



US 20170215899A1

(19) **United States**(12) **Patent Application Publication**
Harrah et al.(10) **Pub. No.: US 2017/0215899 A1**(43) **Pub. Date: Aug. 3, 2017**(54) **MEDICAL DEVICE AND METHODS OF USE****Publication Classification**(71) Applicant: **Boston Scientific Scimed, Inc.**, Maple Grove, MN (US)(72) Inventors: **Timothy P. Harrah**, Cambridge, MA (US); **Christopher L. OSKIN**, Grafton, MA (US); **Derrick LENZ**, Pompton Plains, NJ (US); **Arpita BANERJEE**, Bangalore (IN); **Sandesh GAVADE**, Bangalore (IN); **Abhijit TAKALE**, Pune (IN); **Pavan MISRA**, Bangalore (IN)(73) Assignee: **Boston Scientific Scimed, Inc.**, Maple Grove, MN (US)(21) Appl. No.: **15/415,604**(22) Filed: **Jan. 25, 2017****Related U.S. Application Data**

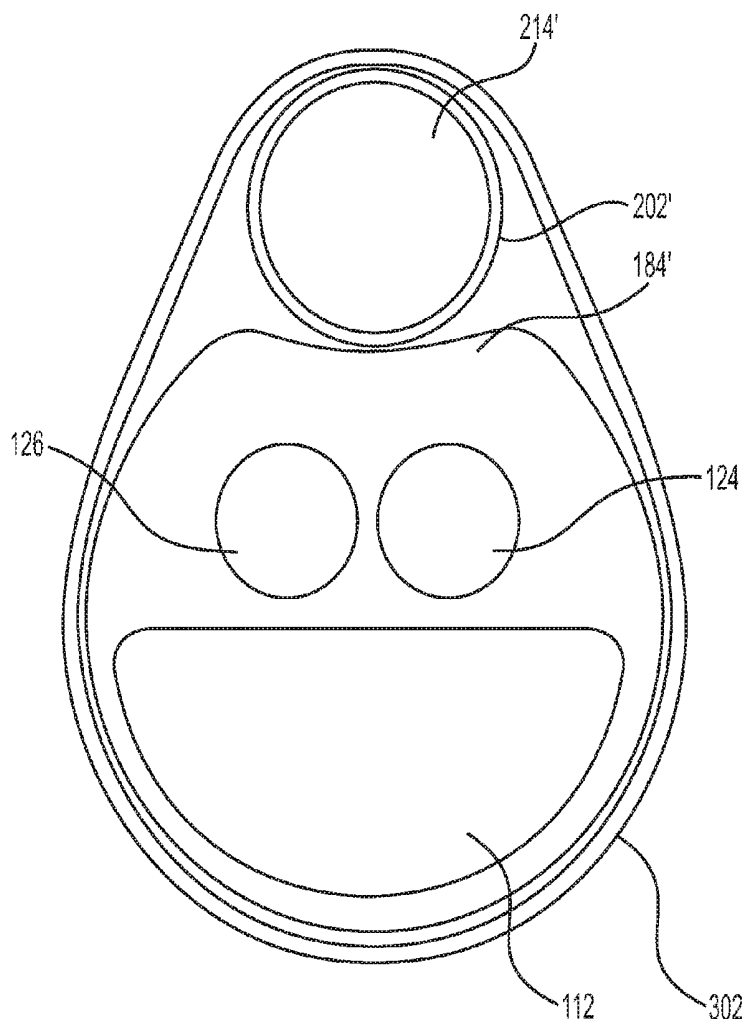
(60) Provisional application No. 62/288,734, filed on Jan. 29, 2016.

(51) **Int. Cl.****A61B 17/22** (2006.01)**A61B 18/24** (2006.01)**A61B 17/30** (2006.01)**A61B 18/26** (2006.01)(52) **U.S. Cl.**CPC **A61B 17/22** (2013.01); **A61B 18/26** (2013.01); **A61B 18/245** (2013.01); **A61B 17/30** (2013.01); **A61B 2017/306** (2013.01); **A61B 2018/00511** (2013.01)

(57)

ABSTRACT

The present disclosure is directed to a medical device. Systems and methods are provided for utilizing a laser to break a kidney stones into smaller fragments and/or dust, and removing particles, stone fragments and/or stone dust from a patient. The medical device may include a delivery device including a tube, and an elongate member having a distal end, a proximal end, and a lumen extending between the proximal end and the distal end, wherein the elongate member is configured to move axially relative to the tube and apply suction through the distal end.



