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(54) **MEDICAL DEVICE FOR REPAIR OF TISSUE AND METHOD FOR IMPLANTATION AND FIXATION**

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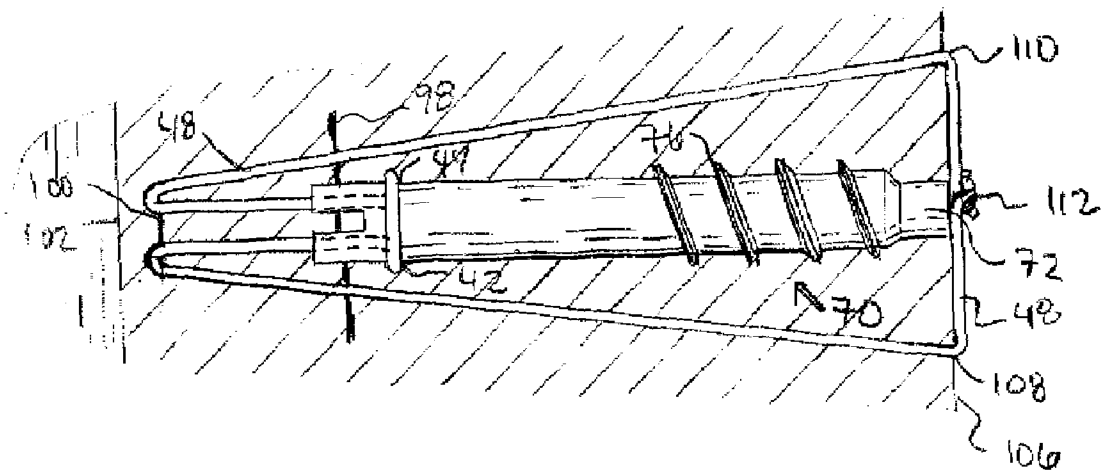
(57) **ABSTRACT**

The present invention relates to medical devices for repairing tissue and more specifically to devices which facilitate tissue regeneration and to surgical methods for the implantation and fixation of such devices. In one embodiment, the medical device is an elongate conduit that includes a longitudinal bore extending therethrough to facilitate the transfer of blood from a vascular region of tissue to a tear or damaged area located in an avascular and/or semi-vascular region of tissue. A filament and/or filaments are attached to the conduit and are positioned to secure the conduit and fixate the adjacent tear walls in mutual engagement. In another embodiment, a series of conduits are connected via a filament and/or filaments to facilitate the implantation of multiple conduits.



