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(54) **MULTI-FUNCTION CLIPPING AND HARVESTING DEVICE**

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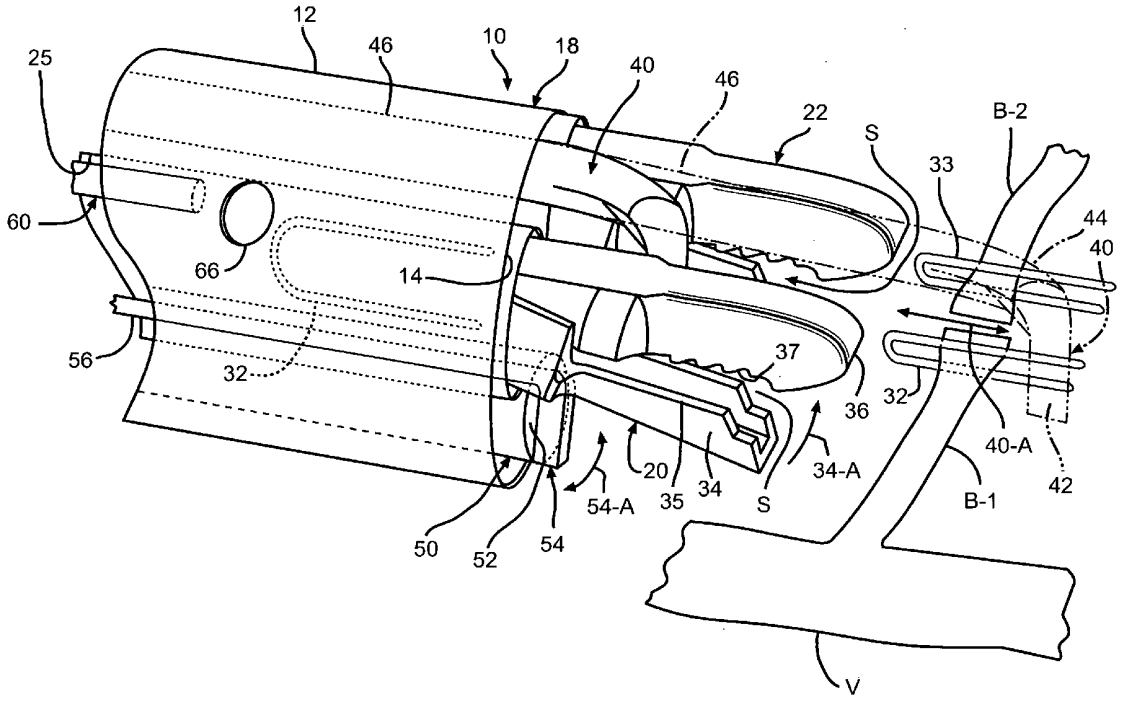
(57) **ABSTRACT**

A multi-function minimally invasive vessel clipping and harvesting device includes at least two clipping devices positioned to advance surgical clips onto a tissue, and a severing device positioned to sever the tissue between the clips.



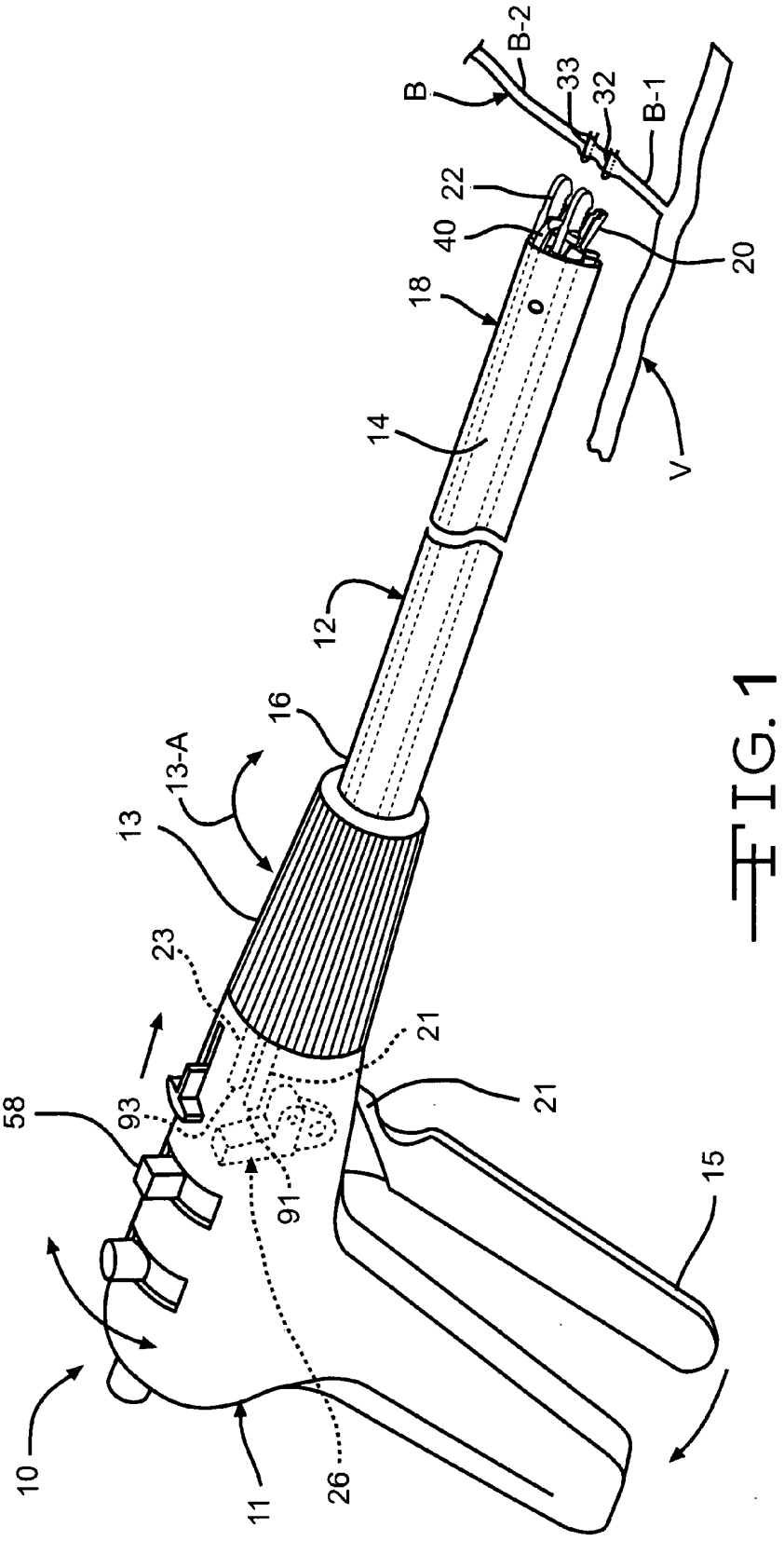
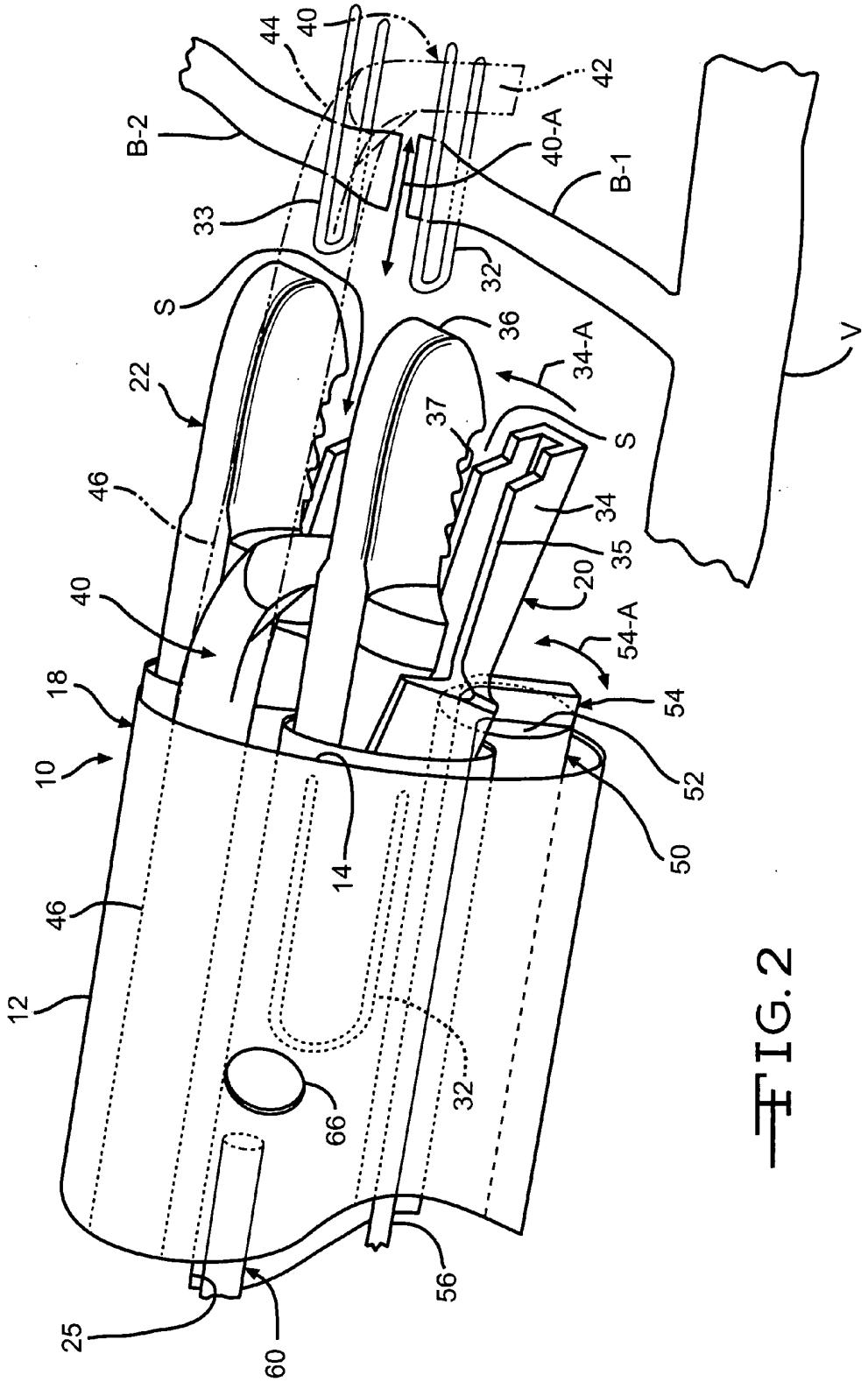


