(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 August 2003 (28.08.2003)

PCT

(10) International Publication Number
WO 03/070107 A2

(51) International Patent Classification[7]: A61B 17/00

(21) International Application Number: PCT/US03/03910

(22) International Filing Date: 11 February 2003 (11.02.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/078,303 15 February 2002 (15.02.2002) US

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for all designations*

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 03/070107 A2

(54) Title: OCCLUDING AND STABLIZING MEDICAL DEVICE

(57) Abstract: A method for occluding a blood vessel at a compression site is provided. Suction is applied to stabilize a surgical location adjacent the compression site. A first compressor is positioned proximal the surgical location and adjacent the blood vessel. The blood vessel is occluded with the first compressor in response to the positioning. Systems and apparatuses for using the method are also provided.

OCCLUDING AND STABILIZING MEDICAL DEVICE

FIELD OF THE INVENTION

The present invention relates to the field of medical methods and devices for stabilizing and occluding an area of tissue. More particularly, the invention relates to devices that are capable of immobilizing an area of epicardial tissue and of occluding an area of epicardial tissue to permit the heart to be operated on while it is beating.

BACKGROUND OF THE INVENTION

The current leading cause of death in the United States is coronary artery disease in which the coronary arteries are blocked by atherosclerotic plaques or deposits of fat. The typical treatment to relieve a partially or fully blocked coronary artery is coronary artery bypass graft (CABG) surgery.

CABG surgery, also known as "heart bypass" surgery, generally entails using a graft to bypass the coronary obstruction. The procedure is generally lengthy, traumatic and subject to patient risks. Conventional CABG procedures are typically conducted on a stopped heart while the patient is on a cardiopulmonary bypass (CPB) circuit. A stopped heart and a CPB circuit enables a surgeon to work in a bloodless, still operative field. However, there are a number of problems associated with CABG procedures performed while on CPB including the initiation of a systemic inflammatory response due to interactions of blood elements with the artificial material surfaces of the CPB circuit and global myocardial ischemia due to cardioplegic cardiac arrest. For these reasons, avoiding the use of CPB or cardioplegic cardiac arrest may help minimize post-operative complications.

Thus, less invasive methods of cardiac surgery have regained interest. In particular, methods of performing cardiac surgery without stopping the heart (i.e., "beating heart surgery") provide desirable alternatives to the risks of a typical stopped heart CABG procedure. Coronary motion can now be adequately restrained with a mechanical stabilization device. For example, WO97/10753 in the name of Applicant describes such a

device. U.S. Patent Nos. 5,836,311; 5,927,284; 6,015,378; 6,328,688 all assigned to Medtronic, Inc., also describe methods and apparatuses for temporarily immobilizing an area of epicardial tissue.

Beating heart surgical methods, however, still present the challenge of a bloodless field to the surgeon. That is, during beating heart surgery, blood may spill from the wound and obscure visibility. A bleeding artery is difficult to see and, therefore, difficult to perform surgery upon.

In one solution, surgeons practicing beating heart surgery may put a suture or silastic snare around an artery in order to occlude the artery temporarily so that bleeding stops and the artery may be operated upon. Typically, the snare is looped around the artery, using a needle. Circumferential snaring may be used to fold the vessel on one of its sides.

Occluding in such a manner has several disadvantages. Firstly, such an occlusion method requires puncturing the myocardium with the needle in order to loop it around the artery. Secondly, a circumferential snare occludes by folding the artery. This snaring may cause multiple sharp folds, which irritate the intima of the artery and induce a protective layer of protein to be laid down. Therefore, any attempt by the artery to repair intimal damage may activate the mechanism that eventually results in a reoccluded field. Thirdly, the folding that may occur from circumferential snaring may prevent adequate sealing. Multiple radial folds are more difficult to seal and typically require more force to seal than does a single flattening fold.

Thus, a need exists in the medical arts for occluding a vessel, particularly in a beating heart procedure, that overcomes the above.

U.S. Patent No. 5,976,069 to Navia, et al. discloses an epicardial immobilization frame having one or more expandable members attached to the frame that, upon inflation, temporarily occlude the passage of blood through the vessel or vessels in the operational field defined by the frame.

U.S. Patent Nos. 6,036,641 to Taylor, et al. and 6,050,266 to Benetti, et al. disclose a compression stabilizer including a pair of substantially planar rectangular contact members attached at one end to a continuous connecting shaft. The contact members are oriented in a

substantially parallel fashion such that a target artery is positioned therebetween and passes along the greater length of the contact members when the compression stabilizer engages the heart. The compression stabilizer may include an artery occluder that may be operated to contact the target artery positioned between the contact members to occlude the passage of blood through the target artery.

U.S. Patent No. 6,120,436 to Anderson, et al. discloses a platform stabilizer having a pair of occluding members configured to slide and move vertically within the platform for positioning over and occluding a section of artery. The platform is sutured to the epicardium of the heart thereby defining an operation field within the platform on the epicardium, and stabilizing the epicardium within the operational field. The occluding members are positioned over and into contact with the epicardium surface over the artery, and temporarily locked in place thereby temporarily occluding a section of artery in the operational field.

All the publications described above are hereby incorporated by reference herein in their respective entireties. As those of ordinary skill in the art will appreciate readily upon reading the Summary of the Invention, the Detailed Description of the Preferred Embodiments and the Claims set forth below, many of the devices and methods disclosed above may be modified advantageously by using the teachings of the present invention.

SUMMARY OF THE INVENTION

One aspect of the present invention provides a method for occluding a blood vessel at a compression site. Suction is applied to stabilize a surgical location adjacent the compression site. A first compressor is positioned proximal the surgical location and adjacent the blood vessel. The blood vessel is occluded with the first compressor in response to the positioning.