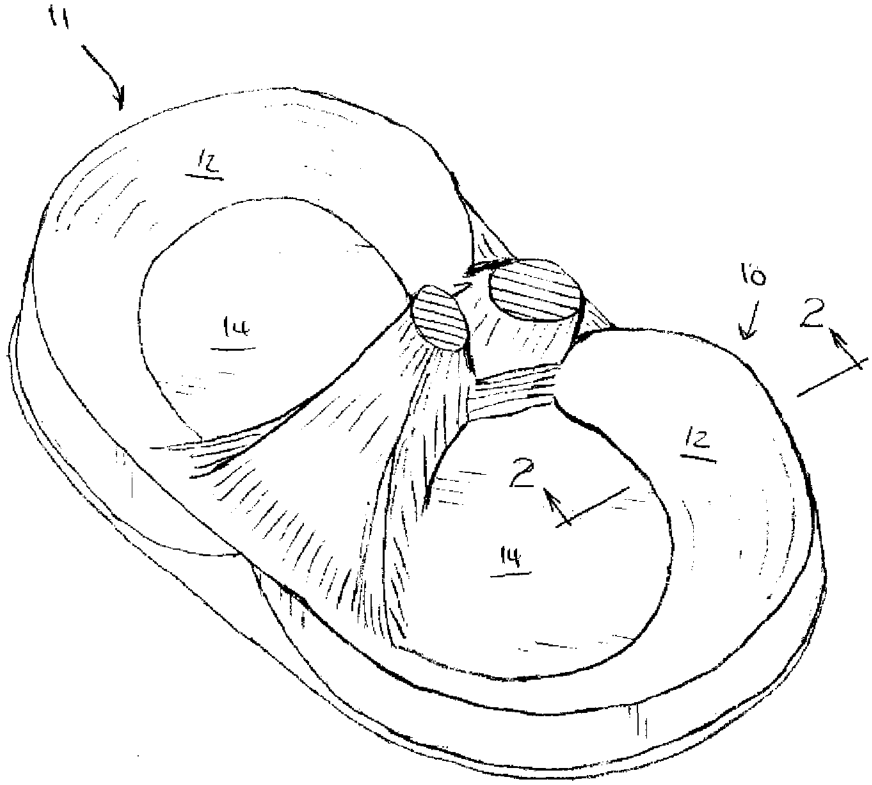


FIG. 1

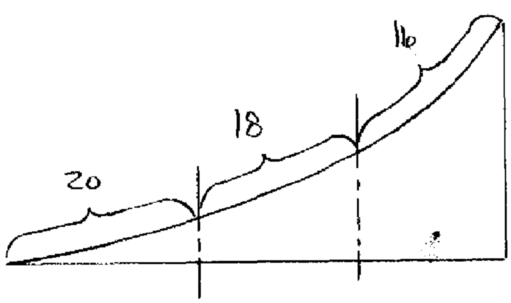


FIG. 2

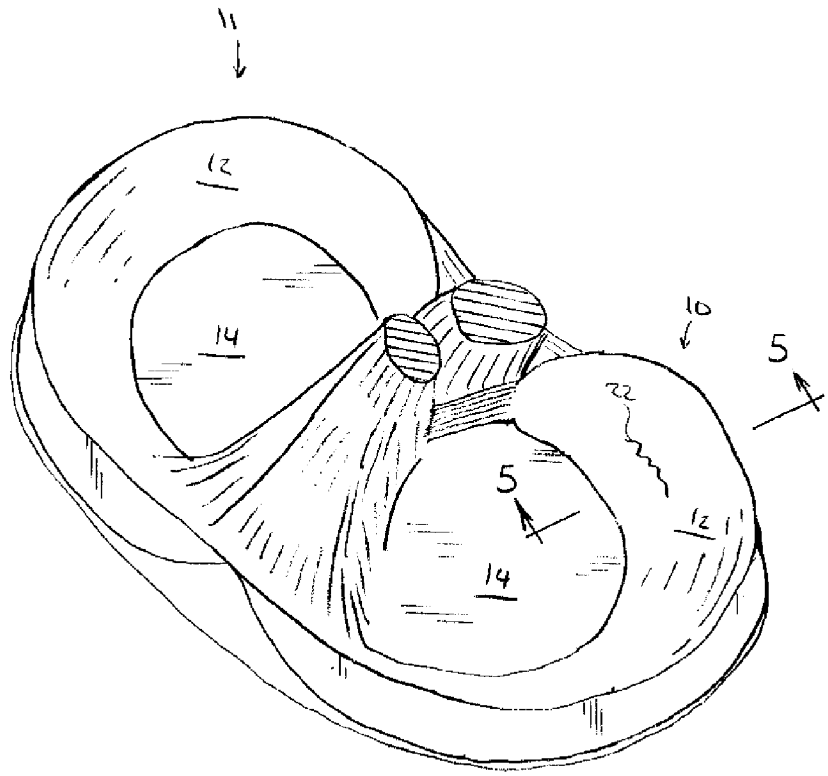


FIG. 3

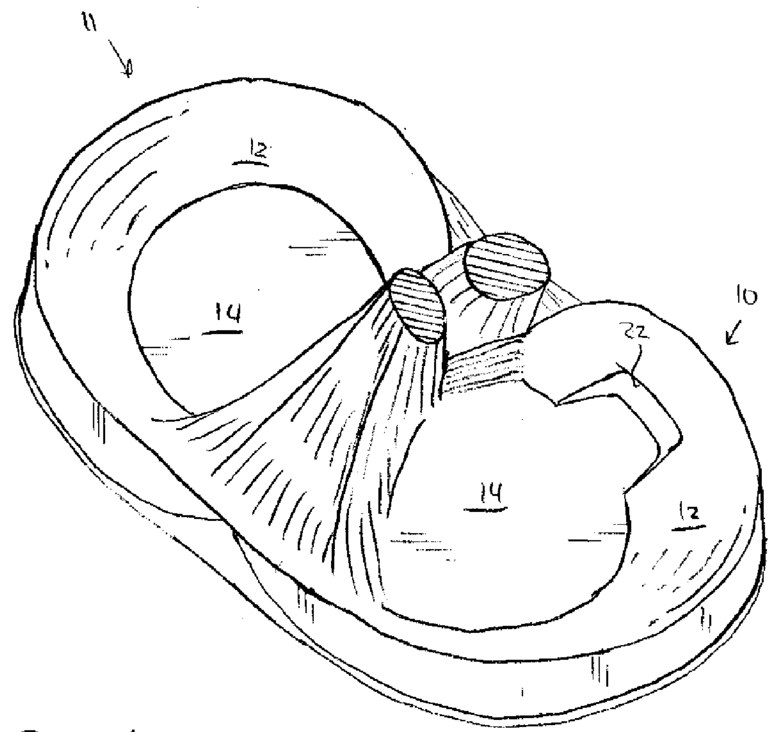


FIG. 4

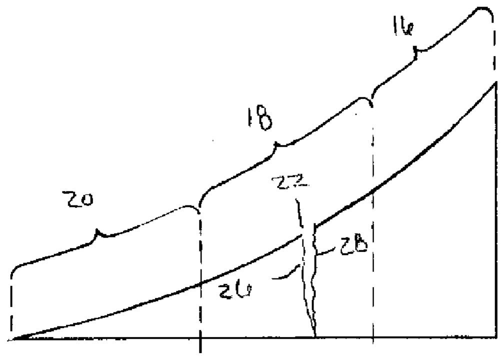


FIG. 5

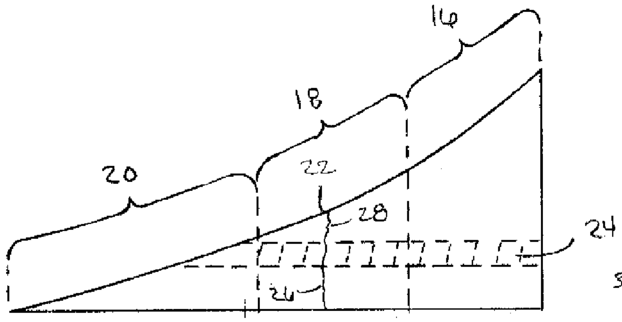


FIG. 6

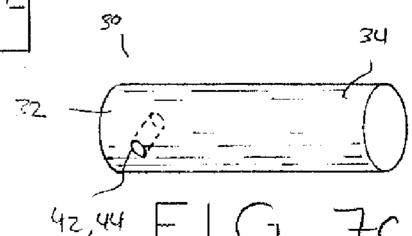


FIG. 7C

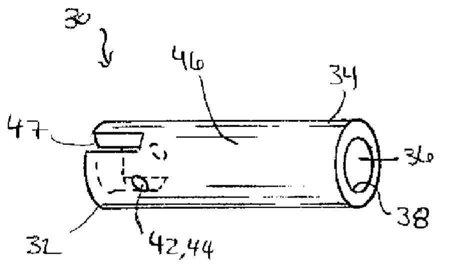


FIG. 7

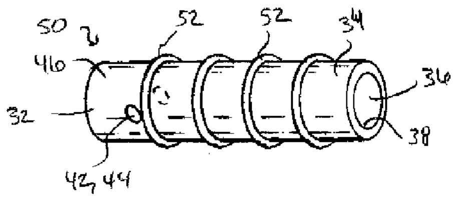


FIG. 8

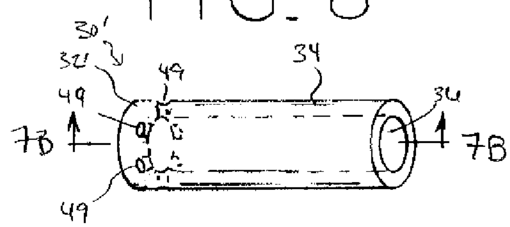


FIG. 7A

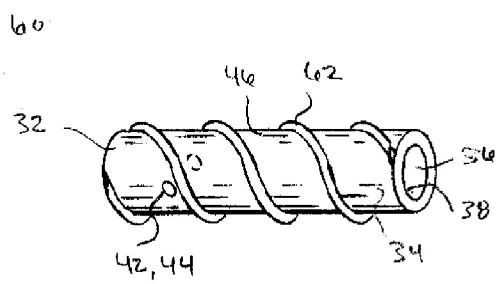


FIG. 9

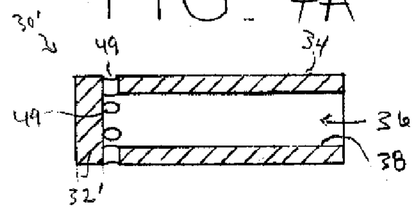


FIG 7B

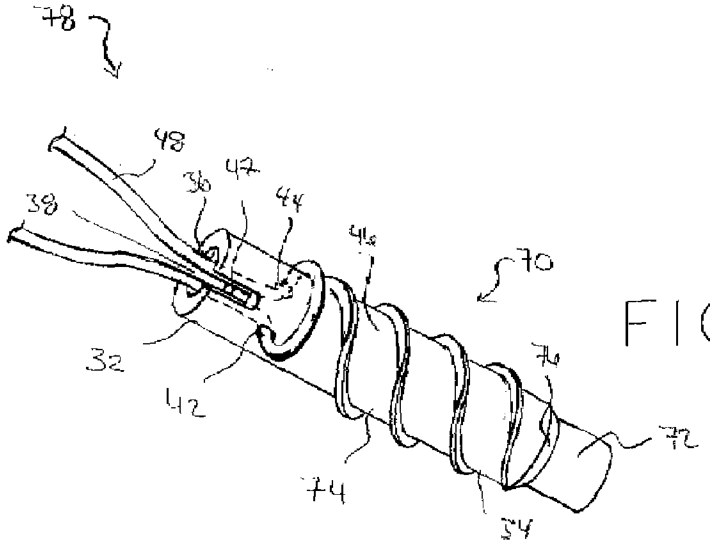


FIG_10

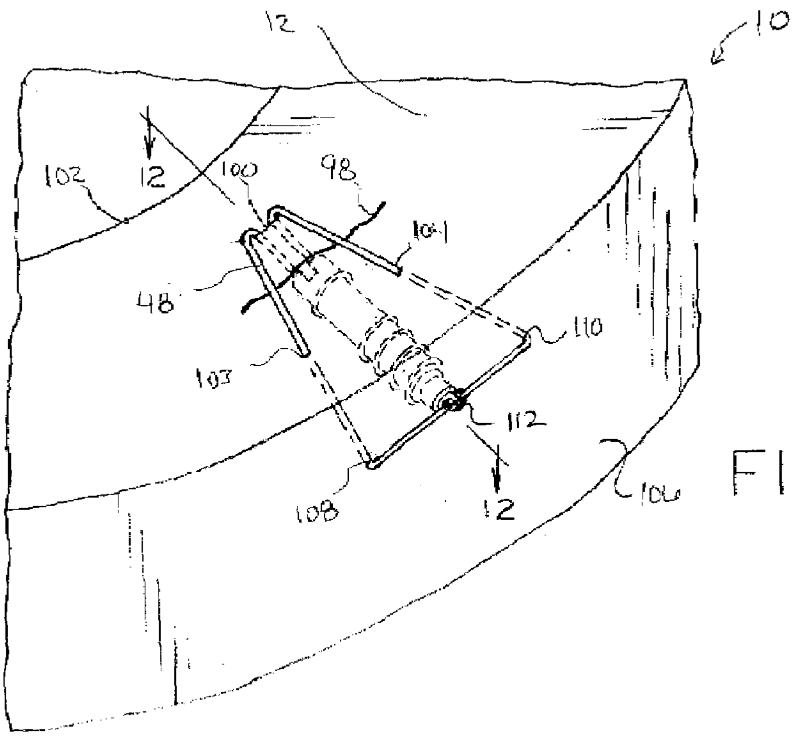


FIG_11

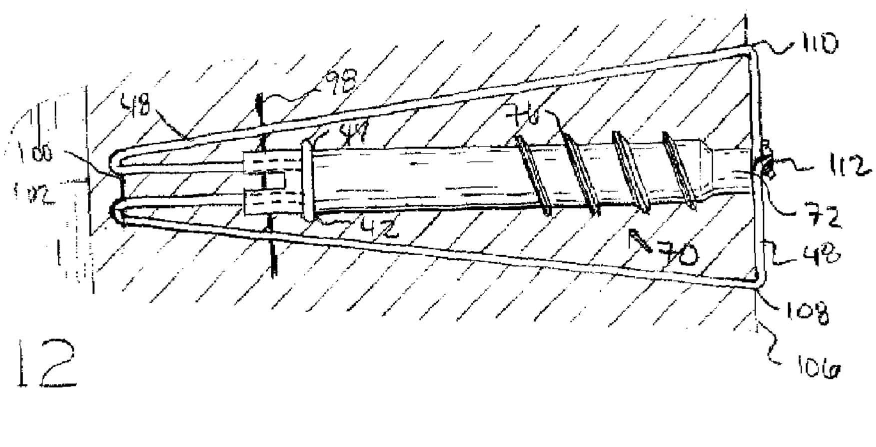


FIG.12

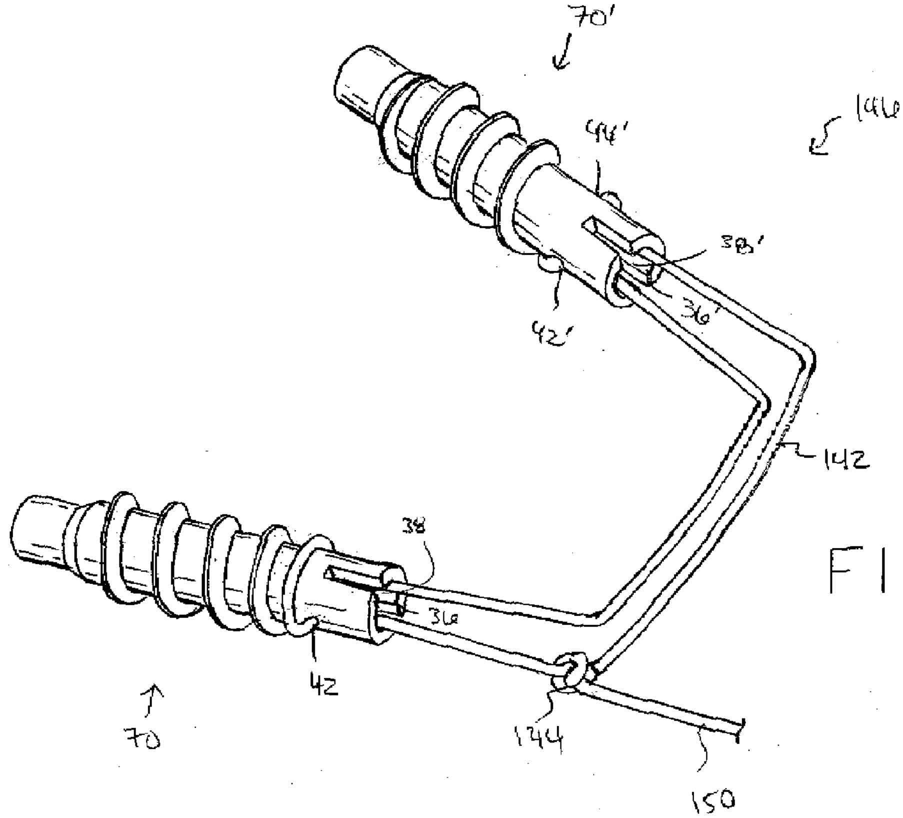


FIG. 13

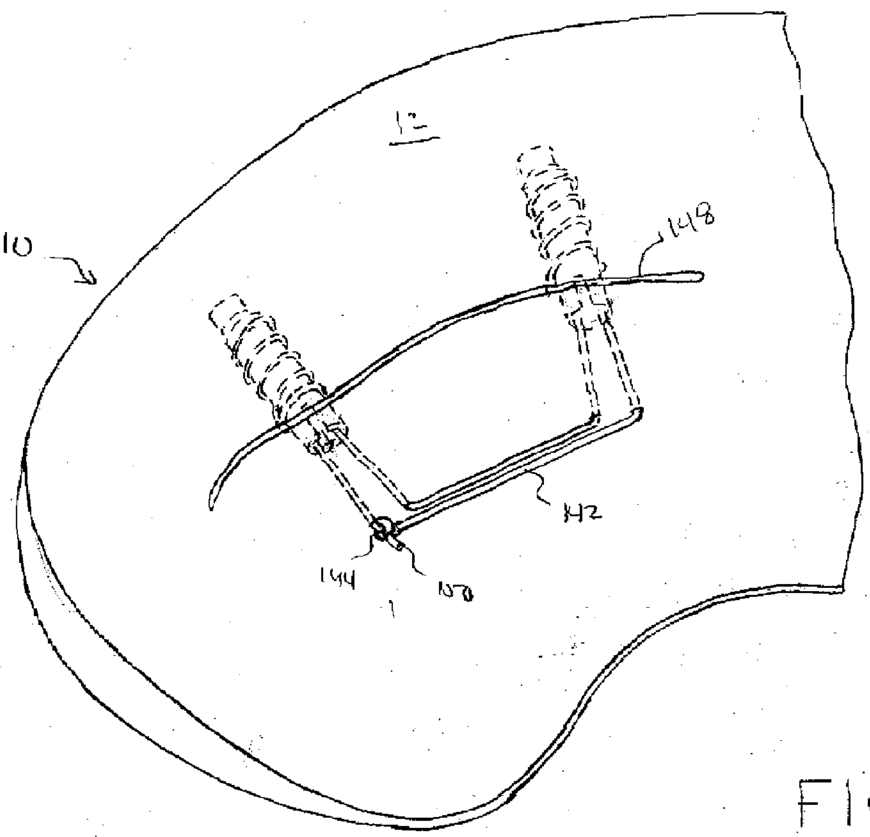


FIG. 14

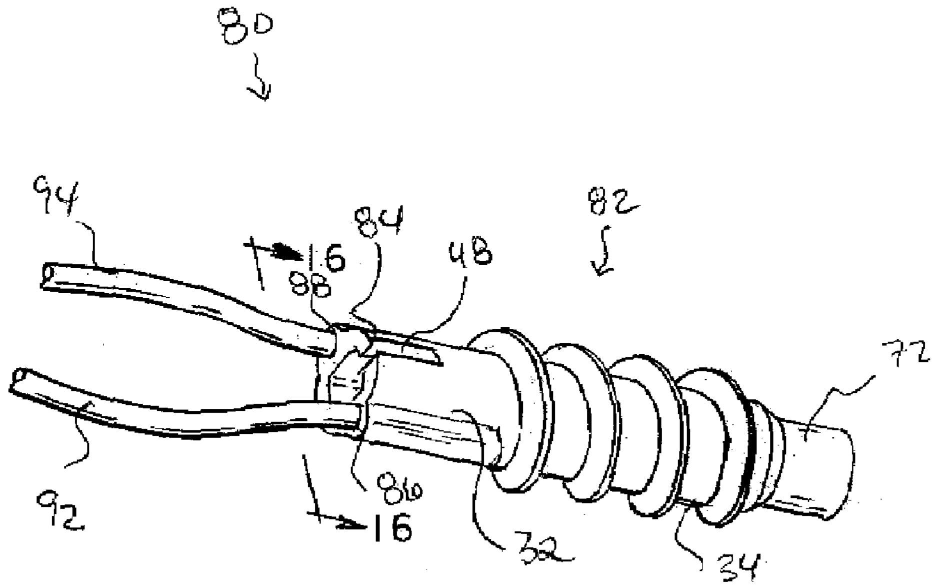


FIG_15

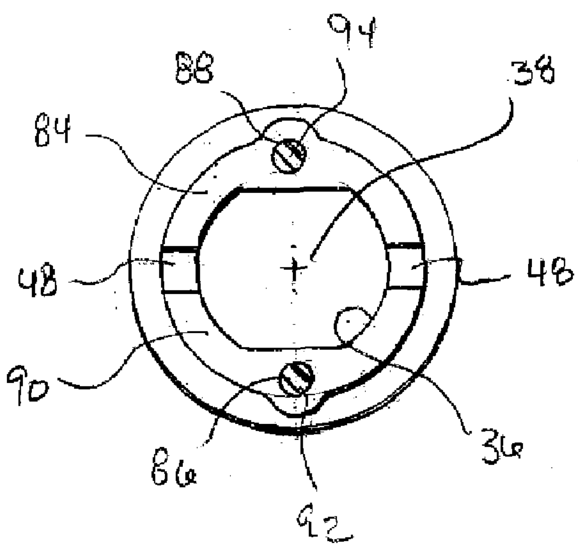


FIG_16

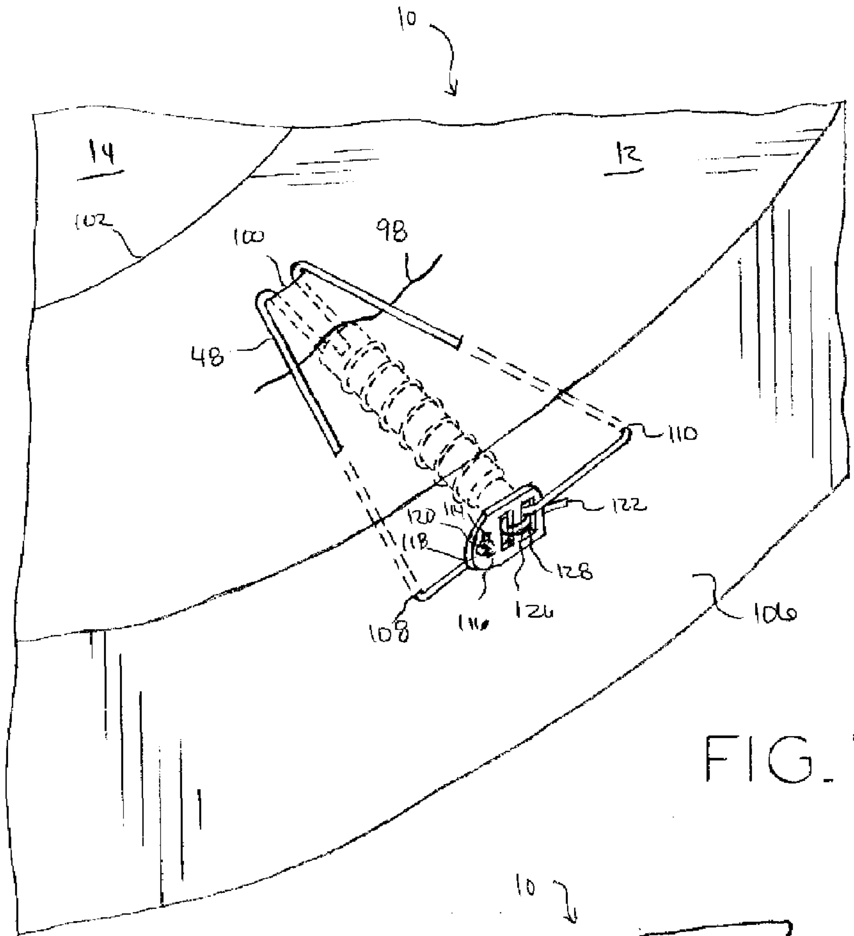


FIG. 17

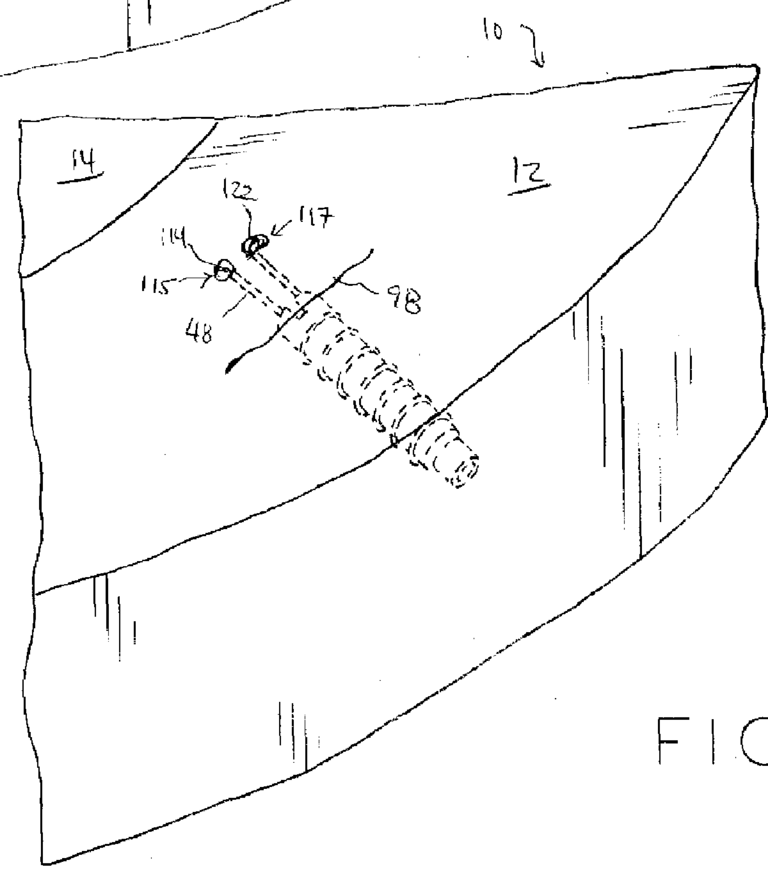


FIG. 19A

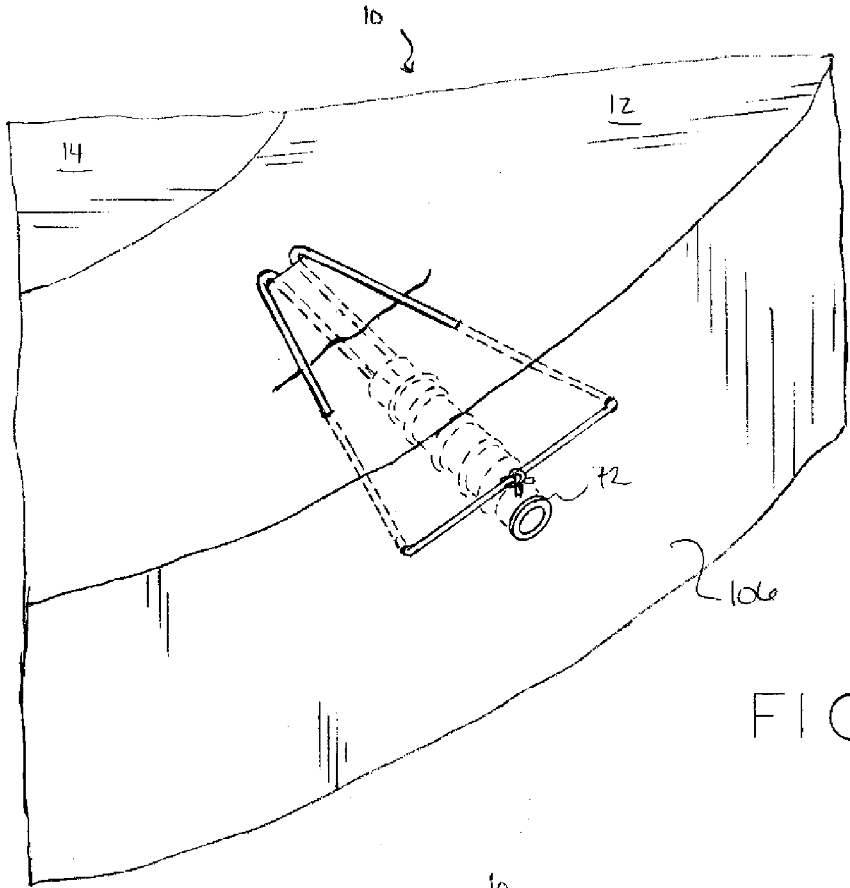


FIG 18

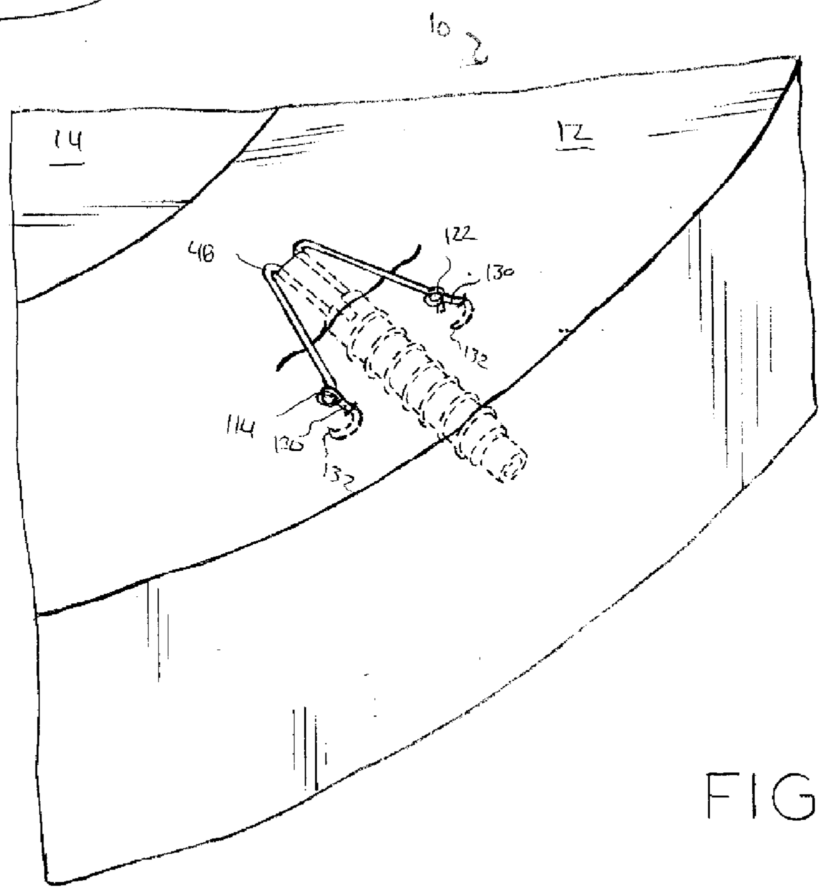


FIG_19

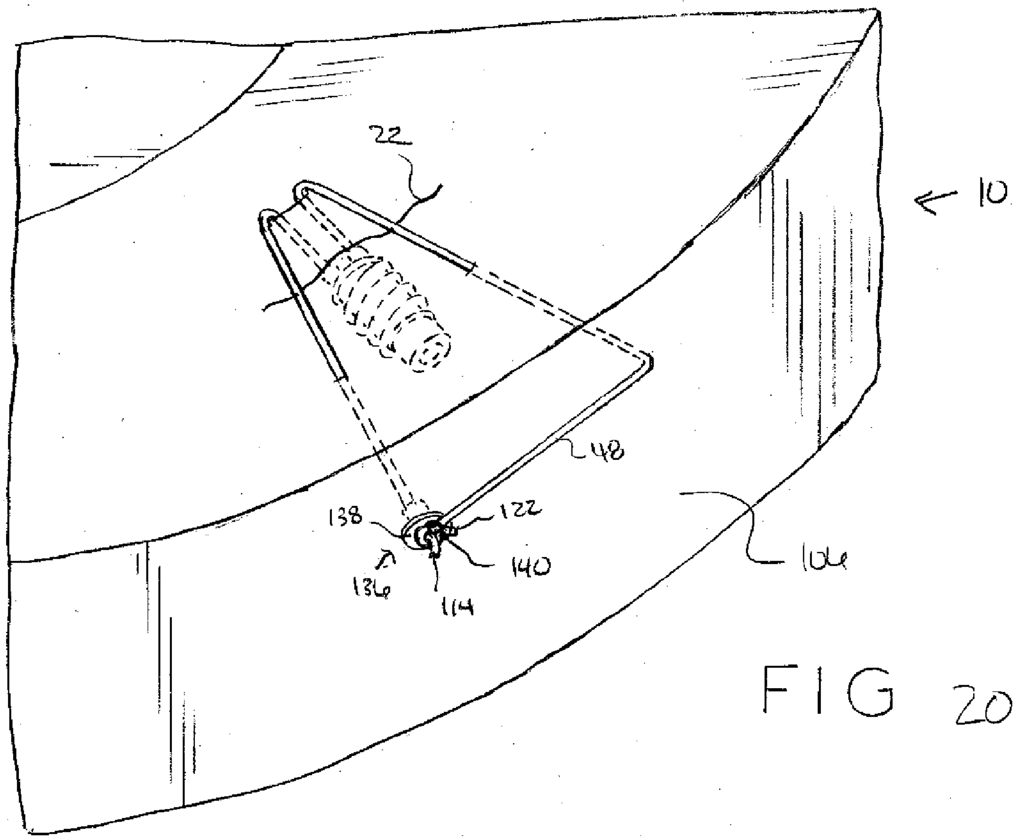

22
10
48
138
122
140
136
114
106

FIG 20

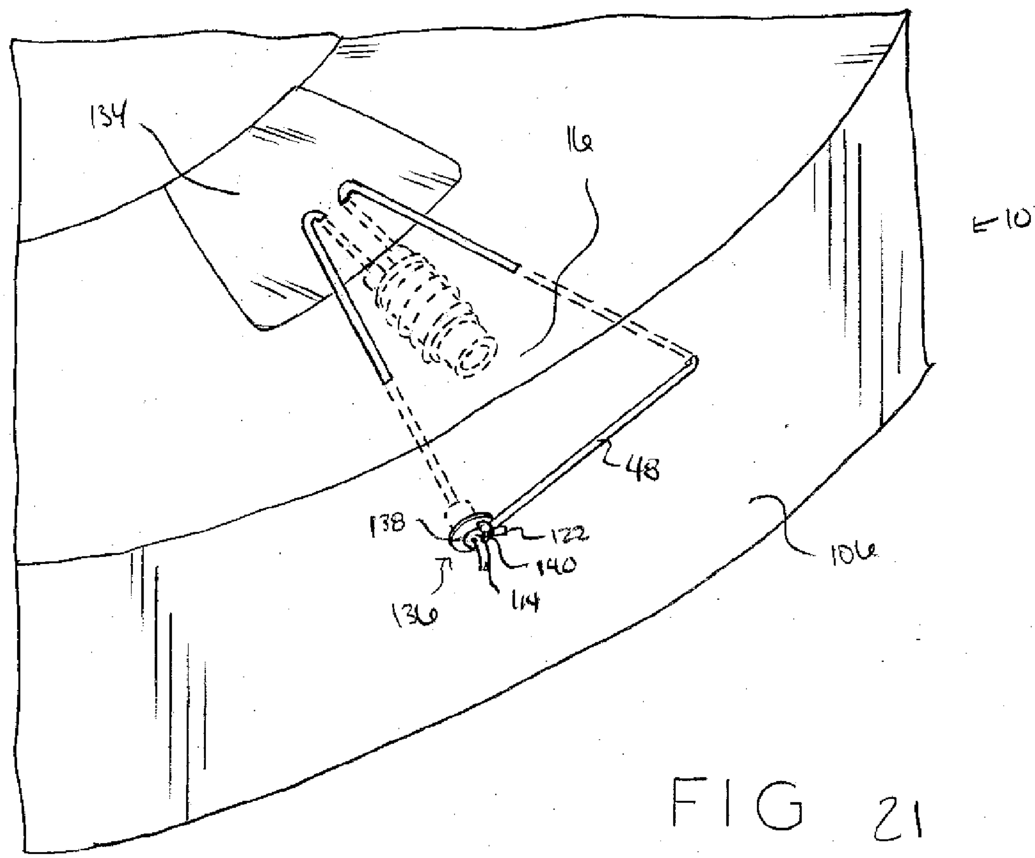

134
16
10
48
138
122
140
136
114
106

FIG 21

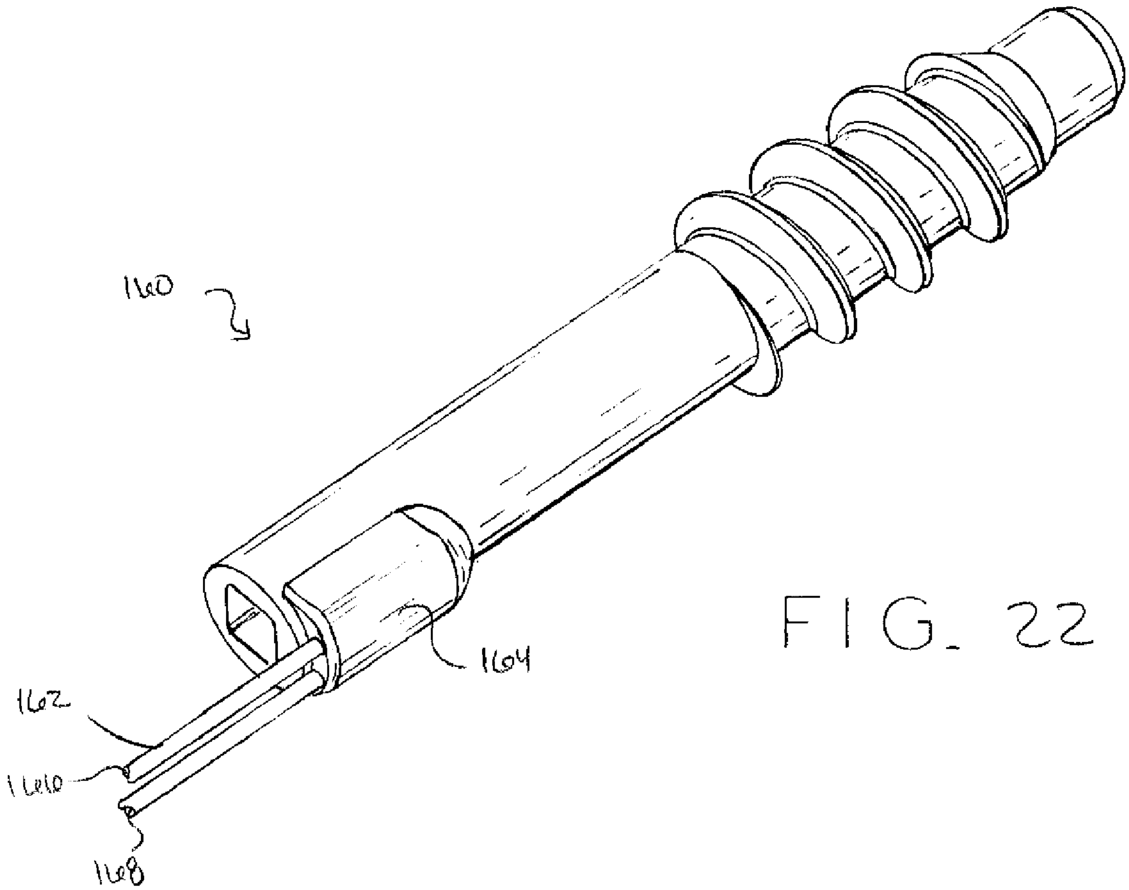


FIG. 22

MEDICAL DEVICE FOR REPAIR OF TISSUE AND METHOD FOR IMPLANTATION AND FIXATION

