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*[Continued on next page]*

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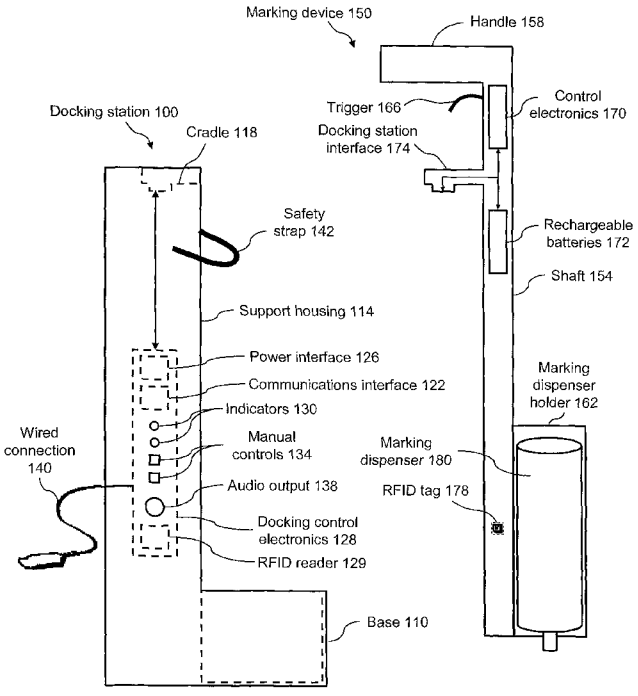


*FIG. 1*

(57) Abstract: A docking station to dock locating equipment (e.g., marking devices, locate devices, combined locate and marking devices) may be communicatively coupled to and/or equipped with a mobile/portable device (e.g., a mobile phone, personal digital assistant or other portable computing device) that provides processing, electronic storage, electronic display, user interface, communication facilities and/or other functionality (e.g., GPS-enabled functionality) for the docking station. A mobile/portable device may be mechanically and/or electrically coupled to the docking station. The mobile/portable device may provide redundant, shared and/or backup functionality for the docking station to enhance robustness. In one example, the mobile/portable device itself serves as a docking station for the locating equipment.

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# LOCATING EQUIPMENT DOCKING STATION COMMUNICATIVELY COUPLED TO OR EQUIPPED WITH A MOBILE/PORTABLE DEVICE

## CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** The present application claims a priority benefit to U.S. provisional application serial no. 61/299,492, filed January 29, 2010, entitled "Marking Device Docking Stations and Methods of Using Same," which application is hereby incorporated herein by reference in its entirety.

## BACKGROUND

**[0002]** Some types of field technicians, such as land surveyors and underground utility location technicians, use various types of marking materials to identify specific locations on the ground during their field work. For this purpose, the field technician may employ a "marking device" to dispense a marking material on the ground, pavement, or other surface. Marking material may be any material, substance, compound, and/or element, 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. Marking devices, such as paint marking wands and/or paint marking wheels, provide a convenient method of dispensing marking materials onto surfaces such as ground or pavement.

**[0003]** Conventional marking devices such as paint marking wands and/or paint marking wheels are relatively simple mechanical devices without electronic components, and hence are relatively inexpensive. Accordingly, the cost of individual marking devices generally is considered insignificant by the field technician using the device. Consequently, users/technicians 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.

**[0004]** Further, users/technicians may carelessly stow marking devices in their vehicles. For example, users/technicians 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.

## SUMMARY

**[0005]** The Applicants have designed significantly improved marking devices to facilitate more reliable and efficient performance of marking operations. Such marking devices also enable acquisition of various field information relating to use of the marking device and performance of marking operations, and storage and transmission of such information for analytical (e.g., quality assessment) and/or archival purposes. Examples of such marking devices are described in the following published U.S. applications: U.S. publication no. 2008-0228294-A1, published September 18, 2008, filed March 13, 2007, and entitled "Marking System and Method With Location and/or Time Tracking;" U.S. publication no. 2008-0245299-Al, published October 9, 2008, filed April 4, 2007, and entitled "Marking System and Method;" U.S. publication no. 2010-0086677 Al, published April 8, 2010, filed August 11, 2009, and entitled, "Methods and Apparatus for Generating an Electronic Record of a Marking Operation Including Service-Related Information and Ticket Information;" U.S. publication no. 2010-0088032-Al, published April 8, 2010, filed September 29, 2009, and entitled, "Methods, Apparatus and Systems for Generating Electronic Records of Locate And Marking Operations, and Combined Locate and Marking Apparatus for Same;" and U.S. publication no. 2010-0189887 Al, published July 29, 2010, filed February 11, 2010, and entitled "Marking Apparatus Having Enhanced Features for Underground Facility Marking Operations, and Associated Methods and Systems," each of which publications is incorporated herein by reference.