The first compressor may also be locked to fix a first compressive force against the blood vessel or the first compressor may be released to release the first compressive force from the blood vessel. The first compressor may be attached to a suction stabilizer to stabilize the surgical location. The first compressor may be ratcheted in order to apply the first compressor to the blood vessel. The surgical location may be further stabilized by applying the first compressor against the surgical location.

A second compressor may also be positioned adjacent the blood vessel, the second compressor located distal the surgical location and the blood vessel may be occluded with the second compressor in response to the positioning. The first and second compressors may be locked to fix compressive forces against the blood vessel or the first and second compressors may be released to release first and second compressive forces from the blood vessel. The first and second compressors may be attached to a suction stabilizer, the suction stabilizer adapted to stabilize the surgical location. The first and second compressors may be ratcheted in order to apply them to the blood vessel. The surgical location may be further stabilized by applying the first and second compressors against the surgical location.

Another aspect of the present invention provides a system for occluding a blood vessel at a compression site. The system includes means for applying a suction to stabilize a surgical location adjacent the compression site, means for positioning a compressor adjacent the blood vessel and proximal the surgical location, as well as means for occluding the blood vessel with the compressor in response to the positioning.

The system may also include means for locking and releasing the compressor in order to fix or release a compressive force against the blood vessel. The system may also include means for attaching the compressor to a stabilizer for stabilizing the surgical location. The system may also include means for ratcheting the compressor to apply the compressor to the blood vessel. The system may also include means for further stabilizing the surgical location by applying the compressor against the surgical location. The system may also include means for positioning a second compressor adjacent the blood vessel and distal the surgical location, as well as means for occluding the blood vessel with the second compressor in response to the positioning.

Yet another aspect of the present invention provides a medical apparatus for performing heart surgery. The apparatus includes a suction stabilizing device, a compressor operably attached to the suction stabilizing device and a positioning member operably attached to the compressor.

The apparatus may also include a support member, at least one suction member and/or at least one screw member, any one of which may be attached to the suction stabilizing device. In one embodiment of the invention, the suction stabilizing device is

operably adapted to insert via an endoscopic port. In another embodiment of the invention, the compressor is removably attached to the suction stabilizing device.

The foregoing, and other, features and advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims in equivalence thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of one embodiment of a medical occluding and immobilizing device in accordance with the present invention;

FIG. 2 is another schematic view of the embodiment of the medical occluding and immobilizing device of **FIG. 1**;

FIG. 3 is a schematic view of another embodiment of a medical occluding and immobilizing device in accordance with the present invention;

FIG. 4 is another schematic view of the embodiment of the medical occluding and immobilizing device of **FIG. 3**; and

FIG. 5 is a flow diagram of one embodiment of a method for occluding a blood vessel in accordance with the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

FIG. 1 shows a side view of one embodiment of a medical device for occluding and compressing a blood vessel in accordance with the present invention at **10**. **FIG. 1** shows medical device **10** situated against an artery **50** on a surface of heart **52**. The distal end of device **10** comprises at least one paddle **22**, and at least one compressor **28**. In the embodiment shown in **FIG. 1**, compressor **28** is attached to the distal end of paddle **22** via a ratchet mechanism **40**. As seen in **FIG. 1**, compressor **28** may further comprise at least one plunger **44**, which may or may not include a plurality of protrusions **45**. Compressor **28** may also comprise one or more actuating mechanisms **53** separate from or working in conjunction with ratchet mechanism **40**. Paddle **22** may further comprise a plurality of

suction ports **33**. Suction ports **33** may further comprise suction apertures **34**. Paddle **22** may further be attached to a suction tube **35** via suction conduit **37**. The proximal end of paddle **22** may be connected to a handle **21**.

In one embodiment of the invention, when paddle **22** is positioned against the target tissue, a face of paddle **22** adjacent to the surface of the heart **52** may be adapted to conform to the surface of the heart. This may be accomplished by making paddle **22** from a flexible material, such as, for example, a pliable polymer, biocompatible rubber, thermoplastic elastomer or PVC. Alternatively, paddle **22** may be made of a more rigid material covered with an elastic material. The elastic material may cover at least the face adjacent the surface of heart **52**. A suction force applied through paddle **22** may cause device **10** to conform more closely to the shape of the target tissue. Paddle **22** may include a malleable stainless steel or other material that is shapeable but not necessarily flexible. Paddle **22** may include a conductive polymer.

In one embodiment of the invention, paddle **22** is a tissue stabilizer such as the tissue stabilizer described in U.S. Patent Nos. 5,836,311, 5,927,284, 6,015,378, 6,328,688 all assigned to Medtronic, Inc., herein incorporated by reference in their entirety. Paddle **22** may be constructed of any suitable material, such as, for example, a biocompatible material. A biocompatible material would prompt little allergenic response and would be resistant to corrosion when placed within the patient's body. The biocompatible material may additionally be impervious to blood. Furthermore, the biocompatible material would not cause any additional stress to the patient's body. For example, it would not scrape detrimentally against any elements within the surgical site. In one embodiment of the invention, paddle **22** may be constructed of stainless steel or a biocompatible rubber. Alternatively, the biocompatibility of paddle **22** may be enhanced by coating the material of paddle **22** with a biocompatible coating.

Paddle **22** may be colored so that it can be easily visible against the heart. Alternatively, it may be translucent or transparent to provide less obstruction to the surgeon's line of sight.

