US Patent & Trademark Office
Patent Public Search | Text View

United States Patent	12383332
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Tyson; Taylor N.

User interface with dual-function control surface for positioning multiple components within a body

Abstract

Disclosed embodiments include apparatuses, systems, and methods for positioning electrodes using a single control surface. In an illustrative embodiment, an apparatus includes an actuator shaft defining a lumen through which a primary electrode and a secondary electrode are linearly movable. A primary actuator is movably couplable with the actuator shaft and a primary electrode with the primary actuator being configured to extend and retract the primary electrode. A secondary actuator is movably couplable with the primary actuator and a secondary electrode with the secondary actuator being configured to extend and retract the secondary electrode. An actuator controller is configured to move along the shaft in a first direction to engage and motivate the primary actuator and is further configured to move along the shaft in a second direction to engage and motivate the secondary actuator. The primary actuator and the secondary actuator are sequentially manipulatable using only the actuator controller.

Inventors: **Tyson; Taylor N. (Seattle, WA)**

Applicant: **Gyrus ACMI Inc.** (Westborough, MA)

Family ID: **1000008747747**

Assignee: **Gyrus ACMI, Inc. (Westborough, MA)**

Appl. No.: **17/554031**

Filed: **December 17, 2021**

Prior Publication Data

Document Identifier	Publication Date
US 20220192744 A1	Jun. 23, 2022

Related U.S. Application Data

Publication Classification

Int. Cl.: **A61B18/14** (20060101); **A61B18/00** (20060101); **A61B18/12** (20060101)

U.S. Cl.:

CPC **A61B18/1492** (20130101); **A61B18/1206** (20130101); A61B2018/00577 (20130101); A61B2018/00702 (20130101)

Field of Classification Search

CPC: A61B (18/1492); A61B (18/1206); A61B (2018/00577); A61B (2018/00702)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2021/0169564	12/2020	Desmarais	N/A	A61B 18/1477

Primary Examiner: Dvorak; Linda C

Assistant Examiner: Bock; Abigail

Attorney, Agent or Firm: Schwegman Lundberg & Woessner, P.A.

Background/Summary

PRIORITY CLAIM (1) This application claims the benefit of U.S. Provisional Application No. 63/127,314 file Dec. 18, 2020, the contents of which are hereby incorporated by reference.

FIELD
(1) The present disclosure relates to a user interface and lock features for positioning multiple components within a body.
BACKGROUND
(2) The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.
(3) Inserting and manipulating thin elements within living bodies or other objects allows for ever-improving types of analysis, diagnosis, and treatment of those bodies or objects with minimally invasive techniques. By way of two examples, endoscopic imaging and catherization treatments have enabled evaluation and treatment of numerous internal lesions without invasive surgery.
(4) Electrosurgical techniques also provide for minimally invasive therapies by selectively applying electrical current to selected tissues. Electrosurgical techniques involve extending one or more electrodes through an orifice or a small incision to a desired location within a body, then applying a radio frequency (“RF”) electric current to the electrodes to coagulate and/or ablate tissue at that location. Monopolar electrosurgical instruments only entail use of one electrode that interacts with a neutral electrode, which is likewise connected to the body of a patient. A bipolar electrosurgical

instrument typically includes a user interface used for positioning two electrodes, which may include a distal electrode and a proximal electrode.

(5) Positioning one or two electrodes at the desired location is an important part of such electrosurgical treatments. Moving and holding electrodes in place, particularly when more than one electrode has to be moved or held independently of another electrode, may present a challenge for medical personnel directing the treatment. Moreover, because a successful procedure may demand that a particular series of steps be followed in positioning each of the electrodes, simplifying control of the electrodes to assist an operator in placing the electrodes may be important.

SUMMARY

(6) Disclosed embodiments include apparatuses for moving multiple components within a body with a single control surface for treating tissue at a reference point and methods for moving electrodes into positions for ablative electrical treatment at a reference point using a single control surface.

(7) In an illustrative embodiment, an apparatus includes an actuator shaft defining a lumen through which a primary electrode and a secondary electrode are linearly movable along an axis of the lumen. A primary actuator is movably couplable with the actuator shaft and couplable with a primary electrode with the primary actuator being configured to extend and retract the primary electrode. A secondary actuator is movably couplable with the primary actuator and couplable with a secondary electrode with the secondary actuator being configured to extend and retract the secondary electrode. An actuator controller is configured to move along the shaft in a first direction to engage and motivate the primary actuator and is further configured to move along the shaft in a second direction to engage and motivate the secondary actuator. The primary actuator and the secondary actuator are sequentially manipulatable responsive to manipulation of only the actuator controller.

(8) In another illustrative embodiment, a system for treating tissue at a reference point includes a controllable electrical power source configured to selectively provide electrical power between a first pole and a second pole. An electrosurgical apparatus is configured to be inserted into a body to convey a sheath housing a primary electrode electrically coupled with the first pole of the electrical power source and a secondary electrode electrically coupled with the second pole of the electrical power source to a vicinity of a reference point. A user interface includes an actuator shaft defining a lumen through which a primary electrode and a secondary electrode are linearly movable along an axis of the lumen. A primary actuator is movably couplable with the actuator shaft and couplable with a primary electrode with the primary actuator being configured to extend and retract the primary electrode. A secondary actuator is movably couplable with the primary actuator and couplable with a secondary electrode with the secondary actuator being configured to extend and retract the secondary electrode. An actuator controller is configured to move along the shaft in a first direction to engage and motivate the primary actuator and is further configured to move along the shaft in a second direction to engage and motivate the secondary actuator. The primary actuator and the secondary actuator are sequentially manipulatable responsive to manipulation of only the actuator controller.

