bone mass. The attached suture is then passed through the tissue for reattachment. The surgeon is required to tie a knot with the suture to complete the surgical process. Some suture anchors can be passed through the soft tissue first and then into the bone. Most suture anchors need to be inserted into the bone first. Only after this has been accomplished can the sutures be passed through the soft tissue. Alternatives to this procedure include non-suture soft tissue anchor systems. A few of these systems, such as those disclosed in U.S. Patent Nos. 5,013,316 and 4,532,926, can be used arthroscopically but fixation with these devices may not be as secure as that achieved with sutures. Only a few points of fixation are possible with the non-suture type anchor since the device is relatively large. Therefore suture devices are more favorable. This type of non-suture staple device is disadvantageous in that it has been known to crack the bone during deployment, or accidentally transect the object being attached to the bone. In addition, the device itself has been known to crack or break during or after deployment. 35 40

[0005] U.S. Patent Nos. 5, 037, 422; 5,224,946; and 5, 236, 445 all disclose bone anchor configurations for attaching sutures within openings formed in bones during joint reconstructive surgery and endoscopic surgical procedures. With all these intricate procedures, the suture itself must be inserted through a tissue mass and tied with a surgical knot to repair the soft tissue to bone. 45

[0006] The applicant has developed a number of mechanisms for a tissue to bone repair which are disclosed in U.S. patent nos. 5,569,306; 5,683,419; 5,728,136; 5,665,112; 5,658,313; 5,720,765; and 5,709,708. US 5,709,708 discloses a knotless suture anchor assembly for the attachment of tissue to a bone mass, comprising an anchor means having a snag means located therewith and a free standing loop suture element comprising at least one continuous loop suture. Said snag means is adapted such that in use it captures two portions of said continuous loop suture simultaneously to draw said tissue into secure attachment with said bone mass. 50

[0007] It is an object of the present invention to provide a knotless suture anchor assembly which is easy to use and install. - 55

[0008] Another object of the present invention is to provide a free loop suture anchor assembly which allows for secure attachment of soft tissue to a bone mass without the use or requirement of tying a knot during the surgical procedure.

[0009] Still another object of the present invention is to provide a suture anchor assembly which is compact and allows

a surgeon to easily guide the anchor means into the bone mass, or an anchoring sleeve if desired, to enhance the security of the repair.

[0010] Yet another object of the present invention is to provide a process whereby a plurality of free loop knotless suture anchor assemblies can be used to effectively attach or reattach tissue to bone.

[0011] Further, another object of the present invention is a mechanism for producing incisions or cuts in tissue for performing reattachment or attachment of tissue to bone using the novel anchor assemblies.

A primary feature of the present invention is to provide free loop knotless anchor assembly that includes an unique snag-type or capture means on an anchoring means which facilitates engagement of the anchor means with the free continuous suture loop, for drawing soft tissue to the bone mass.

SUMMARY OF THE INVENTION

[0012] In accordance with the above objects, the present invention is directed to an assembly using at least one knotless suture anchor assembly for attachment or reattachment of biological soft tissue to bone. More particularly, the present invention is as set out in the accompanying claims. The unique enhanced free loop knotless suture anchor assembly may include one or a plurality of anchor means which can either be installed into a bone mass or into a hollow anchoring sleeve which has been installed into a bone mass. The hollow anchoring sleeve or anchor means can have varying shapes or surfaced exteriors for secure capturing or engagement with a bone mass. Each anchor means engages a free standing suture loop.

[0013] Incorporated by reference are U.S. Patent Nos. 4, 007, 743; 4, 632,101; 4, 721, 103; 4, 870, 957; 4, 898,156; 4, 946, 468; 5, 084, 050; 5, 102, 421; 5, 141, 520; 5,192, 303; and 5,207,679, which all illustrate varying structures which may embody the anchor means or the exterior of the anchoring sleeve of the invention.

