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(54) **MARKING DEVICE DOCKING STATIONS AND METHODS OF USING SAME**

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ABSTRACT

Docking stations and docking methods are provided for use with marking devices used for marking the presence or absence of an underground facility in a dig area. The docking station may serve as a home base for storage of a marking device, for charging the battery of a marking device, for transferring data to and from a marking device, and for securing a marking device against unauthorized use and/or theft. The docking station may be a mobile docking station that is installed in a vehicle or may be a fixed docking station that is installed at a central location in the field, at a central office, at a home base facility, and the like.

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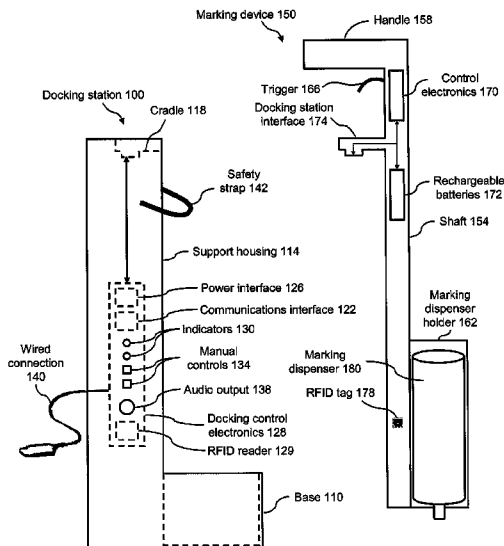
USPC **700/58**; 361/679.01; 361/679.02; 700/56

(58) **Field of Classification Search**

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36 Claims, 22 Drawing Sheets



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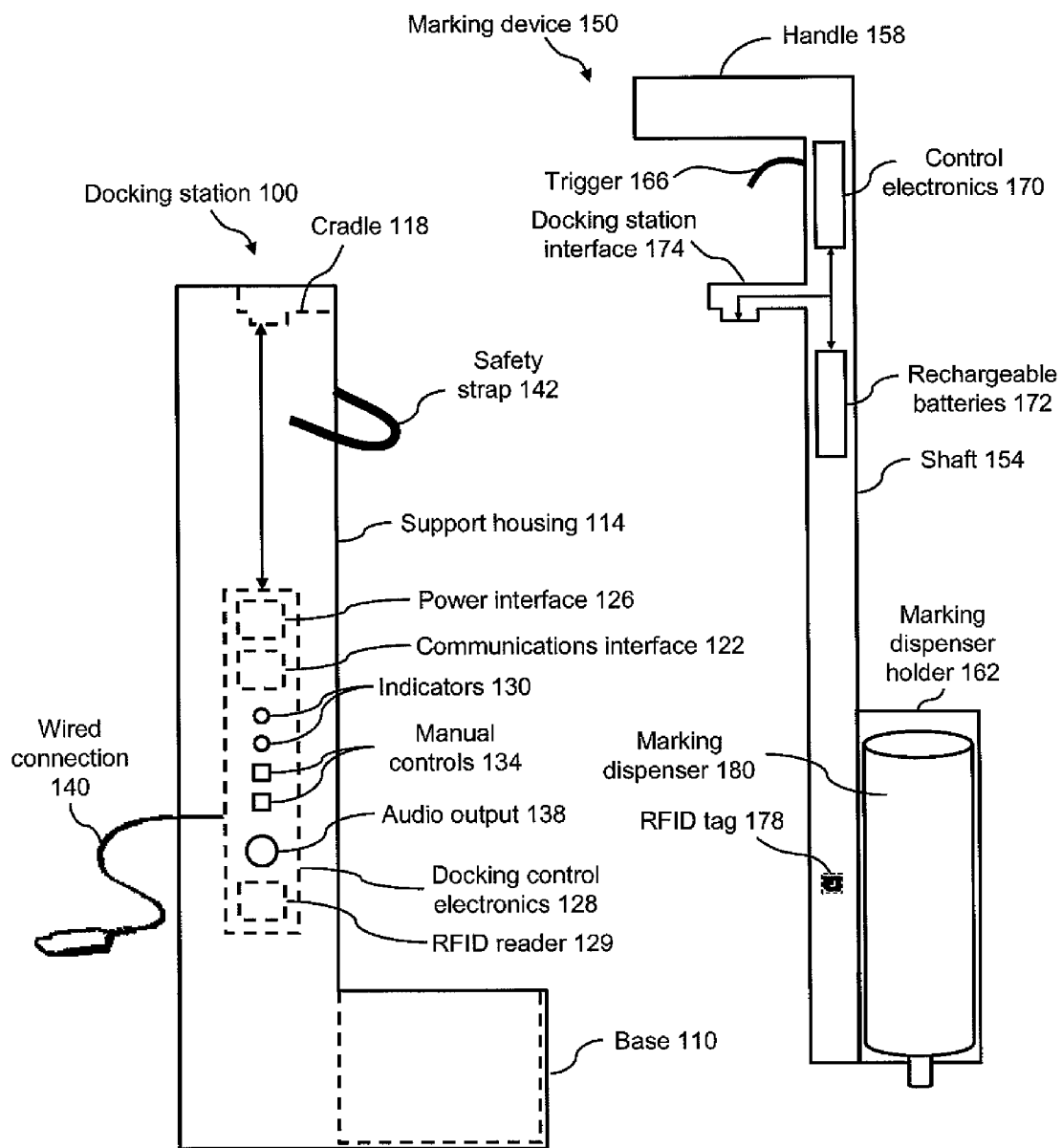


