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Misener et al.

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(54) **MEDICAL DEVICES WITH A QUICK RELEASE DRIVE CONNECTOR**

(58) **Field of Classification Search**
None
See application file for complete search history.

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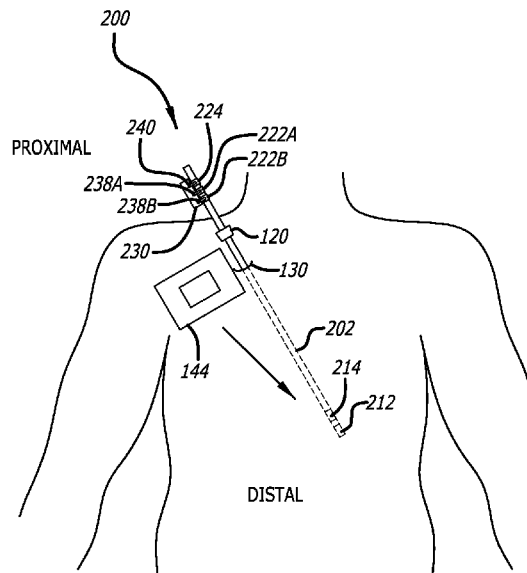
(57) **ABSTRACT**

Disclosed herein, in some embodiments, are medical device systems including an elongate medical device having a proximal end including one or more sensor connectors, a distal end including one or more sensors or emitters communicatively coupled to the one or more sensor connectors, and a drive connector including one or more sensor connector attachments configured to detachably couple to the one or more sensor connectors. The one or more sensor connector attachments can be configured to drive the one or more sensors or emitters of the elongate medical device.

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

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30 Claims, 8 Drawing Sheets



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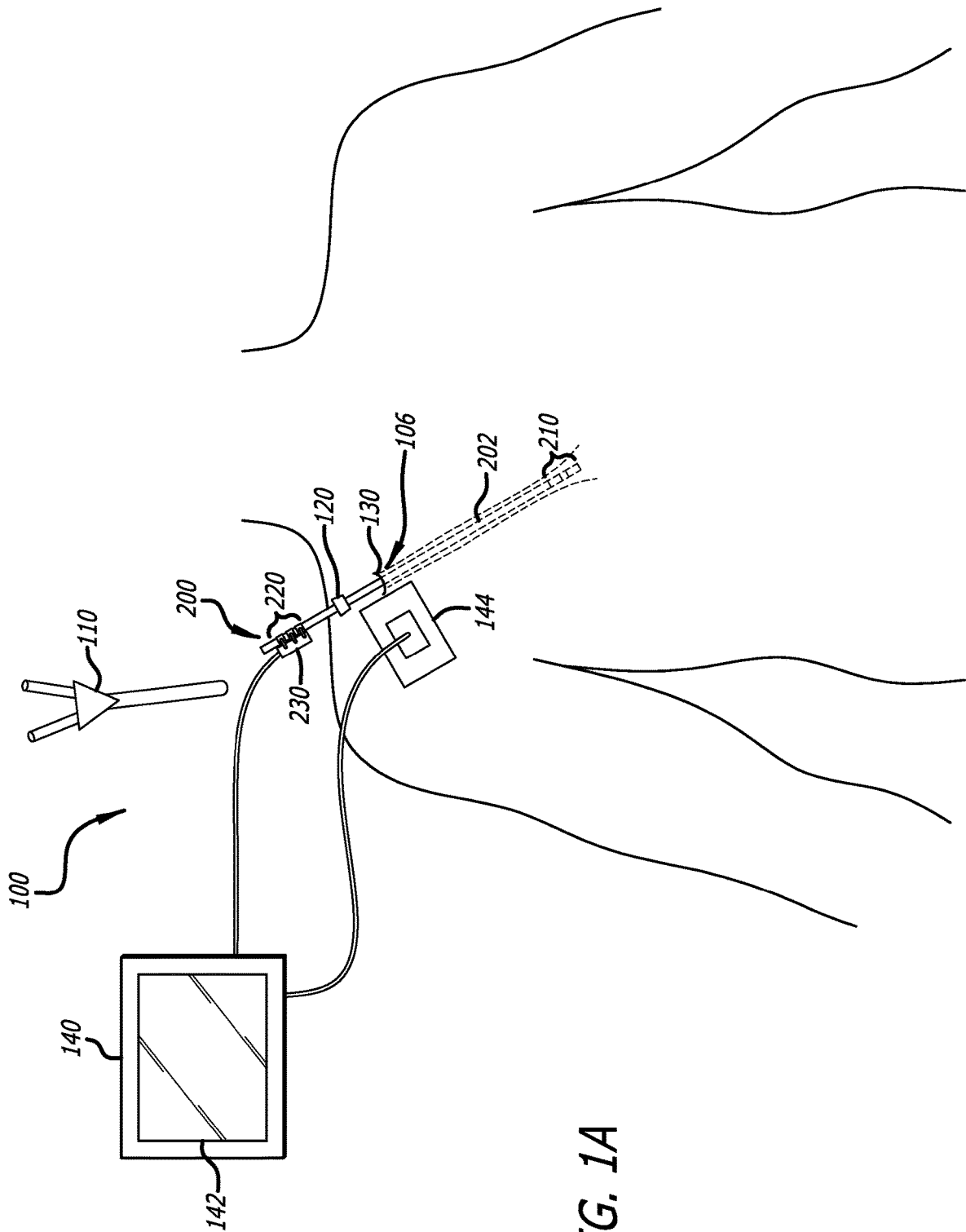