[0014] Further, if desired, the hollow anchoring sleeve can contain a collar on the rear section or rear side to control the depth of sleeve insertion into the bone and prevent excessive insertion depth. The anchor means of the assembly has a first end or configuration which allows for secure capturing of either the hollow anchoring sleeve or the bone mass and a snag component for securing the free standing loop suture element. The first end of the anchor can be pointed or frustoconical in shape. The anchor means can be ribbed, beaded, threaded, or expandable on its exterior surface or further can contain one or more prongs for secure mating with the anchoring sleeve or bone mass.

[0015] The anchor means has located thereon or therein unique snag means in the shape of a hook, or other type projection, or a recess cut into the anchor means, or a slit cut into an existing opening in the anchor, for engaging the free standing continuous loop of a suture element. One particular embodiment provides a recess at the apex of the anchor whereby the free loop suture element can be snagged or captured by the anchor.

[0016] The free standing loop suture element can be a single continuous loop configuration or a plurality of suture lengths tied or attached to form a loop by any suitable means. A hook portion or projection of the anchor means can be made of the same material as the entire anchor means or a different material, as desired. The anchor assembly can be inserted during an open procedure, or an endoscopic procedure. In a preferred method, a first portion of the free standing loop suture element is passed through the soft tissue. The second portion is held for alignment. The two portions are then aligned and captured by the snag means of the anchor. The anchor means is then inserted into the bone mass or into a hollowing anchoring sleeve which has been inserted into the bone mass.

[0017] If desired, an user can use a plurality of assemblies to effectuate a repair.

[0018] The incisions, cuts or passages in the tissue can be accomplished by using needle and suture loop attachment assemblies which have been added to the free standing loop suture element. Upon capture of the first and second portions of the free standing loop suture element and after inserting same into bone mass, the needle and suture loop attachment assemblies are cut away and discarded. This assembly facilitates the method of stitching and reattachment.

[0019] Numerous other features of various embodiments of the enhanced knotless suture anchor assembly will be apparent from the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIGURE 1 is a perspective view of an anchor means having a depression or snag recess;

FIGURE 2 is a perspective view of a wedge-type anchor means having a recess snag means with a continuous loop suture element;

FIGURE 3 is an alternate embodiment of an anchor means having a snag element;

FIGURE 4 is a depiction of a hollow anchoring means;

FIGURE 5 is a depiction of an alternate embodiment of a hollow anchoring means;

5 **FIGURE 6** is a depiction of an alternate embodiment of an anchoring means having a collar;

FIGURE 7 is a depiction of a free loop suture element along with two needle cutaway suture piercing means;

10 **FIGURE 8** illustrates a step in the procedure for attachment of tissue to bone mass utilizing components depicted in Figures 1 and 7;

FIGURE 9 illustrates a step in the procedure for attachment of tissue to bone mass;

15 **FIGURE 10** illustrates a step in the procedure for attachment of tissue to bone mass;

FIGURE 11 illustrates the procedure showing attachment of tissue to bone mass embodying a method of the present invention.

20 **DETAILED DESCRIPTION OF THE PRESENT INVENTION**

[0021] Referring to **Figures 1, 2 and 3**, there is depicted three embodiments of anchor means containing snag recesses or snag means for capturing a free loop suture element. More particularly, **Figure 1** illustrates an anchor means **10** having prongs **16** and **18** which facilitate the attachment of the anchor means **10** to a bone mass. Provided in the body of the anchor means is a snag recess **14** for capturing a free loop suture element. The device can also contain, or be configured, with umbrella spokes or any other type of engaging features on its exterior for securing an attachment with a bone mass. All of these exterior attachment features are known to the industry and incorporated herein by reference.

25 [0022] **Figure 2** illustrates an alternate embodiment of the anchor means. Depicted is a wedge-like anchor means **22**, a free loop suture element **24** and a snag means **26**.

