US006793664B2

(12) United States Patent
Mazzocchi et al.

(10) Patent No.: US 6,793,664 B2
(45) Date of Patent: Sep. 21, 2004

(54) SYSTEM AND METHOD OF MINIMALLY-INVASIVE EXOVASCULAR ANEURYSM TREATMENT

(75) Inventors: **Rudy A. Mazzocchi**, Indian Harbor Beach, FL (US); **Thomas I. Miller**, Palm Bay, FL (US); **Kari Parmer**, Melbourne, FL (US); **Timothy Alan Parmer**, Melbourne, FL (US); **Matthew S. Solar**, Indialantic, FL (US)

(73) Assignee: **Image-Guided Neurologics**, Melbourne, FL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 7 days.

(21) Appl. No.: **09/884,434**

(22) Filed: **Jun. 19, 2001**

(65) **Prior Publication Data**

US 2002/0022837 A1 Feb. 21, 2002

Related U.S. Application Data

(60) Provisional application No. 60/212,420, filed on Jun. 19, 2000.

(51) **Int. Cl.**[7] **A61B 17/08**
(52) **U.S. Cl.** **606/157**; 606/158
(58) **Field of Search** 6/157, 158, 130; 600/411, 425

(56) **References Cited**

U.S. PATENT DOCUMENTS

535,798 A		3/1895	Hawkes	
1,352,978 A		9/1920	Lantieri et al.	
3,326,217 A		6/1967	Kerr	
3,518,993 A		7/1970	Blake	
4,024,868 A		5/1977	Williams	
4,386,602 A	*	6/1983	Sheldon et al.	606/130
4,440,170 A		4/1984	Golden et al.	
4,478,219 A		10/1984	Rozario et al.	
4,527,562 A		7/1985	Mericle	
4,681,107 A		7/1987	Kees, Jr.	
4,706,668 A		11/1987	Backer	128/325
4,943,298 A		7/1990	Fujita et al.	
4,966,603 A		10/1990	Focelle et al.	
5,174,276 A		12/1992	Crockard	128/4
5,201,746 A		4/1993	Shichman	
5,201,900 A		4/1993	Nardella	606/157
5,234,449 A		8/1993	Bruker et al.	
5,304,188 A		4/1994	Marogil	
5,354,306 A		10/1994	Garvey, III et al.	
5,520,701 A		5/1996	Lerch	

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

EP	0178469	4/1986	A61B/17/12
EP	0326426	8/1989	B29C/61/00
EP	0630615	7/1998	A61B/17/12
WO	00/19927	4/2000	A61B/19/00

OTHER PUBLICATIONS

Goodwin, S., "New Stroke Treatment: 'Aneurysm Coil' Available to Patients With Inoperable Aneurysms", http://www.emory.edu/WHSC/HSNEWS/archives/mar96/aneurysm.html, 2 p., (Mar. 25, 1996).

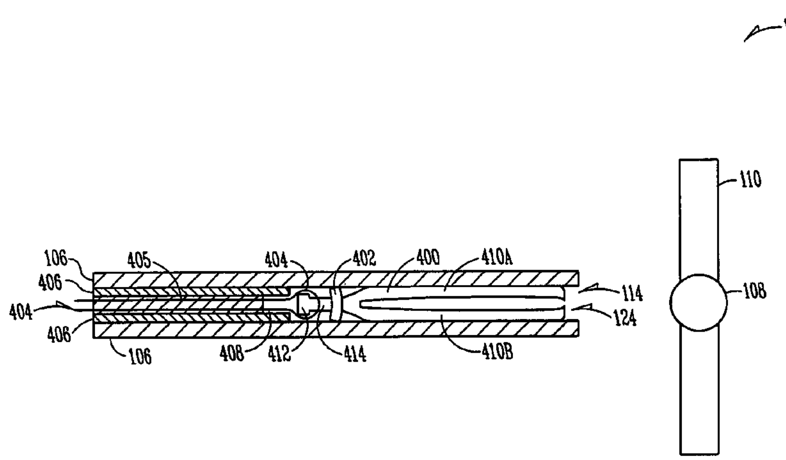
(List continued on next page.)

Primary Examiner—Michael Peffley
(74) *Attorney, Agent, or Firm*—Schwegman, Lundberg, Woessner & Kluth, P.A.

(57) **ABSTRACT**

This document discusses an exovascular approach to treating an aneurysm using a minimally-invasive instrument guided by magnetic resonance imaging (MRI), computed tomography (CT), or another suitable imaging device. A trajectory guide entry device assists in targeting the aneurysm and determining the proper trajectory thereto. Examples of the aneurysm treatment device include a clip, a clasp, a snare, a loop, a hook, a staple, and an electrocautery or other electrode, or any combination of such devices. The aneurysm treatment device is delivered by a probe, such as a tube or other catheter.

52 Claims, 12 Drawing Sheets



U.S. PATENT DOCUMENTS

5,569,274	A		10/1996	Rapacki et al.	606/158
5,634,932	A	*	6/1997	Schmidt	606/157
5,916,235	A		6/1999	Guglielmi	606/200
5,928,226	A		7/1999	Guglielmi et al.	606/32
5,941,888	A		8/1999	Wallace et al.	606/108
5,972,003	A	*	10/1999	Rousseau et al.	606/151
6,019,724	A		2/2000	Gronningsaeter et al.	600/439
6,024,695	A		2/2000	Taylor et al.	600/102
6,195,577	B1		2/2001	Truwit et al.	600/411
6,272,370	B1	*	8/2001	Gillies et al.	606/130
6,464,710	B1	*	10/2002	Foster	606/158

OTHER PUBLICATIONS

Kaut–Roth, C., "MRI Safety", http://www.t2star.com/safety_1/safety1.html, pp. 1–11, (Nov. 1996).

Martin, J.L., "Vascular Malformations of the CNS: Cerebral Aneurysms", *Surgery, the Medicine Group, Ltd., Arlington GB*, 13 (6), pp. 133–136, (Jun. 1, 1995).

Sundt, T.M., "Chapter 6: Basic Principles and Technques", *In: Surgical Techniques for Saccular & Giant Intracranial Aneurysms*, Williams & Wilkins, pp. 39–56, (1990).