FIG. 1

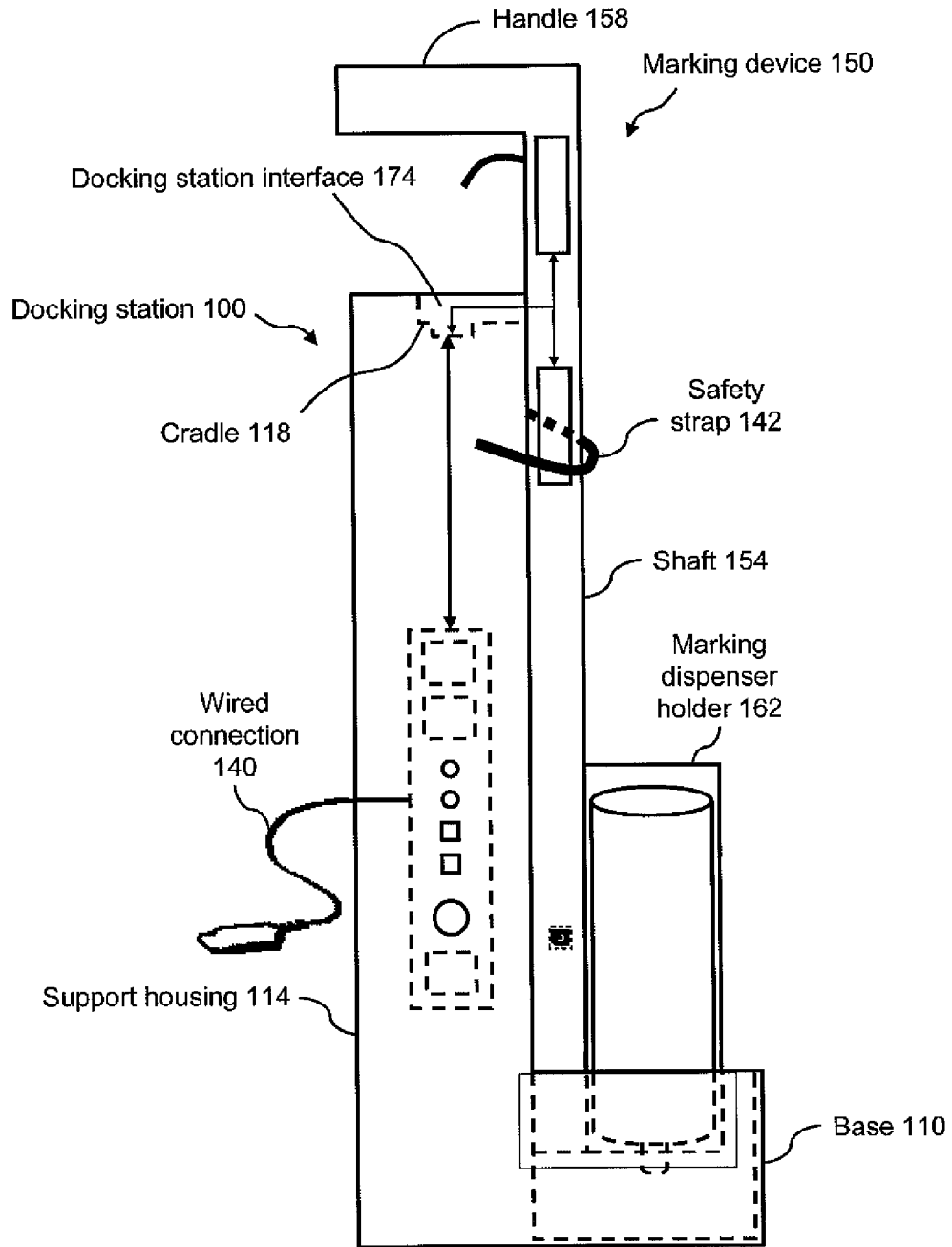


FIG. 2

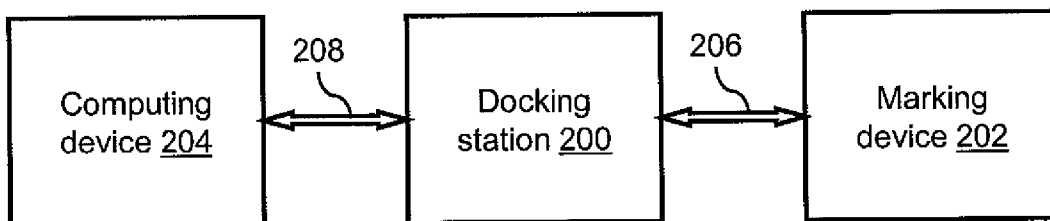


FIG. 3A

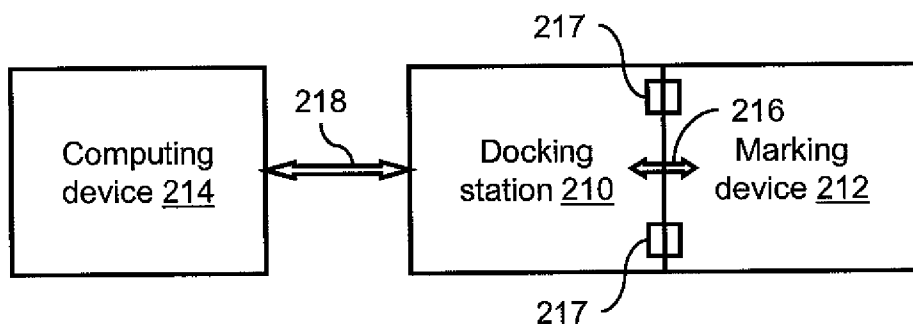


FIG. 3B

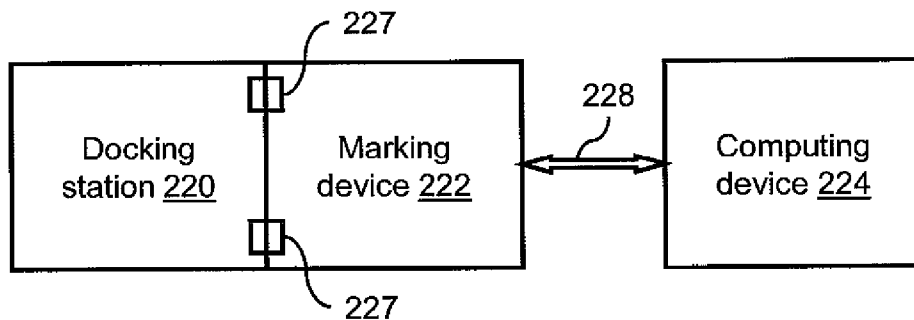


FIG. 3C

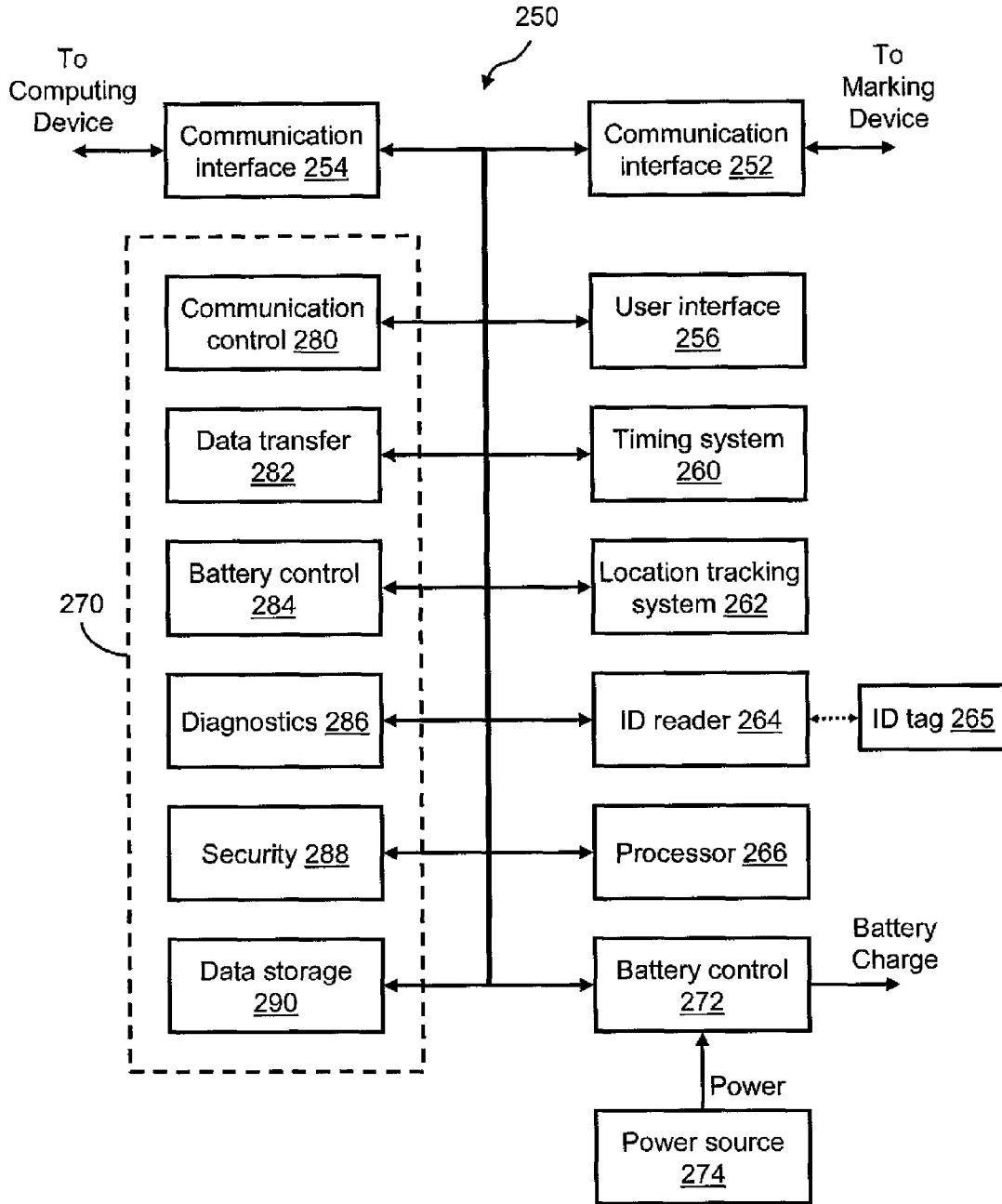


FIG. 4

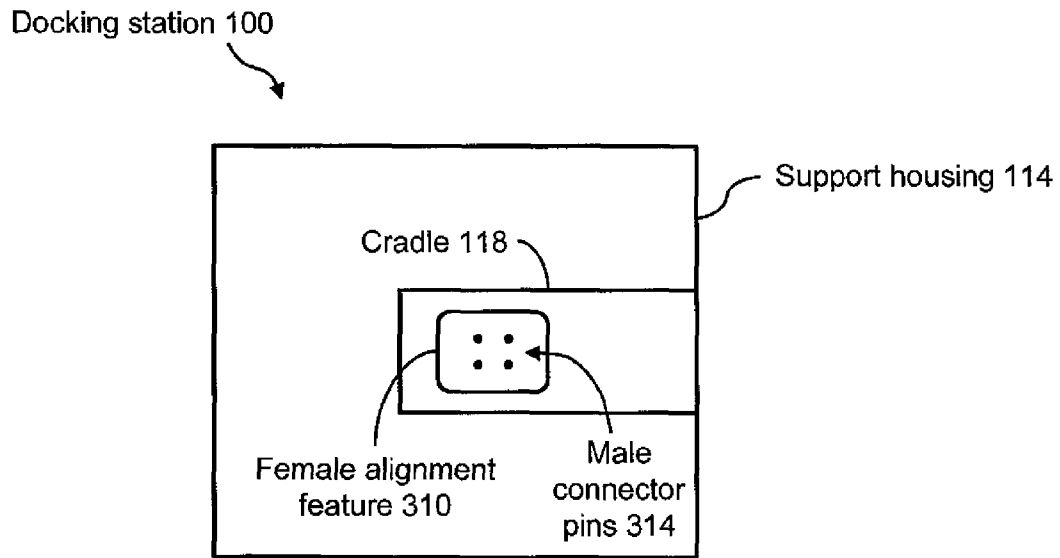


FIG. 5A

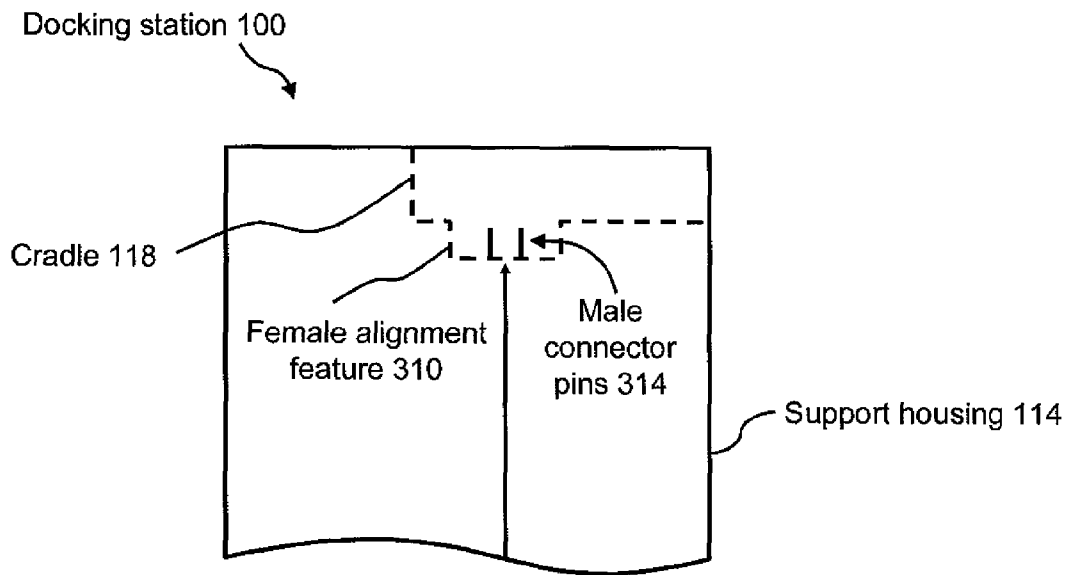


FIG. 5B

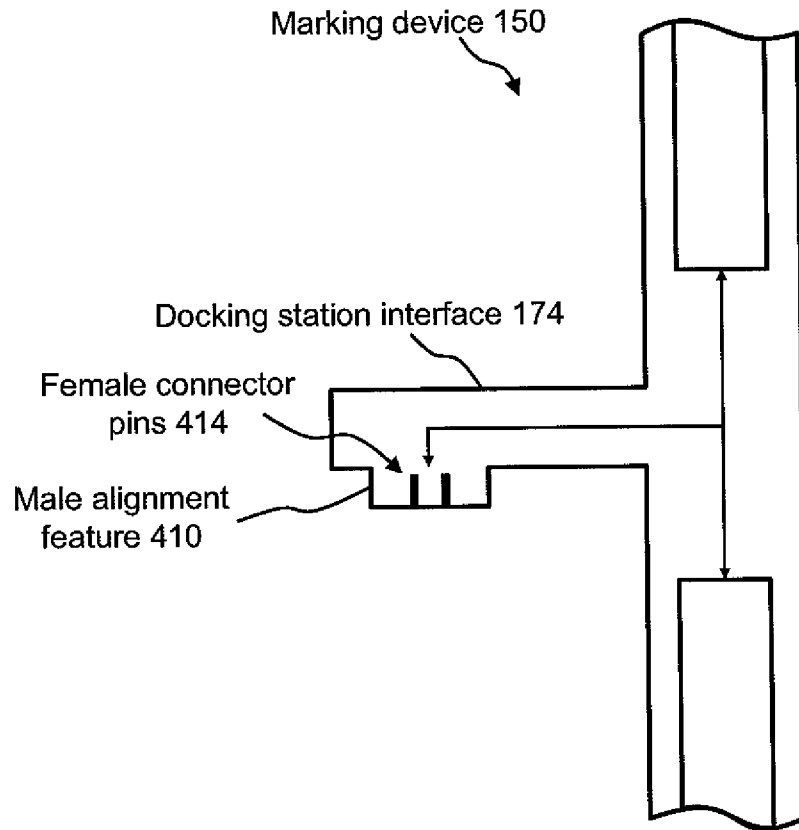


FIG. 6A

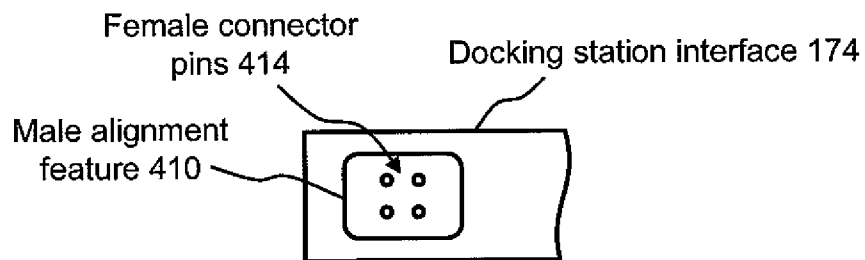


FIG. 6B

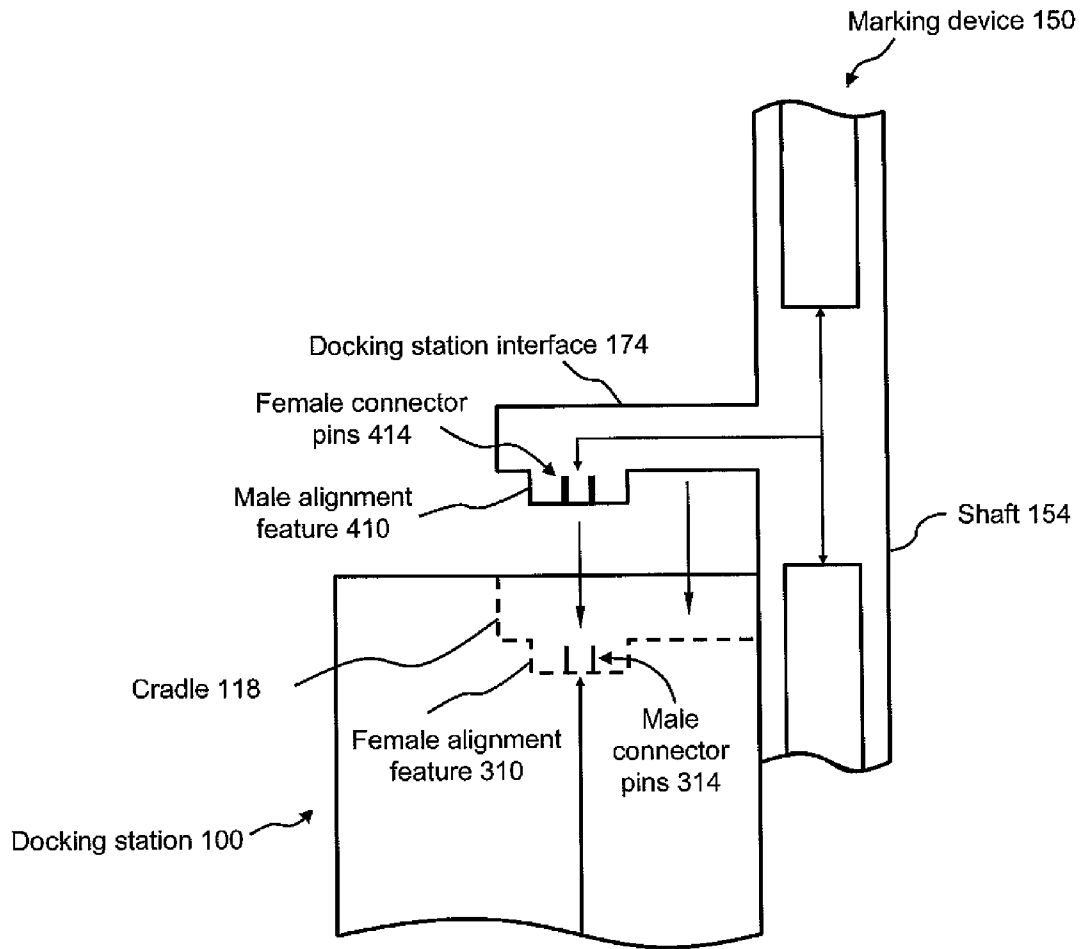


FIG. 7

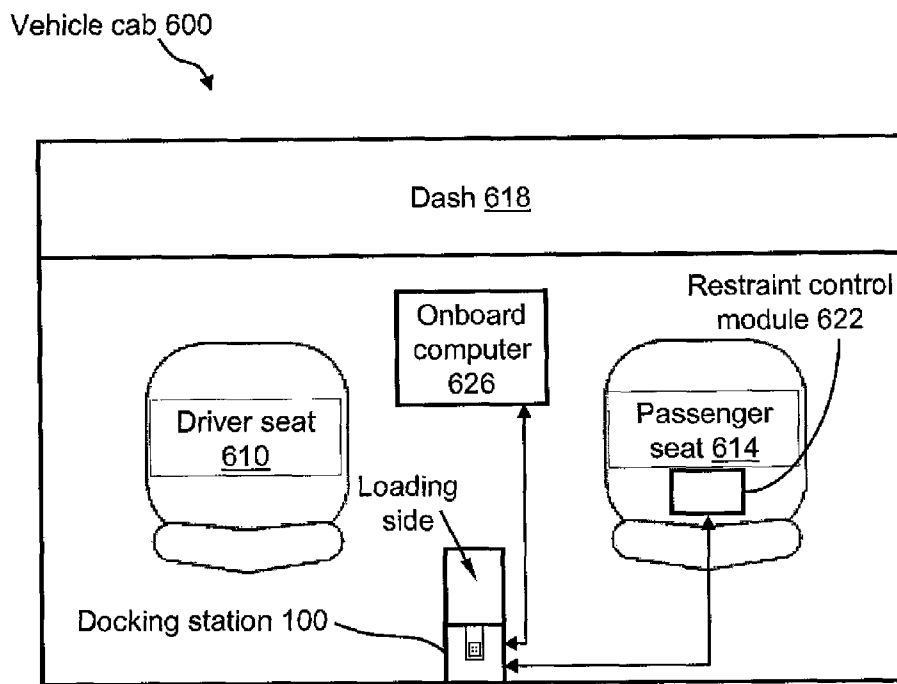


FIG. 8A

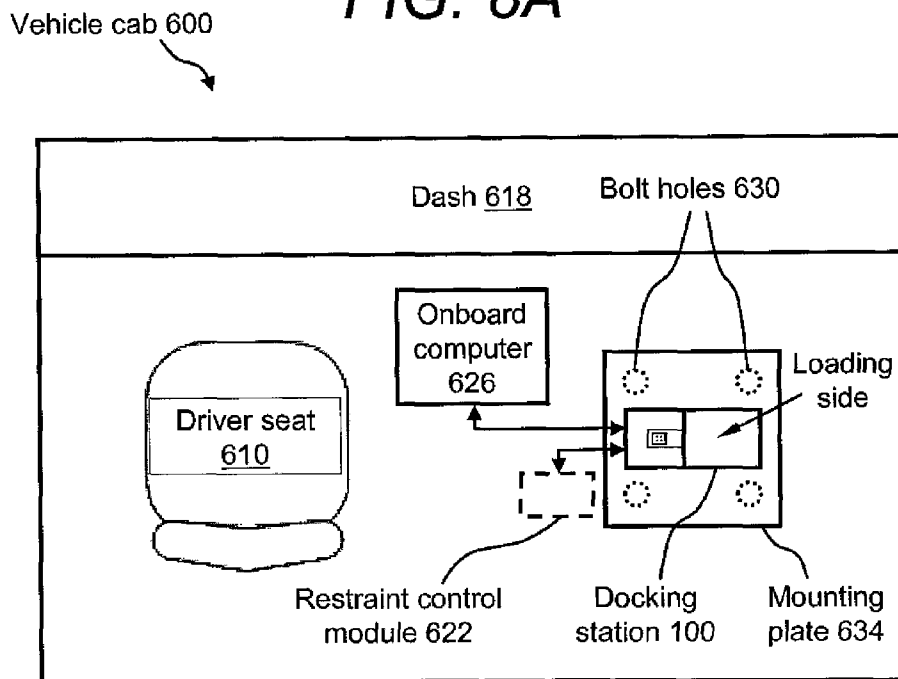


FIG. 8B

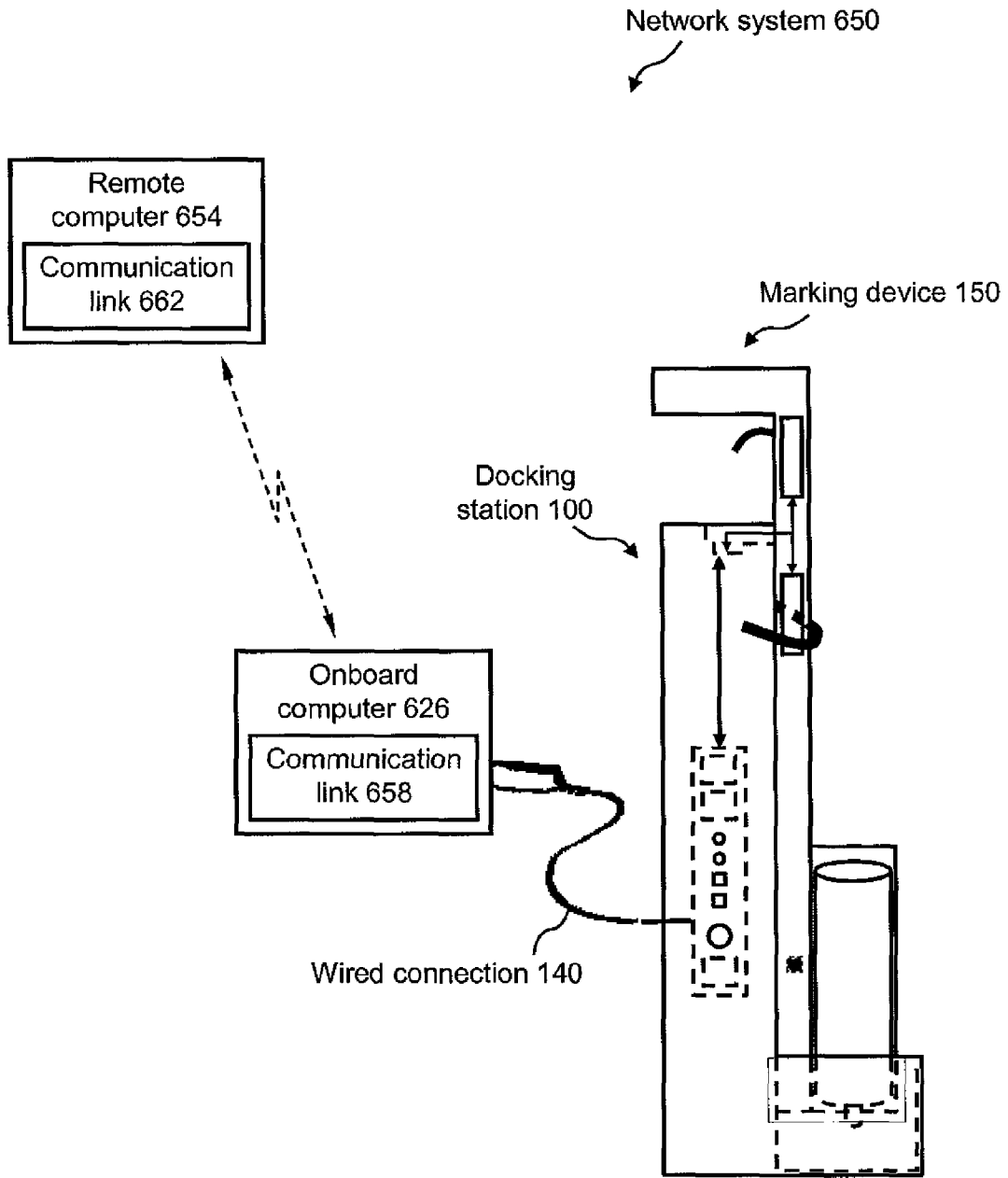


FIG. 8C

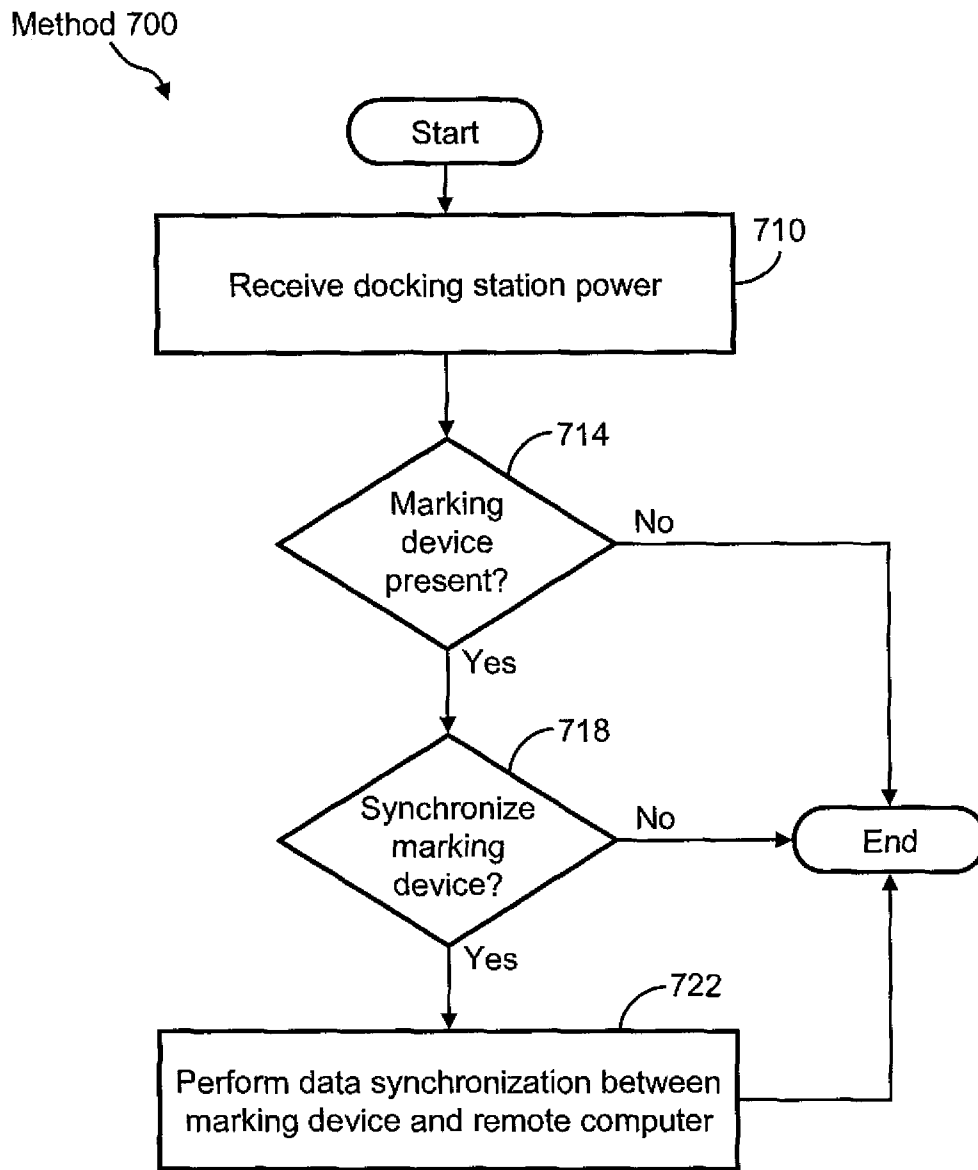


FIG. 9

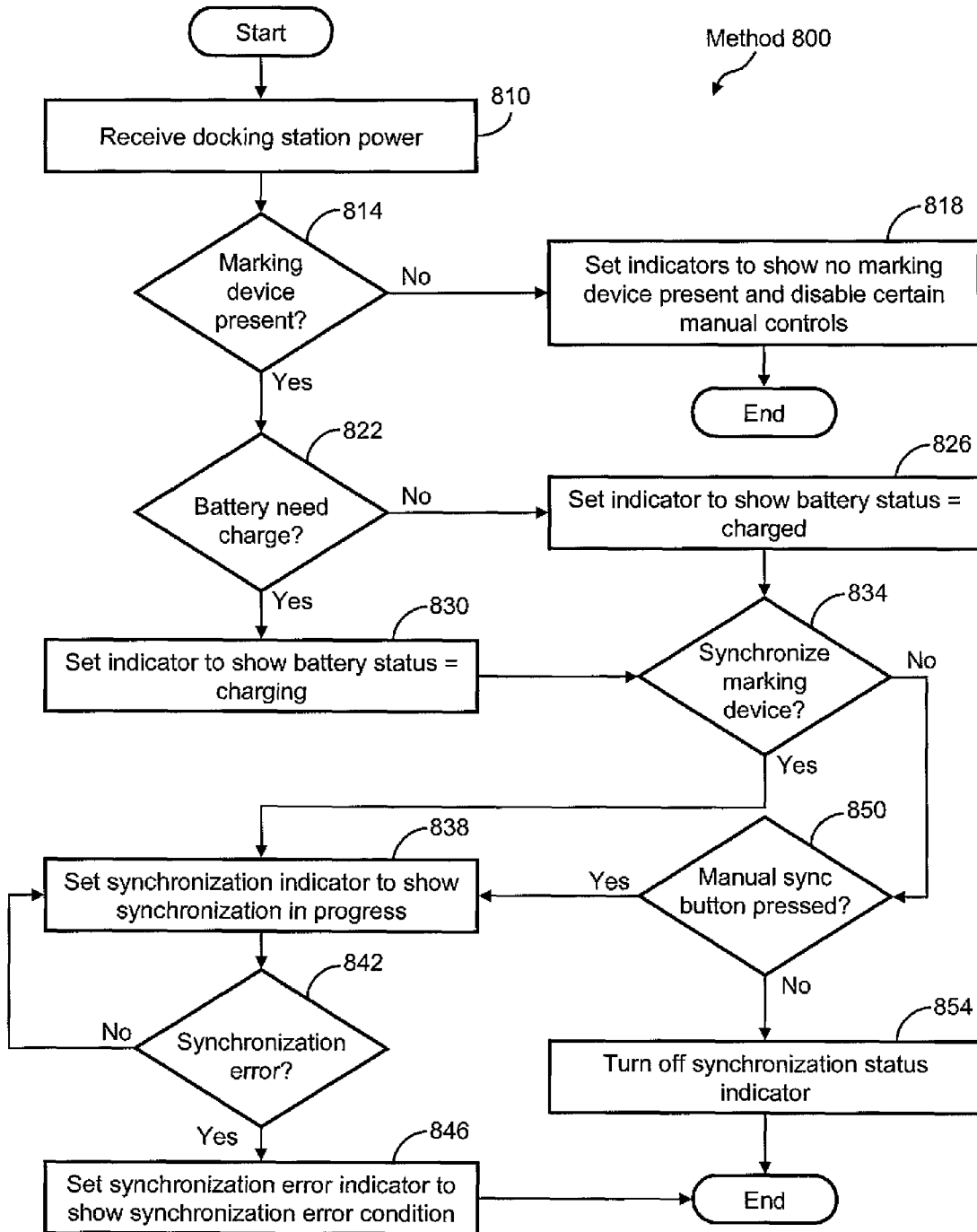


FIG. 10

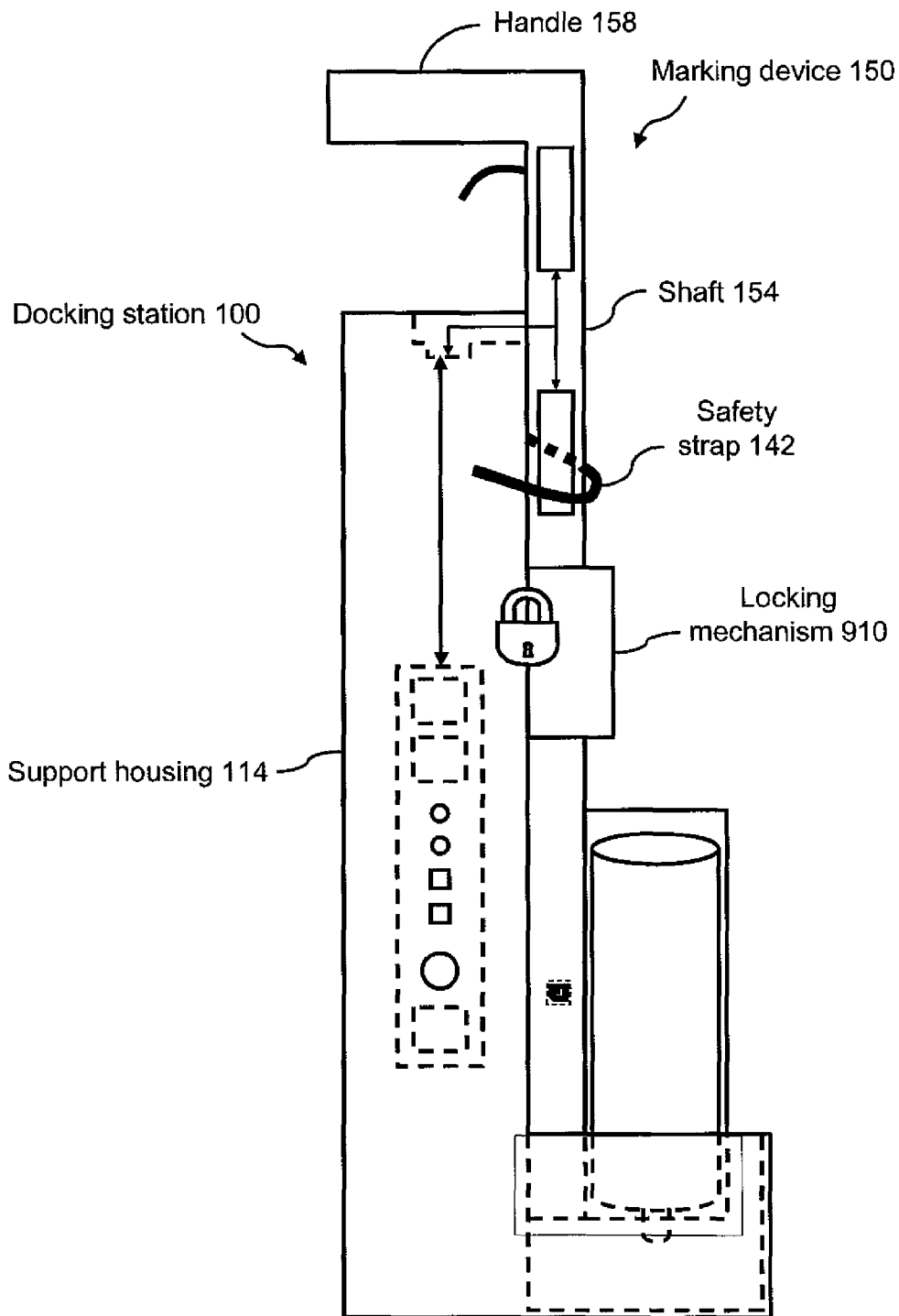


FIG. 11

Method 1000

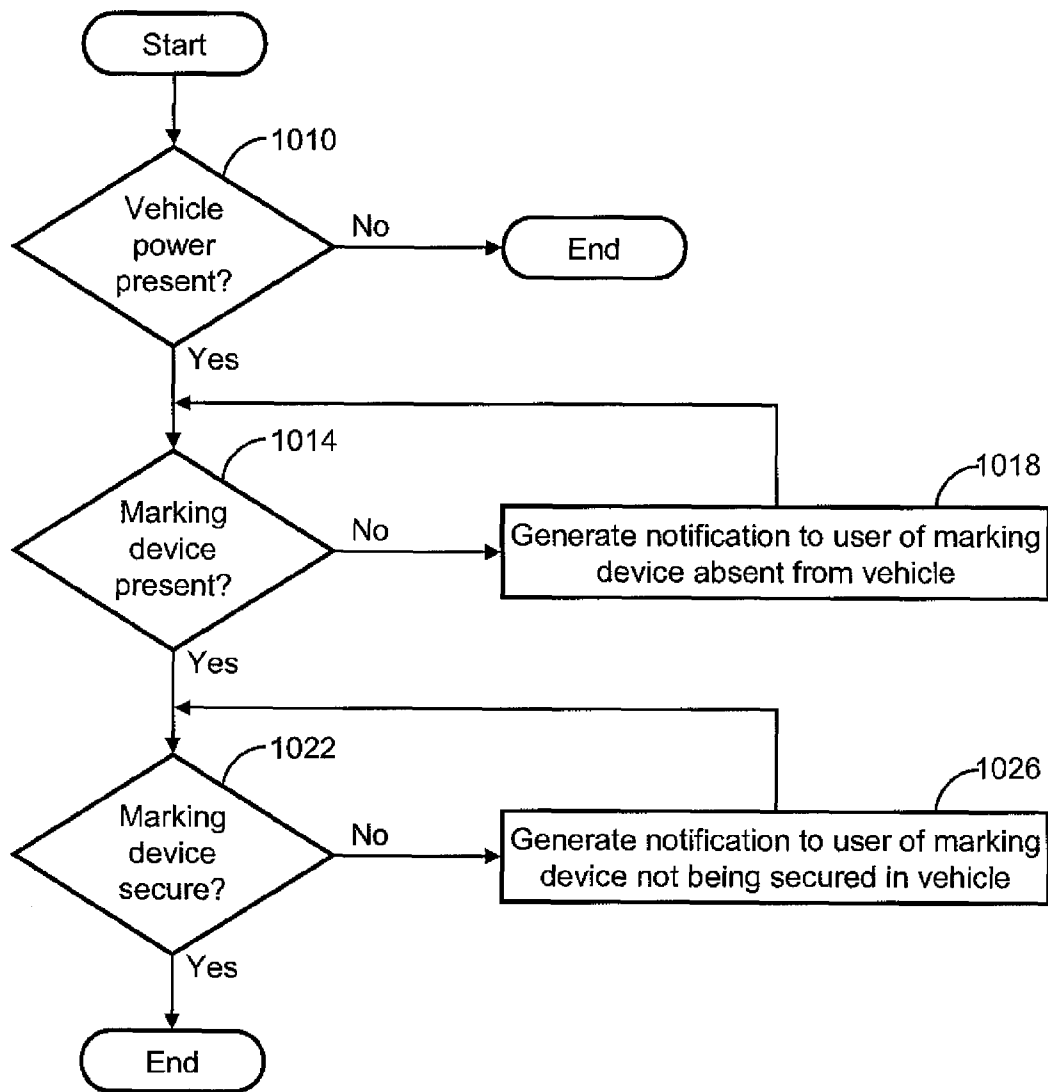


FIG. 12

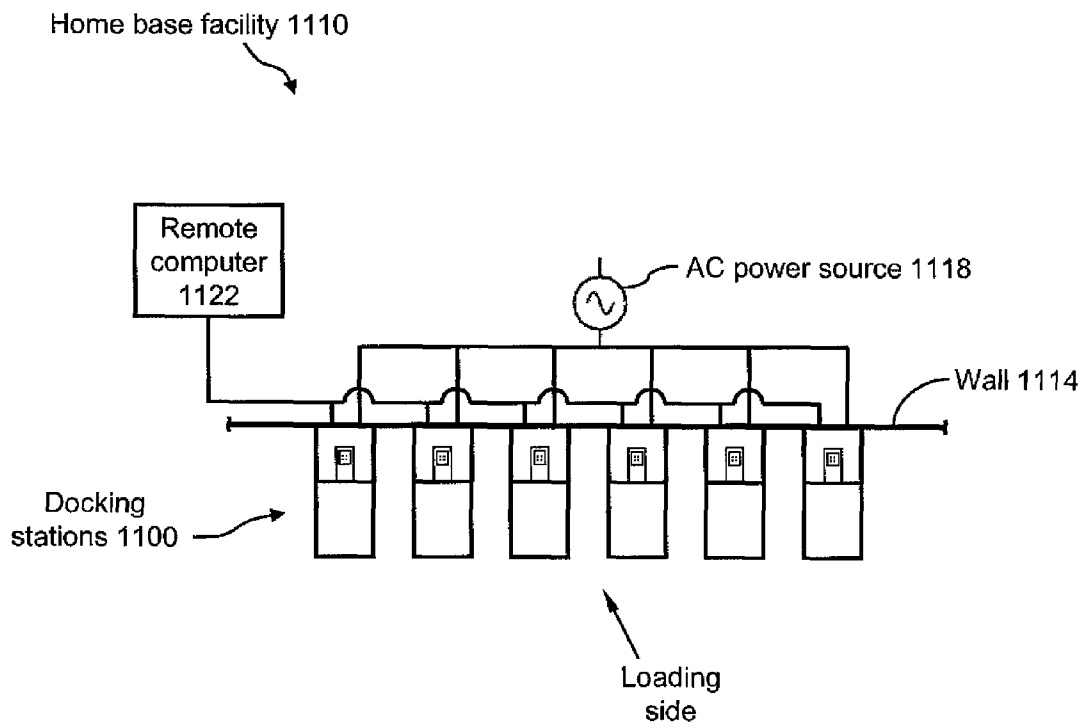


FIG. 13

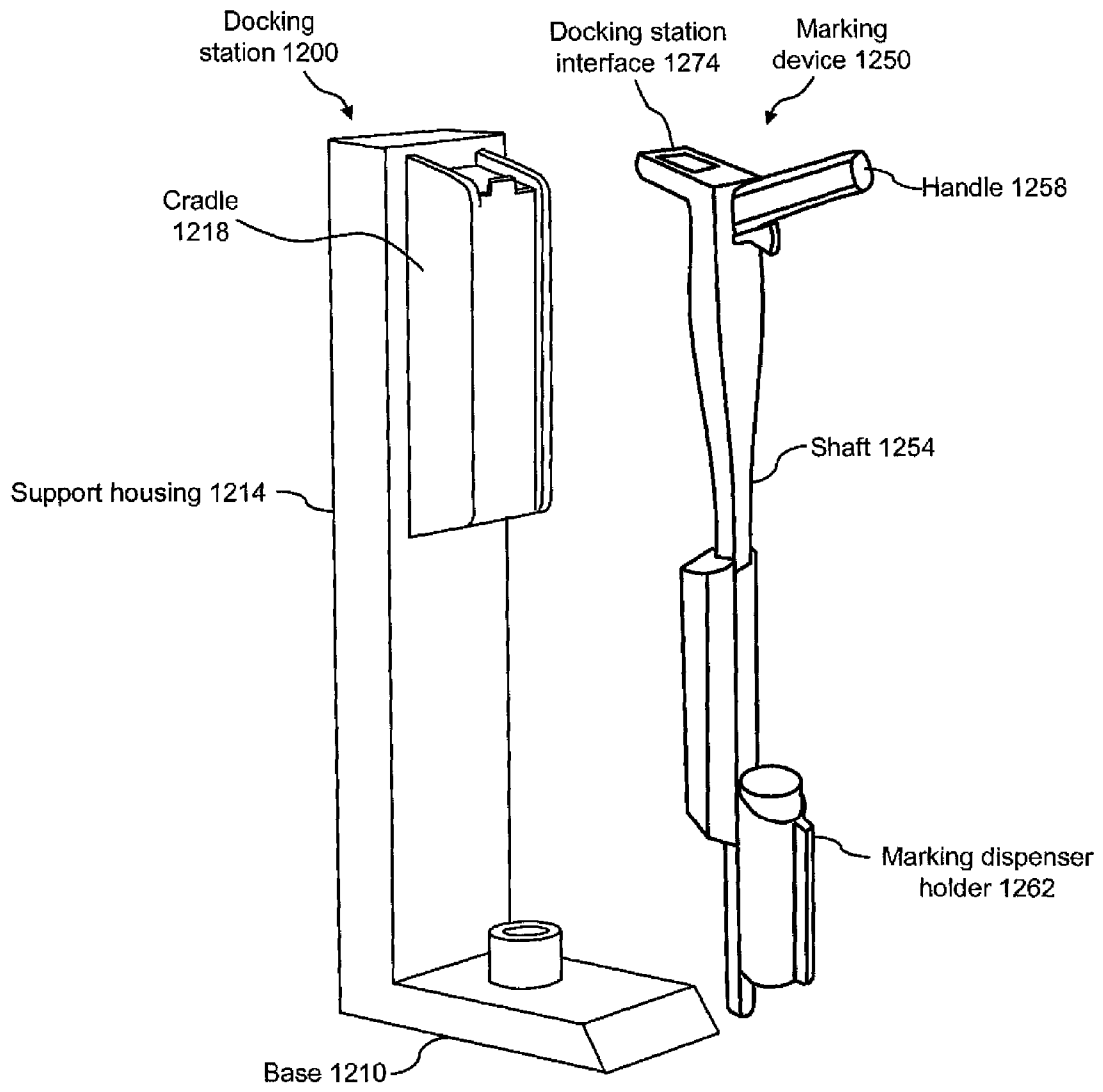


FIG. 14

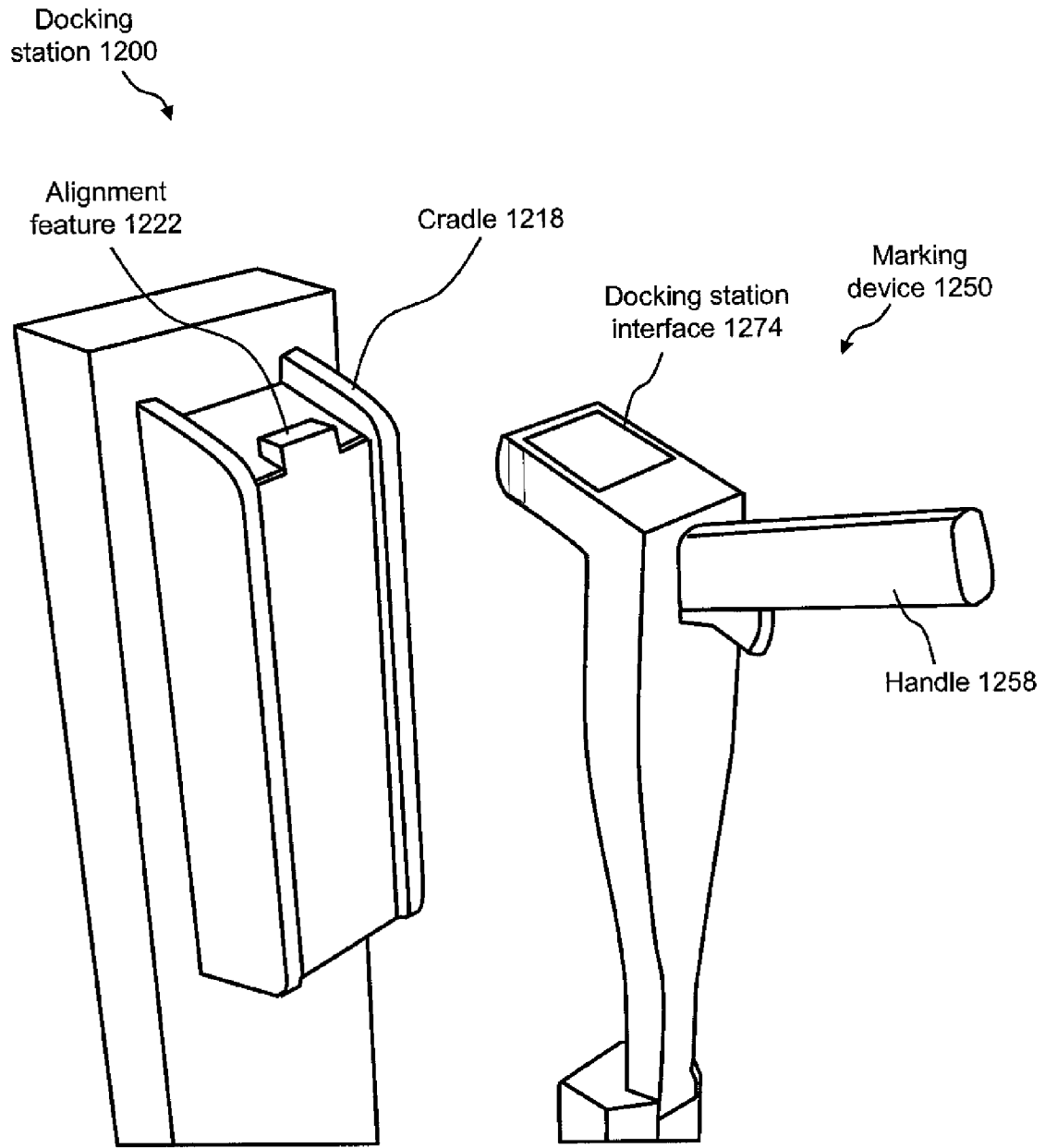


FIG. 15

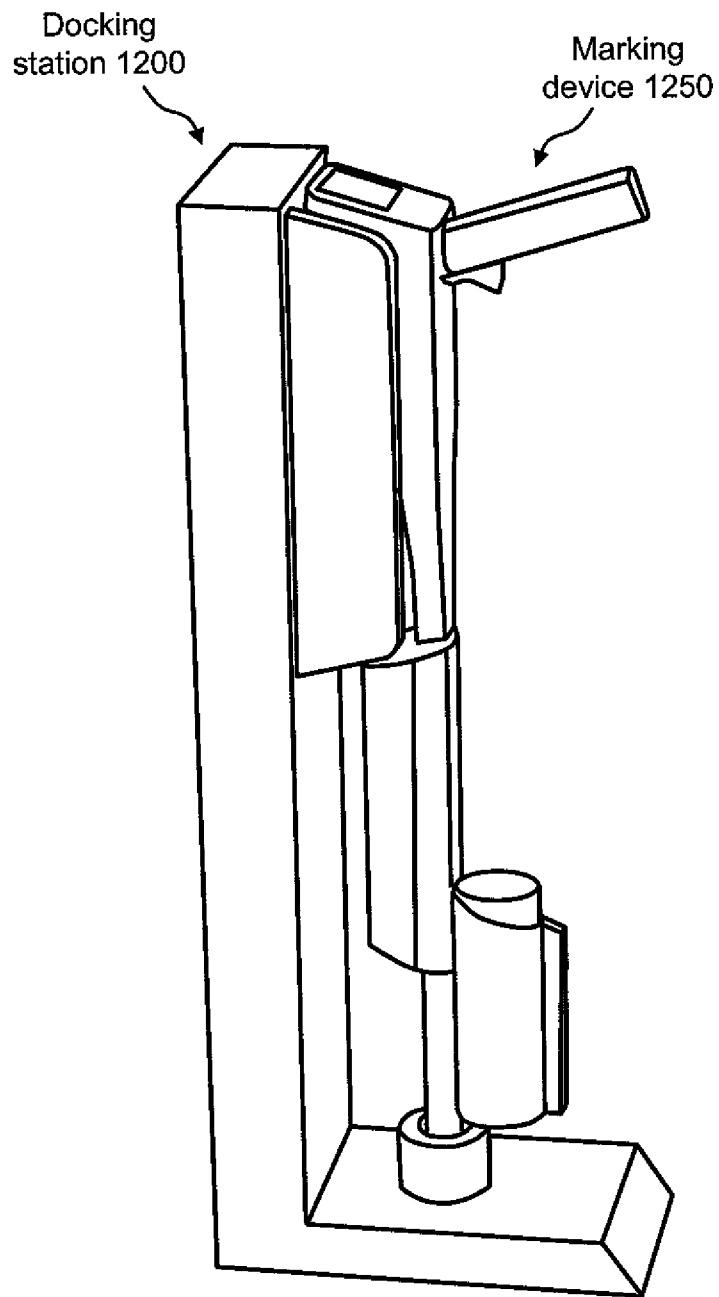


FIG. 16

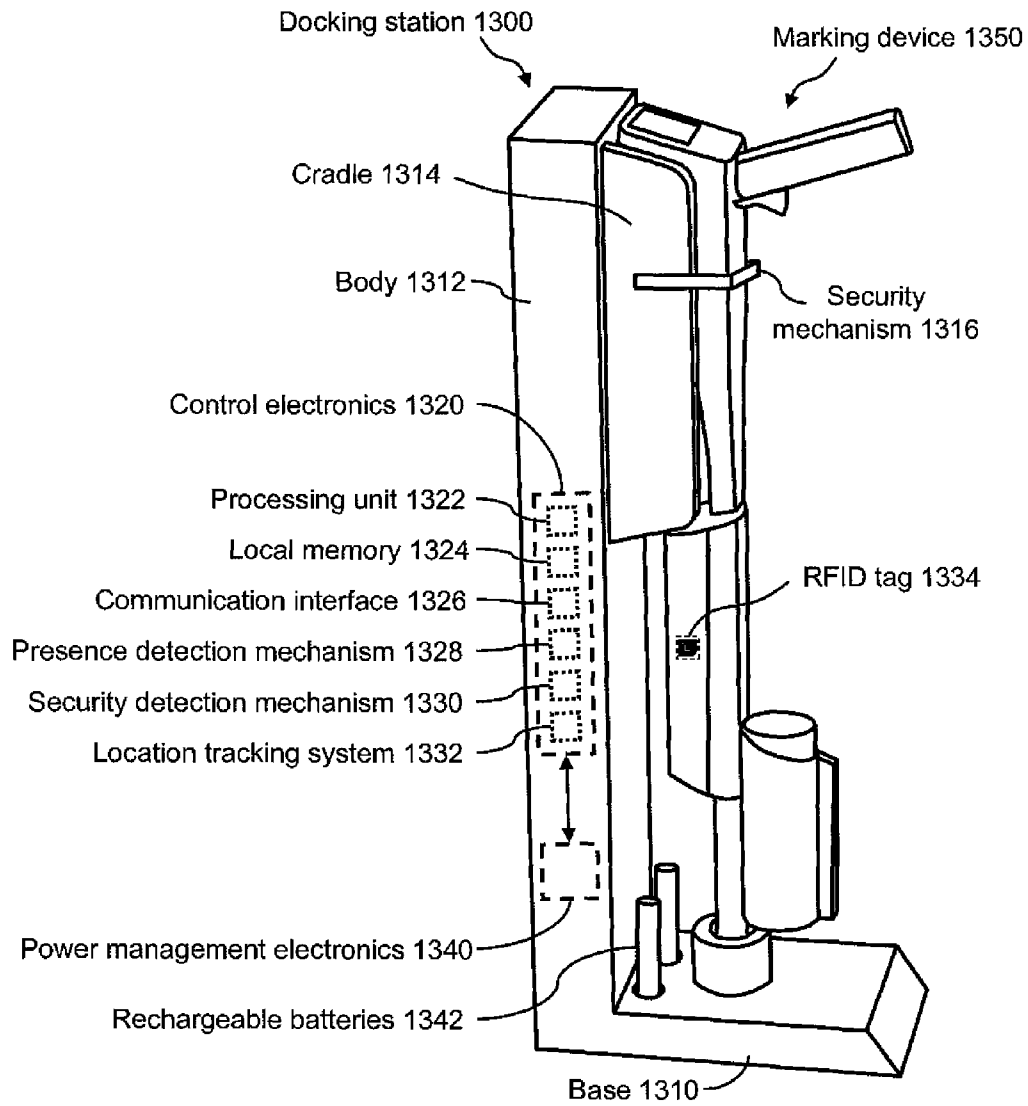


FIG. 17

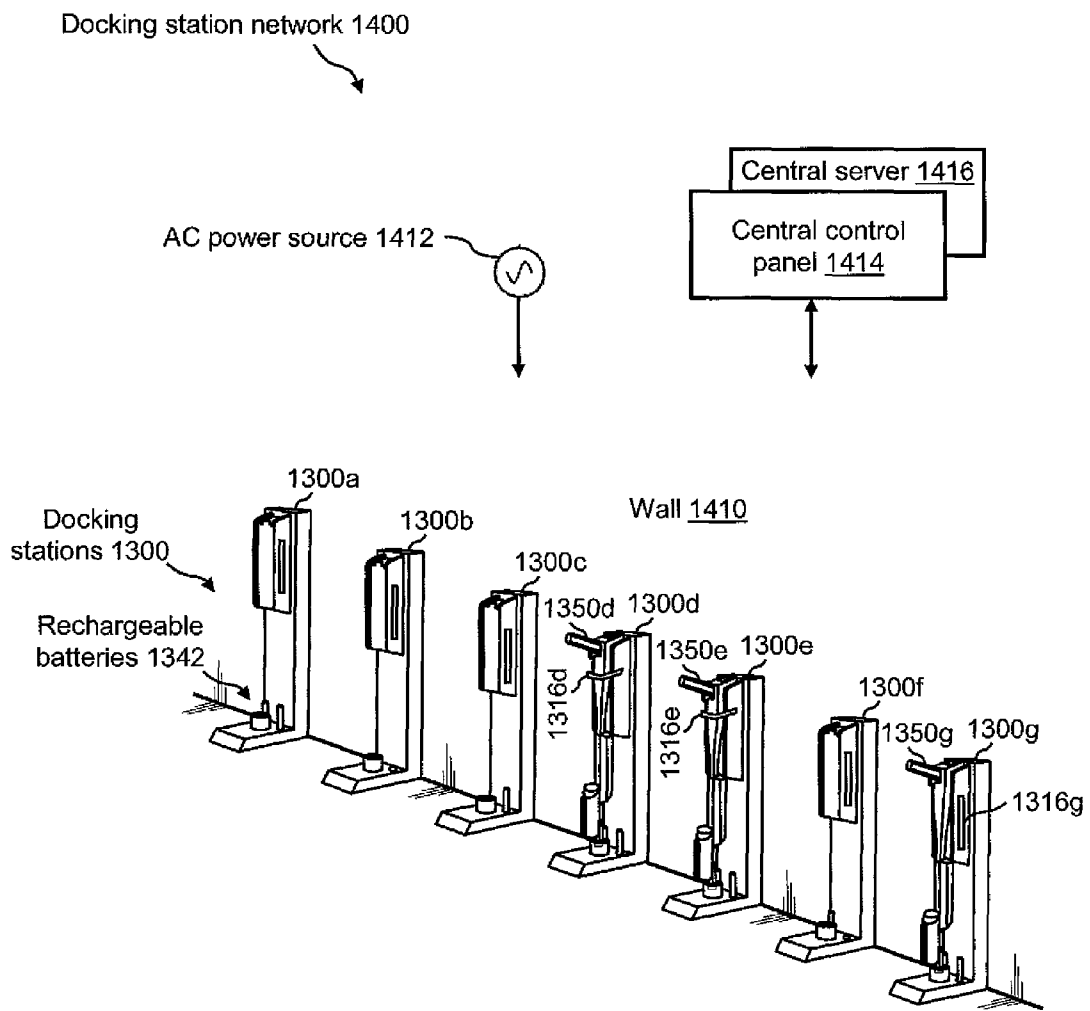


FIG. 18

Docking station network 1500

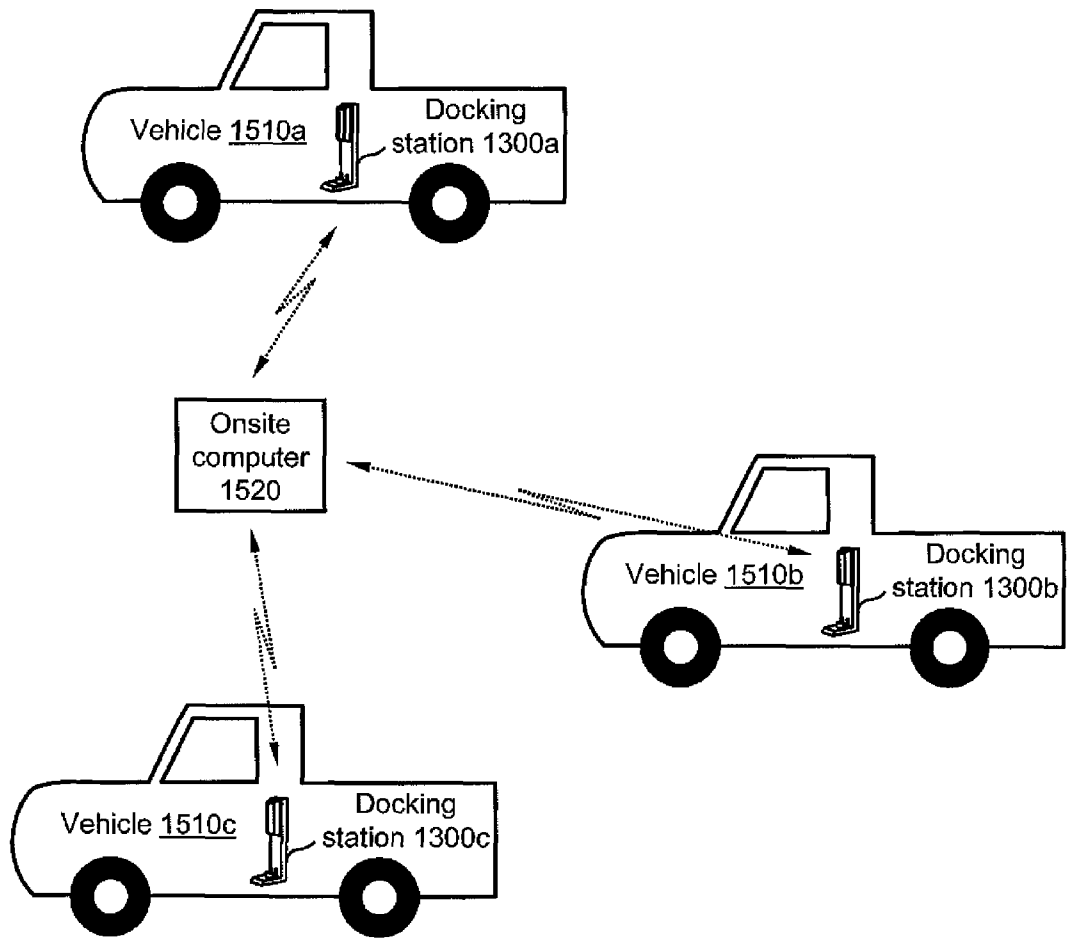


FIG. 19

Docking station network 1600

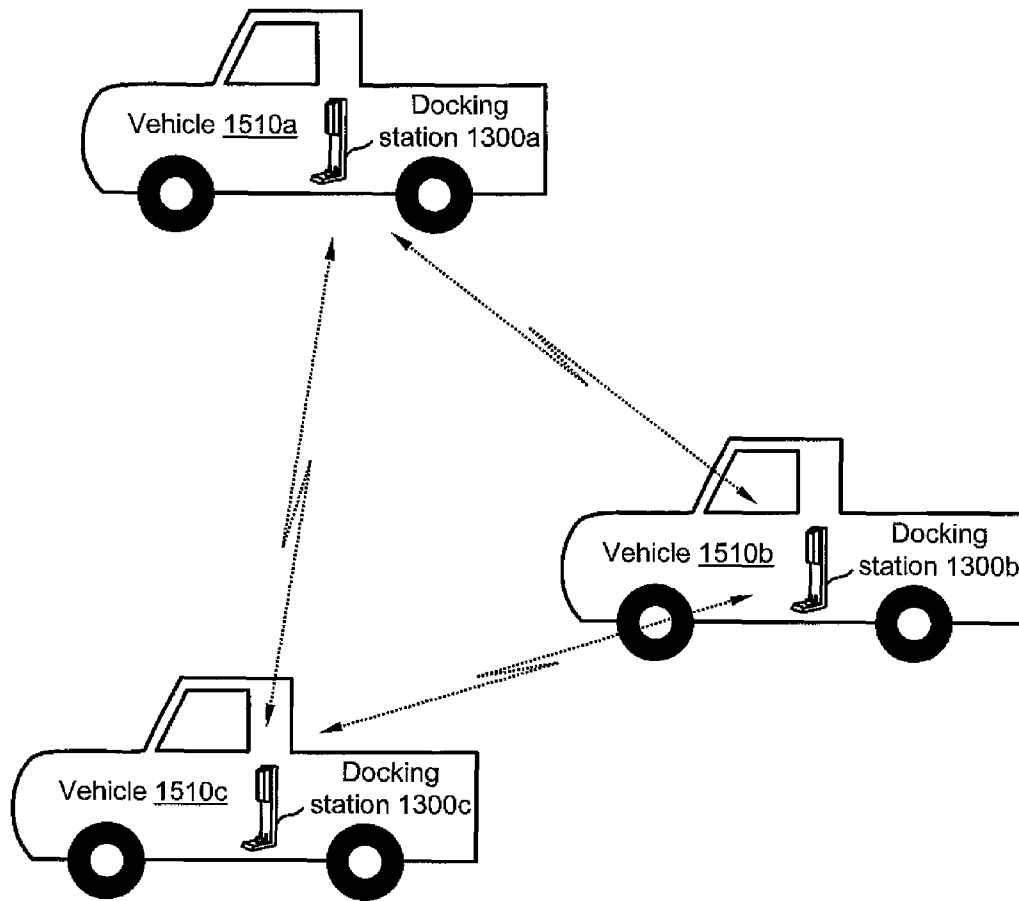


FIG. 20

Docking station network 1700

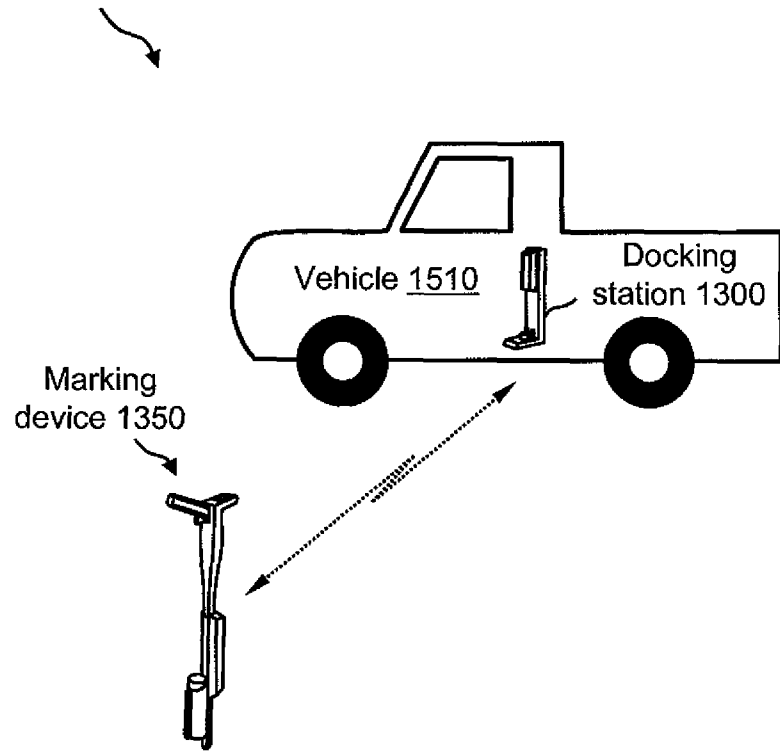


FIG. 21

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MARKING DEVICE DOCKING STATIONS AND METHODS OF USING SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority based on Provisional Application Ser. No. 61/102,115, filed Oct. 2, 2008, which is hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates generally to the field of marking devices and, more particularly, to docking stations for use with marking devices and to methods of using the same.

BACKGROUND

Field technicians, such as land surveyors and utility location experts, often utilize marking material to identify a specific location on the ground. Conventional marking devices are used for dispensing a marking material, such as marking spray paint.