FIG. 1


44
40
42
B-2
40-A
B-1
33
32
S
36
34-A
22
37
S
V
46
34
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54-A
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FIG. 2

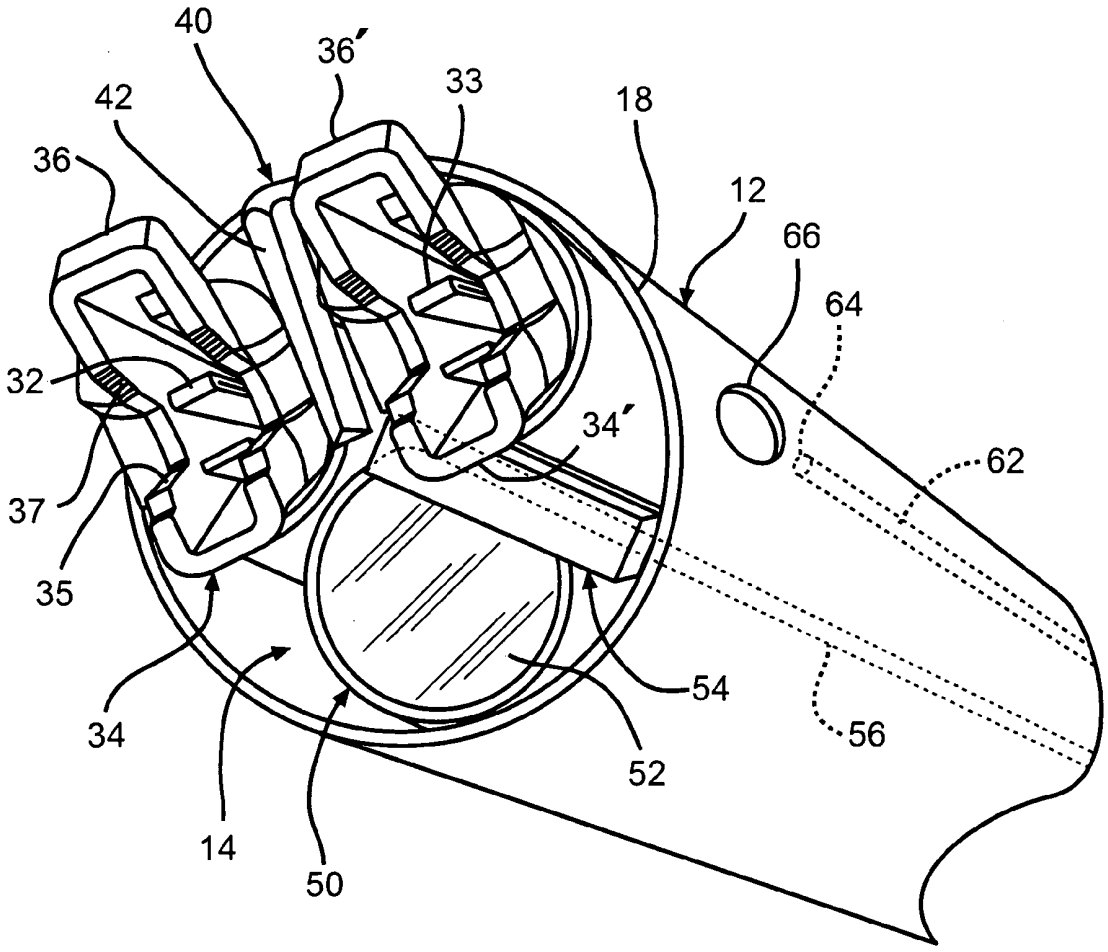


FIG. 3

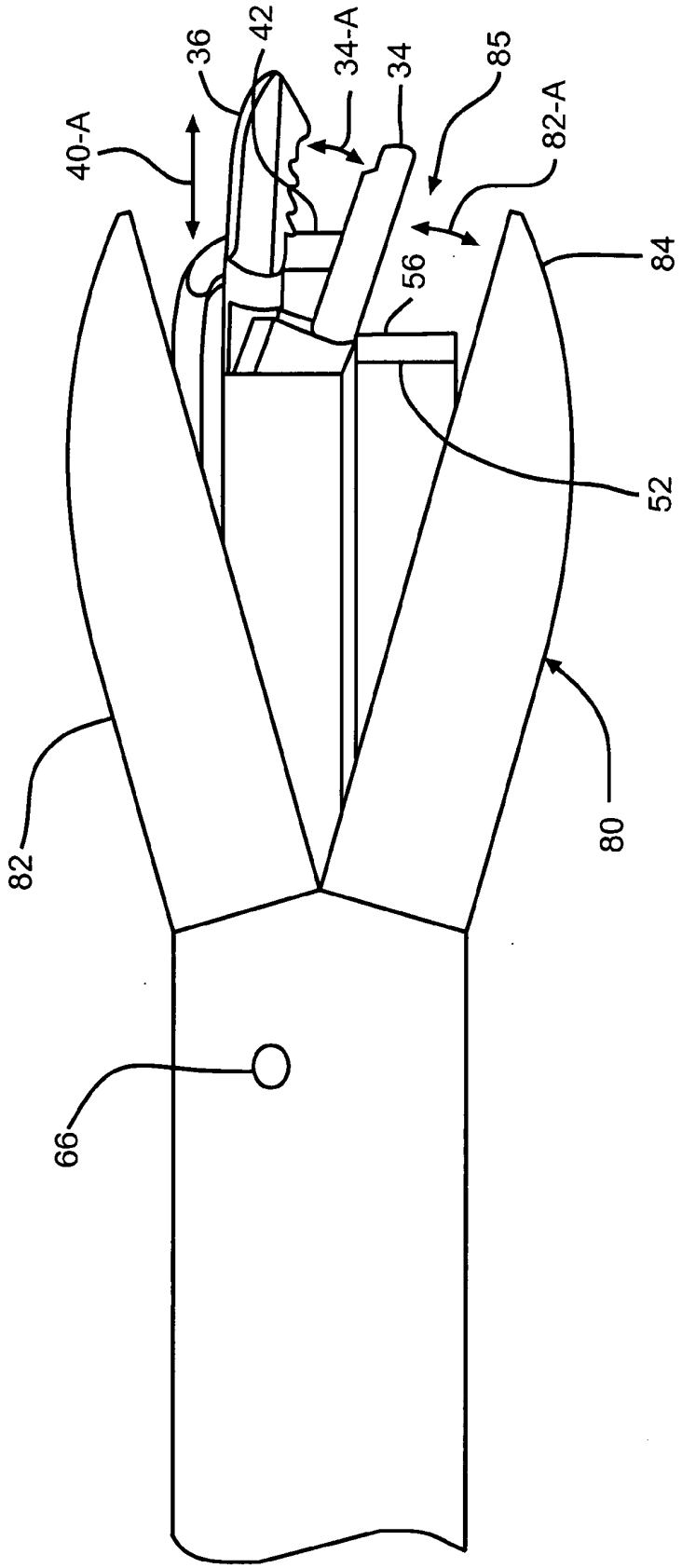
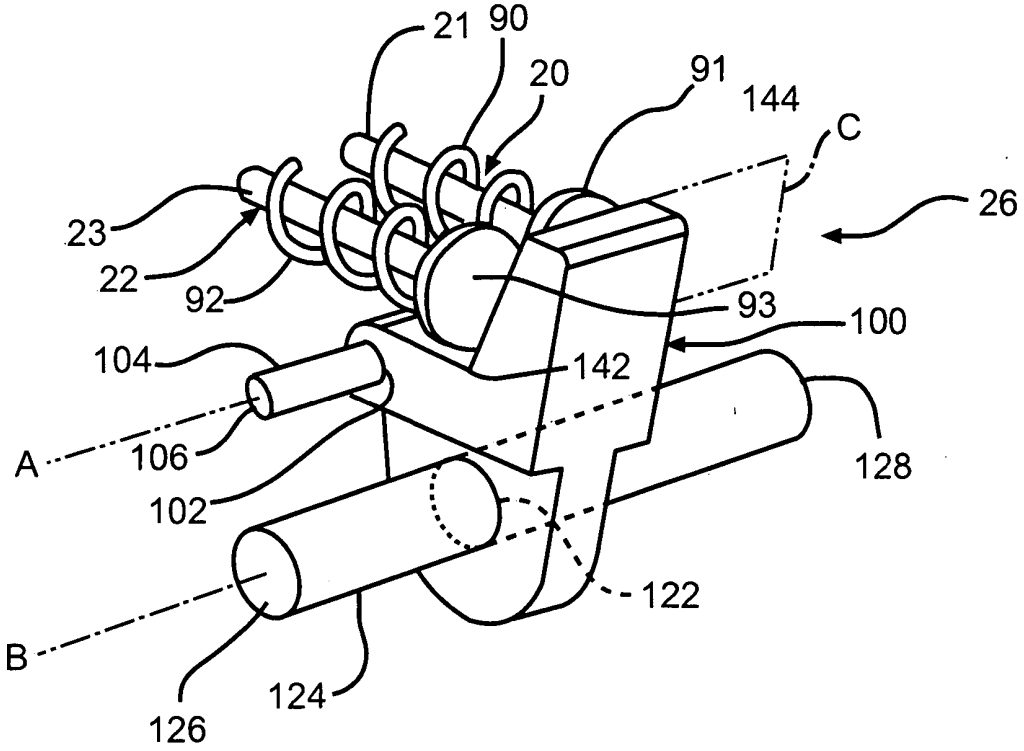


FIG. 4


21
90
20
91
144
C
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23