FIG. 1A

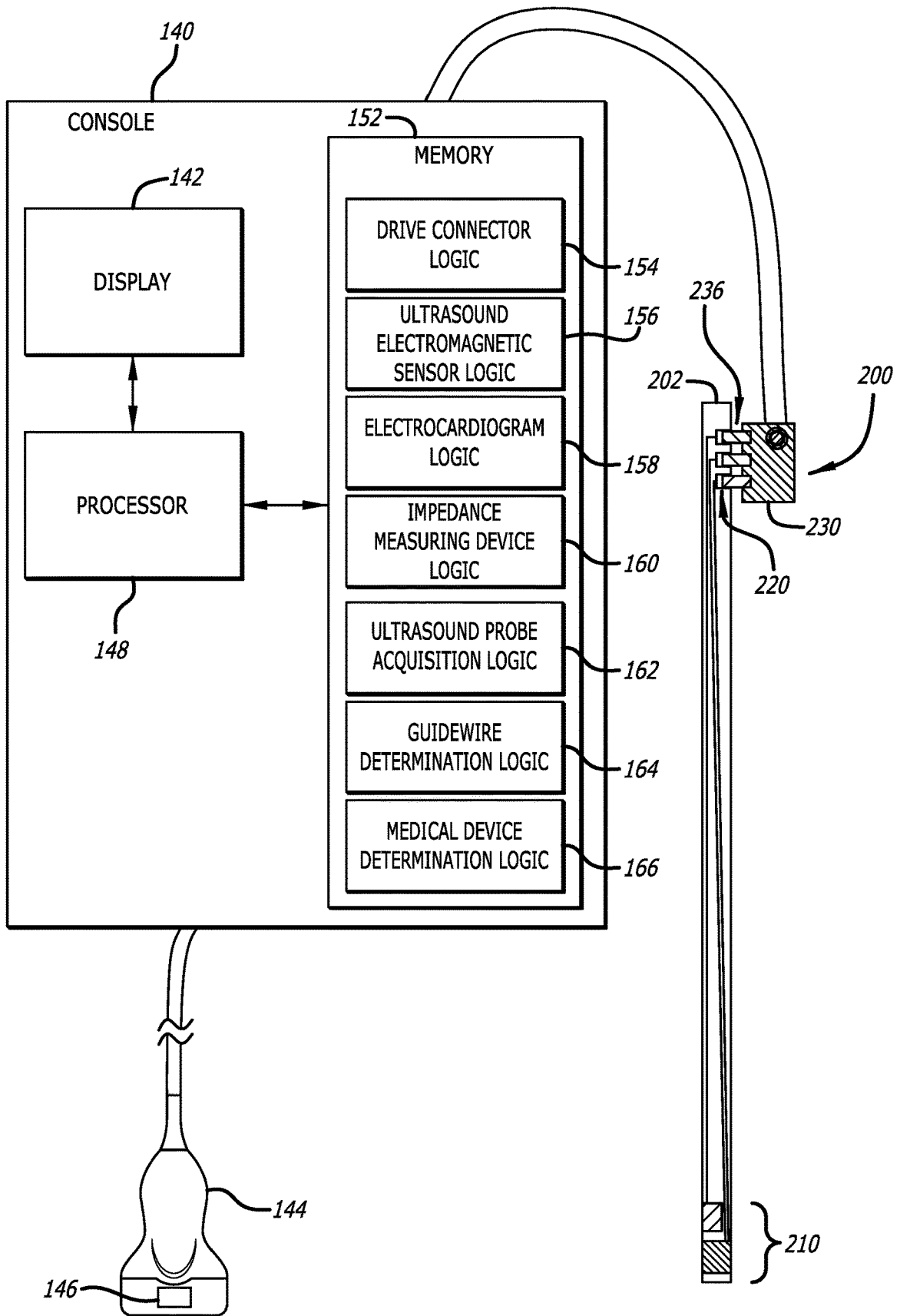


FIG. 1B

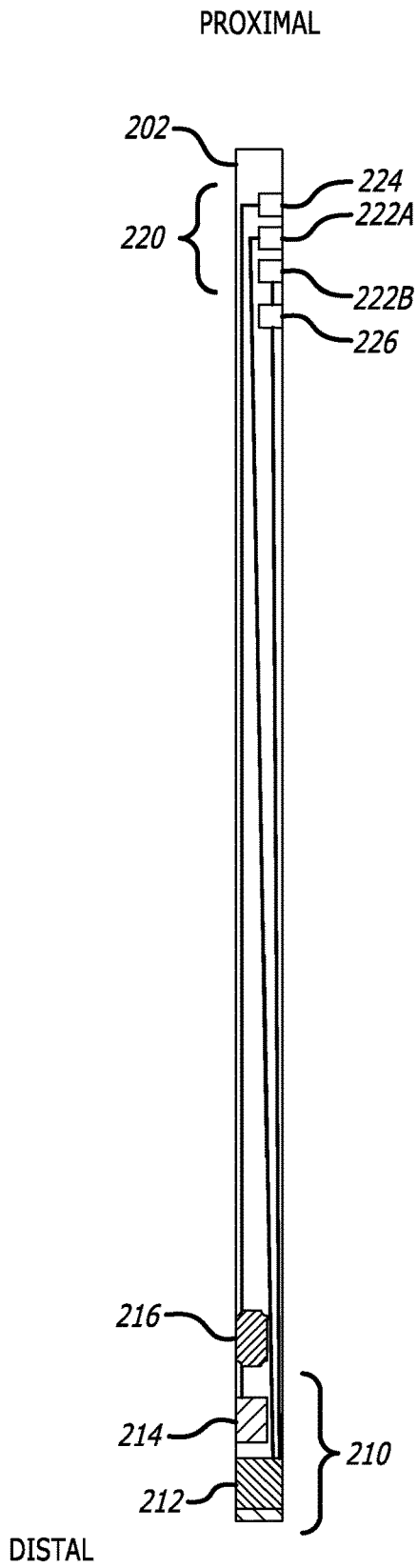


FIG. 2A

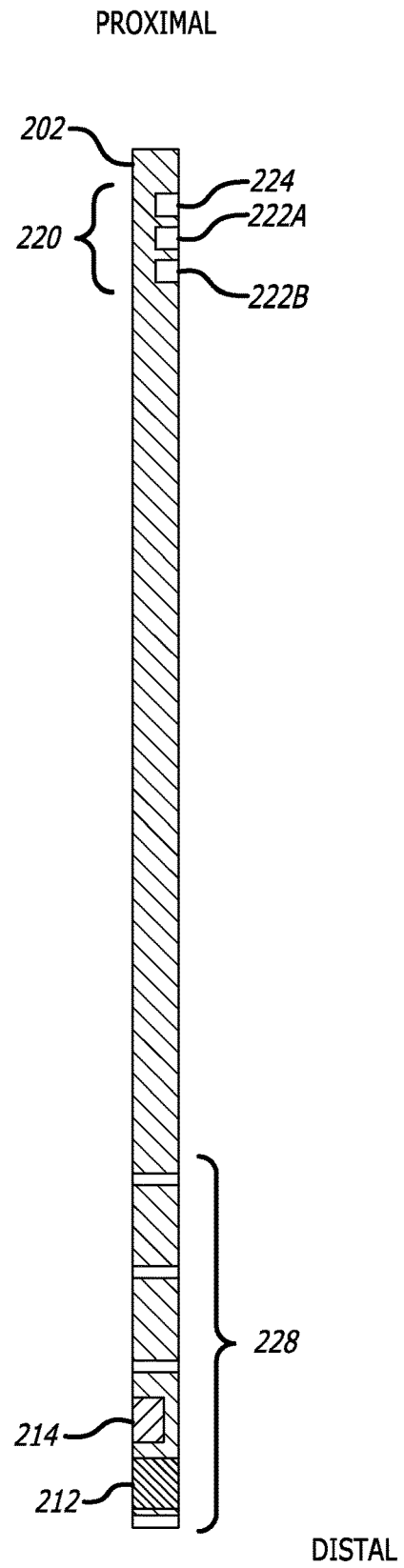


FIG. 2B

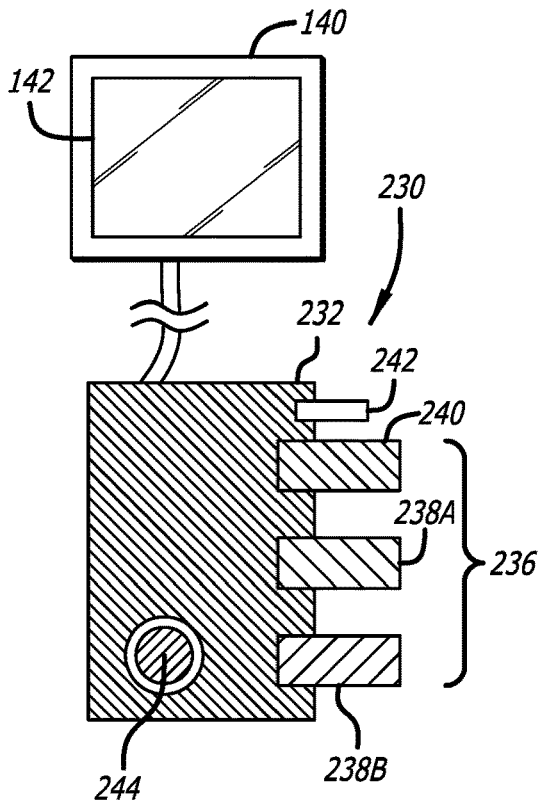


FIG. 3A

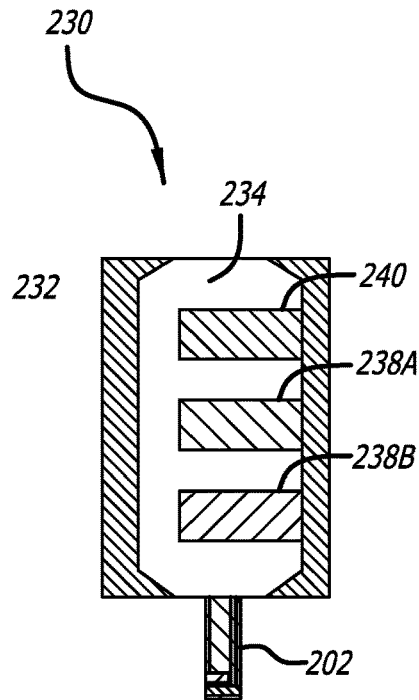


