US 20250255667A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2025/0255667 A1**

XIA et al. (43) **Pub. Date: Aug. 14, 2025**

(54) **MEDICAL DEVICES AND RELATED METHODS**

(71) Applicant: **Boston Scientific Scimed Inc.**, Maple Grove, MN (US)

(72) Inventors: **Yin XIA**, Shanghai (CN); **Xinzhe PEI**, Shanghai (CN); **Longsheng CAI**, Shanghai (CN); **Minfeng HUA**, Shanghai (CN); **Yingzhi LU**, Shanghai (CN); **Xiangqi SU**, Shanghai (CN); **Jizhe YING**, Shanghai (CN)

(73) Assignee: **Boston Scientific Scimed Inc.**, Maple Grove, MN (US)

(21) Appl. No.: **19/193,053**

(22) Filed: **Apr. 29, 2025**

Related U.S. Application Data

(63) Continuation of application No. 18/252,378, filed on May 10, 2023, filed as application No. PCT/US2021/063504 on Dec. 15, 2021.

(30) **Foreign Application Priority Data**

Dec. 31, 2020 (CN) 202011619242.0

Publication Classification

(51) **Int. Cl.**

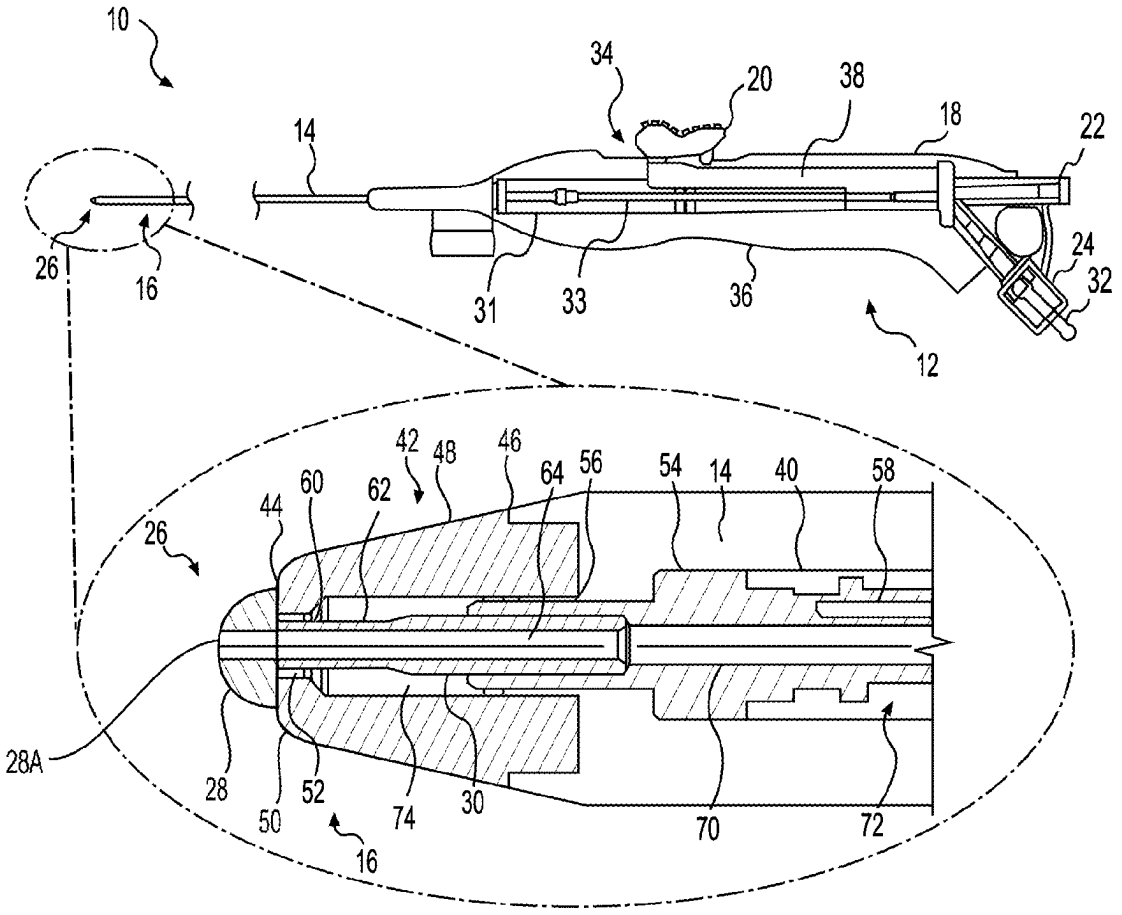
A61B 18/14	(2006.01)
A61B 17/00	(2006.01)
A61B 18/00	(2006.01)
A61B 18/12	(2006.01)
A99Z 99/00	(2006.01)

(52) **U.S. Cl.**

CPC ***A61B 18/1485*** (2013.01); ***A61B 18/1482*** (2013.01); ***A99Z 99/00*** (2019.05); *A61B 2017/00907* (2013.01); *A61B 2018/00083* (2013.01); *A61B 2018/1253* (2013.01); *A61B 2018/126* (2013.01); *A61B 2018/1405* (2013.01)

(57) **ABSTRACT**

A medical device includes a shaft, an end cap, and an electrode. The shaft includes a conductive element. The end cap is coupled to a distal end of the shaft. The electrode is coupled to the distal end of the shaft and passes through the end cap. The electrode includes an electrode shaft and a distal tip, and the electrode is electrically connected to the conductive element. The end cap includes a visualization feature.