* cited by examiner

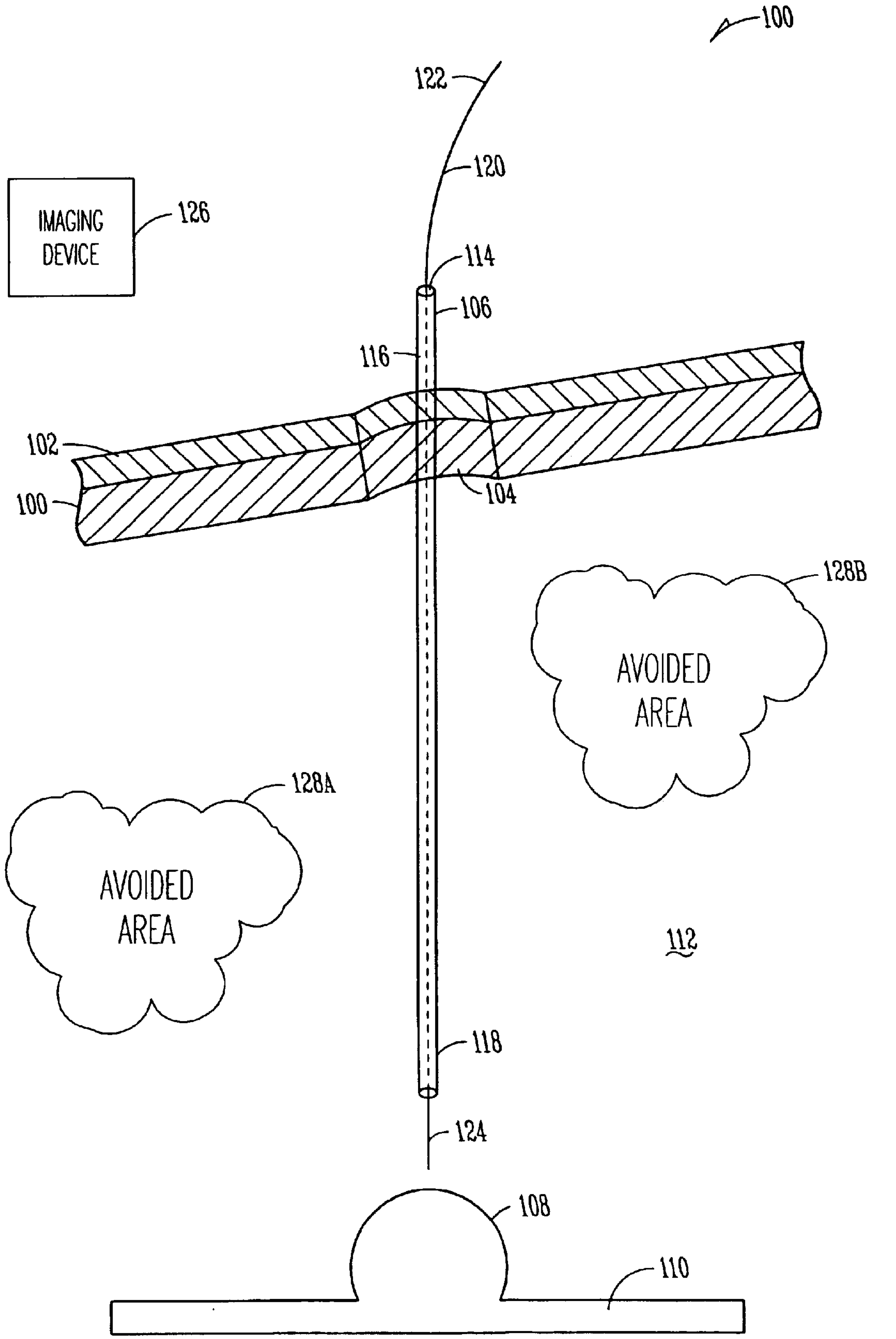

100
122
120
IMAGING DEVICE
126
114
106
116
102
100
104
128B
AVOIDED AREA
128A
AVOIDED AREA
112
118
124
108
110

FIG. 1

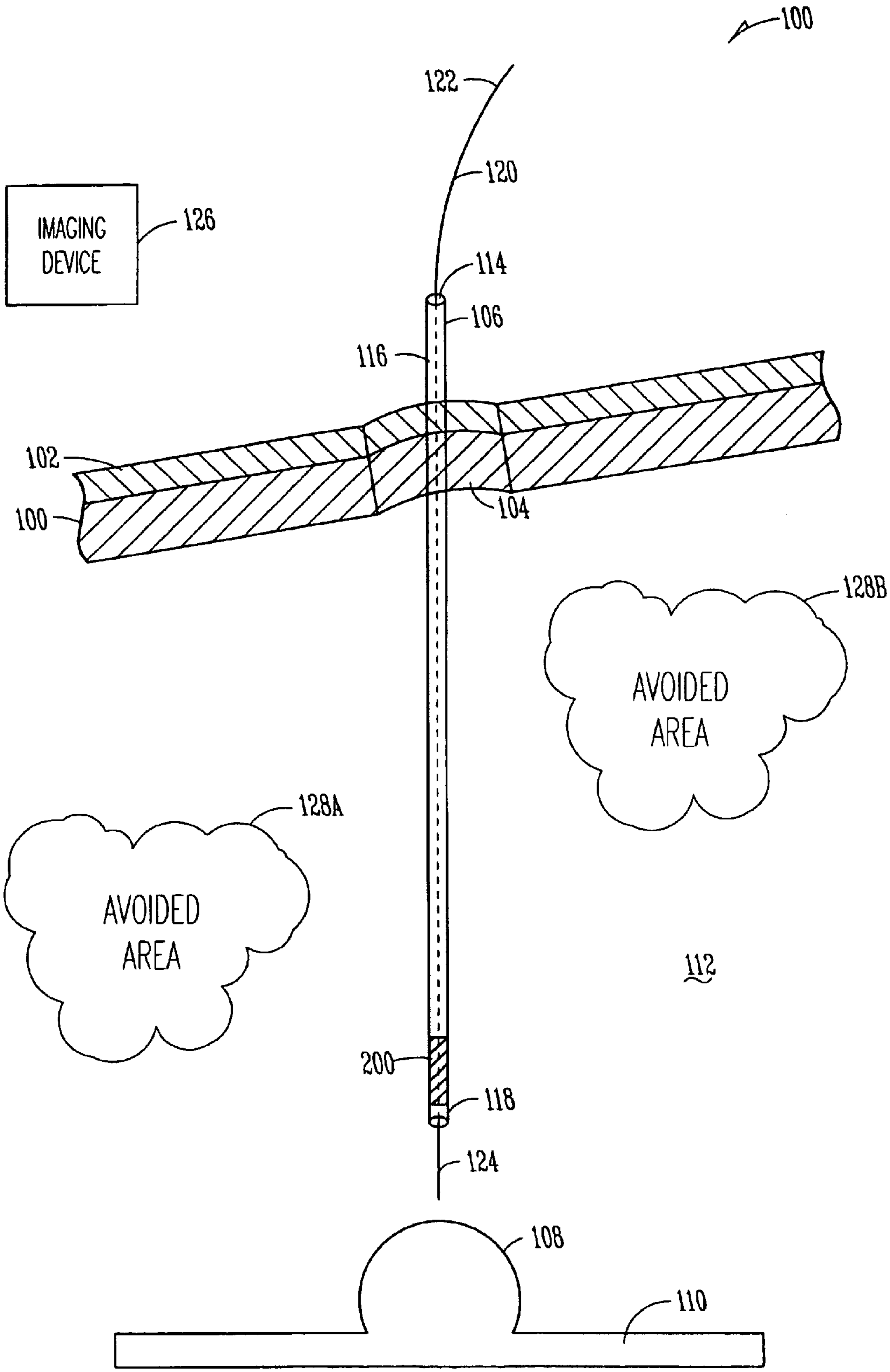

100
122
120
IMAGING DEVICE
126
114
106
116
102
100
104
128B
AVOIDED AREA
128A
AVOIDED AREA
112
200
118
124
108
110

FIG. 2

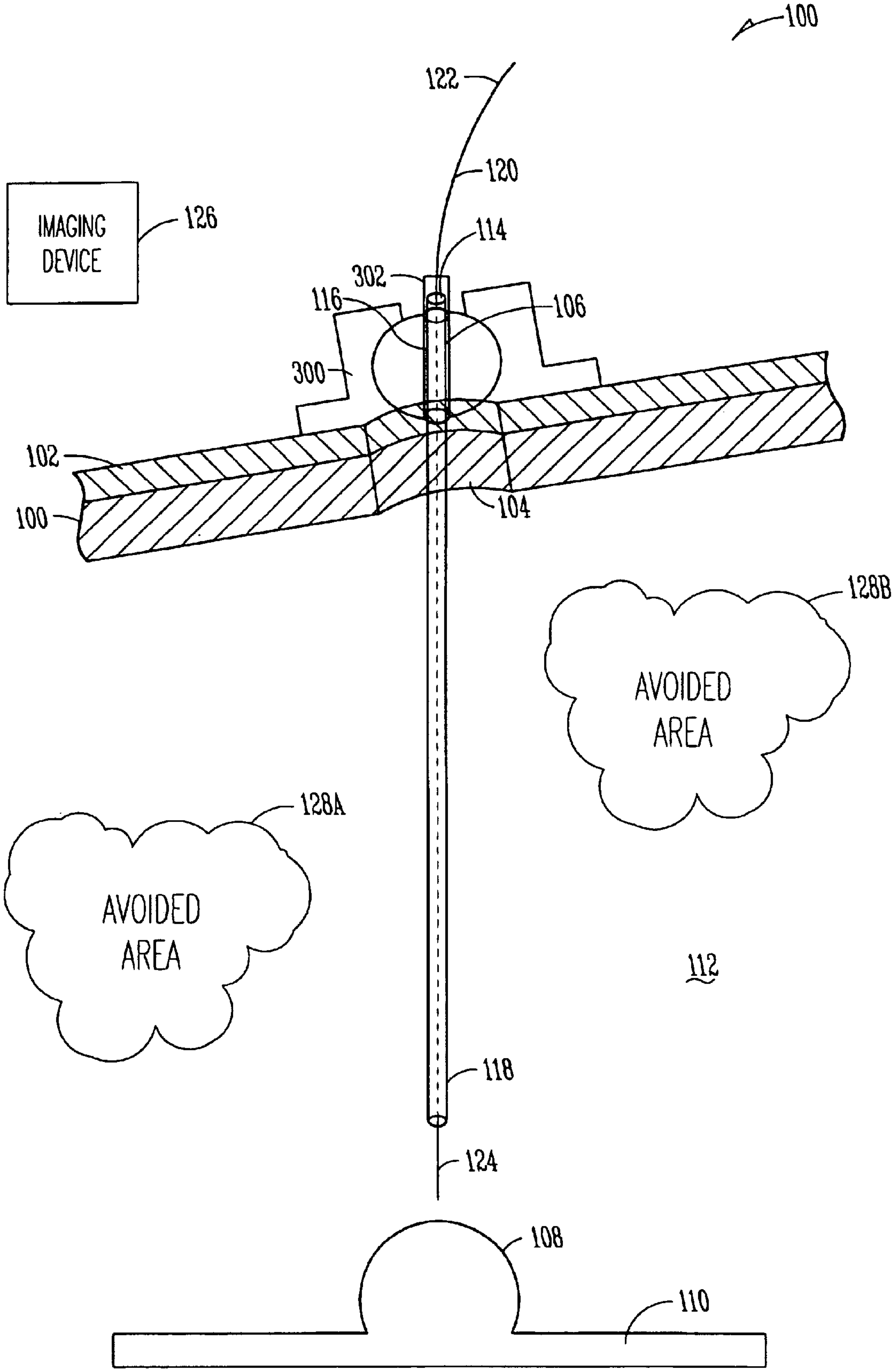

100
122
120
IMAGING DEVICE
126
114
302
116
106
300
102
100
104
128B
AVOIDED AREA
128A
AVOIDED AREA
112
118
124
108
110

FIG. 3

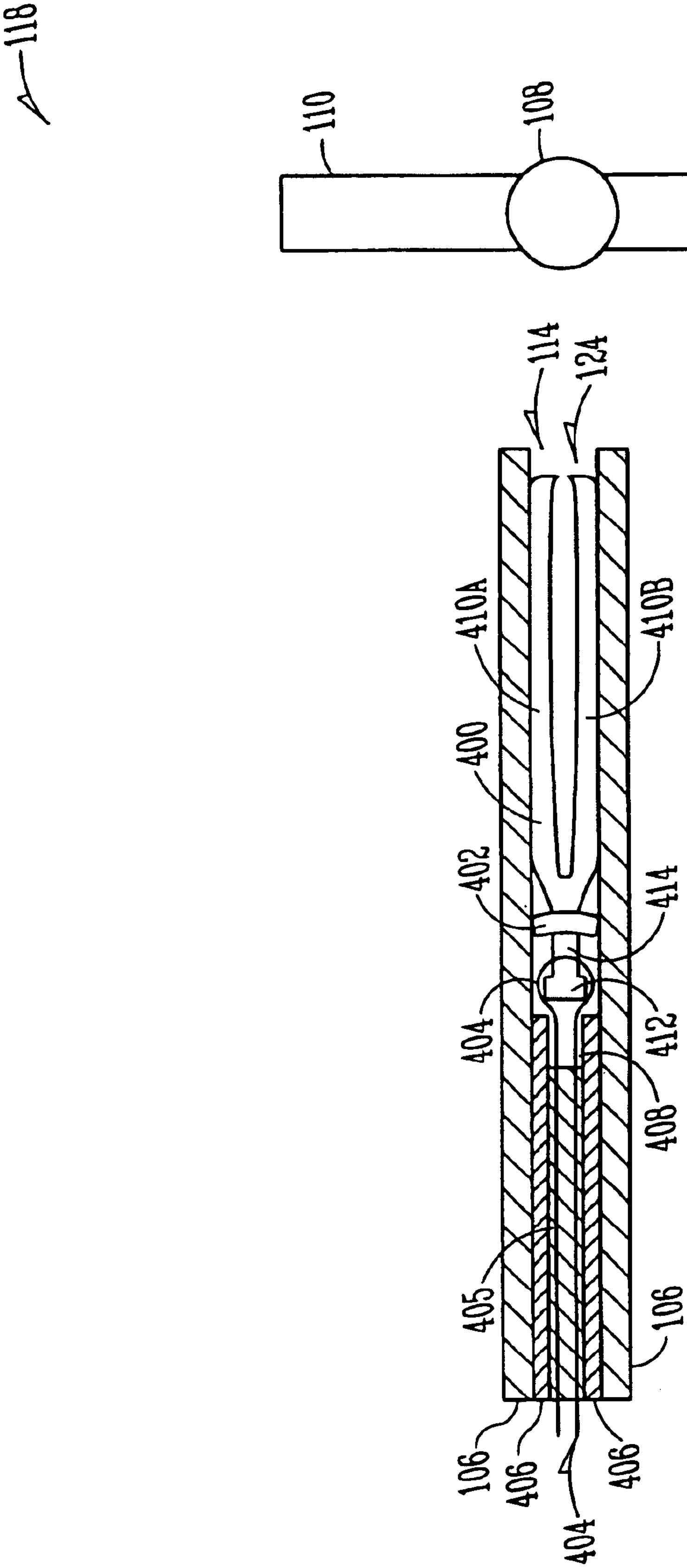

118
110
108
114
124
410A
410B
400
402
414
404
412
408
405
106
106
406
406
404

FIG. 4

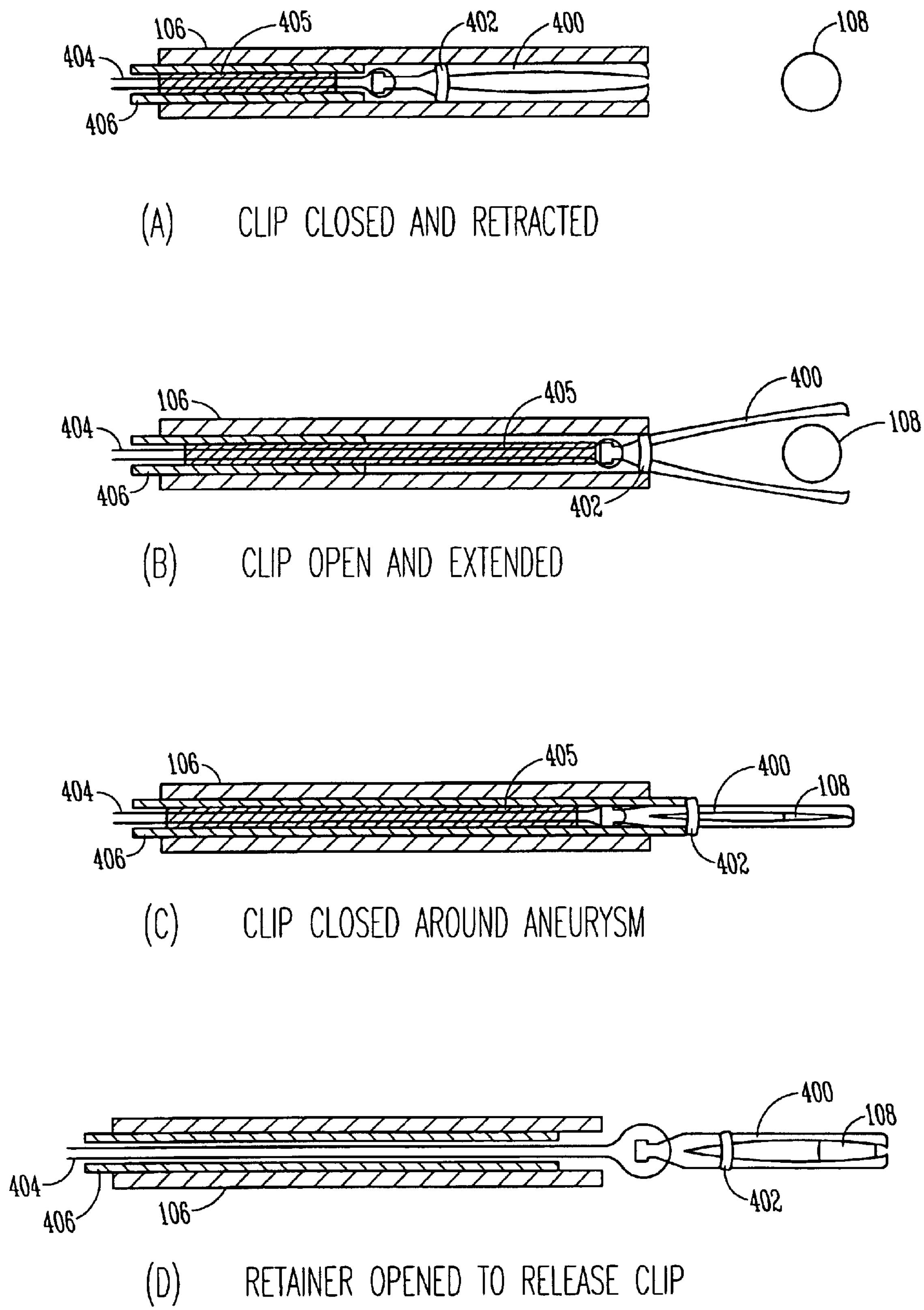

106
405
402
400
108
404
406
(A) CLIP CLOSED AND RETRACTED
106
405
400
108
404
406
402
(B) CLIP OPEN AND EXTENDED
106
405
400
108
404
406
402
(C) CLIP CLOSED AROUND ANEURYSM
400
108
404
406
106
402
(D) RETAINER OPENED TO RELEASE CLIP

