



US010537402B2

(12) United States Patent
Vasan et al.**(10) Patent No.: US 10,537,402 B2**
(45) Date of Patent: Jan. 21, 2020**(54) SURGICAL CLEANING TOOL, SYSTEM,
AND METHOD****(71) Applicant: The Board of Regents of the
University of Oklahoma, Norman, OK
(US)****(72) Inventors: Niles Vasan, Oklahoma City, OK
(US); Michael Petri, Richardson, TX
(US); Andrew Stewart, Edmond, OK
(US); Patrick Stevens, Norman, OK
(US); Rannyu Ngoran, Norman, OK
(US); Jonathan Schick, Duncan, OK
(US); Derrick Jones, Norman, OK
(US)****(73) Assignee: The Board of Regents of the
University of Oklahoma, Norman, OK
(US)****(*) Notice:** Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.**(21) Appl. No.: 15/529,416****(22) PCT Filed: Nov. 24, 2015****(86) PCT No.: PCT/US2015/062493**

§ 371 (c)(1),

(2) Date: May 24, 2017**(87) PCT Pub. No.: WO2016/086028****PCT Pub. Date: Jun. 2, 2016****(65) Prior Publication Data**

US 2017/0354476 A1 Dec. 14, 2017

Related U.S. Application Data**(60) Provisional application No. 62/083,740, filed on Nov.
24, 2014.****(51) Int. Cl.**
A61B 90/70 (2016.01)
B08B 1/00 (2006.01)**(52) U.S. Cl.**
CPC **A61B 90/70** (2016.02); **B08B 1/002**
(2013.01); **B08B 1/006** (2013.01)**(58) Field of Classification Search**
CPC ... A61B 90/70; A61B 1/126; A61B 2090/701;
A61B 1/122
See application file for complete search history.**(56) References Cited**

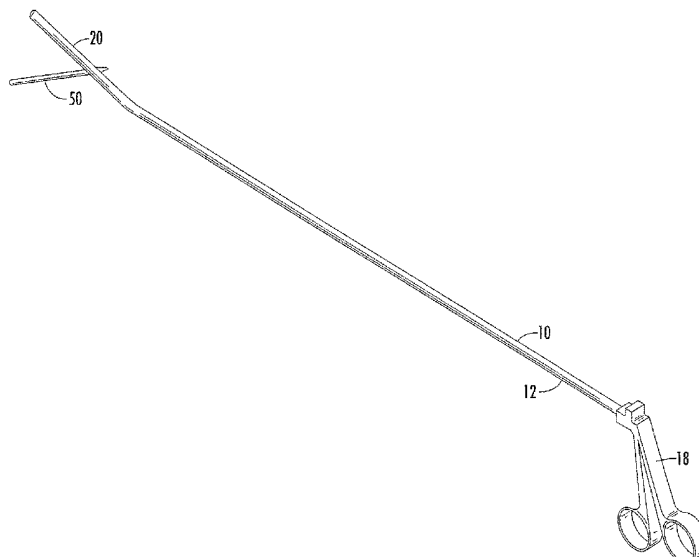
U.S. PATENT DOCUMENTS

5,423,814 A 6/1995 Zhu et al.
5,456,681 A 10/1995 Hajjar
(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion; International
Application No. PCT/US2015/062493; dated Mar. 1, 2016; 9 pages.*Primary Examiner* — Mikhail Kornakov*Assistant Examiner* — Natasha N Campbell**(74) Attorney, Agent, or Firm** — Hall Estill Law Firm**(57) ABSTRACT**

A surgical cleaning tool and method of cleaning a surgical tool. The surgical cleaning tool includes a shaft, a handle and an end portion. The shaft has a distal end and a proximal end. The handle is attached to the distal end of the shaft. The end portion is connected to the proximal end of the shaft, wherein the end portion has an outer surface, an inner cavity, an inner surface, at least one cleaning element connected to at least a portion of the inner surface, and an opening in a wall portion of the end portion, wherein the opening allows access to the cleaning element in the inner cavity of the end portion.

13 Claims, 18 Drawing Sheets

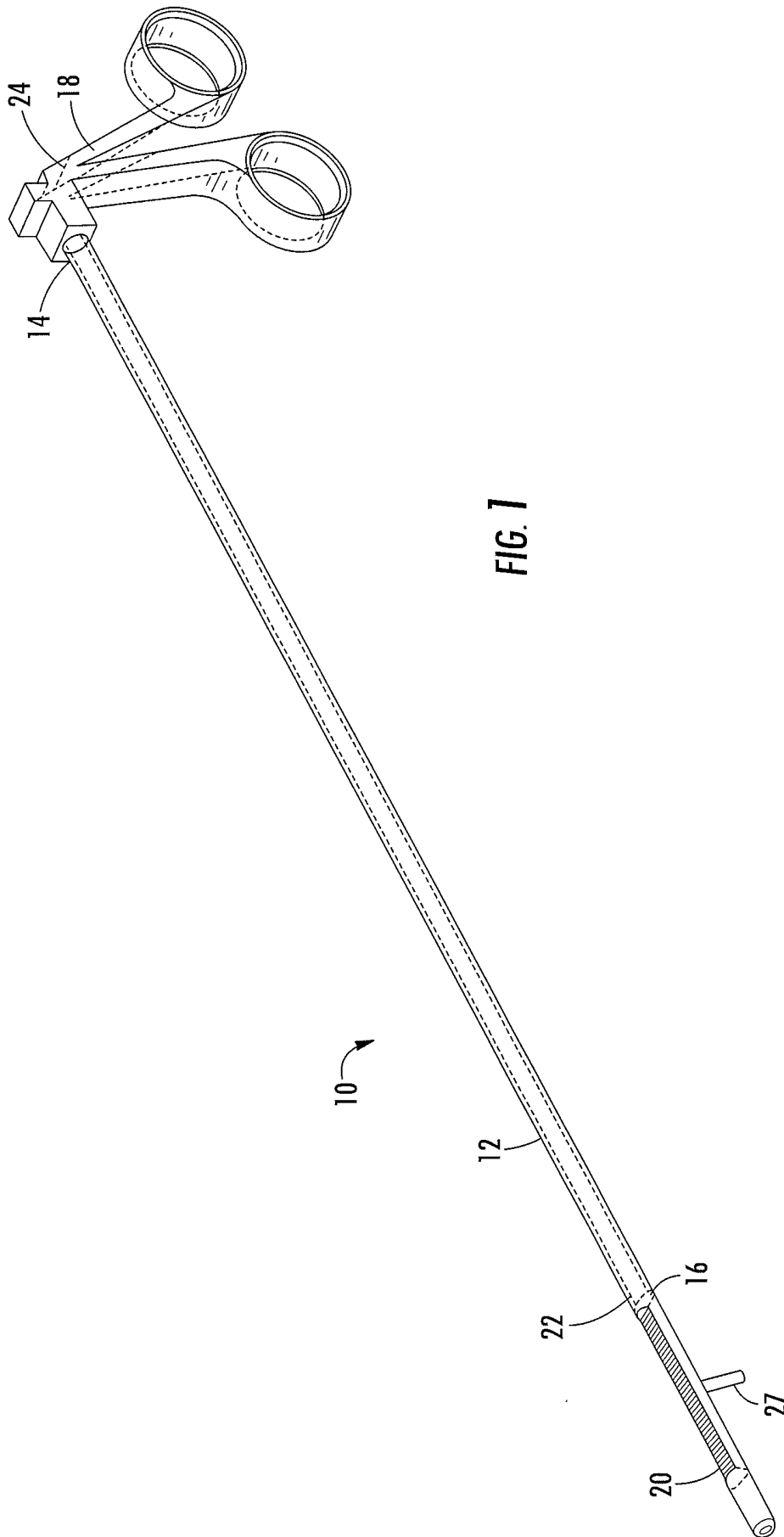
(56)

References Cited

U.S. PATENT DOCUMENTS

5,658,273	A	8/1997	Long	
6,309,397	B1	10/2001	Julian et al.	
6,770,081	B1	8/2004	Cooper et al.	
7,125,403	B2	10/2006	Julian et al.	
7,347,856	B2	3/2008	Wittenberger et al.	
7,772,599	B2	8/2010	Udagawa	
8,182,476	B2	5/2012	Julian et al.	
8,551,116	B2	10/2013	Julian et al.	
2014/0018824	A1	1/2014	Julian et al.	
2014/0215736	A1 *	8/2014	Gomez	 A61B 1/00154 15/104.05
2014/0263541	A1 *	9/2014	Leimbach	 A61B 34/30 227/175.2
2016/0066913	A1 *	3/2016	Swayze	 A61B 17/072 227/176.1

* cited by examiner



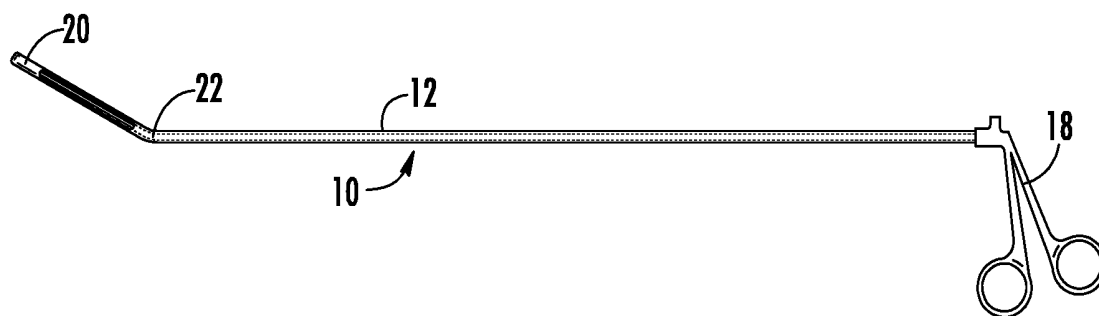


FIG. 2

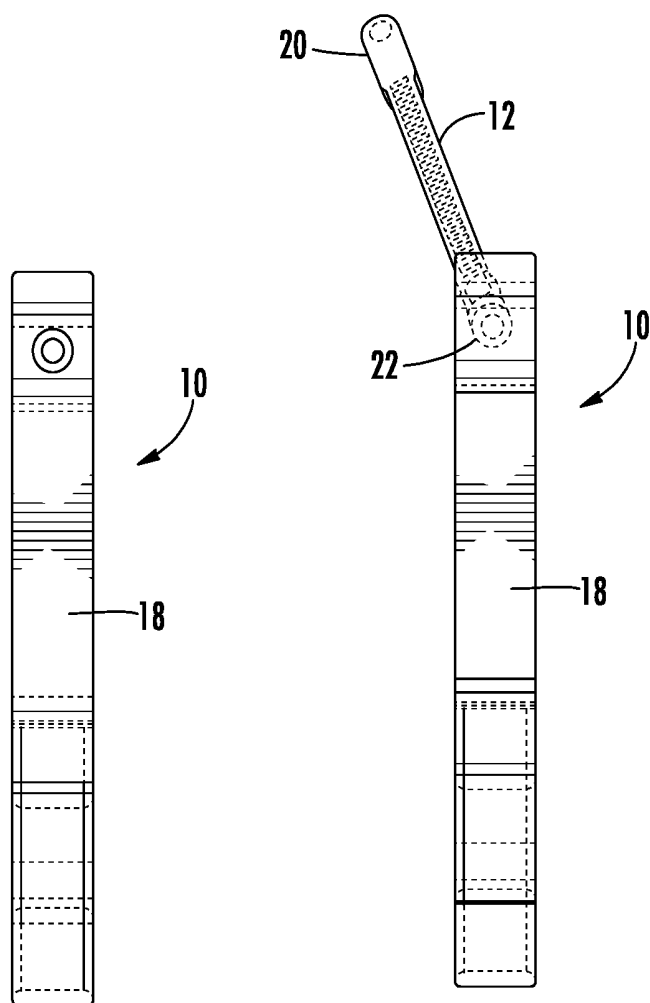
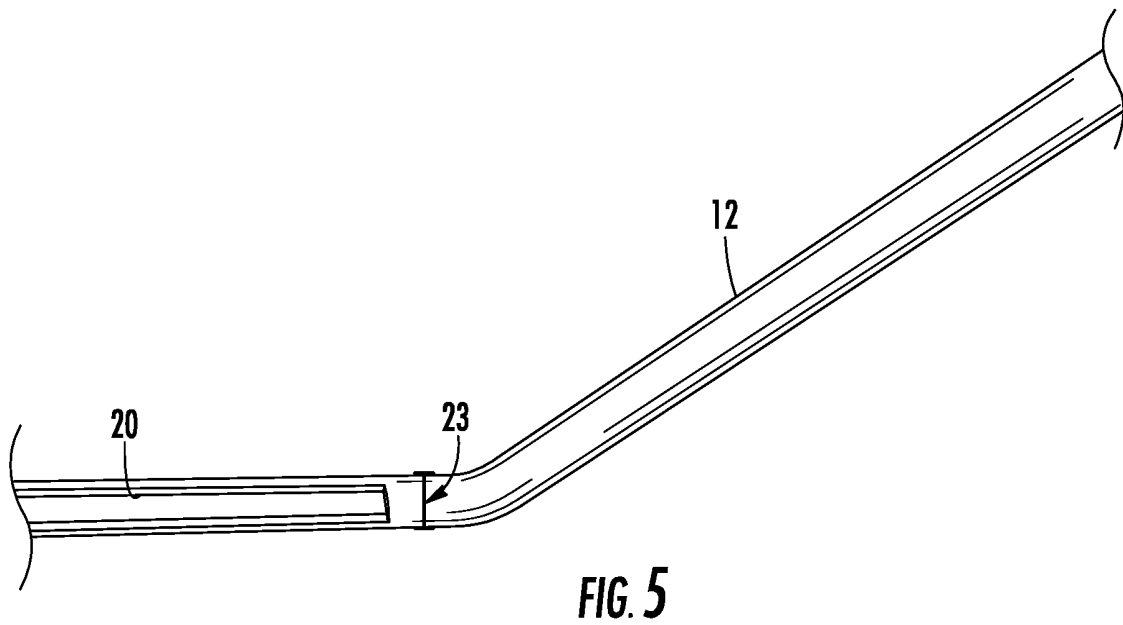