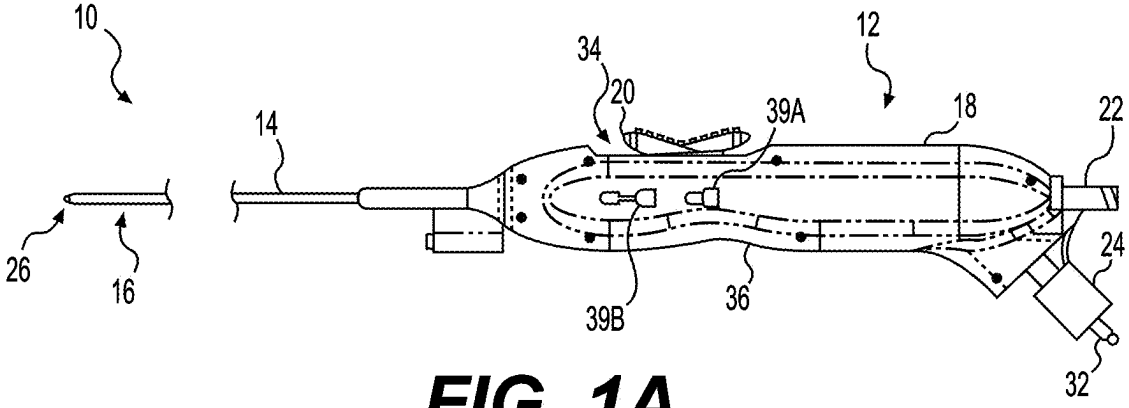

10
12
34
20
39A
18
22
14
26
16
39B
36
24
32

FIG. 1A

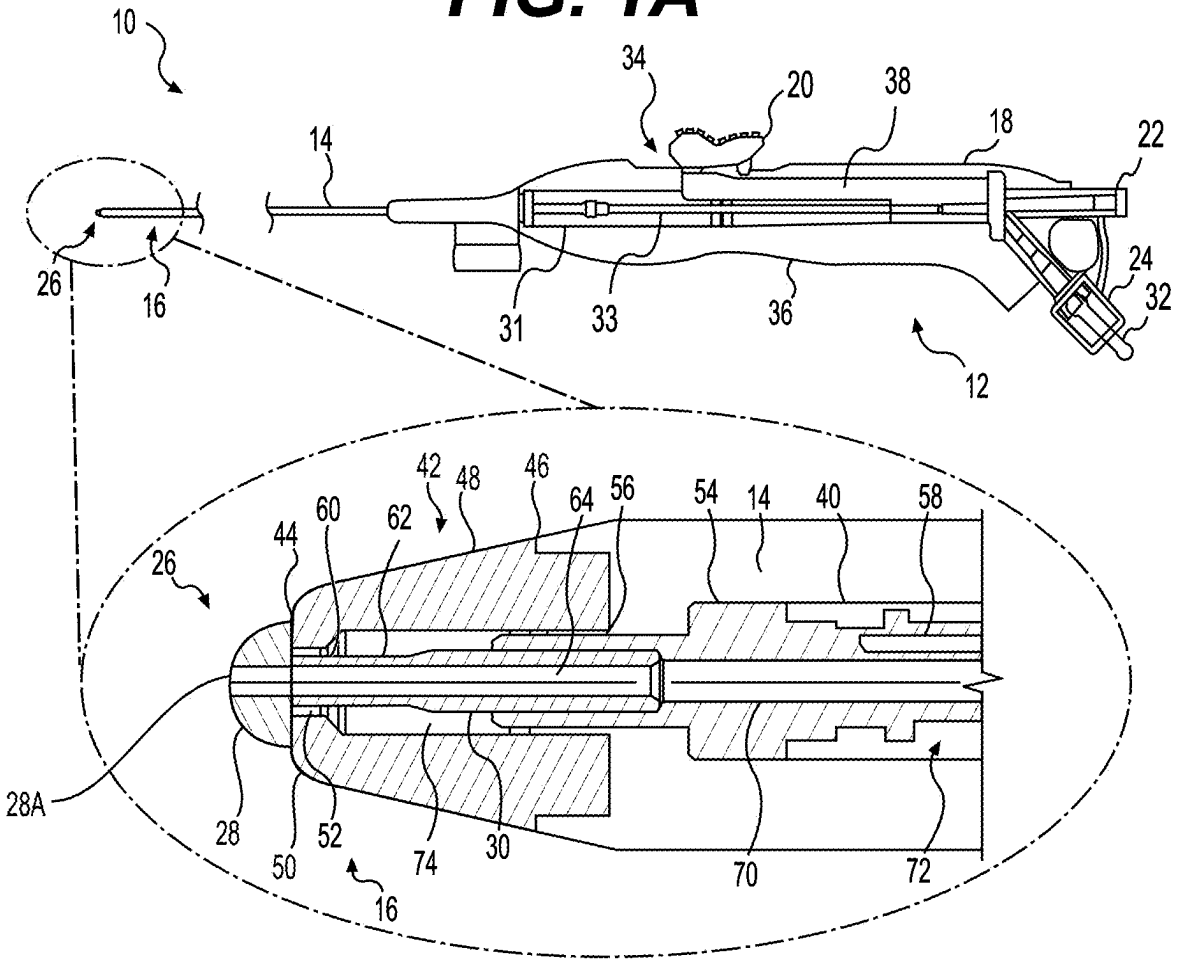

10
34
20
38
18
22
14
26
16
31
33
36
24
32
12
42
48
46
64
56
54
14
40
58
60
62
44
26
28A
28
50
52
74
30
70
72
16

FIG. 1B

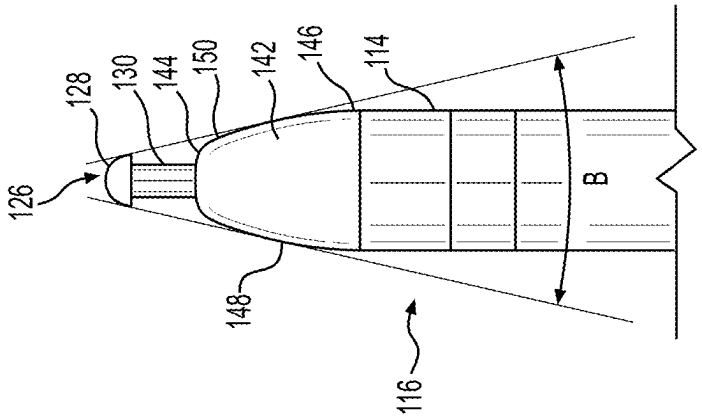

126
128
130
144
150
142
146
114
148
116
B

FIG. 3

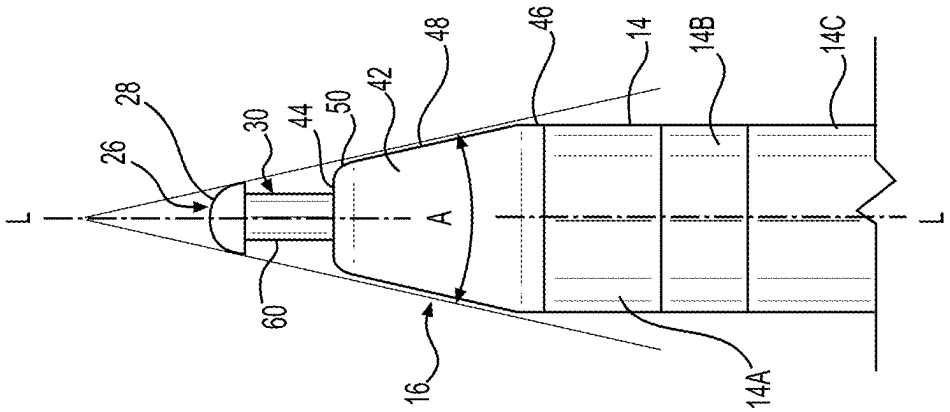

L
26
28
30
44
50
42
48
46
14
14B
14C
A
60
16
14A
L

FIG. 2

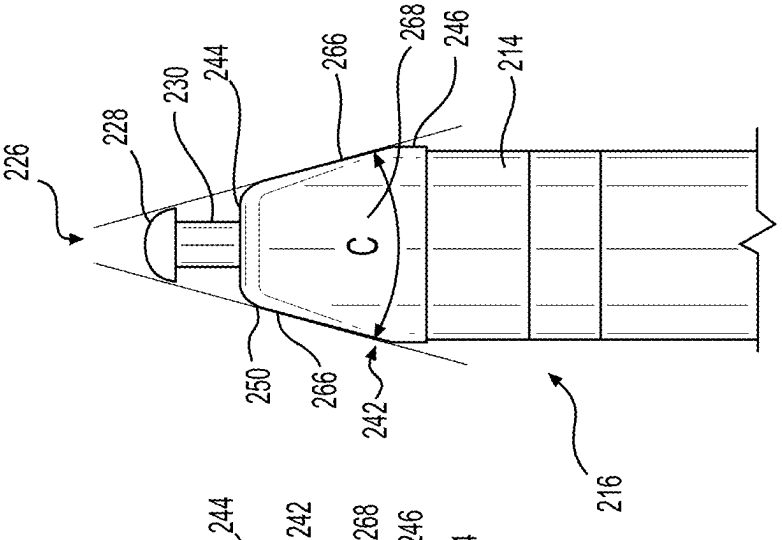


FIG. 4C

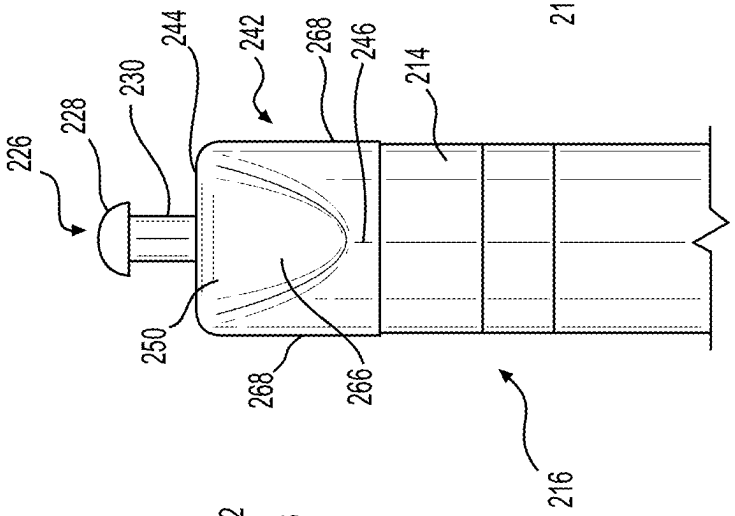


FIG. 4B

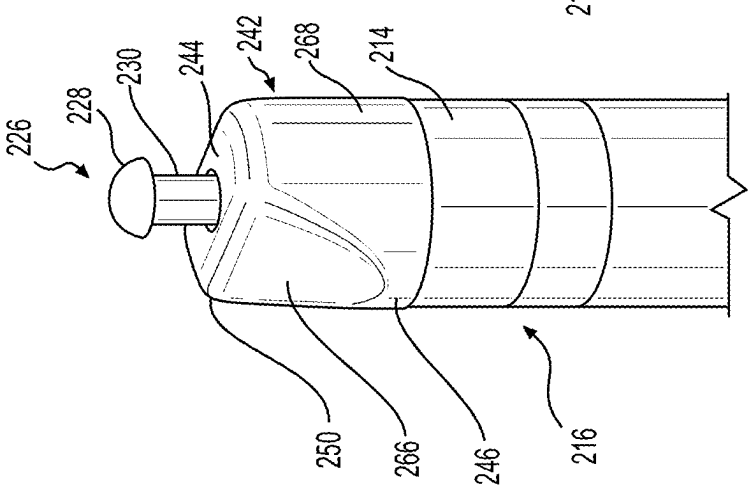


FIG. 4A

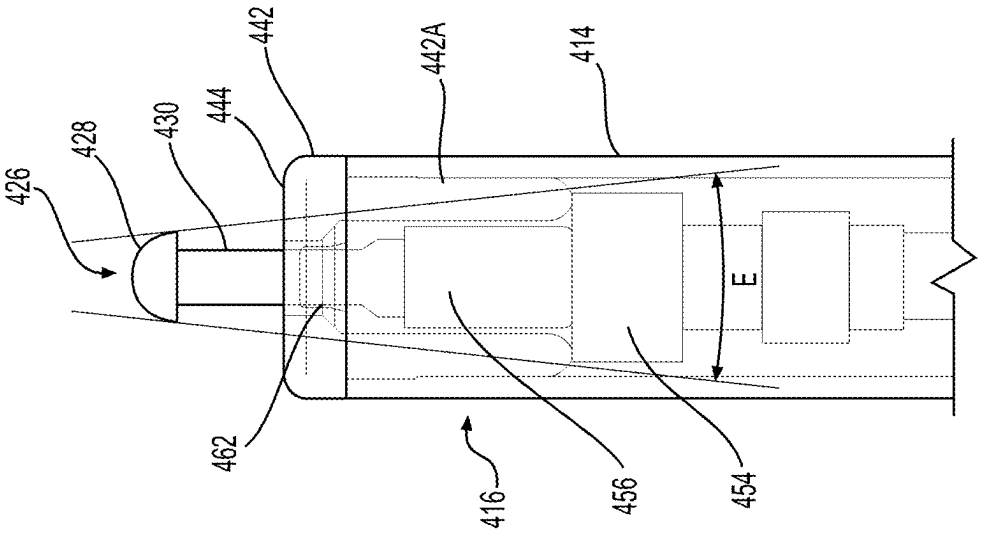

426
428
430
444
442
442A
414
462
416
456
454
E

FIG. 6

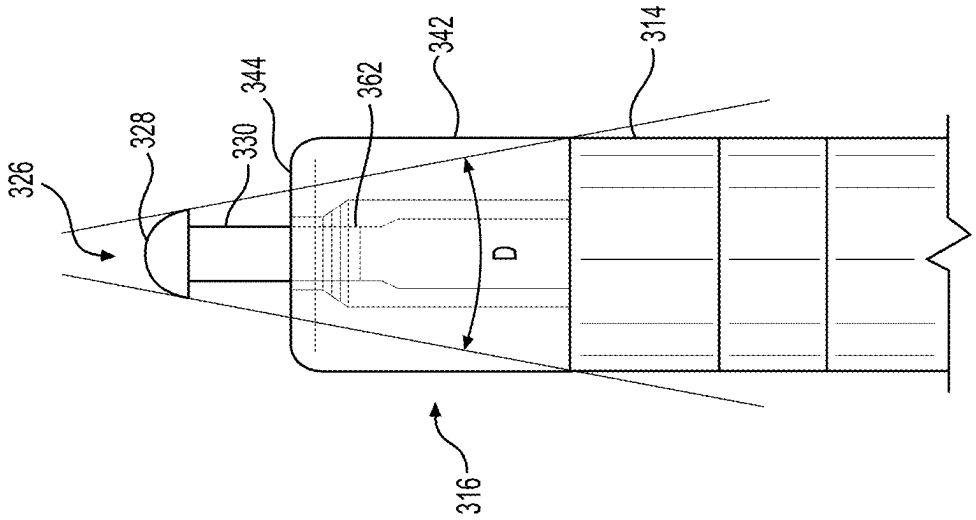

326
328
330
344
362
342
314
316
D

FIG. 5

MEDICAL DEVICES AND RELATED METHODS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to U.S. Nonprovisional application Ser. No. 18/252,378, filed on May 10, 2023, which is a National Stage Entry of PCT/US2021/063504 filed Dec. 15, 2021, which claims priority to Chinese Application No. 202011619242.0, filed Dec. 31, 2020, each of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

[0002] Aspects of this disclosure generally relate to medical devices and related methods. Embodiments of the disclosure relate to medical devices that can treat tissue by delivering electrical energy to or into tissue and/or injecting fluid into and/or under tissue.

BACKGROUND

[0003] Medical devices, such as endoscopes or other suitable insertion devices, are employed for a variety of types of diagnostic and surgical procedures, such as endoscopy, laparoscopy, arthroscopy, gynoscopy, thoracoscopy, cystoscopy, etc. Many of these procedures involve delivering energy to tissue of an organ or a gland to treat tumors, infections, and the like. Examples of such procedures include Endoscopic Mucosal Resection (EMR), Endoscopic Sub-mucosal Resection (ESR), Endoscopic Sub-mucosal Dissection (ESD), polypectomy, mucosectomy, etc. In particular, such procedures may be carried out by inserting an insertion device into a subject's body through a surgical incision, or via a natural anatomical orifice (e.g., mouth, vagina, or rectum), and performing the procedure or operation at a target site with an auxiliary device inserted through the insertion device.

[0004] At times, during a medical procedure, a user may use an auxiliary device that includes a catheter and a distally-extending electrode. The electrode may be energized for purposes of cutting, dissecting, ablating, marking, coagulating, cauterizing, or otherwise treating and/or manipulating tissue. The user may rely on a visualization device at a distal end of the insertion device or at a distal end of another device inserted to or near the target site. With the electrode extending from the distal end of the insertion device, the insertion device may at least partially impair the user's ability to visualize the electrode. As a result, the user may have to maneuver the visualization device closer to the electrode, which may be difficult in a small target site or pose other difficulties.

[0005] The devices and methods of this disclosure may rectify one or more of the deficiencies described above or address other aspects of the art.

SUMMARY

[0006] Examples of the disclosure relate to, among other things, medical devices and related methods for treating tissue by delivering electrical energy to the tissue with an electrode, while also visualizing at least a portion of the electrode. Each of the examples disclosed herein may include one or more of the features described in connection with any of the other disclosed examples.

[0007] A medical device may include a shaft, an end cap, and an electrode. The shaft may include a conductive element. The end cap may be coupled to a distal end of the shaft. The electrode may be coupled to the distal end of the shaft and may pass through the end cap. The electrode may include an electrode shaft and a distal tip, and the electrode may be electrically connected to the conductive element. The end cap may include a visualization feature.