Existing marking devices are relatively inexpensive. Accordingly, the cost of individual marking devices is generally considered insignificant by the user of the marking device. Consequently, users may not take due care when handling such marking devices. As a result, marking devices are often mishandled, broken, or left behind in the field. As marking devices become more complex and incorporate additional functions, the devices become more costly. Therefore, approaches are needed in the marking industry to provide better ways of handling and keeping track of marking devices in the field. Similarly, as increased functionality is incorporated into marking devices, it is desirable to provide methods of managing data and power requirements of the marking devices in the field.

Further, users may carelessly stow marking devices in their vehicles. For example, users often toss marking devices into vehicles and leave them unsecured. In the event of a vehicle accident, the marking device may be thrown about the vehicle cab and cause injury to the passengers. Consequently, it is desirable to provide better methods of securing marking devices in vehicles.

Accordingly, approaches are needed for better ways of handling and tracking marking devices, securing marking devices in vehicles, and managing data and power requirements of marking devices.

SUMMARY OF THE INVENTION

The present invention relates generally to the field of marking devices used for marking the presence or absence of an underground facility in a dig area. More particularly, the invention relates to docking stations for use with such marking devices and to methods for using the docking station with a marking device. The docking station may serve as a home base for storage of a marking device, for charging the battery of a marking device, for facilitating data transfer to and from a marking device, and for securing a marking device against unauthorized use and/or theft. In some embodiments, the docking station may be a mobile docking station that is installed in a vehicle. In other embodiments, the docking station may be a fixed docking station that is installed in a central location in the field, at a central office, at a home base facility, and the like.