FIG. 5

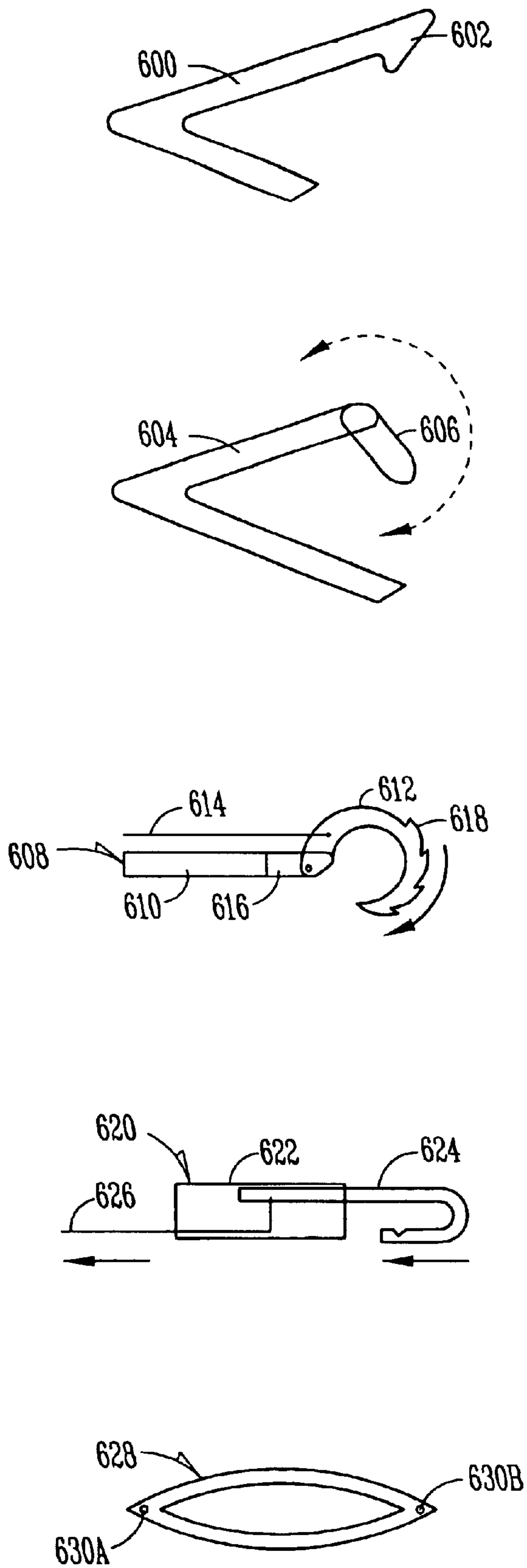

600
602
604
606
608
614
612
618
610
616
620
622
624
626
628
630B
630A

FIG. 6

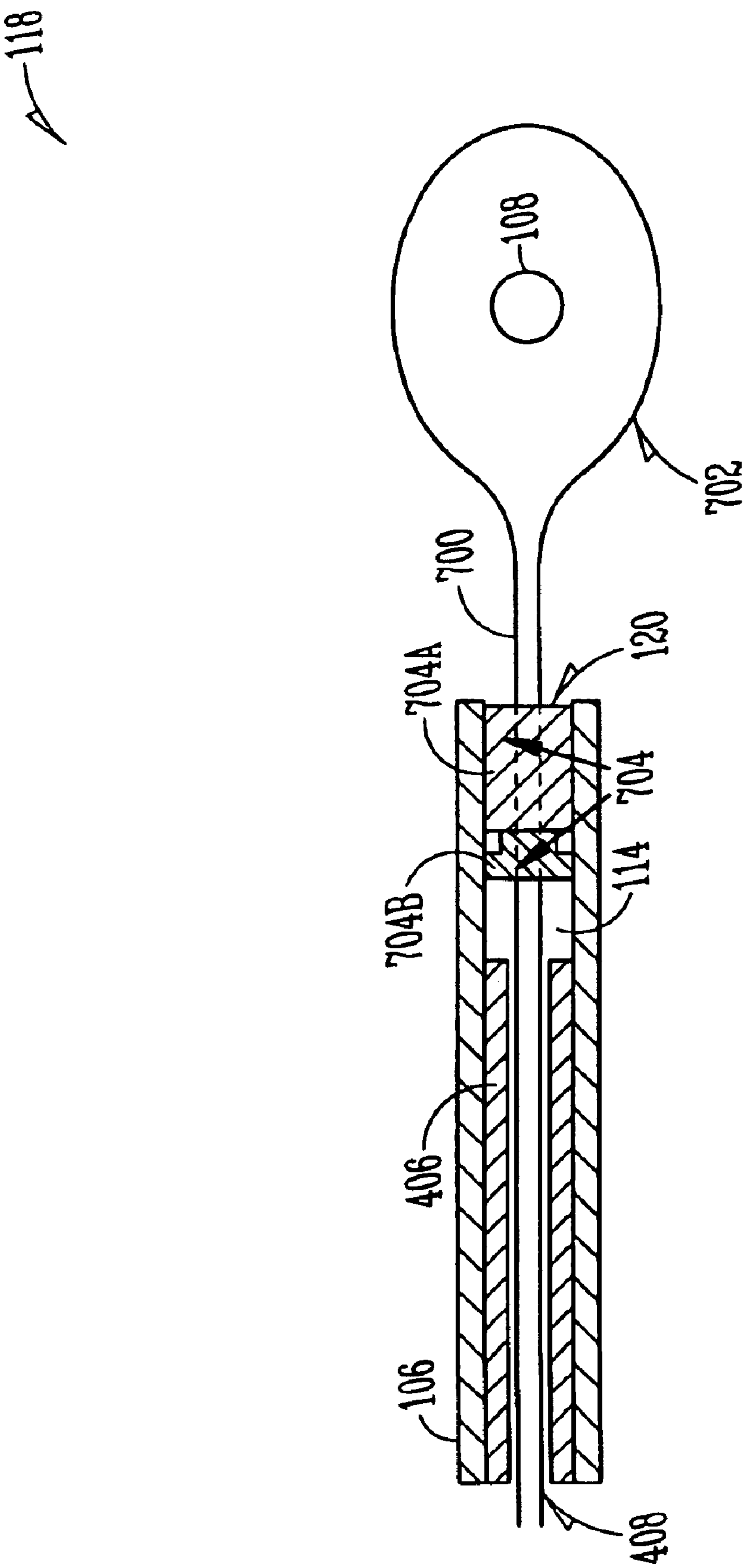


FIG. 7

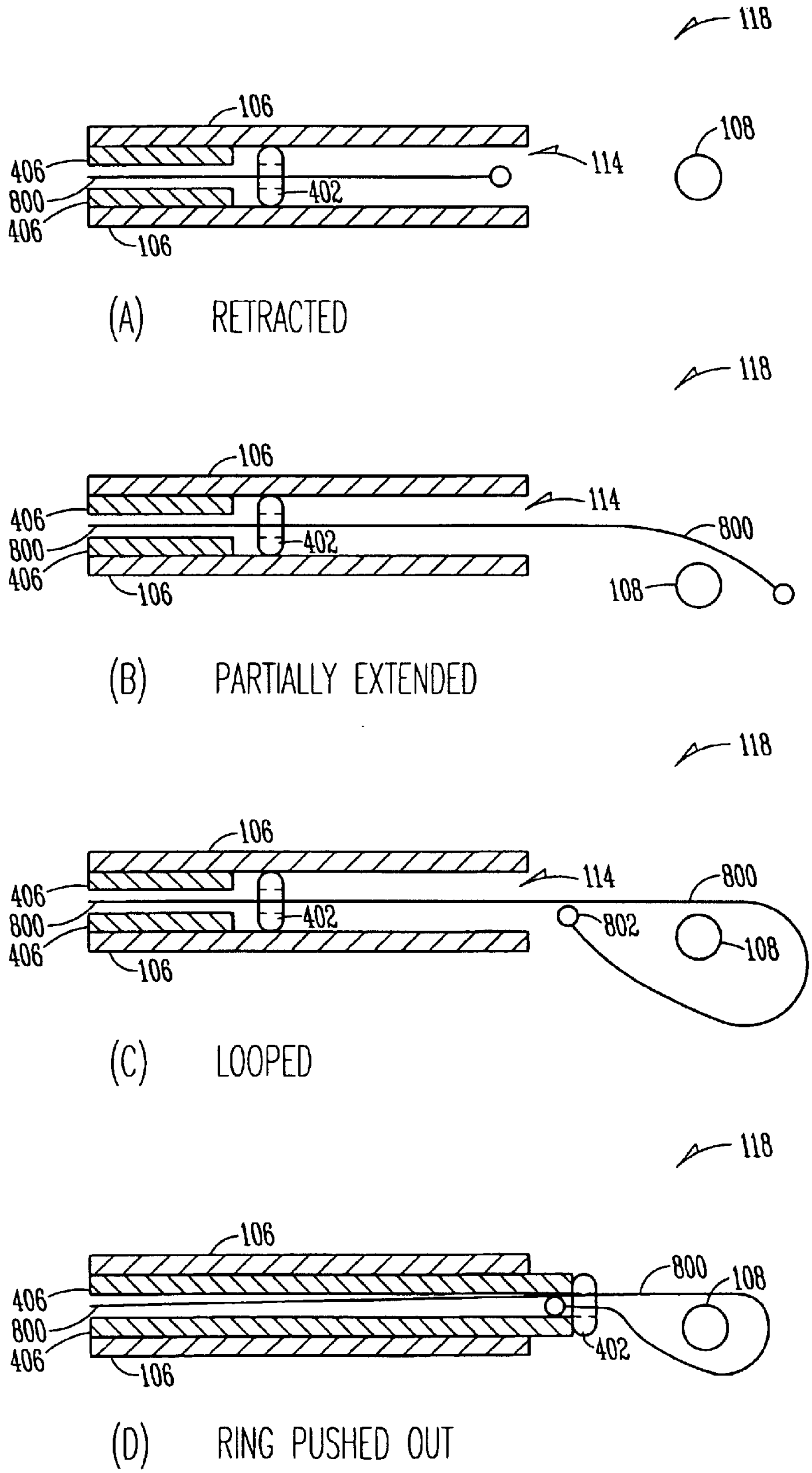

118
106
108
406
800
406
114
402
106
(A) RETRACTED
118
106
406
800
406
114
402
800
108
106
(B) PARTIALLY EXTENDED
118
106
406
800
406
114
402
800
802
108
106
(C) LOOPED
118
106
406
800
406
800
108
402
106
(D) RING PUSHED OUT