[0008] The medical device may include one or more of the following features. The end cap may be at least partially insulating and may include an opening for the electrode to pass through. The visualization feature may form a blind angle of approximately 30 degrees or less when the distal tip of the electrode is extended approximately 1 mm to approximately 3 mm, such as approximately 1.5 mm, from a distal end face of the end cap. The visualization feature may be formed by a tapered portion of the end cap. The tapered portion of the end cap may include a straight taper. The straight taper may form a blind angle of approximately 25 degrees or less. The tapered portion of the end cap may include a rounded taper. The rounded taper may form a blind angle of approximately 25 degrees of less. The tapered portion of the end cap may include one or more tapered side portions, and optionally one or more partially cylindrical portions. The tapered side portion(s) of the end cap may form a blind angle of approximately 25 degrees on at least one side of the end cap. The tapered portion of the end cap may span approximately 80% of a length of the end cap.

[0009] The end cap may be at least partially transparent. The end cap may include a ceramic material, such as artificial sapphire or artificial crystal. The visualization feature may form a blind angle of approximately 21 degrees. A distal portion of the shaft may be at least partially transparent, and the end cap and the distal portion of the shaft may form the visualization feature. The distal portion of the shaft may be approximately 5 mm to approximately 15 mm in length, and the visualization feature may form a blind angle of approximately 11 degrees.

[0010] In another aspect, a medical device may include a shaft, an end cap, and an electrode. The shaft may include a conductive element. The end cap may be coupled to a distal end of the shaft. The end cap may include a tapered portion. The electrode may be coupled to a distal end of the shaft, and the electrode may pass through the end cap. The electrode may include an electrode shaft and a distal tip, and the electrode may be electrically connected to the conductive element. When the distal tip of the electrode is extended approximately 1 mm to approximately 3 mm from a distal end face of the end cap, the tapered portion of the end cap may form a blind angle of approximately 20 degrees to approximately 30 degrees.

[0011] The medical device may include one or more of the following features. The end cap may be at least partially insulating. The tapered portion of the end cap may include a rounded taper. The tapered portion of the end cap may include one or more tapered side portions and one or more partially cylindrical portions.

[0012] In yet another aspect, a medical device may include a shaft, an end cap, and an electrode. The shaft may include a conductive element. The end cap may be coupled to a distal end of the shaft. The end cap may be at least partially transparent. The electrode may be coupled to a distal end of the shaft and may pass through the end cap. The electrode may include an electrode shaft and a distal tip, and the

electrode may be electrically connected to the conductive element. When the distal tip of the electrode is extended approximately 1.5 mm from a distal end face of the end cap, the at least partially transparent end cap may form a blind angle of approximately 21 degrees or less.

[0013] The medical device may include one or more of the following features. The end cap may be at least partially insulating. The at least partially transparent end cap may include artificial sapphire or artificial crystal. A distal portion of the shaft may be at least partially transparent to form a blind angle of approximately 11 degrees.

[0014] It may be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosure, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary aspects of the disclosure and together with the description, serve to explain the principles of the disclosure.

[0016] FIG. **1**A illustrates an exemplary medical device, and FIG. **1**B illustrates a cross-sectional view of the medical device with a distal portion of the medical device enlarged, according to aspects of this disclosure.