In one embodiment of the invention, compressor **28** may be adapted to apply pressure to the surface of heart **52** and/or to artery **50**. Compressor **28** may also be manipulated to apply pressure to a variety of surfaces. Compressor **28** may be in a

disengaged position as seen in **FIGS. 1** and **4**. Alternatively, compressor **28** may be in an engaged position as seen in **FIG. 2**. In one embodiment of the invention, compressor **28** is an arm able to apply pressure, for example, through plunger **44** to artery **50**. Compressor **28** may be constructed of any suitable material such as, for example, a biocompatible material as described above. In one embodiment of the invention, compressor **28** may be constructed of stainless steel, biocompatible plastic or a biocompatible rubber. Compressor **28** may be colored so that it can be easily visible against the heart. Alternatively, it may be translucent or transparent to provide less obstruction to the surgeon's line of sight.

In the embodiment shown in **FIG. 1**, compressor **28** attaches to the distal end of paddle **22**. Additional compressors may also be attached to device **10**. For example, as seen in **FIG. 3**, compressor **28** is attached to device **10** at a distal end of paddle **22** while a second compressor **29** is attached to a frame **354** located proximally to paddle **22**. In addition, more than one device **10** may be used in accordance with the present invention. This is illustrated in **FIG. 3** which shows a second device **310** with a third compressor **328** attached distally to paddle **322** and a fourth compressor **329** attached to a frame **354** located proximally to paddle **322.**

Compressors **28, 29, 328, 329** may be attached to devices **10, 310** in any suitable arrangement. For example, as seen in **FIG. 1**, the compressor **28** may be attached directly to paddle **22**. Alternatively, as seen in **FIG. 3**, one or more of compressors **28, 29, 328, 329** may be attached to a frame **354** surrounding the surgical site. Frame **354** may be made of any suitable material, such as, for example, biocompatible material as described above. Frame **354** may be, for example, a stainless steel tubing arrangement framing the surgical site. Compressors **28, 29, 328, 329** may be attached to frame **354** using any suitable mechanism. In one embodiment of the invention, the compressors are attached to frame **354** using one or more ratchet mechanisms **40** as described further below.

Compressors **28, 29, 328, 329** may be attached to paddles **22, 322** using any suitable mechanism. In one embodiment of the invention, the compressor **28** is attached to paddle **22** using a ratchet mechanism **40**. This is illustrated in **FIG. 4,** which shows a side view of the compressors **28, 328** of **FIG. 3**.

As seen in **FIG. 4**, a plug **43** is attached to the end of paddle **22**. Plug **43** may be attached to paddle **22** using any suitable means. For example, in one embodiment of the invention, plug **43** is glued into an end of the paddle **22**. Plug **43** may be constructed of any suitable material such as biocompatible material described above. In one embodiment of the invention, plug **43** is made of a biocompatible rubber.

Ratchet mechanism **40** may further include a rotor **42.** Plug **43** may serve as an anchor around which rotor **42** may rotate. In the embodiment shown in **FIG. 4**, rotor **42** is restrained by a rotor spring **46**. A plurality of fingers **47** on the rotor spring **46** may act to engage the compressor **28** when the compressor is in an engaged or locked position as illustrated in **FIG. 2**. The fingers **47** may be made of any suitable material such as, for example, biocompatible material as described above. In one embodiment of the invention, the fingers are constructed of plastic. Any suitable number of fingers may be used on the rotor spring **46**. For example, in one embodiment of the invention, eight fingers are used per rotor spring **46**. Rotor **42** may pivot around the axis provided by plug **43**. A cavity within rotor **42** may serve as half of ratchet mechanism **40**.

Ratchet mechanism **40** may further include a plurality of teeth **41**. These teeth may be positioned radially around a center hub of rotor **42**. Ratchet mechanism **40** may further include a gear **48**. In one embodiment of the invention, gear **48** further comprises gear teeth **49**. Gear teeth **49** may mirror and engage teeth **41**. Teeth **41** and corresponding gear teeth **49** may be any suitable shape for engaging each other within ratchet mechanism **42**. For example, teeth **41** and gear teeth **49** may be a series of small triangular teeth. Teeth **41**, **49** may be constructed of any suitable material such as biocompatible material described above. In one embodiment of the invention, teeth **41**, **49** are constructed of biocompatible stainless steel.

Teeth **41**, **49** of rotor **42** and gear **48** may be pulled tightly in contact with each other via any suitable mechanism, such as, for example a spring. The spring may be restrained by compressor **28**, **29** as seen in **FIG. 4**.

In one embodiment of the invention, the distal end of the compressor may further comprise a plunger **44**. Plunger **44** may be constructed of any suitable material, such as, for example, biocompatible material. In one embodiment of the invention, plunger **44** is

constructed of soft, silicone rubber. Plunger **44** may be designed to be atraumatic while still providing maximum occlusion.

As seen in **FIG. 1**, compressor **28** may further comprise a plurality of protrusions **45**. In the embodiment of **FIG. 1**, three protrusions are shown but any suitable number of protrusions may be used in accordance with the present invention. Protrusions **45** may be molded into the soft silicone body of the plunger **44**. Protrusions **45** may serve to provide a tortuous inner path of artery 50 in order to prevent blood leakage. Plunger **44** is designed to press down and flatten vessel **50** in a less traumatic method of occlusion.

Paddle **22** may further comprise a plurality of suction ports **33**. The proximal end of paddle **22** may be connected to a handle **21**. Paddle **22** may further be attached to a suction tube **35** via suction conduit **37.**

Suction tube **35** provides suction to device **10** via suction conduit **37**. This conduit **37** communicates suction to the heart's surface via suction port **33** in paddle **22**. A source for creating suction is attached to suction tube **35** at one end. The suction source may be, for example, the standard vacuum available in an operating room. The suction source may be coupled to the device **10** with a buffer flask (not shown). Suction may be provided, for example, at a negative pressure of between 200-600 mm Hg or alternatively, at a negative pressure of 400 mm Hg.