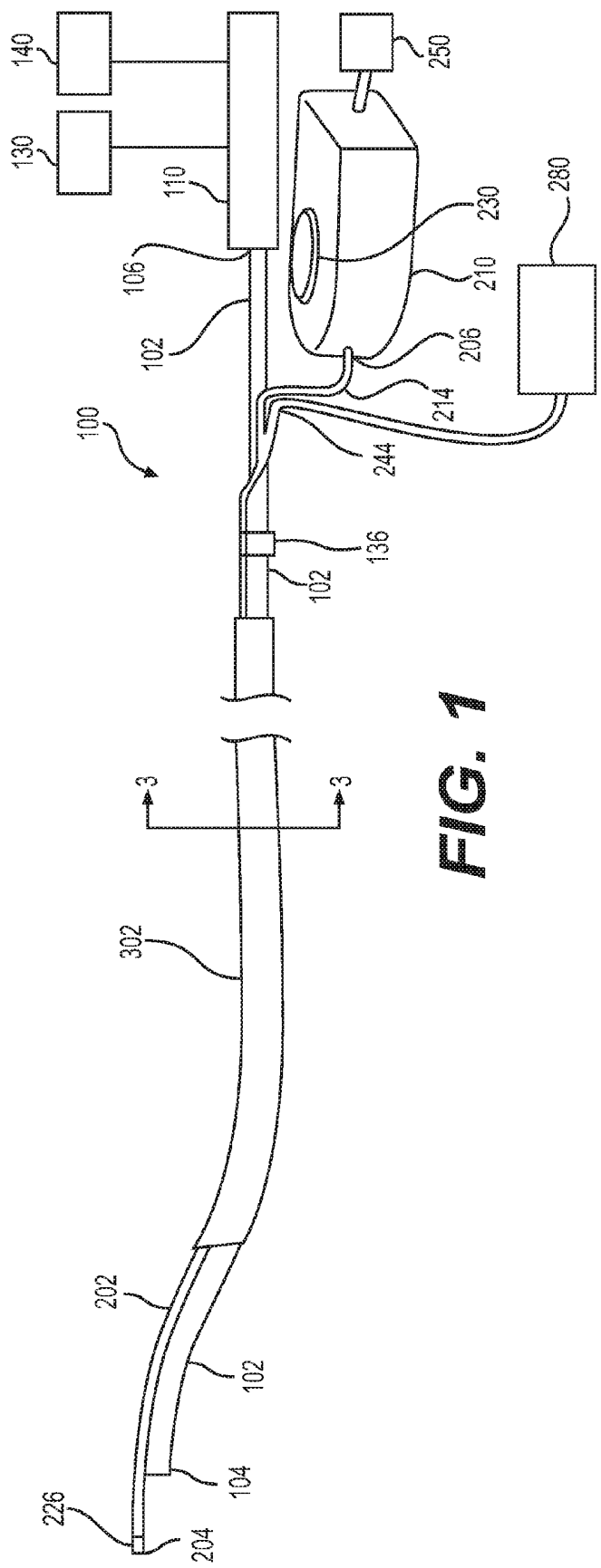


FIG. 1

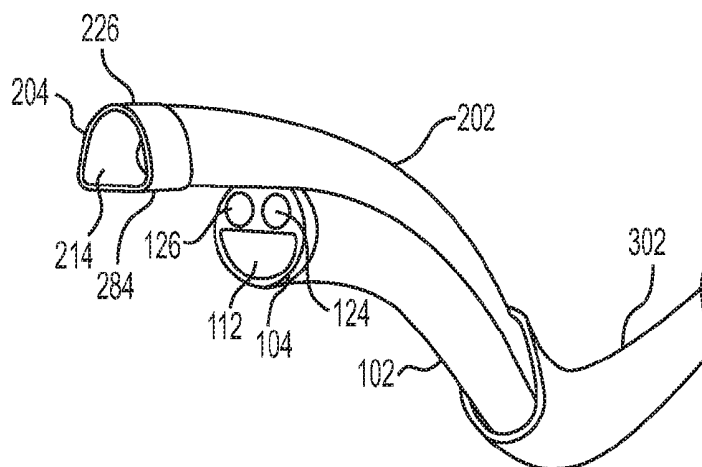


FIG. 2A

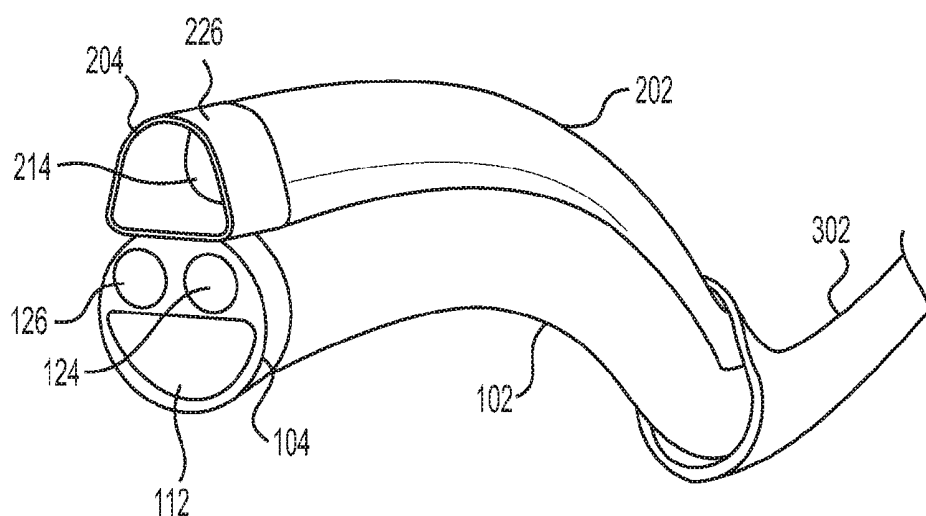


FIG. 2B

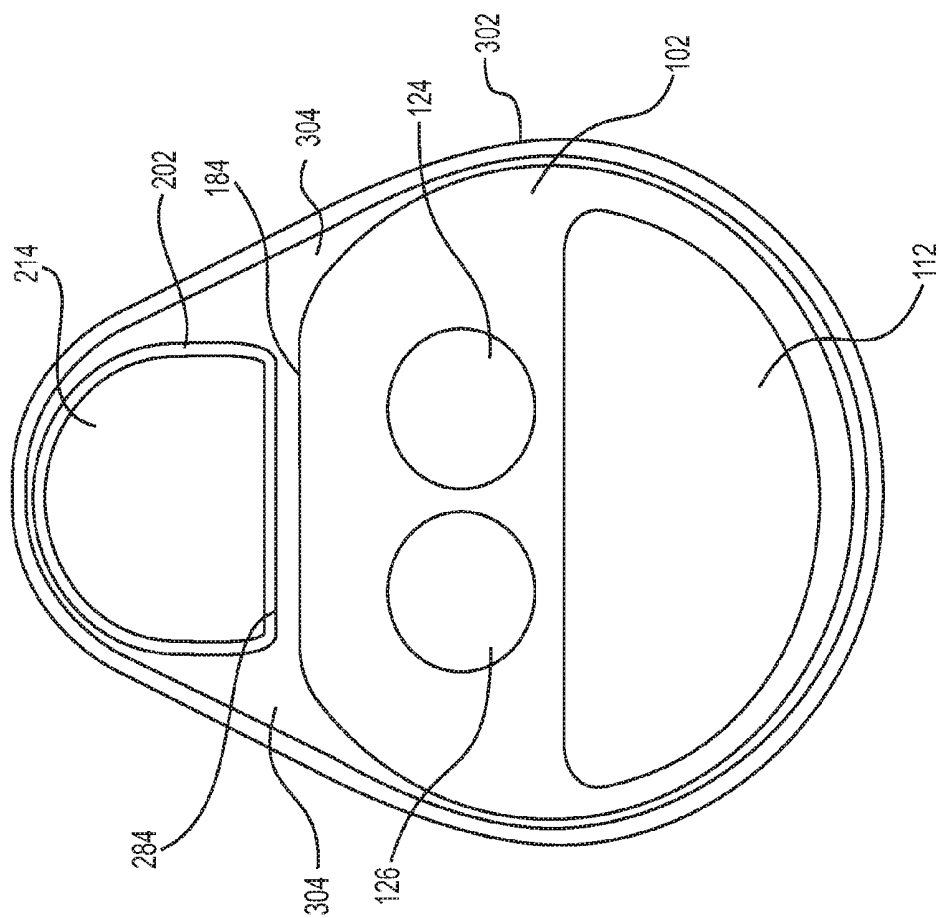


FIG. 3A

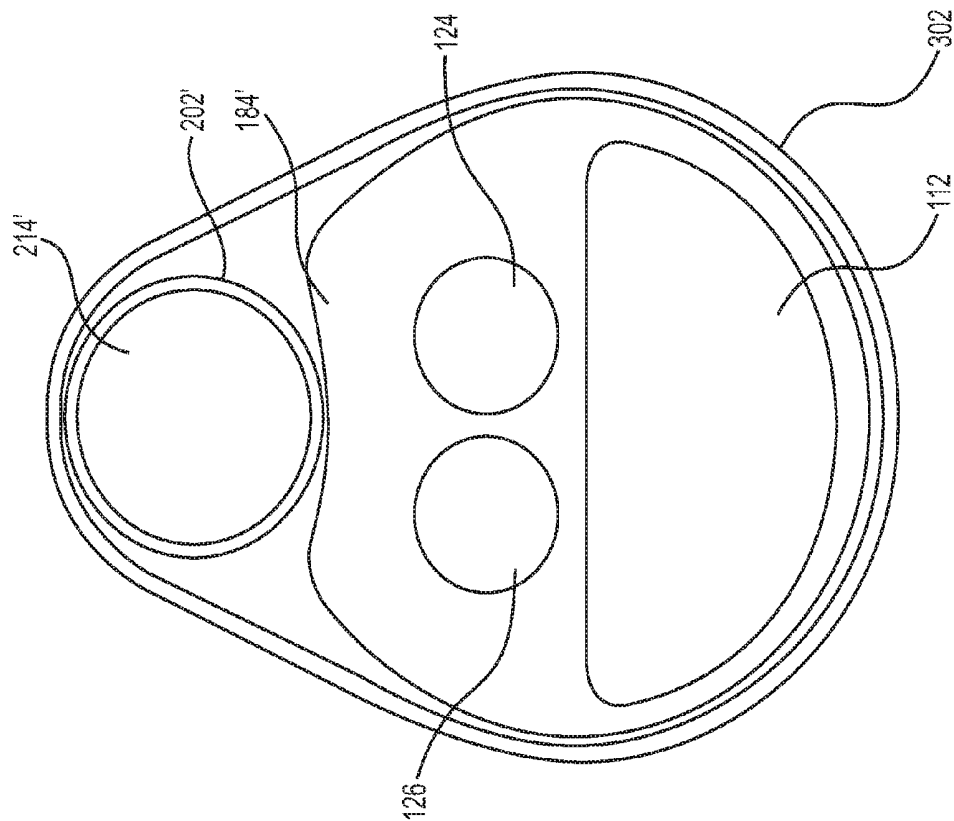