30 [0023] **Figure 3** illustrates another alternate embodiment of the present invention. Depicted is an anchor means **42**, a snag means **46** located at a rear portion of the anchor means **42**. Also pictured in this embodiment are two prongs **39** and **40** for secure attachment or mating with a bone mass or a hollow anchor assembly. **Figures 4-6** depict three potential structures for a hollow anchoring means which can be utilized in conjunction with an anchor means for the desired repair. **Figure 4** depicts a hollow anchoring means **50** which has a pointed end for secure attachment to a bone mass. The exterior of the hollow anchoring means **54** may be smooth, or may contain a rough exterior for gripping a bone mass. In addition, any type of secure attachment means may be placed on the exterior **54** of the hollow anchoring means **50** for a secure attachment. Likewise, on the interior surface **56** such may be smooth or may be roughed or may contain any type of material or surfacing or means for securing gripping of an anchor means which is placed therein.

35 [0024] **Figure 5** depicts an alternate embodiment of a hollow anchoring means **58**. The anchoring means **58** has a flat or rounded bottom end **60** and can be used for desired procedures. As is stated above, the exterior and interiors can be the same as that of the first embodiment.

40 [0025] Further, there is depicted an alternate embodiment of the top portion of a hollow anchor means **62**. The top portion of any embodiment of the hollow anchoring means may contain a lip **65** which grips the surface of a bone mass once the hollow anchoring means is placed into a pre-drilled hole in a bone mass.

45 [0026] **Figure 7** illustrates a free standing suture loop element **70** which is one continuous loop or a plurality of suture elements which have been tied together to form a continuous loop. Provided along with the free standing suture loop element are two needle suture breakaway elements **72** and **74**, respectively. Each breakaway element is comprised of a suture loop **76** or **78**, and a needle **80** or **82**. The breakaway elements are used to pierce tissue and draw the free standing suture loop element therethrough during the attachment or reattachment procedure.

50 [0027] **Figures 8, 9, 10** and **11** depict a method for reattaching or attaching tissue to bone using an embodiment of the invention.

[0028] In **Figure 8**, there is depicted a bone mass **86** and a tissue element **88**. Also illustrated is a pre-drilled hole **90** and a free standing suture loop element **92** which will facilitate the repair. Also depicted are needle suture breakaway elements **94** and **96** which are utilized during a repair procedure. Breakaway element **96** is pulled through tissue **88** in a first step of the repair.

55 [0029] In **Figure 9**, the repair continues and free-standing suture loop element **92** is pulled further through tissue **88** until two loop sections **100** and **102** are brought into alignment.

[0030] In **Figure 10**, an anchor means **105** is introduced which will engage free standing suture loop element **92**, and more particularly, will snag in the snag means **107**, the free aligned loop sections **100** and **102**.

[0031] Figure 11 depicts a completed repair wherein tissue 88 has been attached to bone mass 86 in a secure fashion. Loop sections 100 and 102 of free standing suture loop element 92 have been captured by anchor means 105 in its snag recess 107 and drawn into the hole 90 in bone mass 86 thereby providing the attachment.

[0032] This exact procedure can be repeated with an initial step of inserting a hollow anchoring sleeve such as those depicted in Figures 4-6, and then having at the completion of the procedure the anchor means 105 inserted therein.

[0033] Therefore, there is provided a novel enhanced knotless suture anchor assembly which includes in a preferred embodiment, an anchor means as depicted in Figures 1, 2 or 3 and a free standing suture loop element as depicted in Figure 7. Further, the assembly can include, if desired, a hollow anchoring sleeve as set forth in Figures 4-6.

[0034] In addition to the anchor assembly, there is depicted a method for the attachment of tissue to a bone mass utilizing the novel assembly.

[0035] In many situations throughout the discussion above, the terminology "secure attachment of tissue to bone mass" has been used. Such terminology refers to the attachment or reattachment of tissue to a bone mass by securely binding the tissue to the bone mass utilizing the novel knotless suture anchor assembly. The suture element can be made up of a known suture material, or it can be made of polymer materials, or can be formed of bioabsorbable material such as a polylactide polymer.

[0036] While a preferred embodiment of the invention is illustrated, it should be understood that the present disclosure is made by way of example and that variations to the structure shown and its use are possible within the scope of this disclosure without departing from the subject matter coming within the scope of the claims.