[0017] FIG. **2** illustrates a side view of the distal portion of the medical device of FIGS. **1**A and **1**B, according to aspects of the disclosure.

[0018] FIG. **3** illustrates a side view of a distal portion of another exemplary medical device, according to aspects of the disclosure.

[0019] FIGS. **4**A-**4**C illustrate views of a distal portion of another exemplary medical device, according to aspects of the disclosure.

[0020] FIG. **5** illustrates a side view of a distal portion of another exemplary medical device, according to aspects of the disclosure.

[0021] FIG. **6** illustrates a side view of a distal portion of a further exemplary medical device, according to aspects of the disclosure.

DETAILED DESCRIPTION

[0022] Examples of the disclosure include devices and methods for one or more of: facilitating and improving the efficacy, efficiency, and safety of treating and/or manipulating tissue when, for example, applying electrical energy to tissue with an electrode. For example, aspects of the disclosure may provide a user (e.g., physician, medical technician, or other medical service provider) with a treatment device to deliver energy to a target site with the electrode, while also facilitating visualization of the electrode with a proximally located visualization device. Aspects of the disclosure may provide the user with the ability to apply electrical energy and/or heat to tissue using a medical device having an electrode. Aspects of the disclosure may provide the user with the ability to use a smaller electrode, for example, to maneuver in at the target site, while still visualizing the electrode. Alternatively or additionally, the user may use a larger electrode (e.g., an electrode that extends farther from a distal end of the catheter in order to expose a larger amount of the electrode) in order to better visualize the electrode during the procedure. However, the larger electrode may be more difficult to maneuver, may be more likely to contact tissue inadvertently, etc. Accordingly, aspects of the disclosure may provide the user with the ability to apply electrical energy and/or heat with a reduced likelihood of damaging tissue and/or contacting unintended portions of the tissue. Additionally, aspects of the disclosure may be selectively coupled to an existing medical device to improve the visualization of the electrode. Furthermore, aspects of the disclosure may help the user deliver a distal end of the medical device to the target site. Some aspects of the disclosure may be used in performing an endoscopic, laparoscopic, arthroscopic, gynoscopic, thoracoscopic, cystoscopic, or other type of procedure.

[0023] Reference will now be made in detail to examples of the disclosure described above and 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.

[0024] The terms "proximal" and "distal" are used herein to refer to the relative positions of the components of an exemplary medical device. When used herein, "proximal" refers to a position relatively closer to the exterior of the body of a subject or closer to a user, such as a medical professional, holding or otherwise using the medical device. In contrast, "distal" refers to a position relatively further away from the medical professional or other user holding or otherwise using the medical device, or closer to the interior of the subject's body. As used herein, the terms "comprises," "comprising," "having," "including," or other variations thereof, are intended to cover a non-exclusive inclusion, such that a device or method that comprises a list of elements does not include only those elements, but may include other elements not expressly listed or inherent thereto. Unless stated otherwise, the term "exemplary" is used in the sense of "example" rather than "ideal." As used herein, the terms "about," "substantially," and "approximately," indicate a range of values within +/−10% of a stated value.

[0025] FIGS. **1**A and **1**B depict a medical device **10** that includes a handle **12** and a shaft **14** having a distal end **16**. Handle **12** may include a main body **18** and a movable body **20**. Handle **12** also may include a port **22** configured to receive fluid, and a hub **24** configured to receive electrical energy similar to an electrical plug or socket. Distal end **16** includes an end effector, for example, an energy delivery portion or an electrode portion **26** (hereinafter "electrode **26**"). Electrode **26** is electrically connected to hub **24**, and, as discussed in detail below, may include a channel fluidly connected to, or otherwise in fluid communication with, port **22**. Additionally, as shown in FIG. **1**B and discussed in detail below, electrode **26** includes a distal tip **28** and an electrode shaft **30**. In some aspects, distal tip **28** may be wider (e.g., in a lateral direction away from a longitudinal direction of electrode shaft **30**) than electrode shaft **30**. For example, distal tip **28** may include a mushroom-like or semi-spherical tip. In some aspects, the size and/or shape of distal tip **28** may help the user to deliver energy and/or treat tissue.

[0026] Medical device **10** may be inserted into a body lumen of a subject, either through an insertion device or alone, such that at least a portion of shaft **14** may be within the subject, while handle **12** may remain outside of the subject. Distal end **16** may be positioned at a target site within the subject. From outside of the subject, a user can manipulate handle **12**. Additionally, the user may utilize a visualization device (e.g., a camera) positioned at a distal

end of an insertion device or another medical device to visualize distal end **16**, including electrode **26**, at the target site. Movement of movable body **20** relative to main body **18** in a first direction (e.g., the distal direction) may extend electrode **26** relative to shaft **14** (e.g., move electrode **26** distally relative to a distal end of shaft **14**). Movement of movable body **20** relative to main body **18** in a second direction (e.g., the proximal direction) may retract electrode **26** relative to shaft **14** (e.g., move electrode **26** proximally relative to a distal end of shaft **14**). Although not shown, movable body **20** or additional components of handle **12** may articulate electrode **26** (or electrode **26** and distal end **16**) left or right, and/or up or down relative to shaft **14**.

[0027] In some aspects, handle **12** may be coupled to a fluid source via port **22**. Port **22** may be in fluid communication with electrode **26** via an internal lumen **31**, which may extend through handle **12** (FIG. **1**B) and shaft **14**. It is noted that various portions of handle **12** shown in FIG. **1**B are not necessarily shown to scale, in order to more fully illustrate various portions of handle **12**. In at least one aspect, internal lumen **31** may extend longitudinally through main body **18** of handle **12** and shaft **14** to fluidly connect port **22** to electrode **26**. Port **22** may be positioned on a proximal portion of main body **18**, for example, a proximal end of main body **18**. Alternatively, port **22** may be positioned on a distal or central portion of main body **18**. Moreover, port **22** may include a one-way valve, a luer, a seal, threading, and/or any appropriate connection or mating element to help maintain a secure connection between handle **12** and the fluid source, minimize or prevent back-flow (e.g., fluid flowing proximally out of port **22**), and/or minimize or prevent leakage. In at least one example, port **22** may include a one-way valve having an outer housing containing an inner elastomeric and/or gelatinous sealing member. In some examples, handle **12** does not include a port **22**, e.g., wherein medical device **10** is not used for fluid delivery.

[0028] Handle **12** may be coupled to an energy source via hub **24**. Hub **24** may include one or more prongs or pins **32** to couple to the energy source. Hub **24** may be electrically coupled to electrode **26** via a conductive element **33**, which may be electrically coupled to pin **32** and extend through handle **12** and through at least a portion of shaft **14**. The energy source may be, for example, an electrocautery source, a radio frequency generator, a heating source, a current generator, etc. In other aspects, the energy source may be a part of handle **12** (e.g., an internal battery in handle **12**).

[0029] In at least one aspect, medical device **10** may be used for monopolar electrosurgery, and may include a return electrode positioned remotely from electrode **26** on or otherwise adjacent to the subject. In other aspects, medical device **10** may be used for bipolar electrosurgery. In such instances, electrode **26** may include an active electrode portion, and a return electrode may be provided at or near another portion of electrode **26** and/or shaft **14**. In at least one example, two conductive elements may run through shaft **14**, where the conductive elements may be electrically isolated from each other, allowing one conductive element to conduct energy to the active electrode and the other conductive element to conduct energy from a return electrode.

[0030] Hub **24** may be positioned on main body **18**, for example, on a proximal end of main body **18**. In at least one aspect, port **22** may extend from the proximal end of main body **18** in a direction parallel to or coaxial with a longitudinal axis of main body **18**, and hub **24** may extend from the proximal end of main body **18** at an angle transverse (e.g., approximately 45 degrees) to the longitudinal axis of main body **18**. In other aspects, hub **24** may be positioned on a distal or central portion of main body **18**, or on movable body **20**. According to some examples, main body **18** and/or hub **24** may include a one-way valve, a luer, a seal, threading, and/or any appropriate connection or mating element to help maintain a secure connection between handle **12** and the energy source, minimize or prevent back-flow (e.g., fluid flowing from port **22** and/or internal lumen **31** and proximally out of hub **24**), and/or minimize or prevent leakage.

[0031] In at least one aspect, as shown in FIG. **1**B, pin **32** may extend through hub **24** transverse to a longitudinal axis of handle **12**, and may be electrically and physically connected to conductive element **33**, such as a wire, a cable, and/or a braided sheath. Conductive element **33** may be electrically conductive or otherwise include an electrically conductive component or portion, and conductive element **33** may extend longitudinally through internal lumen **31** and through shaft **14**. As shown in FIG. **1**B, fluid delivered through port **22** may surround at least a portion of conductive element **33**. In at least one aspect, conductive element **33** may include one or more layers of insulation to help insulate conductive element **33** from the fluid in internal lumen **31**. As mentioned above, a second conductive element may be provided as a return pathway when medical device **10** has a bipolar configuration.