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93
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142
A
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B
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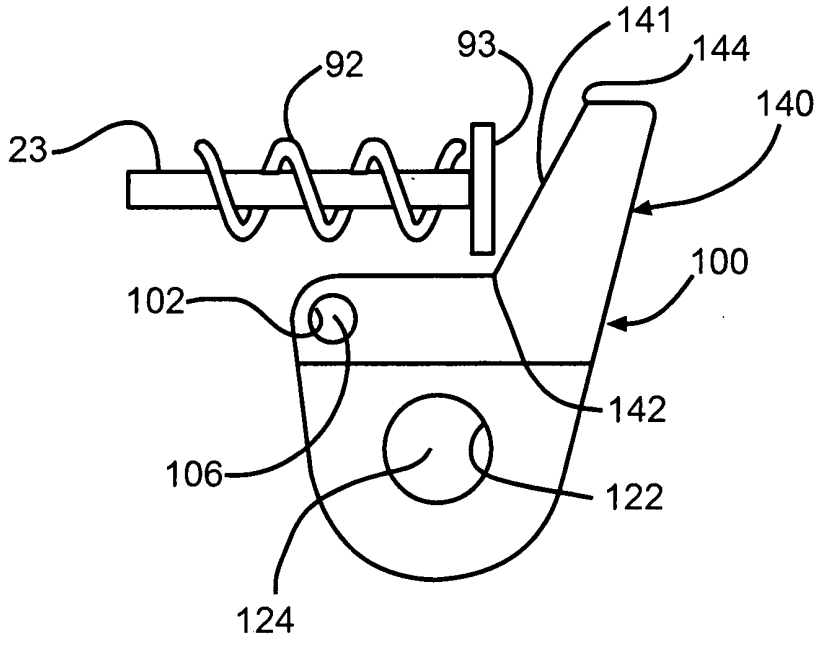
FIG. 5A


141
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92
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FIG. 5B