Claims

1. A knotless suture anchor assembly for the attachment of tissue (88) to a bone mass (86), said assembly comprising:

- i) an anchor means (105) having a snag means (107) located therewith, and
- ii) a free standing loop suture element (92) comprising at least one continuous loop suture,

wherein said snag means is adapted such that in use it captures two portions of said continuous loop suture simultaneously to draw said tissue into secure attachment with said bone mass, **characterized in that** said free standing loop suture element (92) comprises two needle suture breakaway elements (94, 96).

2. A knotless suture anchor assembly as claimed in claim 1, wherein said snag means is a recess formed in said anchor means or an element attached to said anchor means to capture said free standing suture loop element and allow said tissue to be drawn to said bone mass.

3. A knotless suture anchor assembly as claimed in claim 1, further comprising a hollow anchoring sleeve for installation and attachment to said bone mass for receiving said anchor means.

4. A knotless suture anchor assembly as claimed in claim 3, wherein said hollow anchoring sleeve has a collar at a top section facilitating its attachment to said bone mass.

Patentansprüche

1. Knotenlose Nahtankerordnung zur Befestigung von Gewebe (88) an einer Knochenmasse (86), wobei die Anordnung Folgendes umfasst:

- i) ein Ankermittel (105) mit einem darin angeordneten Hakenmittel (107), und
- ii) einem frei stehenden Schlaufennahtelement (92) mit mindestens einer kontinuierlichen Schlaufennaht,

worin das Hakenmittel so ausgelegt ist, dass es im Gebrauch zwei Abschnitte der kontinuierlichen Schlaufennaht gleichzeitig erfasst, um das Gewebe zur sicheren Befestigung an der Knochenmasse heranzuziehen, **dadurch gekennzeichnet, dass** das frei stehende Schlaufennahtelement (92) zwei Nadelnaht-Abbrechelemente (94, 96) umfasst.

2. Knotenlose Nahtankerordnung nach Anspruch 1, worin das Hakenmittel eine in dem Ankermittel geformte Vertiefung oder ein am Ankermittel befestigtes Element zum Erfassen des frei stehenden Nahtschlaufenelements und zum Ziehen des Gewebes zur Knochenmasse ist.

EP 1 161 184 B1

3. Knotenlose Nahtankeranordnung nach Anspruch 1, ferner umfassend eine hohle Verankerungshülse zur Anbringung und Befestigung an der Knochenmasse zur Aufnahme des Ankermittels.
- 5 4. Knotenlose Nahtankeranordnung nach Anspruch 3, worin die hohle Verankerungshülse einen Kragen an einem oberen Abschnitt aufweist, der ihre Befestigung an der Knochenmasse erleichtert.

Revendications

- 10 1. Ensemble d'ancre de suture sans noeud pour la fixation de tissus (88) à une masse osseuse (86), ledit ensemble comprenant:
- 15 i) un moyen d'ancrage (105) ayant un moyen d'accrochage (107) situé sur celui-ci, et
ii) un élément de suture à boucle autonome (92) comprenant au moins une suture à boucle continue,
- 20 dans lequel ledit moyen d'accrochage est prévu de telle sorte que, lors de l'utilisation, il retienne simultanément deux portions de ladite suture à boucle continue pour tirer ledit tissu de manière à l'attacher solidement à ladite masse osseuse, **caractérisé en ce que** ledit élément de suture à boucle autonome (92) comprend deux éléments de rupture de suture à aiguille (94, 96).
- 25 2. Ensemble d'ancre de suture sans noeud selon la revendication 1, dans lequel ledit moyen d'accrochage est un retrait formé dans ledit moyen d'ancrage ou un élément attaché audit moyen d'ancrage pour retenir ledit élément de boucle de suture autonome et permettre audit tissu d'être tiré jusqu'à ladite masse osseuse.
- 30 3. Ensemble d'ancre de suture sans noeud selon la revendication 1, comprenant en outre un manchon d'ancrage creux pour l'installation et la fixation à ladite masse osseuse afin de recevoir ledit moyen d'ancrage.
- 35 4. Ensemble d'ancre de suture sans noeud selon la revendication 3, dans lequel ledit manchon d'ancrage creux a un collier au niveau d'une section supérieure, facilitant sa fixation à ladite masse osseuse.
- 40
- 45
- 50
- 55