FIG. 3B

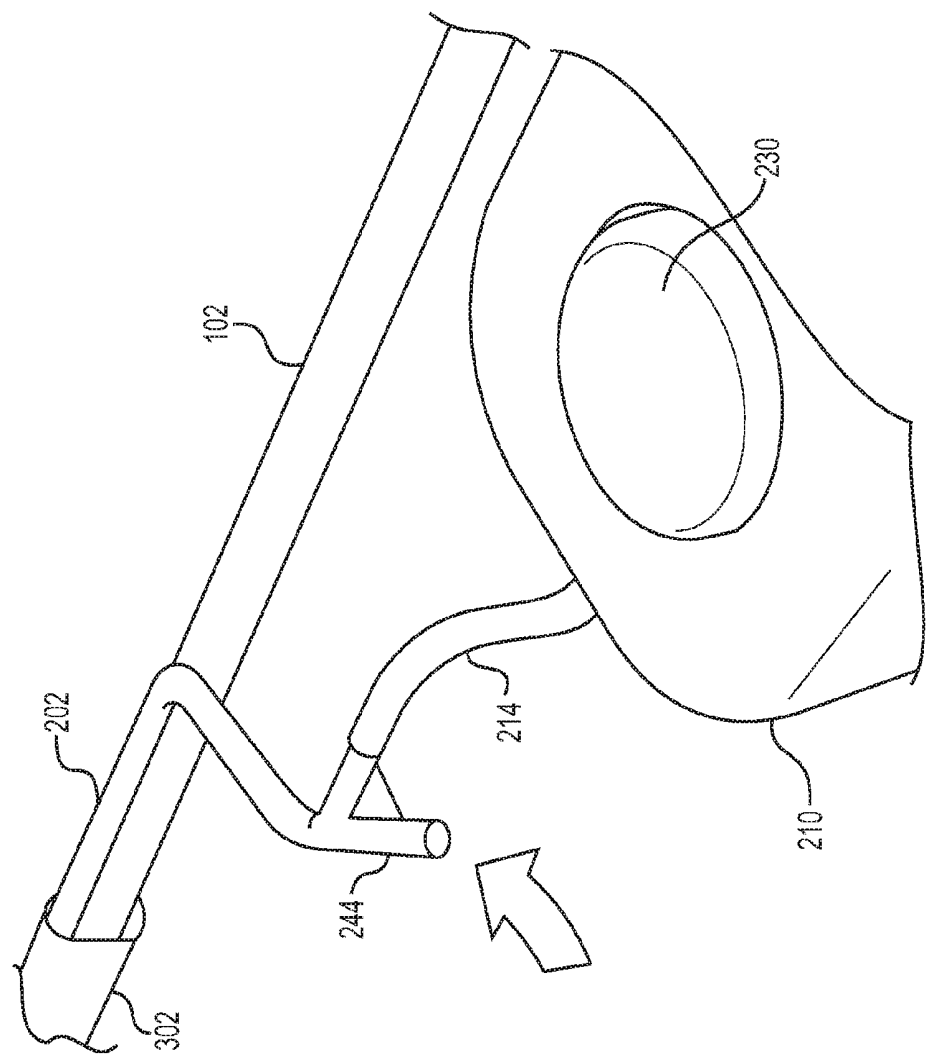
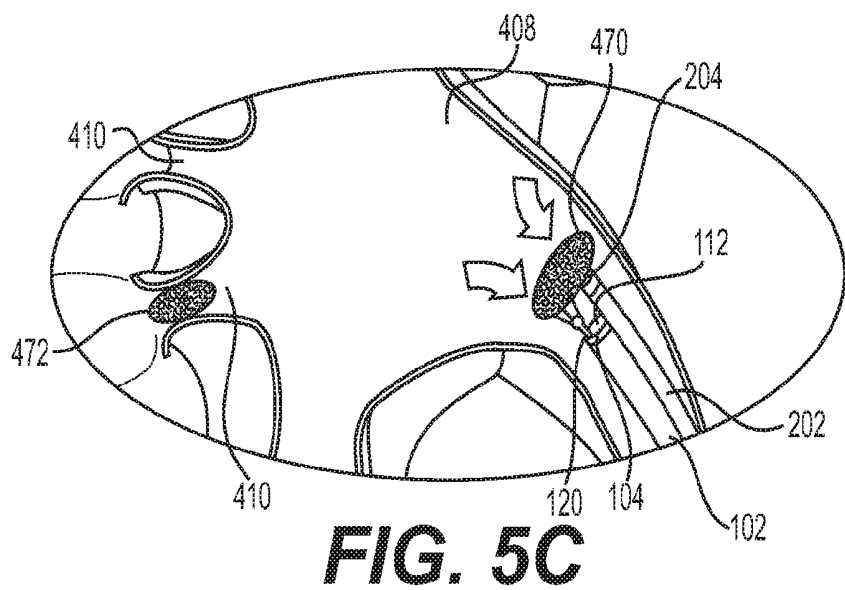
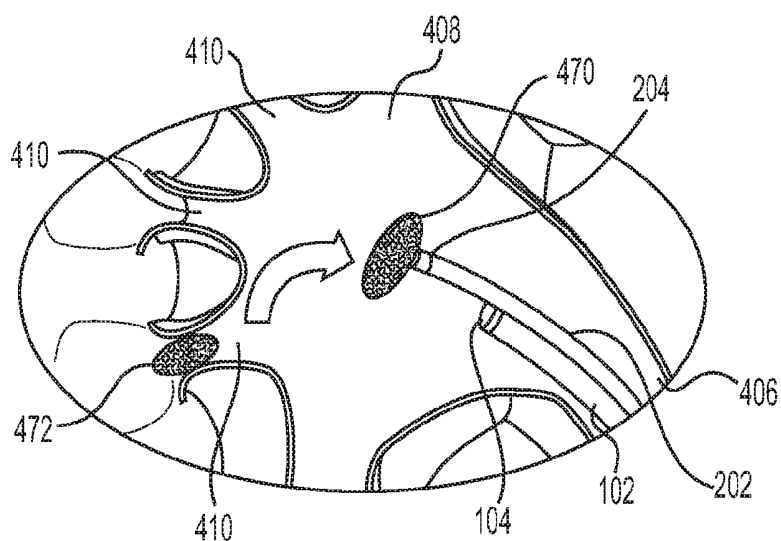
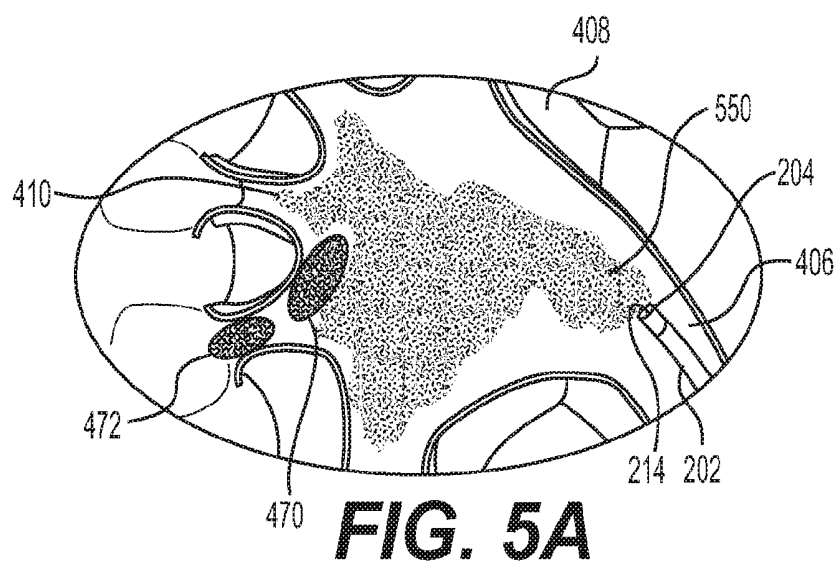
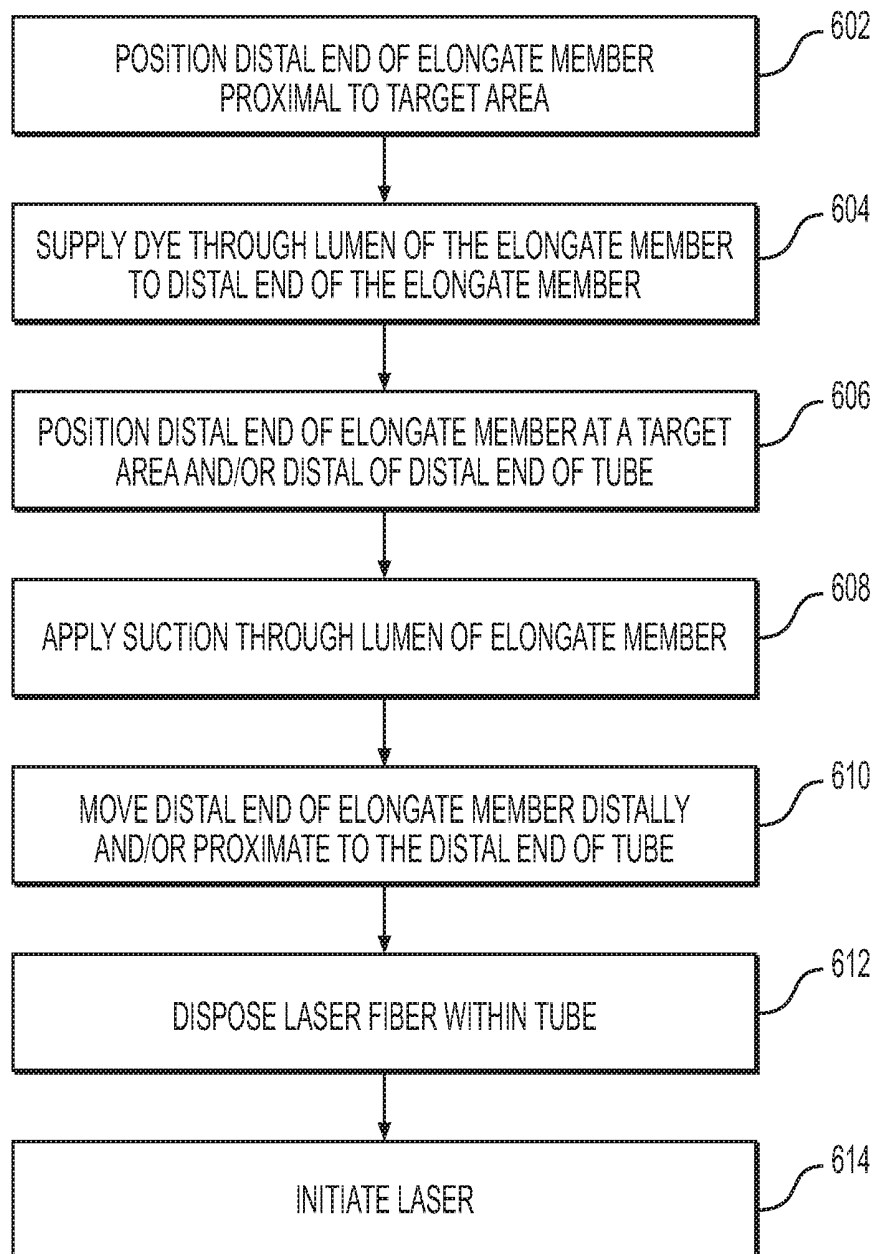