FIG. 3

FIG. 4



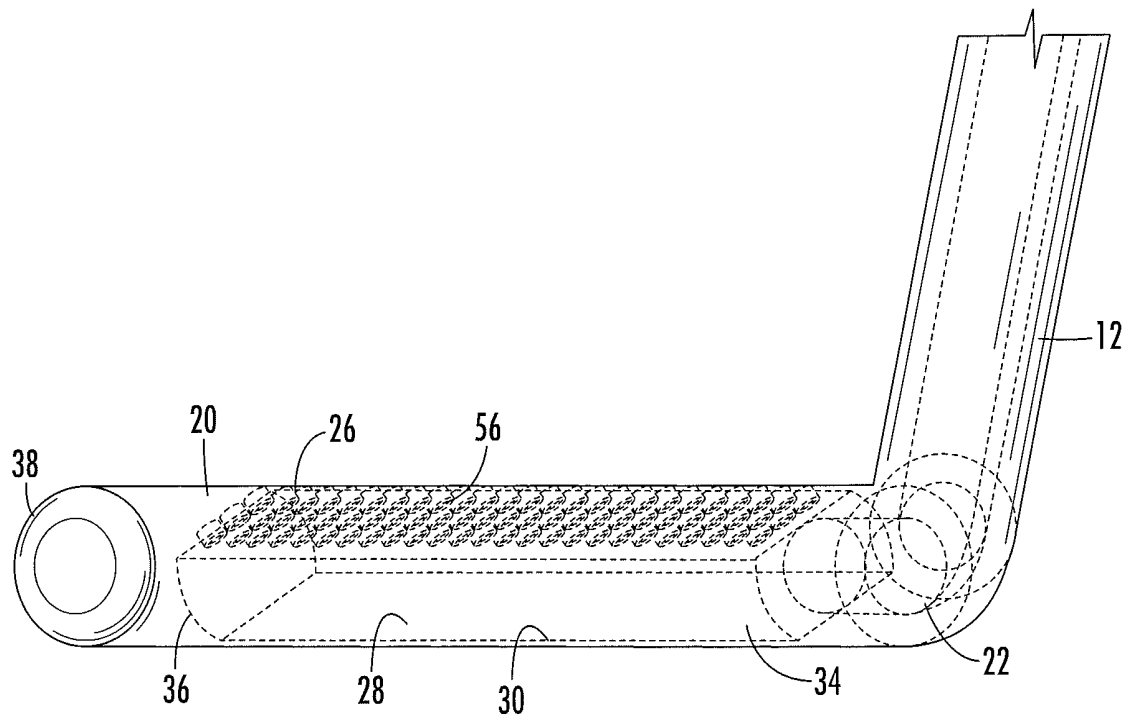
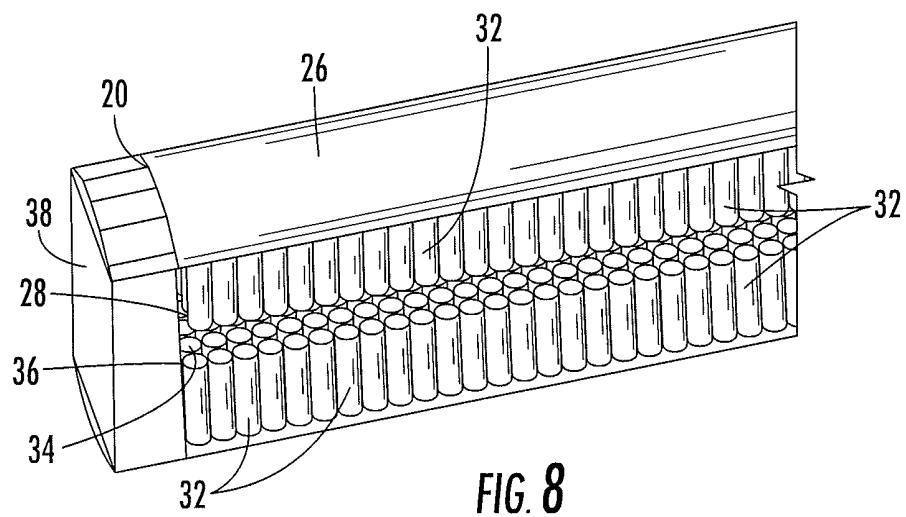
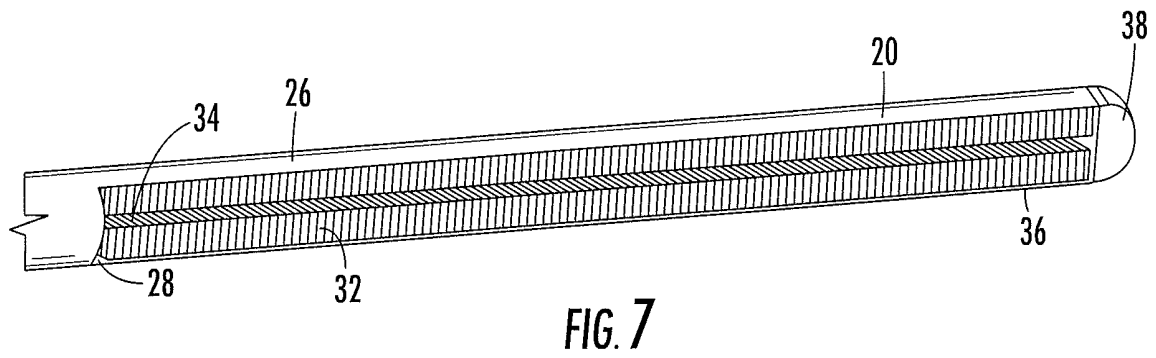
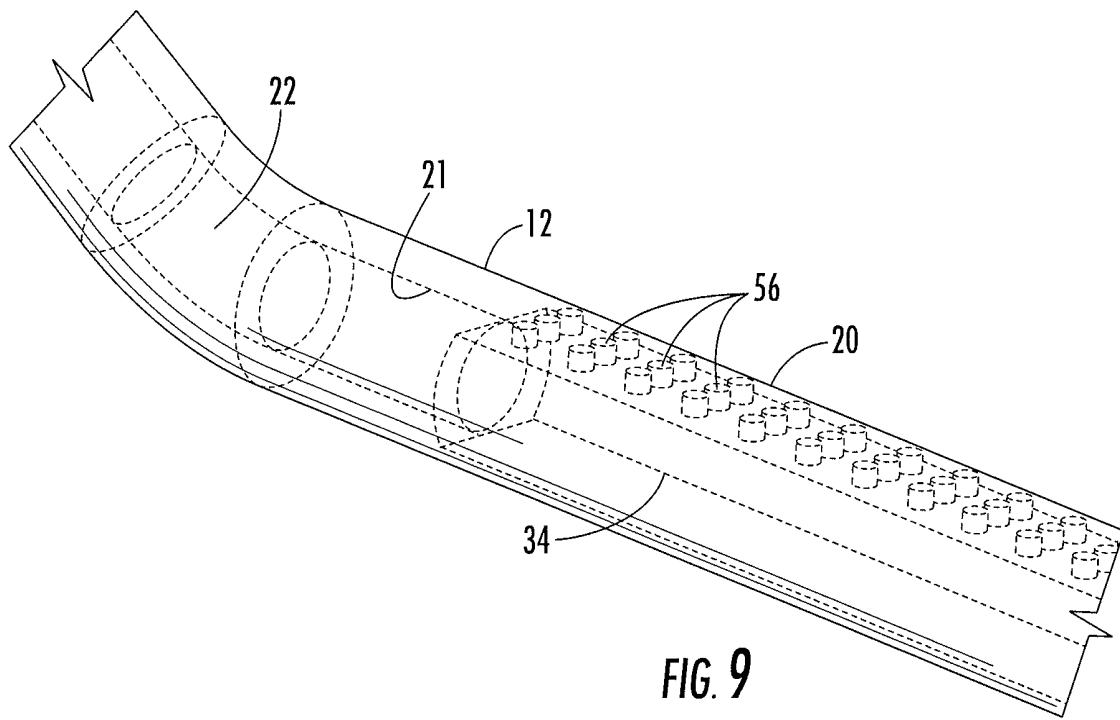