As seen in **FIG. 1**, paddle **22** has a series of suction ports **33** each of which is connected to suction conduit **37** through a suction aperture **34**. Suction aperture **34** may be located in the center or at a position slightly off-center of suction port **33**. Although the apertures **34** are circular in **FIG. 1**, other shapes may be used. The suction ports **33** may also be any suitable shape. For example, in the embodiment of **FIG. 1**, the ports **33** are dome-shaped. Additionally, suction ports **33** may be covered with a covering such as described above to prevent blood or tissue from clogging the openings **34**.

The suction ports **33** may be arranged, for example three to six ports in a row, although the specific number of ports and their positions may vary in accordance with the present invention. In one embodiment of the invention, the ports may be arranged linearly and compressor **28** may also be aligned with the ports **33**. In one embodiment of the invention, device **10** may be covered with a covering during insertion to prevent blood or tissue from clogging the ports **33**, although this is not necessary. Such coverings may

include coverings of biocompatible material that would cover device **10**. Alternatively, coverings may be placed over ports **33**, such as, for example, mesh coverings or ribbed coverings.

Suction apertures **34** may be positioned off center from suction ports **33** so that if a large upwelling of tissue is caused by the suction (which may occur as a blister or bell-shaped curve) the tissue will not immediately close off the suction by obstructing suction aperture **34**, as it would if the aperture were in the center of suction port **33**. In addition, each suction aperture **34** may have a much smaller diameter as compared to the diameter of suction port **33**. This creates a high resistance pathway between suction port **33** and suction conduit **37**. Because of this, loss of a tissue-to-port seal in one suction port (and thus loss of fixation of the suction port to the tissue) does not also cause a precipitous pressure drop in the remainder of the suction ports.

In one embodiment of the invention, compressor **28** may be located within one or more of suction ports **33**. Alternatively, compressor **28** may replace one or more of suction ports **33**.

FIG. 5 shows one embodiment of a method for occluding a blood vessel in accordance with the present invention at **600**.

As seen at block **605**, a surgical site, such as the surface of the heart, may be accessed. In one embodiment, surgical access to the local area of heart tissue is achieved through a sternotomy. Alternatively, surgical access to the local area of heart tissue may also be achieved through a mini-thoracotomy, preferably performed within either the fourth or fifth intercostal space. An incision of, for example, approximately 10 centimeters is made into the chest cavity between the ribs. The rib cartilage may be temporarily removed and the ribs surrounding the incision slightly spread apart to provide adequate surgical access to artery **50** and the heart **52**.

As seen at block **610**, medical device **10** may then be inserted into the chest cavity and placed adjacent a first surface of the heart **52**.

As seen at block **615**, once the device **10** has been placed adjacent the heart, a suction source may then be used to create suction through the suction tube **35**. Via suction conduit **37** through suction ports **33** of the device **10**, the suction source may firmly grasp

the heart. This suction may be used to lock the device **10** to the myocardium of the heart **52**.

As seen at block **620**, the compressor may then be positioned over the vessel **50** to be occluded. In order to determine an optimal position for the compressor **28**, the surgeon may consider such factors as where the anastomosis will be created, how far upstream from the anastomosis the desired occlusion site should be, whether or not to occlude the vessel downstream from the anastomosis site and whether or not multiple occlusions sites may be desirable.

As seen at block **625**, the compressor **28** may be actuated. For example, actuating the compressor **28** may involve rotating the rotor **42** to position the plunger **44** accurately. Then once the plunger **44** is positioned as desired, the compressor **28** may be actuated. For example, the compressor may be pressed down over the plunger **44**. This may be accomplished manually by the surgeon using any suitable mechanism. For example, in the embodiment of **FIG. 1**, the surgeon may press down on actuating mechanism **53**. Alternatively, as seen in **FIG. 2**, compressor **28** may take the form of an arm, which the surgeon may press in order to actuate the compressor. In some embodiments of the invention, the surgeon may actuate more than one compressor separately or concurrently. For example, in the embodiment of **FIG. 3**, the surgeon may press on actuating mechanism **353** to actuate compressors **28** and **328** simultaneously. Alternatively, as seen in **FIG. 4**, compressors **28, 328** may take the form of compressor arms. In the embodiment of **FIG. 4**, the surgeon may press on compressor arm **328**, thereby simultaneously actuating compressor **328** and compressor **28.**

In some embodiments of the invention, the circular gear teeth **49** and rotor teeth **41** will rotate over one another until sufficient force is exerted to force the spring apart and allow the teeth to ratchet into the next set of teeth. When pushing down on the compressor, the ratchet teeth have a slight incline (15 to 30 degrees) to allow frictional rotation. However, when the teeth engage there may be a 90-degree incline to resist slipping backwards, thereby effectively "locking" compressor **28** in position. To prevent the rotor **42** from turning when the compressor **28** is locked, rotor **42** rotates and locks against finger **47** in the rotor spring **46**. This is illustrated in **FIG. 2**. The engagement of

the rotor **42** and the fingers **47** is shown at **53**. In addition, the compressor **28** has rotated down, pushing the plunger **44** against artery 50 and compressing artery **50**.

Optionally, as seen at block **630**, the compressor **28** may be manually locked using any suitable locking mechanism.