(9) In a further illustrative embodiment, a method includes positioning a user interface that includes a primary actuator operably coupled with a primary electrode and a secondary actuator operably coupled with a secondary electrode to position distal ends of the primary electrode and the secondary electrode adjacent to a target region. An actuator controller is moved in a first direction to engage the primary actuator. The actuator controller is manipulated to advance the primary actuator to extend both the primary electrode and the secondary electrode. The actuator controller is moved in a second direction to engage the secondary actuator. The secondary actuator is manipulated to advance the secondary actuator to independently extend the secondary electrode beyond the primary electrode.

(10) Further features, advantages, and areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

Description

DRAWINGS

(1) The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way. The components in the figures are not necessarily to scale, with emphasis instead being placed upon illustrating the principles of the disclosed embodiments. In the drawings:

(2) FIG. **1** is a block diagram in partial schematic form of an illustrative system for treating tissue;

(3) FIGS. **2-5** are diagrams in partial schematic form of positioning of distal ends of a sheath, primary electrode, and secondary electrode relative to a reference point;

(4) FIGS. **6**A and **7**A are diagrams in partial schematic form of an illustrative sheath actuator for positioning a sheath relative to a reference point;

(5) FIGS. **6**B and **7**B are diagrams in partial schematic form of positioning of distal ends of the sheath, a primary electrode, and a secondary electrode relative to a reference point corresponding to positions of the sheath actuator of FIGS. **6**A and **7**A, respectively;

(6) FIG. **8** is a side plan view of an illustrative sheath actuator and a sheath lock;

(7) FIG. **9** is a side plan view in cutaway of the sheath actuator and sheath lock of FIG. **8**;

(8) FIG. **10** is a side view of an illustrative user interface for positioning multiple components relative to the reference point;

(9) FIG. **11** is an exploded view of the user interface of FIG. **10**;

(10) FIGS. **12**A, **13**A, **14**A, **15**A, **16**A, and **17**A are side views of an illustrative user interface for positioning multiple components relative to the reference point;

(11) FIGS. **12**B, **13**B, **14**B, **15**B, **16**B, and **17**B are diagrams in partial schematic form of positioning of distal ends of a sheath, primary electrode, and secondary electrode relative to a reference point corresponding to positions of the components of the user interface of FIGS. **12**A, **13**A, **14**A, **15**A, **16**A, and **17**A, respectively; and

(12) FIG. **18** is a flow chart of an illustrative method of positioning components using a user interface.

DETAILED DESCRIPTION

(13) The following description is merely illustrative in nature and is not intended to limit the present disclosure, application, or uses. It will be noted that the first digit of three-digit reference numbers, the first two digits of four-digit reference numbers correspond to the first digit of one-digit figure numbers and the first two-digits of the figure numbers, respectively, in which the element first appears.

(14) The following description explains, by way of illustration only and not of limitation, various embodiments of user interfaces to position electrodes for electrosurgical apparatuses, as well as systems including such user interfaces and methods of using the same. As will be described in detail below, electrosurgical techniques position first and second electrodes adjacent a reference point where electrical treatment, such as ablative treatment, is to be applied. For a specific example, the user interfaces and methods of their use may be used for ablating and/or coagulating tissue, removing lesions, and for performing other medical procedures within the lung.

(15) It will be appreciated that various embodiments of user interfaces described herein may help to simplify the process of positioning the electrodes and holding the electrodes in place. As will be described below, various embodiments of the user interface accomplish the selective positioning