FIG. 8

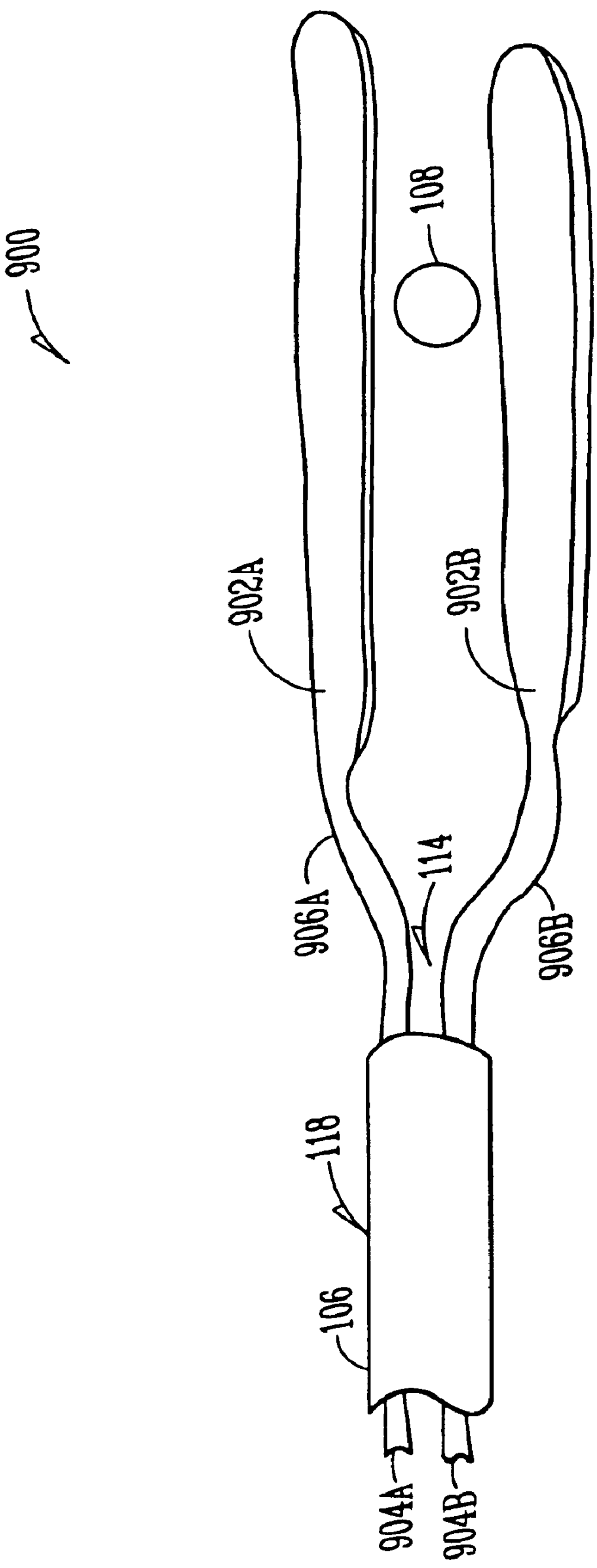


FIG. 9

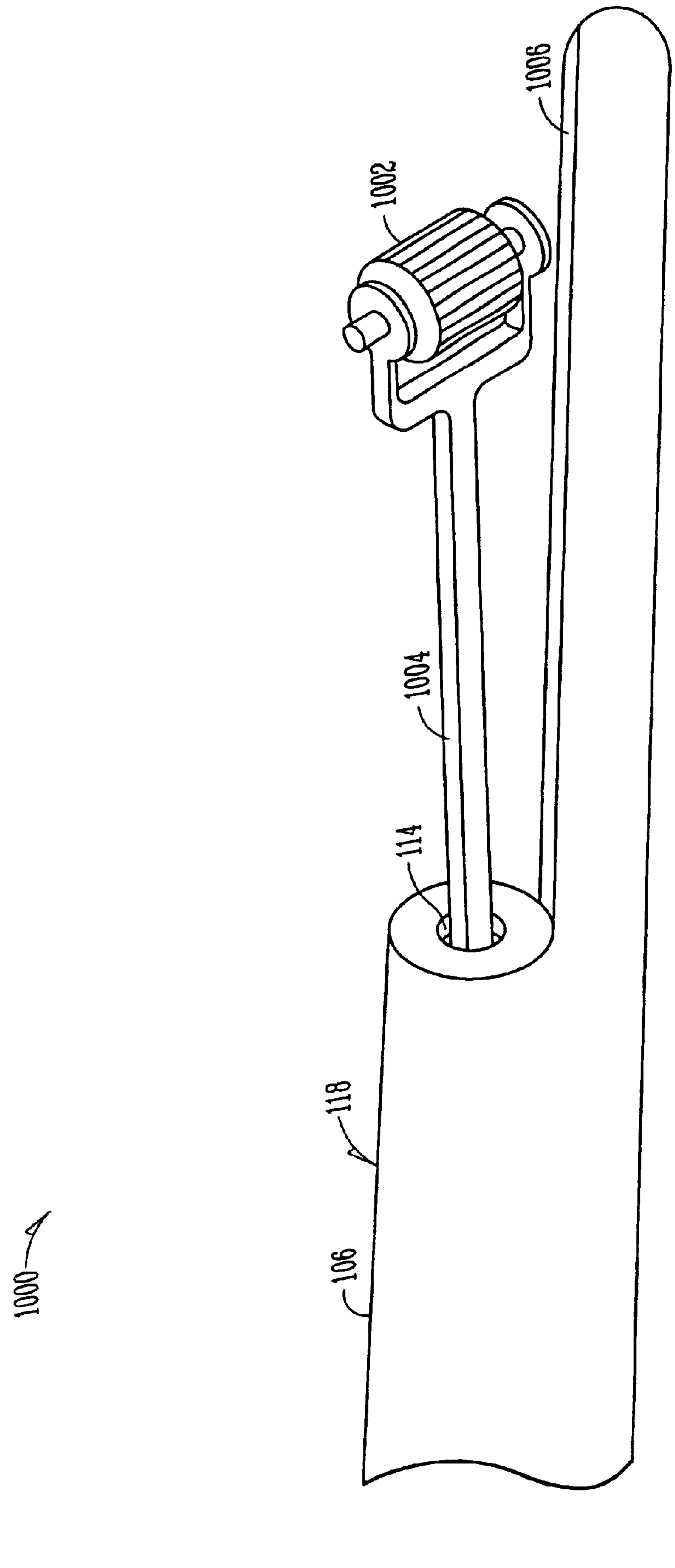


FIG. 10

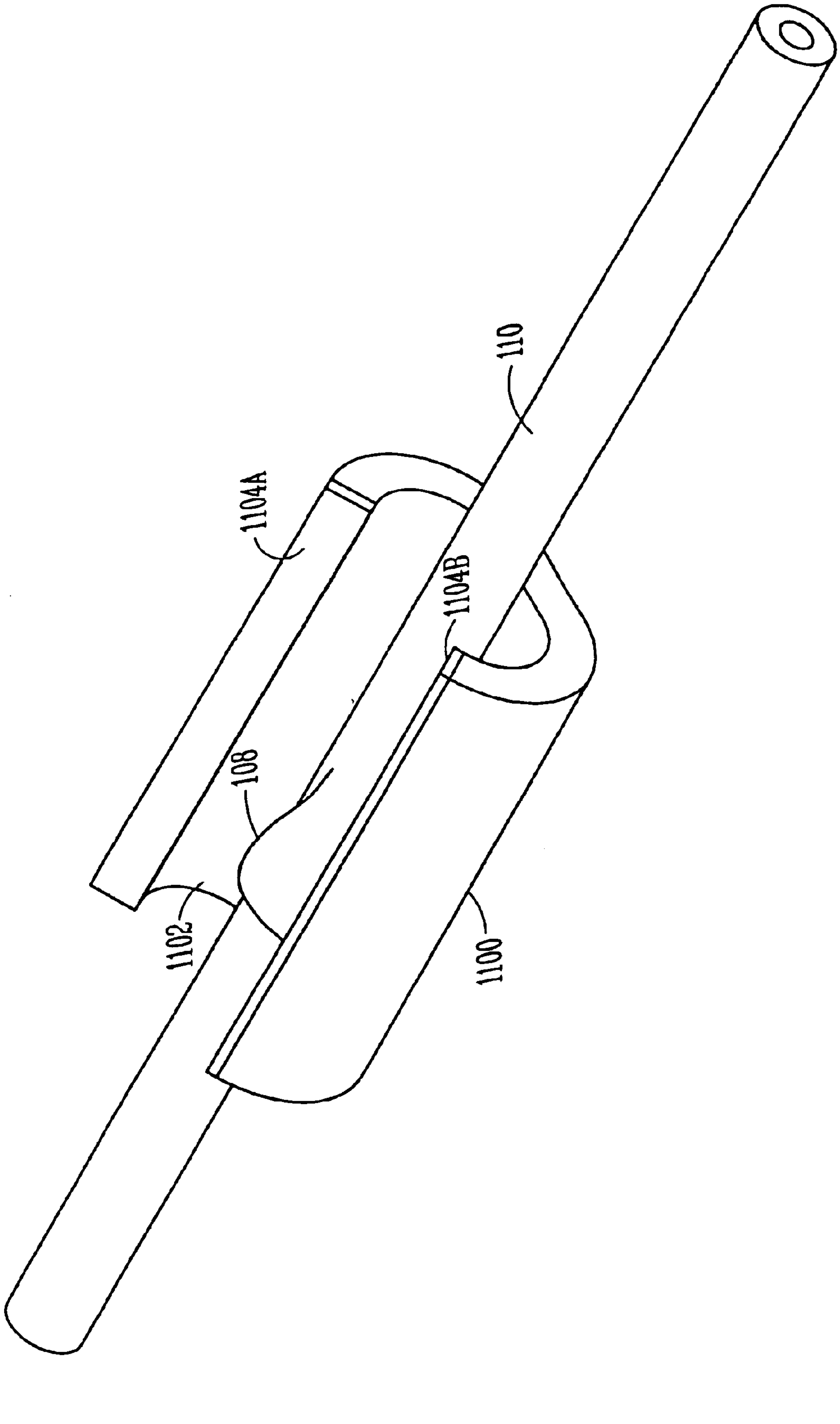


FIG. 11

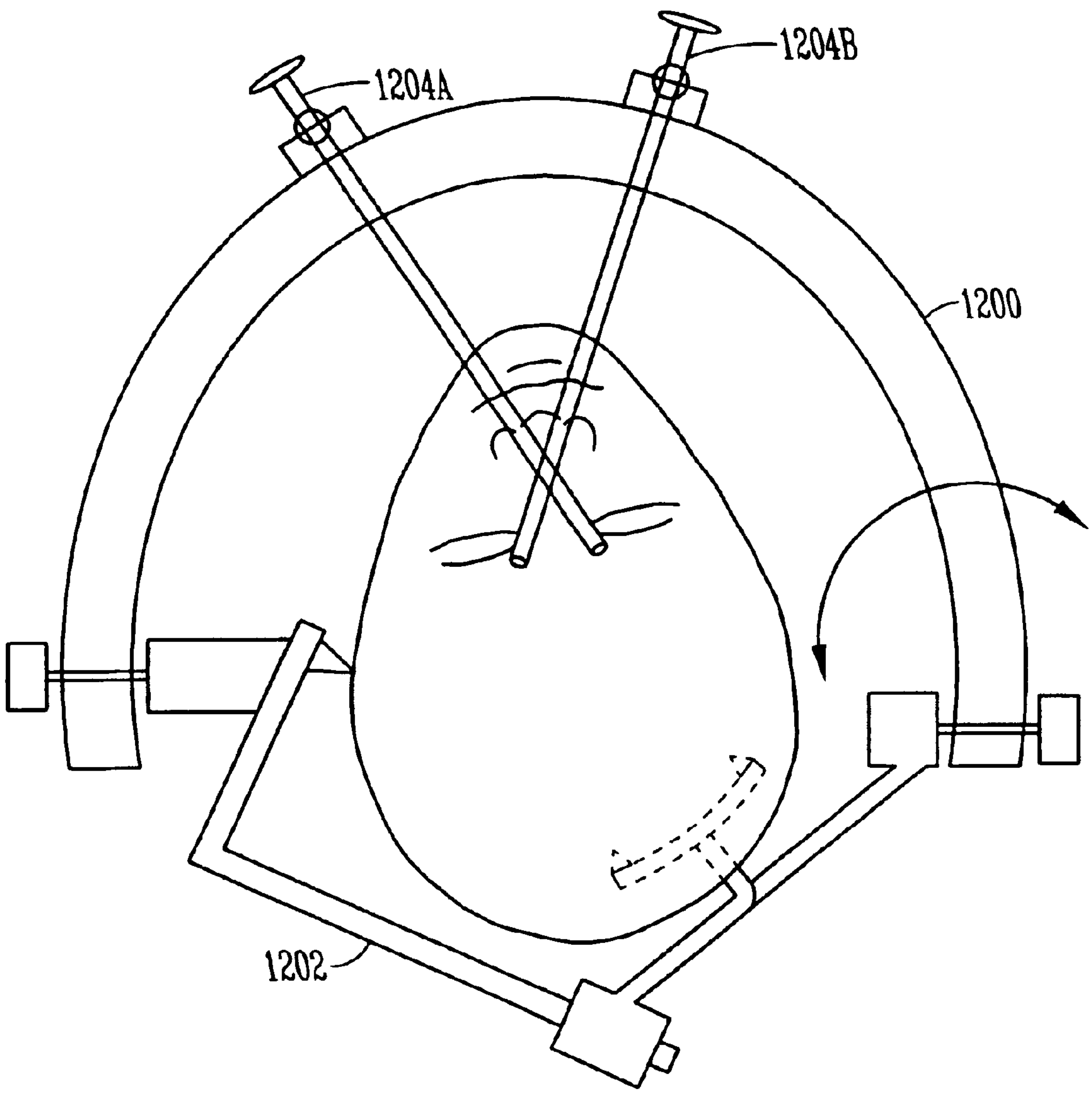


FIG. 12

SYSTEM AND METHOD OF MINIMALLY-INVASIVE EXOVASCULAR ANEURYSM TREATMENT

CROSS-REFERENCE TO RELATED APPLICATION

This patent application claims the benefit of priority, under 35 U.S.C. Section 119(e), to U.S. Provisional Patent Application Ser. No. 60/212,420, entitled “METHOD OF MINIMALLY-INVASIVE ANEURYSM CLIPPING AND APPARATUS,” filed Jun. 19, 2000, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

This document relates generally to minimally-invasive surgical systems, devices, and methods, and particularly, but not by way of limitation, to a system and method of minimally-invasive exovascular aneurysm treatment.

BACKGROUND

An aneurysm is an abnormal dilatation of a blood vessel. Brain aneurysms pose a particular risk of rupture and resulting hemorrhage, resulting in possible significant loss of brain function and even death. Autopsy studies have estimated that between about 1.5% and 8% of the population have intracranial aneurysms. Between 60,000 and 80,000 cerebral aneurysms are diagnosed annually in the U.S. Of these patients, about 20,000 to 30,000 are diagnosed following the occurrence of subarachnoid hemorrhage. The annual risk of an aneurysmal rupture is about 2%. Patients that experience aneurysmal rupture typically experience a mortality rate of about 50–60%. If the ruptured aneurysm is left untreated, about 25–35% of such patients will die of recurrent hemorrhage. For about 20–40% of those patients that do survive, the ruptured aneurysm results in a significant deficit in neurological function.

One conventional technique for treating a brain aneurysm uses standard open surgical intervention techniques. A craniotomy is performed to create a relatively large opening in the patient’s skull. The surgeon uses conventional surgical instruments to retract intervening brain tissue to expose the blood vessel at the aneurysm for direct visualization. With the aneurysm and associated blood vessel in view, the surgeon manipulates and treats the aneurysm using traditional surgical instruments to clip or staple either the body of the vessel or the neck of the aneurysm. Although such surgical clipping yields a high likelihood of procedural success, it is highly invasive. Therefore, it risks inducing associated brain trauma, thereby requiring a long recovery time. Moreover, a significant number of brain aneurysms are located very deep in the brain, rendering such conventional surgical techniques difficult.

Another technique for treating a brain aneurysm uses an endovascular approach. For example, a catheter may be introduced (e.g., near a subject’s groin) through a blood vessel and advanced to the aneurysm. In one technique, a detachable coil is introduced through the endovascular catheter and “packed” into the interior of the aneurysm. This coil, which is usually constructed of stainless steel and/or platinum wire, is intended to interrupt the turbulent blood flow into the aneurysm. The resulting blood clots within the interior of the aneurysm. This reduces the risk of aneurysmal rupture. Another endovascular method of treating aneurysms uses a detachable balloon. The balloon is inflated with cyanoacrylates to occlude the interior of the aneurysm. Yet another endovascular method of treating aneurysms introduces an intravascular stent or graft that occludes the adjacent neck of an aneurysm sufficiently to interrupt blood flow into the aneurysm while maintaining continued flow through the native vessel.

These endovascular techniques for treating aneurysms, however, have not exhibited as high a likelihood of success as the open surgery techniques discussed above. Moreover, application of the endovascular techniques is generally limited to non-bifurcating, small-neck aneurysms, which actually constitute a small percentage of the clinically-diagnosed aneurysms. Furthermore, some aneurysms are exceedingly difficult to reach endovascularly because they require traversal of a long tortuous path through the accessing vessels. For these and other reasons, the present inventors have recognized a need for improved techniques and associated devices for accessing and treating brain or other aneurysms.

SUMMARY

In contrast to the above-discussed open surgery and endovascular approaches to treating aneurysms, this document discusses a minimally-invasive exovascular approach to treating an aneurysm. Using such a minimally-invasive technique, the surgeon need only make a small opening for inserting an exovascular instrument to the aneurysm. In order to perform the treatment, the surgeon need not visualize the aneurysm directly. Instead, a magnetic resonance imaging (MRI), computed tomography (CT), or other suitable imaging device is provided to allow the surgeon to exovascularly guide a minimally-invasive aneurysm treatment device through the brain to the aneurysm, apply the treatment device to the desired portion of the aneurysm, and then remove the aneurysm treatment device. In a further example, an image-guided entry device is used to provide more accurate targeting and determination of a trajectory from the minimally-invasive entry opening to the aneurysm to be treated. The minimally-invasive techniques discussed in this document may permit more effective treatment of aneurysms that would be difficult to access or treat using endovascular techniques. Moreover, these minimally-invasive techniques may result in less shifting of brain tissue than open surgery techniques. This may permit more accurate targeting of the aneurysm, and less trauma to the intervening brain tissue.

In one example, this document discusses a system that includes an elongate exovascular probe. The probe includes proximal and distal ends. The probe also includes an outer dimension that is less than about 18 millimeters to permit the probe to be introduced through a similarly-sized minimally-invasive opening in a portion of a subject’s skull and exovascularly advanced to an aneurysm within the skull. The system also includes an aneurysm treatment device carried by the probe. The aneurysm treatment device is dimensioned to permit the aneurysm treatment device to be introduced through the opening.