[0032] As mentioned, handle **12** may control the extension and/or retraction of electrode **26** relative to the distal end **16** of shaft **14**. For example, main body **18** may include a slot **34**, and movable body **20** may be slidably positioned within slot **34**. For example, main body **18** may be configured to be held by a user's hand, and movable body **20** may be configured to be controlled by the movement of the user's thumb. For example, a side of main body **18** opposite to movable body **20** may include one or more contours **36**, which may help the user grip main body **18**. Movable body **20** may be lockable in one or more positions relative to main body **18**, and/or may be spring-biased in a direction (e.g., toward a proximally retracted position).

[0033] Movable body **20** may be coupled to a drive element, and the drive element may impart distal and/or proximal movement to at least a portion of electrode **26** based on relative movement between main body **18** and movable body **20**. In at least one aspect, the drive element may be physically coupled (directly or indirectly) to movable body **20**, such that movement of movable body **20** extends or retracts the drive element, and thus extends or retracts electrode **26**. In such aspects, conductive element **33** may electrically connect pin **32** to electrode **26**. For example, conductive element **33** may include slack (e.g., be longer than the distance from pin **32** to electrode **26** or another electrical coupling element) in order to help account for any tortuosity shaft **14** may encounter during delivery and/or to help account for the movement (e.g., extension) of electrode **26** or another electrical coupling element.

[0034] In some aspects, conductive element **33** may also act as a drive wire, rod, cable, or the like, such that conductive element **33** may impart distal or proximal movement to at least a portion of electrode **26** while also coupling electrode **26** to hub **24**, e.g., to the one or more pins **32**, to

deliver the energy to (and/or from) electrode **26**. As shown in FIG. **1**B, movable body **20** may be coupled to conductive element **33** via a coupling mechanism, for example, a coupler **38**. In at least one aspect, coupler **38** may be physically coupled (directly or indirectly) to movable body **20**, and may also be physically coupled (directly or indirectly) to conductive element **33**, such that movement of movable body **20** extends and/or retracts conductive element **33**, and thus extends and/or retracts electrode **26**. It is noted that coupler **38** and/or other components within handle **12** may help maintain the electrical connection between pin **32** and conductive element **33** when conductive element **33**, and thus electrode **26**, is in the retracted or extended position. Alternatively, in other aspects, coupler **38** and/or other components within handle **12** may be configured to only electrically connect pin **32** and conductive element **33** when conductive element **33**, and thus electrode **26**, is in the extended position, or an at least partially extended position.

[0035] As shown in FIG. **1**A, handle **12** may also include one or more indicators, for example, indicators **39**A, **39**B. In at least one aspect, indicators **39**A, **39**B may visually indicate to the user the position of electrode **26** relative to shaft **14**. The position of indicators **39**A, **39**B may also correspond with the position of movable body **20**. For example, indicator **39**A may be positioned on handle **12** at a position corresponding with a retracted position of movable body **20**, and may indicate that electrode **26** is retracted relative to shaft **14**. Similarly, indicator **39**B may be positioned on handle **12** at a position corresponding with an extended position of movable body **20**, and may indicate that electrode **26** is extended relative to shaft **14**.

[0036] As shown in FIGS. **1**A and **1**B, shaft **14** extends from a distal portion of main body **18** to distal end **16**, and may surround at least a portion of electrode **26**. Shaft **14** may include a sheath that surrounds at least a portion of one or more lumens (e.g., lumen **31**) and a drive wire (e.g., conductive element **33**). In other aspects, shaft **14** may be an extrusion that includes one or more lumens extending from handle **12** to distal end **16**.

[0037] The enlarged portion of FIG. **1**B illustrates additional exemplary features of shaft **14** and distal end **16**. Electrode **26** includes distal tip **28** and electrode shaft **30**. Electrode **26** may be positioned within a portion of an end cap **42** of distal end **16**. End cap **42** may be coupled to distal end **16** of shaft **14**, and shaft **14** and end cap **42** may partially overlap, as shown in FIG. **1**B. End cap **42** may include a distal end face **44**. End cap **42** may be at least partially electrically insulating. For example, all or part of end cap **42** may be formed of a ceramic material or another non-conductive material. In some examples, only distal end face **44** and an internal portion of end cap **42** that contacts and/or surrounds electrode **26** may be electrically insulating. Distal end face **44** includes a central opening **52** through which electrode **26** may extend and/or retract. End cap **42** includes a central portion **74** through which electrode shaft **30** may move during the extension and/or retraction. End cap **42** may be fixedly coupled to shaft **14** via welding, an adhesive, crimping, friction fit, or other appropriate coupling material or mechanism.

[0038] Electrode **26** may be coupled to a proximal support **54** of distal end **16**, which may include an extension **56**, which may be cylindrical in shape. Proximal support **54** may be coupled to a portion of the drive wire (e.g., conductive element **33**) via a drive wire receiving portion **58**, for example, via welding, an adhesive, crimping, friction fit, or any other permanent or temporary coupling material or mechanism. Extension **56** may extend distally and may receive at least a portion of electrode **26**. Electrode **26** and extension **56** may be coupled via welding, an adhesive, crimping, friction fit, or other appropriate coupling material or mechanism. In at least one aspect, extension **56** may allow for different electrodes **26** to be removably coupled to distal end **16**. Proximal support **54** includes a support lumen **70**, and support lumen **70** fluidly connects port **22** to electrode **26**, for example, via a lumen (e.g., lumen **31**) through shaft **14**.

[0039] Electrode **26** and proximal support **54** may be movable relative to end cap **42** in response to the relative movement of movable body **20** and main body **18** of handle **12**. For example, with movable body **20** in a proximal position relative to main body **18**, electrode shaft **30** may be substantially retracted within end cap **42**. In the example shown in FIG. **1**B, distal tip **28** has a cross-sectional dimension larger than central opening **52**, such that only a distal portion of electrode **26** (e.g., distal tip **28**) extends distally beyond end cap **42**. Then, as movable body **20** is translated distally relative to main body **18**, electrode **26** and proximal support **54** translate distally relative to end cap **42** such that a greater portion of electrode **26** (e.g., electrode shaft **30**) extends distally beyond end cap **42** through central opening **52**.

[0040] Alternatively, central opening **52** may be larger than distal tip **28**, and with movable body **20** in the proximalmost position, electrode **26** (including distal tip **28**) may be fully retracted within central opening **52** of end cap **42**. Furthermore, in at least one aspect, movable body **20** may have an equilibrium position relative to main body **18**, and the equilibrium position may correspond to electrode shaft **30** being partially extended from end cap **42**.

[0041] As shown in the enlarged portion of FIG. **1**B, electrode shaft **30** includes a distal portion **60** adjacent to distal tip **28** and a longitudinal portion **62**. Electrode shaft **30** may include one or more graduated portions, for example, with varying diameters, which may aid in the coupling of electrode shaft **30** to proximal support **54**, may help to form one or stop surfaces (e.g., abutting an internal portion of end cap **42**, etc.). In some aspects, electrode shaft **30** also may include a lumen **64** extending through electrode shaft **30**, for example, extending longitudinally through a central portion of electrode shaft **30**. Lumen **64** may be in fluid communication with port **22** via support lumen **70** through proximal support **54**. In at least one aspect, an inner sheath **40** may form at least a portion of the fluid connection between lumen **70** and port **22**. Additionally, lumen **64** of electrode shaft **30** may be in fluid communication with an outlet **28**A to form a channel to deliver fluid from a distal end (e.g., distal tip **28**) of electrode **26**.

[0042] As mentioned above, in some aspects, medical device **10** may be configured to deliver only energy, and not fluid. In such aspects, electrode shaft **30** optionally does not include lumen **64**, proximal support **54** optionally does not include support lumen **70**, and/or distal tip **28** optionally does not include outlet **28**A. Furthermore, in some aspects, electrode **26** may include one or more insulating portions.

[0043] Electrode **26** may have a length of approximately 5 mm to approximately 20 mm, for example, approximately 10 mm. Electrode **26**, for example, electrode shaft **30**, may have a cross-sectional dimension (e.g., diameter) of approxi-

mately 0.3 mm to approximately 1.0 mm, for example, approximately 0.4 mm to approximately 0.6 mm. A largest portion of distal tip **28** (e.g., the proximal end of distal tip **28**) may have a diameter of approximately 0.4 mm to approximately 1.5 mm, for example, approximately 0.6 mm to approximately 1.0 mm. These dimensions are exemplary only; distal tip **28** and/or electrode shaft **30** may have different sizes and/or shapes than those above.

[0044] FIG. **2** illustrates additional exemplary aspects of distal end **16** of shaft **14** and electrode **26**. As shown in FIG. **2**, electrode **26** may be extended relative to end cap **42** and distal end **16** of shaft **14**. In the exemplary configuration shown, when electrode **26** is extended, distal tip **28** is spaced away from distal end face **44**, and electrode shaft **30** is exposed. For example, electrode **26** may extend from distal end face **44** by approximately 3 mm, approximately 2 mm, approximately 1.5 mm, approximately 1 mm, etc., such as, for example, from approximately 1 mm to approximately 3 mm.