Compression of the artery **50** serves to interrupt blood flow in the recipient artery **50**. In the embodiment of **FIG. 3**, compressor **28** is used to interrupt blood flow distally to the anastomotic site while compressor **328** is used to interrupt blood flow proximally to the anastomotic site. Thus device **10** may be used to assist visualization of the anastomosis site by sufficiently occluding artery **50** so that blood flow stops. Additionally, compressor **28** may reduce blood leakage because it applies a single, flat fold compression. This single fold may be more effective than a multiple folded compression.

As seen at block **635**, once the blood flow is interrupted, the recipient artery **50** may be opened. This may be accomplished by an arteriotomy as is well known in the art.

As seen at block **640**, a surgical procedure, such as an anastomosis, may be performed. For example, the exit (distal end) of the bypass graft may be connected by suturing (or other bonding method, e.g. an anastomotic bonding device) to the recipient artery **50**. This is achieved by suturing the inside of the bypass graft to the inside of the recipient artery **50**. The rationale of this precise anastomosis suturing is that the inner lining of the vessels (the endothelial layer) is anti-thrombogenic, whereas the outer layer is highly thrombogenic. Thrombosis at the transition of donor to recipient vessel reduces the cross-sectional area of the lumen at the anastomosis and hence jeopardizes the quality of the distal anastomosis. Narrowing (stenosis) of the anastomosis limits the maximum blood flow through the bypass graft.

In a proximal anastomosis, the entrance (proximal end) of the bypass graft needs to be connected to an artery that serves as pressure source of oxygenated blood. If a natural artery can serve as bypass graft, for example, the internal mammary artery in coronary artery bypass grafting, only the distal anastomosis as describe above needs to be made. Sometimes, however, the internal mammary artery is used as free graft or the radial artery is used as arterial conduit and a proximal anastomosis has to be made. Venous bypass grafts always require a proximal anastomosis, because their transformation to an arterial

conduit requires connection to a source of arterial blood. Similar to suturing the distal anastomosis of the bypass graft, suturing the proximal anastomosis requires interruption of the source blood flow in the vicinity of the proximal anastomosis site. Again, compressors **28, 29, 328, 329** may be used to achieve interruption of the source blood flow.

In an endoscopic surgical procedure, the device **10** of the present invention is used in a similar manner to that described above. However, surgical access to a local area of heart tissue in an endoscopic procedure is achieved through an endoscopic port in the sternum. This port is a relatively small hole created by a trocar or needle in the sternum. A cannula or tube may be inserted into this hole and the surgical instruments inserted via the cannula. It is contemplated that the device **10** of the present invention may be inserted via a cannula into the surgical space and then placed appropriately on a first surface of the heart and manipulated as described above. It is also contemplated that the device **10** may be attached to the trocar, which creates the hole in the sternum, and thus be inserted in that manner.

Coupling two medical devices **10, 310** in the manner illustrated in **FIG. 3** may provide a structure that further improves immobilization of the heart tissue. In one embodiment of the invention, one paddle **22** may be used to stabilize a surgical site, such as an anastomotic site. Alternatively, two paddles **22, 322** may be used to further improve stability of the site. The frame **354** in accordance with the present invention serves as one means for joining the two stabilizer paddles **22, 322**.

Additionally, as seen in **FIG. 4**, compressing a first compressor **28** on top of a rubber pad on a second compressor **328** may create a friction interface between the two compressors **28, 328**. Typically, an interlocking mechanical structure provides more stability than the individual components of the structure. Thus, the interlocking compressors **28, 328** may provide improved stability and thereby improve the anastomosis quality.

As seen at block **645,** when compression of the vessel **50** is no longer required, the compressor may be released. This may be accomplished, for example, by releasing the ratchet mechanism **40**. For example, the compressor **28** may be pressed against the rotor **42**. This serves to compress the spring and disengages the gear teeth **49** from the rotor teeth **41**.

It will be appreciated by those skilled in the art that while the invention has been described above in connection with particular embodiments and examples, the invention is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto. The entire disclosure of each patent and publication cited herein is incorporated by reference, as if each such patent or publication were individually incorporated by reference herein.

WE CLAIM:

1. A method for occluding a blood vessel at a compression site, comprising:

applying a suction to stabilize a surgical location adjacent the compression site;

positioning a first compressor adjacent the blood vessel, the first compressor located proximal the surgical location; and

occluding the blood vessel with the first compressor in response to the positioning.

2. The method of claim 1, further comprising:

locking the first compressor to fix a first compressive force against the blood vessel.

3. The method of claim 1, further comprising:

releasing the first compressor to release a first compressive force from the blood vessel.

4. The method of claim 1, further comprising:

attaching the first compressor to a suction stabilizer, the suction stabilizer adapted to stabilize the surgical location.

5. The method of claim 1, further comprising:

ratcheting the first compressor to apply the first compressor to the blood vessel.

6. The method of claim 1, further comprising:

further stabilizing the surgical location by applying the first compressor against the surgical location.

7. The method of claim 1 further comprising:

positioning a second compressor adjacent the blood vessel, the second compressor located distal the surgical location; and

occluding the blood vessel with the second compressor in response to the positioning.

8. The method of claim 7, further comprising:

locking the first and second compressors to fix a first and second compressive force against the blood vessel.

9. The method of claim 7, further comprising:

releasing the first and second compressors to release a first and second compressive force from the blood vessel.

10. The method of claim 7, further comprising:

attaching the first and second compressors to a suction stabilizer, the suction stabilizer adapted to stabilize the surgical location.

11. The method of claim 7, further comprising:

ratcheting the first and second compressors to apply the first and second compressors to the blood vessel.