FIG. 3B

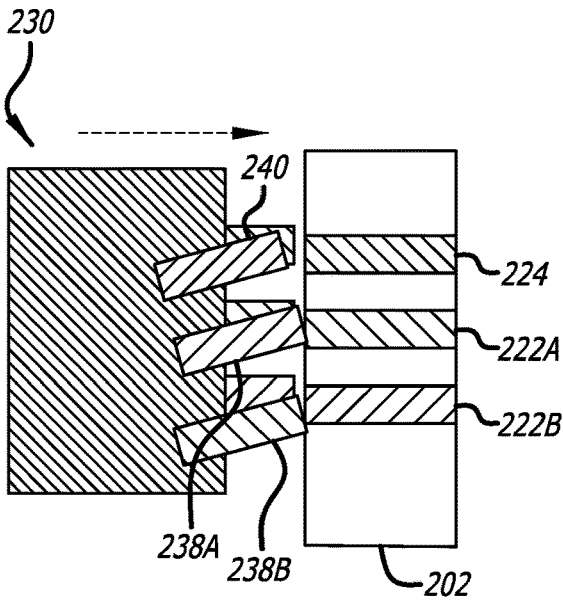


FIG. 3C

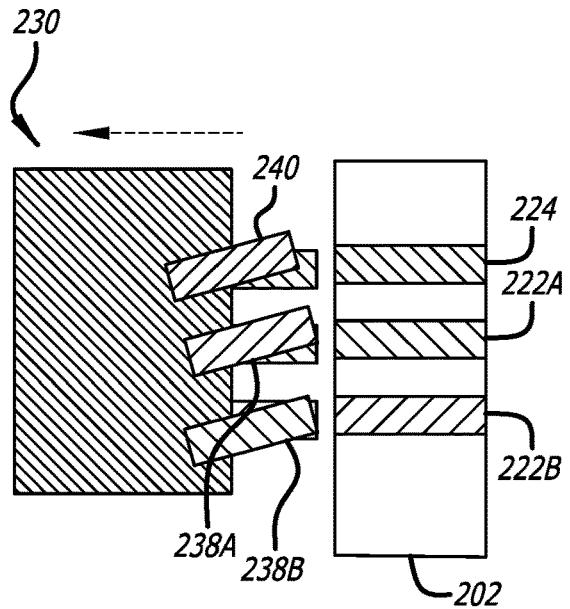


FIG. 3D

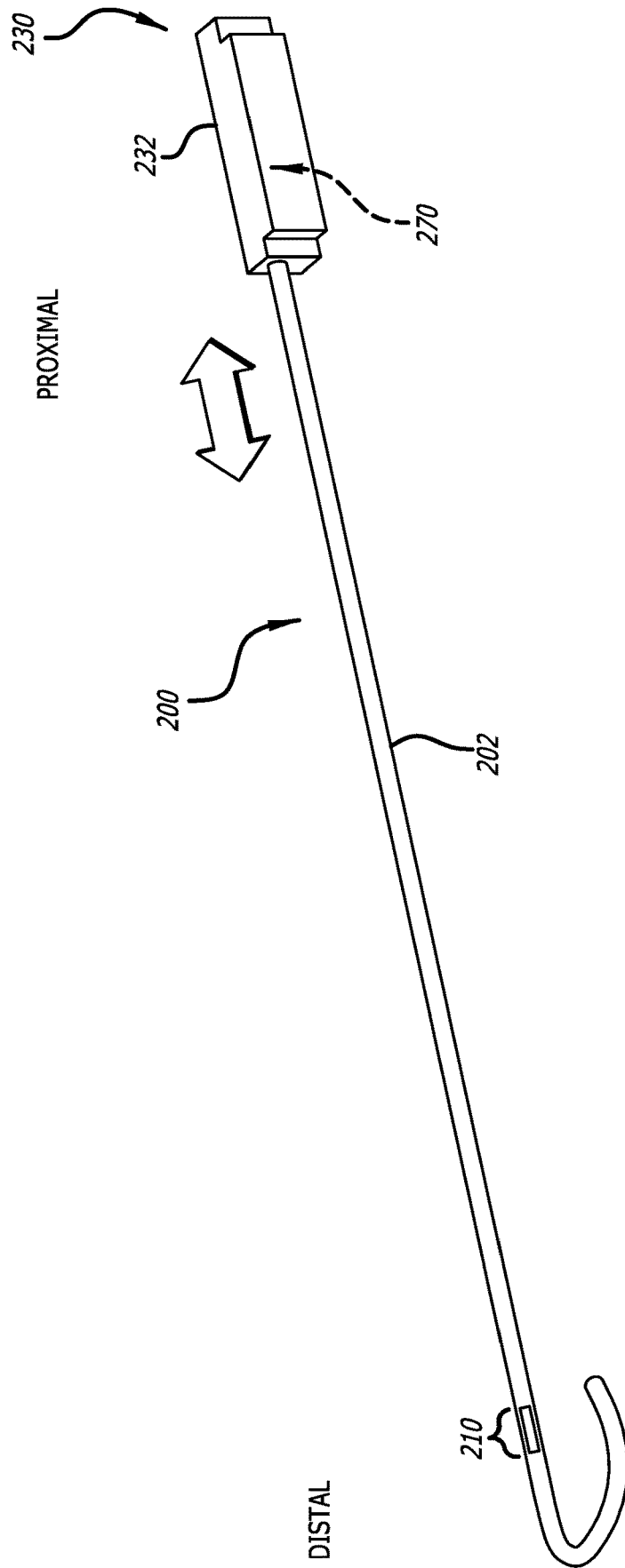


FIG. 3E

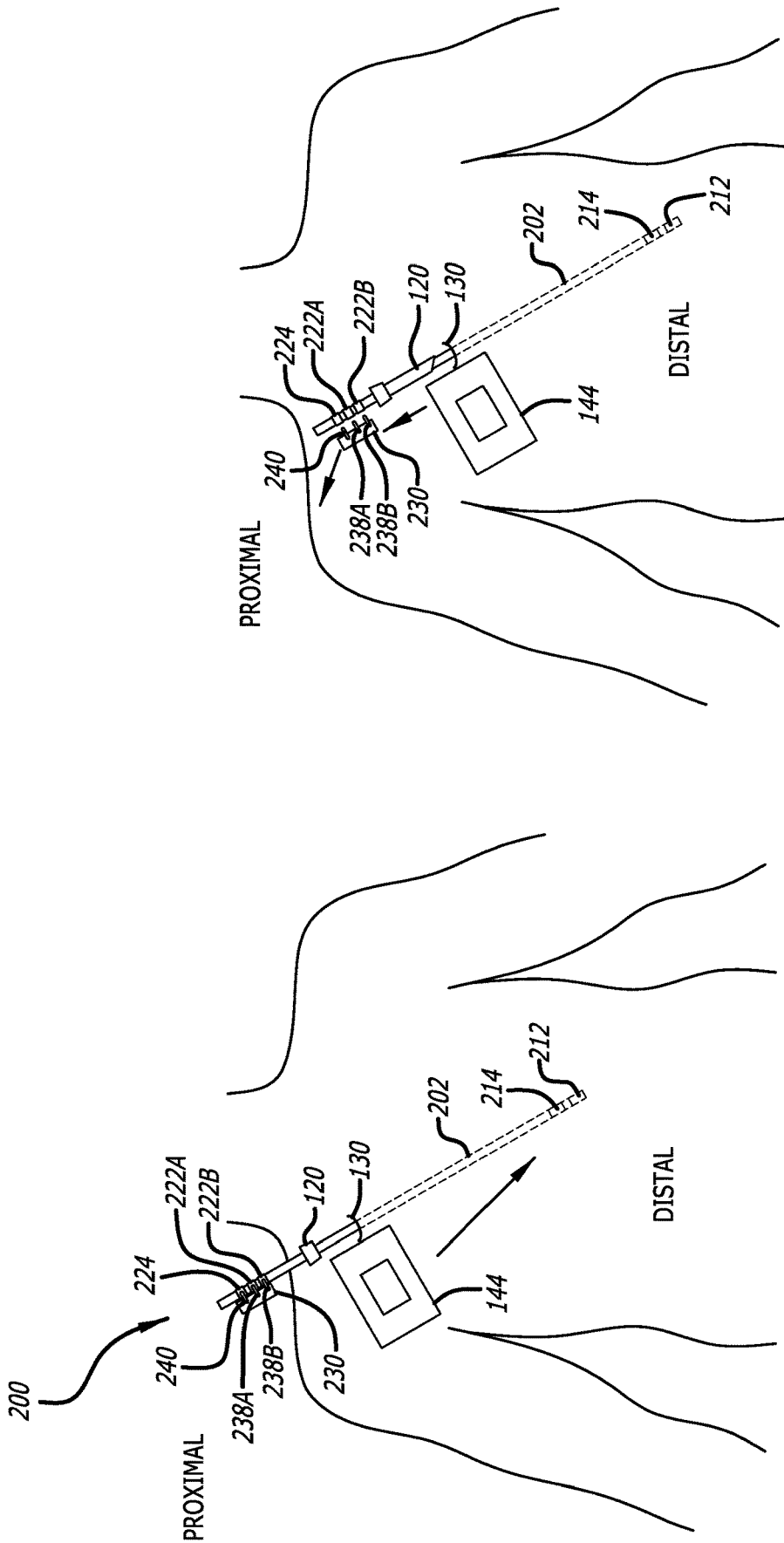
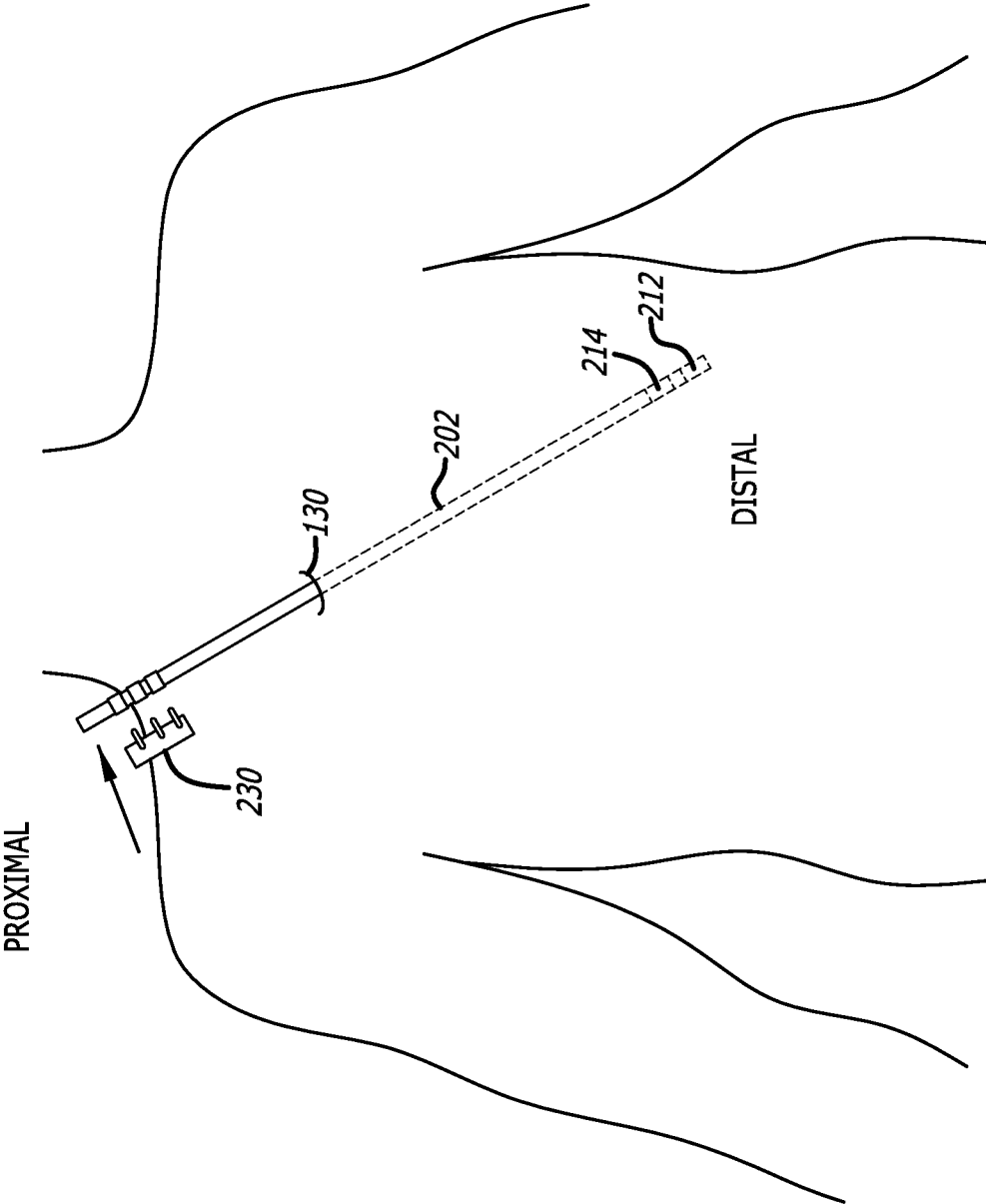