FIG. 6





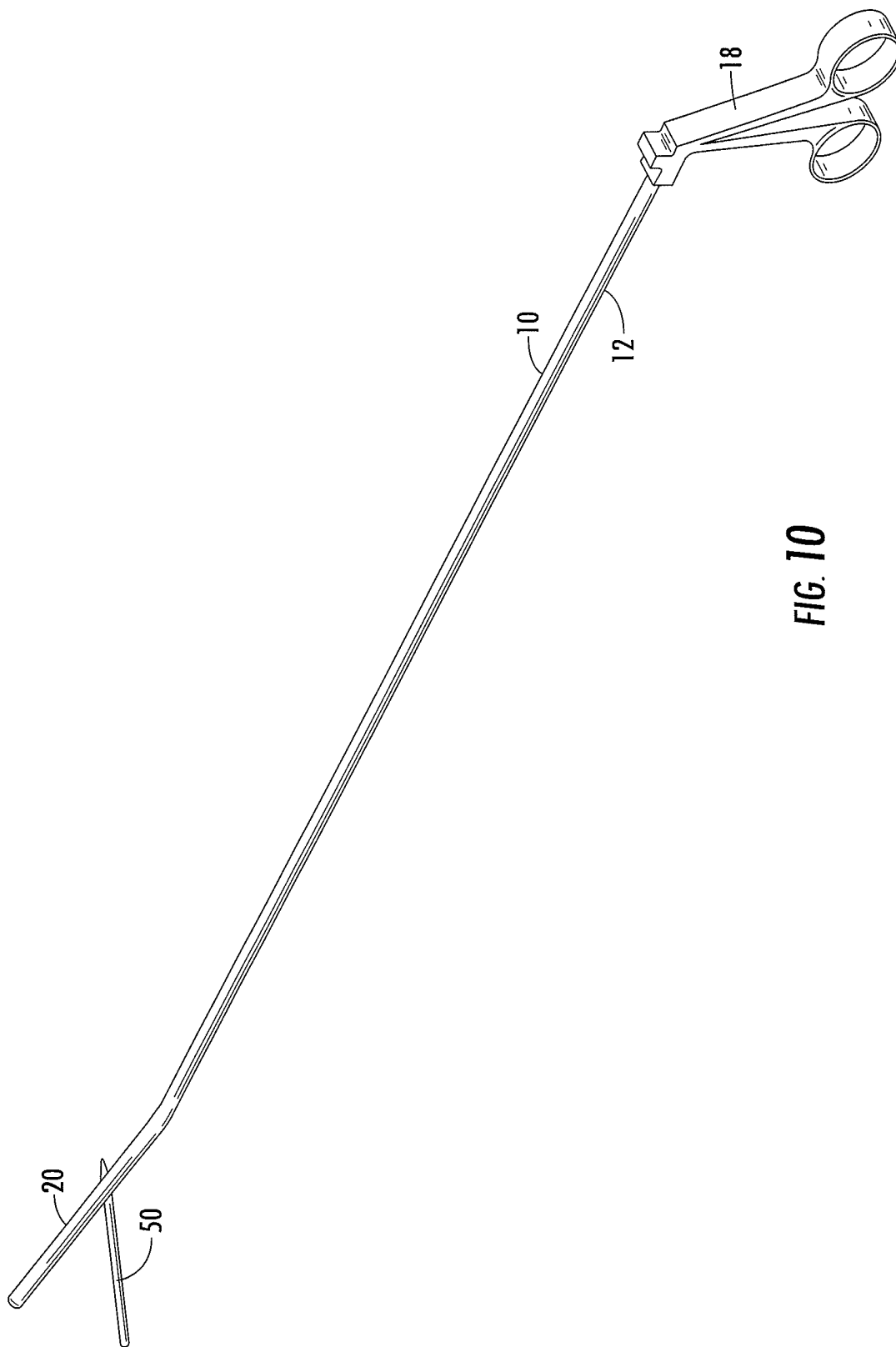
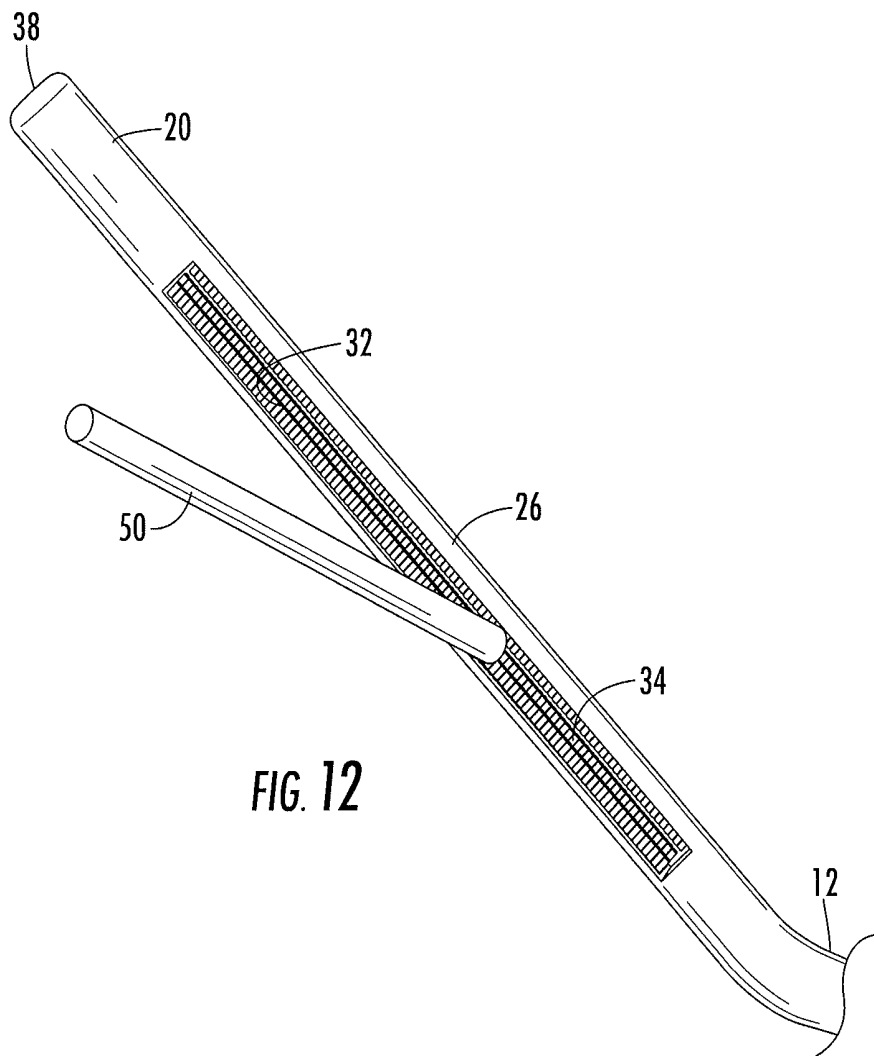
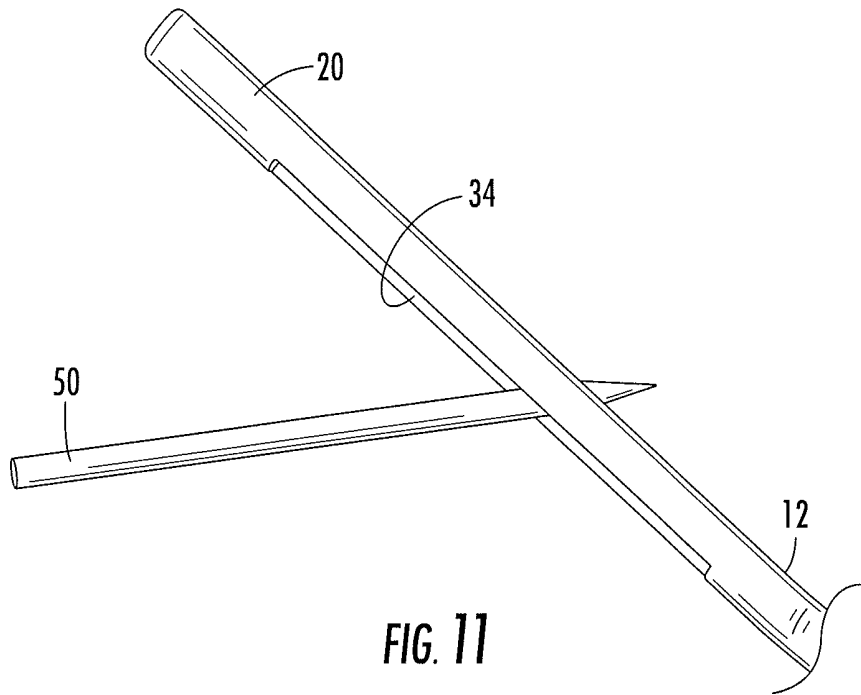