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According to a first aspect of the invention, a docking station is provided for docking a marking device of the type used to mark the presence or absence of an underground facility in a dig area. The docking station comprises a housing, an electronic interface to transfer information to and from the marking device, and docking control electronics to control operation of the docking station.

According to a second aspect of the invention, a method is provided for handling a marking device of the type used to mark the presence or absence of an underground facility in a dig area. The method comprises electronically coupling a marking device to a docking station and transferring information to and between the marking device and the docking station.

According to a third aspect of the invention, a system is provided for use with marking devices of the type used to mark the presence or absence of an underground facility in a dig area. The system comprises at least one docking station configured to communicate electronically with a marking device; and a computing device configured to communicate electronically with the docking station and configured to receive and record marking device data via the docking station and to transmit information to the docking station.

According to a fourth aspect of the invention, a system is provided for operation of marking devices of the type used to mark the presence or absence of an underground facility in a dig area. The system comprises a first docking station configured to communicate electronically with a first marking device; and a second docking station configured to communicate electronically with a second marking device, the first and second docking stations being configured to communicate directly with each other.

According to a fifth aspect of the invention, a system is provided for operation of a marking device of the type used to mark the presence or absence of an underground facility in a dig area. The system comprises at least one docking station configured to communicate electronically with a marking device; and a marking device configured to mark the presence or absence of an underground facility in a dig area and to communicate electronically with the docking station.