FIG. 4B

FIG. 4A

FIG. 4C



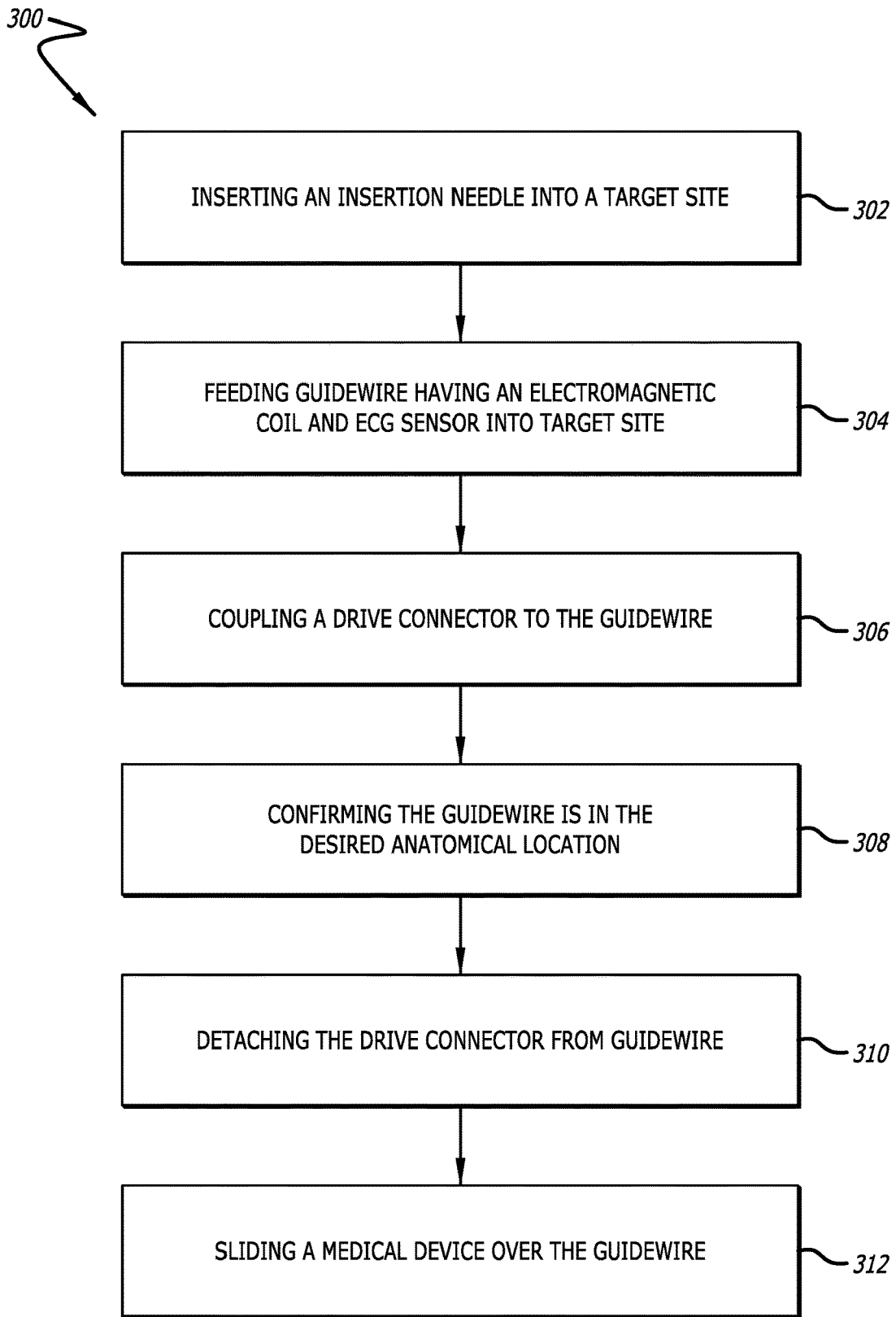


FIG. 5

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**MEDICAL DEVICES WITH A QUICK
RELEASE DRIVE CONNECTOR**

PRIORITY

This application claims the benefit of priority to U.S. Provisional Application No. 63/110,795, filed Nov. 6, 2020, which is incorporated by reference in its entirety into this application.

BACKGROUND

Many medical device implantation procedures require the upper chest to be unobstructed, to confirm, by imaging the target location, that the medical device has been placed in the proper anatomical location. Some of the medical device implantation procedures use guidewire or the like to place the medical device. It would be beneficial and time effective for the clinician to be able to configure the guidewire, stylet or similar to provide information about the guidewire's anatomical location during placement. However, configuring the guidewire, stylet, etc. could present issues preventing sliding of the medical device over the guidewire, stylet, etc. to a proper anatomical location. Disclosed herein are systems, apparatuses and a method that address the foregoing.

SUMMARY

Disclosed herein are systems and apparatuses that provide functionality to the elongate medical device used for introduction, such as a guidewire, stylet, introducer, etc., and/or to a catheter or other elongate medical device inserted into a patient. In some embodiments, the elongate medical device includes one or more sensors operably coupled to one or more sensor connectors. In some embodiments, the number of sensors is equivalent to the number of sensor connectors. A separate drive connector including one or more sensor connector attachments is designed for attachment to the elongate medical device at the one or more sensor connectors. In some embodiments, the number of sensor connector attachments is equivalent to the number of sensor connectors. The drive connector can be communicatively coupled to a console.

Although examples provided herein are with respect to a guidewire, other elongate medical devices are also contemplated, such as, for example, stylets, introducers, catheters or the like. In other words, the quick release drive connector should not be limited to use with guidewires only, but with any elongate device that would benefit from the concepts and examples described herein.

Disclosed herein is a medical device system including an elongate medical device having a proximal end and a distal end, the proximal end having one or more sensor connectors, the distal end having one or more sensors or emitters wired to the one or more sensor connectors and a drive connector having a housing body including one or more sensor connector attachments configured to detachably couple to the one or more sensor connectors to drive the one or more sensors or emitters of the elongate medical device.

In some embodiments, the medical device system includes the one or more sensor connector attachments extending from the housing body.

In some embodiments, the medical device system includes the housing body having a housing body cavity including the one or more sensor attachments located within the housing body cavity.

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In some embodiments, the medical device system includes the drive connector communicatively coupled to a console.

In some embodiments, the medical device system includes the one or more sensors or emitters including one or more electromagnetic coils, one or more electrocardiogram sensors, or one or more impedance measuring devices.

In some embodiments, the medical device system includes the one or more sensor connectors including one or more electromagnetic coil connectors, one or more electrocardiogram sensor connectors, or one or more impedance measuring device connectors.

In some embodiments, the medical device system includes the one or more sensor connector attachments including one or more electromagnetic coil attachments, one or more electrocardiogram sensor attachments, or one or more impedance measuring device attachments.

In some embodiments, coupling of the drive connector to the elongate medical device is configured to stabilize the elongate medical device and prevent embolization of the elongate medical device.

In some embodiments, the housing body includes a thru drape connection. In some embodiments, the housing body is configured to be sterile disposable. In some embodiments, the drive connector is wired to the console. In some embodiments, the drive connector is wirelessly coupled to the console.

In some embodiments, one or more impedance measuring devices may be configured to do one or more of mapping the cross sectional area of one or more blood vessels, confirming the delivery of the elongate medical device to an anatomical target location in a body, or confirming the delivery of a medical device to an anatomical target location.

In some embodiments, one or more electrocardiogram sensors are configured to do one or more of confirming arrival of elongate medical device at an anatomical target location, confirming a depth of the elongate medical device, or confirming a length of the elongate medical device.

In some embodiments, the elongate medical device is selected from the group consisting of a guidewire, a stylet, an introducer, and a catheter. In some embodiments, the elongate medical device includes segmented depth markings.

Also disclosed herein is a medical device insertion system including a medical device system including a guidewire having a proximal end and a distal end, the proximal end having one or more sensor connectors, the distal end having one or more sensors or emitters wired to the one or more sensor connectors, the guide wire having segmented depth markings. The medical device system further includes a drive connector having a housing body including one or more sensor connector attachments configured to detachably couple to the one or more sensor connectors to drive the one or more sensors or emitters of the guidewire. The medical device insertion system includes an ultrasound imaging system including the console configured to receive information from the one or more sensors or emitters of the medical device system, the console having one or more logic modules coupled to memory, and the console communicatively coupled to a display and an ultrasound probe, and a medical device configured for insertion over the guidewire.