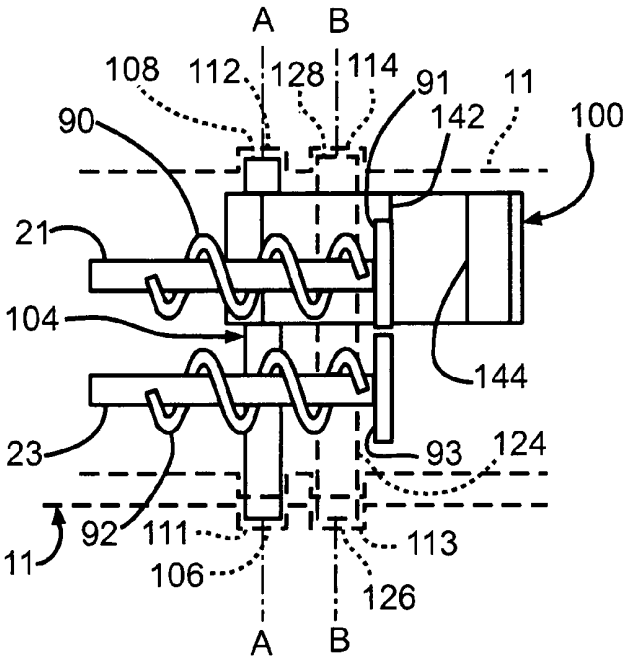

FIG. 6A

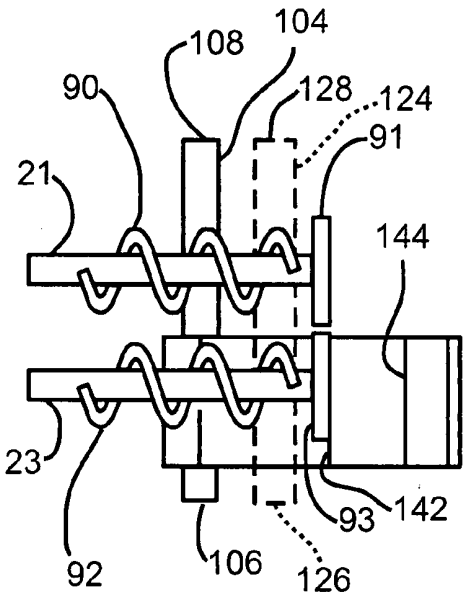

FIG. 6B

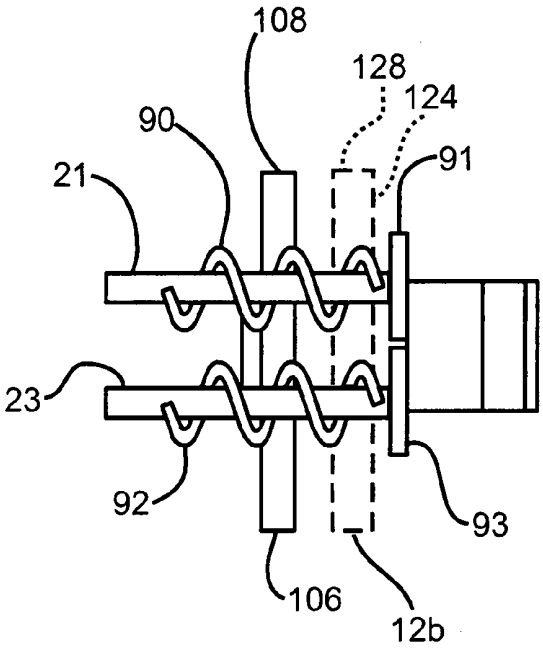

FIG. 6C

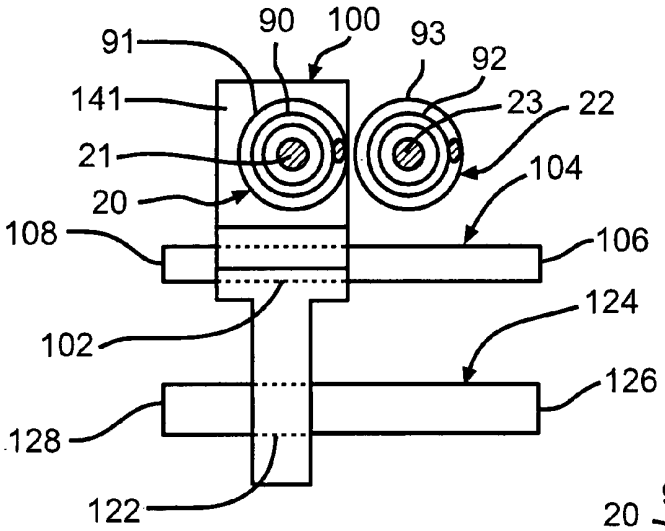

FIG. 7A

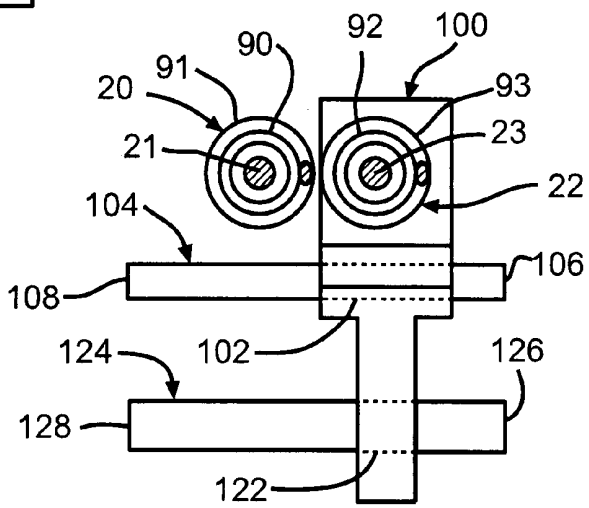

FIG. 7B

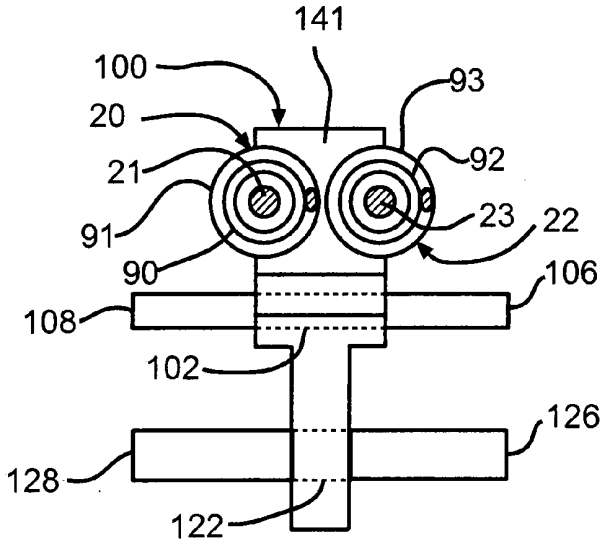

FIG. 7C

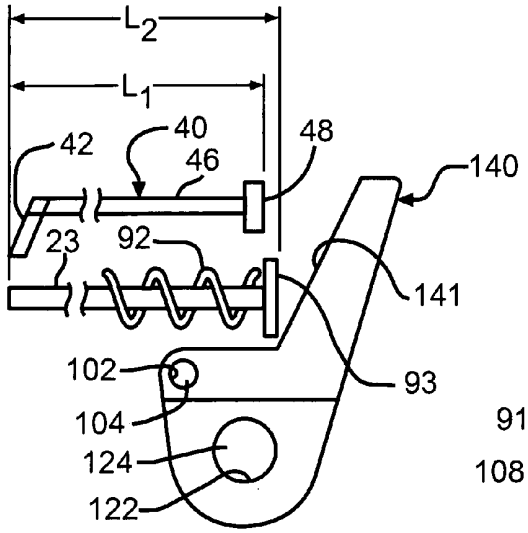

FIG. 8

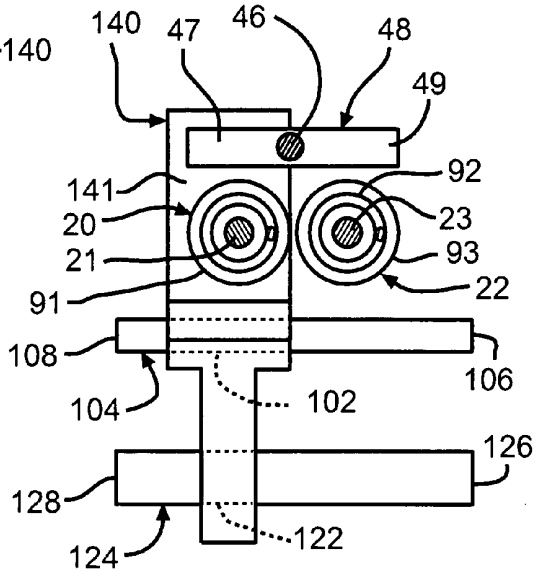

FIG. 9A

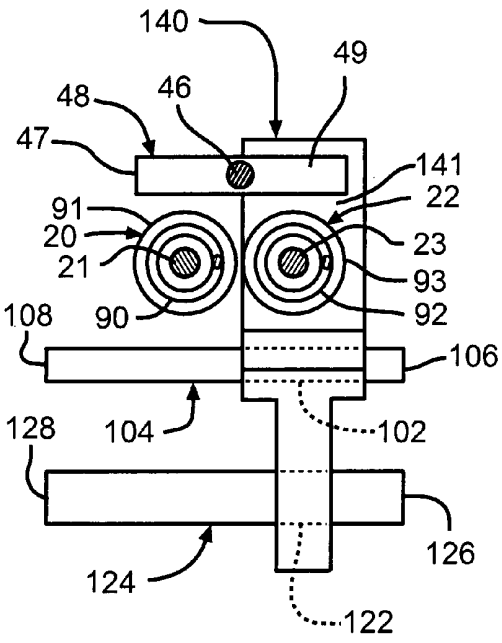

FIG. 9B

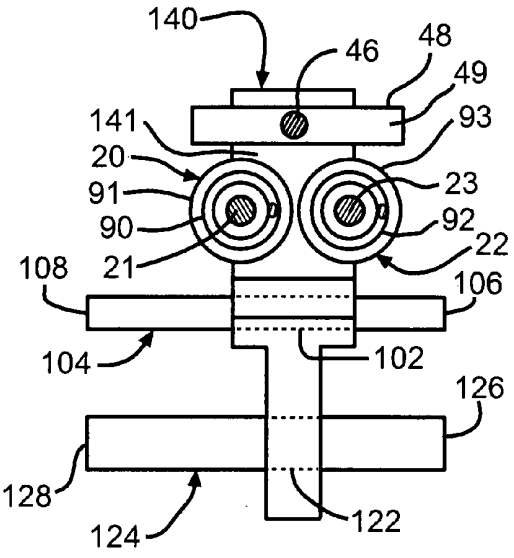

FIG. 9C

MULTI-FUNCTION CLIPPING AND HARVESTING DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not applicable.