12. The method of claim 7, further comprising:

further stabilizing the surgical location by applying the first and second compressors against the surgical location.

13. A system for occluding a blood vessel at a compression site, comprising:

means for applying a suction to stabilize a surgical location adjacent the compression site;

means for positioning a compressor adjacent the blood vessel, the compressor located proximal the surgical location; and

means for occluding the blood vessel with the compressor in response to the positioning.

14. The system of claim 13, further comprising:

means for locking the compressor to fix a compressive force against the blood vessel.

15. The system of claim 13, further comprising:

means for releasing the compressor to release a compressive force from the blood vessel.

16. The system of claim 13, further comprising:

means for attaching the compressor to a stabilizer, the stabilizer adapted to stabilize the surgical location.

17. The system of claim 13, further comprising:

means for ratcheting the compressor to apply the compressor to the blood vessel.

18. The system of claim 13, further comprising:

means for further stabilizing the surgical location by applying the compressor against the surgical location.

19. The system of claim 13 further comprising:

means for positioning a second compressor adjacent the blood vessel, the second compressor located distal the surgical location; and

means for occluding the blood vessel with the second compressor in response to the positioning.

20. A medical apparatus for performing heart surgery, comprising;

a suction stabilizing device;

a compressor operably attached to the suction stabilizing device; and

a positioning member operably attached to the compressor.

21. The apparatus of claim 20, further comprising:

a support member removably attached to the suction stabilizing device.

22. The apparatus of claim 20, further comprising:

at least one suction member operably attached to the suction stabilizing device.

23. The apparatus of claim 20, further comprising:

at least one screw member rotatably attached to the suction stabilizing device.

24. The apparatus of claim 20 wherein the suction stabilizing device is operably adapted to insert via an endoscopic port.

25. The apparatus of claim 20 wherein the compressor is removably attached to the suction stabilizing device.

FIG. 1

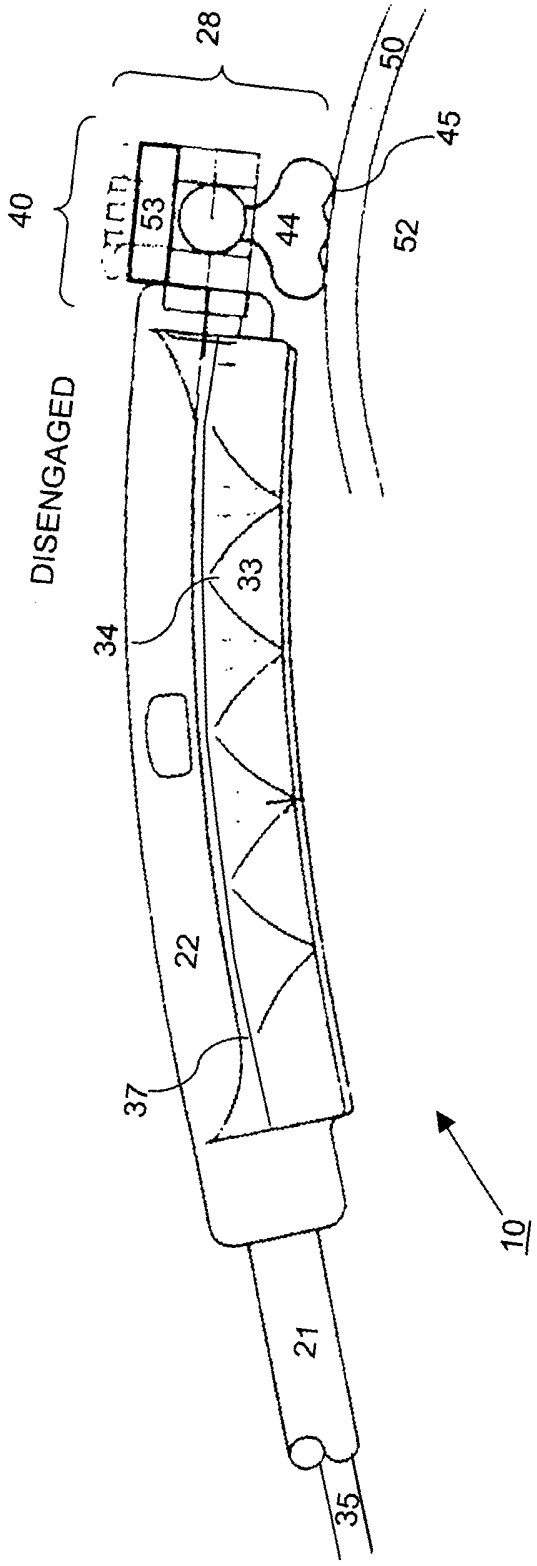
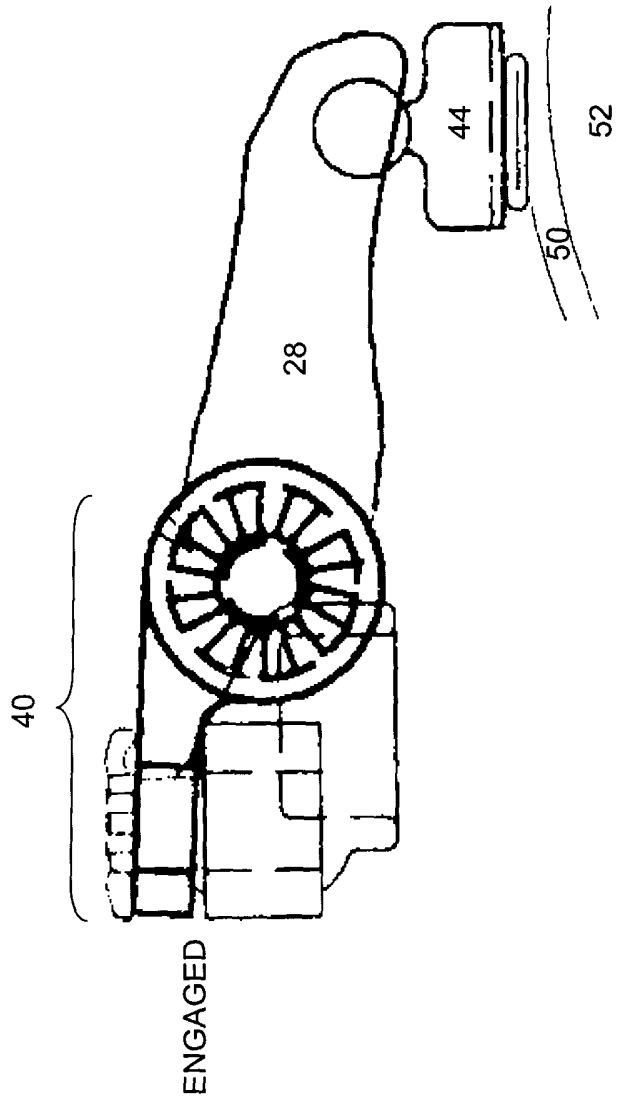