FIG. 4



**FIG. 6**

MEDICAL DEVICE AND METHODS OF USE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims the benefit of priority under 35 U.S.C. §119 to U.S. Provisional Patent Application No. 62/288,734, filed Jan. 29, 2016, which is herein incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to medical devices. More particularly, the disclosure relates to medical devices used, for example, in breaking objects into smaller particles, and removing the resulting particles from a patient. The disclosure also relates to methods of using such devices.

BACKGROUND

[0003] The incidence of hospitalization for the removal of urinary calculi, commonly referred to as kidney stones, has been estimated at 200,000 cases per year. A vast majority of these patients pass their stones spontaneously; however, in the remainder, the kidney stone(s) become impacted in the ureter, a muscle tube joining the kidney to the bladder. An impacted kidney stone is a source of intense pain and bleeding, a source of infection and, if a stone completely blocks the flow of urine for any extended length of time, can cause the loss of a kidney.

[0004] Recently, various methods have been utilized to break the stone into smaller fragments. One such method is stone dusting. Stone dusting is used by some urologists to fragment and evacuate stones from a kidney and is often performed by a ureteroscope. Intense light energy from a laser within the ureteroscope breaks the stone into increasingly smaller pieces. However, in some cases, the stone and/or the stone fragments may be pushed away from the ureteroscope by the laser, thus making it impossible to continue to break the stone or stone fragments into smaller fragments without repositioning the ureteroscope. The disclosure addresses the above-mentioned process and other problems in the art.

[0005] Further, rather than breaking up the stone into chunks, which are removed by baskets, dusting generates very small fragments that are capable of being passed naturally. However, in some cases, these small stone fragments may not pass naturally. For example, the stone fragments may collect in an area of the kidney where they are less likely to flow out naturally, such as the lower calyx of the kidney. In theory, any of these small stone fragments that do not evacuate through natural urine flow, could be a seed for new stone growth. Thus, the application of suction may be employed to remove the stone dust. Breaking up a stone and providing suction requires a working channel with a sufficient internal cross-sectional area to receive a laser fiber and a lumen with sufficient internal cross-sectional area to allow stone fragments and/or dust to pass through without clogging. The combined cross-sectional areas of these two elements may make a device too large to reach the target kidney stone. For example, the kidney stone may be within the kidney, or, specifically, within the lower calyx of the kidney. Often, the space within the kidney and/or lower calyx of the kidney is more limited than the space within the ureter and this space may not be large enough to accommodate both a working channel for a laser fiber and a lumen for

applying suction. The disclosure addresses the above-mentioned process and other problems in the art.

SUMMARY OF THE DISCLOSURE

[0006] Aspects of the present disclosure provide device and methods for breaking an object into smaller particles and removing said particles from portions of the human body.

[0007] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive.

[0008] In one example, a medical device may include a delivery device including a tube, and an elongate member having a distal end, a proximal end, and a lumen extending between the proximal end and the distal end, wherein the elongate member is configured to move axially relative to the tube and apply suction through the distal end.