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to medical devices for repairing tissue and more specifically to devices which facilitate tissue regeneration and to surgical methods for the implantation and fixation thereof.

[0003] 2. Description of the Related Art

[0004] Various parts of the human body are comprised of fibrocartilage. Fibrocartilage forms the disc, meniscus, and labrums, located in the spine and temporo-mandibular joint, knee, and shoulder and hip, respectively. Additionally, fibrocartilage is present in other parts of the human body, such as fingers, wrists, and ankles. Fibrocartilage is a resilient, compressive tissue capable of accepting and withstanding high loads imparted during bodily movement. Generally, fibrocartilage is found between two adjacent bones, such as the locations set forth hereinabove.

[0005] The fibrocartilage of the knee forms menisci **10**, **11**, shown in FIG. **1**. Menisci **10**, **11** are semi-lunar, wedge-shaped portions of tissue that sit atop the tibia and articulate with the tibia and femur during movement of the tibia and/or femur relative to one another. Menisci **10**, **11** have top articulating surfaces **12** which interface with the femoral condyle and bottom articulating surfaces (not shown) which interface with tibia plateau **14**. Menisci **10**, **11** function as shock absorbers between the femur and the tibia to distribute compressive and shear loads from the curved condyles of the femur to the relatively flat plateau of the tibia. While much of menisci **10**, **11** can be classified as avascular and aneural, each menisci **10**, **11** has three distinct zones of vascularity, shown in FIG. **2**, a red zone **16**, a red/white zone **18**, and a white zone **20**. Red zone **16**, comprised of approximately the outer peripheral third of each meniscus, is rich in blood supply and is highly vascular. White zone **20**, comprised of approximately the inner peripheral third of each meniscus, is completely void of blood supply and is avascular. Red/white zone **18**, comprised of the area between the red zone and white zone, has some limited vascularity with limited blood supply. As a patient ages, the size of the white zone **20** will increase and the size of red zone **16** and red/white zone **18** will correspondingly decrease.

[0006] Due to the high stress imparted on fibrocartilage, injuries and pathologies can occur in the fibrocartilage which are manifested in the form of tears, such as tear **22** shown in FIG. **3**, defects, and/or degeneration. Tears may occur due to the existence of prior defects in the fibrocartilage, shear loading of the fibrocartilage, and/or compounded loading resulting from repetitive compressive loading occurring over a period of time. Additionally, fibrocartilage can deteriorate as a result of aging, resulting in hard and/or soft areas which further facilitate the creation of tears therein.

[0007] One common procedure for treating fibrocartilage tears is to surgically remove part or all of the fibrocartilage surrounding the tear, such as removing a portion of the meniscus. These procedures, known as meniscectomies or partial meniscectomies when performed on the meniscus, are commonly utilized in the case of "unrepairable" or complex tears such as radial tears, horizontal tears, and vertical longitudinal tears occurring outside the vascular zone. Additionally, these procedures may be performed when there is fibrillation and/or degeneration caused by defects in an avascular or limited vascular area, since these injuries are unlikely to heal. As shown in FIG. **4**, a partial meniscectomy may be performed in which the meniscus is removed along lines extending inwardly toward the inner meniscus from the peripheral ends of tear **22**. In some cases, implants may be inserted to replace the portion of the meniscus removed during the procedure. Meniscectomies, and similar fibrocartilage procedures, typically provide immediate pain relief and restoration of knee function to a patient. However, cartilage wear on the condylar or tibial plateau surfaces and the eventual development of osteoarthritis may occur as a result of the meniscectomy. Additionally, the onset of osteoarthritis may lead to more chronic conditions resulting in the need for a total knee replacement procedure.