[0006] As marking devices become more complex and incorporate additional functions, these devices become more costly. Accordingly, Applicants have recognized and appreciated that approaches are needed 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.

[0007] In view of the foregoing, various inventive embodiments disclosed herein relate to docking stations for use with such marking devices and to methods for using the docking station with a marking device. In various aspects, 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/or 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.

[0008] In some embodiments, a docking station may be communicatively coupled to and/or equipped with a mobile/portable device (e.g., a mobile computing device), such as a cellular phone or personal digital assistant (PDA), that provides processing, electronic storage, electronic display, user interface, communication facilities, and/or other functionality (e.g., GPS-enabled functionality) for the docking station. In some exemplary implementations, the mobile/portable device may provide essentially all of the processing and related functionality required to operate the docking station, while in other implementations the mobile/portable device may only provide some portion of the overall functionality. In yet other implementations, the mobile/portable device may provide redundant, shared and/or backup functionality for the docking station to enhance robustness.

[0009] In one exemplary implementation, a mobile/portable device may be mechanically coupled to the docking station (e.g., via an appropriate mobile device cradle, harness, or other attachment arrangement) or otherwise integrated with the docking station and communicatively coupled to the docking station (e.g., via one or more wired or wireless connections), so as to permit one or more electronic signals to be communicated between the mobile/portable device and other components of the docking station.

[0010] In some exemplary implementations, one or more electronic signals indicative of operation of the docking station may be supplied by one or more components of the docking station to the mobile/portable device. In other aspects, the mobile/portable device may be appropriately programmed so as to log and generate electronic records of various locate information, marking information, and or landmark information, obtained from one or more pieces of locating equipment (e.g., marking devices, combined marking and locating devices) communicatively coupled to the docking station. Such records may be formatted in various manners, processed and/or analyzed on the mobile/portable device, and/or transmitted to another device (e.g., a remote computer/server) for storage, processing and/or analysis. In one example, one or more pieces of geo-location data (e.g., from a GPS receiver, which may be integrated into the mobile/portable device) are collected and logged on the mobile/portable device. A computer-generated image or other visual representation of a locate and/or marking operation may be electronically rendered in a display field of the mobile/portable device based on logged locate information, marking information, and/or landmark information.

[0011] In sum, one embodiment of the present invention is directed to an apparatus comprising a docking station to dock locating equipment of the type used to locate and/or mark a presence or an absence of an underground facility. The docking station comprises a mobile device interface to facilitate mechanical, electrical and/or communicative coupling of a mobile or portable computing device to the docking station.

[0012] Another embodiment is directed to a system comprising the above-mentioned docking station and the mobile or portable computing device communicatively coupled to the docking station via the mobile device interface.

[0013] Another embodiment is directed to a method for docking locating equipment of the type used to locate and/or mark a presence or an absence of an underground facility. The method comprises: mechanically, electronically and/or communicatively coupling the locating equipment to a docking station; and performing one or more operations of the docking station using a mobile or computing device communicatively coupled to the docking station.

[0014] Another embodiment is directed to a docking station for docking a marking device of the type used to mark a presence or an absence of an underground facility. The docking station comprises a mobile computing device including an electronic interface configured to transfer information to and from the marking device, the mobile computing device programmed to perform at least one operation involving communication with the marking device and functioning as a docking station for the marking device.

[0015] Another embodiment is directed to a method for operating a marking device of the type used to mark a presence or an absence of an underground facility. The method comprises: electronically coupling a mobile computing device to the marking device; and transferring information to and between the marking device and the mobile computing device, wherein the mobile computing device functions as a docking station for the marking device.