[0045] As shown in FIG. **1**B and as shown in greater detail in FIG. **2**, distal end **16** includes a visualization feature. In this exemplary aspect, the visualization feature is formed by end cap **42**, which includes an outer surface that is tapered, for example, such that the radial width and/or cross-sectional dimension (FIG. **1**B) reduces from a proximal end of end cap **42** to a distal end of end cap **42**. For example, the end cap **42** may have a tapered profile.

[0046] As shown in FIGS. **1**B and **2**, a proximalmost portion **46** of end cap **42** does not taper in this example. As shown, for example, the outermost surface of proximalmost portion **46** may be parallel to the longitudinal axis of distal end **16**. Then, as shown, a tapered portion **48** of end cap **42** may extend from proximalmost portion **46** to distal end face **44**. Tapered portion **48** may include a straight taper, as shown in the cross-sectional view of FIG. **1**B and the side view of FIG. **2**. For example, over the span of tapered portion **48**, the cross-sectional diameter of end cap **42** may decrease from the proximal portion of tapered portion **48** to the distal portion of tapered portion **48** at a constant rate. In at least one aspect, and as shown in FIGS. **1**B and **2**, a distalmost portion **50** of end cap **42** may gradually transition (e.g., curve) from tapered portion **48** to distal end face **44**.

[0047] According to some aspects of the present disclosure, end cap **42** may have a length of approximately 2 mm to 6 mm, for example, approximately 3 mm, and end cap **42** may include a cross-sectional diameter (e.g., as shown in FIG. **1**B) of approximately 1.5 mm to approximately 3 mm, for example, approximately 1.8 mm to approximately 2.5 mm. For example, proximalmost portion **46** of end cap **42** may have a cross-sectional diameter of approximately 2.2 mm, and distalmost portion **50** of end cap **42** may have a cross-sectional diameter of approximately 1.4 mm. Distalmost portion **50** of end cap **42** may transition (e.g., curve) from tapered portion **48** to distal end face **44** with a radius of curvature of approximately 0.3 mm. Tapered portion **48** may span a majority (e.g., more than 50% of the length, such as approximately 60% to approximately 98%, e.g., approximately 60%, approximately 70%, approximately 80%, approximately 90%, etc., of the length) of end cap **42**. In at least one aspect, tapered portion **48** may include a longitudinal length of approximately 1.8 mm to approximately 2.2 mm, for example, approximately 1.95 mm.

[0048] In at least one aspect, in a longitudinal cross-section, tapered portion **48** spans an angle A, for example, approximately 20 degrees to approximately 40 degrees. In at least one aspect, tapered portion spans angle A of approximately 25 degrees. In at least one aspect, tapered portion **48** may extend at an angle of approximately 12.5 degrees relative to longitudinal axis L on each side of longitudinal axis L. In this manner, tapered portion **48** may help to improve the visualization of electrode **26** by not blocking the view of the visualization device (e.g., camera) at a distal end an insertion device or separate device, except for angle A. For example, with electrode **26** extended from end cap **42**, the user may be able to visualize electrode **26**, as long as the visualization device (e.g., camera), is not within angle A. For example, electrode **26** may be extended approximately 1.5 mm from end cap **42**, and tapered portion **48** may allow for increased visualization of electrode **26**, including distal tip **28**, when treating tissue or maneuvering electrode **26** at the target site. Tapered portion **48** may also help in the delivery of distal end **16** to the target site.

[0049] Furthermore, in some aspects, a distal portion of shaft **14** may include one or more sections, e.g., sections **14**A, **14**B, and **14**C. Sections **14**A, **14**B, and **14**C may include different material properties (e.g., different flexibilities or rigidities, different conductivities or insulating properties, etc.). In at least one aspect, one or more sections, for example, section **14**B, may be at least partially conductive, such that with electrode **26** in a certain position (e.g., retracted), energy may be delivered through an electrical connection from electrode **26** to section **14**B, for example, to help mark tissue at or near the target site. In other aspects, the one or more of sections **14**A, **14**B, or **14**C may include different colors, indications, etc., which may help the user deliver, maneuver, etc. medical device **10** to and/or around the target site.

[0050] FIG. **3** illustrates a side view of a shaft **114** and distal end **116** of another exemplary medical device, which may include any of the components of medical device **10** above. Shaft **114** and distal end **116** may be similar to shaft **14** and distal end **16**, respectively, with corresponding components. For example, distal end **116** includes an electrode **126** with a distal tip **128** and an electrode shaft **130**, and an end cap **142** with a distal end face **144**.

[0051] Distal end **116** includes a visualization feature formed by end cap **142**. In this example, visualization feature is provided by an outer surface of end cap **142** that is tapered, for example, such that the radial width and/or cross-sectional thickness reduces from a proximal end of end cap **142** to a distal end of end cap **142**. As shown in FIG. **3**, in this example, end cap **142** includes a curved or rounded taper (e.g., rather than a straight taper as illustrated in FIG. **2**). As shown in FIG. **3**, a proximalmost portion **146** of end cap **142** does not include a taper. For example, the outer surface of proximalmost portion **146** may be parallel to the longitudinal axis of distal end **116**. Then, a tapered portion **148** of end cap **142** may extend from proximalmost portion **146** to distal end face **144**. Tapered portion **148** may include a curved taper, e.g., a variable rate of taper. For example, the slope of the taper of tapered portion **148** may increase from a proximal portion of tapered portion **148** to a distal portion of tapered portion **146**. Moreover, tapered portion **148** may include a curved transition from proximalmost portion **146** to distal end face **144**. In at least one aspect, and as shown in FIG. **3**, a distalmost portion **150** of end cap **142** may gradually transition (e.g., curve) from tapered portion **148** to distal end face **144**.

[0052] In at least one aspect, end cap **142** may have a length of approximately 2 mm to 6 mm, and end cap **142** may include a cross-sectional diameter of approximately 1.5 mm to approximately 3 mm, for example, approximately 1.8 mm to approximately 2.5 mm. For example, proximalmost portion **146** may include a cross-sectional diameter of approximately 2.2 mm, and distalmost portion **50** of end cap **42** may have a cross-sectional diameter of approximately 1 mm to approximately 1.4 mm. Tapered portion **148** may span a majority (e.g., more than 50% of the length, such as approximately 60% to approximately 98%, e.g., approximately 60%, approximately 70%, approximately 80%, approximately 90%, etc., of the length) of end cap **142**. In at least one aspect, tapered portion **148** may include a longitudinal length of approximately 2 mm to approximately 3 mm, for example, approximately 2.5 mm.

[0053] In at least one aspect, in a longitudinal cross-section, tapered portion **148** spans an angle B, for example, approximately 20 degrees to approximately 40 degrees. In at least one aspect, tapered portion **148** spans angle B of approximately 25 degrees. In at least one aspect, tapered portion **148** may extend at an angle of approximately 12.5 degrees relative to longitudinal axis of distal end **116** on each side of the longitudinal axis of distal end **116**. In this manner, tapered portion **148** may help to improve the visualization of electrode **126** by not blocking the view of the visualization device (e.g., camera) of an insertion device or separate device, except for angle B. For example, with electrode **126** extended from end cap **142**, the user may be able to visualize electrode **126**, as long as the visualization device (e.g., camera), is not within angle B. For example, electrode **126** may be extended approximately 1.5 mm from end cap **142**, and tapered portion **148** may allow for increased visualization of electrode **126**, including distal tip **128**, when treating tissue or maneuvering electrode **126** at the target site. Tapered portion **148** may also help in the delivery of distal end **116** to the target site.

[0054] FIGS. **4**A-**4**C illustrate various views of shaft **214** and distal end **216** of another exemplary medical device, which may include any of the components of medical device **10** above. Shaft **214** and distal end **216** may be similar to shaft **14** and distal end **16**, respectively, with similar components. For example, distal end **216** includes an electrode **226** with a distal tip **228** and an electrode shaft **230**, and an end cap **242** with a distal end face **244**. FIG. **4**A illustrates a perspective view of distal end **216**. FIG. **4**B illustrates a side view of distal end **216**, and FIG. **4**C illustrates another side view of distal end **216**.

[0055] Distal end **216** includes a visualization feature formed by end cap **242**. In this example, the visualization feature is provided by one or more wedge-like or tapered side portions **266** of end cap **242** that are tapered, for example, such that the radial width and/or cross-sectional thickness reduces from a proximal end of end cap **242** to a distal end of end cap **242**. End cap **242** also includes one or more rounded non-tapered or partially cylindrical portions **268**. For example, as shown in FIGS. **4**A-**4**C, end cap **242** may include two tapered side portions **266**. Tapered side portions **266** may form opposite (e.g., circumferentially opposite) sides of end cap **242**. Additionally, as shown, end cap **242** may include two cylindrical portions **268** that connect tapered side portions **266**. Cylindrical portions **268** of end cap **242** may be substantially the same size (cross-sectional diameter) as shaft **214**, and may also include substantially the same circumferential curvature (e.g., partially circular).