[0008] Another method for treating fibrocartilage tears, including tears of the meniscus, is to attempt to surgically repair the torn tissue. This technique is most commonly performed when the tear is a longitudinal vertical tear located in the vascular area of the fibrocartilage, such as red zone **16** of meniscus **10**, shown in FIG. **2**. To facilitate tissue regeneration, the tear walls may be rasped or trephined to induce bleeding. Additionally, the tear walls may be stabilized with sutures or other retention devices.

[0009] A further method for treating fibrocartilage tears is the subject of U.S. patent application Ser. No. 10/558,926 to Schwartz ("Schwartz '926"). The stent of Schwartz '926 is designed with an interior, longitudinally-extending bore and external threads or ribs. Stent **24**, shown in FIG. **6**, is inserted through fibrocartilage tissue and positioned to extend across walls **26**, **28** of fibrocartilage tear **22**, shown in FIG. **5**, to secure the sides of the tear together. The threads or ribbing of stent **24**, denoted by slanted, dashed lines in FIG. **6**, effectively retain the stent, and corresponding tear walls **26**, **28**, in position. Additionally, the outer wall of stent **24** includes a plurality of apertures, not shown, extending from the interior of the longitudinal bore to the exterior surface of stent **24**. These apertures allow for the dissemination of blood, biological factors, and cells from stent **24**, as blood, biological factors, and cells flow through stent **24** from a vascular region of the fibrocartilage to a semi-vascular or avascular tear region of the fibrocartilage. The dissemination of blood, biological factors, and cells via stent **24** stimulates tissue regeneration. While the device disclosed in Schwartz '926 is effective, the walls of the fibrocartilage tear may actually be pushed apart during implantation of the stent and prevent effective healing of the tear. Additionally, even when the sides of the tear are properly aligned, the tear walls may loosen or migrate over time. Further, the blood dissemination apertures in the stent may not be as effective in providing maximum blood flow to the area of interest as desired to effect healing.

[0010] What is needed is a device that is an improvement over the prior art.

SUMMARY OF THE INVENTION

[0011] The present invention relates to medical devices for repairing tissue and more specifically to devices which facilitate tissue regeneration and to surgical methods for the implantation and fixation of such devices. In one embodiment, the medical device is an elongate conduit that includes a longitudinal bore extending therethrough to facilitate the transfer of blood, biological factors, and cells from a vascular region of tissue to a tear or damaged area located in an avascular and/or semi-vascular region of tissue. A filament and/or filaments are attached to the conduit and are positioned to fixate the adjacent tear walls in mutual engagement. In another embodiment, a series of conduits are connected via a filament and/or filaments to facilitate the implantation of multiple conduits while fixating the adjacent tear walls.

[0012] Advantageously, the present medical device allows for the provision of blood, biological factors, and cells from a vascular region of tissue to a torn or damaged area located in an avascular and/or semi-vascular region of tissue and provides for fixation of the tear walls or damaged area and the securement of a conduit in a desired position. Additionally, because the conduit itself anchors one side of the primary tear fixation, the conduit can be located with one end adjacent the plane of a tear, damaged area, or implant, allowing the conduit to efficiently deliver blood, biological factors, and cells thereto and increase the rapidity of the healing process. Moreover, in addition to facilitating the transfer of blood, biological factors, and cells from a vascular region to an avascular and/or semi-vascular region, the conduit can also provide for delivery of biological treatments, drugs, and other substances, such as blood, platelet rich plasma, growth factors, or cells, to the tear or defect area through the bore of the conduit. The desired substance can be delivered before, during, or after the conduit is inserted and positioned.

[0013] In one form thereof, the present invention provides a medical device including an elongate conduit formed of biocompatible material, the device body having an exterior, a first end, a second end, and a longitudinal bore; and a filament attached to the device body, whereby the filament can be positioned to fixate tissue in a desired position.

[0014] In another form thereof, the present invention provides a method for implanting a medical device in tissue, the tissue having a first area of vascularity and a second area of vascularity, the vascularity of the second area being less than the vascularity of the first area, the method including the steps of: inserting a device into tissue, the device including a conduit and a filament attached to the conduit, the conduit having a first end, a second end, and a bore therethrough; positioning the first end of the conduit adjacent the outside wall of a torn or damaged area of tissue; positioning the filament through the tissue to secure the conduit and fixate the tissue in a desired position; and securing the filament.

[0015] In another form thereof, the present invention provides a method for implanting a medical device in tissue, the method including the steps of: inserting a device into tissue, the device including a plurality of conduits and a filament attached to the conduits, the conduits having a first end, a second end, and a bore therethrough; positioning the first end of each of the conduits adjacent the outside wall of a torn or damaged area of tissue; positioning the filament through the tissue to secure the conduit and fixate the tissue in a desired position; and securing the filament.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following descriptions of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0017] FIG. **1** is a perspective view of the menisci and other knee anatomy;

[0018] FIG. **2** is a partial cross-sectional view along line **2-2** of FIG. **1**;

[0019] FIG. **3** is a perspective view of the menisci, including a tear in the lateral meniscus and other knee anatomy;

[0020] FIG. **4** is a perspective view of the menisci and other knee anatomy following a partial meniscectomy of the lateral meniscus;

[0021] FIG. **5** is a partial cross-sectional view along line **5-5** of FIG. **3**;

[0022] FIG. **6** is a partial cross-sectional view of the lateral meniscus of FIG. **3** including a prior art stent;

[0023] FIG. **7** is a plan view of an embodiment of the conduit of the present invention;

[0024] FIG. **7**A is a plan view of a conduit according to another embodiment;

[0025] FIG. **7**B is a cross-sectional view along line **7**B-**7**B of FIG. **7**A;

[0026] FIG. **7**C is a plan view of a conduit according to another embodiment;

[0027] FIG. **8** is a plan view of a conduit according to another embodiment;

[0028] FIG. **9** is a plan view of a conduit according to another embodiment;

[0029] FIG. **10** is a perspective view of an embodiment of the present invention incorporating a conduit according to another embodiment;

[0030] FIG. **11** is a perspective view of the device of FIG. **10** implanted in a meniscus;

[0031] FIG. **12** is a cross-sectional view along line **12-12** of FIG. **11**;

[0032] FIG. **13** is a perspective view of a device according to another embodiment;

[0033] FIG. **14** is a perspective view of the device of FIG. **13** implanted in a meniscus;

[0034] FIG. **15** is a perspective view of a device according to another embodiment;

[0035] FIG. **16** is a elevational view along line **16-16** of the device of FIG. **15**

[0036] FIG. **17** is a perspective view of the device of FIG. **10** implanted in a meniscus and secured according to another embodiment;

[0037] FIG. **18** is a perspective view of the device of FIG. **10** implanted in a meniscus according to another embodiment;

[0038] FIG. **19** is a perspective view of the device of FIG. **10** implanted in a meniscus and secured according to another embodiment;

[0039] FIG. **19**A is a perspective view of the device of FIG. **10** implanted in a meniscus and secured according to another embodiment;

[0040] FIG. **20** is a perspective view of the device of FIG. **10** implanted in a meniscus and secured according to another embodiment;

[0041] FIG. **21** is a perspective view of the device of FIG. **10** implanted in a meniscus including a scaffold replacement; and

[0042] FIG. **22** is a perspective view of a device according to another embodiment.

[0043] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate preferred embodiments of the invention and such exemplifications are not to be construed as limiting the scope of the invention any manner.

DETAILED DESCRIPTION

[0044] FIG. **7** shows conduit **30** according to one embodiment of the present invention. Conduit, as used herein, means only an elongate body and does not define any other structural features. Conduit **30** includes a first end **32**, a second end **34**, and through bore **36** extending from first end **32** to second end **34**. In one embodiment, bore **36** has a non-circular cross-section. Body **30** can be manufactured from any biocompatible material. Body **30** has a length from first end **32** to second end **34** as small as 2 mm, 3 mm, or 4 mm and as large as 10 mm, 12 mm, or 15 mm. Additionally, conduit **30** may be coated with biocompatible substances to facilitate tissue regeneration, improve circulation, or achieve any other biologically desirable responses. For example, interior **38** of through bore **36** may be coated with an anti-coagulant to prevent coagulation of blood within through bore **36**, thereby promoting the delivery of blood to a torn or damaged tissue area. Alternatively, bore **36** may contain a scaffold material to promote tissue regeneration or to improve healing outcomes.

[0045] Conduit **30** may also be made of any porous material which would allow for the transfer of blood from a vascular to an avascular area as a result of physiological processes in the patient's body. Moreover, such a porous construct may be two-piece, shown in FIG. **7**A and **7**B, wherein end **32'** of conduit **30'** is closed and constructed of a porous material, while the remainder of conduit **30'** is made of a substantially solid, biocompatible material. This allows for blood or other fluid to enter **34** via bore **36** and exit through the porous material at end **32'**. Alternatively, conduit **30** may be constructed entirely of porous material and lack bore **36**, as shown in FIG. **7**C. Fluid would enter conduit **30** from end **34** and travel, due to the interconnected porosity of the porous material, through conduit **36**, exiting at end **32**. The flow of fluid may be directed by altering the material properties of the porous material along the length of conduit **30**.