[0016] Another embodiment is directed to a system, comprising a marking device configured to mark a presence or an absence of an underground facility, and a mobile computing device communicatively coupled to the marking device, wherein the mobile computing device functions as a docking station for the marking device.

[0017] For purposes of the present disclosure, the term "dig area" refers to a specified area of a work site within 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.

[0018] 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.

[0019] 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").

[0020] 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.

[0021] 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.

[0022] 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.

**[0023]** 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.

**[0024]** 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.

**[0025]** 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.

**[0026]** The following U.S. published applications are hereby incorporated herein by reference:

**[0027]** U.S. patent no. 7,640,105, issued December 29, 2009, filed March 13, 2007, and entitled "Marking System and Method With Location and/or Time Tracking;"

**[0028]** U.S. publication no. 2010-0094553-A1, published April 15, 2010, filed December 16, 2009, and entitled "Systems and Methods for Using Location Data and/or Time Data to Electronically Display Dispensing of Markers by A Marking System or Marking Tool;"

**[0029]** U.S. publication no. 2008-0245299-A1 , published October 9, 2008, filed April 4, 2007, and entitled "Marking System and Method;"

**[0030]** U.S. publication no. 2009-001 3928-A1, published January 15, 2009, filed September 24, 2008, and entitled "Marking System and Method;"

**[0031]** U.S. publication no. 2010-0090858-A1, published April 15, 2010, filed December 16, 2009, and entitled "Systems and Methods for Using Marking Information to Electronically Display Dispensing of Markers by a Marking System or Marking Tool;"

**[0032]** U.S. publication no. 2009-0238414-A1, published September 24, 2009, filed March 18, 2008, and entitled "Virtual White Lines for Delimiting Planned Excavation Sites;"

**[0033]** U.S. publication no. 2009-0241 045-A1, published September 24, 2009, filed September 26, 2008, and entitled "Virtual White Lines for Delimiting Planned Excavation Sites;"

**[0034]** U.S. publication no. 2009-023841 5-A1, published September 24, 2009, filed September 26, 2008, and entitled "Virtual White Lines for Delimiting Planned Excavation Sites;"

**[0035]** U.S. publication no. 2009-0241 046-A1, published September 24, 2009, filed January 16, 2009, and entitled "Virtual White Lines for Delimiting Planned Excavation Sites;"

**[0036]** U.S. publication no. 2009-023 8416-A 1, published September 24, 2009, filed January 16, 2009, and entitled "Virtual White Lines for Delimiting Planned Excavation Sites;"

**[0037]** U.S. publication no. 2009-0237408-A1 , published September 24, 2009, filed January 16, 2009, and entitled "Virtual White Lines for Delimiting Planned Excavation Sites;"

**[0038]** U.S. publication no. 2009-0202 10 1-Al, published August 13, 2009, filed February 12, 2008, and entitled "Electronic Manifest of Underground Facility Locate Marks;"

**[0039]** U.S. publication no. 2009-02021 10-Al, published August 13, 2009, filed September 11, 2008, and entitled "Electronic Manifest of Underground Facility Locate Marks;"

**[0040]** U.S. publication no. 2009-020131 1-Al, published August 13, 2009, filed January 30, 2009, and entitled "Electronic Manifest of Underground Facility Locate Marks;"

**[0041]** U.S. publication no. 2009-02021 11-Al, published August 13, 2009, filed January 30, 2009, and entitled "Electronic Manifest of Underground Facility Locate Marks;"

**[0042]** U.S. publication no. 2009-0204625-A1 , published August 13, 2009, filed February 5, 2009, and entitled "Electronic Manifest of Underground Facility Locate Operation;"

**[0043]** U.S. publication no. 2009-0204466-A1, published August 13, 2009, filed September 4, 2008, and entitled "Ticket Approval System For and Method of Performing Quality Control In Field Service Applications;"

**[0044]** U.S. publication no. 2009-020701 9-A 1, published August 20, 2009, filed April 30, 2009, and entitled "Ticket Approval System For and Method of Performing Quality Control In Field Service Applications;"