[0056] In at least one aspect, as shown in FIGS. **4**A-**4**C, tapered side portion(s) **266** may be substantially straight in the longitudinal direction, for example, including a consistent taper from proximalmost portion **246** to distal end face **244** of distalmost portion **250**. Alternatively, one or more of tapered side portions **266** may include a curved, or variable taper similar to the curvature shown in FIG. **3**. For example, as discussed with respect to tapered portion **146** of FIG. **3**, the slope of the taper of tapered side portions **266** may increase from a proximal portion of tapered side portions **266** to a distal portion of tapered side portions **266**. Moreover, in some examples, a proximalmost portion **246** of end cap **242** does not include a taper. For example, the outer surface of proximalmost portion **246** may be parallel to the longitudinal axis of distal end **216**. In at least one aspect, distalmost portion **250** of end cap **242** may gradually transition (e.g., curve) from tapered side portions **266** to distal end face **244**.

[0057] In at least one aspect, end cap **242** may have a length of approximately 2 mm to 6 mm, and end cap **242** may have a cross-sectional diameter of approximately 1.5 mm to approximately 3 mm, for example, approximately 1.8 mm to approximately 2.5 mm. For example, proximalmost portion **246** of end cap **242** may have a cross-sectional diameter of approximately 2.2 mm, and distalmost portion **250** of end cap **242** may have a cross-sectional diameter of approximately 0.5 mm to approximately 1.6 mm, for example, approximately 0.8 mm to approximately 1.3 mm. Distalmost portion **250** of end cap **242** may transition (e.g., curve) from tapered portion **248** to distal end face **244** with a radius of curvature of approximately 0.3 mm. Tapered side portions **266** may span a majority (e.g., more than 50%, such as approximately 60% to approximately 98%, e.g., approximately 60%, approximately 70%, approximately 80%, approximately 90%, etc.) of the length of end cap **242**. In at least one aspect, tapered side portions **266** may include longitudinal lengths of approximately 2.4 mm to approximately 2.8 mm, for example, approximately 2.6 mm. Moreover, end cap **242** may include one, three, four, or more tapered side portions **266**. The one or more tapered side portions **266** may be substantially the same size (e.g., longitudinal length, circumferential width, etc.), or may have different sizes and/or angles as other side portions **266**. The one or more tapered side portions **266** may be evenly or unevenly arranged or spaced around the circumference of end cap **242**, and optionally may be connected by cylindrical portions **268**. In at least one example, end cap **242** includes two or more tapered side portions **266** directly connected to each other, without cylindrical portions **268**.

[0058] In at least one aspect, in a longitudinal cross-section, two tapered side portions **266** of end cap **242** span an angle C (angle C being formed by the slopes of the two tapered side portions **266**), for example, approximately 20 degrees to approximately 40 degrees. In at least one aspect, tapered portions **266** span angle C of approximately 25 degrees. In one aspect, tapered side portions **266** may extend at an angle of approximately 12.5 degrees relative to longitudinal axis of distal end **216** on each side of the longitudinal axis of distal end **216**. In this manner, tapered side portions **266** may help to improve the visualization of electrode **226** by not blocking the view of the visualization

device (e.g., camera) of an insertion device or separate device, except for angle C. For example, with electrode **226** extended from end cap **242**, the user may be able to visualize electrode **226**, as long as the visualization device (e.g., camera), is not within angle C. For example, electrode **226** may be extended approximately 1.5 mm from end cap **242**, and tapered side portions **266** may allow for increased visualization of electrode **226**, including distal tip **228**, when treating tissue or maneuvering electrode **226** at the target site. It is noted that tapered side portions **266** may help in visualization of electrode **226**, and/or may also help with the delivery of distal end **216** to the target site.

[0059] FIG. **5** illustrates a side view of a shaft **314** and distal end **316** of another exemplary medical device, which may include any of the components of medical device **10** above. Shaft **314** and distal end **316** may be similar to shaft **14** and distal end **16**, respectively, with similar components. Distal end **316** includes an electrode **326** with a distal tip **328** and an electrode shaft **330**, and an end cap **342** with a distal end face **344**.

[0060] Distal end **316** includes a visualization feature formed by end cap **342**. In this example, end cap **342** is at least partially transparent. As shown in FIG. **5**, end cap **342** may include a substantially constant cross-sectional dimension (e.g., diameter), and the circumference of end cap **342** may be substantially similar to the circumference of shaft **314**. End cap **342** may comprise a transparent material, for example, a ceramic material such as artificial sapphire, artificial crystal, or another material that is at least partially ceramic and at least partially insulating. In some configurations, one or more proximal portions of electrode **326** disposed within end cap **342**, for example, longitudinal portion **362**, may be at least partially visible through end cap **342**.

[0061] In at least one aspect, end cap **342** may have a length of approximately 2 mm to 6 mm, and end cap **342** may have a cross-sectional diameter of approximately 1.5 mm to approximately 3 mm, for example, approximately 1.8 mm to approximately 2.5 mm. The exposed portion of end cap **342** may include a length of approximately 2.4 mm to approximately 2.8 mm, for example, approximately 2.6 mm, and a cross-sectional diameter of approximately 2.0 mm to approximately 2.4 mm, for example, approximately 2.2 mm. End cap **342** may transition (e.g., curve) from a side portion to distal end face **344** with a radius of curvature of approximately 0.3 mm. In at least one aspect, with end cap **342** being at least partially transparent, shaft **314** may be the only impediment in visualizing electrode **326**, including distal tip **328**. In such aspects, shaft **314** may form an angle D relative to the proximal end of distal tip **328**.

[0062] As shown, because end cap **342** is at least partially transparent in this example, the angle D may be less than an angle formed by outer surfaces of the end cap **342**. For example, the angle D may be approximately 15 degrees to approximately 40 degrees. In at least one aspect, angle D is approximately 18 degrees to approximately 25 degrees, for example, approximately 21 degrees. In at least one aspect, the distal end of a side of shaft **314** (e.g., in a longitudinal cross-section) and a side of distal tip **328** may form an angle (corresponding to half the angle D) of approximately 10.5 degrees. For example, as shown in FIG. **5**, each side of the distal end of shaft **314** and respective side of distal tip **328** of electrode **326** may extend at angle of approximately 10.5 degrees relative to the longitudinal axis of distal end **316**. In this aspect, because end cap **342** is at least partially transparent, distal end **316** may include an angle D of approximately 21 degrees. Accordingly, end cap **342** may help to improve the visualization of electrode **326** by not blocking the view of the visualization device (e.g., camera) of an insertion device or separate device, except for angle D. For example, with electrode **326** extended from end cap **342**, the user may be able to visualize electrode **326**, as long as the visualization device (e.g., camera), is not within angle D. In at least one aspect, electrode **326** may be extended approximately 1.5 mm from end cap **342**, and transparent end cap **342** may allow for increased visualization of electrode **326**, including distal tip **328**, when treating tissue or maneuvering electrode **326** at the target site.

[0063] FIG. **6** illustrates a side view of a shaft **414** and distal end **416** of another exemplary medical device, which may include any of the components of medical device **10** above. Shaft **414** and distal end **416** may be similar to shaft **14** and distal end **16**, respectively, with corresponding components. For example, distal end **416** includes an electrode **426** with a distal tip **428** and an electrode shaft **430**, and an end cap **442** with a distal end face **444**.

[0064] Distal end **416** includes a visualization feature formed by end cap **442** and at least a portion (e.g., a distal portion) of shaft **414**, which are at least partially transparent. As shown in FIG. **6**, end cap **442** may include a substantially constant cross-sectional dimension (e.g., diameter), and the circumference of end cap **442** may be substantially similar to the circumference of shaft **414**. Additionally, in some aspects, end cap **442** may include an exposed portion with a shorter longitudinal length than other exemplary end caps discussed herein (e.g., end cap **42**, **142**, **242**, or **342**). As shown in FIG. **6**, end cap **442** may include a proximal extension **442**A, and a portion of shaft **414** (e.g., a portion of distal end **416**) may overlay at least a portion of proximal extension **442**A. End cap **442** may comprise a transparent material, for example, a ceramic material such as artificial sapphire, artificial crystal, or another material that is at least partially transparent and at least partially insulating.