STATEMENT REGARDING SPONSORED RESEARCH

[0002] Not applicable.

BACKGROUND OF THE INVENTION

[0003] The present invention relates to the clipping, dissecting and harvesting of blood vessels.

[0004] The harvested vessels are used in many surgical procedures, including use as a coronary artery bypass graft, or in other cardiovascular procedures. As one example, in vascular and cardiovascular procedures, a blood vessel or vessel section, such as an artery or vein, is "harvested" (i.e., removed) from its natural location in a patient's body and is used elsewhere in the body. In coronary artery bypass grafting, for example, surgery, the harvested blood vessel is used to form a bypass between an arterial blood source and the coronary artery that is to be bypassed.

[0005] Endoscopic surgical procedures for harvesting a section of a blood vessel (e.g., the saphenous vein) subcutaneously have been developed in order to avoid disadvantages and potential complications of harvesting of the blood vessel in a more invasive fashion. In the past, the harvesting was done through a continuous incision (e.g., along the leg) that exposed the full length of the desired vein section. The continuous incision had been necessary in order to provide adequate exposure for visualizing the vein and for introducing the surgical instruments to dissect and harvest the vessel.

[0006] A more recent development has been a minimally-invasive technique that employs a small incision for locating the desired vessel and for introducing one or more endoscopic devices into the small incision.

[0007] Commercially available products for performing the endoscopic blood vessel harvesting procedure include a number of separate devices that are used. In the past, the clinicians have used one device to dissect the vessel from surrounding tissue. Another device is then typically used to cauterize and cut the branches from the dissected vessel while the vessel is still within the patient. In the past, the harvesting devices have included expensive radio frequency (RF) or ultrasonic generators that require additional support equipment and add additional time and difficulty to the harvesting procedure. Another device is often used to ligate and remove the vessel from the patient.

[0008] The cauterizing or sealing of the branch closed while still in the patient is generally viewed as an intermediate step that is adequate to seal the branches during vessel removal, but is not considered reliable enough to sustain the pressures once the harvested vessel is sutured to the heart as a long-term bypass graft. Therefore, once the harvested vessel is taken out of the patient's arm, another device has been used to securely seal the branch stubs on the harvested vessel. The branch stubs are generally sutured, tied or clipped closed as an additional measure of safety to assure that the branch stubs do not leak.

[0009] Since there is an increasing occurrence of minimally invasive surgery, however, there is also a growing need for more efficient and compact devices that shorten the time and invasiveness of the surgery.

[0010] It would be especially useful to have a device that performed multiple functions so that there would be fewer intrusions into the open wound in the patient.

SUMMARY OF THE INVENTION

[0011] In one aspect, there is provided a multi-function device for harvesting a vessel post dissection. The multi-function device includes a sheath that is to be at least partially inserted in a body through a cut skin portion. First and second clipping devices are positioned within the sheath. Each clipping device advances a surgical clip and closes the advanced surgical clip around the vessel or branch. A severing device is also positioned within the sheath and is advanced to sever the clipped vessel or branch.

[0012] In certain aspects, the severing device is interposed between the first and second clipping devices. Also, a vision system positioned within the sheath aids in the visualization of the clipping and severing steps.

[0013] In another aspect, the sheath can include a dissector tip in an axial position over a distal end of the sheath. The dissector tip is movable between an open position and a closed position such that the first and second clipping devices are in an exposed position when the tip is in the open position.

[0014] The multi-function device includes a clip advancing mechanism having a movable housing to engage at least one of the first or second clipping devices. The movable housing includes a first opening through which a guide bar extends, and second opening through which a pivot bar extends. The movable housing can be slidably moved along a longitudinal axis A extending through the guide bar; slidably moved along a longitudinal axis B extending through the pivot bar; and/or pivotably moved about the longitudinal axis B through the pivot bar. The movable housing is configured to substantially activate: i) the first clipping device followed by the severing device; ii) the second clipping device followed by the severing device; or, iii) the first clipping device and the second clipping device followed by the severing device.

[0015] In yet another aspect, there is provided a method of severing branches and/or vessels during harvesting from a body. The method includes:

[0016] inserting a distal end of the multi-function device into the body alongside the vessel to form a cavity substantially surrounding the vessel or branch;

[0017] activating the first and second clipping devices to seal the vessel or branch; and

[0018] moving the severing device to a position substantially adjacent to the sealed vessel or branch, and activating the severing device, whereby the sealed vessel or branch is severed.

[0019] The multi-function device allows the clinician to have several different operating choices: i) the first and second clipping devices are actuated substantially simultaneously; ii) either the first or the second clipping devices are actuated sequentially; iii) same as i) but followed by the severing device; and, iv) same as ii) but followed by the severing device.

[0020] Also, in certain embodiments, the multi-function device further includes a light source and an imaging system

and/or an insufflation device for supplying a gas subcutaneously to an area adjacent to the vessel to be dissected and harvested.

[0021] Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. **1** is a structure diagram, broken away and partially in phantom, showing a handle portion and a tip or distal end of one embodiment of a multi-function device.

[0023] FIG. **2** is a structure diagram, partially in phantom, showing an enlarged view of the distal end of the multi-function device.

[0024] FIG. **3** is a structure diagram of one embodiment, partially in phantom, of a portion of the distal end of the multi-function device.

[0025] FIG. **4** is a structure diagram of one embodiment of a distal end of a multi-function device and further having a dissecting tip in an open position.

[0026] FIG. **5**A is a structure diagram, in a perspective view, showing one embodiment of an engagement mechanism for the clipping devices.

[0027] FIG. **5**B is a structure diagram, in a side elevational view, of the embodiment shown in FIG. **5**A.

[0028] FIG. **6**A is a structure diagram, shown in a top view, of the embodiment of FIG. **5**A where a first clipping device is being contacted.

[0029] FIG. **6**B is a structure diagram, shown in a top view, of the embodiment of FIG. **5**A where a second clipping device is being contacted.

[0030] FIG. **6**C is a structure diagram, shown in a top view, of the embodiment of FIG. **5**A where first and second clipping devices are being contacted.

[0031] FIG. **7**A is a structure diagram, shown in an end elevational view, of the embodiment of FIG. **5**A where a first clipping device is being contacted.

[0032] FIG. **7**B is a structure diagram, shown in an end elevational view, of the embodiment of FIG. **5**A where a second clipping device is being contacted.

[0033] FIG. **7**C is a structure diagram, shown in an end elevational view, of the embodiment of FIG. **5**A where first and second clipping devices are being contacted.

[0034] FIG. **8** is a structure diagram, in a side elevational view, of another embodiment of an engagement mechanism for the clipping devices and for the severing device.

[0035] FIG. **9**A is a structure diagram, shown in an end elevational view, of the embodiment of FIG. **8** where a first clipping device and the severing device are being contacted.

[0036] FIG. **9**B is a structure diagram, shown in an end elevational view, of the embodiment of FIG. **8** where a second clipping device and the severing device are being contacted.

[0037] FIG. **9**C is a structure diagram, shown in an end elevational view, of the embodiment of FIG. **8** where first and second clipping devices and the severing device are being contacted.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0038] There is provided herein a multi-function device **10** and a system for using such device. The multi-function device is useful for clipping the branches closed and then cutting the clipped branches during the actual harvesting procedure. The multi-function device **10** provides a less expensive and faster system for the harvesting of a vessel. In one particular aspect, the multi-function device **10** eliminates the need for a subsequent tying or clipping procedure of the harvested vessel once the vessel is outside the body. The multi-function device **10** also decreases the amount of time the harvested vessel is outside the patient's body.

[0039] Referring now to FIG. **1**, one embodiment of a multi-function device **10** for harvesting a vessel V and for severing branches B from the vessel V is schematically illustrated.

[0040] The multi-function device **10** includes a handle **11** and an elongated sheath **12**. The sheath **12** defines an inner space **14** and has a proximal end **16** and a distal end **18**. The multi-function device **10** includes first and second clipping devices **20** and **22** that are axially positioned within the sheath **12**.

[0041] In certain embodiments, the handle **11** can include an orientation member **13** that allows rod portion of sheath **12** to be rotated about its axis, as shown by arrow **13**-A, so that the clinician can maneuver the distal end **18** to the desired position within the patient.