and locking in place of the electrodes by engaging, sliding, and/or rotating components.
(16) Referring to FIG. **1**, in various embodiments a system **100** is provided for treating tissue at a reference point in an anatomical region of a patient (not shown in FIG. **1**). The system **100** may be a bipolar or monopolar radio frequency (RF) system, as desired, for treating tissue in a patient. Specifically, the system **100** may be employed for coagulation and/or ablation of soft tissue during percutaneous and/or endoscopic, including bronchoscopic, surgical procedures, such as, for example, partial and/or complete ablation of cancerous and/or noncancerous organ lesions. As will be further described, the tissue is treated by positioning one or more electrodes proximate the tissue to be treated and passing an electrical current through the tissue at a reference point.
(17) In some embodiments, the system **100** includes a user interface **101**, an electrosurgical radio frequency (RF) generator operating as a switchable current source **114**, an infusion pump **116**, and an electrosurgical instrument or apparatus, such as without limitation a bronchoscope **118**. It will be appreciated that the electrosurgical instrument or apparatus may also include an endoscope or any other electrosurgical instrument as desired for a particular application. The bronchoscope **118** may be configured to receive the user interface **101** at a port **148** to enable the user interface **101** to manipulate electrodes at the reference point via the bronchoscope **118**.
(18) The user interface **101** electrically communicates with the switchable current source **114** though an electrical conductor **130**. In some embodiments, the electrical conductor **130** is connected to an outlet **131** when the system is operated in a bipolar mode. The electrical conductor **130** may be coupled with the outlet **131** using an electrical connector **134** configured to electrically engage the outlet **131**. In some other embodiments, the system **100** can be operated in a monopolar mode when the electrical conductor **130** is connected to a secondary outlet **133** with an adapter (not shown in FIG. **1**) as desired. The user interface **101** is further connected to the infusion pump **116** with a tube **132** that facilitates the flow of liquid, for example saline solution, from the infusion pump **116** to the user interface **101**.
(19) The switchable current source **114** can be operated with the use of a foot operated unit **120** electrically connected to the switchable current source **114**. The foot operated unit **120** includes a pedal **122** that instructs the switchable current source **114** to apply an electrical current to electrode(s) (described below) to cut and/or ablate tissue and a pedal **124** that instructs the generator **114** to apply a lower electrical current to the electrode(s) to coagulate tissue.
(20) In various embodiments the bronchoscope **118** includes an insertion tube **119** that permits insertion of a sheath **103** into a body (not shown). A distal end **105** of the sheath **103** is delivered to a location near the tissue to be treated at the reference point. The sheath **103** contains and conveys the electrodes (not shown) to a desired treatment location. Positioning of the distal end **105** of the sheath **103** and the distal ends of the electrodes (not shown in FIG. **1**) may be controlled by the user interface **101** received by the bronchoscope **118** at a port **148**.
(21) Referring additionally to FIGS. **2-5**, in various embodiments distal ends of components are positioned relative to a reference point **201** using various embodiments of a user interface. The reference point **201**, for example, may be at a point within a target region **202** such as a lesion or any portion of tissue to be treated within a body. Given by way of illustration only and not of limitation, the illustrative embodiments of the user interface described below all are capable of positioning the components as described with reference to FIGS. **2-5**, as further described with reference to each of the described embodiments. The description of FIGS. **2-5** is provided as a baseline to describe the operation of the various embodiments of the user interface.
(22) In various embodiments, a secondary electrode **211** is slidably received within a primary electrode **207**, and the primary electrode **207** is slidably received within a sheath **103**. In various embodiments, until a user interface is manipulated to separately move the primary electrode **207** and/or the secondary electrode **211**, the primary electrode **207** and the secondary electrode **211** move in concert with the sheath **103**, which means that the electrodes **207** and **211** move at a same time and through a same distance as the sheath **103**. As will be described below, in some instances,

the secondary electrode **211** also may move in concert with the primary electrode **209** while both electrodes move independently of the sheath **103**. Components contained within other components are represented with dashed lines in FIGS. **2-5**.

(23) As shown in FIG. **2**, in various embodiments the sheath **103**, the primary electrode **207**, and the secondary electrode **211** are positioned at an initial position relative to the reference point **201** at or near the target region **202**. More particularly, the components are positioned upon the insertion of the sheath **103** through an insertion tube in a bronchoscope, such as the insertion tube **119** and the bronchoscope **118** of FIG. **1**, before they are moved into precisely desired locations by manipulating the user interface (not shown) as further described below.

(24) In various embodiments a distal end **105** of the sheath **103** is positioned close to the target region **202**. The primary electrode **207** is slidably received within the sheath **103**, with a distal end **209** of the primary electrode **207** at or near the distal end **105** of the sheath **103**. Specifically, FIG. **2**, for example, shows the distal end **209** of the primary electrode **207** positioned just short of the distal end **105** of the sheath **103**. In turn, the secondary electrode **211** is slidably received within the primary electrode **207**, with the distal end **213** of the secondary electrode **211** positioned just within the distal end **209** of the primary electrode **207**.

(25) As shown in FIG. **3**, in various embodiments the sheath **103**, the primary electrode **207**, and the secondary electrode **211** are positioned once the sheath **103** has been moved closer to the target region **202**. As contrasted with FIG. **2**, in FIG. **3** a distal end **105** of the sheath **103** has been moved closer to the reference point **201** at the edge of the target region **202**. Just as in FIG. **2**, because the primary electrode **207** and the secondary electrode **211** have not been separately moved through the manipulation of a user interface (not shown), the primary electrode **207** and the secondary electrode **211** have moved with the movement of the sheath **103**. Thus, at the deployment position closer to the reference point **201**, the distal end **209** of the primary electrode **207** remains positioned just short of the distal end **105** of the sheath **103**. Similarly, the distal end **213** of the secondary electrode **211** remains positioned just within the distal end **209** of the primary electrode **207**. As will be further described with reference to embodiments of a sheath lock that may be part of a user interface or used in conjunction with a user interface, once the distal end **105** of the sheath **103** has been moved to a desired location, the sheath **103** may be locked in place.