[0065] Additionally, at least a distal portion of shaft **414** (e.g., distal end **416**) may comprise, for example, a material that is at least partially transparent and at least partially insulating. In at least one aspect, approximately 5 mm to approximately 15 mm, for example, approximately 10 mm, of the distalmost portion of shaft **414** (e.g., distal end **416**) may comprise the at least partially transparent and at least partially insulating material. In at least one aspect, the distalmost portion of shaft **414** may be formed of polypropylene (PP), polytetrafluoroethylene (PTFE), polyvinyl chloride (PVC), polyethylene terephthalate (PET), polycarbonate (PC), etc. In some aspects, the at least partially transparent and at least partially insulating material that forms at least the distal portion of shaft **414** may be the same material that forms end cap **442**. In other aspects, the at least partially transparent and at least partially insulating material that forms at least the distal portion of shaft **414** may be a different material than the material the forms end cap **442**. For example, the distal portion (e.g., distal end **416**) of shaft **414** may be at least partially deflectable and insulating. In these aspects, in some configurations, proximal portions of electrode **426**, for example, longitudinal portion **462**, and/or proximal support elements, for example, electrode proximal

support **454** and electrode cylindrical extension **456**, may be at least partially visible through end cap **442** and/or shaft **414**.

[0066] In at least one aspect, end cap **442** may have a length of approximately 1 mm to 4 mm, and end cap **442** may have a cross-sectional diameter of approximately 1.5 mm to approximately 3 mm, for example, approximately 1.8 mm to approximately 2.5 mm. An exposed portion of end cap **442** may include a length of approximately 0.4 mm to approximately 0.8 mm, for example, approximately 0.6 mm, and the exposed portion of end cap **442** may include a cross-sectional diameter of approximately 2.2 mm. End cap **442** may transition (e.g., curve) from a side portion to distal end face **444** with a radius of curvature of approximately 0.3 mm. The at least partially transparent portion of shaft **414** may have a length of approximately 5 mm to approximately 15 mm, for example, approximately 10 mm.

[0067] In at least one aspect, with end cap **442** and a distal portion of shaft **414** being at least partially transparent, proximal support elements, for example, electrode proximal support **454** and electrode cylindrical extension **456**, may be the only impediment in visualizing electrode **426**, including distal tip **428**. In this aspect, the proximal support elements may form an angle E relative to the proximal end of distal tip **428**. As shown, electrode proximal support **454** may be the widest component of electrode **426** that is not transparent. Because end cap **442** and the distal portion of shaft **414** are at least partially transparent, electrode proximal support **454** may form angle E of approximately 5 degrees to approximately 20 degrees. In at least one aspect, angle E is approximately 8 degrees to approximately 15 degrees, for example, approximately 11 degrees. In one aspect, the distal end of each side (e.g., in a longitudinal cross-section) of electrode proximal support **454** may form an angle that is half of angle E, e.g., an angle of approximately 5.5 degrees. For example, as shown in FIG. **6**, each side of the distal end of electrode proximal support **454** and the respective side of distal tip **428** of electrode **426** may extend at angle of approximately 5.5 degrees relative to the longitudinal axis of distal end **416**. In this aspect, because end cap **442** and the distal portion of shaft **414** are at least partially transparent, distal end **416** may include an angle of approximately 11 degrees.

[0068] Accordingly, end cap **442** and shaft **414** may help to improve the visualization of electrode **426** by not blocking the view of the visualization device (e.g., camera) of an insertion device or separate device, except for angle E. For example, with electrode **426** extended from end cap **442**, the user may be able to visualize electrode **426**, as long as the visualization device (e.g., camera), is not within angle E. In at least one aspect, electrode **426** may be extended approximately 1.5 mm from end cap **442**, and end cap **442** and the distal portion of shaft **414** may allow for increased visualization of electrode **426**, including distal tip **428**, when treating tissue or maneuvering electrode **426** at the target site.

[0069] The various electrodes discussed herein are capable of modifying physical properties of tissue when in contact with tissue by delivering energy (e.g., radio frequency energy). As discussed above, the energy delivered may be monopolar or bipolar energy. The various electrodes may be coupled to a shaft, with the shaft configured to extend into a body lumen or cavity of a subject. The shaft includes an electrical element traversing the shaft and connecting the electrode to an energy source, for example, in the handle or coupled to the handle. Additionally various aspects of this disclosure (e.g., rounded distal tip **28**, end caps **42**, **142**, **242**, **342**, **442**, etc.) may help to form an atraumatic tip on the distal end of the medical device as the medical device is delivered to the target site.

[0070] As discussed, the electrodes may also be coupled to an actuation member (e.g., movable body **20**), for example, in the handle or coupled to the handle, that allows a user to translate the electrode relative to the shaft. The electrode may be translatable between at least a first position in which a cutting shaft (e.g., longitudinal portion **62**), of the electrode is retracted within the shaft, and a second position in which the cutting shaft is extended beyond the shaft and exposed. In both the first and second positions, the distal portion (e.g., distal tip **28**) may be extended and exposed beyond the shaft, and not retracted within the shaft. Moreover, the handle may allow for the electrodes to be positioned in one or more intermediate position (i.e., a position in which only a portion of electrode shaft **30** is exposed).

[0071] For example, with the electrode in an extended position to treat the target site, the user may utilize a visualization device (e.g., a camera) that is positioned proximal to the distal end of the medical device, for example, on a separate insertion device, catheter, etc. The various visualization features discussed herein may improve the ability of the user to visualize the electrode with the visualization device. For example, the various visualization features discussed herein may reduce the angle formed by the distal end of the medical device (e.g., the blind angle). As a result, the electrode may be extended from the distal end of the medical device, and, as long as the visualization device is not within the blind angle formed by one or more elements at the distal end of the medical device, the electrode will be within the field of view of the visualization device. Moreover, with an increased field of view, the visualization device may be positioned farther away from the electrode, and the electrode need not be extended far from the distal end of the medical device. With the electrode extending a shorter distance from the medical device, the user may apply electrical energy or heat to tissue at the target site, with a reduced likelihood of damaging tissue or contacting unintended portions of the tissue.

[0072] While principles of the disclosure are described herein with reference to illustrative aspects for particular applications, it should be understood that the disclosure is not limited thereto. Those having ordinary skill in the art and access to the teachings provided herein will recognize additional modifications, applications, aspects, and substitution of equivalents all fall within the scope of the aspects described herein. Accordingly, the disclosure is not to be considered as limited by the foregoing description.

We claim:

1. A medical device, comprising:

a shaft; and

an end cap coupled to a distal end of the shaft,

wherein the end cap is at least partially transparent and includes a central channel having a proximal opening and a distal opening, and

wherein the end cap includes a tapered portion extending distally of the shaft.

2. The medical device of claim **1**, wherein the end cap is at least partially insulating.

3. The medical device of claim 1, wherein a diameter of an outer surface of the tapered portion reduces from a proximal end of the tapered portion to a distal end of the tapered portion.

4. The medical device of claim 3, wherein the tapered portion of the end cap includes a straight taper.

5. The medical device of claim 4, wherein the straight taper forms a blind angle of approximately 25 degrees or less.

6. The medical device of claim 3, wherein the end cap includes a length of approximately 2 mm to approximately 6 mm.

7. The medical device of claim 3, wherein a proximal portion of the end cap, proximal of the tapered portion, is not tapered.

8. The medical device of claim 7, wherein the proximal portion of the end cap is coupled to the distal end of the shaft via a friction fit.

9. The medical device of claim 7, wherein an outer surface of the proximal portion of the end cap extends parallel to or coaxial with a central axis of the distal end of the shaft.

10. The medical device of claim 1, wherein the shaft includes a shaft channel, wherein the shaft channel is in communication with the central channel of the end cap.

11. The medical device of claim 10, further comprising a movable device, wherein the movable device is movable within the shaft channel and the central channel and out of the distal opening.

12. The medical device of claim 10, further comprising a handle, wherein the handle includes a port, and wherein the port is in fluid communication with the shaft channel.

13. A medical device, comprising:

a handle, including a port;

a shaft coupled to the handle and including a shaft channel in communication with the port; and

an end cap coupled to a distal end of the shaft,

wherein the end cap includes a central channel having a proximal opening and a distal opening, the central channel being in communication with a distal end of the shaft channel,

wherein the end cap includes a tapered portion with an outer surface having a diameter that reduces from a proximal end of the tapered portion to a distal end of the tapered portion, and

wherein at least the tapered portion of the end cap is transparent.

14. The medical device of claim 13, wherein the end cap is at least partially insulating.

15. The medical device of claim 13, wherein the tapered portion of the end cap includes a straight taper.

16. The medical device of claim 13, wherein a proximal portion of the end cap, proximal of the tapered portion, is coupled to the shaft via a friction fit.

17. The medical device of claim 13, further comprising a movable device, wherein the movable device is movable within the shaft channel and the central channel and out of the distal opening.

18. An end cap for a medical device, comprising:

a proximal portion configured to be coupled to a distal end of a shaft of a medical device; and

a distal portion configured to extend distally of the distal end of the shaft and configured to improve visualization of a target site,

wherein the end cap is at least partially transparent,

wherein the proximal portion of the end cap includes a constant diameter, and

wherein the distal portion of the end cap tapers in diameter from the proximal portion toward a distal end of the end cap.

19. The end cap of claim 18, wherein the end cap is at least partially insulating.

20. The end cap of claim 18, wherein the distal portion of the end cap includes a straight taper.

* * * * *