In some embodiments, the one or more sensor connector attachments extend from the housing body.

In some embodiments, the housing body includes a housing body cavity having the one or more sensor connector attachments within the housing body cavity.

In some embodiments, the drive connector is communicatively coupled to the console. In some embodiments, the one or more sensors or emitters includes one or more electromagnetic coils, one or more electrocardiogram sensors, or one or more impedance measuring devices. In some embodiments, the one or more sensor connectors includes one or more electromagnetic coil connectors, one or more electrocardiogram sensor connectors, or one or more impedance measuring device connectors. In some embodiments, the one or more sensor attachments include one or more electromagnetic coil attachments, one or more electrocardiogram sensor attachments, or one or more impedance measuring device attachments.

In some embodiments, the housing body includes a thru drape connection. In some embodiments, the housing body is configured to be sterile disposable.

In some embodiments, the one or more logic modules may be configured to perform one or more of determining the anatomical location of the guidewire, determining the depth or length of the guidewire, determining the anatomical location of the medical device threaded over the guidewire, or mapping one or more blood vessels. In some embodiments, the one or more logic modules determine the anatomical location of the guidewire through tracking the one or more sensors or emitters. In some embodiments, the one or more logic modules determine the anatomical location of the medical device through tracking the one or more sensors of the guidewire as the medical device is threaded on the guidewire. In some embodiments, the one or more logic modules map the one or more blood vessels through tracking the one or more sensors or emitters.

In some embodiments, the medical device insertion system includes an ultrasound probe having one or more electromagnetic sensors configured to detect a magnetic field.

In some embodiments, the medical device configured for insertion over the guidewire is selected from the group consisting of a catheter, a peripherally inserted central catheter, a central venous catheter, and a midline catheter.

Also disclosed herein is a method for implanting a medical device including inserting an insertion needle into a target site, feeding a guidewire of a medical device system into the target site, the medical device system including a guidewire having a proximal end and a distal end, the proximal end having one or more sensor connectors, the distal end having one or more sensors or emitters wired to the one or more sensor connectors. The medical device system further includes a drive connector having a housing body including one or more sensor connector attachments configured to detachably couple to the one or more sensor connectors to drive the one or more sensors or emitters of the guidewire. The method further includes coupling the drive connector to the guidewire, confirming the guidewire is in the desired anatomical location, detaching the drive connector from the guidewire, and sliding a medical device over the guidewire.

In some embodiments, the method includes the sensor connector attachments extending from the housing body.

In some embodiments, the method includes the housing body having a housing body cavity including the sensor connector attachments within the housing body cavity.

In some embodiments, the method includes the one or more sensors or emitters including one or more impedance measuring devices, one or more electrocardiogram sensors, or one or more electromagnetic coils.

In some embodiments, the method includes the one or more sensor connectors including one or more impedance

measuring device connectors, one or more electrocardiogram sensor connectors, or one or more electromagnetic coil connectors.

In some embodiments, the method includes the one or more sensor connector attachments including one or more impedance measuring device attachments, one or more electrocardiogram sensor attachments, or one or more electromagnetic coil attachments.

In some embodiments, coupling the drive connector to the guidewire includes slidably engaging the drive connector with the proximal end of the guidewire.

In some embodiments, detaching the drive connector to the guidewire includes slidably disengaging the drive connector with the proximal end of the guidewire.

In some embodiments confirming the guidewire is in the desired anatomical location includes confirming with the one or more sensors or emitters and an ultrasound imaging system including a console having one or more logic modules, the console being coupled to a display and an ultrasound probe having one or more electromagnetic sensors.

In some embodiments, sliding the medical device over the guidewire includes confirming the medical device is in the target site with the one or more sensors or emitters and an ultrasound imaging system including a console having one or more logic modules, the console being coupled to a display and an ultrasound probe having one or more electromagnetic sensors.

In some embodiments, the method includes the medical device selected from a group consisting of a catheter, a peripherally inserted central catheter, a central venous catheter, a midline catheter, and an introducer.

In some embodiments, the method includes the target site including one or more blood vessels.

These and other features of the concepts provided herein will become more apparent to those of skill in the art in view of the accompanying drawings and following description, which describe particular embodiments of such concepts in greater detail.

DRAWINGS

A more particular description of the present disclosure will be rendered by reference to specific embodiments thereof that are illustrated in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. Example embodiments of the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

FIG. 1A illustrates a medical device insertion system including a medical device system, in accordance with some embodiments.

FIG. 1B illustrates a block diagram depicting various components of a medical device insertion system including a medical device system, in accordance with some embodiments.

FIGS. 2A-2B illustrate a guidewire of a medical device system, in accordance with some embodiments.

FIGS. 3A-3B illustrate a plan view of drive connectors, in accordance with some embodiments.

FIGS. 3C-3D illustrate an exemplary method of detachably coupling the drive connector of FIG. 3A. to the guidewire of a medical device system, in accordance with some embodiments.

FIG. 3E illustrates an exemplary method for detachably coupling the drive connector of FIG. 3B to a guidewire of the medical device system, in accordance with some embodiments.

FIGS. 4A-4C illustrate an exemplary method of placing a guidewire, in accordance with some embodiments.

FIG. 5 illustrates a block diagram of an exemplary method for implanting a medical device, in accordance with some embodiments.

DESCRIPTION

Before some particular embodiments are disclosed in greater detail, it should be understood that the particular embodiments disclosed herein do not limit the scope of the concepts provided herein. It should also be understood that a particular embodiment disclosed herein can have features that can be readily separated from the particular embodiment and optionally combined with or substituted for features of any of a number of other embodiments disclosed herein.

Regarding terms used herein, it should also be understood the terms are for the purpose of describing some particular embodiments, and the terms do not limit the scope of the concepts provided herein. Ordinal numbers (e.g., first, second, third, etc.) are generally used to distinguish or identify different features or steps in a group of features or steps, and do not supply a serial or numerical limitation. For example, "first," "second," and "third" features or steps need not necessarily appear in that order, and the particular embodiments including such features or steps need not necessarily be limited to the three features or steps. Labels such as "left," "right," "top," "bottom," "front," "back," and the like are used for convenience and are not intended to imply, for example, any particular fixed location, orientation, or direction. Instead, such labels are used to reflect, for example, relative location, orientation, or directions. Singular forms of "a," "an," and "the" include plural references unless the context clearly dictates otherwise.

With respect to "proximal," a "proximal portion" or a "proximal-end portion" of, for example, a guidewire disclosed herein includes a portion of the guidewire intended to be near a clinician when the guidewire is used on a patient. Likewise, a "proximal length" of, for example, the guidewire includes a length of the guidewire intended to be near the clinician when the guidewire is used on the patient. A "proximal end" of, for example, the guidewire includes an end of the guidewire intended to be near the clinician when the guidewire is used on the patient. The proximal portion, the proximal-end portion, or the proximal length of the guidewire can include the proximal end of the guidewire; however, the proximal portion, the proximal-end portion, or the proximal length of the guidewire need not include the proximal end of the guidewire. That is, unless context suggests otherwise, the proximal portion, the proximal-end portion, or the proximal length of the guidewire is not a terminal portion or terminal length of the guidewire.

With respect to "distal," a "distal portion" or a "distal-end portion" of, for example, a guidewire disclosed herein includes a portion of the guidewire intended to be near or in a patient when the guidewire is used on the patient. Likewise, a "distal length" of, for example, the guidewire includes a length of the guidewire intended to be near or in the patient when the guidewire is used on the patient. A "distal end" of, for example, the guidewire includes an end of the guidewire intended to be near or in the patient when the guidewire is used on the patient. The distal portion, the distal-end portion, or the distal length of the guidewire can

include the distal end of the guidewire; however, the distal portion, the distal-end portion, or the distal length of the guidewire need not include the distal end of the guidewire. That is, unless context suggests otherwise, the distal portion, the distal-end portion, or the distal length of the guidewire is not a terminal portion or terminal length of the guidewire.

The term "logic" may be representative of hardware, firmware or software that is configured to perform one or more functions. As hardware, the term logic may refer to or include circuitry having data processing and/or storage functionality. Examples of such circuitry may include, but are not limited or restricted to a hardware processor (e.g., microprocessor, one or more processor cores, a digital signal processor, a programmable gate array, a microcontroller, an application specific integrated circuit "ASIC", etc.), a semiconductor memory, or combinatorial elements.

Additionally, or in the alternative, the term logic may refer to or include software such as one or more processes, one or more instances, Application Programming Interface(s) (API), subroutine(s), function(s), applet(s), servlet(s), routine(s), source code, object code, shared library/dynamic link library (dll), or even one or more instructions. This software may be stored in any type of a suitable non-transitory storage medium, or transitory storage medium (e.g., electrical, optical, acoustical or other form of propagated signals such as carrier waves, infrared signals, or digital signals). Examples of a non-transitory storage medium may include, but are not limited or restricted to a programmable circuit; non-persistent storage such as volatile memory (e.g., any type of random access memory "RAM"); or persistent storage such as non-volatile memory (e.g., read-only memory "ROM", power-backed RAM, flash memory, phase-change memory, etc.), a solid-state drive, hard disk drive, an optical disc drive, or a portable memory device. As firmware, the logic may be stored in persistent storage.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by those of ordinary skill in the art.