In another example, this document discusses a method of aneurysm treatment. The method includes forming an opening in a subject’s skull. The opening having a diameter that is less than or equal to the diameter of a burr hole. A probe is exovascularly inserted through the opening to an aneurysm using real-time or preoperative imaging to guide the probe to the aneurysm. An aneurysm treatment device is exovascularly introduced through a lumen in the probe to the aneurysm. Using the aneurysm treatment device, a morphology of the aneurysm is altered. Other aspects of the inven-

tion will be apparent on reading the following detailed description of the invention and viewing the drawings that form a part thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are offered by way of example, and not by way of limitation, and which are not necessarily drawn to scale, like numerals describe substantially similar components throughout the several views. Like numerals having different letter suffixes represent different instances of substantially similar components.

FIG. **1** is a schematic/block diagram illustrating generally an example of portions of a minimally-invasive aneurysm treatment system and portions of an environment in which it is used.

FIG. **2** is a schematic/block diagram of another example of portions of an aneurysm treatment system, in which a distal tip of a catheter also includes a local imaging device for providing enhanced visualization of nearby regions, such as an aneurysm and nearby blood vessels and brain tissue or other structures.

FIG. **3** is a schematic/block diagram of a further example of portions of an aneurysm treatment system, further including an entry device located at, in, and/or around an entry opening.

FIG. **4** is a cross-sectional schematic diagram illustrating generally an example of a distal end of a catheter. Disposed in a retracted position within a lumen of the catheter is distal end of an example aneurysm treatment device.

FIG. **5** includes several cross-sectional diagrams illustrating generally one technique for operating the aneurysm treatment device of FIG. **4**.

FIG. **6** is a schematic illustration of several alternative components for aneurysm-clipping in an aneurysm treatment device.

FIG. **7** is a cross-sectional schematic diagram illustrating generally another example of a distal end of a catheter, the distal end including a lumen through which another example aneurysm treatment device is disposed for treating an aneurysm.

FIG. **8** includes several cross-sectional diagrams illustrating another example of a distal portion of a snare-like aneurysm treatment device that includes a strand, the end of which has a normally-looped shape-memory property.

FIG. **9** is a perspective view illustrating another example of an aneurysm treatment device, which includes a pair of electrodes that are exovascularly delivered through a lumen of a catheter.

FIG. **10** is a perspective view illustrating another example of an aneurysm treatment device including a movable electrode and a fixed electrode.

FIG. **11** is a perspective view illustrating another example of a catheter-delivered aneurysm treatment device, which in this case includes a C-channel clamp shaped for being fitted around an exterior portion of a blood vessel and clamping a desired portion of an aneurysm therebetween.

FIG. **12** is a perspective view illustrating a number of possible variations of the minimally-invasive aneurysm treatment techniques discussed above, such as nasalpharyngeal access, frame-mounted entry devices, using a plurality of minimally-invasive devices, and/or using separate minimally-invasive devices for imaging and aneurysm treatment.

DETAILED DESCRIPTION

In the following detailed description, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that the embodiments may be combined, or that other embodiments may be utilized and that structural, logical and electrical changes may be made without departing from the spirit and scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims and their equivalents.

In this document, the term "minimally-invasive" shall be interpreted as referring to techniques that are less invasive than conventional open surgical techniques that involve making a large enough opening to permit direct visual inspection of the internal surgical procedure. In particular, the term "minimally-invasive" is not restricted to the least-invasive technique possible.

FIG. **1** is a schematic/block diagram illustrating generally an example of portions of a minimally-invasive aneurysm treatment system **100** and portions of an environment in which it is used. In this example, a portion of a top or side of a patient's skull **100** and scalp **102** are illustrated. A minimally-invasive entry opening **104** is created through skull **100** and scalp **102**. In one example, opening **104** is a substantially circular burr-hole having a diameter that is approximately between 8 millimeters and 18 millimeters, such as about 14 millimeters. A exovascular probe/tube/catheter **106** (or other rigid, semi-rigid, or flexible device) is inserted through opening **104**, and is directed toward an aneurysm (e.g., a saccular, globular, giant, or other aneurysm) **108** associated with blood vessel **110** within brain **112**. Catheter **106** includes a lumen **114** extending between its proximal end **116** and its distal end **118**. In one example, catheter **106** has an outer diameter that is less than the burr-hole diameter. In another example, catheter **106** has an outer diameter that is less than about 10 millimeters, such as an outer diameter of about 5 millimeters. In general, using a smaller outer diameter value results in less trauma to the intervening tissue. In one example, catheter **106** has an inner (i.e., lumen) diameter that is approximately between 1 millimeter and 8 millimeters, such as about 3 millimeters.