FIG. 10



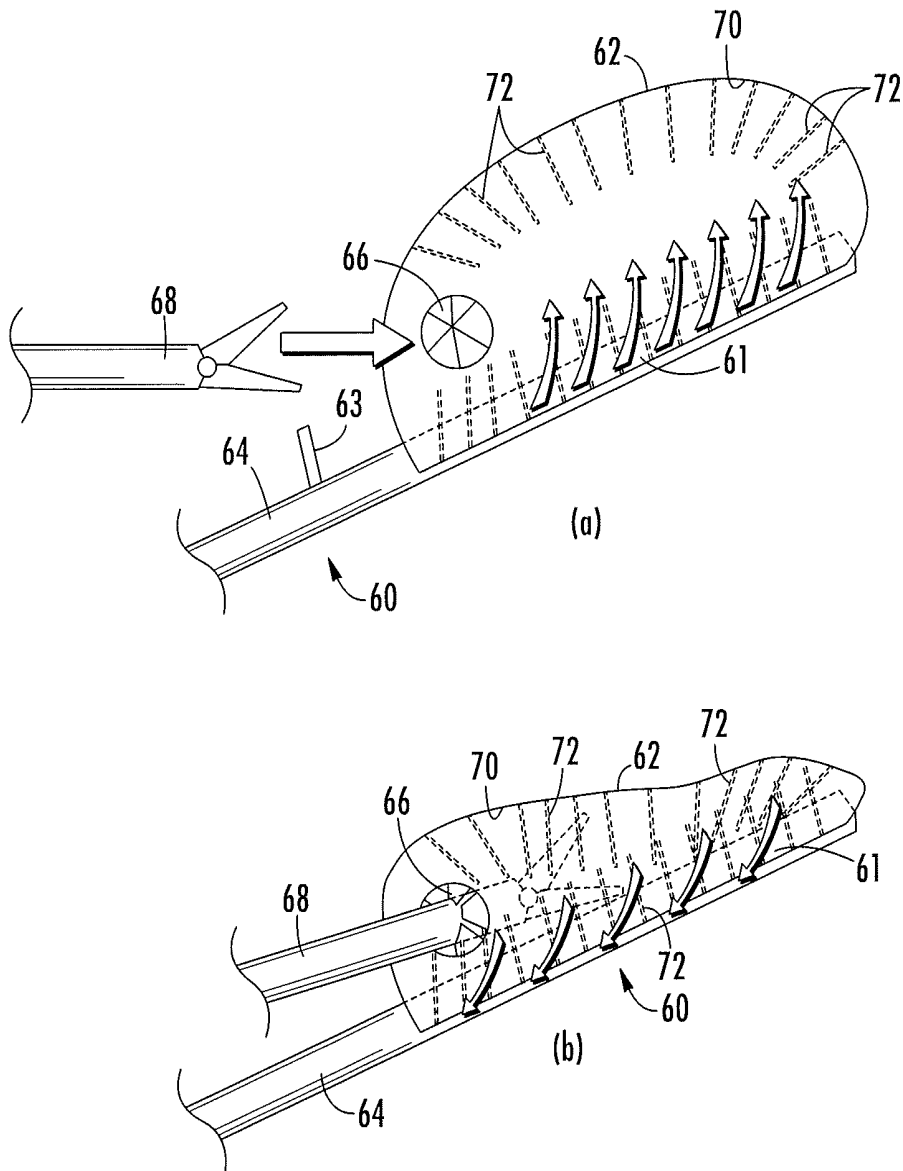


FIG. 13

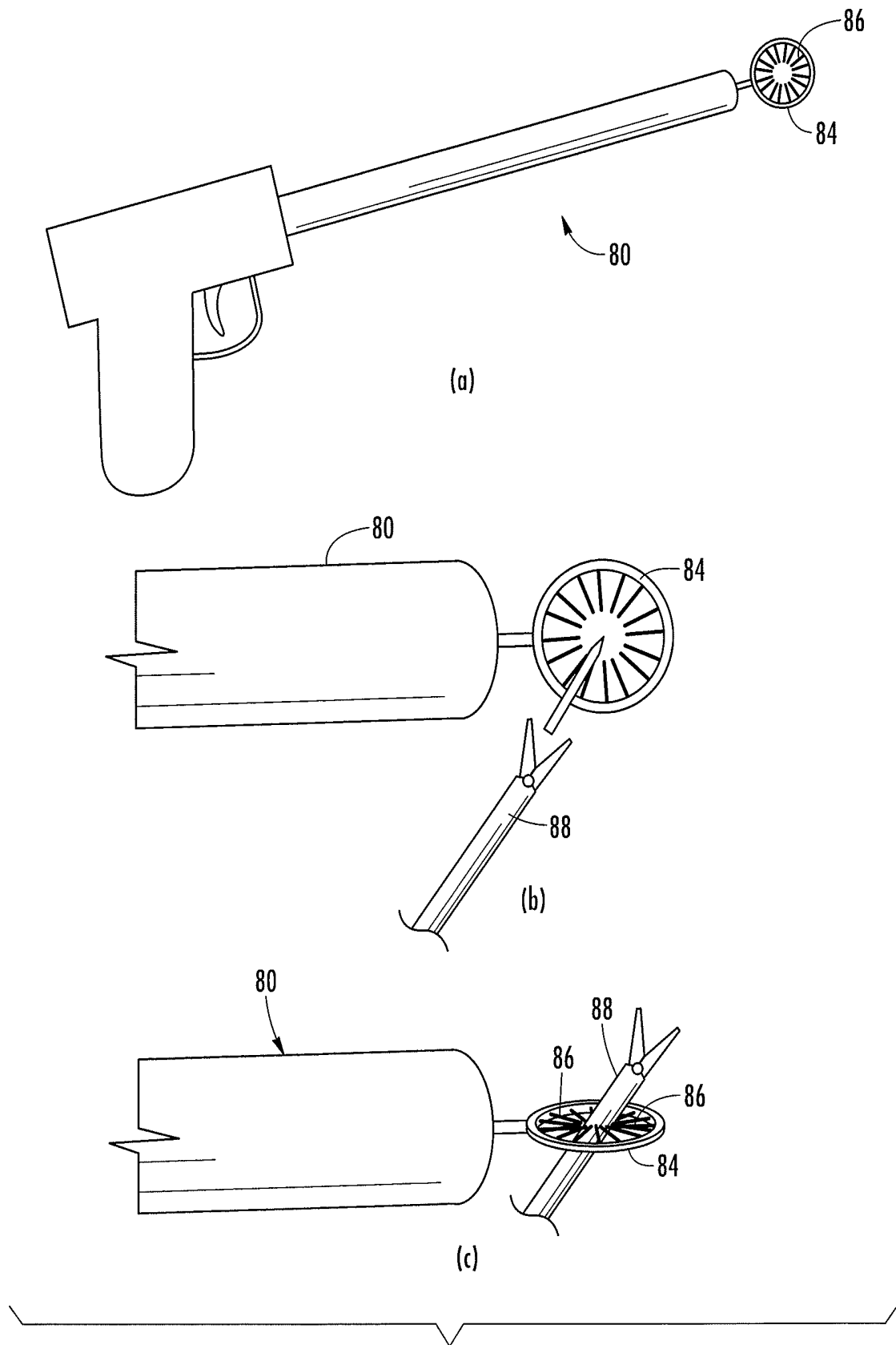
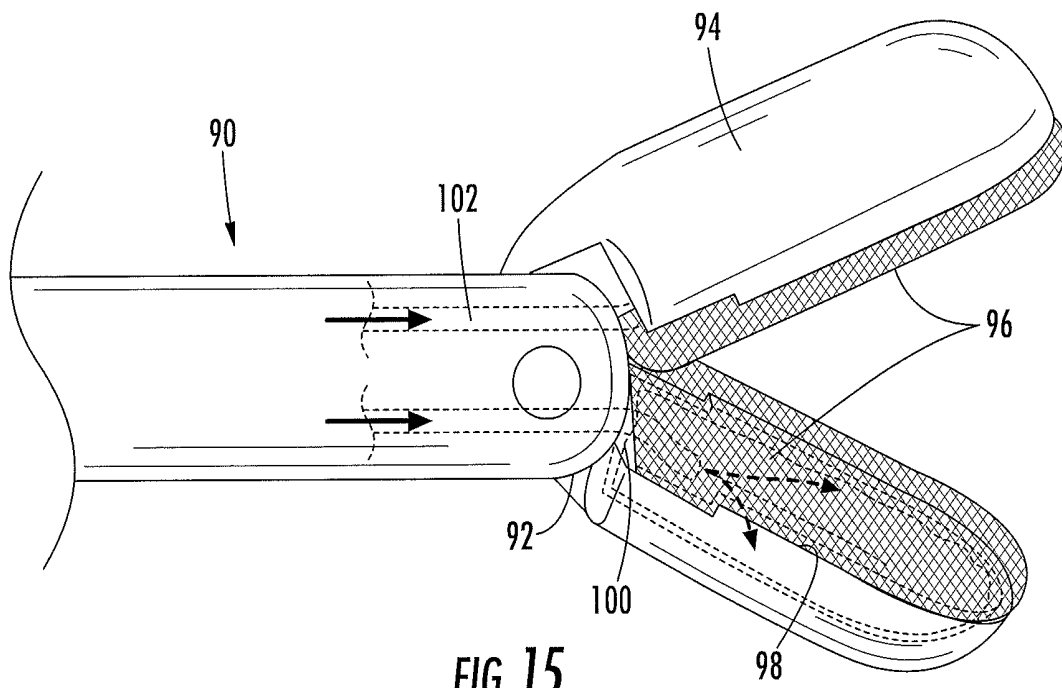


FIG. 14



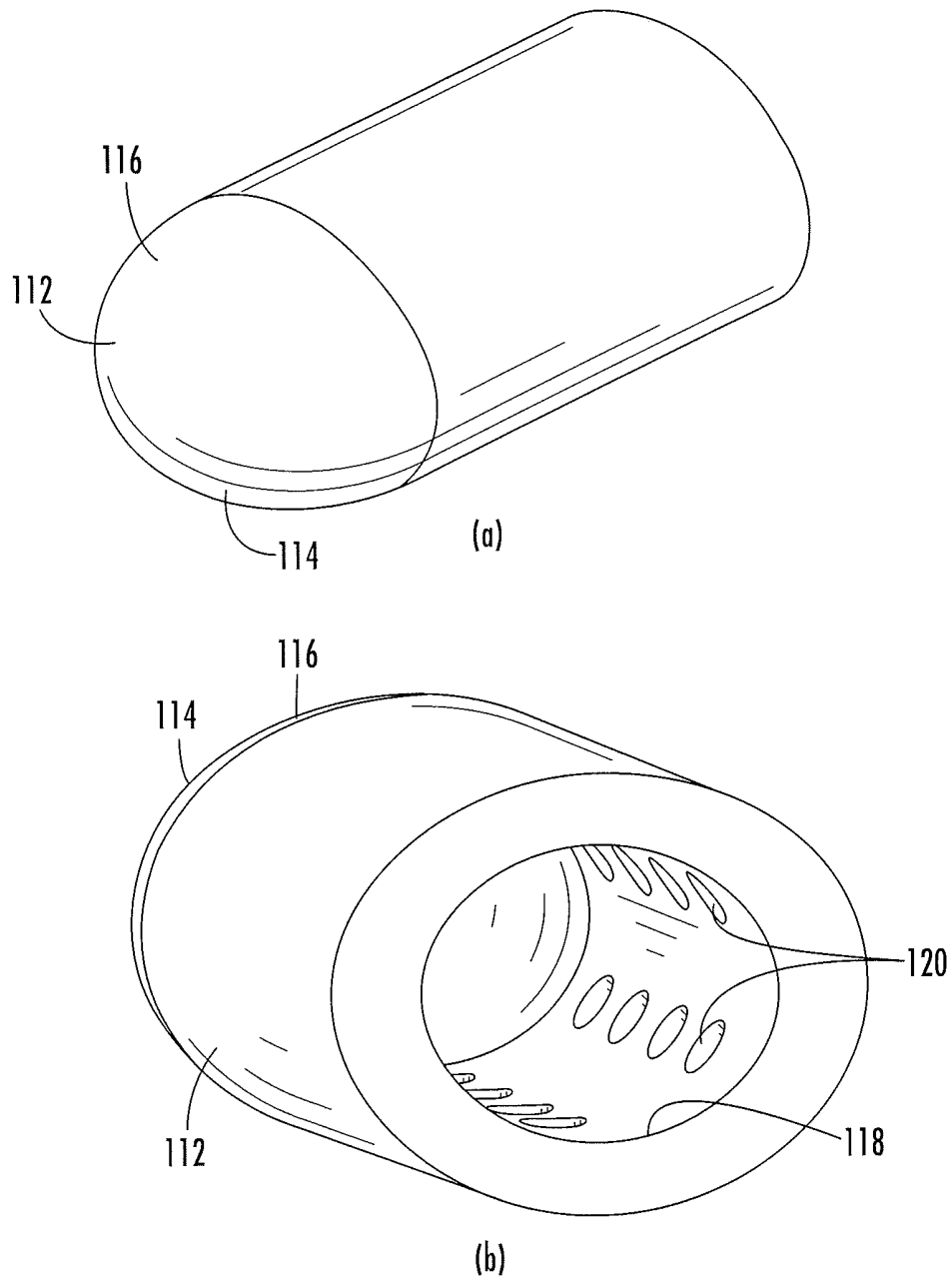
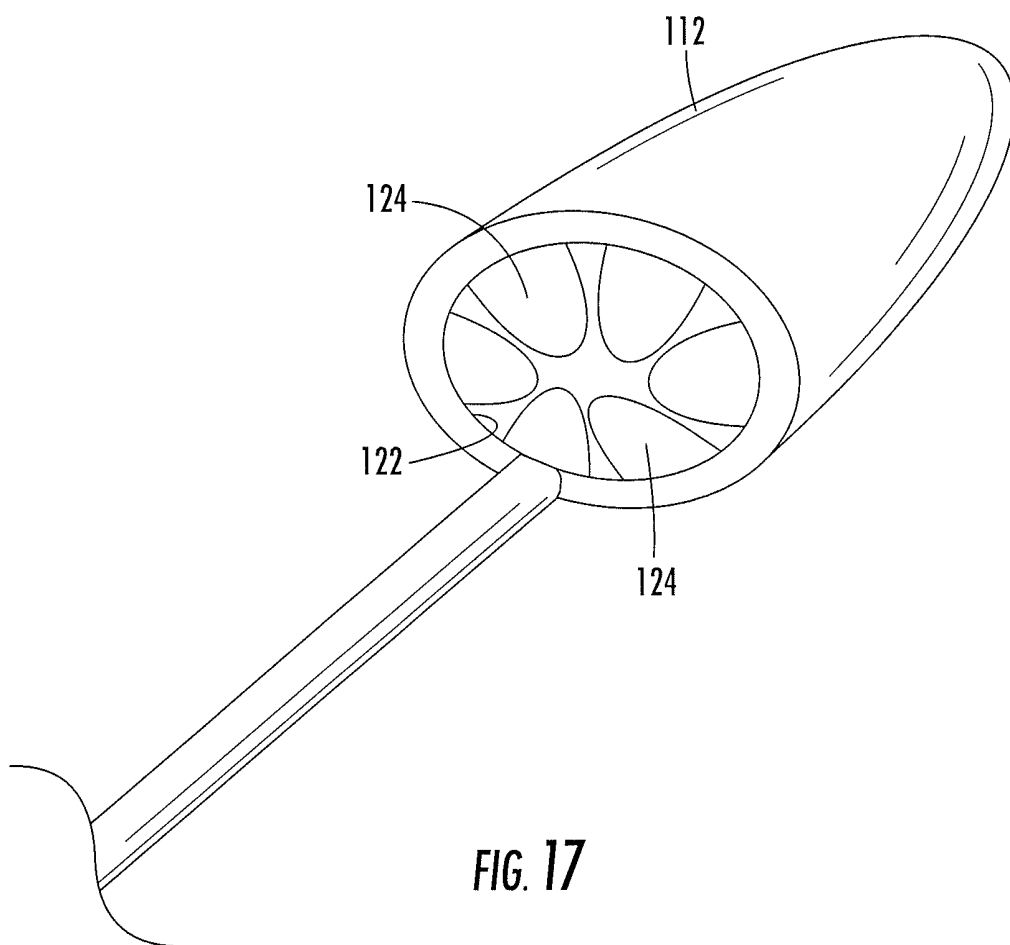