[0009] Examples of the medical device may additionally and/or alternatively include one or more other features. Features of the various examples described in the following may be combined unless explicitly stated to the contrary. For example, the proximal end of the elongate member may be forked. The proximal end of the elongate member may be connected to a control system. The control system may control the vacuum source. The proximal end of the elongate member may be in fluid communication with a vacuum source. The medical device may include a sleeve, wherein the sleeve may be configured to receive the tube and the elongate member simultaneously. The delivery device may be one of ureteroscope, sheath, catheter, or endoscope. The medical device may include a laser fiber connected to the tube. The lumen of the elongate member may be substantially D-shaped. The tube may include an illumination device. The tube may include an imaging device. The tube may have a first engaging surface, and the elongate member may have a second engaging surface, and the first engaging surface may be substantially complementary of the second engaging surface. The elongate member may be in fluid communication with a fluid source. The lumen of the elongate member may have an inner diameter of approximately 1 mm to approximately 3.5 mm. The elongate member may be at least partially controlled by a control system and the tube may be at least partially controlled by a handle.

[0010] In another example, a method operating a medical device may include positioning a distal end of an elongate member of the medical device at a target area, applying suction through a lumen of the elongate member to seal an object to the distal end of the elongate member, and moving the distal end of the elongate member to move the object sealed to the distal end of the elongate member.

[0011] Examples of the method of operating the medical device may additionally and/or alternatively include one or more other features. For example, prior to positioning the distal end of the elongate member of the medical device at the target area, the method may include positioning the distal end of the elongate member proximal to the target area, and supplying dye through the lumen of the elongate member to the distal end of the elongate member. The method may include moving the object proximate to a tube, disposing a laser fiber within the tube, and initiating the laser.

[0012] In another example, a method operating a medical device may include positioning a distal end of an elongate member of the medical device distal to a distal end of a tube

of the medical device, applying suction through a lumen of the elongate member to seal a kidney stone to the distal end of the elongate member, and moving the distal end of the elongate member to move the kidney stone sealed to the distal end of the elongate member proximally toward the distal end of the tube.

[0013] Examples of the method of operating the medical device may additionally and/or alternatively include one or more other features. For example, the method may include disposing a laser fiber within the tube, and initiating the laser.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate various examples and together with the description, serve to explain the principles of the disclosure.

[0015] FIG. 1 illustrates an exemplary medical device, including a tube, an elongate member, a handle portion, a control system, and a sleeve;

[0016] FIG. 2A illustrates an exemplary distal end of the medical device of FIG. 1 with the elongate member in a retrieval position;

[0017] FIG. 2B illustrates an exemplary distal end of the medical device of FIG. 1 with the elongate member in an operating position;

[0018] FIG. 3A illustrates an exemplary cross-section of the medical device taken at 3-3 of FIG. 1;

[0019] FIG. 3B illustrates an alternative exemplary cross-section of the medical device taken at 3-3 of FIG. 1;

[0020] FIG. 4 illustrates an exemplary connection between a proximal end of the elongate member and the control system of FIG. 1;

[0021] FIGS. 5A-C illustrates an exemplary method of operation of the medical device of FIG. 1; and

[0022] FIG. 6 is a block diagram of an exemplary method of using the medical devices disclosed herein.

DETAILED DESCRIPTION

[0023] Reference is now made in detail to examples of the present disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. The term “distal” refers to a position farther away from a user end of the device. The term “proximal” refers a position closer to the user end of the device. As used herein, the terms “approximately” and “substantially” indicate a range of values within $\pm 5\%$ of a stated value.

[0024] Overview

[0025] Aspects of the present disclosure relate to systems and methods for breaking kidney stones into smaller particles and removing those particles from a target area of a patient's body. The medical device described herein may work by securing an elongate member for suction to an outer surface of a tube of a delivery device. A distal end of the tube and a distal end of the elongate member may be positioned within a ureter of a patient. In some examples, radiopaque dye may be injected into the target area, e.g., the kidney, from a lumen of the elongate member. Then, the elongate member may be extended distally to a retrieval position in which the distal end of the elongate member is positioned within the target area, e.g., the lower calyx of the kidney,

and/or proximate the target kidney stone. Suction may be applied through the elongate member, pulling the stone toward a distal opening of the elongate member until the stone contacts and forms a seal with the distal opening of the elongate member. The formed seal secures the kidney stone to the distal opening of the elongate member. With the stone secured to the elongate member, the elongate member may be retracted or pulled proximally toward the distal end of the tube until the elongate member is in the operating position, e.g., the secured stone is proximate a distal opening of the tube. At this point, a laser fiber, disposed within the tube, may be used to break up kidney stones into particles. It should be noted that the stone may be broken into particles in any way known in the art, including the application of ultrasound and/or sound waves on the stone. Once the stone is broken into particles that are smaller than the distal opening the elongate member, the seal may be broken and/or particles may be suctioned into the lumen of the elongate member. These particles may be vacuumed through the elongate member and out of the patient's body.

DETAILED EXAMPLES

[0026] FIG. 1 illustrates medical device 100 for removing stones from a patient's body. Medical device 100 may include a retrieval system. The retrieval system may include elongate member 202 and control system 210. Elongate member 202 may be a hollow, flexible, elongate tube having a distal end 204 and a proximal end 206 and at least one lumen (e.g., lumen 214 of FIGS. 2A-B) extending therebetween. Proximal end 206 of elongate member 202 may be coupled to control system 210, vacuum source 250, and/or fluid source 280. As shown in FIG. 1, medical device 100 may include a delivery device. The delivery device may be, for example, any traditional delivery device, including a ureteroscope, sheath, catheter, endoscope, etc. The delivery device may include a tube 102 and a handle portion 110. Tube 102 may be a hollow, flexible, elongate tube having a distal end 104 and a proximal end 106 and at least one lumen (e.g., lumen 112 of FIGS. 2A-B) extending therebetween. Proximal end 106 of tube 102 may be coupled to handle portion 110. The handle portion 110 and/or the proximal end 106 of tube 102 may be attached to a laser control 130 and/or a fluid supply assembly 140. In some examples, medical device 100 may include a sleeve 302 and fastener 136. Sleeve 302 and fastener 136 may be any mechanism known in the art for allowing elongate member 202 (and/or the entirety of the retrieval device) to move axially relative to tube 102 and prevent radial movement of elongate member 202 relative to tube 102.

[0027] Depending upon the particular implementation and intended use, the length of tube 102, elongate member 202, and/or sleeve 302 may vary. In the example shown in FIG. 1, sleeve 302 may be shorter in length than tube 102 and elongate member 202. Depending upon the particular implementation and intended use, tube 102, elongate member 202, and/or sleeve 302 can be rigid along its entire length, flexible along a portion of its length, or configured for flexure at only certain specified locations. In one example, tube 102, elongate member 202, and/or sleeve 302 may be flexible, adapted for flexible steering within bodily lumens, as understood in the art. For example, tube 102 can include a steering system (not shown) to move at least a portion (e.g., distal end 104) up/down and/or side-to-side. Additional degrees of freedom, provided for example via rotation, translational

movement of tube **102**, or additional articulation of bending sections, may also be implemented. Examples of such steering systems may include at least one of or more of pulleys, control wires, gearing, and electrical actuators.

[0028] Tube **102**, elongate member **202**, and/or sleeve **302** may be formed of any suitable material having sufficient flexibility to traverse body cavities and tracts. In general, tube **102**, elongate member **202**, and/or sleeve **302** may be made of any suitable material that is compatible with living tissue or a living system. That is, tube **102**, elongate member **202**, and/or sleeve **302** may be non-toxic or non-injurious, and it should not cause immunological reaction or rejection. In some examples, tube **102**, elongate member **202**, and/or sleeve **302** may be made of polymeric elastomers, rubber tubing, and/or medically approved polyvinylchloride tubing. Polymeric elastomers may be, for example, EVA (Ethylene vinyl acetate), silicone, polyurethane, and/or C-Flex.