(26) As shown in FIG. **4**, in various embodiments the sheath **103**, the primary electrode **207**, and the secondary electrode **211** are positioned once the primary electrode **207** has been extended from the sheath **103** toward the reference point **201** and into the target region **202**. In various embodiments, unless the user interface (not shown) is manipulated to disengage movement of the secondary electrode **211** from movement of the primary electrode **207**, the secondary electrode **211** moves in concert with the primary electrode **207**, with the secondary electrode **211** moving in the same direction and the same distance as the primary electrode **207**. Thus, as shown in FIG. **4**, the primary electrode **207** as the primary electrode **207** is extended beyond the distal end **105** of the sheath **103**, and the secondary electrode **211** moves in concert with the primary electrode **207**. As shown in FIG. **4**, the distal end **209** of the primary electrode **207** is extended toward the reference point **201** and beyond the distal end **105** of the sheath **103**. The distal end **213** of the secondary electrode **211** remains positioned just within the distal end **209** of the primary electrode **207**. In various embodiments, the primary electrode **207** is in the form of a needle, with the distal end **209** being configured to pierce tissue, such as tissue comprising the target region **202**, to enable the distal end **209** of the primary electrode **207** to reach a desired position, and to be able to situate the secondary electrode **211** at a desired point.

(27) As will be further described below, once the distal end **105** of the sheath **103** is in a desired location and locked in place, embodiments of the user interface allow the primary electrode **207** to be unlocked so that the primary electrode **207** may be moved independently of the sheath **103**. As also further described below, embodiments of the user interface may keep motion of the secondary electrode **211** locked with motion of the primary electrode **207** so that the distal end **213** of the

secondary electrode **211** moves in concert with the distal end **209** of the primary electrode **207**. As also further described below, embodiments of a user interface permit one or both of the primary electrode **207** and the secondary electrode **211** to be fixed in position—that is, remain in place—so that one or both of the electrodes **207** and **211** are secured at a current position. Thus, for example, a position of the primary electrode **207** may be fixed while the secondary electrode **211** may be moved independently of the primary electrode **207**. Also, both electrodes **207** and **211** may be fixed in place, for example, when treatment is administered by applying an electrical current using an electrosurgical apparatus such as that shown in the system **100** of FIG. **1**.

(28) As shown in FIG. **5**, in various embodiments the sheath **103**, the primary electrode **207**, and the secondary electrode **211** are positioned once the secondary electrode **211** has been extended from the primary electrode **207**. A distal end **213** of the secondary electrode **211** is deployed at a position on an opposite side of the reference point **201** from the primary electrode **207**. In various embodiments, the secondary electrode **211** is configured as coiled wire which is received within the primary electrode **207** in a straightened form. Once the user interface is manipulated to independently extend the secondary electrode **211** from the primary electrode **207**, the secondary electrode **211** coils. As a result, the distal end **213** of the secondary electrode **211** corkscrews into tissue at the target region **202**. The corkscrewing of the distal end **213** of the secondary electrode **211** may assist in securing the position of the distal end **213** of the secondary electrode **211** during treatment. Although not specifically shown in FIG. **5**, a portion of the secondary electrode **211** may be coated with insulation, with the insulated portion stopping short of the distal end **213** of the secondary electrode **211**. The insulation electrically insulates the secondary electrode **211** from the primary electrode **207** such that, when electrical current is applied to proximal ends (not shown) of the primary electrode **207** and the secondary electrode **211**, the electrical current may only flow between the distal end **209** of the primary electrode **207** and the uninsulated distal end **213** of the secondary electrode **211**.

(29) Referring additionally to FIGS. **6**A and **6**B, in various embodiments an illustrative apparatus **600** includes an illustrative user interface **101** received at the port **148** of an electrosurgical apparatus **118**, such as a bronchoscope or another minimally invasive device used for performing diagnostic or therapeutic tasks by extending a sheath or catheter into a body (not shown in FIGS. **6**A and **6**B). In various embodiments the user interface **101** includes a sheath actuator **604** and a sheath lock **606** configured to move the sheath **103** to a desired location to position a distal end **105** of the sheath **103** relative to the reference point **201**. In some embodiments, the sheath actuator **604** may be a slidable mechanism that incorporates a slidable sleeve **612** that is received within a collar **614**. The slidable sleeve **612** may be locked in position at the collar **614** by the sheath lock **606**. The sheath lock **606** may be a spring-loaded locking pin, a thumbscrew, or another mechanism configured to mechanically engage the slidable sleeve **612** to secure the slidable sleeve **612**—and, in turn, the sheath **103** (FIGS. **2-5**)—in place at a desired location.

(30) In some embodiments, the sheath actuator **604** may be part of the user interface **101**. For example, in the user interface **101** of FIG. **6**A, the slidable sleeve **612** is fixably engaged with the user interface **101** at a distal end **616** of the user interface **101**. The collar **614** then may engage the port **148** on the electrosurgical apparatus **118**, where movement of the slidable sleeve **612** within the collar **614** controls movement of the sheath **103** (FIGS. **2-5**). In some other embodiments, the sheath actuator **604** may, for example, be part of the electrosurgical apparatus **118**. The collar **614** may be fixably joined to the port **148**. The slidable sleeve **612** may be associated with the port **148** to engage the distal end **616** of the user interface **101**. In another embodiment, the slidable sleeve **612** may be fixably joined to the distal end **616** of the user interface **101** and be configured to receivably engage the collar **614** that is fixably attached to the port **148**. Any of these embodiments of the sheath actuator **604** may facilitate movement of the sheath **103** as described below.