FIG. 1A illustrates a medical device insertion system **100**, in accordance with some embodiments. In some embodiments, the medical device insertion system **100** includes a medical device **110**, a medical device system **200** including an elongate medical device **202** having one or more sensors or emitters **210** coupled to one or more sensor connectors **220**, and a quick release drive connector ("drive connector") **230**, detachably coupled to the one or more sensor connectors **220**, configured to drive or provide electrical current to the one or more sensors or emitters **210**. In some embodiments, the elongate medical device **202** includes a guidewire, a stylet, an introducer, a catheter or the like.

In some embodiments, the medical device insertion system **100** can further include an ultrasound probe **144** coupled to a console **140** having a one or more logic modules, the console **140** configured to use the information from the one or more sensors or emitters **210** and the ultrasound probe **144** to do one or more of the following: determine the anatomical location of the elongate medical device **202**, determine the depth or length of the elongate medical device **202** after insertion, determine the anatomical location of the medical device **110** in a body or map one or more target blood vessels **106**. In some embodiments, the medical device insertion system **100** further includes an insertion needle **120** configured to be inserted at a target site **130**. In some embodiments, the target site **130** can include one or more target blood vessels **106**. In some embodiments, the medical device **110** can include a catheter, peripherally

inserted central catheter (“PICC”), central venous catheter (“CVC”), midline catheter, an introducer, a stylet or the like.

In some embodiment, the drive connector **230** may be configured to transmit the information detected by the one or more sensors or emitters **210** to the console **140**. In an embodiment of using the medical device insertion system **100** to place the medical device **110**, the insertion needle **120** can be inserted at the target site **130**. In an embodiment, the elongate medical device **202** can include guidewire. The guidewire **202** may be configured to slide through the insertion needle **120** into the target site **130**, and the drive connector **230** detachably coupled to the one or more sensor connectors **220**. The drive connector **230** may be configured to drive the one or more sensors or emitters **210**. The console **140** may be configured to obtain information from the one or more sensors or emitters **210** for placing the guidewire **202** in the target site **130**. The ultrasound probe **144** may be configured to transmit ultrasound images of the guidewire **202** being placed in the target site **130**, to the console **140**. Once the guidewire **202** is placed at the proper anatomical location using the information gathered from one or more of: the one or more sensors or emitters **210** or the ultrasound images, the drive connector **230** can be detached from the one or more sensor connectors **220**. The insertion needle **120** can be slidably removed, over the guidewire **202** from the target site **130**. In some embodiments, the guidewire **202** can be used to facilitate placing the medical device **110**. Advantageously, the medical device system **200** can be configured to selective drive the one or more sensors or emitters **210** for appropriately placing the guidewire **202**, then remove the drive connector **230** from the guidewire **202** to easily thread additional medical devices over the guidewire **202**. The drive connector **230** can then be re-coupled to the one or more sensor connectors **220** to obtain information from the one or more sensors or emitters **210** for medical device delivery confirmation or to stabilize the guidewire **202** to prevent embolization.

FIG. 1B illustrates a block diagram depicting various components of a medical device insertion system **100** including the medical device system **200**, in accordance with some embodiments. In some embodiments, the console **140** is communicatively coupled to the display **142**. In some embodiments, the display **142** may be wired to the console **140** or wirelessly coupled to the console **140**. Exemplary wireless communication modalities can include WiFi, Bluetooth, Near Field Communications (NFC), cellular Global System for Mobile Communication (“GSM”), electromagnetic (EM), radio frequency (RF), combinations thereof, of the like.

The console **140** may be coupled to the ultrasound probe **144**. The ultrasound probe **144** may be configured to transmit ultrasound images to the console **140**. In some embodiments as illustrated in FIG. 1B, the ultrasound probe **144** may include one or more electromagnetic sensors **146** for detecting a magnetic field. Details of exemplary multimodal tracking systems including ultrasound imaging systems can be found in U.S. Pat. Nos. 8,388,541, 8,781,555, 8,849,382, 9,445,743, 9,456,766, 9,492,097, 9,521,961, 9,554,716, 9,636,031, 9,649,048, 10,159,531, 10,172,538, 10,413,211, 10,449,330, U.S. Publication No. 2014/0031674, U.S. Publication No. 2014/0188133, U.S. Publication No. 2015/0080762, and U.S. Publication No. 2018/0116551, each of which are incorporated by reference in their entirety into this application.

In some embodiments, the console **140** may be communicatively coupled to the drive connector **230**. In some embodiments, the drive connector **230** may transmit infor-

mation from the one or more sensors or emitters **210** on the elongate medical device **202** to the console **140**. In some embodiments, the console **140** may be configured to receive information from the one or more sensors or emitters, by way of an external sensor coupled to the console **140**. In some embodiments, the console **140** includes a processor **148** and one or more logic modules coupled to non-transitory, computer-readable medium (“memory”) **152**. The one or more logic modules may be configured to include one or more of: a drive connector logic **154**, an ultrasound electromagnetic sensor logic **156**, an electrocardiogram logic **158**, an impedance measuring device logic **160**, an ultrasound probe acquisition logic **162**, a guidewire determination logic **166** or a medical device determination logic **168**. In some embodiments, the drive connector logic **154** may be configured to selectively drive one or more sensor connector attachments **236** and determine if adequate electrical current is being provided to the one or more sensors or emitters **210**. In some embodiments, the ultrasound electromagnetic sensor logic **156** may be configured to acquire a detected magnetic field generated by an electromagnetic coil. In some embodiments, the electrocardiogram logic **158** may be configured to acquire an electrocardiogram signal generated by an electrocardiogram sensor on the guidewire **202**. In some embodiments, the impedance measuring device logic **160** may be configured to acquire changes in an impedance signal from an impedance measuring device on the guidewire **202**. In some embodiments, the ultrasound probe acquisition logic **162** may be configured to acquire ultrasound probe data. In some embodiments, the guidewire determination logic **164** may be configured to determine the anatomical location of the elongate medical device **202**, determine the depth or length of the elongate medical device **202** or map the one or more blood vessels. In some embodiments, the medical device determination logic **166** may be configured to determine the anatomical location of the medical device **110** as the medical device **110** is configured to slide over the guidewire **202**.

FIGS. 2A-2B illustrate a guidewire **202** of a medical device system **200**, in accordance with some embodiments. As illustrated in FIG. 2A, in some embodiments, the one or more sensors or emitters **210** may be located at a distal end of the guidewire **202** and the one or more sensor connectors **220** may be located at the proximal end of the guidewire **202**. In some embodiments, the one or more sensors or emitters **210** may include sensors or emitters configured to be sensed by an external sensor. In some embodiments, the one or more sensors or emitters **210** may be coupled, by wired connection, to the one or more sensor connectors **220**. In some embodiments, the wired connection between the one or more sensors **210** and the one or more sensor connectors **220** may be contained within the guidewire **202**. In some embodiments, number of sensors **210** is equivalent to the number of sensor connectors **220**. In some embodiments, the one or more sensors **210** coupled to the one or more sensor connectors **220** include one or more of: an electrocardiogram (ECG) sensor **214** coupled to an ECG connector **224**, an electromagnetic (EM) coil **212** coupled to a pair of EM connectors **222A/B**, or an impedance measuring device **216** coupled to an impedance connector **226**. In an embodiment, the EM coil **212** coupled to a pair of EM connectors **222A/B** may include a plurality of EM coils coupled to a plurality of pairs of EM connectors. In this embodiment, the plurality of EM coils may be distributed evenly along the guidewire **202**. In another embodiment, the plurality of EM coils may be distributed unevenly along the guidewire **202**. In a preferred embodiment, the medical

device system **200** may include a guidewire **202** having an EM coil **212** located at the distal end of the guidewire **202** wired to a pair of EM coil connectors **222A/B** at the proximal end of the guidewire **202** configured to provide electrical current therebetween. In the preferred embodiment, the guidewire **202** further includes an ECG sensor **216** is located at the distal end of the guidewire **202** wired to an ECG sensor connector **226** at the proximal end of the guidewire **202**.

In some embodiments, as illustrated in FIG. 2B, the guidewire **202** can include a plurality of depth indicators **228** on at least a portion the guidewire **202**. In some embodiments, the plurality of depth indicators **228** may include indentations evenly spaced on the guidewire **202**. In some embodiments, the plurality of depth indicators **228** may include radiopaque material evenly spaced on at least a portion of the guidewire **202**. In some embodiments, the one or more sensors **210** and one or more sensor connectors **220** can be configured on the guidewire **202** to sit flush along the surface of the guidewire **202** to prevent any hindrance when the guidewire **202** is configured to slide into the target site **130** or when additional devices are configured to slide thereon.

FIGS. 3A-3B illustrate a plan view of drive connectors **230**, in accordance with some embodiments. The drive connector **230** may be configured to drive or provide electrical current to the one or more sensors or emitters **210** through coupling with the one or more sensor connectors **220**. In some embodiments, the drive connector **230** is designed for attachment to an elongate medical device **202** at the one or more sensor connectors **220**. The drive connector **230** includes a housing body **232** having one or more sensor connector attachments **236** configured to detachably couple to the one or more sensor connectors **220** on the guidewire **202**. In some embodiments, the sensor connector attachments **236** may be configured to be quick-releasing as will be described in more detail herein.