An aneurysm treatment device **120** is inserted through lumen **114** in catheter **106**. Aneurysm treatment device **120** includes a proximal end **122** and a distal end **124**. Distal end **124** of aneurysm treatment device **120** includes a device for altering a morphology of aneurysm **108**, such as to reduce the risk of its rupture. Such aneurysm treatments include, by way of example, but not by way of limitation, clipping, clasping, snaring, looping, hooking, stapling, applying electrical energy to diathermically heat and/or electrocauterize, grasping, retrieving, securing, and/or aspirating the contents of an aneurysm. The devices for performing such treatments may be mechanical, chemical and/or electromagnetic. The choice of an appropriate treatment will depend on the size, location, and type of aneurysm.

Because minimally-invasive opening **104** is generally too small to permit convenient direct visualization, this example of system **100** includes an alternative remote external imaging device **126** to assist the surgeon in guiding distal tip **118** of catheter **106** to aneurysm **108** while avoiding areas **128**A–B of brain **112**. In one example, imaging device **126** is a magnetic resonance (MR) imaging device and/or a computed tomography (CT) imaging device providing real-time and/or preoperative images for guiding catheter to aneurysm **108** and then treating aneurysm **108**. Such imaging modalities allow the surgeon to view images that include information about the three dimensional morphology of the aneurysm, the vessel associated with the aneurysm, and any nearby major and perforating vessels in and around the base of the aneurysm. The information yielded by such imaging modalities is advantageous for deciding whether and how to proceed with the aneurysm treatment, or for selecting a particular device or method for treating the aneurysm. In one example, an MR or CT imagable fiducial structure is positioned at a predetermined location at one or both of distal end **118** of catheter **106** and/or a distal end **124** of aneurysm treatment device **120** to create a locatable image for guiding and operating that particular device. The fiducial structure may produce either a positive image on the imaging modality or, alternatively, may be recognizable by producing a contrast with the image of the surrounding brain tissue.

FIG. **2** is a schematic/block diagram of another example of portions of aneurysm treatment system **100** in which distal tip **118** of catheter **106** also includes a local imaging device **200** for providing enhanced visualization of nearby regions, such as aneurysm **108** and nearby blood vessels and brain tissue or other structures. In one example, local imaging device **200** includes at least one microcoil for local MR imaging. Some suitable microcoil examples are described in: Truwit et al. U.S. Pat. No. 5,964,705 entitled "MR-COMPATIBLE MEDICAL DEVICES;" Kucharczyk et al. U.S. patent application Ser. No. 09/448,720, filed on Nov. 24, 1999, entitled "MR-COMPATIBLE DEVICES;" Viswanathan et al. U.S. patent application Ser. No. 09/532,145, filed on Mar. 21, 2000, entitled "A DEVICE FOR HIGH GAIN AND UNIFORMLY LOCALIZED MAGNETIC RESONANCE IMAGING;" Viswanathan U.S. patent application Ser. No. 09/532,667, filed on Mar. 21, 2000, entitled "A MICROCOIL DEVICE FOR LOCAL, WIDE FIELD-OF-VIEW AND LARGE GAIN MAGNETIC RESONANCE IMAGING;" and Viswanathan U.S. patent application Ser. No. 09/532,037, filed on Mar. 21, 2000, entitled "A MICROCOIL DEVICE WITH A FORWARD FIELD-OF-VIEW FOR LARGE GAIN MAGNETIC RESONANCE IMAGING." Each of these documents is incorporated herein by reference in its entirety, and also for their collective disclosure of microcoil examples and related techniques and their equivalents. In one example, one or more of such microcoils is molded into distal end **118** of catheter **106**, with appropriate connection wires extending along the length of elongate catheter **106** to its proximal end **116** for coupling to imaging device **126** or other suitable device for delivering and/or receiving energy for performing the local imaging.

Such microcoils typically enhance the visual resolution of the imaging at the working distal end **118** of catheter **106** or other probe. This actively-visible deployment probe improves the surgeon's ability to visualize the overall structure and position of the aneurysm as well as any branching capillaries or perforators that might be extending from the aneurysm or its vicinity. This can be important in ensuring effective treatment of the aneurysm. Moreover, such localized imaging allows the surgeon to avoid damaging such ancillary vessels, thereby preserving needed blood flow through such vessels to surrounding tissue. Alternatively, it allows the surgeon to also provide similar or different treatment to such ancillary vessels, where appropriate. In one example, imaging of ancillary vessels permits the surgeon to cauterize one or more of such vessels to avoid possible hemorrhaging and/or related complications.

FIG. **3** is a schematic/block diagram of a further example of portions of system **100** further including an entry device **300** located at, in, and/or around minimally-invasive entry

opening **104**. In this example, ball-and-socket-type entry device **300** includes a stem-like cylindrical trajectory guide **302** that is used in conjunction with imaging device **126** to determine and lock-in a desired trajectory from opening **104** to aneurysm **108**. Suitable examples of skull-mounted entry device **300**, and ancillary devices and techniques for introducing a medical instrument such as catheter **106**, are described in: Truwit et al. U.S. Pat. No. 6,195,577 B1 entitled "METHOD AND APPARATUS FOR POSITIONING A DEVICE IN A BODY;" Truwit U.S. patent application Ser. No. 09/058,092, filed on Apr. 9, 1998, entitled "TRAJECTORY GUIDE AND METHOD OF USE IN MAGNETIC RESONANCE AND COMPUTERIZED TOMOGRAPHIC SCANNERS;" Skakoon et al. U.S. patent application Ser. No. 09/828,451, filed on Apr. 6, 2001, entitled "DEEP ORGAN ACCESS DEVICE AND METHOD;" Mazzocchi U.S. Provisional Patent Application No. 60/225,952, filed on Aug. 17, 2000 entitled "IMPROVED TRAJECTORY GUIDES FOR SURGICAL INSTRUMENTS;" Skakoon et al. U.S. patent application Ser. No. 09/827,266, filed on Apr. 5, 2001, entitled "MEDICAL DEVICE INTRODUCER." Each of these documents is incorporated by reference in its entirety, and particularly for their description of entry devices, trajectory guides, and ancillary devices and techniques and their equivalents.

FIG. **4** is a cross-sectional schematic diagram illustrating generally an example of distal end **118** of catheter **106**. Disposed in a retracted position within lumen **114** of catheter **106** is distal end **124** of an example aneurysm treatment device **120**. In this example, aneurysm treatment device **120** includes a clip **400**, an O-shaped ring **402** (or C-shaped partial ring), a wire-like retaining strand **404** snaring clip **400** (or other retention device), a middle tube **406** having a lumen **408** therethrough, and an inner tube **405** also having a lumen therethrough through which a portion of strand **404** extends. In this example, clip **400** is a molded plastic clip having a normally-open shape-memory property. When it is pushed out of lumen **114**, such as by inner tube **405**, jaws **410**A–B of clip **400** spring open apart from each other such that clip **400** is in a substantially open position. Jaws **410**A–B are then positioned around a desired portion of aneurysm **108** (such as around a neck portion at which aneurysm **108** extends from vessel **110**, but leaving enough tissue to bridge the gap in the wall of the vessel created by the aneurysm). Then, jaws **410**A–B are closed around the desired portion of aneurysm **108**. In one example, this is accomplished by firmly holding retaining strand **404**, which is looped around a knob **412** or within a groove **414** of clip **400**, while pushing middle tube **406** out from lumen **114**. In this manner, middle tube **406** engages ring **402** and pushes ring **402** out around jaws **410**A–B. This closes jaws **410**A–B around the desired portion of aneurysm **108**, so that clip **400** is in its substantially closed position. Then, by manipulating the proximal end of retaining strand **404**, its looped distal end is pushed out slightly to open sufficiently to disengage retaining strand **404** from clip **400**, so that clip **400** is freed and left behind to clip the desired portion of aneurysm **108** to reduce its risk of rupture. In one example, inner tube **405** is optionally withdrawn to promote loosening and disengaging retaining strand **404** from clip **400**. Retaining strand **404**, middle tube **406**, inner tube **405**, and catheter **106** are then withdrawn from brain **112**, and minimally-invasive opening **104** is closed. FIG. **5** includes several cross-sectional diagrams illustrating generally one technique for operating this example of aneurysm treatment device **120** of FIG. **4**.

The example illustrated in FIGS. **4** and **5** includes many variations within its scope. In one such variation, retaining strand **404** includes a third strand extending through lumen **114** and coupled to a collar around the illustrated looped pair of strands of retaining strand **404**. By tightening or loosening the collar by manipulating the third strand, the loop is more securely opened or closed to respectively release or retain clip **400**. In another example, retaining strand **404** (which need not be a loop, but is alternatively a single strand affixed to a portion of clip **400**), includes a pre-weakened breakaway portion at or near clip **400**. By pulling back on the proximal end of retaining strand **404** while pushing out on middle tube **406** to close jaws **410**A–B of clip **400** using ring **402**, the pre-weakened portion of retaining strand **404** breaks at a predefined degree of tension. This releases closed clip **400**. The proximal portion of retaining strand **404** is then removed. Middle tube **406** and catheter **106** are also withdrawn from brain **112**. In another variation, distal end **118** of catheter **106** includes an inward extending longitudinal slot that is shaped to permit one of jaws **410**A–B to spring outward toward its substantially open position even before clip **400** is extended out of lumen **114**. This permits clip **400** to open around aneurysm **108** along the side of catheter **106** rather than concentrically outward.

FIG. **6** is a schematic illustration of several alternative components for aneurysm-clipping in an aneurysm treatment device. In the examples of FIG. **6**, clip **600** includes distal hook **602** or other self-locking mechanism that avoids the need for a separate sliding ring **402** to close and/or retain clip **600** in its substantially closed position. In this example, clip **600** has a normally-open shape-memory property. Clip **600** may be delivered through catheter **106** and closed by a middle tube **406** or any other suitable technique.

Clip **604** includes another example of a self-locking mechanism, such as a ring **606** located at a distal end of one of its jaws. This self-locking mechanism moves (e.g., rotates) to engage the distal end of the opposing jaw to retain normally-open clip **604** in its substantially-closed position. Clip **604** may also be delivered through catheter **106** and closed by a middle tube **406** or other suitable technique.

Clip **608** is an example of a geared latch hook device that is delivered through catheter **106** and closed around a portion of aneurysm **108**. In this example, clip **608** includes a body portion **610** and a hook portion **612**. It also includes a resilient strand **614** or shaft that extends to proximal end **116** of catheter **106**. By pushing on a proximal end of strand **614**, curved hook portion **612** is closed around aneurysm **108**. A distal portion of curved hook portion is received by hole **616** in clip body **610**. One or more teeth **618** on hook **612** engages a pawl-like device associated with hole **616**, allowing hook **612** to clasp and retain aneurysm **108**. Body **610** and strand **614** are releasably coupled to hook **612** by any suitable releasable fastening technique. Some suitable examples include, by way of example, but not by way of limitation, a pre-weakened breakaway portion, a rotatably-releasable strand or shaft, and/or a threaded coupler.

Clip **620** is an example of another aneurysm clip or clasp that is delivered through catheter **106** and closed around aneurysm **108**. In this example, clip **620** includes a body **622** portion and a hooked shaft **624** portion that operate together in a padlock-like fashion to clasp and retain aneurysm **108**. Strand or shaft **626** engages hooked shaft **624** to pull it back, thereby clasping the desired portion of aneurysm **108** between hooked shaft **624** and body **622** of clip **620**. Strand **626** releasably engages hooked shaft **624**, such as by one of the above-described releasable fastening techniques, or by simply receiving a hooked or other suitably shaped portion of a distal end of strand **626** in a slot or other suitable opening from which it can be disengaged by manipulating the proximal end of strand **626**.