According to a sixth aspect of the invention, a system is provided for operation of marking devices of the type used to mark the presence or absence of an underground facility in a dig area. The system comprises a plurality of docking stations mounted in fixed locations for storage of respective marking devices; and a computing device configured to communicate electronically with the docking stations and to monitor and control the operational status of marking devices docked in the docking stations.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objectives and advantages, may be best understood by reference to the following description, taken in connection with the accompanying drawings as set forth below:

FIG. 1 is a schematic design of a docking station and a marking device, with the marking device removed from the docking station, according to embodiments of the invention; docking station;

FIG. 2 is a schematic diagram of a marking device attached to a FIG. 3A is a simplified block diagram of a system that includes an electronic docking station coupled to a marking device, in accordance with embodiments of the invention;

FIG. 3B is a simplified block diagram of a system that includes an electronic and mechanical docking station coupled to a marking device, in accordance with embodiments of the invention;

FIG. 3C is a simplified block diagram of a system that includes a mechanical docking station coupled to a marking device, in accordance with embodiments of the invention;

FIG. 4 is a schematic block diagram of docking station electronics, in accordance with embodiments of the invention;

FIG. 5A is a top view of a portion of a docking station;

FIG. 5B is a side view of a portion of a docking station;

FIG. 6A is a side view of a portion of a marking device that may be attached to a docking station;

FIG. 6B is a bottom view of a portion of a marking device that may be attached to a docking station; docking station;

FIG. 7 is a side view of a marking device being attached to a FIG. 8A is a top view of an exemplary vehicle configuration incorporating a docking station;

FIG. 8B is a top view of another exemplary vehicle configuration incorporating a docking station;

FIG. 8C is a schematic block diagram of a network system incorporating a docking station;

FIG. 9 is a flow diagram of a method of using a docking station; station;

FIG. 10 is a flow diagram of another method of using a docking

FIG. 11 is a schematic diagram of a marking device attached to a docking station, according to another embodiment of the invention; docking station;

FIG. 12 is a flow diagram of an additional method of using a FIG. 13 is a schematic diagram of an exemplary configuration incorporating docking stations;

FIG. 14 is a perspective view of an embodiment of a docking station and a marking device, with the marking device removed from the docking station;

FIG. 15 is an enlarged perspective view of a portion of the docking station and marking device of FIG. 14;

FIG. 16 is a perspective view of the docking station with the marking device docked therein;

FIG. 17 is a perspective view of a marking device docking station that has processing and communications capability, in accordance with embodiments of the invention;

FIG. 18 is a schematic diagram of multiple fixed marking device docking stations in communication with a central computing device, which is one example of a docking station network, in accordance with embodiments of the invention;

FIG. 19 is a schematic diagram of multiple mobile marking device docking stations in the field and in communication with an onsite computing device, which is another example of a docking station network, in accordance with embodiments of the invention;

FIG. 20 is a schematic diagram of multiple mobile marking device docking stations in the field and in communication with each other, which is yet another example of a docking station network, in accordance with embodiments of the invention; and

FIG. 21 is a schematic diagram of at least one marking device docking station in communication with at least one marking device, which is still another example of a docking station network, in accordance with embodiments of the invention.

DETAILED DESCRIPTION

The present invention relates to marking devices used for marking the presence or absence of an underground facility in

a dig area and, more particularly, to docking stations for use with such marking devices. The present invention further includes methods for using docking stations with marking devices. By way of example, the docking station may serve as a home base for storage of a marking device and for charging the battery of a marking device. In some embodiments, the docking station may be a mobile docking station that is installed in a vehicle. In other embodiments, the docking station may be a fixed docking station that is installed at a central location in the field, at a central office, at a home base facility, and the like. The docking station may be used in a variety of locations that are convenient and/or accessible for a user, including worksites, and may be fixed or mobile depending on the configuration.

For purposes of the present disclosure, the term “dig area” refers to a specified area of a work site within in which there is a plan to disturb the ground (e.g., excavate, dig holes and/or trenches, bore, etc.), and beyond which there is no plan to excavate in the immediate surroundings. Thus, the metes and bounds of a dig area are intended to provide specificity as to where some disturbance to the ground is planned at a given work site. It should be appreciated that a given work site may include multiple dig areas.

The term “facility” refers to one or more lines, cables, fibers, conduits, transmitters, receivers, or other physical objects or structures capable of or used for carrying, transmitting, receiving, storing, and providing utilities, energy, data, substances, and/or services, and/or any combination thereof. The term “underground facility” means any facility beneath the surface of the ground. Examples of facilities include, but are not limited to, oil, gas, water, sewer, power, telephone, data transmission, cable television (TV), and/or internet services.

The term “locate device” refers to any apparatus and/or device for detecting and/or inferring the presence or absence of any facility, including without limitation, any underground facility. In various examples, a locate device may include both a locate transmitter and a locate receiver (which in some instances may also be referred to collectively as a “locate instrument set,” or simply “locate set”).

The term “marking device” refers to any apparatus, mechanism, or other device that employs a marking dispenser for causing a marking material and/or marking object to be dispensed, or any apparatus, mechanism, or other device for electronically indicating (e.g., logging in memory) a location, such as a location of an underground facility. Additionally, the term “marking dispenser” refers to any apparatus, mechanism, or other device for dispensing and/or otherwise using, separately or in combination, a marking material and/or a marking object. An example of a marking dispenser may include, but is not limited to, a pressurized can of marking paint. The term “marking material” means any material, substance, compound, and/or element, used or which may be used separately or in combination to mark, signify, and/or indicate. Examples of marking materials may include, but are not limited to, paint, chalk, dye, and/or iron. The term “marking object” means any object and/or objects used or which may be used separately or in combination to mark, signify, and/or indicate. Examples of marking objects may include, but are not limited to, a flag, a dart, and arrow, and/or an RFID marking ball. It is contemplated that marking material may include marking objects. It is further contemplated that the terms “marking materials” or “marking objects” may be used interchangeably in accordance with the present disclosure.

The term “locate mark” means any mark, sign, and/or object employed to indicate the presence or absence of any underground facility. Examples of locate marks may include,

but are not limited to, marks made with marking materials, marking objects, global positioning or other information, and/or any other means. Locate marks may be represented in any form including, without limitation, physical, visible, electronic, and/or any combination thereof.

The terms “actuate” or “trigger” (verb form) are used interchangeably to refer to starting or causing any device, program, system, and/or any combination thereof to work, operate, and/or function in response to some type of signal or stimulus. Examples of actuation signals or stimuli may include, but are not limited to, any local or remote, physical, audible, inaudible, visual, non-visual, electronic, mechanical, electromechanical, biomechanical, biosensing or other signal, instruction, or event. The terms “actuator” or “trigger” (noun form) are used interchangeably to refer to any method or device used to generate one or more signals or stimuli to cause or causing actuation. Examples of an actuator/trigger may include, but are not limited to, any form or combination of a lever, switch, program, processor, screen, microphone for capturing audible commands, and/or other device or method. An actuator/trigger may also include, but is not limited to, a device, software, or program that responds to any movement and/or condition of a user, such as, but not limited to, eye movement, brain activity, heart rate, other data, and/or the like, and generates one or more signals or stimuli in response thereto. In the case of a marking device or other marking mechanism (e.g., to physically or electronically mark a facility or other feature), actuation may cause marking material to be dispensed, as well as various data relating to the marking operation (e.g., geographic location, time stamps, characteristics of material dispensed, etc.) to be logged in an electronic file stored in memory. In the case of a locate device or other locate mechanism (e.g., to physically locate a facility or other feature), actuation may cause a detected signal strength, signal frequency, depth, or other information relating to the locate operation to be logged in an electronic file stored in memory.

The terms “locate and marking operation,” “locate operation,” and “locate” generally are used interchangeably and refer to any activity to detect, infer, and/or mark the presence or absence of an underground facility. In some contexts, the term “locate operation” is used to more specifically refer to detection of one or more underground facilities, and the term “marking operation” is used to more specifically refer to using a marking material and/or one or more marking objects to mark a presence or an absence of one or more underground facilities. The term “locate technician” refers to an individual performing a locate operation. A locate and marking operation often is specified in connection with a dig area, at least a portion of which may be excavated or otherwise disturbed during excavation activities.

The term “user” refers to an individual utilizing a locate device and/or a marking device and may include, but is not limited to, land surveyors, locate technicians, and support personnel.

The term “power source” refers to an apparatus, a device, a system, and/or any other means, and/or any combination thereof that generates, transmits, converts, and/or supplies power or energy, including, but not limited to, electrical power.

Reference is now made to the following description of embodiments of the present invention, which are illustrated in the accompanying figures. The same reference numbers in different drawings may identify the same or similar elements. In addition, the following detailed description does not limit the present invention.

A docking station **100** and a marking device **150**, removed from docking station **100**, are shown in the schematic diagram of FIG. **1**. Docking station **100** may be installed in, for example, a vehicle and is suitable for use in conjunction with marking device **150**. In other embodiments, the docking station **100** may be installed at a central facility, office or other fixed location. Thus, the docking station **100** may be mobile or fixed. Docking station **100** may serve as a home base for storage of marking device **150** and for charging the battery of marking device **150**.

Docking station **100** may include a base **110** and a support housing **114**. Base **110** and support housing **114** may be made of any suitably strong, rigid, and lightweight material. Such material may include, but is not limited to, molded plastic and metal. Docking station **100** may be designed and constructed to be bolted to the body of a vehicle and may be made of materials that prevent unauthorized removal from a vehicle. In the embodiment of FIG. **1**, docking station **100** is configured and mounted to support marking device **150** in an upright, or vertical, position. In other embodiments, docking station may be configured and mounted to support marking device **150** in a horizontal position or in any other position.

In an embodiment, a cradle **118** is integrated into the upper end of support housing **114**. This provides a mechanism to mechanically and electrically couple marking device **150** to docking station **100**. Other embodiments illustrating a cradle that may be integrated into support housing **114** are described with reference to FIGS. **5A**, **5B**, **6A**, **6B**, and **7**.

Electronic and electro-mechanical components that provide an interface between a marking device, an external computing device, and/or a power source may be installed in support housing **114**. For example, docking control electronics **128**, including a communications interface **122** and a power interface **126**, may be installed in support housing **114**. Communications interface **122** and power interface **126** may be the drive and buffer circuitry for supplying electrical signals and power, respectively, to cradle **118**, which in turn supplies electrical signals and power to marking device **150** when marking device **150** is attached to docking station **100**. In the embodiment of FIG. **1**, communications interface **122** provides a wired connection to control electronics in marking device **150**. In other embodiments, docking station **100** may include a wireless link to control electronics in marking device **150**. Docking station **100** may supply electrical signals and power to any configuration or embodiment of marking device **150**, and marking device **150** may receive electrical signals and power from any configuration or embodiment of docking station **100**.

Docking control electronics **128** may include a processor and other circuitry for managing and driving various user interface devices, such as, but not limited to, indicators **130**, manual controls **134**, and audio output **138**. Docking station **100** may include visible and/or audible means of informing the user of status changes and other conditions requiring attention. Further, docking station **100** may include user controls that allow a user to initiate activities, such as data synchronization (e.g., uploading and downloading data). For example, indicators **130** may include one or more light-emitting diode (LED) devices of specified colors and indicate a meaning to the user (e.g., red, green, and yellow battery status indicators; yellow and orange data synchronization status indicators, and the like). Manual controls **134** may include one or more manual push buttons for initiating various functions (e.g., an initiate data synchronization push button). Audio output **138** may be, for example, an audio speaker, an audio alarm and/or buzzer. Docking control electronics **128**

may include an audio input (not shown). For example, an audio input, such as a microphone, may be incorporated into the docking station.

Docking control electronics **128** may also include a mechanism for short range identification, such as radio-frequency identification (RFID). For example, docking station **100** may include an RFID reader **129** for reading an RFID tag affixed to marking device **150**. In another embodiment, docking station **100** may include a barcode reader for reading a barcode affixed to marking device **150**.

The processor of docking control electronics **128** may be capable of managing data transfer between marking device **150** and an external computing device. For example, a wired connection **140**, such as a universal serial bus (USB) connection, RS232 connectors, RJ45 connectors, Ethernet, and any combination thereof may be provided between docking control electronics **128** of docking station **100** and an external computing device. Further, the processor of docking control electronics **128** may be programmable to perform any user-defined function, such as, but not limited to, executing a security function programmed to ensure that only authorized personnel may access and use marking device **150** and/or docking station **100**. Additionally, a wired power connection (not shown) may be provided for connecting docking station **100** to the power source of a vehicle in which it is installed. The power source of a vehicle may be used to charge the battery of marking device **150**.

Additionally, a safety strap **142** for securing marking device **150** in docking station **100** may be attached to support housing **114** of docking station **100**. In one embodiment, a device, incorporated in safety strap **142**, is capable of conducting an electrical signal that may be detected by docking control electronics **128** to indicate whether safety strap **142** has been secured around marking device **150**. For example, a small tracer wire may be installed within safety strap **142**, which changes a logic state depending upon whether both ends or one end only is fastened to support housing **114**. As described below, docking station **100** may include additional or different locking and security devices.

Marking device **150** may be any marking device that has, for example, battery powered electronics incorporated therein for any functionality (e.g., global positioning system (GPS) technology, RFID technology, data storage devices, electronic actuator, electronic display, marking material sensing technology, wired and/or wireless communications technology and the like). For example, marking device **150** may be a marking device as described in U.S. publication no. 2008-0228294-A1, published Sep. 18, 2008, filed Mar. 13, 2007, and entitled "Marking System and Method With Location and/or Time Tracking;" U.S. publication no. 2008-0245299-A1, published Oct. 9, 2008, filed Apr. 4, 2007, and entitled "Marking System and Method;" and U.S. publication no. 2009-0204238-A1, published Aug. 13, 2009, filed Feb. 2, 2009, and entitled "Electronically Controlled Marking Apparatus and Methods;" which are incorporated by reference herein in their entirety.

It will be understood that the docking stations described herein can be used with other marking devices, including but not limited to marking devices that have limited electronic capability and marking devices that have no electronic capability. In some embodiments, the docking station may be used for holding, storage and/or locking of the marking device, without electronic functionality. In addition, the docking station may be used for docking of a combination locate and marking device, which includes both locate and marking functions.

Marking device **150** may include a shaft **154**, a handle **158**, a marking dispenser holder **162**, an actuator **166**, control electronics **170**, at least one rechargeable battery **172** for powering control electronics **170**, a docking station interface **174**, and an RFID tag **178**. Rechargeable battery **172** may be a power source for the marking device **150**. Rechargeable batteries **172** may be, for example, rechargeable lithium ion batteries, which are sized according to the requirements of control electronics **170**. RFID tag **178** may store a unique identification code, which may be used to identify and track marking device **150**.

A marking dispenser **180** (e.g., an aerosol marking paint canister) may be installed in marking dispenser holder **162** of marking device **150** as illustrated. Actuator **166** may be an electrical/mechanical actuator for activating the marking material spray action of marking dispenser **180**.

Control electronics **170** may include, but is not limited to, a processor, GPS technology, RFID technology, data storage devices, electronic actuator, electronic display, marking material sensing technology and wired and/or wireless communications technology (e.g., an Intranet connection, Internet, Bluetooth® technology, Wi-Fi, Wi-Max, IEEE 802.11 technology, radio frequency (RF), Infrared Data Association (IrDA) compatible protocols, Local Area Networks (LAN), Wide Area Networks (WAN), Shared Wireless Access Protocol (SWAP), combinations thereof, and other types of wireless networking protocols).

Docking station interface **174** is a mechanism that is designed to fit cradle **118** of docking station **100** to provide a mechanical and electrical connection therebetween. The physical dimensions and shape of docking station interface **174** of marking device **150** substantially correspond to the physical dimensions and shape of cradle **118** of docking station **100**. Furthermore, electrical inputs/outputs (I/Os) (e.g., signal, data, and power), integrated into docking station interface **174**, are designed to connect to their counterparts integrated in cradle **118** of docking station **100**. An example of docking station interface **174** of marking device **150** is described with reference to FIGS. 5A, 5B, 6A, 6B, and 7.

FIG. 2 is a schematic diagram of marking device **150** attached to docking station **100**, according to embodiments of the invention. More specifically, FIG. 2 depicts marking device **150** resting and retained within a cavity of base **110** of docking station **100**. Docking station interface **174** of marking device **150** is engaged with cradle **118** of docking station **100**. Docking station **100** can be configured to dock marking device **150** either with or without marking dispenser **180** installed in marking device **150**. Safety strap **142** may be fastened around shaft **154** of marking device **150** to hold marking device **150** securely, so that the marking device remains mechanically and electrically coupled to docking station **100**.

The docking station **100** shown in FIGS. 1 and 2 and described above provides both mechanical and electronic docking of a marking device. In particular, the docking station **100** is mechanically coupled to the marking device **150** in the docked position and has docking station electronics **128** which communicate electronically with control electronics **170** in marking device **150**. It will be understood, however, that the docking station may have a variety of configurations within the scope of the present invention.

Referring to FIG. 3A, a block diagram of an electronic docking station **200** is shown. Docking station **200** includes docking control electronics coupled by an electronic connection **206** to a marking device **202**. Electronic connection **206** may be a wired connection, such as by a cable or electrical connector, or may be a wireless connection. Embodiments of

docking control electronics for docking station **200** are described below. Docking station **200** may be connected to a computing device **204** via an electronic connection **208**, which may be a wired connection or a wireless connection. The computing device **204** may be an on-site computer, such as an in-vehicle computer, or may be a remote computer, such as a central office computer. Docking station **200** provides electronic support of marking device **202** and supports such functions as data storage and/or transfer, battery charging and diagnostics and calibration, for example. However, docking station **200** is not mechanically coupled to marking device **202** and does not provide mechanical support, storage or locking of marking device **202**. The physical configuration of docking station **200** may be an electronics enclosure or housing having suitable connectors, cables and/or antennas for communication with marking device **202** and computing device **204**, and optional user interface components as described below.

Referring to FIG. 3B, a docking station **210** is mechanically and electronically coupled to a marking device **212**. An electronic connection **216** between docking station **210** and marking device **212** may be a wired connection, such as by a cable or electrical connector, or may be a wireless connection between docking station electronics and marking device electronics. Docking station **210** further includes a mechanical connection **217** to marking device **212**. Mechanical connection **217** may have a variety of configurations, including, but not limited to, a holder to support and retain marking device **212**, a locking mechanism that is mechanically or electronically controlled and/or a partial or complete enclosure for marking device **212**. The partial or complete enclosure for the marking device may provide security for the marking device and/or may protect the marking device against exposure to weather conditions. The docking station **210** may provide mechanical support for marking device **212** in any desired position, such as vertical or horizontal, for example, and may be fixed or mobile. Docking station **210** may include an electronic connection **218** to a computing device **214**, which may be local or remote as described above in connection with computing device **204**. Electronic connection **218** may be a wired connection or a wireless connection. The docking station **100** shown in FIGS. 1 and 2 may be of the type shown in FIG. 3B.

Referring to FIG. 3C, a docking station **220** is mechanically coupled to a marking device **222** by a mechanical connection **227**. The mechanical connection between docking station **220** and marking device **222** may have any desired mechanical configuration, including but not limited to a holder to support and retain marking device **222** in a desired orientation, such as vertical or horizontal, a locking mechanism to secure marking device **222** to docking station **220** and/or a partial or complete enclosure for marking device **222**. The partial or complete enclosure for the marking device may provide security for the marking device and/or may protect the marking device against exposure to weather conditions. In the embodiment of FIG. 3C, an electronic connection is not provided between docking station **220** and marking device **222**. Marking device **222** may communicate directly with a computing device **224** via an electronic connection **228**, which may be a wired connection or a wireless connection. Computing device **224** may be a local computer, such as an in-vehicle computer or may be a remote computer, such as a central office computer. The physical configuration of docking station **220** may be similar to docking station **100** shown in FIGS. 1 and 2, with most or all electronic components omitted.

In each of FIGS. 3A, 3B and 3C, the electronic connection to the computing device is optional. The computing device may provide control of the docking station and may receive marking device data, such as data from electronic records of marking operations. The marking device data may be transferred by the docking station from the marking device directly to the computing device and/or may be stored in a local memory of the docking station. The data transfer may occur at the time of docking of the marking device or may occur at a later time, such as at the end of the day. In other embodiments, the electronic connection between the docking station and the computing device is omitted. For example, data can be transferred from the docking station to any desired computing device by use of a removable memory.

In the embodiments of FIGS. 3A, 3B and 3C, the docking station may provide a battery charging function for the marking device. Thus, for example, the docking station can be connected to a power source, such as an AC power source for fixed applications, or a DC source, such as vehicle power, for mobile applications. The docking station may include circuitry for charging batteries in the marking device. In other embodiments, a separate battery charger is connected directly to the marking device.

A block diagram of docking control electronics **250** in accordance with embodiments of the invention is shown in FIG. 4. Docking control electronics **250** may include components for managing the overall operation of the docking stations described herein. Docking control electronics **250** may include a communication interface **252** for communication with a marking device, a communication interface **254** for communication with a local or remote computing device, and a user interface **256** for interacting with a user by receiving user inputs and/or providing information to a user. Docking control electronics **250** may further include a timing system **260** for timing of docking station operations and events, a location tracking system **262** for determining geographical coordinates of the docking station and an ID reader **264** for reading an identification tag **265** on the marking device.