(31) In various embodiments the user interface **101** is mechanically coupled with a primary electrode **207** that is slidably received within the sheath **103**. In some such embodiments, a distal

end **209** of the primary electrode **207** is positioned just short of the distal end **105** of the sheath **103**. The user interface **101** is also mechanically coupled with a secondary electrode **211** slidably received within the primary electrode **207**, with the distal end **213** of the secondary electrode **211** being positioned just within the distal end **209** of the primary electrode **207**. It will be appreciated that various embodiments of the user interface **101** may be configured to secure the primary electrode **207** and the secondary electrode **211** relative to the sheath **103** so that both the primary electrode **207** and the secondary electrode **211** move in concert with the sheath **103** as the sheath is moved as described with reference to FIG. **3**.
(32) Referring additionally to FIGS. **7**A and **7**B, manipulation of the sheath actuator **604** illustrates an example of how the sheath **103** may be unlocked and moved into position as previously described with reference to FIG. **3**. As shown in FIGS. **7**A and **7**B, the sheath actuator **604** has been manipulated to enable the sheath **103** to be moved a distance **719** closer to the reference point **201** and the target region **202**. Specifically, once the sheath lock **606** of the sheath actuator **604** is manipulated to enable movement of the slidable sleeve **612** within the collar **614**, the user interface **101** is moved the distance **719** to move the sheath **103** the same distance **719** toward the reference point **201** in the target region **202**. Once the sheath **103** has reached the desired location, the slidable sleeve **612** may be locked in position at the collar **614** by the sheath lock **606**. As will be described further below, in various embodiments, the user interface **101** maintains the positions of the primary electrode **207** and the secondary electrode **211** relative to the sheath **103** as the sheath actuator **604** is used to move the sheath **103**. Therefore, a distal end **209** of the primary electrode **207** and a distal end **213** of the secondary electrode **211** also are moved by the distance **719** toward the reference point **201** in the target region **202**.
(33) Referring additionally to FIG. **8**, in various embodiments an illustrative sheath actuator **604** includes a slidable sleeve **612** that is fixably attached to a coupling **820** configured to engage a port (not shown in FIG. **8**) of an electrosurgical apparatus (not shown in FIG. **8**) such as a bronchoscope. In various embodiments, a sheath lock **606** may include, such as without limitation a thumbscrew or the like that that may be loosened to permit movement of a collar **614** that is fixably attached to the user interface **101** to move the sheath (not shown in FIG. **8**) as previously described with reference to FIGS. **6** and **7**. After the user interface **101** has been manipulated to slide the collar **614** relative to the slidable sleeve **612** to move the sheath to a desired location, the sheath lock **606** is re-engaged, such as by turning a thumbscrew, to fix the position of the sheath.
(34) Referring additionally to FIG. **9**, in various embodiments the sheath actuator **604** includes the slidable sleeve **612** that is fixably attached to the coupling **820**. In some embodiments the sheath lock **606** may include a thumbscrew that may be loosened to permit movement of the collar **614** that may be fixably attached to the user interface **101** to move the sheath **103** and, in concert therewith, the primary electrode **207** and the secondary electrode **211** received within the sheath **103**. After the user interface **101** is manipulated to slide the collar **614** relative to the slidable sleeve **612** to move the sheath **103** to the desired location, the sheath lock **606** is turned to fix the position of the collar **614** relative to the slidable sleeve **612** to fix the position of the sheath **103**.
(35) Referring additionally to FIGS. **10** and **11**, in various embodiments an illustrative user interface **101** for positioning electrodes includes an actuator shaft **1010**, a primary actuator **1020**, a secondary actuator **1030**, and an actuator controller **1050**. The actuator shaft **1010** provides a frame for operation of the user interface **101** and terminates in a mount **1012** that is couplable with a sheath actuator **604** as previously described with reference to FIGS. **6-9**. The actuator shaft **1010** supports the primary actuator **1020**, the secondary actuator **1030**, and the actuator controller **1050**. The actuator shaft **1010** defines a lumen through which the electrodes **207** and **211** (FIGS. **2-5**) are conveyed.
(36) In various embodiments, the primary actuator **1020** is slidably mounted on the actuator shaft **1010** and is coupled to the primary electrode **207** (FIGS. **2-5**). The primary actuator **1020** includes a primary engagement interface **1022** that is configured to be engaged by the actuator controller