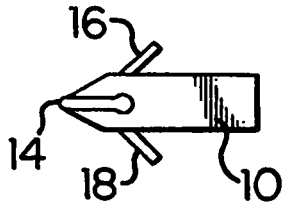


FIG. 1

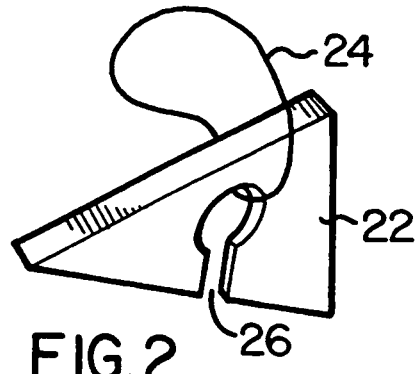


FIG. 2

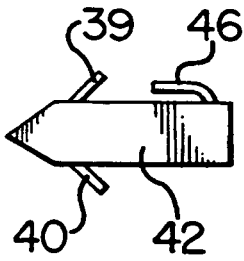


FIG. 3

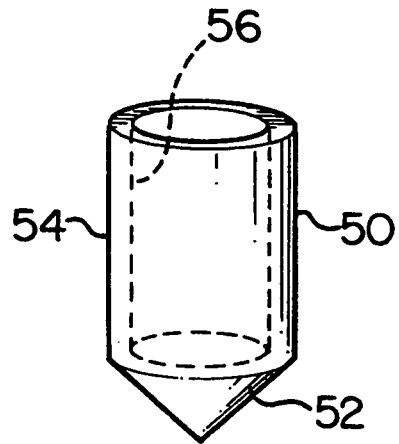


FIG. 4

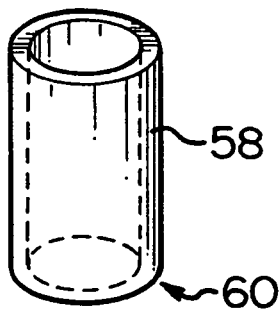