In some embodiments, the one or more sensor connector attachments **236** may extend from the housing body **232**. In an embodiment as illustrated in FIG. 3B, the housing body **232** may include a housing body cavity **234** having the one or more sensor connector attachments **236** therein. In this embodiment, a portion of the proximal end of the guidewire **202** may be configured to fit within the housing body cavity **234** with the one or more sensor connectors attachments **236** coupling with the one or more sensor connector **220** of the guidewire **202**. In this embodiment, the housing body **232** may be configured to slidably engage the proximal end of the guidewire **202**. In some embodiments, the housing body **232** may be configured to be sterile disposable, configured with a thru-drape connection configured to mate with the guidewire **202** below a sterile drape or a combination thereof. In some embodiments, sterile disposable includes the housing body **232** being pre-sterilized and single use disposable.

The drive connector **230** may be configured to provide information from the one or more sensors or emitters **210** to the console **140**. In some embodiments, the drive connector **230** may be configured to be wired to the console **140** or in wireless communication with the console **140**. Exemplary wireless communication modalities can include WiFi, Bluetooth, Near Field Communications (NFC), cellular Global System for Mobile Communication ("GSM"), electromagnetic (EM), radio frequency (RF), combinations thereof, of the like. In some embodiments, the drive connector **230** may be configured to provide information from one or more but not all of the sensors or emitters **210**. For example, when the

one or more sensors or emitters **210** include an EM coil **212** and an ECG sensor **216**, the drive connector **230** may be configured to drive the EM coil **212** to generate an electromagnetic field that is configured to be detected by an external sensor coupled to the console **140** (e.g., the electromagnetic sensor **146** on the ultrasound probe **144**) while the drive connector **230** transmits information from the ECG sensor **216** to the console **140**.

In some embodiments, when the drive connector **230** is wired to the console **140**, the console **140** may be configured to provide the electrical current necessary to drive the one or more sensors or emitters **210**. In some embodiments, when the drive connector **230** is in wireless communication with the console **140**, the housing body **232** may be configured to include an energy source **270** configured to provide electrical current to the one or more sensors or emitters **210**. In some embodiments, detaching the drive connector **230** from the guidewire **202** breaks the electrical current to the one or more sensors or emitters **210**. In some embodiments, breaking the electrical current to the one or more sensors or emitters **210** can break the information emitted or transmitted from the one or more sensors or emitters **210** to the console **140** until the electrical current is reestablished by coupling the drive connector **230** to the guidewire **202**.

In some embodiments, as illustrated in FIG. 3A, the drive connector **230** may have an indicator **244** (e.g., LED, tactile feedback, or auditory feedback) or provide an indicator (e.g., visual message on a display coupled to the console or auditory message originating from the console **140**) when the one or more sensor connector attachments **236** are adequately or inadequately coupled to the one or more sensor connectors **220**. For example, if the one or more sensor connector attachments **236** are inadequately coupled to the one or more sensor connectors **220**, an LED could flash indicating an inadequate connection has been formed between the one or more sensor connector attachments **236** and the one or more sensor connectors **220**. In some embodiments, the console **140** may be configured to provide indicators that the console **140** is receiving information from the one or more sensors or emitters **210**, indicating a proper connection between the drive connector **230** and the guidewire **202** has been formed and the one or more sensors or emitters **210** has sufficient electrical current. In some embodiments the console **140** may be configured to provide indicators that the console **140** is not receiving information from the one or more sensors or emitters **210**, indicating a proper connection between the drive connector **230** and the guidewire **202** has not been formed or the one or more sensors or emitters **210** does not have sufficient electrical current. In an embodiment, the drive connector **230** may be configured to include a configuration of all sensor connector attachments **236** (e.g., one or more ECG sensor connector attachments **240**, one or more pairs of EM connector attachments **238A/B**, or one or more impedance measuring device attachments **242**) that may be used with a guidewire **202** having any number or configuration of the one or more sensors or emitters **210**. In this embodiment, the user may configure the drive connector **230** or the console **140** to only provide electrical current to the desired one or more sensors or emitters **210**.

FIGS. 3C-3D illustrate an exemplary method of detachably coupling the drive connector **230** to the guidewire **202**, in accordance with some embodiments. As illustrated in FIG. 3C, the drive connector **230**, through the one or more sensor connector attachments **236**, can detachably couple to the one or more sensor connectors **220**. In some embodiments, the sensor connector attachments **236** may be con-

figured to be quick-releasing. In some embodiments, the one or more sensor connector attachments **236** can be configured in a way to only detachably couple with the one or more sensor connectors **220** in a proper orientation. For example, the one or more EM coil connector attachment **238A/B** may be configured in a way to only detachably couple with the one or more EM coil connector **222A/B**. If the one or more EM coil connector attachment **238A/B** attempts to detachably couple with an ECG sensor connector **224**, the one or more EM coil connector attachment **238A/B** may not be able to couple with the ECG sensor connector **224** or the drive connector **230** may not provide sufficient electrical current to power to the ECG sensor **214**. In some embodiments, the drive connector **230** can only drive the one or more sensors or emitters **210** when the one or more sensor connector attachments **236** are properly coupled to the one or more sensor connectors **220**. For example, the one or more EM coil connector attachments **238A/B** can only provide sufficient electrical current to drive the EM coil **212** when the one or more EM connector attachments **238A/B** is coupled to the pair of EM coil connector **222A/B**. In some embodiments, the one or more sensor connector attachments **238** can detachably couple with the one or more sensor connectors **220** through a spring loaded clamping interaction, a magnetic interaction, a snap fit, a press fit, a quick release interaction, an interference fit or the like. The drive connector **230** can be brought to the guidewire **202** and the one or more sensor connector attachments **236** can be clamp fit onto the respective one or more sensor connectors **220**. As illustrated in FIG. 3D, the one or more sensor connector attachments **236** can be quick released from the one or more sensor connectors **220** and the drive connector **230** can be pulled away from the guide wire **202**.

FIG. 3E illustrates an exemplary method for detachably coupling the drive connector **230** of FIG. 3B to a guidewire **202** of the medical device system **200**, in accordance with some embodiments. The drive connector **230** may include one or more sensor connector attachments **236** within the housing body **232**. The drive connector **230** may be configured to slide onto the proximal end of the guidewire **202**, the one or more sensor connector attachments **236** engaging the one or more sensor connectors **220** of the guidewire **202**. The one or more sensor connector attachments **236** engaging the one or more sensor connectors **220** may configure the energy source **270** to drive the one or more sensors or emitters **210**.

FIGS. 4A-4C illustrate an exemplary method of placing a guidewire **202** of the medical device system **200**, in accordance with some embodiments. The medical device system **200** includes the guidewire **202** having the EM coil **212** at the distal end of the guidewire **202**, coupled to the pair of EM coil connectors **222A/B** at the proximal end of the guidewire **202** and the ECG sensor **214** at the distal end of the guidewire **202** coupled to the ECG connector **224** at the proximal end of the guidewire **202**. The drive connector **230** includes the pair of EM coil connector attachments **22238A/B** and the ECG connector attachment **240**. In FIG. 4A, the guide wire **202** can be inserted into the target site **130** through the insertion needle **120**. In some embodiments, the target site **130** includes one or more target blood vessels **106**. The drive connector **230** can be detachably coupled to the guidewire **202** with the pair of EM coil connector attachments **238A/B** coupling to the pair of EM coil connectors **222A/B** and the ECG connector attachment **240** coupling to the ECG connector **224**. The drive connector **230** may then be configured to drive the EM coil **212** through the pair of EM coil connectors **222A/B** and receive information from the ECG sensor **214**. Simultaneously, the

ultrasound probe **144** may be configured to capture and transmit ultrasound images of the guidewire **202** moving to the proper anatomical location. In some embodiments, the ultrasound probe **144** may be configured to detect the magnetic field of the EM coil **212**. The information from the ECG sensor **214**, the images from the ultrasound probe **144** and the detection of the magnetic field generated by the EM coil **212** by the ultrasound probe **144** can be used to further guide the guidewire **202** to the proper anatomical location. Once the guidewire **202** is placed, as illustrated in FIG. 4B, the drive connector **230** can be removed and the insertion needle **120** can be removed from the target site **130** over the guidewire **202**. A medical device **110** may be configured to threaded thereon. As illustrated in FIG. 4C, the drive connector **230** can be re-coupled to the guidewire **202** at any time to drive the EM coil **212** and ECG sensor **214**. The information from the EM coil **212** and ECG sensor **214** can be used to provide delivery confirmation of the medical device **110** while being threaded on the guidewire **202**. Furthermore, re-coupling the drive connector **230** to the guidewire **202** may prevent embolization of the guidewire **202**.

FIG. 5 illustrates a block diagram of a method **300** of implanting a medical device **110**, in accordance with some embodiments. The method **300** includes inserting an introducer needle **120** into a target site **130** (block **302**). In some embodiments, the target site **130** includes a target blood vessel **106**. In some embodiments, the method **300** further includes feeding a guidewire **202** of a medical device system **200** into the target site **130** (block **304**). In some embodiments, the medical device system **200** includes a guidewire **202** having a proximal end and a distal end, the proximal end having one or more sensor connectors **220** including a pair of EM coil connectors **222A/B** and a ECG sensor connector **224**, the distal end having one or more sensors or emitters **210** including an EM coil **212** and an ECG sensor **214** wired to the sensor connectors. The medical device system **200** further includes a drive connector having a housing body including one or more sensor connector attachments **236** including a pair of EM coil attachments **238A/B** and an ECG sensor attachment **240** extending therefrom, the pair of EM coil attachments **238A/B** and the ECG sensor attachment **240** configured to detachably couple to the pair of EM coil connectors **222A/B** and the ECG sensor connector **224** to drive the EM coil **212** and the ECG sensor **214**.