1050. The primary engagement interface **1022** of the primary actuator **1020** may include one or more engagement structures **1024**. The one or more engagement structures **1024**, which may include ridges, notches, or similar structures, are configured to positively engage a corresponding structure (not shown) on the actuator controller **1050**. As described further below, the actuator controller **1050** may be moved in either direction along an axis **1001** of the user interface to engage the actuators **1020** and **1030** and to extend and retract the primary electrode **207** (not shown in FIGS. **10** and **11**). For example, moving the actuator controller **1050** in a first direction **1003** may engage the actuator controller **1050** with the primary actuator **1020** and advance the primary actuator **1020** and the secondary actuator, as further described below. Moving the actuator controller **1050** in a second direction **1005** may engage the actuator controller **1050** with the secondary actuator **1030** to extend or retract the secondary electrode **211** or, when the actuator controller **1050** is engaged with the primary actuator **1020**, may retract the primary electrode **207** and the secondary electrode **209**, as also further described below.
(37) In various embodiments, the one or more engagement structures **1024** may enable the actuator controller **1050** to be mechanically and/or frictionally engaged with the primary actuator **1020** to secure the actuator controller **1050** to the primary actuator **1020** as the actuator controller **1050** is used to slide the primary actuator **1020** along the axis **1001**.
(38) In various embodiments, the secondary actuator **1030** is threadably and rotatably mounted on the primary actuator **1020** and is mechanically coupled to the secondary electrode **211** (FIGS. **2-5**). The secondary actuator **1030** includes a secondary engagement surface **1032** that, like the primary engagement interface **1022** of the primary actuator **1020**, permits the secondary actuator **1030** to be positively engaged by the actuator controller **1050**. As a result of the positive engagement, when the actuator controller **1050** is rotated, the secondary actuator **1030** also will be rotated. Referring to FIG. **11**, the primary actuator **1020** includes a series of outward-facing threads **1028** that are threadably engaged by inward-facing threads **1038** (represented by dotted lines) inside the secondary actuator **1030**. Engagement of the outward-facing threads **1028** of the primary actuator **1020** with the inward-facing threads **1038** of the secondary actuator **1030** facilitates the screwable movement of the secondary actuator **1030** relative to the primary actuator **1020** to advance and retract the secondary electrode **207**, as further described below.
(39) In various embodiments, the actuator controller **1050** is slidably mounted on the primary actuator **1020** where the actuator controller **1050** is selectively movable between the primary engagement interface **1022** of the primary actuator **1020** and the secondary engagement surface **1032** of the secondary actuator **1030**. In various embodiments, the actuator controller **1050** may include a release mechanism **1052** that is used to selectively lock or unlock one or both of the primary actuator **1020** and the secondary actuator **1030** and/or to engage or disengage the actuator controller **1050** with the one or more engagement structures **1024** of the primary actuator **1020** and/or the engagement surface **1032** of the secondary actuator **1030**.
(40) As will be described further below, in various embodiments, the actuator controller **1050** thus serves as a single control surface that may be used to control both the primary actuator **1020** to manipulate the primary actuator **1020** and the secondary actuator **1030** without a user having to remove his or her hand from the actuator controller **1050** during manipulation of the electrodes **207** and **211**. As will be further described below, because the secondary actuator **1030** is mounted on the primary actuator **1020**, the actuator controller **1050** may be used to simultaneously move the primary actuator **1020** and the secondary actuator **1030** in concert to collectively move the primary electrode **207** and the secondary electrode **211** (FIGS. **2-5**). In addition, the user can individually manipulate the secondary actuator **1030** and, thus, the secondary electrode **211** independently of the first electrode **207**. In various embodiments, these manipulations are performable using only the single control surface provided by the actuator controller **1050**.
(41) Referring to FIGS. **12**A-**17**B, the actuator controller **1050** is used to extend and retract the primary electrode **207** and the secondary electrode **211** to facilitate an electrosurgical procedure at a

reference point **201** in a target region **202**, such as ablation of tissue. For performing such a procedure, the user interface **101** may be coupled via the sheath actuator **604** to a bronchoscope **118** or similar insertion device **118** (not shown in FIGS. **12**A-**17**B for the sake of visual simplicity) to control movements of the distal ends **209** and **213** of the primary electrode **207** and secondary electrode **211**, respectively. In the example of FIGS. **12**A-**17**B, it is assumed that the bronchoscope **118** or other insertion device has been used to convey the distal ends **209** and **213** of the primary electrode **207** and the secondary electrode **211**, respectively, to the vicinity of the target region **202**. It is also assumed that the sheath actuator **604** has been manipulated to position a distal end **105** of the sheath **103** directly adjacent to the target region **202**.

(42) Referring additionally to FIG. **12**A, in various embodiments the user interface **101** is in a ready position with the primary actuator **1020** and the secondary actuator in retracted positions. Referring additionally to FIG. **12**B, as a result, in various embodiments the distal ends **209** and **213** of the primary electrode **207** and the secondary electrode **211**, respectively, are positioned within the distal end **105** of the sheath **103**. In preparation for advancing the electrodes **207** and **211**, the actuator controller **1050** is engaged with the primary engagement interface **1022** of the primary actuator **1020**.

(43) Referring additionally to FIG. **13**A, in various embodiments the actuator controller **1050** is advanced a distance **1305**. Because the actuator controller **1050** is engaged with the primary engagement interface **1022**, moving the actuator controller **1050** through the distance **1305** advances the distal end **209** of the primary electrode **207** through the distance **1305**. Also, because the secondary actuator **1030** is threadably mounted on the primary actuator **1020**, advancing the primary actuator **1020** through the distance **1305** also advances the secondary actuator **1030** and the distal end **213** of the secondary electrode **211** through the distance **1305**. As a result, the distal ends **209** and **213** of the primary electrode **207** and the secondary electrode **211**, respectively, are both advanced into the target region **202** toward the reference point **201**. In various embodiments, advancing the primary actuator **1020** with the actuator controller **1050** moves the secondary actuator **1030** in concert with the primary actuator **1020**.