**[0045]** U.S. publication no. 2009-02 10284-A1, published August 20, 2009, filed April 30, 2009, and entitled "Ticket Approval System For and Method of Performing Quality Control In Field Service Applications;"

**[0046]** U.S. publication no. 2009-02 10297-A 1, published August 20, 2009, filed April 30, 2009, and entitled "Ticket Approval System For and Method of Performing Quality Control In Field Service Applications;"

**[0047]** U.S. publication no. 2009-02 10298-A1, published August 20, 2009, filed April 30, 2009, and entitled "Ticket Approval System For and Method of Performing Quality Control In Field Service Applications;"

**[0048]** U.S. publication no. 2009-02 10285-A1, published August 20, 2009, filed April 30, 2009, and entitled "Ticket Approval System For and Method of Performing Quality Control In Field Service Applications;"

**[0049]** U.S. publication no. 2009-03248 15-A1, published December 31, 2009, filed April 24, 2009, and entitled "Marking Apparatus and Marking Methods Using Marking Dispenser with Machine-Readable ID Mechanism;"

**[0050]** U.S. publication no. 2010-0006667-A1, published January 14, 2010, filed April 24, 2009, and entitled, "Marker Detection Mechanisms for use in Marking Devices And Methods of Using Same;"

**[0051]** U.S. publication no. 2010-0085694 Al, published April 8, 2010, filed September 30, 2009, and entitled, "Marking Device Docking Stations and Methods of Using Same;"

**[0052]** U.S. publication no. 2010-0085701 Al, published April 8, 2010, filed September 30, 2009, and entitled, "Marking Device Docking Stations Having Security Features and Methods of Using Same;"

**[0053]** U.S. publication no. 2010-0084532 Al, published April 8, 2010, filed September 30, 2009, and entitled, "Marking Device Docking Stations Having Mechanical Docking and Methods of Using Same;"

**[0054]** U.S. publication no. 2010-0088032-A1, published April 8, 2010, filed September 29, 2009, and entitled, "Methods, Apparatus and Systems for Generating Electronic Records of Locate And Marking Operations, and Combined Locate and Marking Apparatus for Same;"

**[0055]** U.S. publication no. 2010-0117654 Al, published May 13, 2010, filed December 30, 2009, and entitled, "Methods and Apparatus for Displaying an Electronic Rendering of a Locate and/or Marking Operation Using Display Layers;"

**[0056]** U.S. publication no. 2010-0086677 Al, published April 8, 2010, filed August 11, 2009, and entitled, "Methods and Apparatus for Generating an Electronic Record of a Marking Operation Including Service-Related Information and Ticket Information;"

**[0057]** U.S. publication no. 2010-0086671 Al, published April 8, 2010, filed November 20, 2009, and entitled, "Methods and Apparatus for Generating an Electronic Record of A Marking Operation Including Service-Related Information and Ticket Information;"

**[0058]** U.S. publication no. 2010-0085376 Al, published April 8, 2010, filed October 28, 2009, and entitled, "Methods and Apparatus for Displaying an Electronic Rendering of a Marking Operation Based on an Electronic Record of Marking Information;"

**[0059]** U.S. publication no. 2010-0088164-A1 , published April 8, 2010, filed September 30, 2009, and entitled, "Methods and Apparatus for Analyzing Locate and Marking Operations with Respect to Facilities Maps;"

**[0060]** U.S. publication no. 2010-0088134 Al, published April 8, 2010, filed October 1, 2009, and entitled, "Methods and Apparatus for Analyzing Locate and Marking Operations with Respect to Historical Information;"

**[0061]** U.S. publication no. 2010-0088031 Al, published April 8, 2010, filed September 28, 2009, and entitled, "Methods and Apparatus for Generating an Electronic Record of Environmental Landmarks Based on Marking Device Actuations;"

**[0062]** U.S. publication no. 2010-0188407 Al, published July 29, 2010, filed February 5, 2010, and entitled "Methods and Apparatus for Displaying and

Processing Facilities Map Information and/or Other Image Information on a Marking Device;"