FIG. 2



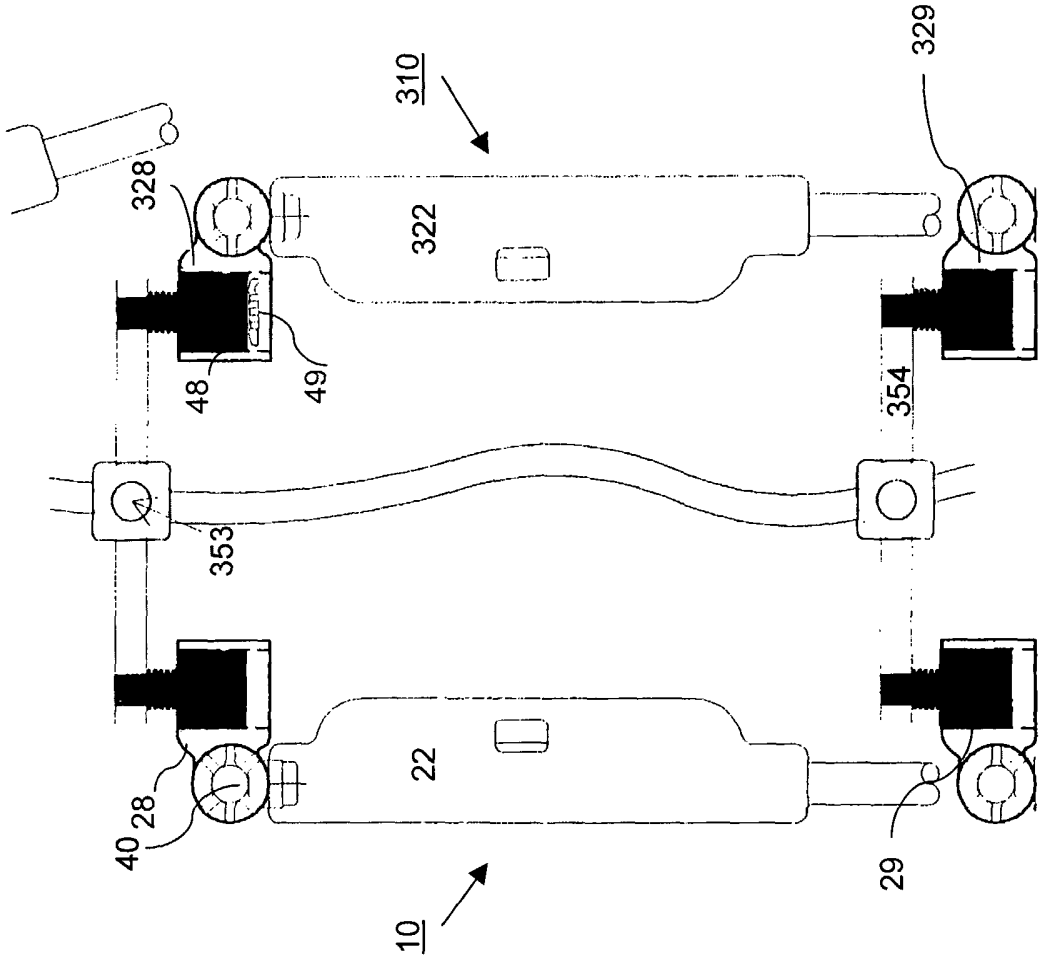
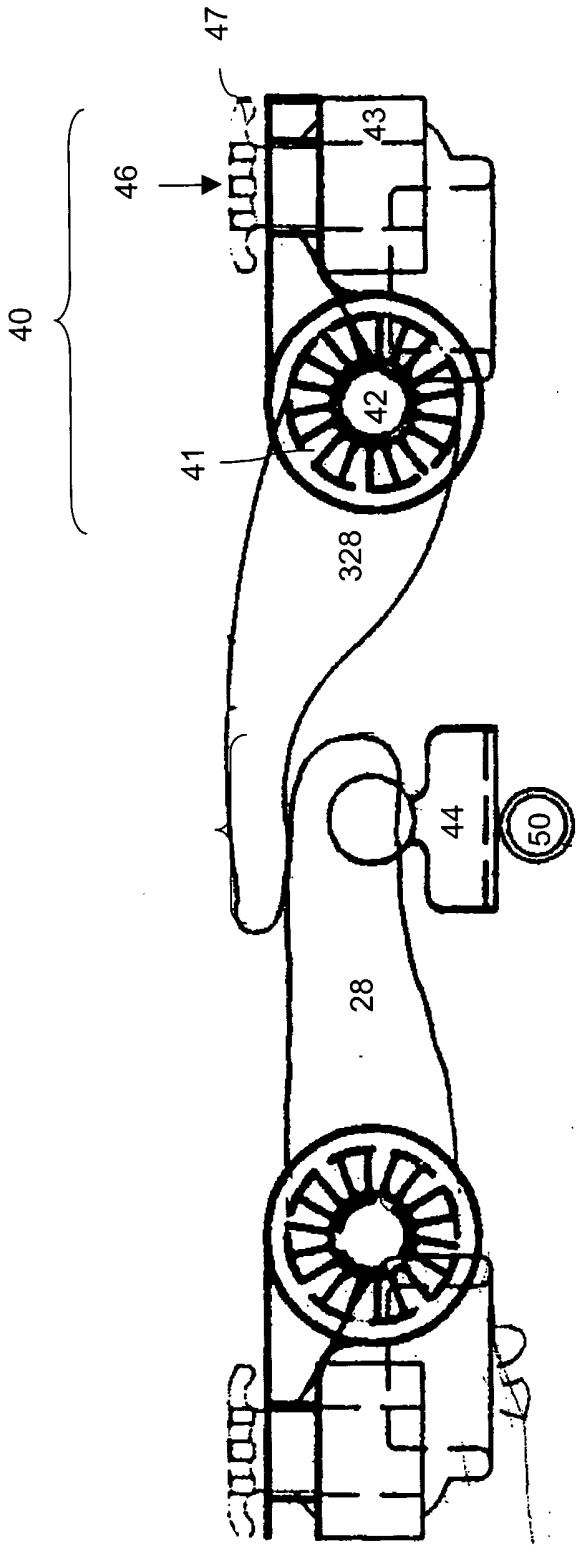