[0029] Further, tube **102**, elongate member **202**, and/or sleeve **302** may include any suitable coating and/or covering. For example, the outer surface may include a layer of lubricous material to facilitate insertion through a body lumen or through sleeve **302**. Further, tube **102**, elongate member **202**, and/or sleeve **302** may be coated with a biocompatible material such as Teflon. To inhibit bacterial growth in the body cavity, tube **102**, elongate member **202**, and/or sleeve **302** may be coated with an antibacterial coating. Further, an anti-inflammatory substance may also be applied to the outer surface of the tube **102**, elongate member **202**, and/or sleeve **302**, if required.

[0030] Tube **102**, elongate member **202**, and/or sleeve **302** may be designed to impose minimum risk to the surrounding tissues while in use. To this end, one or more portions of tube **102**, elongate member **202**, and/or sleeve **302** may include atraumatic geometrical structures, such as rounded or beveled terminal ends or faces (e.g., distal end **104** of tube **102**), to reduce trauma and irritation to surrounding tissues.

[0031] I. Sleeve

[0032] Sleeve **302** may be hollow and configured to slidably receive tube **102** and elongate member **202** simultaneously. Tube **102** may be circular, ovoidal, irregular, and/or any shape suitable to enter a body and/or receive tube **102** and elongate member **202**. In some examples, a lumen running through sleeve **302** may be shaped to accommodate the size and shape of tube **102** and elongate member **202**. In other examples, the lumen may be substantially circular and sleeve **302** may be made of elastic material to stretch to accommodate the size and shape of the combination of tube **102** and elongate member **202**. A lumen extending through sleeve **302** may include any suitable coating. For example, the lumen may include a layer of lubricous material, for example, to facilitate insertion of tube **102** and elongate member **202**.

[0033] II. Delivery Device

[0034] As previously described, medical device **100** may include a delivery device. The delivery device may be, for example, any delivery device known in the art, including ureteroscope, sheath, catheter, endoscope, etc. The delivery device may include a tube **102** and a handle portion **110**.

[0035] A. Handle Portion

[0036] Handle portion **110** can be attached to proximal end **106** of tube **102** by, for example, welding, a locking configuration, use of an adhesive, or integrally forming with tube **102**. The handle portion **110** may include a plurality of ports. For example, a first port may supply to distal end **104**

of tube **102** a laser fiber (e.g., laser fiber **120**) coupled to laser control (e.g., laser control **130**). In some examples, a second port may place lumen **112** in fluid communication with a fluid supply assembly (e.g., fluid supply assembly **140**). Additional ports and lumens may be provided for supplying and/or controlling an illumination device and/or an imaging device located at or near distal end **104** of tube **102**. The handle portion **110** may include an actuating mechanism (not shown) to actuate one or more medical devices that may be located at the distal end **104** of tube **102**. For example, handle portion **110** may include an actuating mechanism to power on or off the laser, the illumination device, and/or the imaging device.

[0037] B. The Tube

[0038] Tube **102** may be circular, ovoidal, irregular, and/or any shape suitable to enter a body. Further, tube **102** may have a uniform shape along its length, or may having a varying shape, such as a taper at the distal end to facilitate insertion within the body. In some embodiments of the present disclosure, the distal end **104** of tube **102** includes visualization devices such as a camera and/or a light source. These devices may attach to the distal end **104** using known coupling mechanisms. Alternatively, the visualization devices may be detachably introduced into tube **102** through lumen **112** (or a separate lumen, e.g., lumen **124** or **126** of FIGS. 2A-B) when required.

[0039] Lumen **112** may be defined by an elongate hollow lumen that extends between proximal end **106** and distal end **104** of tube **102**. Lumen **112** may be any size, shape, and/or in any configuration within tube **102**. Exemplary cross-sections of tube **102** and lumen **112** will be described in further detail below with respect to FIGS. 3A and 3B.

[0040] III. Retrieval System

[0041] As previously described, medical device **100** may include a retrieval system. The retrieval system may include elongate member **202** and control system **210**.

[0042] A. The Elongate Member

[0043] Elongate member **202** may be circular, ovoidal, irregular, and/or any shape suitable to enter a body and/or sleeve **302**. Further, elongate member **202** may have a uniform shape along its length, or may having a varying shape, such as a taper at the distal end to facilitate insertion within the body. In some embodiments of the present disclosure, the distal end **204** of elongate member **202** includes reinforced section **226**. The walls of reinforced section **226** may be thicker than the remainder of elongate member **202**. This may prevent distortion of the reinforced section **226** when a stone is vacuumed and held against a distal opening/distal end **204** (as described in further detail below with respect to FIGS. 5A-C).

[0044] Lumen **214** may be defined by an elongate hollow lumen that extends between proximal end **206** and distal end **204** of elongate member **202**. Lumen **214** may be any size, shape, and/or in any configuration within elongate member **202**. For example, the inner diameter of lumen **214** may be approximately 1 mm to approximately 3.5 mm, approximately 1.5 mm to approximately 3 mm, or approximately 2 mm to approximately 3 mm. Exemplary cross-sections of elongate member **202** and lumen **214** will be described in further detail below with respect to FIGS. 3A and 3B.

[0045] In some examples, elongate member **202** may act as a guidewire to guide attached tube **202**. For example, elongate member **202** may be inserted into the body before the insertion of tube **102**, and tube **102** may be tracked along

an outer surface (e.g., engaging surface **284**) of elongate member **202** in order to position tube **102** within the body. It should be noted that any of lumens **112** or **214** may additionally or alternatively be configured to receive a guidewire. In some embodiments, lumen **214** may receive a guidewire to facilitate positioning elongate member **202** in the body.

[0046] To effectively maneuver the elongate member **202** within a body cavity and, for example, position distal end **204** proximate of a kidney stone within a lower calyx of a kidney, an operator may need to know the exact location of the elongate member **202** in the body. To this end, one or more portions of elongate member **202** may be made of radiopaque, such as by inclusion of barium sulfate in plastic material or inclusion of one or more metal portions, which provide sufficient radiopacity. In some examples, elongate member **202** may have a radiopaque coating. Additionally or alternatively, distal end **204** of elongate member **202** may include radiopaque or sonoreflective markers (not shown). These markings facilitate detection of a position and/or orientation of elongate member **202** within a patient's body, and an operator, with the aid of suitable imaging equipment, may track the path followed by elongate member **202**. This may help the operator avoid potential damage to sensitive tissues. By using fluoroscopic guidance, elongate member **202** may be located without the visualization devices within tube **102** and, therefore, move independently of and/or not within the field of view of these visualization devices. Further, with such guidance, the space within elongate member **202** that would be needed for direct visualization (e.g., an imaging apparatus) may instead be used to maximize the size of the lumen and/or the flow rate of the suction.

[0047] FIGS. 2A-B illustrate exemplary distal ends of medical device **100** with elongate member **202** in a retrieval position and an operating position, respectively. As shown in FIG. 2A, in a retrieval position, distal end **204** of elongate member **202** may be distal of the distal end **104** of tube **102**. In an operating position, as shown in FIG. 2B, distal end **204** of elongate member **202** may be closer to and/or flush with the distal end **104** of tube **102**.