(44) Referring additionally to FIG. **14**A, in various embodiments after the primary electrode **207** and the secondary electrode **211** both have been extended into the target region **202**, it is now desired to further extend the secondary electrode **211** into the target region **202** to position the distal ends **209** and **213** of the primary electrode **207** and the secondary electrode **211** across a distance before application of electric current to the tissue of interest. In various embodiments, this process is initiated by moving the actuator controller **1050** from the primary engagement interface **1022** of the primary actuator **1020** to the secondary engagement surface **1032** of the secondary actuator. In various embodiments, the release mechanism **1052** of the actuator controller **1050** may first be engaged to release the actuator controller **1050** from the primary engagement interface **1022** of the primary actuator **1020**. In various embodiments, the release mechanism **1052** may be released by pressing the release mechanism **1052**. In various embodiments, disengaging the actuator controller **1050** from the primary engagement surface **1022** of the primary actuator **1020** also may engage a locking mechanism (not shown) to hold the primary actuator **1020** in place relative to the actuator shaft **1010** and thereby hold the primary electrode **207** in place.

(45) After withdrawing the actuator controller **1050** from the primary engagement surface **1022** of the primary actuator **1020**, in various embodiments the actuator controller **1050** may be slidably moved across the primary actuator toward the secondary actuator **1030** and coupled with the secondary engagement surface **1032** of the secondary actuator **1030**. The actuator controller **1050** then may be rotated in a direction **1403** to threadably advance the secondary actuator **1030** through a distance **1405** relative to the primary actuator **1020** to extend the distal end **213** of the secondary electrode **211**.

(46) Referring additionally to FIG. **14**B, in various embodiments extending the distal end **213** of the secondary electrode **211** results in the secondary electrode coiling into tissue of the target

region **202** as previously described with reference to FIG. **5**. With the distal end **213** of the secondary electrode **211** deployed at an opposite side of the reference point **201** from the distal end **209** of the primary electrode **207**, an electric current may be applied between the distal ends **209** and **213** of the electrodes **207** and **211**, respectively, to treat tissue at the reference point **201**.
(47) Referring additionally to FIGS. **15**A and **15**B, to retract the distal end **213** of the secondary electrode **211** back within the distal end **209** of the primary electrode **207**, in various embodiments the actuator controller **1050** is rotated in an opposite direction **1503** to threadably retract the secondary actuator **1030** through a distance **1505**.
(48) Referring additionally to FIGS. **16**A and **16**B, to prepare for retraction of the primary electrode **207** and the secondary electrode **211** from the target region **202**, in various embodiments the actuator controller **1050** is moved from the secondary engagement surface **1032** of the secondary actuator **1030** to the primary engagement interface **1022** of the primary actuator **1020**. In various embodiments, the release mechanism **1052** of the actuator controller **1050** may be engaged to release the actuator controller **1050** from the secondary engagement surface **1032** of the secondary actuator **1030** and/or the actuator controller **1050** may be slid along the primary actuator **1020** until the actuator controller **1050** once again engages the primary engagement interface **1022** of the primary actuator **1020**.
(49) Referring additionally to FIGS. **17**A and **17**B, in various embodiments the primary electrode **207** and the secondary electrode **211** are withdrawn from the target region **202** by sliding the actuator controller **1050** rearward through a distance **1705**. Because the secondary actuator **1030** is threadably mounted to the primary actuator **1020**, sliding the primary actuator **1020** through the distance **1705** will simultaneously move the secondary electrode **211** through the same distance, thereby retracting the primary electrode **207** and the secondary electrode **211**. After this operation, the distal end **213** of the secondary electrode **211** is retracted within the distal end **209** of the primary electrode **207**, and both distal ends **209** and **213** are retracted within the distal end **105** of the sheath **103**, thereby restoring the primary electrode **207** and the secondary electrode **211** to the starting position shown within the distal end **105** of the sheath **103** as described with reference to FIG. **12**B.
(50) Referring additionally to FIG. **18**, an illustrative method **1800** of positioning electrodes for treatment is provided. The method **1800** starts at a block **1805**. At a block **1810**, a user interface, that includes a primary actuator operably coupled with a primary electrode and a secondary actuator operably coupled with a secondary electrode, is positioned to position distal ends of the primary electrode and the secondary electrode adjacent to a target region. At a block **1820**, an actuator controller is moved in a first direction to engage the primary actuator. At a block **1830**, the actuator controller is manipulated to advance the primary actuator to extend both the primary electrode and the secondary electrode. At a block **1840**, the actuator controller is moved in a second direction to engage the secondary actuator. At a block **1850**, the secondary actuator is manipulated to advance the secondary actuator to independently extend the secondary electrode beyond the primary electrode. The method ends at a block **1855**, with the electrodes now positioned for the administration of treatment.
(51) In some instances, one or more components may be referred to herein as “configured to,” “configured by,” “configurable to,” “operable/operative to,” “adapted/adaptable,” “able to,” “conformable/conformed to,” etc. Those skilled in the art will recognize that such terms (for example “configured to”) generally encompass active-state components and/or inactive-state components and/or standby-state components, unless context requires otherwise.
(52) While particular aspects of the present subject matter described herein have been shown and described, it will be apparent to those skilled in the art that, based upon the teachings herein, changes and modifications may be made without departing from the subject matter described herein and its broader aspects and, therefore, the appended claims are to encompass within their scope all such changes and modifications as are within the true spirit and scope of the subject