**[0063]** U.S. publication no. 2010-0198663 Al, published August 5, 2010, filed February 5, 2010, and entitled "Methods and Apparatus for Overlaying Electronic Marking Information on Facilities Map Information and/or Other Image Information Displayed on a Marking Device;"

**[0064]** U.S. publication no. 2010-0188215 Al, published July 29, 2010, filed February 5, 2010, and entitled "Methods and Apparatus for Generating Alerts on a Marking Device, Based on Comparing Electronic Marking Information to Facilities Map Information and/or Other Image Information;"

**[0065]** U.S. publication no. 2010-0188088 Al, published July 29, 2010, filed February 5, 2010, and entitled "Methods and Apparatus for Displaying and Processing Facilities Map Information and/or Other Image Information on a Locate Device;"

**[0066]** U.S. publication no. 2010-0189312 Al, published July 29, 2010, filed February 5, 2010, and entitled "Methods and Apparatus for Overlaying Electronic Locate Information on Facilities Map Information and/or Other Image Information Displayed on a Locate Device;"

**[0067]** U.S. publication no. 2010-0188216 Al, published July 29, 2010, filed February 5, 2010, and entitled "Methods and Apparatus for Generating Alerts on a Locate Device, Based ON Comparing Electronic Locate Information TO Facilities Map Information and/or Other Image Information;"

**[0068]** U.S. publication no. 2010-0189887 Al, published July 29, 2010, filed February 11, 2010, and entitled "Marking Apparatus Having Enhanced Features for Underground Facility Marking Operations, and Associated Methods and Systems;"

**[0069]** U.S. publication no. 2010-0188245 Al, published July 29, 2010, filed February 11, 2010, and entitled "Locate Apparatus Having Enhanced Features for Underground Facility Locate Operations, and Associated Methods and Systems;"

**[0070]** U.S. publication no. 2009-0204238-A1, published August 13, 2009, filed February 2, 2009, and entitled "Electronically Controlled Marking Apparatus and Methods;"

**[0071]** U.S. publication no. 2009-0208642-A1, published August 20, 2009, filed February 2, 2009, and entitled "Marking Apparatus and Methods For Creating an Electronic Record of Marking Operations;"

**[0072]** U.S. publication no. 2009-021 0098-A1, published August 20, 2009, filed February 2, 2009, and entitled "Marking Apparatus and Methods For Creating an Electronic Record of Marking Apparatus Operations;"

**[0073]** U.S. publication no. 2009-0201 178-A1, published August 13, 2009, filed February 2, 2009, and entitled "Methods For Evaluating Operation of Marking Apparatus;"

**[0074]** U.S. publication no. 2009-023 841 7-A1, published September 24, 2009, filed February 6, 2009, and entitled "Virtual White Lines for Indicating Planned Excavation Sites on Electronic Images;"

**[0075]** U.S. publication no. 201 0-0205264-A1, published August 12, 2010, filed February 10, 2010, and entitled "Methods, Apparatus, and Systems for Exchanging Information Between Excavators and Other Entities Associated with Underground Facility Locate and Marking Operations;"

**[0076]** U.S. publication no. 201 0-020503 1-Al, published August 12, 2010, filed February 10, 2010, and entitled "Methods, Apparatus, and Systems for Exchanging Information Between Excavators and Other Entities Associated with Underground Facility Locate and Marking Operations;"

**[0077]** U.S. publication no. 20 10-020 1706-A 1, published August 12, 2010, filed June 1, 2009, and entitled "Virtual White Lines (VWL) for Delimiting Planned Excavation Sites of Staged Excavation Projects;"

**[0078]** U.S. publication no. 2010-0205555-A1, published August 12, 2010, filed June 1, 2009, and entitled "Virtual White Lines (VWL) for Delimiting Planned Excavation Sites of Staged Excavation Projects;"

**[0079]** U.S. publication no. 2010-0205195-A1, published August 12, 2010, filed June 1, 2009, and entitled "Methods and Apparatus for Associating a Virtual White Line (VWL) Image with Corresponding Ticket Information for an Excavation Project;"

**[0080]** U.S. publication no. 2010-0205536-A1, published August 12, 2010, filed June 1, 2009, and entitled "Methods and Apparatus for Controlling Access to a Virtual White Line (VWL) Image for an Excavation Project;"