FIG. 3

FIG. 4



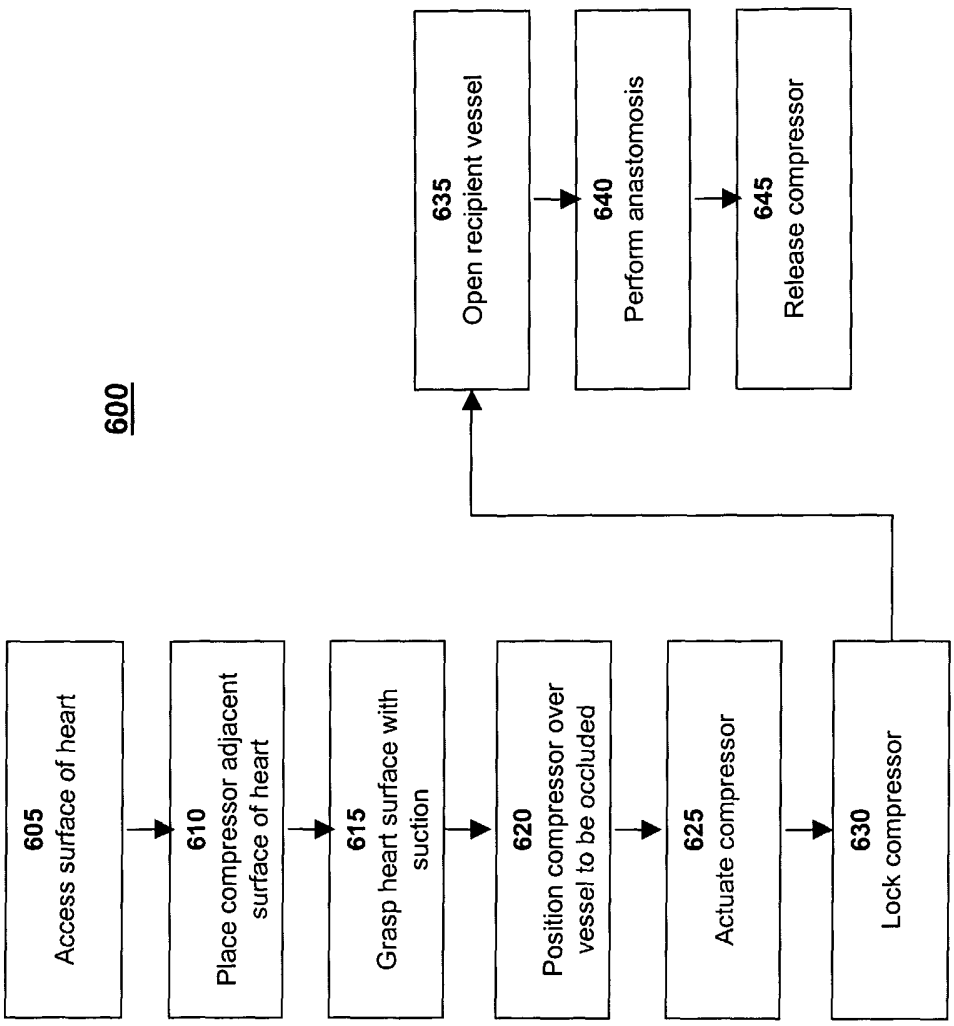

600
605
Access surface of heart
610
Place compressor adjacent surface of heart
615
Grasp heart surface with suction
620
Position compressor over vessel to be occluded
625
Actuate compressor
630
Lock compressor
635
Open recipient vessel
640
Perform anastomosis
645
Release compressor

FIG. 5