[0042] The first and second clipping devices **20** and **22** generally have first and second proximal ends **21** and **23**, respectively, that are mounted in the handle **11**, as further explained below.

[0043] The first and second clipping devices **20** and **22** are axially aligned in a parallel relationship within the sheath **12**. The first clipping device **20** is configured to apply a first surgical clip **32** and to close the surgical clip **32** around a selected portion of the branch B or vessel V. Similarly, the second clipping device **22** is configured to apply a second surgical clip **33** and to close the surgical clip **33** around an adjacent selected portion of the branch B or vessel V.

[0044] Referring now to FIGS. **1** and **2** in particular, the first and second clipping devices **20** and **22** will be described in detail. In the embodiment shown, each clipping device **20** and **22** has the same configuration. It is to be understood, however, that in certain embodiments, it may be desired that the clipping devices **20** and **22** can each have a configuration to deliver different types of clips. For ease of illustration herein, however, the first and second clipping devices **20** and **22** are shown herein as having the same configuration, and only one will be described in detail.

[0045] It should be noted, however, that non-limiting examples of suitable clipping devices include the Ligaclip MCA® and Ligaclip Allport® made by Ethicon Endo-Surgery Inc. of Cincinnati, Ohio, the Weck® Hemoclip® made by Teleflex of Research Triangle Park, N.C., and the Surgiclip® AutoSuture made by United States Surgical of Norwalk, Conn. It is to be understood that there are different mechanisms for the application of the clips within the clipping devices and that such mechanisms can be used with the embodiments described herein. As such, while various types of clipping devices are useful in the multi-function device **10**, illustrated herein is one such suitable clipping device where the clipping device **20** generally includes a clip dispensing mechanism **26**.

[0046] The clip dispensing mechanism **26** is configured to advance the surgical clip **32** along a cartridge or channel **25** that holds a plurality of clips. The dispensing mechanism **26** is configured to receive and position the surgical clip **32** around a vessel V or branch B.

[0047] During use of the multi-function device **10**, the distal end **18** of the sheath **12** is positioned adjacent the vessel V or branch B. The clip dispensing mechanism **26** receives the advancing surgical clip **32**, at least momentarily holds the clip **32** in a ready position, and then pinches or closes the clip **32** about the branch B.

[0048] In the embodiment shown in the FIGURES, the clip dispensing mechanism **26** includes opposing first and second sealing members **34** and **36**. The first sealing member **34** is configured to be moved between open and closed positions as shown by arrow **34**-A. In use, when in an open position, a space S is defined between the first and second sealing members **34** and **36**. The first and second sealing members **34** and **36** are positioned around portions of the branch B. Once that portion of the branch B is in the space S between the first and second sealing members **34** and **36**, the clip dispensing mechanism **26** is actuated, thereby delivering a clip **32** to seal the branch B. As shown in FIGS. **1** and **2**, the first and second clipping devices **20** and **22** are activated to dispense separate surgical clips **32** and **33** onto separate portions B-**1** and B-**2** of the branch B.

[0049] In certain embodiments, one or more of the sealing members **34** and **36** can have engaging faces **35** and **37**, respectively, that are configured to aid in securing the branch to prevent the branch from slipping during the positioning of the clip **32** in the clipping step.

[0050] In certain embodiments, the first and second clipping devices **20** and **22** are positioned within the sheath **12** such that the first and second clips **32** and **33** are separated by about a centimeter or less on the branch B. For example, in the use of such embodiments, the first clip **32** can be applied at a portion of the branch B that is right next to the main vessel V (i.e., the graft vessel side), and the second clip **33** can be applied roughly a centimeter or less further down the branch (i.e., the patient side). Also, during certain procedures, it is desired that the first, or graft-side, clip **32** be positioned as close as possible to the main vessel V. The close positioning of the surgical clip **32** to the longitudinal axis of the harvested vessel V is done in order to provide a smooth and continuous flow path in the main vessel's inner diameter, thereby avoiding flow turbulence once the vessel has been grafted into place.

[0051] In one particular embodiment, first and second clipping devices **20** and **22** are engaged substantially simultaneously so that two clips **32** and **33** are applied in a single actuation step.

[0052] As best seen in FIGS. **2** and **3**, the multi-function device **10** includes a severing device **40** that is also axially positioned within the sheath **12**. It is to be understood that various types of severing devices can be used in the multi-function device **10** and that non-limiting examples of suitable severing devices include a knife blade, as illustrated herein, a radio-frequency powered bovie, an ultrasonic cauterizing tool, or a bipolar electrocautery tool.

[0053] In the embodiment shown in the FIGURES herein, the severing device **40** includes a cutting tool **42** on a distal end **44** of an axially extending rod **46**. The severing device **40** is activated by axially extending cutting tool **42** as shown by arrow **40**-A. In use, the cutting tool **42** is maneuvered adjacent to the captured branch portions B-**1** and B-**2**. The cutting tool **42** is then advanced in a direction between the first and second surgical clips **32** and **33**.

[0054] In certain embodiments, the severing device **40** can be actuated just after the surgical clips **32** and **33** are applied. It is also within the contemplated scope of the system described herein that the multi-function device **10** can also be used to clip the patient sides of the main vessel once the vessel branches have bee sealed, and then cut the ends of the main vessel. This procedure is colloquially called a "stab and grab" phase of the harvesting procedure. In such uses, the first and second clipping devices provide additional gripping and holding of the vessel being grabbed and removed and only the patient-side clipping device is actuated. (The ends of the graft should remain unobstructed).

[0055] It is also contemplated that the multi-function device **10** can be used in a suturing manner by the clinician. In such procedures, the multi-function device **10** can be used after harvesting a graft from the patient. The harvested graft can be further clipped or tied (sutured) to close the graft's branch stubs even if they have been sealed during harvesting via electrocautery, ultrasonics, etc., as a further precaution against leaks or ruptures of the harvested vessel.

[0056] Also, in certain situations, when the harvested vessel is examined by the clinician, there can be a determination that the harvested vessel should be modified for final use in the grafting procedure. In such situations, the multi-function device can be again used to dispense a surgical clip close to the patient side of the vessel and to further trim any excess branch portion from the vessel.

[0057] Referring again to the FIGURES, and in particular to FIGS. **2** and **3**, in certain embodiments, the multi-function device **10** includes a vision system **50**. In the embodiment shown, the vision system **50** is illustrated as an endoscope, as currently utilized in Terumo CVS's Virtuosaph® endoscope device. In such embodiment, the endoscope is hard-wired to a video output monitor (not shown). In other embodiments, the vision system **50** can be a wireless camera sensor sometimes also referred to as "chip on the tip" technology. In such embodiment, the wireless vision system helps preserve valuable space within the sheath **12**.

[0058] In the embodiment shown in FIGS. **2** and **3**, the imaging system **50** is positioned within the sheath **12**. The imaging system **50** has a lens **52** and a suitable image-receiving device (not shown) that converts images into signals for transmission, recording and/or storage, and/or takes photographs of such images. During use, the imaging system **50** is operated so that an image beyond the distal end **18** of the sheath **12** is visible when the branch B is being clipped and severed from the vessel V.

[0059] In certain embodiments, the vision system **50** can also include a wiper **54** that is positioned on a wiper rod **58** (shown in FIG. **1**). The wiper rod **56** is axially positioned in the sheath **12** and is connected to a wiper switch **56**. The wiper rod **56** with the wiper **54** attached thereto extends from the distal end **18** of the sheath **12**. The wiper **54** is adjacent to the lens **52** and is at least partially pivotable about a longitudinal axis extending through the rod **56** (as shown by arrow **54**-A in FIG. **2**). The wiper **54** can be pivotably moved across the lens **52** when needed in order to clear any fluids or debris away from the lens **52**.

[0060] In certain embodiments, the multi-function device **10** further includes an insufflation device **60**. The insufflation device **60** is configured to supply a gas subcutaneously to an area adjacent to the vessel or branch. The insufflation device **60** can be axially positioned within the inner space **14** of the sheath **12**. The insufflation device **60** includes a supply (not shown) of a suitable gas that is supplied into the sheath **12**. In certain embodiments, as shown in FIGS. **2** and **3**, the insuf-

flation device **60** can have a supply line **62** having a discharge end **64**. In certain embodiments, the discharge end **64** of the supply line **62** is located near the distal end **18** of the sheath **12**. The sheath **12** can include one or more discharge ports or holes **66** that are in communication with the inner space **14**. The gas escaping from the ports **66** enters the patient and keeps the surrounding tissue away from the vessel and branch.