The method **300** further includes coupling the drive connector **230** to the guidewire **202** (block **306**) to drive the EM coil **212** and the ECG sensor **214** and prevent embolization of the guidewire **202**. In some embodiments, coupling the drive connector **230** to the guidewire **202** includes connecting the pair of EM coil attachments **238A/B** to the pair of EM coil connectors **222A/B** and the ECG sensor attachment **240** to the ECG sensor connector **224**. In some embodiments, coupling the drive connector **230** to the guidewire **202** includes slidably engaging the drive connector **230** with the proximal end of the guidewire **202**. In some embodiments, slidably engaging includes sliding the drive connector **230** distally on the proximal end of the guidewire **202**. The method **300** further includes confirming the guidewire **202** is in the desired anatomical location (block **308**). In some embodiments, confirming the guidewire **202** is at the desired anatomical location includes using one or more of the EM coil **212**, the ECG sensor **214** and the ultrasound probe **144** coupled to the console **140**.

The method **300** further includes detaching the drive connector **230** from the guidewire **202** (block **310**). In some embodiments, detaching the drive connector **230** from the

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guidewire 202 occurs only after the guidewire 202 is confirmed to be in the desired anatomical location. In some embodiments, detaching the drive connector 230 from the guidewire 202 includes removing the pair of EM coil attachments 238A/B from the pair of EM coil connectors 222A/B and the ECG sensor attachment 240 from the EM sensor 224. In some embodiments, detaching the drive connector 230 from the guidewire 202 includes slidably disengaging the drive connector 230 from the proximal end of the guidewire 202. In some embodiments, slidably disengaging includes sliding the drive connector 230 proximally from the proximal end of the guidewire 202.

The method 300 further includes sliding a medical device 110 over the guidewire 202 (block 312). In some embodiments, the medical device 110 may include catheter, a peripherally inserted central catheter, a central venous catheter, a midline catheter, and an introducer.

In some embodiments, sliding the medical device 110 over the guidewire 202 occurs after detaching the driver connector 230 from the guidewire 202 has occurred. In some embodiments, the medical device 110 can include a catheter, peripherally inserted central catheter ("PICC"), central venous catheter ("CVC"), midline catheter, an introducer, a stylet or the like. In some embodiments, sliding the medical device 110 over the guidewire 202 can include confirming the medical device 110 is in the target site with one or more of the EM coil 212, the ECG sensor 214 and the ultrasound probe 144 coupled to the console 140.

While some particular embodiments have been disclosed herein, and while the particular embodiments have been disclosed in some detail, it is not the intention for the particular embodiments to limit the scope of the concepts provided herein. Additional adaptations and/or modifications can appear to those of ordinary skill in the art, and, in broader aspects, these adaptations and/or modifications are encompassed as well. Accordingly, departures may be made from the particular embodiments disclosed herein without departing from the scope of the concepts provided herein.

What is claimed is:

1. A medical device system, comprising: an elongate medical device, comprising: a proximal end including one or more sensor connectors; and a distal end including one or more sensors or emitters wired to the one or more sensor connectors, wherein the one or more sensors or emitters include one or more electromagnetic coils and one or more electrocardiogram (ECG) sensors; and a quick-release drive connector comprising a housing body including one or more sensor connector attachments including one or more electromagnetic coil attachments and one or more electrocardiogram sensor attachments, the quick-release drive connector configured to: a) slide over the proximal end of the elongate medical device and engage the one or more sensor connectors with the one or more sensor connector attachments, wherein engagement is configured to cause current to flow from the quick-release drive connector to the one or more electromagnetic coils causing generation of an electromagnetic field, and b) slide off the proximal end of the elongate medical device and disengage the one or more sensor connectors from the one or more sensor connector attachments wherein disengagement is configured to stop the current from flowing from the quick-release drive connector to the one or more sensors or emitters.

2. The medical device system according to claim 1, wherein the one or more sensor connector attachments extend from the housing body.

3. The medical device system according to claim 1, wherein the housing body includes a housing body cavity,

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the housing body cavity having the one or more sensor connector attachments therein.

4. The medical device system according to claim 1, wherein the quick-release drive connector is communicatively coupled to a console.

5. The medical device system according to claim 1, wherein the one or more sensors or emitters further include one or more impedance measuring devices.

6. The medical device system according to claim 1, wherein the one or more sensor connectors include one or more electromagnetic coil connectors, one or more electrocardiogram sensor connectors, or one or more impedance measuring device connectors.

7. The medical device system according to claim 1, wherein the one or more sensor connector attachments further include one or more impedance measuring device attachments.

8. The medical device system according to claim 1, wherein sliding the quick-release drive connector over the elongate medical device is configured to stabilize the elongate medical device and prevent embolization with the elongate medical device.

9. The medical device system according to claim 1, wherein the housing body includes a through-drape connection.

10. The medical device system according to claim 1, wherein the housing body is configured to be sterile disposable.

11. The medical device system according to claim 4, wherein the quick-release drive connector is wired to the console.

12. The medical device system according to claim 4, wherein the quick-release drive connector is wirelessly coupled to the console.

13. The medical device system according to claim 1, wherein the one or more sensors or emitters comprise one or more impedance measuring devices configured to perform one or more of mapping a cross-sectional area of one or more blood vessels, confirming delivery of the elongate medical device to an anatomical target location in a body, or confirming delivery of a medical device to the anatomical target location.

14. The medical device system according to claim 5, wherein the one or more sensors or emitters comprise the one or more electrocardiogram sensors, the one or more electrocardiogram sensors configured to perform one or more of confirming arrival of the elongate medical device at an anatomical target location, confirming a depth, or confirming a length.

15. The medical device system according to claim 1, wherein the elongate medical device is selected from the group consisting of a guidewire, a stylet, an introducer, and a catheter.

16. The medical device system according to claim 1, wherein the elongate medical device includes segmented depth markings.

17. A medical device insertion system, comprising: a guidewire system comprising: a guidewire comprising: a proximal end including one or more sensor connectors; and a distal end including one or more sensors or emitters wired to the one or more sensor connectors, wherein the one or more sensors or emitters include one or more electromagnetic coils and one or more electrocardiogram (ECG) sensors; and a quick-release drive connector comprising a housing body including one or more sensor connector attachments including one or more electromagnetic coil attachments and one or more electrocardiogram sensor

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attachments, the quick-release drive connector configured to: a) slide over the proximal end of the guidewire and engage the one or more sensor connectors with the one or more sensor connector attachments, wherein engagement is configured to cause current to flow from the quick-release drive connector to the one or more electromagnetic coils causing generation of an electromagnetic field, and b) slide off the proximal end of an elongate medical device and disengage the one or more sensor connectors from the one or more sensor connector attachments wherein disengagement is configured to stop the current from flowing from the quick-release drive connector to the one or more sensors or emitters; an ultrasound imaging system including a console, the ultrasound imaging system configured to receive information from the one or more sensors or emitters of the guidewire system, the console including one or more logic modules coupled to memory, wherein the console is communicatively coupled to a display and an ultrasound probe; and a medical device configured for insertion over the guidewire.

18. The medical device insertion system according to claim 17, wherein the one or more sensor connector attachments extend from the housing body.

19. The medical device insertion system according to claim 17, wherein the housing body includes a housing body cavity, the housing body cavity having the one or more sensor connector attachments therein.

20. The medical device insertion system according to claim 17, wherein the Quick-release drive connector is communicatively coupled to the console.

21. The medical device insertion system according to claim 17, wherein the one or more sensors or emitters further include one or more impedance measuring devices.

22. The medical device insertion system according to claim 17, wherein the one or more sensor connectors include one or more electromagnetic coil connectors, one or more electrocardiogram sensor connectors, or one or more impedance measuring device connectors.

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23. The medical device insertion system according to claim 17, wherein the one or more sensor connector attachments further include one or more impedance measuring device attachments.

24. The medical device insertion system according to claim 17, wherein the housing body includes a through-drape connection and/or is sterile disposable.

25. The medical device insertion system according to claim 17, wherein the one or more logic modules may be configured to perform one or more of:

- determining an anatomical location of the guidewire;
- determining a depth or length of the guidewire;
- determining an anatomical location of the medical device threaded over the guidewire; or
- mapping one or more blood vessels.

26. The medical device insertion system according to claim 17, wherein the one or more logic modules are configured to determine the anatomical locations of the guidewire through tracking the one or more sensors or emitters.

27. The medical device insertion system according to claim 17, wherein the one or more logic modules are configured to determine anatomical locations of the medical device through tracking the one or more sensors or emitters of the guidewire as the medical device is inserted over the guidewire.

28. The medical device insertion system according to claim 25, wherein the one or more logic modules are configured to map the one or more blood vessels through tracking the one or more sensors or emitters.

29. The medical device insertion system according to claim 17, wherein the ultrasound probe includes one or more electromagnetic sensors configured to detect a magnetic field.

30. The medical device insertion system according to claim 17, wherein the medical device is selected from the group consisting of a catheter, a peripherally inserted central catheter, a central venous catheter, a midline catheter, and an introducer.

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