Docking control electronics **250** may further include a processor **266** and at least one memory **270**. Memory **270** may be used for storage of control software and for data storage. It will be understood that memory **270** may be configured as one or more memories, such as separate memories for data storage and program storage. Memory **270** may include a data storage area **290** for storage of data transferred from the marking device and/or other data involved in operation of the docking station.

Docking control electronics **250** may further include a battery control circuit **272** which receives AC or DC power from an external power source **274** and performs charging of the battery of the marking device under control of processor **266**.

In some embodiments, docking control electronics **250** may include a memory connector (not shown) to permit connection of a memory device, such as a memory device containing data from the marking device. In further embodiments, docking control electronics **250** may include a battery connector (not shown) to permit connection of one or more batteries from the marking device, for charging.

Control software, typically stored in memory **270**, may include a communication control module **280** to control communication with the marking device and with the computing device, and a data transfer module **282** to perform data transfer to and between the marking device, a local memory and the computing device. The control software may further include a battery control module **284** to control battery charging and recording of battery information, a diagnostics mod-

ule **286** to perform diagnostics and calibration of the marking device, as well as diagnostics of the docking station itself. The control software may further include a security module **288** that controls a locking mechanism and/or data transfer operations based on information including, but not limited to, a table of approved marking device IDs, allowed and prohibited geographical coordinates and/or allowed and prohibited times and dates.

Communication interface **252** may be any wired and/or wireless communication interface by which information may be exchanged between the docking station and a marking device. Similarly, communication interface **254** may be any wired and/or wireless communication interface by which information may be exchanged between the docking station and a local or remote computing device. Examples of wired communication interfaces may include, but are not limited to, USB ports, RS232 connectors, RJ45 connectors, Ethernet, and combinations thereof. Examples of wireless communication interfaces may include, but are not limited to, Bluetooth® Technology, Wi-Fi, Wi-Max, IEEE 802.11 Technology, Radio Frequency (RF), Local Area Networks (LAN) and Wide Area Networks (WAN), Internet, Shared Wireless Access Protocol (SWAP), Infrared Data Association (IrDS) compatible protocols and other types of wireless networking protocols, and combinations thereof.

User interface **256** may be any mechanism or combination of mechanisms by which the user may interact with the docking station. For example, user interface **256** may include, but is not limited to, a display (including integrated displays and external displays, such as Heads-Up Displays (HUDs)), a touch screen, one or more manual pushbuttons, one or more toggle switches, a keypad, and combinations thereof. In one example, the display includes one or more liquid crystal displays (LCD) or light-emitting diode (LED) displays that are suitably small for use in a portable device yet suitably large for ease of viewing. User interface **256** may include standard zoom in and out controls for the display. In one example, a display includes a 4.3 inch diagonal LCD. Preferably, the display is at least 5 characters tall by 40 characters wide, is full-sun daylight readable and includes automatic backlighting for low light applications. In one implementation, the user interface **256** includes a “menu/on” button to power up the docking station and provide a menu-driven graphical user interface (GUI) displayed by the display device (e.g., menu items and/or icons displayed on the display device) and navigated by the technician via a joystick or a set of four “up/down/left/right” buttons, as well as a “select/ok” button to take some action pursuant to the selection of a menu item/icon. In further implementations, the user interface may include a microphone and the processor may be configured to accept and process audible commands, such that docking station operations may be accomplished via voice-activated commands by simply speaking into the microphone.

Additionally, user interface **256** may include one or more indicators such as, for example, LED indicators, audio devices, such as a speaker, a buzzer and/or an alarm, and combinations thereof. During normal usage of the docking station, the components of user interface **256** may be used to display, for example, the current status of the docking station, the current status of the docked marking device, alerts and notifications and option selections.

Timing system **260** may include an internal clock, such as a crystal oscillator device, for processor **266**. Additionally, timing system **260** may include a mechanism for registering time with a specified degree of accuracy, such as accuracy to the minute, second or millisecond. Timing system **260** may also include a mechanism for registering the calendar date.

Using timing system **260**, a timestamp may be appended to any information that is handled by the docking station, such as for example marking device data, time of docking the marking device, time of undocking the marking device, time of battery charging, and the like. In some embodiments, timing system **260** may register the time and date using its internal clock. In other embodiments, timing system **260** may receive time and date information from location tracking system **262**. In further embodiments, timing system **260** may receive time and date information from an external timing system, such as a remote computer or network, via communication interface **254**.

Location tracking system **262** may include any device that can determine geographical coordinates to a specified degree of accuracy. For example, location tracking system **262** may include a Global Positioning System (GPS) receiver or a Global Navigation Satellite System (GNSS) receiver. A GPS receiver may provide, for example, any standard format data stream, such as a National Marine Electronics Association (NMEA) data stream. The location tracking system **262** may include an error correction component which may be a mechanism for improving the accuracy of the geographical coordinates provided by the location tracking system **262**. In one example, the error correction component may include an algorithm for correcting offsets, such as due to local disturbances in the atmosphere, in the geographical coordinates provided by location tracking system **262**. Using location tracking system **262**, geographical coordinates can be recorded and/or transmitted for any docking station operation or information.

In another embodiment, location tracking system **262** may include a device or mechanism that determines location such as by performing triangulation by the use of cellular telephone towers.

ID reader **264** includes a mechanism for short range identification of the ID tag **265** which may be affixed to the marking device. ID reader **264** may be a radio frequency identification (RFID) reader for reading an RFID tag affixed to the marking device. In another embodiment, ID reader **264** may include a barcode reader for reading a barcode tag affixed to the marking device. The ID reader **264** typically reads the ID tag **265** when the marking device is docked in the docking station.

Processor **266** may be any general purpose processor, controller or microcontroller device that is capable of managing the overall operations of the docking station as described herein. The processor **266** may include a single processing device or more than one processing device.

Memory **270** may comprise any computer-readable media and may store computer instructions for implementing the various functions described herein as well as any data associated with operation of the docking station. The processor **266** may be used to execute the stored instructions. Memory **270** may include volatile and/or non-volatile data storage media and/or data storage devices. For example, memory **270** may be, but is not limited to, a random access memory (RAM), a read-only memory (ROM) and/or a removable memory device, such as a USB flash memory.

As indicated above, communication control module **280** includes software for controlling communication interface **252** to communicate with the marking device and for controlling communication interface **254** to communicate with a local or remote computing device. The communication may be associated with any function of the docking station, including but not limited to data transfer, control of the marking device, battery charging, diagnostics and calibration, for example. As indicated above, the communication with the

marking device may be by wired connection or may be wireless. Further, the communication with the computing device may be by wired connection or may be wireless.

Data transfer module **282** controls data transfer to and between the marking device, the docking station and the local or remote computing device. Marking device data may be transferred from the marking device to data storage **290** in memory **270** for later transfer to the computer device. In other embodiments, data transfer module **282** is configured to control data transfer between the marking device and the computing device without temporary storage in data storage **290**. In further embodiments, data transfer module **282** is configured to control data transfer from the docking station to the marking device. The data may be transferred to the marking device from data storage **290** and/or from the computing device. By way of example only, the data transferred to the marking device may define some or all parameters of a marking operation to be performed by the marking device.

In some embodiments, data transfer module **282** may be configured to provide data backup for the marking device. By copying marking device data to the local memory in the docking station and/or to the local or remote computing device at specified times, data integrity and data security are provided, even if the marking device is damaged, lost or stolen. For example, data can be copied from the marking device to the docking station upon completion of a marking operation or a part thereof, or at specified intervals.

Data transfer module **282** may ensure synchronization of data between the marking device and data storage **290** as described below. Data transfer module **282** may perform functions such as format conversion, data compression and the like, related to data communication. In some embodiments, data storage **290** may be a removable memory component, such as a USB flash memory, that is physically removed from the docking station and installed in the local or remote computing device for data transfer.

Battery control module **284** may control monitoring and charging of one or more batteries in the marking device by battery control circuit **272**. The battery control module **284** may determine the charge state of the one or more batteries in the marking device and, if necessary, initiate and control battery charging. The battery control module, in conjunction with timing system **260**, may be configured to record a date and time of battery charging. The battery control module **284**, in conjunction with location tracking system **262**, may be configured to record geographical coordinates of the battery charging operation. The battery control module **284** may be configured to determine and/or record various parameters of the one or more batteries in the marking device, including but not limited to battery quality and/or battery capacity.

Diagnostics module **286** may be configured to perform diagnostics of the marking device. In particular, diagnostics module **286** may place the marking device in a diagnostics mode and may execute a diagnostics routine on the marking device. The diagnostics routine may include sending stimulus signals to the marking device and receiving responses or lack thereof which indicate the operational state of the marking device. The diagnostics routine may test some or all of the components of the marking device.

Diagnostics module **286** may also perform calibration of one or more components of the marking device. For example, when a component of the marking device provides a response that does not meet specification, the component may be adjusted by appropriate signals sent by the diagnostics module **286** to meet specification.

Diagnostics module **286** may also be configured to perform self-diagnostics of the docking station. In this case, diagnos-

tics module **286** may place the docking station in a diagnostics mode and may execute a diagnostics routine for testing some or all components of the docking station. The result of the diagnostics routine can be recorded and/or transmitted to the local or remote computing device.

The diagnostics module **286**, in conjunction with timing system **260**, may be configured to record a time and date when a diagnostics and/or calibration routine was performed. Diagnostics module **286**, in conjunction with location tracking system **262**, may be configured to record the geographical coordinates where a diagnostics and/or calibration routine was performed. The recording of diagnostics information may be important in establishing that the marking device and/or the docking station was functioning properly at a particular time and date and/or location.

Security module **288** may be configured to control various security components and functions of the docking station. In some embodiments, security module **288** may be configured to receive the ID of the marking device from ID reader **264** and compare the ID of the marking device with a list of approved marking device IDs. If the ID of the marking device does not match one of the approved marking device IDs in the list, operation of the docking station may be modified and/or terminated. For example, an alert can be generated by the docking station and/or an alert can be transmitted to the local or remote computing device. Furthermore, operations such as data transfer, battery charging and the like can be terminated when the ID of the marking device does not match an approved marking device ID.

In other embodiments, security module **288** may be configured to receive a user ID from user interface **256**, such as via a keypad or other input device, and compare the user ID with a list of approved user IDs. In the absence of a match between the user ID and one of the approved user IDs, operation of the docking station can be modified or terminated and an alert can be generated as described above.

In further embodiments, security module **288** may be configured to control a locking mechanism, such as a safety strap, a locking bar or other locking device. The locking mechanism may secure the marking device or may secure an enclosure for the marking device, such as for example a weatherproof enclosure. Thus, for example, security module **288** may be configured to maintain the locking mechanism in a locked state if the user ID does not match one of the approved user IDs. In further embodiments, security module **288** may be configured, in conjunction with timing system **260**, to maintain the locking mechanism in a locked state at specified times and dates, such as, for example, during nighttime, weekends and holidays. In further embodiments, security module **288** may be configured, in conjunction with location tracking system **262**, to maintain the locking mechanism in a locked state when the docking station is outside specified geographical coordinates, is at specified geographical coordinates, or is within specified geographical coordinates. The specified geographical coordinates may indicate a location or area where removal of the marking device from the docking station is not permitted.

In further embodiments, the security module **288** may be configured to generate a user alert or notification when a marking device is not present in the docking station. Presence or lack of presence of the marking device may be detected, for example, by a sensor switch. In other embodiments, the security module **288** may be configured to generate a user notification or alert when the marking device is present in the docking station but is not secured in the docking station, for example, the marking device is not properly positioned or the locking mechanism is not engaged. In further embodiments,

security module **288** may be configured to respond to a security command from a local or remote computing device. The security command may cause the security module **288** to terminate operations, to engage any locking mechanism and/or to shut down, for example.

It will be understood that the above described components and functions of the docking station may be utilized separately or in any combination. Furthermore, various components of the docking control electronics **250** shown in FIG. **4** and described above may be omitted from the docking station, within the scope of the invention. As noted above, battery charging may be a separate function not included in the docking station. The docking station, for example, may not include ID reader **264**, timing system **260** and/or location tracking system **262** in particular applications and configurations. In some embodiments, the docking station may be controlled by the computing device, in which case, all or part of user interface **256** may be omitted. Depending on the configuration, various software modules may be omitted, and in other embodiments, additional software modules may be included in the docking station. As described above, some embodiments of the docking station may include minimal or no electronics, in which case the docking station serves as a holder for the marking device.

FIGS. **5A** and **5B** are top and side views, respectively, of a portion of docking station **100**. FIGS. **5A** and **5B** illustrate that cradle **118** is recessed into the upper end of support housing **114**. Additionally, a female alignment feature **310** is provided within cradle **118** and is recessed into support housing **114**. Male connector pins **314** are arranged within female alignment feature **310**, to which electrical signals and power are connected. The number, type, and arrangement of male connector pins **314** may vary according to the requirements of docking station **100**. The dimensions of cradle **118** and female alignment feature **310** may vary according to the requirements of docking station **100**.

FIGS. **6A** and **6B** are side and bottom views, respectively, of a portion of marking device **150**. FIG. **7** is a side view of marking device **150** being attached to docking station **100**. Docking station interface **174** of marking device **150** is designed to fit into cradle **118** of docking station **100**. Accordingly, FIGS. **6A** and **6B** show that the geometry of docking station interface **174** is complementary to the geometry of cradle **118** of FIGS. **5A** and **5B**. For example, the body of docking station interface **174** is designed to fit within the recessed area of cradle **118**. Further, a male alignment feature **410** is integrated into docking station interface **174**. Male alignment feature **410** is designed to fit within the recessed female alignment feature **310** of cradle **118** shown in FIGS. **5A** and **5B**. A set of female connector pins **414** are arranged within male alignment feature **410**, to which electrical signals and power are connected. The number, type, and arrangement of female connector pins **414** may vary according to the requirements of marking device **150** and docking station **100**. Female connector pins **414** of marking device **150** are arranged to substantially align with the arrangement of male connector pins **314** of docking station **100**. As a result, when marking device **150** is attached to docking station **100**, male connector pins **314** fit into female connector pins **414** of marking device **150**, providing an electrical connection therebetween, as shown in FIG. **7**.

While FIGS. **5A**, **5B**, **6A**, and **6B** describe a pin and hole type of connection (e.g., male connector pins **314** fitting into female connector pins **414**) between docking station **100** and marking device **150**, this connection is exemplary. Those skilled in the art will recognize that any type of electrical connection mechanism may be used, such as, but not limited

to, an induction coupling mechanism. In addition, the mechanical and electrical coupling between docking station **100** and marking device **150** can be at any convenient location on the two devices, with complementary elements on the two devices to facilitate coupling and decoupling. Furthermore, the mechanical and electrical coupling elements can be combined, as shown in FIGS. **5A**, **5B**, **6A**, **6B** and **7**, or can be separate coupling elements.

As illustrated in FIG. **7**, docking station interface **174** of marking device **150** fits into cradle **118** of docking station **100**. In particular, male alignment feature **410** of docking station interface **174** having female connector pins **414** is aligned with and fit into female alignment feature **310** of cradle **118** that has male connector pins **314**.

FIG. **8A** is a top view of an exemplary configuration incorporating docking station **100**. More specifically, FIG. **8A** is a top view of a configuration incorporating docking station **100** in a vehicle cab **600** of the type typically used in the field. Vehicle cab **600** may include both a driver seat **610** and a passenger seat **614**, which are facing a dash **618**. In this mounting configuration, docking station **100** may be mounted to the back wall of vehicle cab **600** (i.e., the wall opposite dash **618**) in a location that is substantially centralized between driver seat **610** and passenger seat **614** for ease of access. For example, docking station **100** may be secured to the back wall of vehicle cab **600** by use of security screws to prevent the unauthorized removal of docking station **100**. Docking station **100** is positioned to face the front (i.e., toward dash **618**) of vehicle cab **600** to allow for easy attachment and removal of marking device **150**.

Docking station **100** may be wired directly into a vehicle's power system. Docking station **100** thus receives power simultaneously with other vehicle components (when the key is in the accessory, power, start, or run position), and powers down upon vehicle power off. In one embodiment, the design and construction of docking station **100** provides a power line and a ground line. Both lines may be spliced into, for example, a restraint control module **622** that is typically located directly under passenger seat **614** of the vehicle. As a result, docking station **100** receives power when restraint control module **622** receives power. Docking station **100** provides a battery charging mechanism for marking device **150** via the combination of the vehicle power and docking control electronics **128**. In another embodiment, the docking station may charge the marking device at any time (including accessory, power, start, run or off positions), for example, at preset times before the beginning of a shift to ensure that the marking device is fully charged, or for a period of time after the vehicle is shut off at the end of a shift.

Additionally, FIG. **8A** shows an onboard computer **626** within vehicle cab **600**. Onboard computer **626** may be any computing device, such as, but not limited to, any laptop computer, handheld computer or onboard server that is capable of executing software applications related to operations of docking station **100** and marking device **150**. In particular, there may be a wired connection, such as wired connection **140**, between docking station **100** and onboard computer **626**. In an embodiment, onboard computer **626** communicates with marking device **150** via a wireless communication link when within range. Also, when marking device **150** is attached to docking station **100**, docking station **100** provides a wired communications link between onboard computer **626** and marking device **150**. The type of information that may be exchanged between onboard computer **626** and marking device **150** may include, but is not limited to,

marking data, timing data, GPS data, RFID data, status data, health data, software, and firmware updates, diagnostics information, and the like.

FIG. 8B is a top view of another embodiment incorporating docking station 100. In this mounting configuration, docking station 100 may be securely fastened to the floor of vehicle cab 600 in place of a passenger seat. In an embodiment, docking station 100 is securely bolted to the floor of vehicle cab 600 using, for example, a set of existing passenger seat bolt holes 630 in the floor of vehicle cab 600. Optionally, a mounting plate 634 may be provided at base 110 of docking station 100 for bolting to bolt holes 630. As depicted in FIG. 8B, a passenger seat is not present and restraint control module 622 may be located underneath the cab floor covering. As previously discussed, the power line and ground lines of docking station 100 may be spliced into restraint control module 622. Additionally, a USB or similar connection may be provided between docking station 100 and onboard computer 626. This mounting configuration allows docking station 100 to be installed without drilling additional holes in the floor of vehicle cab 600. As a result, docking station 100 is positioned in place of the passenger seat and may be oriented to allow easy access through the passenger door of vehicle cab 600.

FIGS. 8A and 8B illustrate embodiments where the docking station is mounted within a vehicle cab. It will be understood that the docking station can be mounted in any convenient location in a vehicle. For example, docking station may be mounted in the bed of a truck, in the rear of a van, within a panel truck or trailer, or in any other desired location. Further, the docking station can retain the marking device in any desired orientation, such as vertical, horizontal or any other desired orientation. In addition, any number of docking stations can be mounted in a vehicle.

In some embodiments, the docking station may include a weatherproof enclosure for the marking device. The weatherproof enclosure may be beneficial, for example, when the docking station is exposed to the weather, such as in the bed of a truck. The weatherproof enclosure may also provide enhanced security and may include a locking mechanism.

FIG. 8C is a functional block diagram of a network system 650 that includes the mobile docking station 100. More specifically, network system 650 includes one or more mobile docking stations 100 and one or more associated marking devices 150. Each mobile docking station 100 of network system 650 may be connected to onboard computer 626 of the vehicle in which it is installed, as shown in FIGS. 8A and 8B. In another embodiment, onboard computer 626 may be any on-site computer, and is not limited to a computer in a vehicle. Additionally, each onboard computer 626 or other on-site computer of network system 650 may be connected to a remote computing device, such as remote computer 654. Remote computer 654 may be a centralized computer, such as a central server of, for example, the locate service provider.