[0061] Also, in certain embodiments, as shown in FIG. **4**, the multi-function device **10** can further include a dissector tip **80** that is axially positioned over the distal end **18** of the sheath **12**. At least a portion of the dissector tip **80** is transparent in order to allow visualization of the vessel V and the surrounding tissue, as further explained below. As best seen in FIG. **4**, the dissector tip **80** can include two or more dissecting tip members **82** and **84** that define an inner space **85**. The dissecting tip members **82** and **84** are movable between an open position and a closed position, as shown by arrow **82**-A. When the dissector tip **80** is in the open position the first and second clipping devices **20** and **22** are in an exposed position.

[0062] At least one of the tip members **82** and/or **84** can have a conical or other tapered shape to aid in the harvesting of a vessel.

[0063] To begin the dissection procedure, the dissector tip **80** is inserted through an initial incision in the patient. In operation, the dissector tip **80** is pressed into the tissues surrounding the vessel, thereby forming a tunnel or cavity around the vessel. In certain embodiments, it is desired that the dissector tip **80** be pressed into the surrounding tissue generally along the direction of the vessel in order to separate the vessel from adjacent tissue without damage to the vessel or the surrounding tissue.

[0064] Upon inserting the multi-function device **10** under the patient's skin, it is possible to obtain an image illuminated by the vision system **50**. The dissector tip **80** is used to perform an initial, or blunt, dissection of the vessel from the surrounding tissue. The tip members **82** and **84** are then moved to the open position, as illustrated in FIG. **4**.

[0065] The first and second clipping devices **20** and **22** are activated to seal the branch portions B-**1** and/or B-**2**. The severing device **40** is moved to a position substantially adjacent to the sealed branch portions B-**1** and B-**2**. The severing device **40** is activated, thereby severing the branch B from the vessel V.

[0066] It is also within the contemplated scope of the various embodiments described herein that one or more of the clipping devices **20** and **22** can have a two-step firing procedure. In such embodiments, at least one or more of the first and second clipping devices **20** and **22** can be advanced to a gripping position adjacent to the vessel or branch to be sealed and cut. In a first step, the branch is first grabbed, and optionally, at least temporarily constricted. In a second step, a final decision is made to proceed with the actual clipping of the branch B and the clip is delivered to seal the branch.

[0067] Referring now to FIGS. **1** and **5**-**7**, one embodiment of a suitable clip dispensing mechanism **26** is schematically illustrated. The clip dispensing mechanism **26** is enclosed within the handle **11**. The clip dispensing mechanism **26** is positioned adjacent to the proximal ends **21** and **23** of the clipping devices **20** and **22**, respectively.

[0068] In the embodiment shown, a first spring **90** is axially positioned over the first proximal end **21** of the first clipping device **20**. The first proximal end **21** terminates at a first flange **91**, against which the first spring **90** is biased. Similarly, a second spring **92** is axially positioned over the second proximal end **23** of the second clipping device **22**. The second proximal end **21** terminates at a second flange **93**, against which the second spring **92** is biased.

[0069] The clip dispensing mechanism **26** includes a movable housing **100** that is operatively mounted in the handle **11**. The movable housing **100** has a first opening **102** through which a guide bar **104** extends. As best illustrated in FIG. **6**A, the guide bar **104** has axially opposing first and second ends **106** and **108** that are pivotably secured in opposing detents **110** and **112** in the handle **11**. The movable housing **100** is slideably movable along a longitudinal axis A that extends through the guide bar **104** between the first and second ends **106** and **108**.

[0070] The movable housing **100** also has a second opening **122** through which a pivot bar **124** extends. The pivot bar **124** has axially opposing first and second ends **126** and **128** that are held in detents **113** and **114** in the handle **11**. The movable housing **100** is slideably movable along a longitudinal axis B that extends through the pivot bar **124** between the first and second ends **126** and **128**. The movable housing **100** is also pivotably movable about the axis B in a direction toward the first and second proximal ends **21** and **23** of the clipping devices **20** and **22**, as further explained below.

[0071] The movable housing **100** is thus: i) slideably movable along the longitudinal axis A extending through the guide bar **104**; ii) slideably movable along the longitudinal axis B extending through the pivot bar **124**; iii) pivotably movable about the longitudinal axis B through the pivot bar **124**; and, iv) can be pivotably movable about its axis.

[0072] As best shown in FIGS. **5**A and **5**B, the movable housing **100** includes a hammer **140** having a contact face **141**. When not in use, the hammer **140** is in a spaced apart relationship to the first and second proximal ends **21** and **23**. The contact face **141** extends in a planar direction C. The plane C, defined by the contact face **141**, extends in a direction that is parallel to the axes A and B that extend through the guide bar **104** and the pivot bar **124**, respectively. The contact face **141** has a lower, or leading edge **142** and an upper, or trailing, edge **144**. The leading edge **142** is positioned at a first distance from the flanges **91** and **93**, and the trailing edge **144** is positioned at a second, greater distance from the flanges **91** and **93**. As the movable housing **100** is pivoted about the axis A of the pivot bar **124**, first the leading edge **142** and then the trailing edge **144** contact at least one of the flanges **91** and/or **93**.

[0073] In FIGS. **6**A and **7**A, the movable housing **100** is shown as being positioned or moved to the second end **108** of the guide bar **104** and to the second end **128** of the pivot bar **124**. When the movable housing **100** is pivoted about the axis B, the contact face **141** is rotated in a direction toward the first flange **91** of the first clipping device **20**. The pivotal rotation of the movable housing **100** causes the leading edge **142** and then the trailing edge **144** of the contact face **141** to contact the first flange **91**, thereby compressing the first spring **90**. In this manner, the first clipping device **20** is actuated and the surgical clip **32** is dispensed from the clip dispensing mechanism **26** onto the first branch portion B-**1**.

[0074] In FIGS. **6**B and **7**B, the movable housing **100** is shown as being positioned or moved to the first end **106** of the guide bar **104** and to the first end **126** of the pivot bar **124**. When the movable housing **100** is pivoted about the axis B, the hammer **140** is rotated in a direction toward the second flange **93** of the second clipping device **22**. The pivotal rota-

tion of the movable housing **100** causes the leading edge **142** and then the trailing edge **144** of the contact face **141** to contact the second flange **93**, thereby compressing the second spring **92**. In this manner, the second clipping device **22** is actuated and the surgical clip **33** is dispensed from the clip dispensing mechanism **26** onto the second branch portion B-**2**.

[0075] In FIGS. **6**C and **7**C, the movable housing **100** is moved to a midpoint on the guide bar **104** and to a midpoint on the pivot bar **124**. When the movable housing **100** is pivoted about the axis B, the contact face **140** is rotated in a direction toward both the first flange **91** and the second flange **93** on the first and second clipping devices **20** and **22**, respectively. The pivotal rotation of the movable housing **100** causes the leading edge **142** and then the trailing edge **144** of the contact face **141** to contact the both the first and second flanges **91** and **93**, thereby compressing both the first and second springs **90** and **92**, respectively. In this manner, both the first and second clipping devices **20** and **22** are substantially simultaneously activated, and the surgical clips **32** and **33** are dispensed onto the first and second branch portions B-**1** and B-**2**.

[0076] Referring now to FIGS. **8** and **9**, the clip dispensing mechanism **26** is shown as also activating the severing device **40**. At least the rod **46** of the severing device **40** is in an axial alignment with the first and second cutting devices **20** and **22**. In the embodiment shown in FIGS. **8** and **9**, the severing device **40** has the cutting tool **42** at a distal end of the rod **46** and further includes a base member **48** at a proximal end of the rod **46**. The base member **48** extends radially from the rod **46** such that the base member **48** rod is in a planar relationship with the contact face **141** of the hammer **140**. The base member **48** has opposing first and second ends **47** and **49**, respectively

[0077] In the configuration shown in FIG. **9**A, the pivotal rotation of the movable housing **100** will cause the leading edge **142** and then the trailing edge **144** of the contact face **141** to contact the first flange **91** on the first clipping device **20**. In this manner, as with the embodiment described above, the first clipping device **20** is activated and the surgical clip **323** is dispensed from the clip dispensing mechanism **26** onto the first branch portion B-**1**. In this configuration, the pivotal rotation of the movable housing **100** also will cause the contact face **141** to contact at least the first end **47** of the base member **48**. The continued rotation of the contact face **141** thus also causes the rod **46** to be axially moved, thereby advancing the cutting tool **42**.