[0048] FIG. 3A illustrates a cross-sectional view of an exemplary medical device **100**. This view may, for example, be at line 3-3 of FIG. 1. As shown, tube **102** may include a lumen **112**, illumination device **126**, imaging apparatus **124**, and/or engaging surface **184**. Lumen **112** may be semi-circular in shape. Lumen **112**, however, may have any cross-sectional size and/or shape. In the example shown in FIG. 3A, engaging surface **184** may be substantially planar. Engaging surface **184** is not limited thereto and may have shape, including any shape that is substantially complementary with an engaging surface of an elongate member (e.g., engaging surface **284** of tube **202**). For example, as shown in FIG. 3A, elongate member **202** has a substantially planar engaging surface **284**. Lumen **214** of elongate member **202** may be substantially D-shaped, however, lumen **214** is not limited thereto and may have any cross-sectional size and/or shape. FIG. 3A shows a space between engaging surface **284** of elongate member **202** and engaging surface **184** of tube **102**. In some examples, however, gravity may pull and/or sleeve **302** may push engaging surface **284** of elongate member **202** to contact engaging surface **184** of tube **102**. Sleeve **302** should be configured to avoid so much friction as to restrict axial movement of elongate member **202** relative to tube **102**. Spaces **304** are spaces between an

interior wall of sleeve **302** and the outer surfaces of elongate member **202** and/or tube **102**. In some examples, these spaces may be minimized, for example, if sleeve **302** is made of an elastic material configured to "hug" on the outer surfaces of elongate member **202** and/or tube **102**.

[0049] FIG. 3B illustrates a cross-sectional view of an alternative exemplary medical device **100**. This view may, for example, be at line 3-3 of FIG. 1. As shown, the cross-sectional area of elongate member **202'** and lumen **214'** of elongate member **202'** are substantially circular. Tube **102** includes a lumen **112**, illumination device **126**, imaging apparatus **124**, and/or engaging surface **184'**. Engaging surface **184'** is substantially concave and may be substantially complementary to an outer surface of elongate member **202'**.

[0050] It should be noted that in some examples, elongate member **202** and/or elongate member **202'** may be configured to engage (and/or slide across) an outer surface of a conventional or substantially circular delivery device. In such examples, engaging surface **284** and/or **284'** may be concave and/or be complementary with the outer surface of a substantially circular delivery device.

[0051] B. Control System

[0052] FIG. 4 is an enlarged exemplary view of proximal end **206** of elongate member **202** and control system **210**. Distal of proximal end **206**, elongate member **202** may fork, for example, into first end **214** and second end **244**. First end **244** of elongate member **202** may be open and configured to attach to, for example any fluid source known in the art, e.g., a fluid source **280** of FIG. 1. For example, dye or, more specifically, radiopaque dye may be within fluid source **280**.

[0053] Second end **214** of elongate member **202** may attach to control system **210** by, for example, a locking configuration, use of an adhesive, or integrally forming with elongate member **202**. Control system **210** may allow an operator to control operation of the retrieval system. For example, as described in further detail below, control system **210** may include the ability to control steering of elongate member **202**, introduce dye into elongate member **202**, and/or apply suction through elongate member **202**. In some examples, control system **210** may include or be in fluid communication with a vacuum source, e.g., vacuum source **250** of FIG. 1. A vacuum source may include a house vacuum, vacuum pump, compressor unit, etc. Control system **210** may include any input devices known in the art, including buttons, switches, keyboards, dials, touchscreens, etc. Input device **230** may, for example, be an on-off button to turn on or off the vacuum source and either apply or cease application of suction from distal end **204** of elongate member **202**. Input device **230** may be a dial for adjusting the flow rate of this suction.

[0054] IV. Insertion and Operation of the Medical Device

[0055] FIG. 5A-C illustrate an exemplary method of operation of medical device **100**, including an enlarged view of upper ureter **406** and lower calyx **410** of kidney **408**. Kidney stones **470** and **472** are located in lower calyx **410**. As previously mentioned, the space within calyx **410** of kidney **408** is often more limited than the space within the ureter **406**.

[0056] An operator (e.g., a doctor or other medical professional) may connect elongate member **202** and tube **102** by sliding their respective distal ends through a proximal opening of sleeve **302**. In some examples, medical device **100** may be pre-assembled and this step may omitted. In

some examples, one or both of tube 102 and elongate member 202 may be separately or simultaneously inserted into patient's urethra, through the urinary bladder, and into ureter 406. In examples in which elongate member 202 is used as a guidewire, distal end 204 of elongate member 202 may be inserted into a patient's urethra, through the urinary bladder, and into ureter 406. In some examples, once distal end 204 of elongate member 202 is positioned within the upper ureter, an operator may initiate the introduction of fluid into kidney 408 through lumen 214 of elongate member 202. For example, a fluid source (e.g., fluid source 280 of FIG. 1) may be fluidly connected to first end 244 of elongate member 202 and fluid may be transmitted through first end 244, through lumen 214 of elongate member 202, to distal end 204 of elongate member 202, and into the kidney 408. In some examples, the fluid may be radiopaque dye. As shown in FIG. 5A, dye 550 may enter the ureter 406 and/or kidney 408 (depending on the location of distal end 204 of elongate member 202) and may disperse throughout kidney 408 and/or lower calyx 410. This may allow the operator to determine the location of any kidney stones within the kidney. The introduction of any fluid (e.g., not limited to radiopaque) into the kidney may at least partially inflate the kidney, thus providing additional space to perform the desired procedure. Further, the introduction of fluid as an initial step may ensure that the pressure within the kidney remains at a sufficient level, e.g., the kidney will not collapse, once suction is applied to the kidney through lumen 214 of elongate member 202 (as described in further detail below). It should be noted that in some examples, fluid is not introduced through lumen 214 of elongate member 202, and once disposed with the patient's body, an operator may proceed to the next step, e.g., locating and securing a kidney stone.

[0057] Elongate member 202 may be extended distally into kidney 408, so that the distal opening of lumen 214 is proximate to kidney stone 470. At this point, elongate member 202 is in a retrieval position, e.g., distal end 204 of the elongate member 202 is positioned distal of distal end 104 of tube 102. An operator may initiate a vacuum source, e.g., by selecting input device 230 of FIG. 4, to apply suction through lumen 214 to distal end 204 of elongate member 202. Suction into lumen 214 of elongate member 202 may pull the stone toward a distal opening of elongate member 202 until the stone contacts and forms a seal with the distal opening of elongate member 202. The formed seal may secure the kidney stone to the distal opening of the elongate member 202. As shown in FIG. 5B, with the stone secured to elongate member 202, elongate member 202 may be retracted or pulled proximally toward ureter 406 and/or distal end 104 of tube 102 until the elongate member is in the operating position, e.g., secured stone 470 is proximate a distal opening of tube 102. At any time between the insertion of elongate member 202 into the patient and the above step of securing the stone proximate the distal opening of tube 102, tube 102 may track elongate member 202 like a guidewire, so that distal end 104 is positioned within ureter 406. FIG. 5C illustrates an operating position of elongate member 202 in which distal end 204 of elongate member 202 is closer to distal end 104 of tube 102 than in the retrieval position.

[0058] As shown in FIG. 5C, once the laser fiber 120 is in a sufficient position to aim for secured kidney stone 470, the operator may initiate the laser to break up kidney stone 470.

Laser fiber 120 may be introduced into a patient through lumen 112 of tube 102. Laser fiber 120 may be connected to and/or controlled by laser control 130. (It should be noted that the stone may be broken into particles in any way known in the art, including the application of ultrasound and/or sound waves on the stone.) Once stone 470 is broken into particles that are smaller than the cross-sectional area of the distal opening of elongate member 202, the seal may be broken and/or particles may be suctioned into lumen 214 of elongate member 202. These particles may be vacuumed through elongate member 202 and out of the patient's body. The stone particles are suctioned out from lumen 214 of elongate member 202 along with the used saline fluid and collect in the chamber outside the patient body through the saline outlet pathway.