**[0081]** U.S. publication no. 2010-0228588-A1, published September 9, 2010, filed February 11, 2010, and entitled "Management System, and Associated Methods and Apparatus, for Providing Improved Visibility, Quality Control and Audit Capability for Underground Facility Locate and/or Marking Operations;"

**[0082]** U.S. publication no. 2010-0201690-A1, published August 12, 2010, filed April 13, 2009, and entitled "Virtual White Lines (VWL) Application for Indicating a Planned Excavation or Locate Path;"

**[0083]** U.S. publication no. 2010-0205554-A1, published August 12, 2010, filed April 13, 2009, and entitled "Virtual White Lines (VWL) Application for Indicating an Area of Planned Excavation;"

**[0084]** U.S. publication no. 2009-0202112-A1, published August 13, 2009, filed February 11, 2009, and entitled "Searchable Electronic Records of Underground Facility Locate Marking Operations;"

**[0085]** U.S. publication no. 2009-0204614-Al, published August 13, 2009, filed February 11, 2009, and entitled "Searchable Electronic Records of Underground Facility Locate Marking Operations;"

**[0086]** U.S. publication no. 2010-0205032-A1, published August 12, 2010, filed February 11, 2010, and entitled "Marking Apparatus Equipped with Ticket Processing Software for Facilitating Marking Operations, and Associated Methods;"

**[0087]** U.S. publication no. 2009-0327024-A1, published December 31, 2009, filed June 26, 2009, and entitled "Methods and Apparatus for Quality Assessment of a Field Service Operation;"

**[0088]** U.S. publication no. 2010-0010862-A1, published January 14, 2010, filed August 7, 2009, and entitled, "Methods and Apparatus for Quality Assessment of a Field Service Operation Based on Geographic Information;"

**[0089]** U.S. publication No. 2010-0010863-A1, published January 14, 2010, filed August 7, 2009, and entitled, "Methods and Apparatus for Quality Assessment of a Field Service Operation Based on Multiple Scoring Categories;"

**[0090]** U.S. publication no. 2010-0010882-A1, published January 14, 2010, filed August 7, 2009, and entitled, "Methods and Apparatus for Quality Assessment of a Field Service Operation Based on Dynamic Assessment Parameters;"

**[0091]** U.S. publication no. 2010-0010883-A1, published January 14, 2010, filed August 7, 2009, and entitled, "Methods and Apparatus for Quality Assessment of a Field Service Operation Based on Multiple Quality Assessment Criteria;"

**[0092]** U.S. publication no. 2010-0088135 Al, published April 8, 2010, filed October 1, 2009, and entitled, "Methods and Apparatus for Analyzing Locate and Marking Operations with Respect to Environmental Landmarks;"

**[0093]** U.S. publication no. 2010-0085185 Al, published April 8, 2010, filed September 30, 2009, and entitled, "Methods and Apparatus for Generating Electronic Records of Locate Operations;"

**[0094]** U.S. publication no. 2010-0090700-A1, published April 15, 2010, filed October 30, 2009, and entitled "Methods and Apparatus for Displaying an Electronic Rendering of a Locate Operation Based on an Electronic Record of Locate Information;"

**[0095]** U.S. publication no. 2010-0085054 Al, published April 8, 2010, filed September 30, 2009, and entitled, "Systems and Methods for Generating Electronic Records of Locate And Marking Operations;"

**[0096]** U.S. publication no. 2010-0256825-A1, published October 7, 2010, filed June 9, 2010, and entitled "Marking Apparatus Having Operational Sensors For Underground Facility Marking Operations, And Associated Methods And Systems;"

**[0097]** U.S. publication no. 201 0-0255 182-A1, published October 7, 2010, filed June 9, 2010, and entitled "Marking Apparatus Having Operational Sensors For Underground Facility Marking Operations, And Associated Methods And Systems;"

**[0098]** U.S. publication no. 2010-0245086-A1, published September 30, 2010, filed June 9, 2010, and entitled "Marking Apparatus Configured To Detect Out-Of-Tolerance Conditions In Connection With Underground Facility Marking Operations, And Associated Methods And Systems;"