[0046] As shown in FIG. **7**, conduit **30** further includes a plurality of apertures **42**, **44** at end **32** of body **30**. Apertures **42**, **44** extend from interior **38** of through bore **36** to exterior surface **46**. Apertures **42**, **44** may receive filament **48**, as shown in FIG. **10** and described in detail hereinbelow, for securing conduit **30** within tissue and fixating a tear, damaged tissue, or an implant in a desired position. As used herein, filament is inclusive of single or multiple strands, threads, fibers, strings, wires or sutures. In another exemplary embodiment, apertures **42**, **44** are positioned adjacent one another on the same side of conduit **30**, i.e., along the axial length of conduit **30**, and receive filament **48** in the same manner described in detail herein below. Location of apertures **42**, **44** on the same side of conduit **30** provides for eccentric loading of conduit **30** when filament **48** is fully secured, which impedes pull out of conduit **30**. Additionally, conduit **30** may include slot **47**, shown in FIG. **7**, in end **32** of conduit **30** which allow for the exit of blood or other substances therethrough. Slot **47** aid the surgeon in positioning conduit **30** within tissue by eliminating the need for the surgeon to precisely align end **32** of body **30** with the plane of a tear, damaged area, or implant to provide blood thereto. As long as the surgeon positions a portion of slot **47** in or adjacent the plane of the tear, damaged area, or implant, blood or other substances will be delivered to the tear, damaged area, or implant. In effect, slot **47** provides an increased length, only a portion of which the surgeon must locate adjacent the tear, damaged tissue, or implant, thereby increasing the likelihood of a successful implantation.

[0047] In an exemplary embodiment, end **32** is perforated with a plurality of apertures of sufficient size and spacing to provide a substantially similar benefit as slot **47**, described above. In another exemplary embodiment, shown in FIGS. **7**A-**7**B, conduit **30'** includes closed end **32'** perforated by a plurality of apertures **49** of sufficient size to allow for the dissemination of blood therethrough. In another embodiment, the entire length of conduit **30** is perforated by a plurality of apertures **49** of sufficient size to allow for the dissemination of blood therethrough. Additionally, in another exemplary embodiment, the entire length of conduit **30** is porous, allow the release of fluid along the entire length of conduit **30**.

[0048] FIGS. **8**-**10** show conduits **50**, **60**, **70**, respectively, according to additional embodiments of the present invention. Conduits **50**, **60**, **70** include several features which are identical to the embodiment of FIG. **7** discussed above and identical reference numerals have been used to indicate identical or substantially identical features therebetween. Conduits **50**, **60**, shown in FIGS. **8** and **9**, respectively, include surface features, such as outwardly extending ribs **52** and outwardly extending thread **62**, respectively, on external surface **46** of conduits **50**, **60**. Ribs **52** and threads **62** provide an additional mechanism for fixation of conduits **50**, **60** within tissue. As shown in FIG. **10**, conduit **70** further includes nose **72**. Nose **72** is separated from main body portion **74** via tapering section **76**. During implantation, nose **72** facilitates insertion of conduit **70** into the tissue and can be positioned such that nose **72** is in a vascular tissue, such as the synovium, while ribs **52** and/or threads **62** provide fixation. Additionally, nose **72** may itself be tapered to further ease insertion.

[0049] As shown in FIG. **10**, conduit **70** includes filament **48** attached thereto, forming completed medical device **78**. The devices of the present invention are an improvement over the stent disclosed in U.S. patent application Ser. No. 10/558,926 to Schwartz, which is assigned to the assignee of the present invention, the entire disclose of which is incorporated by reference herein. Filament **48** may be manufactured from any flexible, biocompatible material, such as polyglactin, polydioaxanone, surgical gut, nylon, polypropeylyene, polyglycolic acid, polylactic acid, copolymers, Vicryl®, and Ethibond Excel®. Vicryl® and Ethibond Excel® are registered trademarks of Johnson & Johnson Corporation, One Johnson & Johnson Plaza, New Brunswick, N.J. 08933. Filament **48** and conduit **70** may be preassembled or may be assembled by the surgeon before or during surgery. Filament **48** and conduit **70** may be connected together by inserting a first end (not shown) of filament **48** into interior **38** of through bore **36**. The first end of filament **48** is then threaded through aperture **42** and wrapped half-way around exterior surface **46** until the first end reaches aperture **44**. In another embodiment, filament **48** is wrapped substantially entirely around exterior surface **46**. The first end of filament **48** is then inserted through aperture **44** into interior **38** of through bore **36**. First end of filament **48** is then pulled out of through bore **36** through end **32**. In another embodiment, exterior surface **46** includes a groove (not shown) on at least a portion of exterior surface **46** transverse to the longitudinal axis of body **70**. As filament **48** is pulled from end **32** of body **70**, filament **48** tightens, seating filament **48** within the groove. Once device **78** is assembled, device **78** may be inserted into the meniscus as described in detail hereinbelow.

[0050] In another embodiment, the first end of filament **48** is inserted through aperture **42** into interior **38** of through bore **36** and pulled out of through bore **36** through aperture **44**. In this embodiment, a portion of filament **48** extends through interior **38** of through bore **36** in a direction transverse to the longitudinal axis of body **70**. In another embodiment, device **80**, as shown in FIGS. **15-16**, includes conduit **82** having nose **72**, through bore **36**, and overmolded end **84**. Device **80** include several features which are identical to the embodiment of FIG. **10** discussed above and identical reference numerals have been used to indicate identical or substantially identical features therebetween. As best seen in FIG. **16**, overmolded end **84** includes apertures **86**, **88** extending from rim **90** of end **32** toward opposing end **34** along a portion of conduit **82**. Bores **86**, **88** may be formed to be slightly larger than filaments **92**, **94** and, during manufacturing, shrink around the ends of filaments **92**, **94** to retain the ends therein. Utilizing overmolded end **84** prevents filaments **92**, **94** from extending into through bore **36** and provides an uninterrupted path for the flow of blood and other substances therethrough. In another embodiment, a biocompatible adhesive is used to secure the ends of filaments **92**, **94** within bores **86**, **88**. Once device **80** is assembled, device **80** may be inserted into the meniscus as described in detail hereinbelow.

[0051] The method for inserting the devices will now be described in detail with reference to medical device **78**, shown in FIG. **10**. Device **78** may be inserted into meniscus **10** as shown in FIGS. **11** and **12**. In one embodiment, the entire procedure is performed arthroscopically using standard techniques, procedures, and devices. Device **78** is inserted from the interior side of tear **98** at insertion point **100**, located between inner rim **102** of meniscus **10** and the interior side of tear **98**. In another exemplary embodiment, the insertion point is the face of tear **98**. Device **78** is inserted along a plane substantially parallel to bottom articulation surface **14** of meniscus **10**. While device **78** may be inserted at any angle relative to bottom articulation surface **14**, insertion along a plane substantially parallel to bottom articulation surface **14** provides the optimal purchase for conduit **70**. In one embodiment, insertion of device **78** is performed using a compatible insertion tool, such as those disclosed in U.S. patent application Ser. No. 10/558,926 to Schwartz. The insertion tool (not shown) may be inserted into the interior of through bore **36** to retain device **78** thereon and advance device **78** through meniscus **10**. In one embodiment, the insertion device is cannulated. The use of a cannulated insertion tool allows for the delivery of biological substances through the insertion device and conduit **70** directly to the torn or damaged area of meniscus **10**. In another exemplary embodiment, device **78** is inserted utilizing any technique known technique, including an all-inside technique, inside-out technique, and/or an outside-in technique.

[0052] Device **78** is advanced via the insertion tool until end **32** of conduit **70** is substantially aligned with the plane of tear **98**, damaged area, or regenerative or replacement meniscus implant **134**. Additionally, when inserted to align with a damaged area of tissue, the deterioration of the damaged tissue may provide tactile feedback to the surgeon that the outer plane of the damaged area has been encountered. As shown in FIG. **18**, conduit **70** may be positioned adjacent a tear, damaged area, or regenerative or replacement meniscus implant **134** with nose **72** extending from outer wall **106** of meniscus **10**. In this position, nose **72** extends into the synovium and/or other tissue surrounding the knee joint, which is a highly vascular membrane surrounding the knee. In the same manner as set forth above with reference to red zone **16** of meniscus **10**, blood, biological factors, cells, and fluid from the synovium and/or other tissue surrounding the knee joint can be delivered to a torn or damaged area of meniscus **10** via conduit **70**.

[0053] Once positioned, the insertion tool is removed, leaving conduit **70** in position and filament **48** extending from insertion point **100**. Ends (not shown) of filament **48** are then looped over tear **98** and inserted in meniscus **10** at second insertion points **103**, **104**, shown in FIG. **11**, located between outer wall **106** of meniscus **10** and tear **98** or between inner rim **102** of meniscus **10** and tear **98**, using, for example, a needle. The ends of filament **48** are advanced through meniscus **10** at diverging angles until the ends exit outer wall **106** at points **108**, **110**. The ends of filament **48** are then tightened by pulling the ends away from outer wall **106**. In addition to the stitching method set out above, filament **48** can be positioned via any method known to one of ordinary skill in the art, including any horizontal or vertical mattress suture technique.

[0054] With filament **48** taut, fixating inner and outer walls of tear **98** in mutual engagement, the ends of filament **48** are secured to one another. Once secured, device **78** is secured and the walls of tear **98** are fixed in their relative positions. In one exemplary embodiment, the ends of filament **48** are secured by tying the ends together to form knot **112**, shown in FIG. **11**. Excess portions of filament **48** may then be trimmed and discarded.