[0059] The application of suction through lumen 214 of elongate member 202 may improve the ability to break kidney stones by creating an anti-retropulsion effect. By applying suction through lumen 214, a kidney stone may be pulled toward laser fiber 120, thus countering the effect of the laser energy pushing the kidney stone away. This configuration thus assists in generating the smaller stone fragments by pulling the stones into the reach of laser fiber 120.

[0060] Once the operator determines a sufficient amount of the resulting particles of stone 470 have been removed from the patient's body or does not want to continue for other reasons, the laser process and/or application of suction may be stopped. At any point, an operator may additionally choose to move the device within the patient. For example, an operator may choose repeat the process. In FIG. 5C, elongate member 202 has secured a first kidney stone 470, but a second kidney stone 472 remains within lower calyx 410. Once kidney stone 470 has been removed from the patient's body, the operator may move distal end 204 of elongate member 202 to a retrieval position and position its distal opening proximate to kidney stone 472. The above process may then be repeated for securing, moving, and breaking up stone 472. An operator may reposition any element of the medical device and/or repeat any of the above described steps any number of times. Once an operator determines no more kidney stones can and/or should be broken apart and/or no more stone fragments/dust can and/or should be removed, medical device 100 may be removed from the patient's body.

[0061] FIG. 6 illustrates an exemplary method of use of a medical device for removal of stone fragments/dust. For purposes of discussion, method 600 will be described using medical device 100 of FIG. 1 and the urinary system of FIGS. 5A-C, as described above, but method 600 is not intended to be limited thereto. As shown in FIG. 6, method 600 includes steps 602, 604, 606, 608, 610, 612, and 614. However, it should be noted that method 600 may include more or fewer steps as desired for a particular implementation and the order of the steps may be varied.

[0062] Method 600 may commence after elongate member 202 and/or tube 102 of medical device 100 have been inserted into a patient's body. In step 602, distal end 204 of elongate member 202 may be positioned proximal of a target area (e.g., kidney 408 and/or lower calyx 410). In step 604, as illustrated in FIG. 5A, dye (e.g., dye 550) may be supplied through a lumen (e.g., lumen 214) of the elongate member (e.g., elongate member 202) to the distal end (e.g., distal end 204) of the elongate member. In step 606, distal end 204 of elongate member 202 may be positioned at the target area

(e.g., kidney 408 and/or lower calyx 410) and/or distal of distal end 104 of tube 102. Once distal end 204 of elongate member 202 is proximate an object (e.g., kidney stone 470), method 600 may proceed to step 608 and suction may be applied through lumen 214 of elongate member 202. An operator may apply suction to lumen 214 of elongate member 202 by, for example, initiating vacuum source 250 of FIG. 1. The application of suction may move the object to the distal opening of lumen 214 and the object (e.g., kidney stone 470) may form a seal with distal end 204 of elongate member 202. In some examples, distal end 204 of elongate member 202 may be repositioned in order to capture the object with the applied suction. Once a seal is formed, method 600 may proceed to step 610. In step 610, distal end 204 of elongate member 202 may be moved distally and/or proximate to distal end 104 of tube 102, as shown in FIG. 5B. Moving distal end 204 of elongate member 202 may also move the object (e.g., kidney stone 470) distally and/or proximate to distal end 104 of tube 102. In step 612, once the object is proximate to distal end 104 of tube 102, a laser fiber may be disposed within the tube. For example, laser fiber 120 may extend through lumen 112 to distal end 104 of tube 102 and may aim at kidney stone 470. In step 614, the laser may be initiated. For example, an operator may initiate the laser through laser control 130 and/or handle portion 110 of FIG. 1.

[0063] The many features of the disclosure are apparent from the detailed specification, and thus, it is intended by the appended claims to cover all such features of the disclosure which fall within the true spirit and scope of the disclosure. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the disclosure to the exact construction and operation illustrated and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the disclosure.

[0064] Other embodiments of the disclosure will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

What is claimed is:

1. A medical device, comprising:
a delivery device including a tube; and
an elongate member having a distal end, a proximal end, and a lumen extending between the proximal end and the distal end, wherein the elongate member is configured to move axially relative to the tube and apply suction through the distal end.
2. The medical device of claim 1, wherein the proximal end of the elongate member is forked.
3. The medical device of claim 1, wherein the proximal end of the elongate member is connected to a control system.
4. The medical device of claim 3, wherein the control system controls the vacuum source.
5. The medical device of claim 1, wherein the proximal end of the elongate member is in fluid communication with a vacuum source.

6. The medical device of claim 1, further comprising:
a sleeve, wherein the sleeve is configured to receive the tube and the elongate member simultaneously.
7. The medical device of claim 1, wherein the delivery device is one of ureterscope, sheath, catheter, or endoscope.
8. The medical device of claim 1, further comprising:
a laser fiber connected to the tube.
9. The medical device of claim 1, wherein the lumen of the elongate member is substantially D-shaped.
10. The medical device of claim 1, wherein the tube includes an illumination device.
11. The medical device of claim 1, wherein the tube includes an imaging device.
12. The medical device of claim 1, wherein the tube has a first engaging surface, and the elongate member has a second engaging surface, and the first engaging surface is substantially complementary of the second engaging surface.
13. The medical device of claim 1, wherein the elongate member is in fluid communication with a fluid source.
14. The medical device of claim 1, wherein the lumen of the elongate member has an inner diameter of approximately 1 mm to approximately 3.5 mm.
15. The medical device of claim 1, wherein the elongate member is at least partially controlled by a control system and the tube is at least partially controlled by a handle.
16. A method of operating a medical device, comprising:
positioning a distal end of an elongate member of the medical device at a target area;
applying suction through a lumen of the elongate member to seal an object to the distal end of the elongate member; and
moving the distal end of the elongate member to move the object sealed to the distal end of the elongate member.
17. The method of claim 16, wherein, prior to positioning the distal end of the elongate member of the medical device at the target area, the method further comprises:
positioning the distal end of the elongate member proximal to the target area; and
supplying dye through the lumen of the elongate member to the distal end of the elongate member.
18. The method of claim 16, further comprising:
moving the object proximate to a tube;
disposing a laser fiber within the tube; and
initiating the laser.
19. A method of operating a medical device, comprising:
positioning a distal end of an elongate member of the medical device distal to a distal end of a tube of the medical device;
applying suction through a lumen of the elongate member to seal a kidney stone to the distal end of the elongate member; and
moving the distal end of the elongate member to move the kidney stone sealed to the distal end of the elongate member proximally toward the distal end of the tube.
20. The method of claim 19, further comprising:
disposing a laser fiber within the tube; and
initiating the laser.

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专利名称(译)	医疗器械和使用方法		
公开(公告)号	US20170215899A1	公开(公告)日	2017-08-03
申请号	US15/415604	申请日	2017-01-25
[标]申请(专利权)人(译)	波士顿科学西美德公司		
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IPC分类号	A61B17/22 A61B18/24 A61B17/30 A61B18/26		
CPC分类号	A61B17/22 A61B18/26 A61B18/245 A61B90/30 A61B2017/306 A61B2018/00511 A61B90/361 A61B17/30 A61B1/00094 A61B1/00135 A61B1/015 A61B1/307 A61B2018/00982 A61M1/008 A61M1/0084 A61M2205/106 A61M2210/1082		
优先权	62/288734 2016-01-29 US		
其他公开文献	US10499936		
外部链接	Espacenet USPTO		

摘要(译)

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