In order to facilitate the network connection, each onboard computer 626 or other on-site computer includes a communication link 658. Likewise, remote computer 654 includes a communication link 662. Communication link 658 and communication link 662 may be any wired and/or wireless communication interface by which information may be exchanged. Examples of wired communication interfaces may include, but are not limited to, USB ports, RS232 connectors, RJ45 connectors, Ethernet, and any combinations thereof. Examples of wireless communication interfaces may include, but are not limited to, an Intranet connection, Internet, Bluetooth® technology, Wi-Fi, Wi-Max, IEEE 802.11 technology, radio frequency (RF), Infrared Data Association

(IrDA) compatible protocols, Local Area Networks (LAN), Wide Area Networks (WAN), Shared Wireless Access Protocol (SWAP), combination thereof, and other types of wireless networking protocols. The wireless interface may be capable of capturing signals that reflect a user's intent. For example, the wireless interface may include a microphone that can capture a user's intent by capturing the user's audible commands. The wireless interface may also interact with a device that monitors a condition of the user, such as eye movement, brain activity, and/or heart rate.

FIG. 9 is a flow diagram of a method 700 of using a docking station according to embodiments of the invention. In particular, FIG. 9 is a flow diagram of method 700 of synchronizing the data of, for example, marking device 150 with a local or remote computer, such as onboard computer 626, when detected in docking station 100. Method 700 may include, but is not limited to, the following acts, which are not limited to any order.

In act 710, the docking station receives power. For example, when docking station 100 is installed in a vehicle, as shown in FIGS. 8A and 8B, docking station 100 receives direct current (DC) power when the vehicle key is in the accessory, power, start, or run position.

In act 714, it is determined whether a marking device 150 is present in the docking station 100. For example, using software of onboard computer 626, queries of docking station 100 may be performed in order to determine the presence or absence of marking device 150. In one embodiment, onboard computer 626 may query the RFID reader of docking station 100 in order to determine whether RFID data is returned. More specifically, when marking device 150 is present in docking station 100, RFID data is returned from its RFID tag 178 to onboard computer 626 by the RFID reader 129 of docking station 100. By contrast, when marking device 150 is not present in docking station 100, no RFID data is returned to onboard computer 626 from docking station 100.

In another example, a logic state may be returned from docking control electronics 128, depending upon whether an electrical connection exists between docking station 100 and marking device 150 (e.g., between male connector pins 314 of docking station 100 and female connector pins 414 of marking device 150). This may be referred to as "docking pin awareness." Other methods of determining whether a marking device is present in the docking station are possible, such as pressure sensors and any number of other solutions. If it is determined that marking device 150 is present in docking station 100, method 700 proceeds to act 718. If it is determined that marking device 150 is not present in docking station 100, method 700 ends.

In act 718, it is determined whether a data synchronization operation is needed between the marking device and the local or remote computer. Data synchronization is the process by which the local or remote computer receives data that was not previously exchanged between the marking device and the local or remote computer. For example, using software of onboard computer 626, it may be determined whether a data synchronization operation is needed between marking device 150 and onboard computer 626. For example, onboard computer 626 interrogates the data (e.g., marking data, timing data, GPS data, RFID data, and the like) that may be stored on marking device 150 and checks a flag, such as a send/acknowledge flag, to determine whether a packet of data was transmitted and received successfully. When the expected flags are present, onboard computer 626 skips over that packet of data in order to avoid collecting duplicate data. Any data that was not successfully transmitted and/or received is transmitted from marking device 150 to onboard computer

626 (or remote computer via wireless communication) via the USB or similar connection between docking station 100 and onboard computer 626. If it is determined that a data synchronization operation is needed, method 700 proceeds to act 722. If it is determined that a data synchronization operation is not needed, method 700 ends.

In act 722, a data synchronization operation is performed between the marking device 100 and the remote or local computer. For example, a data synchronization operation is performed between marking device 150 and onboard computer 626 via the USB connection between docking station 100 and onboard computer 626. Once the data is synchronized, method 700 ends.

Referring again to method 700 of FIG. 9, docking station 100 communicates with onboard computer 626 and, if appropriate, may begin synchronizing data immediately when marking device 150 is detected in docking station 100. Alternatively, a manual control 134, such as the “initiate data synchronization” push button of docking station 100 allows the operator to manually perform synchronization at any time. Also, data synchronization may occur automatically upon the docking of the marking device.

A data synchronization operation is described above in connection with FIG. 9. It will be understood that communication between docking station 100 and marking device 150 may include any control and/or data transfer function, including but not limited to issuing commands to marking device 150, receiving status and other operating information from marking device 150, downloading ticket information and other operating parameters, uploading information of any type, performing diagnostics, and the like.

FIG. 10 is a flow diagram of another method of using a docking station. In particular, FIG. 10 is a flow diagram of a method 800 of managing the indicators and/or manual controls of docking station 100 when a marking device, such as marking device 150, is detected therein. Method 800 informs the user of status changes and other conditions that may require attention. Method 800 may include, but is not limited to, the following acts, which are not limited to the following order.

In act 810, the docking station receives power. For example, when docking station 100 is installed in a vehicle, as shown in FIGS. 8A and 8B, docking station 100 receives DC power when the vehicle key is in the accessory, power, start, or run position.

In act 814, it is determined whether a marking device is present in the docking station. For example, if it is determined that marking device 150 is not present in docking station 100, method 800 proceeds to act 818. If it is determined that marking device 150 is present in docking station 100, method 800 proceeds to act 822. The presence or absence of marking device 150 in docking station 100 may be determined as described above in connection with FIG. 9.

In act 818, indicators 130 are set to show that no marking device is present and certain manual controls are disabled. For example, a red battery status indicator and a red synchronization status indicator may be turned on, and the initiate data synchronization push button may be deactivated.

In act 822, it is determined whether the power source, for example, a battery, of marking device 150 needs charging. For example, onboard computer 626 interrogates control electronics 170 of marking device 150 in order to determine the health status of rechargeable batteries 172. If it is determined that rechargeable batteries 172 of marking device 150 do not need charging, method 800 proceeds to act 826. If it is determined that rechargeable batteries 172 of marking device 150 do need charging, method 800 proceeds to act 830.

In act 826, an indicator 130 is set to show battery status=charged. For example, a green battery status indicator may be turned on. Method 800 proceeds to act 834.

In act 830, an indicator 130 is set to show battery status=charging. For example, a yellow battery status indicator may be turned on and caused to blink. Alternatively, in the case of total battery failure, a red battery failure indicator may be turned on in order to show a defective battery in marking device 150.

In act 834, it is determined whether a data synchronization operation is needed between the marking device and the local or remote computer. For example, if it is determined that a data synchronization operation is needed, method 800 proceeds to act 838. However, if it is determined that a data synchronization operation is not needed, method 800 proceeds to act 850. The need for a synchronization operation may be determined as described above in connection with FIG. 9.

In act 838, an indicator 130 is set to show synchronization is in progress. For example, an orange synchronization status indicator may be turned on and caused to blink. In act 842, it is determined whether a data synchronization error condition is present. For example, onboard computer 626 determines whether a data synchronization error condition has been identified. If a data synchronization error condition is not present, method 800 returns to act 838. If a data synchronization error condition is present, method 800 proceeds to act 846.

In act 846, an indicator 130 is set to show whether a data synchronization error condition is present. For example, a red synchronization error indicator may be turned on and caused to blink. In act 850, it is determined whether the initiate data synchronization push button of docking station 100 has been pushed. For example, onboard computer 626 interrogates docking control electronics 128 of docking station 100 to determine the status thereof. If it is determined that the initiate data synchronization push button has been pushed, method 800 proceeds to act 838. If it is determined that the initiate data synchronization push button has not been pushed, method 800 then proceeds to act 854.

In act 854, an indicator 130 is deactivated. For example, the orange synchronization status indicator may be turned off.

FIG. 11 is a schematic diagram of a marking device attached to a docking station. In particular, FIG. 11 depicts a side view of marking device 150 attached to docking station 100. Docking station 100 further includes a locking mechanism 910. In addition to safety strap 142, marking device 150 may be lockable within a vehicle via the optional locking mechanism 910 of FIG. 11. In one embodiment, locking mechanism 910 may be a suitably rigid, strong, and tamper-proof bracket (e.g., hinged bracket) that is installed on support housing 114. Locking mechanism 910 may include a switch or lever (not shown) to ensure that marking device 150 is properly secured within docking station 100 during driving (i.e., for safety) in the event of an accident, as well as to ensure proper charging and data transfer. A keyed lock, such as a padlock, may be used to secure marking device 150 against theft.

FIG. 12 is a flow diagram of a method of using a docking station. In particular, FIG. 12 illustrates a method 1000 of notifying the user of the presence and security of the marking device in docking station 100. Method 1000 may provide an audible means of informing the user of the presence and security of marking device 150 in docking station 100. Method 1000 may include, but is not limited to, the following acts, which are not limited to the following order.

In act 1010, it is determined whether docking station 100 is receiving power. For example, when docking station 100 is

installed in a vehicle, such as shown in FIGS. 8A and 8B, docking station 100 receives DC power when the vehicle key is in the accessory, power, start, or run position. If onboard computer 626 determines that vehicle power is present, method 1000 proceeds to act 1014. If onboard computer 626 determines that vehicle power is not present, method 1000 ends.

In act 1014, it is determined whether a marking device 150 is present within the docking station. For example, if it is determined that marking device 150 is not present in docking station 100, method 1000 proceeds to act 1018. If it is determined that marking device 150 is present in docking station 100, method 1000 proceeds to act 1022. The presence or absence of marking device 150 in docking station 100 may be determined as described above in connection with FIG. 9.

In act 1018, an audible notification is generated to the user that the marking device 150 is absent from the docking station 100 within the vehicle. For example, a buzzer (via audio output 138 of docking station 100) may be triggered until the vehicle is shut off or until marking device 150 is placed in docking station 100. Thus, it may be ensured that the user returns marking device 150 to the vehicle after each use. Method 1000 then returns to act 1014.

In act 1022, it is determined whether the marking device is secure within the docking station 100. For example, onboard computer 626 determines the status of safety strap 142 and/or the switch or lever of locking mechanism 910 in order to determine whether such items are in a secure state. If it is determined that marking device 150 is secure in docking station 100, method 1000 ends. If it is determined that marking device 150 is not secure in docking station 100, method 1000 proceeds to act 1026.

In act 1026, an audible notification is generated, indicating to the user that the marking device is not secure in docking station 100 within the vehicle. For example, a buzzer (via audio output 138 of docking station 100) may be triggered until the vehicle is shut off or until marking device 150 is placed in docking station 100. This ensures that marking device 150 is physically secure in the vehicle while the vehicle is moving. Method 1000 then returns to act 1022.

FIG. 13 is a schematic diagram of an exemplary configuration incorporating docking stations. In particular, FIG. 13 is a schematic diagram of a bank of one or more docking stations 1100, which may be fixed and suitable for use with at least one marking device. For example, FIG. 13 shows a home base facility 1110 at which a bank of docking stations 1100 are installed along a wall 1114. In another configuration, the bank of docking stations 1100 may be installed on the floor or a table. Each docking station 1100 may be substantially the same as docking station 100 as depicted in FIGS. 1 through 12, except that its power source may be designed and constructed to utilize an alternating current (AC) power source (e.g., an AC power source 1118), instead of the DC power of a vehicle. A shielded power cord terminated in a three (3) prong plug may be used. The bank of docking stations 1100 may also be powered by direct current (DC) power sources. Like docking station 100, each docking station 1100 allows a marking device, such as marking device 150, to be attached and detached easily for charging and, where applicable, for data synchronization.

Each docking station 1100 is designed and constructed to be mounted against a fixed structure such as a wall. In addition, each docking station 1100 is designed and constructed of materials that prevent unauthorized removal thereof. The bottom of each docking station 1100 may be flat in order to allow for placement on the floor of a building or on a table. Each docking station 1100 may be affixed to the floor and/or wall

using security screws to prevent the unauthorized removal of the docking station. A variety of attachment means may be used to affix docking stations 1100. In addition, each docking station 1100 may be positioned to allow the easy attachment and removal of a marking device.

Docking station 100 and where applicable, docking station 1100, may support the synchronization of the marking device to a local or remote computer, such as a remote computer 1122, which may be, for example, a host server. This synchronization may be performed through the use of a USB cable. Upon attachment of the marking device, each docking station 1100 may determine whether or not data synchronization is necessary and, if it is, perform substantially the same data synchronization process that is shown in method 700 of FIG. 9 and described above.

The status indicators and device controls of each docking station 1100 may be substantially the same as those of docking station 100. A method of managing the indicators and/or manual controls of each docking station 1100 may be substantially the same as method 800 of FIG. 10 for docking station 100.

In another embodiment, each docking station 1100 may include a cleaning mechanism at the base thereof for cleaning any components that may be installed at the marking dispenser holder end of a marking device. An example of a cleaning mechanism may be a compact ultrasonic cleaning station that utilizes cleaning fluid, such as, but not limited to, isopropyl alcohol.

FIGS. 14, 15, and 16 are perspective views of another embodiment of the docking station according to the present invention. FIG. 14 depicts a docking station 1200 for docking a marking device 1250. Docking station 1200 may be an example of another embodiment of both docking station 100 and docking station 1100, which may be in a variety of locations in fixed or mobile configurations.

In this embodiment of the docking station, docking station 1200 may include a base 1210, a support housing 1214, and a cradle 1218. The functions of base 1210, support housing 1214, and cradle 1218 are substantially the same as the functions of base 110, support housing 114, and cradle 118, respectively, of FIGS. 1 through 13. Docking station 1200 of FIGS. 14, 15, and 16 differs primarily from docking station 100 and docking station 1100 of FIGS. 1 through 13 in its physical attributes.

In this embodiment of the docking station, marking device 1250 may include a shaft 1254, a handle 1258, a marking dispenser holder 1262 and a docking station interface 1274. The functions of shaft 1254, handle 1258, marking dispenser holder 1262, and docking station interface 1274 are substantially the same as the functions of shaft 154, handle 158, marking dispenser holder 162 and docking station interface 174, respectively, of FIGS. 1 through 13. Marking device 1250 of FIGS. 14, 15, and 16 differs primarily from marking device 150 of FIGS. 1 through 13 in its physical attributes. In particular, in this embodiment, docking station interface 1274 is incorporated on the side of shaft 1254 that is opposite handle 1258. By contrast and referring to FIG. 1, docking station interface 174 of marking device 150 is incorporated on the same side of shaft 154 as handle 158.

With reference to FIGS. 14 and 16, respectively, marking device 1250 is shown separated from and attached to docking station 1200. FIG. 15 shows further details of docking station 1200. More specifically, FIG. 15 shows an alignment feature 1222 of cradle 1218 that provides the electrical and mechanical coupling to a corresponding alignment feature (not visible) of docking station interface 1274 of marking device 1250.

Additional security features may be incorporated into the docking stations described herein (e.g., docking station **100**, docking station **1100** and docking station **1200**). For example, in addition to the physical locking mechanism, the docking stations may be equipped with a positive identification mechanism. This positive identification mechanism (not shown) is provided to ensure that the user is authorized to remove the marking device from the docking station. This mechanism may include biometric, RFID, passcode, or any other means of positively identifying the user. For example, using intelligence that may be incorporated into docking stations, in order to unlock the marking device, the user may be prompted to provide input that validates that he/she is authorized to use the marking device. In the event that the proper credentials are supplied, the locking mechanism of the docking station releases the marking device to the user. If improper credentials are supplied, the docking station may enter a security lockdown mode, trigger a remote alert to a supervisor of the user, and/or trigger an audible or visible alarm indicating that it is not available for use.

In this embodiment, the docking stations may not allow the user to remove the marking device until positive identification, as explained above, has been provided. In this embodiment, the biometric, RFID, passcode or any other means shall be a feature of the docking stations and provide enhanced security to the physical locking measures (e.g., strap and padlock) already described.

In an embodiment and with regard to docking station **100**, an audible security alarm may be tied into existing vehicle alarms, such as an alarm that sounds when the key is left in the ignition when the user opens the door, when the lights are left on or when the user opens the door and so on. Alternatively, the vehicle may be disabled from starting if marking device **150** is not properly secured in docking station **100**.

In another embodiment and with regard to docking stations **1100** and **1200**, a supervisor of a user may view (e.g., using a graphical user interface (GUI) of remote computer **1122**) the status of docking stations **1100** and **1200**, such as whether a marking device **150** is present and properly secured or not.

The docking stations of the present invention (e.g., docking station **100**, docking station **1100**, and docking station **1200**) are not limited to use with a portable marking device. The docking stations may be suitable for use with other types of portable devices. In an embodiment, the docking stations described herein may accommodate and function with a locate device or similar instrument for detecting facilities. Moreover, the docking stations described herein may also accommodate and function with a combination marking and locate device.

FIG. **17** is a perspective view of a marking device docking station **1300** that has processing and communications capability. Docking station **1300** may be installed in, for example, a vehicle and is suitable for use in conjunction with a marking device, such as marking device **1350**. In other embodiments, docking station **1300** may be installed at a central facility, office or other fixed location. Thus, docking station **1300** may be mobile or fixed. Docking station **1300** may serve as a home base for storage of marking device **1350** and for charging the battery of marking device **1350**. Marking device **1350** is, for example, an electronic marking device. In one example, marking device **1350** may be based on the electronic marking devices that are described above in connection with marking device **150**.

Docking station **1300** may include a base **1310** and a body **1312**. Additionally, a cradle **1314** is integrated into the upper end of body **1312** (the end opposite base **1310**). Cradle **1314** provides a means to mechanically and electrically couple

marking device **1350** to docking station **1300**. Base **1310**, body **1312**, and cradle **1314** may be made of any suitably strong, rigid, and lightweight material, such as, but not limited to, molded plastic and metal. Additionally, docking station **1300** may include a security mechanism **1316** for holding and securing marking device **1350** into cradle **1314** in a lockable manner. For example, security mechanism **1316** may be a flexible strap or a rigid bracket that may be placed around the body of marking device **1350** and secured with a locking mechanism (not shown) to docking station **1300**.

Docking station **1300** may also include control electronics for providing processing and communications capability to docking station **1300**. For example, docking station **1300** may include control electronics **1320** that includes a processing unit **1322**, a local memory **1324**, a communication interface **1326**, a presence detection mechanism **1328**, a security detection mechanism **1330**, and, optionally, a location tracking system **1332**.

Processing unit **1322** may include any standard controller or microprocessor device that is capable of executing program instructions. Local memory **1324** may be any data storage mechanism for storing any information that is processed locally at docking station **1300**. Processing unit **1322** and local memory **1324** may be used for managing the overall operations of docking station **1300**.

Communication interface **1326** may include any wired and/or wireless communication interface for connecting to a network (not shown) and by which information may be exchanged with other computing devices that may be separate from docking station **1300** and/or with other docking stations **1300**. Examples of wired communication interfaces may include, but are not limited to, USB ports, RS232 connectors, RJ45 connectors, Ethernet, and any combinations thereof. Examples of wireless communication interfaces may include, but are not limited to, an Intranet connection, Internet, Bluetooth® technology, Wi-Fi, Wi-Max, IEEE 802.11 technology, radio frequency (RF), Infrared Data Association (IrDA) compatible protocols, Local Area Networks (LAN), Wide Area Networks (WAN), Shared Wireless Access Protocol (SWAP), any combinations thereof, and other types of wireless networking protocols.

Presence detection mechanism **1328** may include any mechanism of control electronics **1320** that is capable of determining whether a marking device **1350** is present within cradle **1314**. In one example, presence detection mechanism **1328** may be a radio frequency identification (RFID) reader that is able to read, for example, an RFID tag **1334** that is affixed to marking device **1350**. When marking device **1350** is present in cradle **1314**, the RFID reader is able to read information (e.g., a marking device ID) from RFID tag **1334**, which indicates that marking device **1350** is present in docking station **1300**. However, when marking device **1350** is not present in cradle **1314**, the RFID reader is unable to read information from RFID tag **1334**, which indicates that marking device **1350** is not present in docking station **1300**.

In another example, presence detection mechanism **1328** may include circuitry for reading the state of a “presence signal,” which may be an electronic signal that has one state (e.g., a logic high) when marking device **1350** is present and another state (e.g., a logic low) when marking device **1350** is not present. The “presence signal” may be generated based, for example, upon sensing an electrical connection (or not) between docking station **1300** and marking device **1350** at the interface of cradle **1314**.

Security detection mechanism **1330** may include any mechanism of control electronics **1320** that is capable of determining whether security mechanism **1316** is engaged

around marking device 1350 and locked. For example, presence detection mechanism 1328 may include circuitry for reading the state of a “locked signal,” which may be an electronic signal that has one state (e.g., a logic high) when security mechanism 1316 is engaged and locked and another state (e.g., a logic low) when security mechanism 1316 is not engaged and locked.