FIG. 16



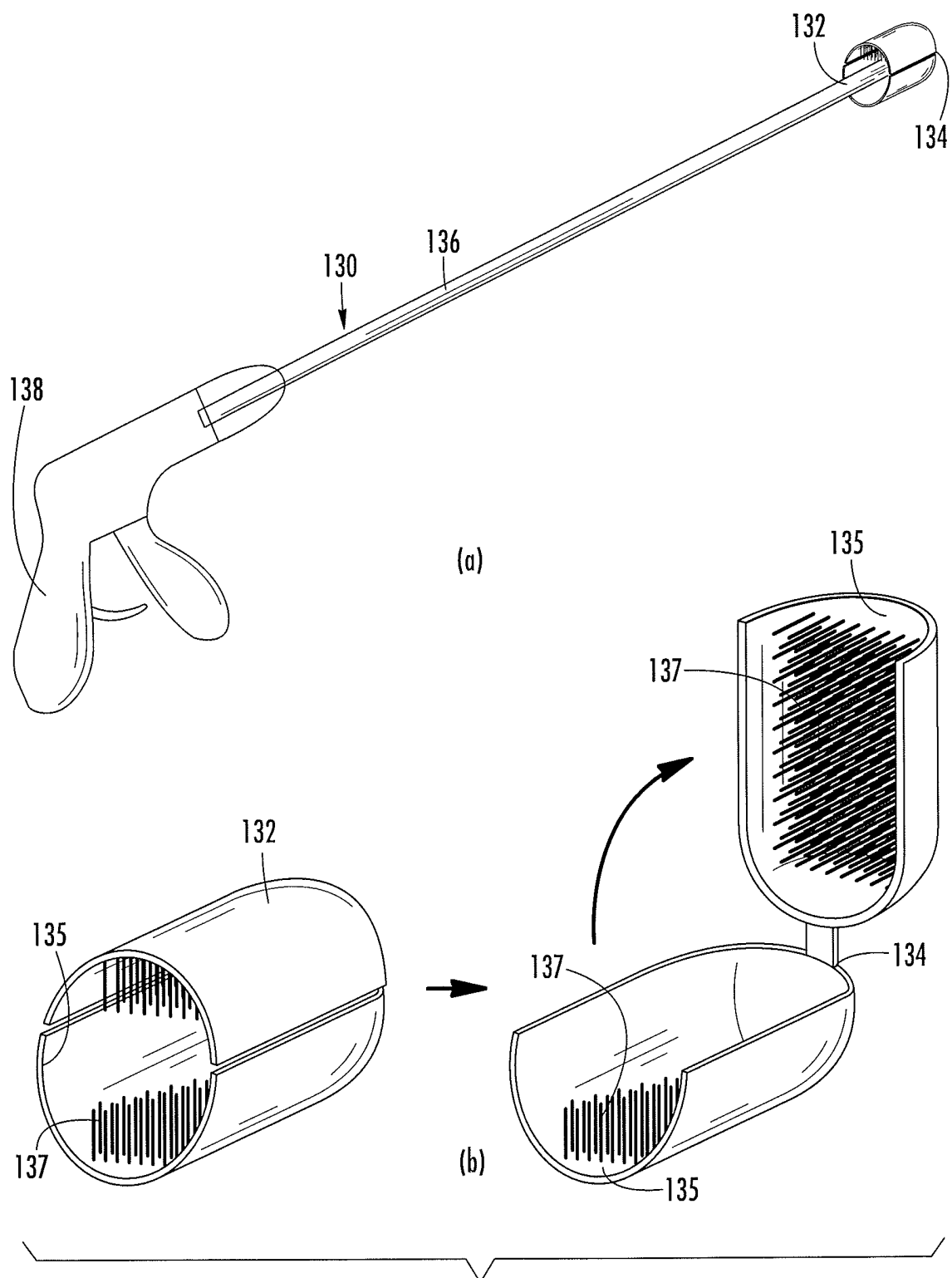


FIG. 18

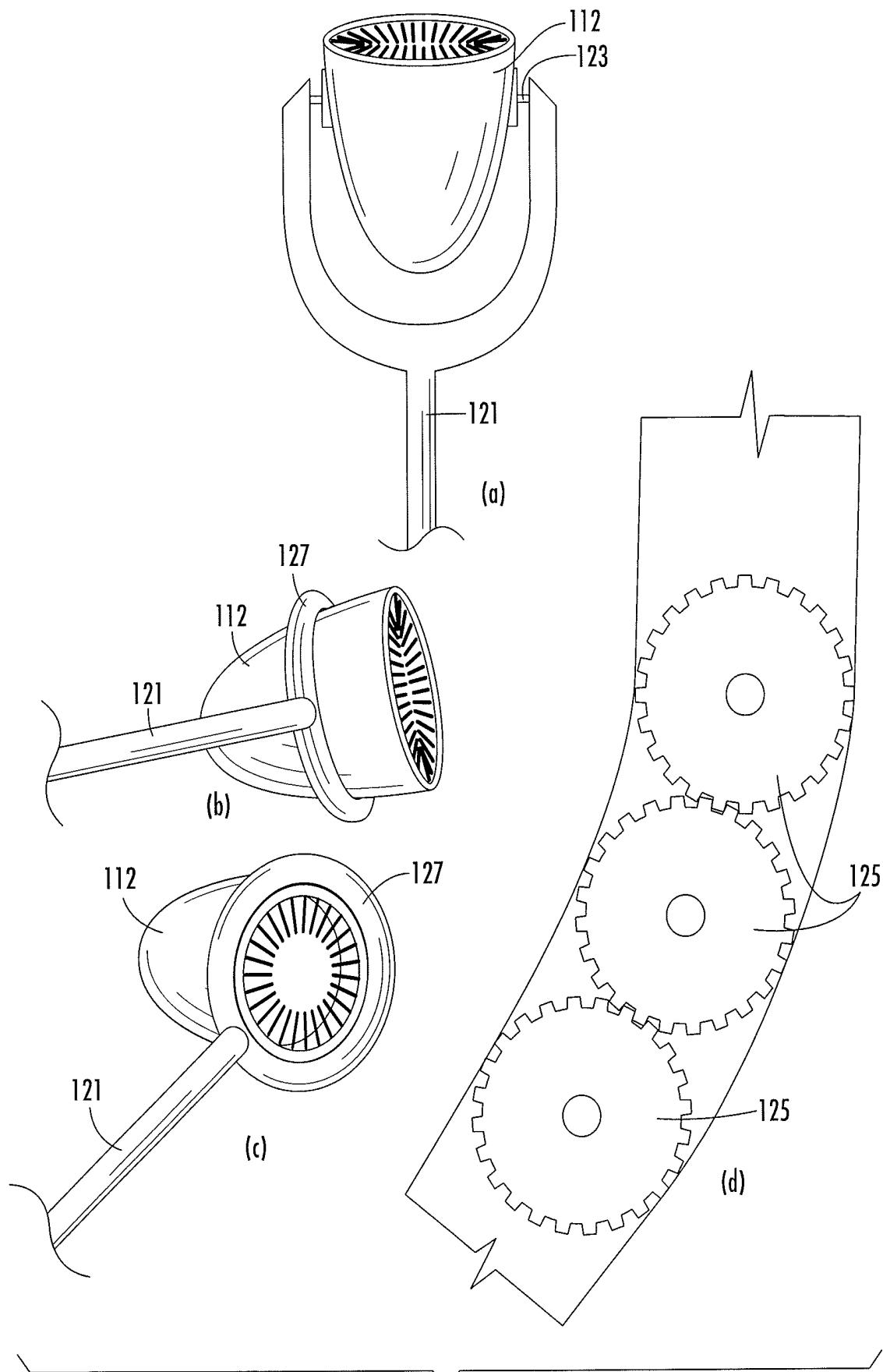
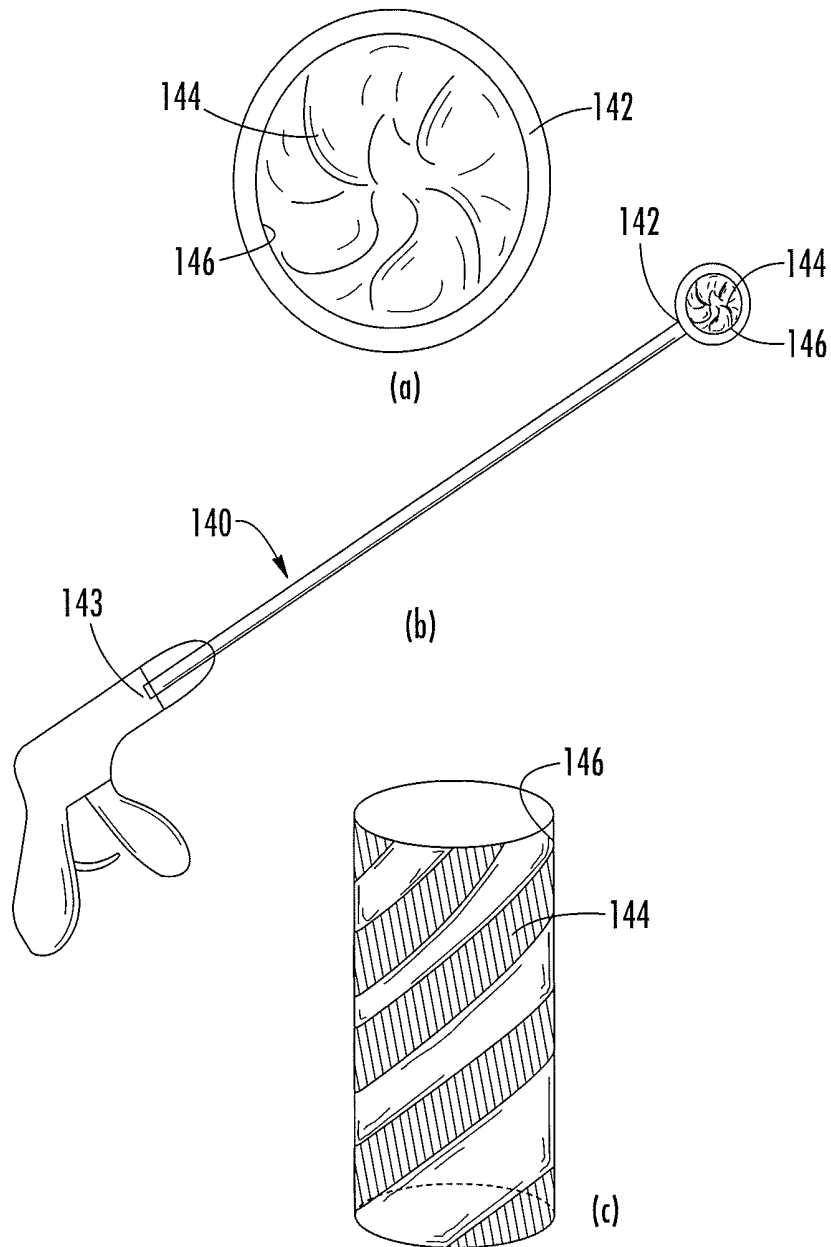