**[0099]** U.S. publication no. 2010-0247754-A1, published September 30, 2010, filed June 9, 2010, and entitled "Methods and Apparatus For Dispensing Marking Material In Connection With Underground Facility Marking Operations Based on Environmental Information and/or Operational Information;"

**[00100]** U.S. publication no. 2010-0262470-A1, published October 14, 2010, filed June 9, 2010, and entitled "Methods, Apparatus, and Systems For Analyzing Use of a Marking Device By a Technician To Perform An Underground Facility Marking Operation;"

**[00101]** U.S. publication no. 2010-0263591-A1, published October 21, 2010, filed June 9, 2010, and entitled "Marking Apparatus Having Environmental Sensors and Operations Sensors for Underground Facility Marking Operations, and Associated Methods and Systems;"

**[00102]** U.S. publication no. 2010-025351 1-Al, published October 7, 2010, filed June 18, 2010, and entitled "Locate Apparatus Configured to Detect Out-of-Tolerance Conditions in Connection with Underground Facility Locate Operations, and Associated Methods and Systems;"

**[00103]** U.S. publication no. 2010-0257029-A1, published October 7, 2010, filed June 18, 2010, and entitled "Methods, Apparatus, and Systems For Analyzing Use of a Locate Device By a Technician to Perform an Underground Facility Locate Operation;"

**[00104]** U.S. publication no. 201 0-02535 13-A1, published October 7, 2010, filed June 18, 2010, and entitled "Locate Transmitter Having Enhanced Features For Underground Facility Locate Operations, and Associated Methods and Systems;"

**[00105]** U.S. publication no. 2010-0253514-A1, published October 7, 2010, filed June 18, 2010, and entitled "Locate Transmitter Configured to Detect Out-of-Tolerance Conditions In Connection With Underground Facility Locate Operations, and Associated Methods and Systems;"

**[00106]** U.S. publication no. 2010-025 69 12-A 1, published October 7, 2010, filed June 18, 2010, and entitled "Locate Apparatus for Receiving Environmental Information Regarding Underground Facility Marking Operations, and Associated Methods and Systems;"

**[00107]** U.S. publication no. 2010-02593 81-Al, published October 14, 2010, filed June 28, 2010, and entitled "Methods, Apparatus and Systems for Notifying Excavators and Other Entities of the Status of in-Progress Underground Facility Locate and Marking Operations;"

**[00108]** U.S. publication no. 201 0-0262670-A1, published October 14, 2010, filed June 28, 2010, and entitled "Methods, Apparatus and Systems for Communicating Information Relating to the Performance of Underground Facility Locate and Marking Operations to Excavators and Other Entities;"

**[00109]** U.S. publication no. 2010-0259414-A1, published October 14, 2010, filed June 28, 2010, and entitled "Methods, Apparatus And Systems For Submitting Virtual White Line Drawings And Managing Notifications In Connection With Underground Facility Locate And Marking Operations;"

**[00110]** U.S. publication no. 2010-0268786-A1, published October 21, 2010, filed June 28, 2010, and entitled "Methods, Apparatus and Systems for Requesting Underground Facility Locate and Marking Operations and Managing Associated Notifications;"

**[00111]** U.S. publication no. 2010-0257477-A1, published October 7, 2010, filed April 2, 2010, and entitled "Methods, Apparatus, and Systems for Documenting and Reporting Events Via Time-Elapsed Geo-Referenced Electronic Drawings;"

**[00112]** U.S. publication no. 201 0-025698 1-Al, published October 7, 2010, filed April 2, 2010, and entitled "Methods, Apparatus, and Systems for Documenting and Reporting Events Via Time-Elapsed Geo-Referenced Electronic Drawings;"

**[00113]** U.S. publication no. 2010-028521 1-Al, published November 11, 2010, filed April 21, 2010, and entitled "Method Of Using Coded Marking Patterns In Underground Facilities Locate Operations."