matter described herein. It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (for example, bodies of the appended claims) are generally intended as “open” terms (for example, the term “including” should be interpreted as “including but not limited to,” the term “having” should be interpreted as “having at least,” the term “includes” should be interpreted as “includes but is not limited to,” etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases “at least one” and “one or more” to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles “a” or “an” limits any particular claim containing such introduced claim recitation to claims containing only one such recitation, even when the same claim includes the introductory phrases “one or more” or “at least one” and indefinite articles such as “a” or “an” (for example, “a” and/or “an” should typically be interpreted to mean “at least one” or “one or more”); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should typically be interpreted to mean at least the recited number (for example, the bare recitation of “two recitations,” without other modifiers, typically means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to “at least one of A, B, and C, etc.” is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (for example, “a system having at least one of A, B, and C” would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that typically a disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms unless context dictates otherwise. For example, the phrase “A or B” will be typically understood to include the possibilities of “A” or “B” or “A and B.”
(53) With respect to the appended claims, those skilled in the art will appreciate that recited operations therein may generally be performed in any order. Also, although various operational flows are presented in a sequence(s), it should be understood that the various operations may be performed in other orders than those which are illustrated or may be performed concurrently. Examples of such alternate orderings may include overlapping, interleaved, interrupted, reordered, incremental, preparatory, supplemental, simultaneous, reverse, or other variant orderings, unless context dictates otherwise. Furthermore, terms like “responsive to,” “related to,” or other past-tense adjectives are generally not intended to exclude such variants, unless context dictates otherwise.
(54) It will be appreciated that the detailed description set forth above is merely illustrative in nature and variations that do not depart from the gist and/or spirit of the claimed subject matter are intended to be within the scope of the claims. Such variations are not to be regarded as a departure from the spirit and scope of the claimed subject matter.

Claims

1. An apparatus comprising: an actuator shaft defining a lumen through which a primary electrode and a secondary electrode are linearly movable along an axis of the lumen; a primary actuator movably couplable with the actuator shaft and couplable with a primary electrode, the primary actuator being configured to extend and retract the primary electrode; a secondary actuator movably couplable with the primary actuator and couplable with a secondary electrode, the secondary actuator being configured to extend and retract the secondary electrode; and an actuator

controller movably disposed around an elongate body of the primary actuator, the actuator controller configured to move along the elongate body in a first direction to engage with a shoulder portion of the primary actuator and motivate the primary actuator, the actuator controller being further configured to move along the elongate body in a second direction to engage a distal end of the secondary actuator and motivate the secondary actuator, the primary actuator and the secondary actuator being sequentially manipulatable responsive to manipulation of only the actuator controller.

2. The apparatus of claim 1, wherein the primary actuator is configured to be slidable relative to the actuator shaft to one of extend and retract the primary electrode.

3. The apparatus of claim 1, wherein the secondary actuator is movable in concert with the primary actuator to move the primary electrode and the secondary electrode in concert responsive to the actuator controller being engaged to motivate the primary actuator.

4. The apparatus of claim 1, wherein the secondary actuator is configured to be threadably coupled to the primary actuator, the secondary actuator being further configured to be threadably moved to extend and retract the secondary electrode without moving the primary electrode.

5. The apparatus of claim 1, wherein the actuator controller includes a sleeve configured to be slidable between the primary actuator and the secondary actuator.

6. The apparatus of claim 5, wherein the actuator controller includes a collar configured to alternately engage one of a primary actuator control surface and a secondary actuator control surface.

7. The apparatus of claim 6, wherein the primary actuator control surface includes a primary lock configured to hold the primary actuator in place relative to the actuator shaft until the primary lock is released, the primary lock being releasable by a user with the actuator controller engaging the primary actuator control surface.

8. The apparatus of Claim 7, wherein the actuator controller includes a lock release configured to be engageable by a user to release the primary lock.

9. The apparatus of claim 8, wherein the secondary actuator control surface includes a secondary lock configured to hold the secondary actuator in place relative to the primary actuator until the secondary lock is released, the secondary lock being releasable by a user with the actuator controller engaging the secondary actuator control surface.

10. A method comprising: positioning a user interface, that includes a primary actuator operably coupled with a primary electrode and a secondary actuator operably coupled with a secondary electrode, to position distal ends of the primary electrode and the secondary electrode adjacent to a target region; moving an actuator controller in a first direction to engage the primary actuator; manipulating the actuator controller to advance the primary actuator to extend both the primary electrode and the secondary electrode; moving the actuator controller in a second direction to engage the secondary actuator; and manipulating the secondary actuator to advance the secondary actuator to independently extend the secondary electrode beyond the primary electrode.

11. The method of claim 10, further comprising: sliding the actuator controller to advance the primary actuator to extend both the primary electrode and the secondary electrode; and rotating the actuator controller to advance the secondary actuator to independently extend the secondary electrode beyond the primary electrode.