FIG. 19

**FIG. 20**

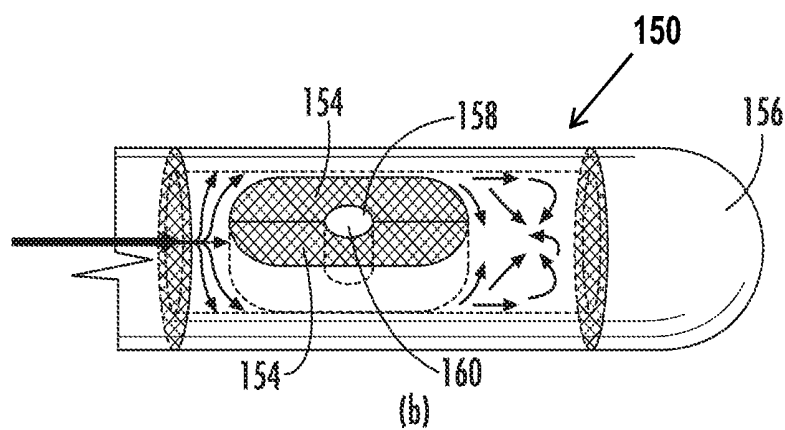
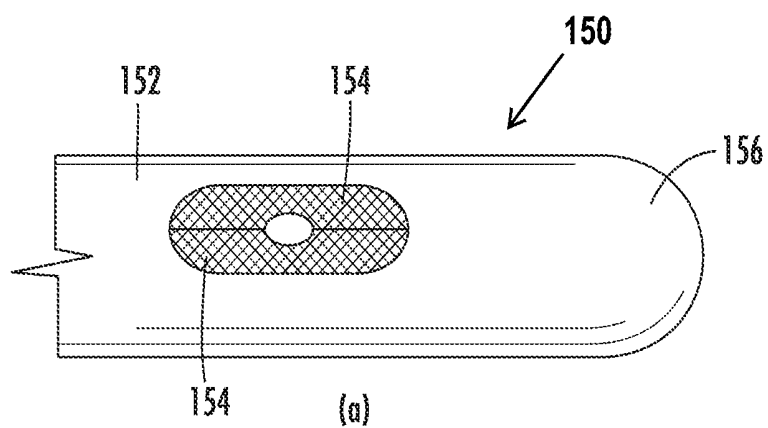
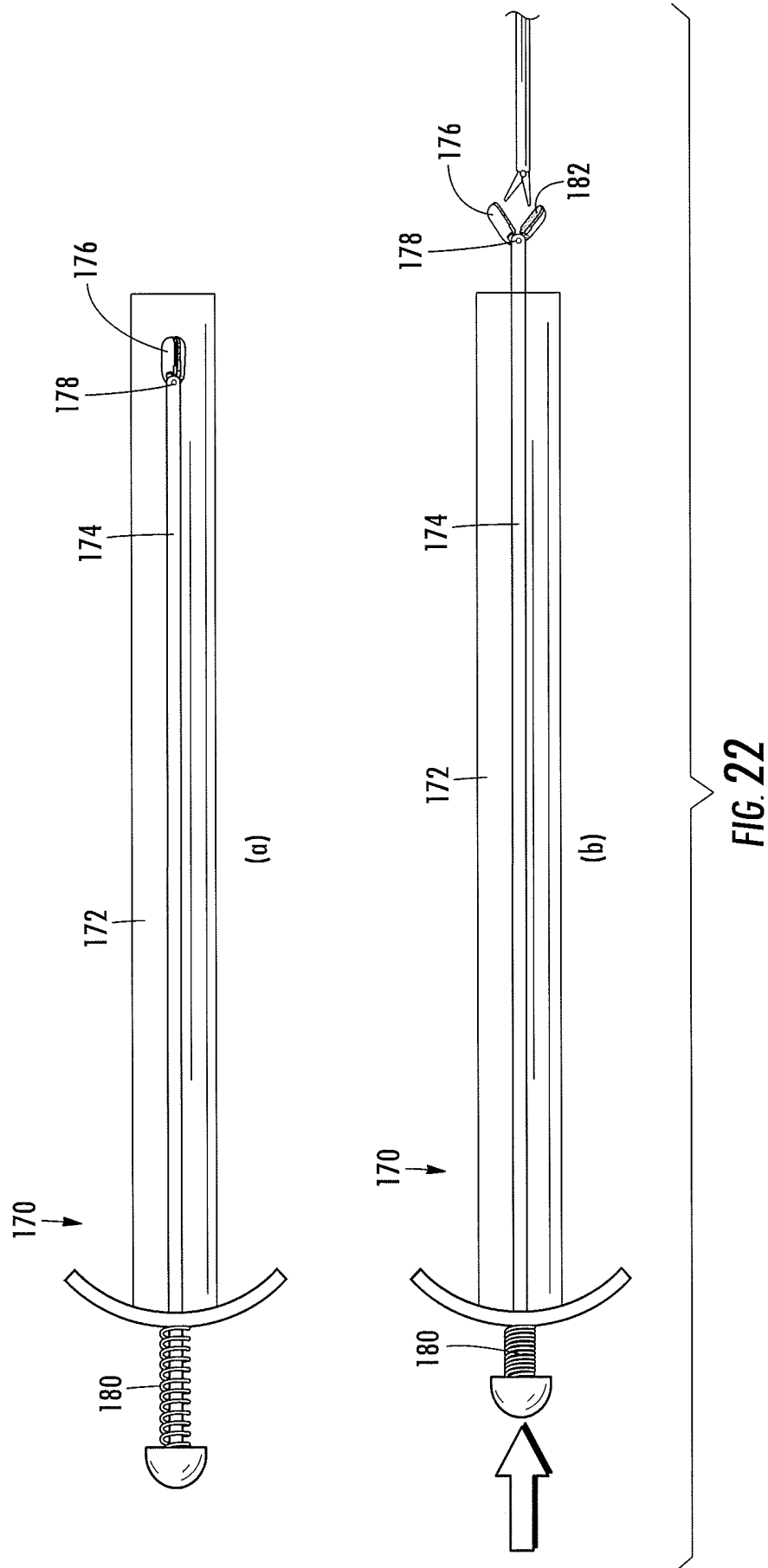


FIG. 21



1

SURGICAL CLEANING TOOL, SYSTEM, AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a national stage application of a PCT application having International Application No. PCT/US2015/062493, filed Nov. 24, 2015, which claims priority to U.S. Provisional Application having U.S. Ser. No. 62/083,740, filed Nov. 24, 2014, which claims the benefit under 35 U.S.C. 119(e). The disclosure of which is hereby expressly incorporated herein by reference.

BACKGROUND

Surgeons who use electro-cautery tools (e.g., “cautery tools,” “surgical tools,” “surgical instruments,” or “robotic tools,”) and/or laser tools within body cavities cause charring of patient tissue. The charred tissue builds up on the cautery tool surface and inhibits the effectiveness of the cautery tool. Currently, proper cleaning of these surgical tools requires removal of the surgical tool from the patient’s body to be cleaned manually, externally, by a surgical assistant. This cleaning process may be needed as often as every 5 to 10 minutes, depending on the surgery, and each tool removal step may consume as much as 1 to 2 minutes. Established practice for cleaning of the cautery tools dictates the use of cloth, gauze, sponge or abrasive (e.g., polyurethane) pads to remove charred tissue from the cautery tool and then reattaching the cautery tool to the robotic surgical system and reintroducing the cautery tool to the internal surgical site through an opening into the body cavity.

In an effort to avoid the time consumption required to clean surgical tools with this established practice, many surgeons scrape their surgical tools together at the surgical site (internally) to remove charred tissue from their instruments. Cupspoon or grasping forceps, a commonly used laparoscopic accessory tool manipulated by the surgical assistant, are also used for cleaning surgical instruments at the surgical site, but are only effective at removing large chunks of tissue. Therefore, cupspoon forceps do not resolve the charred tissue buildup problem. Furthermore, tool scraping is a dangerous practice, as contacting the tools in this manner can lead to accidental electrical arcing or the forceful release of tension from two tools being pressed together, leading to the potential for puncture wounds. Tool scraping also dulls bladed tools, leading to less effective instruments and shortened usable lifespan. New tools and methods to alleviate and resolve these problems would be desirable and it is to such a solution that the presently disclosed inventive concepts are directed.

BRIEF DESCRIPTION OF THE DRAWINGS

Several embodiments of the present disclosure are hereby illustrated in the appended drawings. It is to be noted however, that the appended drawings only illustrate several typical embodiments and are therefore not intended to be considered limiting of the scope of the presently disclosed inventive concepts.

FIG. 1 is an isometric view of one embodiment of a cleaning tool constructed in accordance with the present disclosure.

FIG. 2 is a side view of the cleaning tool of FIG. 1 in an angled position.

2

FIG. 3 is an end view of the cleaning tool of FIG. 1 in a straight position.

FIG. 4 is an end view of the cleaning tool in FIG. 1 in an angled position.

FIG. 5 is a side view of an end portion of the cleaning tool of FIG. 1 in the angled position.

FIG. 6 is a cut-away view of the end portion of the cleaning tool of FIG. 5.

FIG. 7 is a side view of the end portion of the cleaning tool of FIG. 1.

FIG. 8 is a close-up side view of the end portion of the cleaning tool of FIG. 7.

FIG. 9 is a transparent view of an end portion of another embodiment of a cleaning tool constructed in accordance with the present disclosure.

FIG. 10 is a perspective view showing the interaction between the cleaning tool of FIG. 1 and a surgical tool.

FIG. 11 is a top view of an end portion of the cleaning tool and surgical of FIG. 10.

FIG. 12 is a side view of the end portion of the cleaning tool interacting with the surgical tool of FIG. 10.

FIG. 13a is a perspective view and another embodiment of a cleaning tool having an end portion in an inflated position.

FIG. 13b is a perspective view and another embodiment of a cleaning tool having an end portion in a deflated position.

FIG. 14a is a side view of another embodiment of a cleaning tool having a cleaning element with a collapsible ring.

FIG. 14b is a side view of the cleaning element of the cleaning tool of FIG. 14 in an open position.

FIG. 14c is a side view of the cleaning element of the cleaning tool of FIG. 14 in a closed position.

FIG. 15 is a perspective view of another embodiment of a cleaning tool having an end portion with modified forceps.

FIG. 16a is a perspective view of another embodiment of an end portion of the cleaning tool of FIG. 1, the end portion having a bullet shape.

FIG. 16b is a perspective view of the end portion of FIG. 16a showing an inner surface of the end portion.

FIG. 17 is another embodiment of the end portion of FIG. 16a showing an inner cavity having flaps.

FIGS. 18a-18b are perspective views of another embodiment of a cleaning tool having an end portion having a hinge.

FIGS. 19a-19d are perspective views of another embodiment of an end portion of FIG. 16a with various methods of attaching the end portion to a shaft of the cleaning tool.

FIGS. 20a-20c are side views of another embodiment of a cleaning tool having a rotatable end portion.

FIGS. 21a-21b are side views of another embodiment of an end portion of FIG. 16a, the end portion having a rod with a plurality of entry points.

FIG. 22a is a side view of another embodiment of cleaning tool having an end portion in a retracted position.

FIG. 22b is a side view of the cleaning tool of FIG. 22a having an end portion in an expanded position.

DETAILED DESCRIPTION

The presently disclosed inventive concepts include a surgical accessory tool, referred to herein by the term IvTEC (“In-vivo Tool for Electrocautery Cleaning”) and also referred to herein as an “accessory tool,” “surgical accessory,” “cleaning tool,” or “surgical cleaning tool.” The cleaning tool provides surgeons, particularly those working

with robotic surgical systems, a way to clean surgical tools, including but not limited to those with electrocautery function, laser-cautery function, or other energy emitting capabilities, at the surgical site (inside the patient) without having to remove the surgical tool from the (intra-body) surgical site to be cleaned externally. As mentioned, this cleaning tool is particularly applicable to robotic surgeries, but has applications in other surgeries including, but not limited to, general laparoscopic surgeries, open surgeries, and combined open, robotic, and/or laparoscopic surgeries. In each, also as mentioned, this cleaning tool has utility in cleaning electrocautery tools, tools with laser functions, and any other surgical instruments that emit thermal energy against tissue.

The present application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application Ser. No. 62/083,740, filed Nov. 24, 2014, entitled "SURGICAL CLEANING TOOL, SYSTEM AND METHOD," which is hereby expressly incorporated herein in its entirety.

The cleaning tool disclosed herein enables in-vivo cleaning of surgical tools and combines the effectiveness of the established (external) cleaning practice with the convenience and time-savings of an internal method. Referring now to the drawings, and more particularly to FIG. 1, shown therein is one non-limiting embodiment of a cleaning tool **10** constructed in accordance with the inventive concepts disclosed and claimed herein. The cleaning tool **10** includes a shaft **12** having a distal end **14** and a proximal end **16**, a handle **18** graspable by a user (not shown) attached to the distal end **14** of the shaft **12**, and an end portion **20** connected to the proximal end **16** of the shaft **12**.

Components of the cleaning tool **10** can be made of materials including, but not limited to metal, metal alloys, plastic and/or polymers, a coated metal, a ceramic material, or a rigid or semi-flexible plastic material, such as, but not limited to, a high density polyethylene (HDPE), acrylonitrile butadiene styrene (ABS), or other synthetic, carbon-based polymer or combination thereof. Some components may be autoclaved and/or sterilized. Components may also be constructed of sterile materials.

The shaft **12** may be solid or hollow or partially hollow and may be constructed of similar materials as disclosed herein, such as, but not limited to, rigid or semi-flexible plastic materials, metals, or medical grade coated or uncoated metals, such as stainless steel (S.S.) **440C** or aluminum or combinations thereof. Similarly, the handle **18** can be constructed of a material such as described herein. The shaft **12** may have a separate tube or conduit **21** longitudinally attached thereto or externally integral thereto for supplying a saline solution to the end portion **20**. The shaft **12** attaches the end portion **20** to the handle **18**. The handle **18** of the cleaning tool **10** is similar to that used to manipulate existing laparoscopic tools known in the art.