In one example, the locking mechanism of security mechanism 1316 may include an electromagnetic locking mechanism (not shown) that may be engaged/disengaged by a user of docking station 1300. In this example, the “locked signal” may be generated based upon sensing the state of the electromagnetic locking mechanism. In another example, the locking mechanism of security mechanism 1316 may include an electromechanical locking mechanism (not shown) that may be engaged/disengaged by a user of docking station 1300. Again, the “locked signal” may be generated based upon sensing the state of the electromechanical locking mechanism.

Location tracking system 1332, which is optional in docking station 1300, may include any device that can determine its geographical location to a specified degree of accuracy. For example, location tracking system 1332 may include a global positioning system (GPS) receiver or a global navigation satellite system (GNSS) receiver. A GPS receiver may provide, for example, any standard format data stream, such as a National Marine Electronics Association (NMEA) data stream. Location tracking system 1332 may also include an error correction component (not shown), which may be any mechanism for improving the accuracy of the geo-location data.

With respect to docking station 1300 being a recharging station for one or more batteries (not shown) of marking device 1350, docking station 1300 may include power management electronics 1340. When marking device 1350 is present in docking station 1300, power management electronics 1340 provides a standard battery charging function. Power management electronics 1340 is also able to communicate to control electronics 1320 the charging state of the one or more batteries of marking device 1350, for example, 50% charged, 75% charged, and so on.

Optionally, receptacles may be integrated into base 1310 of docking station 1300 for accepting rechargeable batteries 1342, which may be spare rechargeable batteries for use in marking device 1350. In one example, FIG. 1 shows two receptacles for accepting two rechargeable batteries 1342. When at least one rechargeable battery 1342 is present in base 1310, power management electronics 1340 provides a standard battery charging function. Power management electronics 1340 is also able to communicate to control electronics 1320 the presence of and the charging state of any rechargeable batteries 1342.

In operation, under the control of processing unit 1322, any information acquired and/or generated by docking station 1300 may be stored in local memory 1324. For example, information about the presence and security of marking device 1350 at docking station 1300 may be logged in local memory 1324. Information about the charging state of the one or more batteries of marking device 1350 may be logged in local memory 1324. Information about the charging state of any rechargeable batteries 1342 in base 1310 may be logged in local memory 1324. The geo-location data from location tracking system 1332 may be logged in local memory 1324, and the like.

Additionally, when marking device 1350 is present in docking station 1300, any information about locate operations (hereafter called marking data) that is stored in marking

device 1350 may be transferred from marking device 1350 to local memory 1324 of docking station 1300.

With respect to any of the aforementioned information, whether originating from docking station 1300 or from marking device 1350, communication interface 1326 may be used to exchange information between docking station 1300 and any other computing devices that may be separate from docking station 1300. Additionally, communication interface 1326 may be used to exchange information between docking station 1300 and any other docking stations 1300. Further, when, for example, marking device 1350 is in use in the field (i.e., not docked), communication interface 1326 may be used to exchange information wirelessly between docking station 1300 and marking device 1350. Docking station 1300 may communicate information regardless of whether a marking device 1350 is present. Examples of marking device docking station configurations and networks are described with reference to FIGS. 18 through 21.

FIG. 18 is a schematic diagram of a docking station network 1400, which is one example of a docking station network. In this example, docking station network 1400 may include multiple fixed marking device docking stations 1300 in communication with a central computing device.

In particular, FIG. 18 shows a bank of one or more docking stations 1300, which may be fixed and suitable for use with at least one marking device 1350 at, for example, a home base facility. The bank of docking stations 1300 may be floor-mounted along a wall 1410, as shown in FIG. 18. In another configuration, the bank of docking stations 1300 may be hung on a wall, free-standing on the floor, free-standing on a table, and any combinations thereof. In this configuration, the power source for each docking station 1300 may be designed and constructed to utilize an alternating current (AC) power source (e.g., an AC power source 1412). For example, a shielded power cord terminated in a three (3) prong plug may be used. The bank of docking stations 1300 may also be powered by direct current (DC) power sources (not shown). Each docking station 1300 allows a marking device, such as marking device 1350, to be attached and detached easily for charging and, where applicable, for data transfer.

In the configuration of docking station network 1400, the one or more docking stations 1300 are in communication with a central computing device. The central computing device may be, for example, a central control panel 1414 and/or a central server 1416. Docking stations 1300 may communicate with central control panel 1414 and/or central server 1416 via their respective communication interfaces 1326. Further, the communication of each docking station 1300 may be managed by its processing unit 1322. Central control panel 1414 and/or central server 1416 may be used to collect information from docking stations 1300, such as, but not limited to, marking device presence information, marking device security information, marking device battery status information, spare battery status information, marking data of marking devices, and the like. The information returned from docking stations 1300 may be useful, for example, for monitoring marking device inventory, monitoring marking device battery status, monitoring marking device security, monitoring spare battery inventory and status, collecting marking data, and so on.

By way of example and referring again to FIG. 18, by using the processing and communications capabilities of docking stations 1300a through 1300g, central control panel 1414 and/or central server 1416 may determine, log, and report the following.

- a) no marking device 1350 is present in docking station 1300a, two rechargeable batteries 1342 are present in

- docking station **1300a**, the first rechargeable battery **1342** is 100% charged, the second rechargeable battery **1342** is 100% charged;
- b) no marking device **1350** is present in docking station **1300b**, no rechargeable batteries **1342** are present in docking station **1300b**;
- c) no marking device **1350** is present in docking station **1300c**, one rechargeable battery **1342** is present in docking station **1300c**, the rechargeable battery **1342** is 78% charged;
- d) a marking device **1350d** is present in docking station **1300d**, marking device **1350d** is locked down and secure, the batteries of marking device **1350d** are 100% charged, two rechargeable batteries **1342** are present in docking station **1300d**, the first rechargeable battery **1342** is 100% charged, the second rechargeable battery **1342** is 100% charged;
- e) a marking device **1350e** is present in docking station **1300e**, marking device **1350e** is locked down and secure, the batteries of marking device **1350e** are 67% charged, two rechargeable batteries **1342** are present in docking station **1300e**, the first rechargeable battery **1342** is 82% charged, the second rechargeable battery **1342** is 74% charged;
- f) no marking device **1350** is present in docking station **1300f**, no rechargeable batteries **1342** are present in docking station **1300f**;
- g) a marking device **1350g** is present in docking station **1300g**, marking device **1350g** is not locked down and secure, the batteries of marking device **1350g** are 100% charged, two rechargeable batteries **1342** are present in docking station **1300g**, the first rechargeable battery **1342** is 100% charged, the second rechargeable battery **1342** is 94% charged;
- h) three of a possible seven marking devices **1350** are present and accounted for, two of the three present are fully charged, one of the three present is not fully charged; and
- i) ten of a possible fourteen rechargeable batteries **1342** are present and accounted for, five of the ten present are fully charged, five of the ten present are not fully charged.

FIG. 19 is a schematic diagram of a docking station network **1500**, which is another example of a docking station network. In this example, docking station network **1500** may include multiple mobile marking device docking stations **1300** in the field and in communication with an onsite computing device. More specifically, FIG. 19 shows multiple vehicles **1510**, such as a vehicle **1510a**, **1510b**, and **1510c**. Installed in each vehicle **1510** is a docking station **1300**. For example, installed in vehicles **1510a**, **1510b**, and **1510c** are docking stations **1300a**, **1300b**, and **1300c**, respectively. Vehicles **1510a**, **1510b**, and **1510c** may be, for example, the vehicles of locate technicians that are dispatched to a jobsite in the field. Docking stations **1300a**, **1300b**, and **1300c** are used to hold marking devices (not shown) in vehicles **1510a**, **1510b**, and **1510c**. In this configuration, the power source for each docking station **1300** may be designed and constructed to utilize the DC power of a vehicle. Alternatively, instead of multiple docking stations **1300** in multiple vehicles **1510**, there may be multiple docking stations **1300** in a one vehicle **1510**.

In the configuration of docking station network **1510**, the one or more docking stations **1300** are in communication with a central computing device. In one example, the central computing device may be an onsite computer **1520**. Onsite computer **1520** may be any onsite computing device, such as, but

not limited to, a laptop computer, a handheld computer, and a tablet device, that has network capability. In particular, onsite computer **1520** is capable of communicating with any docking stations **1300** within its range. In one example, onsite computer **1520** may be present in one of the vehicles **1510**.

As described with reference to FIG. 18, by using the processing and communications capabilities of docking stations **1300a**, **1300b**, and **1300c**, onsite computer **1520** may determine, log, and report, for example, marking device presence, marking device battery status, marking device security, spare battery presence and status, marking data from each marking device, and so on.

FIG. 20 is a schematic diagram of a docking station network **1600**, which is yet another example of a docking station network. In this example, docking station network **1600** may include multiple mobile marking device docking stations **1300** in the field and in communication with each other. Docking station network **1600** is substantially the same as docking station network **1500** of FIG. 19, except that the multiple docking stations **1300** are communicating directly with each other instead of to a central computing device, such as onsite computer **1520** of FIG. 19.

With respect to docking station network **1600**, any docking station **1300** may poll any other docking station **1300** to determine their status (i.e., peer-to-peer communication). This may be accomplished using communication interface **1326** of each docking station **1300**, which may have short range wireless communication capability, such as Bluetooth®.

The configuration of docking station network **1600** may be useful, for example, to implement certain protocols with respect to performing locate operations. In one example, a project ticket calls for two locate technicians. Therefore, two vehicles **1510** with two docking stations **1300** (holding two marking devices), respectively, are present at the jobsite. In this example, a software rule may be implemented that once the locate operation is complete, the marking devices **1350** must be present in the respective docking stations **1300** before any data from either marking device **1350** is processed and before the ticket can be classified as complete. In order to accomplish this, there is communication between the two docking stations **1300** as to the presence of their respective marking devices **1350** and no data can be transferred until both are present. This may be useful to ensure a complete set of data to accompany the completed project ticket (i.e., eliminating any chance of partial data). Further, this scenario may ensure the association of data of the two marking devices involved. Any removal of either marking device in the middle of data transfer is communicated between the two docking stations **1300**, which will stop data transfer of the remaining marking device.

FIG. 21 is a schematic diagram of a docking station network **1700**, which is still another example of a docking station network. In this example, docking station network **1700** may include at least one marking device docking station **1300** in communication with at least one marking device **1350**.

Docking station network **1700** is an example of using communication interface **1326** of docking station **1300** to exchange information wirelessly with a marking device **1350**. The configuration of docking station network **1700** may be useful, for example, to implement certain protocols with respect to performing locate operations. In one example, docking station **1300** may receive a message from an external system via, for example, onsite computer **1520** of FIG. 19. This message is then flashed from docking station **1300** to its

associated marking device 1350. The user of marking device 1350 receives the message at his/her marking device 1350 and may respond accordingly.

The various methods or processes outlined herein may be coded as software that is executable on one or more processors that employ any one of a variety of operating systems or platforms. Additionally, such software may be written using any of a number of suitable programming languages and/or programming or scripting tools, and also may be compiled as executable machine language code or intermediate code that is executed on a framework or virtual machine.

In this respect, various inventive concepts may be embodied as a computer readable storage medium (or multiple computer readable storage media) (e.g., a computer memory, one or more floppy discs, compact discs, optical discs, magnetic tapes, flash memories, circuit configurations in Field Programmable Gate Arrays or other semiconductor devices, or other tangible computer storage medium) encoded with one or more programs that, when executed on one or more computers or other processors, perform methods that implement the various embodiments of the invention discussed above. The computer readable medium or media can be transportable, such that the program or programs stored thereon can be loaded onto one or more different computers or other processors to implement various aspects of the present invention as discussed above.

The terms "program" or "software" are used herein in a generic sense to refer to any type of computer code or set of computer-executable instructions that can be employed to program a computer or other processor to implement various aspects of embodiments as discussed above. Additionally, it should be appreciated that according to one aspect, one or more computer programs that when executed perform methods of the present invention need not reside on a single computer or processor, but may be distributed in a modular fashion amongst a number of different computers or processors to implement various aspects of the present invention.

Computer-executable instructions may be in many forms, such as program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. Typically the functionality of the program modules may be combined or distributed as desired in various embodiments.

Also, data structures may be stored in computer-readable media in any suitable form. For simplicity of illustration, data structures may be shown to have fields that are related through location in the data structure. Such relationships may likewise be achieved by assigning storage for the fields with locations in a computer-readable medium that convey relationship between the fields. However, any suitable mechanism may be used to establish a relationship between information in fields of a data structure, including through the use of pointers, tags or other mechanisms that establish relationship between data elements.

Also, various inventive concepts may be embodied as one or more methods, of which an example has been provided. The acts performed as part of the method may be ordered in any suitable way. Accordingly, embodiments may be constructed in which acts are performed in an order different than illustrated, which may include performing some acts simultaneously, even though shown as sequential acts in illustrative embodiments.

All definitions, as defined and used herein, should be understood to control over dictionary definitions, definitions

in documents incorporated by reference, and/or ordinary meanings of the defined terms.

The indefinite articles "a" and "an," as used herein in the specification and in the claims, unless clearly indicated to the contrary, should be understood to mean "at least one."

The phrase "and/or," as used herein in the specification and in the claims, should be understood to mean "either or both" of the elements so conjoined, i.e., elements that are conjunctively present in some cases and disjunctively present in other cases. Multiple elements listed with "and/or" should be construed in the same fashion, i.e., "one or more" of the elements so conjoined. Other elements may optionally be present other than the elements specifically identified by the "and/or" clause, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, a reference to "A and/or B", when used in conjunction with open-ended language such as "comprising" can refer, in one embodiment, to A only (optionally including elements other than B); in another embodiment, to B only (optionally including elements other than A); in yet another embodiment, to both A and B (optionally including other elements); etc.

As used herein in the specification and in the claims, "or" should be understood to have the same meaning as "and/or" as defined above. For example, when separating items in a list, "or" or "and/or" shall be interpreted as being inclusive, i.e., the inclusion of at least one, but also including more than one, of a number or list of elements, and, optionally, additional unlisted items. Only terms clearly indicated to the contrary, such as "only one of" or "exactly one of," or, when used in the claims, "consisting of," will refer to the inclusion of exactly one element of a number or list of elements. In general, the term "or" as used herein shall only be interpreted as indicating exclusive alternatives (i.e. "one or the other but not both") when preceded by terms of exclusivity, such as "either," "one of," "only one of," or "exactly one of." "Consisting essentially of," when used in the claims, shall have its ordinary meaning as used in the field of patent law.

As used herein in the specification and in the claims, the phrase "at least one," in reference to a list of one or more elements, should be understood to mean at least one element selected from any one or more of the elements in the list of elements, but not necessarily including at least one of each and every element specifically listed within the list of elements and not excluding any combinations of elements in the list of elements. This definition also allows that elements may optionally be present other than the elements specifically identified within the list of elements to which the phrase "at least one" refers, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, "at least one of A and B" (or, equivalently, "at least one of A or B," or, equivalently "at least one of A and/or B") can refer, in one embodiment, to at least one, optionally including more than one, A, with no B present (and optionally including elements other than B); in another embodiment, to at least one, optionally including more than one, B, with no A present (and optionally including elements other than A); in yet another embodiment, to at least one, optionally including more than one, A, and at least one, optionally including more than one, B (and optionally including other elements); etc.

In the claims, as well as in the specification above, all transitional phrases such as "comprising," "including," "carrying," "having," "containing," "involving," "holding," "composed of," and the like are to be understood to be open-ended, i.e., to mean including but not limited to. Only the transitional phrases "consisting of" and "consisting essentially of" shall be closed or semi-closed transitional phrases,

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respectively, as set forth in the United States Patent Office Manual of Patent Examining Procedures, Section 2111.03.

What is claimed is:

1. A docking station for docking a marking device of a type used to mark a presence or absence of an underground facility in a dig area, the docking station comprising:

a housing;

an electronic interface to transfer information to and from the marking device of the type used to mark the presence or absence of the underground facility in the dig area;

docking control electronics to control operation of the docking station; a user interface of the docking station to interact with a user; and

a local memory, communicatively coupled to the electronic interface and the docking control electronics, to store at least marking device information transferred from the marking device to the docking station.

2. A docking station as defined in claim 1, further comprising a communication interface to transfer marking device information to and from a computing device.

3. A docking station as defined in claim 1, wherein the docking control electronics is configured to store the marking device information in the local memory for later transfer to a computing device.

4. A docking station as defined in claim 1, wherein the docking control electronics is configured to control transfer of data to and between the marking device and a computing device.

5. A docking station as defined in claim 1, wherein the docking control electronics is configured to control data synchronization between the docking station and the marking device.

6. A docking station as defined in claim 1, further comprising a wired interface for wired communication between the docking station and a computing device.

7. A docking station as defined in claim 1, further comprising a wireless interface for wireless communication between the docking station and a computing device.

8. A docking station as defined in claim 1, further comprising a wired interface for wired communication between the docking station and the marking device.

9. A docking station as defined in claim 1, further comprising a wireless interface for wireless communication between the docking station and the marking device.

10. A docking station as defined in claim 1, wherein the user interface includes a touch screen to receive user inputs and to display information to a user.

11. A docking station as defined in claim 1, wherein the user interface includes a keypad to receive user inputs.

12. A docking station as defined in claim 1, wherein the user interface includes one or more light emitting devices.

13. A docking station as defined in claim 1, wherein the user interface includes a display device to display information associated with docking station operation.

14. A docking station as defined in claim 1, wherein the user interface includes one or more sound emitting devices.

15. A docking station as defined in claim 1, further comprising at least one control input to enable control of the docking station by a user.

16. A docking station as defined in claim 1, further comprising at least one indicator to indicate an operating condition of the docking station and/or the marking device.

17. A docking station as defined in claim 1, further comprising a control interface to receive control inputs from an external user interface.

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18. A docking station as defined in claim 1, further comprising a timing system to generate a current date and time.

19. A docking station as defined in claim 18, wherein the docking control electronics is configured to record dates and times of docking and/or undocking of the marking device.

20. A docking station as defined in claim 18, wherein the docking control electronics is configured to record dates and times of docking station operations.

21. A docking station as defined in claim 18, wherein the docking control electronics is configured to record a date and time of testing, diagnostics and/or calibration of the marking device.

22. A docking station as defined in claim 1, further comprising a location tracking system to determine geographical coordinates of the docking station.

23. A docking station as defined in claim 22, wherein the docking control electronics is configured to record the geographical coordinates of the docking station upon docking and undocking of the marking device.

24. A docking station as defined in claim 22, wherein the docking control electronics is configured to record the geographical coordinates of the docking station during docking station operations.

25. A docking station as defined in claim 22, wherein the docking control electronics is configured to receive geographical coordinates of the marking device and to record the geographical coordinates of the marking device relative to the geographical coordinates of the docking station.

26. A docking station as defined in claim 1, wherein the docking control electronics is configured to execute a diagnostics routine for testing of the marking device.

27. A docking station as defined in claim 1, wherein the docking control electronics is configured to execute a diagnostics routine for testing of the docking station.

28. A docking station as defined in claim 1, wherein the docking control electronics is configured to execute a calibration routine for calibration of the marking device.

29. A docking station as defined in claim 1, further comprising a power interface to charge a battery in the marking device.

30. A docking station as defined in claim 29, wherein the docking control electronics is configured to determine a charge state of the battery in the marking device.

31. A docking station as defined in claim 29, wherein the docking control electronics is configured to record a date and time of battery charging.

32. A docking station as defined in claim 29, wherein the docking control electronics is configured to record geographical coordinates of battery charging.

33. A docking station as defined in claim 29, wherein the docking control electronics is configured to determine a battery quality and/or a battery capacity of the battery in the marking device.

34. A docking station as defined in claim 1, wherein the docking control electronics is configured to verify the identity of the marking device.

35. A docking station as defined in claim 34, wherein the docking control electronics is configured to verify an identity of the marking device by receiving an identification from the marking device and comparing the received identification with stored identifications of marking devices.

36. A docking station as defined in claim 35, wherein the docking control electronics is configured to generate an alert if the received identification does not match one of the stored identifications of marking devices.

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