[0055] As shown in FIG. **17**, in another exemplary embodiment, first end **114** of filament **48** is secured to a retention device, such as buckle **116**, by inserting first end **114** through an aperture in end **118** of buckle **116** and tying end **114** to form knot **120**. Second end **122** of filament **48** may then be secured to buckle **116** by inserting second end **122** through opening **124** in buckle **116**, looping end **122** around bar **126**, and threading end **122** through second opening **128**. In this manner, filament **48** is looped back onto itself and retained by friction within buckle **116**. For large tears or damaged areas, multiple devices may be implanted in accordance with the method described hereinabove.

[0056] As shown in FIG. **19**, in another exemplary embodiment, first end **114** and second end **122** of filament **48** are secured, via knots for example, to hooks **130**. Hooks **130** are curved and terminate at sharpened tips **132**. At any time during the procedure, tips **132** are inserted through the upper articulation surface **12** of meniscus **10**. Once conduit **70** is properly positioned and hooks **130** attached to meniscus **10** via tips **132**, filament **48** acts to fixate tear **22** and secure conduit **70** in position, as described hereinabove.

[0057] In another exemplary embodiment, shown in FIG. **19**A, first end **114** and second end **122** of filament **48** are pulled tight through top articulating surface **12** of meniscus **10**. Knot **115** is tied using first end **114** and knot **117** is tied using second end **122** to secure the walls of tear **98** in mutual engagement. Due to the physical properties of meniscus **10**, knots **115**, **117** will sink into top articulating surface **12**, preventing any damage to or pain in the patient's knee. Similarly, any other securement method or device disclosed herein may potentially be used atop top articulating surface **12** to secure ends **114**, **122** of filament **48** together and fixate tissue in the desired position.

[0058] Additionally, in another exemplary embodiment shown in FIGS. **20-21**, conduit **70** is positioned within meniscus **10** in a similar manner as described hereinabove. To secure conduit **70** in position within meniscus **10** and fixate tear **22** or regenerative or replacement meniscus implant **134**, shown in FIG. **21**, slide **136** is used. Slide **136** has a body with a bore extending therethrough and flange **138** projecting from an end of the body of slide **136**. First end **114** of filament **48** is threaded through the bore of slide **136** toward flange **138**. Second end **122** of filament **48** is then secured to first end **114** of filament **48** via slipknot **140**. By pulling first end **114** of filament **48** away from outer wall **106** of meniscus **10**, slipknot **140** moves toward outer wall **106** and pushes slide **136** into meniscus **10**. Once filament **48** is taught, flange **138** will contact outer wall **106** of meniscus **10**, preventing slipknot **140** from sliding further. Slipknot **140** can then be tightened to secure ends **114**, **122** of filament **48** together. Once secured, ends **114**, **122** of filament **48** may be trimmed and the removed portion discarded.

[0059] While the devices of the present invention may be implanted as an alternative to a meniscectomy, the devices may also be implanted in native meniscus tissue or a regenerative or replacement meniscus implant following a meniscectomy to encourage and/or promote tissue regeneration and, when a regenerative or replacement meniscus implant is used, the device may further fixate the implant to the natural meniscus tissue, as shown in FIG. **21**. As shown in FIG. **21**, regenerative or replacement meniscus implant **134** is fixated via filament **48** in position against natural meniscus **10**. Implant **134** further receives blood, biological factors, cells, and other fluids from the red zone **16** of meniscus or, in another embodiment shown in FIG. **18**, from the synovium via conduit **70**.

[0060] As shown in FIG. **13**, two conduits **70**, **70'** are connected together via filament **130**. In connecting the conduits, a first end of filament **142** is inserted through interior **38** of through bore **36** of conduit **70**, pulled from aperture **42**, and wrapped half way around conduit **70**. The end is then inserted through aperture **44**, shown in hidden lines in FIG. **10**, and pulled from interior **38** of through bore **36**, as discussed in detail hereinabove. Filament **130** is then inserted through interior **38'** of through bore **36'** of conduit **70'**, pulled from aperture **42'**, and wrapped half way around conduit **70'**. The end is then inserted through aperture **44'** and pulled from interior **38'** of through bore **36'**, as discussed in detail hereinabove. The ends of filament **130** are then connected together via slipknot **144**, forming device **146**. While two conduits are depicted in FIG. **13**, any number of conduits needed to facilitate tissue regeneration and healing may be connected together. Generally, as the size of the tear or damaged area increases, the number of conduits needed to facilitate tissue regeneration and healing will correspondingly increase.

[0061] By using multiple conduits, blood and/or other substances can be delivered to multiple points along the plane of a tear or damaged area of tissue and fixated by the tightening of only a single filament. The insertion of device **146** will now be described in detail. Conduits **70**, **70'** are inserted individually relative to tear **148** using the same procedure discussed hereinabove with respect to conduit **70** and tear **98**. Once each conduit **70**, **70'** is properly inserted, as shown in FIG. **14**, filament **142** remains partially exposed along top articulating surface **12** of meniscus **10**. Filament **142** is then tightened, by pulling end **150** of filament **142** away from top articulating surface **12** until the inner and outer walls of tear **148** are in mutual engagement. The interference of top articulating surface **12** of meniscus **10** with the tightening of filament **142** secures conduits **70**, **70'** in their desired positions.

[0062] In one exemplary embodiment, a knot (not shown) is used to fix filament **142**, and correspondingly secure device **146**, in position. In one exemplary embodiment, slip knot **144** is used to retain filament **142** in the tightened position. To tighten filament **142**, end **150** is pulled away from top articulating surface **12** of meniscus **10** and, at the same time, slip knot **144** slides downwardly toward top articulating surface **12**. Once slip knot **144** is tightened, excess filament **142** can be trimmed and discarded. Due to the resilient nature of fibrocartilage tissue, filament **142** and slipknot **144** will become integrated with meniscus preventing any adverse effects, such pain or discomfort during articulation of the condyles of the femur against top articulation surface **12** and filament **142**. In one embodiment, a series of devices **78**, shown in FIG. **10**, may be utilized with a single tear. Each device **78** can then be fixated in the manner discussed hereinabove providing additional tension on tear **98**, shown in FIG. **11**, and placing knot **112** outside of the contact area of meniscus **10** and against outer wall **106**.

[0063] In another exemplary embodiment, conduit **160**, shown in FIG. **22**, includes filament **162** secured through apertures in projection **164**. Projection **164** may be overmolded, as described in detail above, or may allow for sliding movement of filament **162** within projection **164**. If sliding movement of filament **162** is allowed, end **166** of filament **162** could be pulled away from projection **164** drawing end **168** toward projection **164**. In another embodiment, projection **164** is replaced by apertures located adjacent one another on the same side of conduit **160**, i.e., along the axial length of conduit **160**. These apertures accept filament **162** in the same manner as apertures **42**, **44**, described in detail above with reference to FIGS. **7-10**. The use of either projection **164** or the apertures located on the same side of conduit **160** provides for eccentric loading of conduit **160** when filament **162** finally secured, which impedes pull out of conduit **160**.

[0064] While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

1. A medical device comprising:

an elongate conduit formed of biocompatible material, said device body having an exterior, a first end, a second end, and a longitudinal bore; and a filament attached to said device body, whereby said filament can be positioned to fixate tissue in a desired position.

2. The medical device of claim **1** wherein said longitudinal bore of said conduit extends from said first end to said second end.

3. The medical device of claim **1**, wherein said conduit further comprises an aperture.

4. The medical device of claim **3** wherein said filament is attached to said conduit via said aperture.

5. The medical device of claim **3** wherein said apertures are in communication with said longitudinal bore.

6. The medical device of claim **1** wherein said conduit further comprises a surface feature extending from said exterior of said body selected from the group consisting of ribs and threading.

7. The medical device of claim **1** wherein said conduit further includes a slot.

8. The medical device of claim **1** wherein said conduit further comprises a buckle.

9. A method for implanting a medical device in tissue, the tissue having a first area of vascularity and a second area of vascularity, the vascularity of the second area being less than the vascularity of the first area, the method comprising the steps of:

inserting a device into tissue, said device including a conduit and a filament attached to said conduit, said conduit having a first end, a second end, and a bore therethrough;

positioning said first end of said conduit adjacent the outside wall of a torn or damaged area of tissue;

positioning said filament through said tissue to secure said conduit and fixate the tissue in a desired position; and

securing said filament.

10. The method of claim **9** wherein the first said positioning step further comprises locating said first end in a second area of vascularity.

11. The method of claim **10** wherein the first said positioning step further comprises positioning said second end of said device body in a first area of vascularity.

12. The method of claim **9** wherein said securing step further comprises looping said filament over said outside wall of a torn or damaged area of tissue.

13. A method for implanting a medical device in tissue, the method comprising the steps of:

inserting a device into tissue, said device including a plurality of conduits and a filament attached to said conduits, said conduits having a first end, a second end, and a bore therethrough;

positioning said first end of each said conduits adjacent the outside wall of a torn or damaged area of tissue;

positioning said filament through said tissue to secure said conduit and fixate said tissue in a desired position; and

securing said filament.

14. The method of claim **13** wherein said tissue has a first area of vascularity and a second area of vascularity, said first area having greater vascularity than said second area, the first said positioning step further comprising positioning said first end in said second area of vascularity.

15. The method of claim **14** wherein the first said positioning step further comprises positioning said second end of said conduit in said second area of vascularity.

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