The end portion **20** may be connected to the shaft **12** by a hinge mechanism **22** (also referred to herein as an angling mechanism) which is adjustable in two or three dimensions, as shown in FIGS. 2-6. The hinge mechanism **22** is positioned between the end portion **20** and the proximal end **16** of the shaft **12**. A trigger mechanism **24** is positioned in the handle **18** that enables actuation of movement of the hinge mechanism **22** by the user to effect a change in an angle of the end portion **20** in relation to the shaft **12**. The angle of the end effector **20** in relation to the shaft **12** may be changed from 0° to 90° or more to allow better surgical tool access to the cleaning surface of the end effector **20**. In certain embodiments, the change of angle of the angling mechanism is controlled with a trigger or button **25** that the assistant

controls (See FIG. 1). The trigger or button **25** may control the action of the trigger mechanism **24** via one or more narrow metal rods, cables, wires, string, springs, and/or pulleys, or any combination of these or similar, small, mechanical structures. The action of the trigger **25** is translated to the angling motion of the angling mechanism **22** for changing the orientation of the end effector **20** in two dimensions or three dimensions. In certain embodiments, the trigger **25** angles the end effector **20** in one of two directions. These two directions are 180° offset from each other, i.e., the end effector **20** can angle left or right. Multidirectional functionality (more than 2 directions of motion) and other degree offsets (45°, 60°, or 120°, for instance) may also be included. A locking mechanism (not shown) may optionally be present to allow the end effector **20** to remain stationary and stable in any fraction of its range after the trigger **25** has moved the end effector **20** to the desired angle. The hinge (angling) mechanism **22** may comprise one or more 'joint like' hinges. The hinge mechanism **22** may also allow for a "rotational" ('wristed') movement similar to that of the Da Vinci robotic surgical arms. The external diameter **23** of the shaft **12** of the cleaning tool **10** is minimized in certain embodiments so that it can be inserted into a 5 mm diameter (or other sizes as indicated below) laparoscopic port and safely introduced to the surgical site.

The cleaning tool **10** may also have an element **27**, such as a small tab, flange, extension, or handle attached to the end portion **20** (FIG. 1) or elsewhere along the shaft **12** that is graspable by the surgeon's robotic tools, enabling the surgeon to manipulate and reposition the cleaning tool **10** as desired.

Referring to FIGS. 1, 2, 3, and 7-9, the end portion **20** (also referred to herein as an end effector) has an outer surface **26**, an inner cavity **28**, an inner surface **30**, at least one cleaning element **32** and an opening **34** in a wall portion **36** of the end portion **20**. The at least one cleaning element **32** is connected to at least a portion of the inner surface **30**. The end portion **20** is a hollow shell constructed of a material such as, but not limited to, a coated metal, a ceramic material, or a rigid or semi-flexible plastic material, such as, but not limited to, a high density polyethylene (HDPE), acrylonitrile butadiene styrene (ABS), or other synthetic, carbon-based polymer or combination thereof. The opening **34** is for receiving a surgical tool.

The tip **38** of the end portion **20** of the cleaning tool **10** can be rounded so as to avoid the potential for puncture wounds and can be easily and quickly removed from a port at any time. The cleaning tool **10** has been designed to be removable quickly without the potential of a "barbed hook effect," so that removal of the cleaning tool **10** through the laparoscopic port is not inhibited.

As noted, the end portion **20** of the cleaning tool **10** has a cleaning element **32** (also referred to herein as a cleaning surface) into which the surgical tool is inserted wherein the surgical tool is rubbed, scraped, scoured, or otherwise moved against the cleaning element **32** to cause removal of charred tissue from the surgical tool using friction. The cleaning element **32** may be constructed of traditional materials used for cleaning, such as, but not limited to, bristles, protuberances, brushes, pads, open- or closed-cell foam, natural or synthetic sponge, porous inert substances, cotton, fabrics, natural or synthetic materials, polymeric materials such as nylon or polyurethane, flexible materials, and/or rigid materials. The cleaning element **32** can be made of a single material or a combination of materials from classes such as polyurethane, nylon, polyethylene, or other synthetic, carbon-based polymers, as well as other materials

described elsewhere herein. The cleaning element **32** of the end portion **20** may be attached to the inner surface **30** of the end portion **20** through chemical adhesion or physical attachment, or any other suitable means.

Generally, laparoscopic surgical port dimensions range from 3 mm to 12 mm, so the external diameter of the cleaning tool shaft and end effector will be less than 12 mm, for example in a range of from about 3 mm to 7 mm. In one embodiment the external diameter of the shaft and end effector is 5 mm. In certain non-limiting embodiments, the end effector has a length in a range of about 2 mm to about 100 mm, or for example a range of about 20 mm to about 50 mm. The entire cleaning tool from the tip of the end effector to the handle will generally have, but is not limited to, a length in a range of from about 150 mm to about 1000 mm, for example in a range of from about 300 mm to about 600 mm. In one embodiment, the cleaning tool has a length in a range of about 400 mm to about 500 mm. The handle has dimensions which are about the same as handles used on other commonly used laparoscopic instruments.

Another benefit of the cleaning tool disclosed herein, in certain embodiments, is the ability to use it to cool a surgical tool so that the risk of thermal injury to tissues or organs by a hot electro-cautery tool may be reduced. In certain embodiments, cool saline solution can be provided through or adjacent the shaft and applied onto, through or into the cleaning element of the cleaning tool (as explained below) so that heat energy of the hot electro-cautery tool may be quickly removed/dissipated as it is cleaned. The cleaning tool end effector could also be soaked in saline prior to insertion and the retained fluid would also aid in cooling of the instrument. The cooling saline is also used to help prevent thermal distortion of the materials of the cleaning element of the cleaning tool. By taking advantage of the relatively high heat capacity of water, thermal energy may be rapidly removed from the surgical cautery tool, thus protecting both the patient and the cleaning element material.

Method of Cleaning Tool Insertion/Assistant Interaction

In use, a surgical assistant manually inserts the cleaning tool **10** through a laparoscopic port or through an open cavity and maneuvers the accessory tool to the surgical site of the patient. In general, the cleaning tool **10** is not maneuvered by, manipulated by, or coupled to other surgical instruments, such as a Da Vinci Surgical System™ forceps. In certain embodiments, however, the cleaning tool **10** may also have a small “tab,” “flange,” “extension,” or “handle” attached to a portion thereof, for example, along the shaft or on the effector end that is graspable by the surgeon’s surgical tools, enabling the surgeon to manipulate and reposition the cleaning tool as desired. The surgical assistant controls the cleaning tool **10** externally by using the handle (FIG. 1) which remains outside of the patient’s body.

Method of Use of Cleaning Tool to Clean Surgical Tool

Referring to FIGS. 10-12, a surgical tool **50** is utilized with the cleaning tool **10** as described herein. During a surgical procedure, the surgical tool **50** has been inserted by a surgeon into a body cavity or internal site of a patient. After use, charred tissue accumulates on the surgical tool **50**. The surgeon partially or completely inserts the surgical tool **50** into the opening **34** of the end portion **20** having the cleaning element **32**, wherein the tool **50** is rubbed, scraped, and/or scoured by or against the cleaning element **32**, e.g., bristles, to remove charred tissue from the surgical tool **50**. The end portion **20** may also have one or more water jets (not shown) to aid in the removal of the charred tissue. The surgical tool **50** can be inserted into the end portion **20** of the

cleaning tool **10** from several different angles, including either of the two open sides **34a** and **34b**, the end of the tool **10** (should an end cap **52** be removed from the cleaning tool **10**), other entry ports (should more than 2 lengthwise openings be included in the design), or an opening orthogonal to the plane of insertion (an opening facing “backward” toward the laparoscopic port through which the cleaning tool may be inserted). The surgical tool **50** is manipulated by surgeon to contact the cleaning element **32** of the cleaning tool **10** as described above to apply force to the surgical tool **50** and charred tissue thereon to achieve desired tissue removal from surgical tool **50**. The cleaning tool **10** remains stationary, unless angling of end portion **20** or repositioning of the tool **10** is desired by the surgeon, at which point the surgical assistant manipulating the cleaning tool **10** controls the angle with handle **18** or positional change by physically moving or rotating the tool **10**. Primary control and orientation of the cleaning tool **10** is done externally by the assistant. These movements are independent of the surgeon or robotic surgical system. The cleaning tool **10** may be removed from (or inserted into) the patient at any time. Positioning of the end portion **20** of the cleaning tool **10** is also dependent upon how far the tool **10** is inserted into the patient, the same as with any laparoscopic accessory tool used by surgical assistants.

As noted above, the cleaning tool **10** may also have the element **27**, such as small tab, flange, extension, or handle attached to the end effector **20** or elsewhere along the shaft **12** that is graspable by the surgeon’s robotic tools, enabling the surgeon to manipulate and reposition the cleaning tool **10** as desired. The supports or cap **52** of the end effector tip **38** may also be used for this surgeon-guided function. This feature of enabling the surgeon to guide the tool **10** increases the versatility of the cleaning tool **10** and enables the tool **10** to be more easily and more efficiently positioned near the surgical site for easier access to the cleaning element **32** in certain situations.

As noted above, referring to FIG. 9, a cooling effect may be performed during the cleaning operation through the use of cool saline solution, particularly when intense surgical tool power settings, and therefore high temperatures, are involved. In certain embodiments the cool saline solution is provided through the conduit/tube **21** within the shaft **12** of the cleaning tool **10** (or alternately via a tube attached to the outside of the shaft) and supplied to cleaning element **32** through small holes **56** on the inner surface **30** of the end effector **20** where the cleaning element **32** is connected to the inner surface **30**.

Referring now to FIGS. 13a and 13b, shown therein is another embodiment of a cleaning tool **60** similar to the cleaning tool **10** except that a cleaning element **61** of the cleaning tool **60** includes an inflatable balloon **62** moveable between an inflated position (FIG. 13a) and a deflated position (FIG. 13b). Various mechanisms known for inflating and deflating an object may be utilized for inflating and deflating the balloon **62** with air and may be positioned in the shaft **64** of the cleaning tool **60**. The balloon **62** has a single, one-way valve **66** for receiving a tool **68**, such as a cauterizing tool, and an inner surface **70** having bristles **72**. In use, for example, the cauterizing tool **68** having charred material is inserted through the valve **66** of the balloon **62** while in the inflated position. A suction mechanism (not shown) is triggered to collapse the balloon **62** into the deflated position. The bristles **72** are used to scrap off the charred material on the cauterizing tool **68**. The charred tissue/material removed from the tool **66** is contained inside of the balloon **62**. The cleaning tool **60** similar to cleaning

tool **10** may also have an element **63**, such as a small tab, flange, extension, or handle attached along the shaft **64** that is graspable by the surgeon's robotic tools, enabling the surgeon to manipulate and reposition the cleaning tool **60** as desired.

Referring now to FIGS. **14a-14c**, shown therein is another embodiment of a cleaning tool **80** similar to the cleaning tool **10** except that a cleaning element **82** of the cleaning tool **80** comprises a collapsible ring **84** having bristles **86**. The collapsible ring **84** is movable between an open position (FIG. **14b**) and a collapsed position (FIG. **14c**). In use, a surgical tool **88** is inserted into the open ring **84** of bristles **86** in the open position. The ring **84** is compressed (e.g., through trigger or other mechanism action) into the collapsed position in order for the bristles **86** to come into contact with the tool **88** so as to remove any charred tissue from the tool **88**, as discussed herein.

Referring to FIG. **15**, shown therein is another embodiment of a cleaning tool **90** similar to the cleaning tool **10** except that a cleaning element **92** includes modified forceps **94** movable between an open position and closed position. The modified forceps **94** are similar to cupspoon forceps, a common laparoscopic tool. However, the forceps **94** includes bristles or an abrasive pad **96** on the inside surface **98** of jaws **100** of the forceps **94**. In use, a surgical tool, such as a cautery tool, (not shown) is positioned on the inside surface **98** of the jaws **100** in the open position. This would allow the surgeon's assistant to clamp down and close the jaws **100** on the surgical tool and use pressure and friction to remove charred tissue from the tool. A cooling system **102** may be provided that would supply water, or possibly saline, to the mouth of the forceps **94**. This allows for a better cleaning capability as well as cooling down the tool and preventing the bristles or pads **96** of the forceps **94** from being damaged from the heat of the tool.