FIG. 5

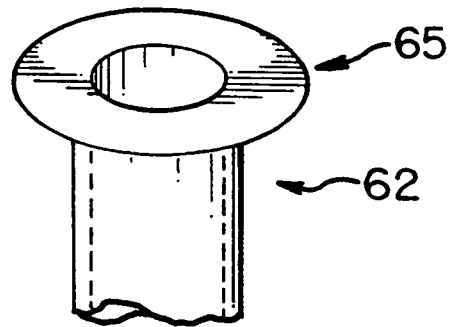


FIG. 6

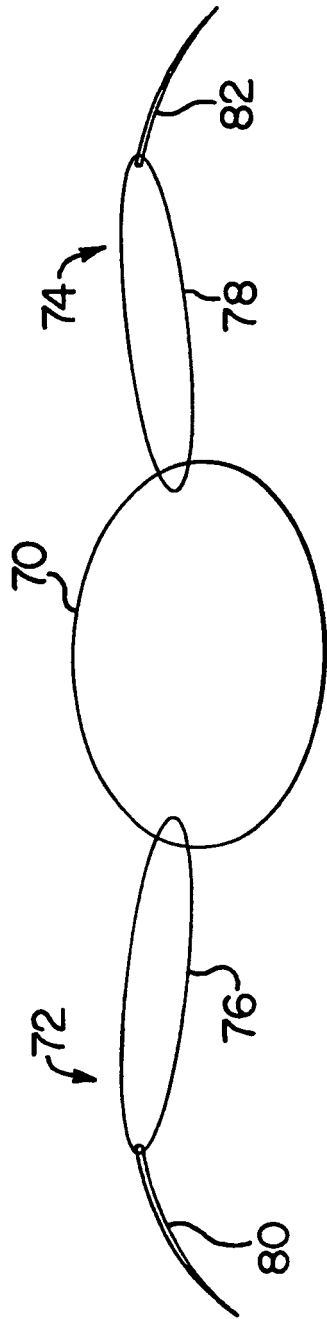


FIG.7

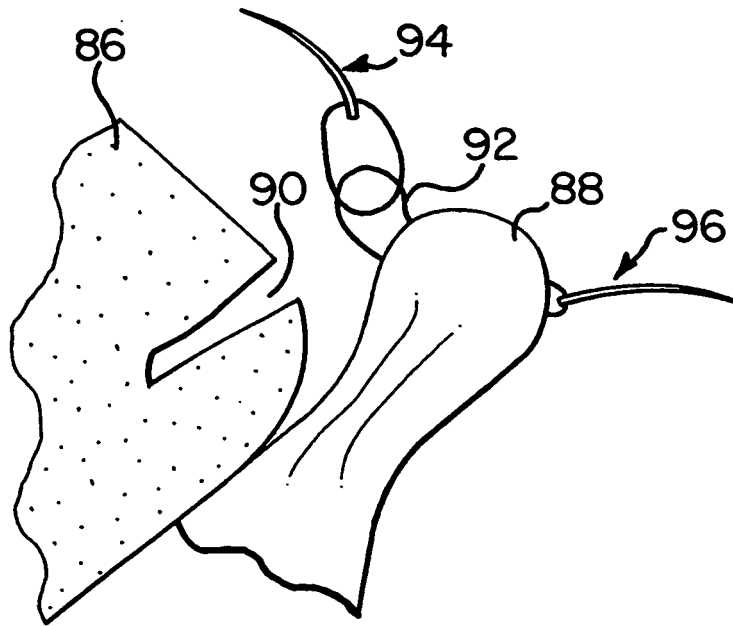


FIG. 8

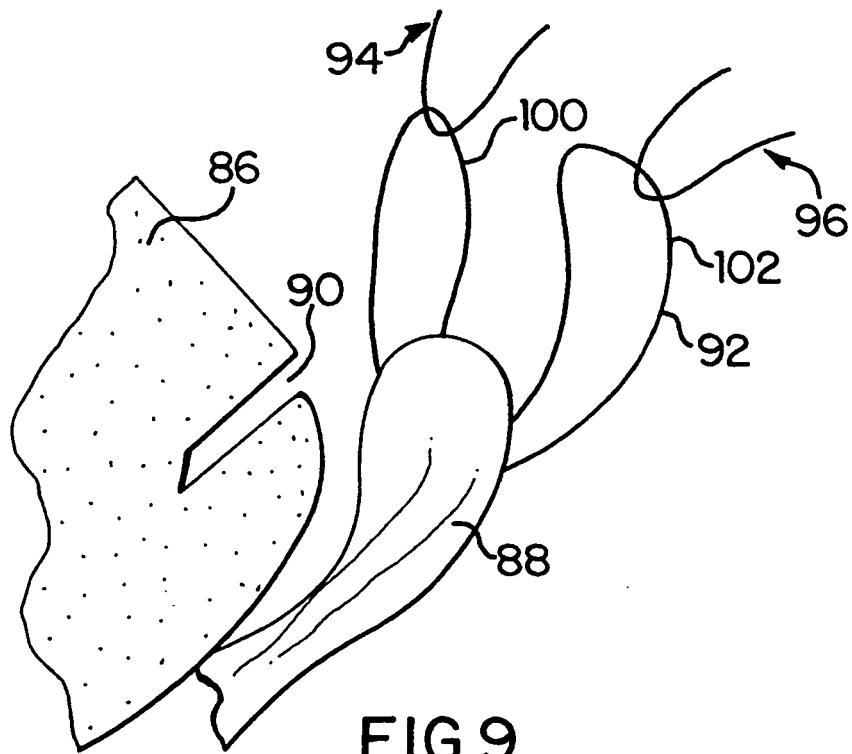


FIG. 9