[0078] Similarly, in the configuration shown in FIG. **9**B, the pivotal rotation of the movable housing **100** will cause the leading edge **142** and then the trailing edge **144** of the contact face **141** to contact the second flange **93** on the second clipping device **22**. In this manner, as with the embodiment described above, the second clipping device **22** is activated and the surgical clip **33** is dispensed from the clip dispensing mechanism **26** onto the second branch portion B-**2**. In this configuration, the pivotal rotation of the movable housing **100** also will cause the contact face **141** to contact at least the second end **49** of the base member **48**. The pivotal rotation of the contact face **141** thus also causes the rod **46** to be axially moved, thereby advancing the cutting tool **42**.

[0079] In the illustration in FIG. **9**C, the movable housing **100** is moved to a midpoint on the guide bar **104** and to a midpoint on the pivot bar **124**. When the movable housing **110** is pivoted about the axis B, the contact face **140** is rotated in a direction toward both the first flange **91** and the second flange **93**, thereby compressing both the first and second springs **90** and **92**, respectively. In this manner both the first and second clipping devices **20** and **22** are substantially simultaneously activated, and the surgical clips **32** and **33** are dispensed onto the first and second branch portions B-**1** and B-**2**. The pivotal rotation of the movable housing **100** also causes the contact face **141** to contact the base member **48**. In this manner, both of the first and second clipping devices **20** and **22** are activated to dispense the first and second surgical clip **32** and **33** substantially simultaneously. Again, the pivotal rotation of the movable housing **100** also will cause the contact face **141** to contact the base member **48**. The pivotal rotation of the contact face **141** thus also causes the rod **46** to be axially moved, thereby advancing the cutting tool **42**.

[0080] It is to be understood, that in certain embodiments, the base member **48** is contacted with the same actuating stroke as for the dispensing of the surgical clips **32** and **33**. It should be noted that the actuating stroke can be accomplished in two or more steps: the first part of the stroke closes the clipping devices **20** and **22** to grasp the branch, the second part of the stroke applies the clips **32** and **33**; and the third part of the stroke makes the cut. The actuating stroke can be controlled by the clinician so that the sequence can be interrupted and started over again, if needed.

[0081] Referring again to FIG. **8**, the rod **46** is shown as having a first length L_1 and the clipping devices **20** and **22** are shown as having a second length L_2. The length L_1 of the rod **46** can be the same, shorter or longer than the length L_2 of the clipping devices **20** and **22**. The length L_1 of the rod **46**, at least in part, determines when the contacting face **141** will strike the base member **48**. As such, the multi-function device **10** can be configured to, first, have the clipping devices **20** and **22** dispense the surgical clips **32** and **33**; and, second, have the severing device **40** be extended to sever the branch.

[0082] It is also to be understood that while the various descriptions herein are directed to use of the multi-function device **10** while being inserted into an opening in a patient, the multi-function device **10** can also be used after the vessel is harvested to clip any branch stubs on the vessel. Also, the multi-function device **10** can be used in an open procedure in addition to the endoscopic-types fully explained herein. In addition, it is to be understood that while the present description herein has been directed to the dissecting and harvesting of a vessel from a patient, that the multi-function device **10** is also useful in many other types of procedures in addition to the exemplary ones described herein.

[0083] While the invention has been described with reference to various and preferred embodiments, it should be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the essential scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed herein contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims.

What is claimed is:

1. A multi-function device for clipping and harvesting a vessel and any branches extending therefrom comprising:

a sheath configured to be at least partially inserted in a body through a cut skin portion;

a vision system positioned within the sheath;

first and second clipping devices positioned within the sheath, each clipping device configured to advance a surgical clip and to close the advanced surgical clip around the vessel or branch; and,

a severing device positioned within the sheath and configured to sever the vessel or branch.

2. The multi-function device of claim **1**, wherein the severing device is interposed between the first and second clipping devices and configured to sever the vessel or branch between the surgical clips.

3. The multi-function device of claim **1**, wherein the first and second clipping devices are in a parallel relationship within the sheath.

4. The multi-function device of claim **1**, wherein the first clipping device, the second clipping device and the severing device are in a parallel alignment within the sheath.

5. The multi-function device of claim **1**, wherein the severing device is configured to be extendible in an axial direction away from the first and second clipping devices.

6. The multi-function device of claim **1**, wherein the sheath includes a tip in an axial position over a distal end of the sheath, the tip being configured to be movable between an open position and a closed position, wherein the first and second clipping devices are in an exposed position when the tip is in the open position.

7. The multi-function device of claim **6**, wherein the tip has a distal end configured to dissect the vessel from surrounding tissue.

8. The multi-function device of claim **1**, further including an insufflation device configured to supply a gas subcutaneously to an area adjacent to the vessel or branch.

9. The multi-function device of claim **1**, wherein the severing device comprises one or more of a knife, a bovie, an ultrasonic cauterizing tool, or a bipolar electrocautery tool.

10. The multi-function device of claim **1**, further including a clip dispensing mechanism having a movable housing configured to engage at least one of the first or second clipping devices.

11. The multi-function device of claim **10**, wherein the movable housing includes a first opening through which a guide bar extends, and a second opening through which a pivot bar extends, wherein the movable housing is configured to be:

i) slidably movable along a longitudinal axis A extending through the guide bar;

ii) slidably movable along a longitudinal axis B extending through the pivot bar;

iii) pivotably movable about the longitudinal axis B through the pivot bar; and,

iii) pivotably movable about the longitudinal axis a through the pivot bar.

12. The multi-function device of claim **10**, wherein the movable housing includes a contact face that is in a spaced apart relationship to the first and second clipping devices when the multi-function device is unengaged.

13. The multi-function device of claim **10**, wherein the movable housing is configured to substantially simultaneously activate both the first and second clipping devices.

14. The multi-function device of claim **10**, wherein the movable housing is configured to: substantially activate: i) the first clipping device followed by the severing device; ii) the second clipping device followed by the severing device; or, iii) the first clipping device and the second clipping device followed by the severing device.

15. A method of clipping branches and/or vessels during harvesting from a body by a multi-function device, the multi-function device including

a sheath configured to be at least partially inserted in a body through a cut skin portion;

first and second clipping devices positioned within the sheath, each clipping device configured to advance a surgical clip and to close the surgical clip around opposing portions of the vessel or branch; and,

a severing device positioned within the sheath and configured to sever the vessel or branch,

wherein the method comprises:

inserting a distal end of the multi-function device into the body alongside the vessel to form a cavity substantially surrounding the vessel or branch;

activating the first and second clipping devices to seal the vessel or branch; and

moving the severing device to a position substantially adjacent to the clipped vessel or branch, and activating the severing device, whereby the clipped vessel or branch is severed.

16. The method of claim **15**, including

advancing the first and second clipping devices to a grasping position adjacent to the vessel or branch to be dissected, and thereafter

closing at least a distal portion of the first and second clipping devices on the vessel or branch.

17. The method of claim **15**, wherein the first and second clipping devices are actuated substantially simultaneously.

18. The method of claim **15**, wherein either the first or the second clipping devices are actuated sequentially.

19. The method of claim **15**, wherein the multi-function device further includes a light source and an imaging system, and the method further includes:

activating the light source to at least illuminate a portion of the vessel or branch; and

activating the imaging system to view at least a portion of the illuminated branch;

20. The method of claim **15**, wherein the multi-function device further includes an insufflation device, the method further including:

supplying a gas subcutaneously to an area adjacent to the vessel to be dissected and harvested.

* * * * *

专利名称(译)	多功能剪切和收割装置		
公开(公告)号	US20080255589A1	公开(公告)日	2008-10-16
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[标]申请(专利权)人(译)	心血管系统股份有限公司		
申请(专利权)人(译)	泰尔茂心血管系统股份有限公司		
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摘要(译)

一种多功能微创血管夹闭和收获装置，包括至少两个定位成将手术夹推进到组织上的夹持装置，以及定位成切断夹子之间的组织的切断装置。