Referring to FIGS. **16a** and **16b**, shown therein is another embodiment of an end portion **112** for a cleaning tool similar to the cleaning tool **10**. The end portion **112** has a bullet shaped tip **114**, such as a cylinder with a domed end **116** and a single opening **118** that would be lined with plastic bristles or possibly another similar cleaning surface such as abrasive pads (not shown). In use, an operating surgeon would insert surgical tools into the opening **118** of the bullet shaped tip **114** and remove charred tissue from the tools via contact and friction with the abrasive surface. This design allows for the collection of charred tissue, the supply of liquid to the cavity via a plurality of ports **120** as shown in FIG. **16b**, and to the adaption of being either a manual or a motorized tool. This system may be used in open robotic procedures such as transoral robotic surgery. The handle may be malleable and the shape changed by the assistant at the bedside to allow the end portion to reach the surgeons cautery/laser tool.

Referring to FIGS. **19a-19d**, the end portion **112** may be attached to a shaft **121** by hinges **123** so that the end portion **112** may be rotated 180°. The end portion **112** may also be fixed to the shaft **121** by a ring **127** at various angled degrees. In another embodiment, the end portion **112** may be connected to the shaft **121** with gears **125** for angling the end portion **112**. The end portion **112** would be rotatable mechanically via the gears **125** operationally connected to a trigger on the handle of a cleaning tool as described herein. Movement of the gears **125** may be motorized.

In another embodiment, an inner cavity **122** of the end portion **112** includes a plurality of flaps **124** for collecting charred tissue once it has been removed from a surgical tool tip, such as a cautery tool (FIG. **17**). The plurality of flaps **124** may be constructed of rubber, plastic and the like. The

flaps **124** allow the surgical tool to be inserted into the end portion **112** and to scrap the char from the tool as it is removed from the end portion **112**.

Referring to FIGS. **18a** and **18b**, another embodiment of a cleaning tool **130** similar to the cleaning tool **110** is shown herein except that an end portion **132** at the end of a shaft **136** is split in half along a hinge **134**. The hinge **134** allows the end portion **132** to be opened wider for receiving a surgical tool, as opposed to having a single point of entry. The hinge **134** is controlled via a trigger mechanism of a laparoscopic tool handle **138** as disclosed herein. An inner surface **135** of the end portion **132** includes a plurality of cleaning elements **137** for cleaning off a surgical tool.

Referring to FIGS. **20a-20c**, shown therein is another embodiment of a cleaning tool **140** similar to cleaning tool **110** except that an end portion **142** having a bullet shaped tip rotates based on the input of a trigger mechanism on a laparoscopic tool **143** as described herein. A series of strips of a cleaning material **144** are provided on an interior portion **146** of the end portion **142** for cleaning a surgical tool. Alternatively, the interior portion **146** of the end portion **142** could be lined with alternating strips of abrasive pads or bristles and a softer sponge-like material that could hold a lubricant or a coolant. In another embodiment, the cleaning element comprises an absorbent material which may be soft or fluffy so as to retain liquid, resist high temperatures, and be able to clean charred tissue off of cautery tools.

Referring to FIGS. **21a** and **21b**, shown therein is another embodiment of a portion of a cleaning tool **150** similar to the cleaning tool **10** except that the cleaning tool **150** includes a rod **152** (end effector) with a plurality of entry points **154** for the cautery tools near a tip **156** of the cleaning tool **150**. Inside of the plurality of entry points **154**, sponges **158** are used as the cleaning element to remove the charred tissue from the cautery tools. An opening **158** in the sponge **160**, as well as splitting the sponge into two segments, allows easy entry for the cautery tools as well as cleaning surface to remove tissue. A liquid cooling system is provided to the cleaning tool **150** in which water or saline could be supplied to the sponges **158** through the rod **152**.

Referring now to FIGS. **22a** and **22b**, shown therein is another embodiment of a cleaning tool **170** similar to the cleaning tool **10** except that the cleaning tool **170** comprises a hollow, cylindrical shaft **172** which contains an inner cylindrical shaft **174** with metal tongs **176** at its end **178** that are shaped like claws. The cleaning tool **170** is movable between a retracted position (FIG. **22a**) and an expanded position (FIG. **22b**). In the retracted position, the shaft **174** is compressed into the external hollow cylindrical shaft **172** by means of a spring **180**. In the expanded position, the tongs **176** extend out of the cylinder and expand. The tongs **176** of the cleaning tool **170** have cleaning elements **182** (e.g., bristles, foam pads, or other abrasive pads) attached thereto. In use, a surgeon maneuvers his surgical tool to the middle of the tongs **176** in an open position. The assistant then causes the tongs **176** to be retracted wherein they collapse upon the surgical tool producing friction on the surgical tool so as to remove the charred tissue.

While the presently disclosed inventive concepts have been described herein in connection with certain embodiments so that aspects thereof may be more fully understood and appreciated, it is not intended that the presently disclosed inventive concepts be limited to these particular embodiments. On the contrary, it is intended that all alternatives, modifications and equivalents are included within the scope of the presently disclosed inventive concepts as defined herein. Thus the examples described above, which

include particular embodiments, will serve to illustrate the practice of the presently disclosed inventive concepts, it being understood that the particulars shown are by way of example and for purposes of illustrative discussion of particular embodiments of the presently disclosed inventive concepts only and are presented in the cause of providing what is believed to be the most useful and readily understood description of procedures as well as of the principles and conceptual aspects of the inventive concepts. Changes may be made in the formulation of the various compositions described herein, the methods described herein or in the steps or the sequence of steps of the methods described herein without departing from the spirit and scope of the presently disclosed inventive concepts.

What is claimed is:

1. A surgical cleaning tool, comprising:
a shaft having a distal end and a proximal end;
a handle attached to the distal end of the shaft;
an end portion connected to the proximal end of the shaft, wherein the end portion has an outer surface, an inner cavity, an inner surface, at least one cleaning element connected to at least a portion of the inner surface, and an opening in a wall portion of the end portion, wherein the opening is along the length of the wall portion and wherein the opening allows access through the wall portion to the at least one cleaning element in the inner cavity of the end portion;
a hinge mechanism positioned between the end portion and the proximal end of the shaft; and
a trigger mechanism in the handle, wherein the trigger mechanism enables actuation of movement of the hinge mechanism by a user to effect a change in an angle of the end portion in relation to the shaft;
and wherein the cleaning tool is independent of a surgical instrument.
2. The surgical cleaning tool of claim 1, further comprising a conduit for supplying a cooling solution to the at least one cleaning element during use.
3. The surgical cleaning tool of claim 1, wherein the shaft and end portion each has an external diameter which is sized to be able to allow insertion into a laparoscopic surgical port of a patient undergoing a surgical procedure.
4. The surgical cleaning tool of claim 1 wherein a portion of the shaft is hollow for receiving a conduit for supplying a cooling solution to the at least one cleaning element.
5. A method of cleaning a surgical tool, comprising:
providing a cleaning tool, the cleaning tool comprising:
a shaft having a distal end and a proximal end;
a handle attached to the distal end of the shaft; and
an end portion connected to the proximal end of the shaft, wherein the end portion has an outer surface, an inner cavity, an inner surface, at least one cleaning element connected to at least a portion of the inner surface, and an opening in a wall portion of the end portion, wherein the opening is along the length of the wall portion and wherein the opening allows access through the wall portion to the at least one cleaning element in the inner cavity of the end portion;
positioning at least the end portion of the cleaning tool within a body cavity of a patient undergoing a surgical procedure; and
causing a surgical tool in the body cavity to engage the end portion of the cleaning tool, wherein at least a portion of the surgical tool is inserted into the opening of the end portion of the cleaning tool, and wherein the surgical tool is rubbed and/or scraped against the at

- least one cleaning element of the end portion of the cleaning tool to remove charred tissue from the surgical tool while the surgical tool is within the body cavity; and wherein the cleaning tool is independent of the surgical tool.
6. The method of claim 5, wherein the cleaning tool further comprises a hinge mechanism positioned between the end portion and the proximate end of the shaft, and a trigger mechanism in the handle, wherein the trigger mechanism enables actuation of movement of the hinge mechanism by a user to effect a change in an angle of the end portion in relation to the shaft.
 7. The method of claim 5, wherein the cleaning tool further comprises a conduit for supplying a cooling solution to the at least one cleaning element during use.
 8. The method of claim 7, wherein a portion of the shaft of the cleaning tool is hollow for receiving the conduit.
 9. The method of claim 5, wherein the shaft and end portion of the cleaning tool each has an external diameter which is sized to be able to allow insertion into a laparoscopic surgical port of a patient undergoing a surgical procedure.
 10. A method of cleaning a surgical tool, comprising:
providing a cleaning tool, the cleaning tool comprising:
a shaft having a distal end and a proximal end;
a handle attached to the distal end of the shaft;
an end portion connected to the proximal end of the shaft, wherein the end portion has an outer surface, an inner cavity, an inner surface, at least one cleaning element connected to at least a portion of the inner surface, and an opening in a wall portion of the end portion, wherein the opening allows access to the at least one cleaning element in the inner cavity of the end portion; and
a conduit for providing a cooling solution to the at least one cleaning element during use;
positioning at least the end portion of the cleaning tool within a body cavity of a patient undergoing a surgical procedure;
causing a surgical tool in the body cavity to engage the end portion of the cleaning tool, wherein at least a portion of the surgical tool is inserted into the opening of the end portion of the cleaning tool, and wherein the surgical tool is rubbed and/or scraped against the at least one cleaning element of the end portion of the cleaning tool to remove charred tissue from the surgical tool while the surgical tool is within the body cavity, and wherein the cleaning tool is independent of the surgical tool; and
providing the cooling solution via the conduit to the at least one cleaning element.
 11. The method of claim 10, wherein the cleaning tool further comprises a hinge mechanism positioned between the end portion and the proximate end of the shaft, and a trigger mechanism in the handle, wherein the trigger mechanism enables actuation of movement of the hinge mechanism by a user to effect a change in an angle of the end portion in relation to the shaft.
 12. The method of claim 10, wherein a portion of the shaft of the cleaning tool is hollow for receiving the conduit.
 13. The method of claim 10, wherein the shaft and end portion of the cleaning tool each has an external diameter which is sized to be able to allow insertion into a laparoscopic surgical port of a patient undergoing a surgical procedure.

专利名称(译)	手术清洁工具，系统和方法		
公开(公告)号	US10537402	公开(公告)日	2020-01-21
申请号	US15/529416	申请日	2015-11-24
申请(专利权)人(译)	俄克拉何马大学的校董会		
当前申请(专利权)人(译)	俄克拉何马大学的校董会		
[标]发明人	VASAN NILESH PETRI MICHAEL STEWART ANDREW STEVENS PATRICK NGORAN RANNYU SCHICK JONATHAN JONES DERRICK		
发明人	VASAN, NILESH PETRI, MICHAEL STEWART, ANDREW STEVENS, PATRICK NGORAN, RANNYU SCHICK, JONATHAN JONES, DERRICK		
IPC分类号	A61B90/70 B08B1/00		
CPC分类号	B08B1/006 B08B1/002 A61B90/70 A61B17/00234 A61B34/30 A61B2018/0097 A61B18/00		
优先权	62/083740 2014-11-24 US		
其他公开文献	US20170354476A1		
外部链接	Espacenet		

摘要(译)

外科清洁工具和清洁外科工具的方法。外科清洁工具包括轴，手柄和端部。轴具有远端和近端。所述手柄附接至所述轴的远端。所述端部连接至所述轴的近端，其中所述端部具有外表面，内腔，内表面，至少一个连接至至少一个清洁元件。所述内表面的一部分以及在所述端部的壁部分中的开口，其中所述开口允许进入所述端部的内腔中的清洁元件。