Clip **628** is an example of yet another aneurysm clip or clasp that is delivered through catheter **106** and closed around aneurysm **108**. In this example, clip **628** is a double bow-like clasp having a normally-closed shape-memory property. After being delivered through catheter **106**, tension is applied to force its midregions outward so that aneurysm **108** can be positioned therebetween. One technique for applying such tension is to use one or more resilient strands or shafts that releasably engage features on clip **628** (e.g., receptacles **630**A–B). In an alternative example, clip **628** includes a normally-open shape-memory property. Such a normally-open clip **628** is closed around aneurysm **108** using a suitable closure technique, such as by using a middle tube **406** to push a surrounding ring **402** out around normally open clip **628** to close it around aneurysm **108**.

FIG. **7** is a cross-sectional schematic diagram illustrating generally another example of distal end **118** of catheter **106**, the distal end **118** including a lumen **114** through which another example aneurysm treatment device **120** is disposed for treating aneurysm **108**. In this example, aneurysm treatment device **120** includes a wire-like snare **700** having at least one strand that extends through lumen **114** of catheter **106** from its proximal end **116** to its distal end **118**, and extending outward from distal end **118** in a loop **702**. In its substantially open position, as illustrated in FIG. **7**, loop **702** is large enough to encircle a desired portion of aneurysm **108**. In this example, snare **700** extends through a unidirectional retention mechanism, such as cuff **704**, in lumen **114** at distal end **118** of catheter **106**. In this example, cuff **704** includes two pieces **704**A–B that lock when snare **700** is rotated after loop **702** is pulled snugly around aneurysm **108** to tie off aneurysm **108**. In one example, snare **700** includes a pre-weakened breakaway portion that is slightly more proximal than cuff **704**, so that when the user pulls firmly back on the proximal end of snare **700** with sufficient tension, snare **700** breaks away to leave behind loop **702**, around aneurysm **108**, and securing cuff **704**. In this example, aneurysm treatment device **120** also includes a middle tube **406** having a lumen **408** through which a portion of snare **700** extends. The user pushes on the proximal end of middle tube **406** to push against cuff **704**, while the proximal end of snare **700** is being pulled back, to break the pre-weakened portion of snare **700**. Then, the user further pushes on the proximal end of middle tube **406** to push out and release cuff **704** and the tightened loop portion of snare **700**. In an alternative example, in which snare **700** need not include a pre-weakened portion, cuff **704** includes a blade-like projection that cuts a portion of snare **700** to release loop **702** after it is secured around aneurysm **108**. In addition to cuff **704**, other modes of unidirectional retention devices operating noose-like loops **702** include a toothed or other structure operating similarly to a plastic cable-tie and/or a bag-tie, or a pawl or other ratcheting/escapement mechanism that allows loop **702** to be securely tightened around aneurysm **108**.

FIG. **8** includes several cross-sectional diagrams illustrating another example of a distal portion of a snare-like aneurysm treatment device **120** that includes a strand **800**, the end of which has a normally-looped shape-memory property. In this example, strand **800** extends from proximal end **116** to distal end **118** of catheter **106** through its lumen **114**, through a central lumen of a middle tube **406**, and through a central lumen of ring **402**. A distal end of strand **800** is extended out from the distal end **118** of catheter **106** for a sufficient distance to allow its shape-memory property to hook the distal end of strand **800** around the desired portion of aneurysm **108**. In this example, the distal end of strand **800** includes a catch **802** (e.g., a ball, a grooved ball, a hook, or any other suitable structure). Catch **802** engages a more proximal portion of strand **800** after being hooked around the desired portion of aneurysm **108**. Middle tube **406** is then used to push ring **402** out over catch **402**. Then, the proximal end of strand **800** is pulled back to draw a noose-like loop to clamp off the desired portion of aneurysm **108**. In one example, strand **800** includes a more proximal pre-weakened portion that breaks away when sufficient tension is applied, leaving behind the loop and ring tying off aneurysm **108**. In an alternative example, a portion of strand **800** includes a toothed or other structure operating similarly to a plastic cable-tie and/or a bag-tie, or a pawl or other ratcheting/escapement mechanism, as discussed above, to retain the now-looped hook snare in its substantially closed position around aneurysm **108**. In another alternative example, ring **402** is omitted, and catch **802** includes a hook or other suitable structure that catches a more proximal portion of strand **800** when its proximal end is drawn back to break away a pre-weakened portion of strand **800** that is more proximal than the engaged hook.

FIG. **9** is a perspective view illustrating another example of an aneurysm treatment device **900**. In this example, aneurysm treatment device **900** includes a pair of electrodes **902**A–B that are exovascularly delivered through lumen **114** of catheter **106**. In the illustration of FIG. **9**, electrodes **902**A–B are elongate paddles extending outward from respective insulated stylet shafts **904**A–B at resiliently flexible outward necked portions **906**A–B. In this manner, when electrodes **902**A–B are extended out of lumen **114** at distal end **118** of catheter **106**, they spring outward into a substantially open position to allow aneurysm **108** to be positioned therebetween. By then either sliding catheter **106** out over necked portions **906**A–B, or by then pulling back necked portions **906**A–B into lumen **114** at distal end **118** of catheter **106**, electrodes **902**A–B are forced together into a substantially closed position, clamping aneurysm **108** therebetween. Electrical energy is then applied between proximal ends of the insulated stylet shafts **904**A–B and conducted to electrodes **902**A–B to cauterize shut the clamped portion of aneurysm **108**. Electrodes **906**A–B are then again manipulated into their substantially open position and retracted together with catheter **106**.

FIG. **10** is a perspective view illustrating another example of an aneurysm treatment device **1000** including a movable electrode and a fixed electrode. In this example, aneurysm treatment device **1000** includes a movable electrode **1002** extending out from lumen **114** at distal end **118** of catheter **106** on an electrically insulated stylet shaft **1004**. A flat fixed electrode **1006** is formed integrally with distal end **118** of catheter **106**, extending outwardly therefrom, with an associated conductor coupling it to proximal end **116** of catheter **106**. In this example, fixed electrode **1006** is first positioned adjacent to aneurysm **108**. Then, movable electrode **1002** is extended out around the other side of aneurysm **108**. In this example, movable electrode **1002** includes a rolling electrode that is rolled back and/or forth along aneurysm **108**, by manipulating a proximal end of shaft **1004**, to clamp the desired portion of aneurysm **108** between the electrodes **1002** and **1006** as electrical energy is applied to cauterize shut the desired portion aneurysm **108**.

FIG. **11** is a perspective view illustrating another example of a catheter-delivered aneurysm treatment device, which in this case includes a C-channel clamp **1100** shaped for being fitted around a portion of blood vessel **110** and clamping a desired portion of aneurysm **108** therebetween. In one technique, C-channel clamp **1100** is mounted on the tip of a stylet shaft having a sufficient diameter to keep channel **1102** sufficiently open to slide around the desired portion of aneurysm **108** when the stylet shaft is extended out of distal tip **118** of catheter **106**. A second stylet (or a middle tube, such as middle tube **406**) is used to slide C-channel clamp **1100** off the first stylet into place around vessel **110** and aneurysm **108**. In this example, C-channel clamp **1100** has a normally-closed shape-memory property, so that it closes around the desired portion of aneurysm **108** after it is slid into place off of the first stylet shaft. In a further example, electrically insulative C-channel clamp **1100** also includes conductive electrodes **1104**A–B located along the edges of its C-channel for cauterizing closed the clamped portion of aneurysm **108**. In this example, electrodes **1104**A–B include receptacles, at any suitable location, for subsequent access by conductors delivering the electrical cautery energy after the delivery stylet(s) are removed from lumen **114** of catheter **106**.

FIG. **12** is a perspective view illustrating a number of possible variations of the minimally-invasive aneurysm treatment techniques discussed above, such as nasalpharyngeal access, frame-mounted entry devices, using a plurality of minimally-invasive devices, and/or using separate minimally-invasive devices for imaging and aneurysm treatment. For example, while FIG. **3** illustrated access through the top or the side of a patient's skull, FIG. **12** illustrates a nasalpharyngeal node of access through a patient's nose and sinuses. In this example, a rotatable arc-like frame **1200** is mounted to a head holding device **1202**. One or more entry devices, such as ball-and-socket trajectory-guide bearing entry devices **1204**A–B, is mounted to a suitable location on frame **1200**. In one example, such as illustrated in FIG. **12**, a first entry device (e.g., entry device **1204**A) is used to provide an image-guided trajectory of a catheter-delivered aneurysm treatment device to a target aneurysm (for example, using the above-discussed clip, electrocautery electrodes, etc.). A second entry device (e.g., entry device **1204**B) is used to establish a trajectory and introduce a minimally-invasive localized imaging modality (e.g., a microcoil for localized MRI, an endoscope for optical visualization, and ultrasound probe, etc.).

In the examples of FIGS. **1**–**12**, example materials suitable for constructing catheter **106**, middle tube **406**, inner tube **405**, and/or cuff **704** include, by way of example, but not by way of limitation, one or a combination of nonmagnetic carbon fiber, titanium, rigid or semi-rigid extruded plastic, polyetheretherketone (PEEK), and/or polyurethane. In a non-MR (e.g., CT) environment, in which nonmagnetic components are not required, stainless steel is also an example of a suitable material for these components. Example materials suitable for constructing ring **402**, clip **400**, clip **600**, clip **604**, clip **608**, clip **620**, and/or clip **628** include, by way of example, but not by way of limitation, one or a combination of titanium, polyurethane, polyolefin, polyethylene, and/or polypropylene. Examples of suitable materials for constructing strand **404** and/or snare **700** include, by way of example, but not by way of limitation, one or a combination of titanium, tungsten, platinum-iridium, an extruded plastic monofilament, nylon, and/or KEVLAR.® Moreover, strand **404** could be constructed from a twisted pair of strands constructed from the same or different ones of these or other materials. Examples of suitable materials for constructing hook/snare portion of strand **800** include, by way of example, but not by way of limitation, nickel-titanium (nitonol) and/or other suitable nonmagnetic memory metal. Examples of suitable materials for constructing electrodes **902**A–B, electrode **1002**, electrode **1006**, and/or electrodes **1104**A–B include, by way of example, but not by way of limitation, one or a combination of platinum-iridium and/or other nonmagnetic conductive material. Examples of suitable materials for constructing frame **1200** include, by way of example, but not by way of limitation, one or more of aluminum and/or other rigid nonmagnetic material.

It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-discussed embodiments may be used in combination with each other. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein."

What is claimed is:

1. A system including:

an elongate exovascular probe, including proximal and distal ends, the probe including an outer dimension that is less than about 18 millimeters to permit the probe to be introduced through a similarly-sized minimally-invasive opening in a portion of a subject's skull and exovascularly advanced along a longitudinal axis of the probe to an aneurysm within the skull; and

an aneurysm treatment device carried by the probe and dimensioned to permit the aneurysm treatment device to be introduced through the opening, at least a distal portion of the aneurysm treatment device being releasable via axial translation of at least a portion of the probe without lateral motion of the probe with respect to the probe axis, to grasp about the aneurysm.

2. The system of claim **1**, further including an imaging device to permit viewing of an image of both the aneurysm treatment device and the aneurysm.

3. The system of claim **2**, in which the imaging device includes a magnetic resonance (MR) imaging device.

4. The system of claim **3**, in which the imaging device further includes a local MR imaging device near the distal end of the probe.

5. The system of claim **4**, in which the local MR imaging device includes at least one microcoil.

6. The system of claim **1**, in which at least one of the aneurysm treatment device and the distal end of the probe includes at least one of an MR or CT imagable fiducial structure.

7. The system of claim **1**, in which the probe and aneurysm treatment device are both at least one of MR or CT compatible.

8. The system of claim **1**, in which the aneurysm treatment device includes a structure having substantially open and substantially closed positions, wherein the open position is sized to permit at least one portion of the aneurysm treatment device to be positioned around at least a portion of at least one of a saccular, globular, or giant aneurysm, and wherein the closed position is sized to permit the at least one portion of the aneurysm treatment device to press against at least a portion of the aneurysm.

9. The system of claim **8**, in which the aneurysm treatment device structure includes a shape-memory property.

10. The system of claim **9**, in which the shape-memory property, in the absence of applied bias, is associated with one of the open or closed positions.

11. The system of claim **1**, further including an elongate member shaped to extend through a lumen in the probe, the elongate member releasably coupling to the aneurysm treatment device.

12. The system of claim **1**, in which the aneurysm treatment device is shaped to be extendable from and retractable into a lumen of the probe.

13. The system of claim **1**, in which the aneurysm treatment device includes at least one of a clip, a clasp, a snare, a loop, a hook, a staple, or an electrode.

14. The system of claim **1**, in which the aneurysm treatment device includes a normally substantially open clip that is substantially closed when retracted into a lumen of the probe, and further including:

an elongate tube shaped to extend through the lumen of the probe, a distal end of the elongate tube shaped to extend out of the distal end of the probe and around a portion of the clip to substantially close a portion of the clip around a portion of the aneurysm; and

a flexible strand shaped to extend through the elongate tube, and releasably coupled to a portion of the clip.

15. The system of claim **14**, further including a ring shaped to engage the distal end of the elongate tube, the ring shaped to encircle a portion of the clip to hold the clip in the substantially closed position around the portion of the aneurysm.

16. The system of claim **1**, further including an entry device, the entry device including:

a first securing mechanism to secure the entry device in association with the subject's skull; and

a second securing mechanism to secure an orientation of a trajectory guide portion of the entry device to define a path between the minimally-invasive opening and the aneurysm.

17. The system of claim **16**, further including an imaging device to provide information upon which the orientation of the trajectory guide is determined.

18. The system of claim **1**, wherein the probe includes a substantially uniform cylindrical outer surface that is sized and shaped to be accepted within and guided by a similarly sized and shaped lumen of a trajectory guide device.

19. The system of claim **18**, wherein the aneurysm treatment device carried by the probe is dimensioned to permit the aneurysm treatment device to be introduced via the trajectory guide device through the opening, at least a distal portion of the aneurysm treatment device being releasable to grasp about the aneurysm, while a proximal portion of the aneurysm treatment device is disposed within the probe and the probe is accepted within the lumen of the trajectory guide device.

20. The system of claim **1**, in which the aneurysm treatment device includes at least one clip.

21. The system of claim **1**, in which the aneurysm treatment device includes at least one clasp.

22. The system of claim **1**, in which the aneurysm treatment device includes at least one snare.

23. The system of claim **1**, in which the aneurysm treatment device includes at least one loop.

24. The system of claim **1**, in which the aneurysm treatment device includes at least one hook.

25. The system of claim **1**, in which the aneurysm treatment device includes at least one staple.

26. The system of claim **1**, in which the aneurysm treatment device includes at least one electrode.

27. A system including:

an elongate exovascular probe, including proximal and distal ends, the probe including an outer dimension that is less than about 18 millimeters to permit the probe to be introduced through a similarly-sized minimally-invasive opening in a portion of a subject's skull and exovascularly advanced along a longitudinal axis of the probe to an aneurysm within the skull;

an aneurysm treatment device carried by the probe and dimensioned to permit the aneurysm treatment device to be introduced through the opening, at least a distal portion of the aneurysm treatment device being releasable via axial translation of at least a portion of the probe without lateral motion of the probe with respect to the probe axis, to grasp about the aneurysm; and

a local imaging device located near the distal end of the probe.

28. The system of claim **27**, in which the local imaging device includes a magnetic resonance (MR) imaging device.

29. The system of claim **27**, in which the aneurysm treatment device includes a structure having substantially open and substantially closed positions, wherein the open position is sized to permit at least one portion of the aneurysm treatment device to be positioned around at least a portion of an aneurysm, and wherein the closed position is sized to permit the at least one portion of the aneurysm treatment device to press against at least a portion of the aneurysm.

30. The system of claim **27**, further including an entry device shaped to introduce the probe.

31. The system of claim **30**, in which the entry device includes:

a first securing mechanism to secure the entry device in association with the subject's skull; and

a second securing mechanism to secure an orientation of a trajectory guide portion of the entry device to define a path between the minimally-invasive opening and the aneurysm.

32. The system of claim **27**, wherein the probe includes a substantially uniform cylindrical outer surface that is sized and shaped to be accepted within and guided by a similarly sized and shaped lumen of a trajectory guide device.

33. The system of claim **32**, wherein the aneurysm treatment device carried by the probe is dimensioned to permit the aneurysm treatment device to be introduced via the trajectory guide device through the opening, at least a distal portion of the aneurysm treatment device being releasable to grasp about the aneurysm, while a proximal portion of the aneurysm treatment device is disposed within the probe and the probe is accepted within the lumen of the trajectory guide device.

34. A system including:

an elongate exovascular probe, including proximal and distal ends, the probe including an outer surface that is conformally sized and shaped to be accepted within and guided by a correspondingly sized and shaped lumen of a trajectory guide device, the probe also sized and shaped to permit the probe to be introduced through an opening in a portion of a subject's skull and exovascularly advanced along a longitudinal axis of the probe to an aneurysm within the skull; and

an aneurysm treatment device carried by the probe and dimensioned to permit the aneurysm treatment device to be introduced via the trajectory guide device through the opening, at least a distal portion of the aneurysm treatment device being releasable via axial translation of at least a portion of the probe without lateral motion of the probe with respect to the probe axis, to grasp about the aneurysm, while a proximal portion of the aneurysm treatment device is disposed within the probe and the probe is accepted within the lumen of the trajectory guide device.

35. The system of claim **34**, in which the outer surface of the probe includes a substantially cylindrical surface that is sized and shaped to be accepted within and guided by the lumen of the trajectory guide device.

36. The system of claim **35**, in which the outer surface of the probe is a substantially uniform cylindrical surface.

37. The system of claim **36**, in which the probe includes:

an elongate outer tube, providing the substantially uniform cylindrical outer surface of the probe that is sized and shaped to be accepted within and guided by a similarly sized and shaped lumen of a trajectory guide device, the outer tube including a longitudinal outer tube lumen; and

an elongate inner tube, including a substantially uniform cylindrical outer surface that is sized and shaped to be accepted within and guided by the outer tube lumen, the inner tube including a longitudinal inner tube lumen.

38. The system of claim **37**, in which the aneurysm treatment device includes a clip that is sized and shaped to fit within the inner tube lumen, when the clip is retracted into a closed position, and wherein the clip is sized and shaped to fit about a portion of an aneurysm, when the clip is expanded into an open position.

39. The system of claim **38**, in which the probe further includes a strand that is sized and shaped to extend through the inner tube lumen, and wherein the strand is releasably coupled to a portion of the clip.

40. The system of claim **39**, further including a ring, the ring sized and shaped to be carried within the outer tube lumen, and sized and shaped to engage a distal end of the inner tube, and sized and shaped to encircle a portion of the clip to close and hold the clip around the portion of the aneurysm.

41. The system of claim **34**, further including an entry device, the entry device including:

a first securing mechanism to secure the entry device in association with the subject's skull; and

a second securing mechanism to secure an orientation of a trajectory guide portion of the entry device to define a path between the minimally-invasive opening and the aneurysm.

42. The system of claim **41**, further including means for providing information upon which the orientation of the trajectory guide is determined.

43. The system of claim **42**, further including a local imaging device located near the distal end of the probe.

44. A system for use with a subject's skull including:

a trajectory guide having a trajectory that is fixable or fixed with respect to the subject's skull;

an elongate exovascular probe, including proximal and distal ends, the probe is sized and shaped to be guided along the trajectory by the trajectory guide, the probe also includes an outer dimension that is less than about 18 millimeters to permit the probe to be introduced through a similarly-sized minimally-invasive opening in a portion of the subject's skull and exovascularly advanced along the trajectory to a location within the skull; and

an aneurysm treatment device carried by the probe and dimensioned to permit the aneurysm treatment device to be introduced through the opening, at least a distal portion of the aneurysm treatment device being releasable, to grasp about the aneurysm, while a proximal portion of the aneurysm treatment device is disposed within the probe, and the probe is guided along the trajectory and the trajectory is fixed with respect to the subject's skull, wherein the distal portion of the aneurysm treatment device is released via axial translation of at least a portion of the probe without lateral motion of the probe with respect to the trajectory guide trajectory.

45. A system including:

an elongate exovascular probe, including proximal and distal ends, the probe including a substantially uniform cylindrical outer surface that is sized and shaped to be accepted within and guided by a similarly sized and shaped lumen of a trajectory guide device, the probe also including an outer dimension that is less than about 18 millimeters to permit the probe to be introduced through a similarly-sized minimally-invasive opening in a portion of a subject's skull and exovascularly advanced to an aneurysm within the skull; and

an aneurysm treatment device carried by the probe and dimensioned to permit the aneurysm treatment device to be introduced via the trajectory guide device through the opening, at least a distal portion of the aneurysm treatment device being releasable, to grasp about the aneurysm, while a proximal portion of the aneurysm treatment device is disposed within the probe and the probe is accepted within the lumen of the trajectory guide device, wherein the aneurysm treatment device includes:

a normally substantially open clip that is substantially closed when retracted into a lumen of the probe,

an elongate tube shaped to extend through the lumen of the probe, a distal end of the elongate tube shaped to extend out of the distal end of the probe and around a portion of the clip to substantially close a portion of the clip around a portion of the aneurysm, and

a flexible strand shaped to extend through the elongate tube, and releasably coupled to a portion of the clip.

46. The system of claim **45**, further including a ring shaped to engage the distal end of the elongate tube, the ring shaped to encircle a portion of the clip to hold the clip in the substantially closed position around the portion of the aneurysm.

47. A system including:

an elongate exovascular probe, including proximal and distal ends, the probe including a substantially uniform cylindrical outer surface that is sized and shaped to be accepted within and guided by a correspondingly sized and shaped lumen of a trajectory guide device, the probe also sized and shaped to permit the probe to be introduced through an opening in a portion of a subject's skull and exovascularly advanced to an aneurysm within the skull, the probe including:

an elongate outer tube, providing the substantially uniform cylindrical outer surface of the probe, the outer tube including a longitudinal outer tube lumen

an elongate inner tube, including a substantially uniform cylindrical outer surface that is sized and shaped to be accepted within and guided by the outer tube lumen, the inner tube including a longitudinal inner tube lumen; and

an aneurysm treatment device carried by the probe and dimensioned to permit the aneurysm treatment device to be introduced via the trajectory guide device through the opening, at least a distal portion of the aneurysm treatment device being releasable, to grasp about the aneurysm, while a proximal portion of the aneurysm treatment device is disposed within the probe and the probe is accepted within the lumen of the trajectory guide device.

48. The system of claim **47**, in which the aneurysm treatment device includes a clip that is sized and shaped to fit within the inner tube lumen, when the clip is retracted into a closed position, and wherein the clip is sized and shaped to fit about a portion of an aneurysm, when the clip is expanded into an open position.

49. The system of claim **48**, in which the probe further includes a strand that is sized and shaped to extend through the inner tube lumen, and wherein the strand is releasably coupled to a portion of the clip.

50. The system of claim **49**, further including a ring, the ring sized and shaped to be carried within the outer tube lumen, and sized and shaped to engage a distal end of the inner tube, and sized and shaped to encircle a portion of the clip to close and hold the clip around the portion of the aneurysm.

51. A system including:

an elongate exovascular probe, including proximal and distal ends, the probe including an outer surface that is conformally sized and shaped to be accepted within and guided by a correspondingly sized and shaped lumen of a trajectory guide device, the probe also sized and shaped to permit the probe to be introduced through an opening in a portion of a subject's skull and exovascularly advanced to an aneurysm within the skull;

an aneurysm treatment device carried by the probe and dimensioned to permit the aneurysm treatment device to be introduced via the trajectory guide device through the opening, at least a distal portion of the aneurysm treatment device being releasable, to grasp about the aneurysm, while a proximal portion of the aneurysm treatment device is disposed within the probe and the probe is accepted within the lumen of the trajectory guide device;

an entry device including:

a first securing mechanism to secure the entry device in association with the subject's skull, and

a second securing mechanism to secure an orientation of a trajectory guide portion of the entry device to define a path between the minimally-invasive opening and the aneurysm; and

means for providing information upon which the orientation of the trajectory guide is determined.

52. The system of claim **51**, further including a local imaging device located near the distal end of the probe.

* * * * *