**[00114]** It should be appreciated that all combinations of the foregoing concepts and additional concepts discussed in greater detail below (provided such concepts are not mutually inconsistent) are contemplated as being part of the inventive subject matter disclosed herein. In particular, all combinations of claimed subject matter appearing at the end of this disclosure are contemplated as being part of the inventive subject matter disclosed herein. It should also be appreciated that terminology explicitly employed herein that also may appear in any disclosure incorporated by reference should be accorded a meaning most consistent with the particular concepts disclosed herein.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[00115]** The skilled artisan will understand that the figures, described herein, are for illustration purposes only, and that the drawings are not intended to limit the scope of the disclosed teachings in any way. In some instances, various aspects or features may be shown exaggerated or enlarged to facilitate an understanding of the inventive concepts disclosed herein (the drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the teachings). In the drawings, like reference characters generally refer to like features, functionally similar and/or structurally similar elements throughout the various figures.

**[00116]** Figure 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;

**[00117]** Figure 2 is a schematic diagram of a marking device attached to a docking station;

**[00118]** Figure 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;

**[00119]** Figure 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;

**[00120]** Figure 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;

**[00121]** Figure 4 is a schematic block diagram of docking station electronics, in accordance with embodiments of the invention;

**[00122]** Figure 5A is a top view of a portion of a docking station;

**[00123]** Figure 5B is a side view of a portion of a docking station;

[00124] Figure 6A is a side view of a portion of a marking device that may be attached to a docking station;

[00125] Figure 6B is a bottom view of a portion of a marking device that may be attached to a docking station;

[00126] Figure 7 is a side view of a marking device being attached to a docking station;

[00127] Figure 8A is a top view of an exemplary vehicle configuration incorporating a docking station;

[00128] Figure 8B is a top view of another exemplary vehicle configuration incorporating a docking station;

[00129] Figure 8C is a schematic block diagram of a network system incorporating a docking station;

[00130] Figure 9 is a flow diagram of a method of using a docking station;

[00131] Figure 10 is a flow diagram of another method of using a docking station;

[00132] Figure 11 is a schematic diagram of a marking device attached to a docking station, according to another embodiment of the invention;

[00133] Figure 12 is a flow diagram of an additional method of using a docking station;

[00134] Figure 13 is a schematic diagram of an exemplary configuration incorporating docking stations;

[00135] Figure 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;

[00136] Figure 15 is an enlarged perspective view of a portion of the docking station and marking device of Figure 14;

**[00137]** Figure 16 is a perspective view of the docking station with the marking device docked therein;

**[00138]** Figure 17 is a perspective view of a marking device docking station that has processing and communications capability, in accordance with embodiments of the invention;

**[00139]** Figure 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;

**[00140]** Figure 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;

**[00141]** Figure 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;

**[00142]** Figure 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;

**[00143]** Figures 22A - 22D are perspective views of exemplary mobile device-specific cradles integrated into a docking station, in accordance with embodiments of the invention;

**[00144]** Figures 23A and 23B are perspective views of an exemplary mobile device universal cradle integrated into a docking station, in accordance with embodiments of the invention;

[00145] Figures *24A* and 24B are perspective views of an exemplary slot, pocket, and/or pouch in a docking station for holding a mobile device, in accordance with embodiments of the invention;

[00146] Figure 25 is a perspective view of exemplary mobile device-specific adaptors for use with a docking station, in accordance with embodiments of the invention;

[00147] Figure 26 is a perspective view of a user-worn mobile device in communication with a docking station, in accordance with embodiments of the invention; and

[00148] Figure 27 is a perspective view of a mobile device connected to a marking device, the mobile device functioning as a docking station for the marking device, in accordance with embodiments of the invention.

## DETAILED DESCRIPTION

[00149] Following below are descriptions of various concepts related to, and inventive embodiments of, locating equipment docking stations communicatively coupled to and/or equipped with a mobile/portable device. It should be appreciated that various concepts introduced above and discussed in greater detail below may be implemented in any of numerous ways, as the disclosed concepts are not limited to any particular manner of implementation. Examples of specific implementations and applications are provided primarily for illustrative purposes.

[00150] In embodiments discussed below in connection with the figures, various concepts relating to docking stations for locating equipment are introduced for purposes of illustration using a marking device as an exemplary piece of locating equipment. It should be appreciated, however, that the inventive concepts disclosed herein are not limited in this respect, and that docking stations according to the present disclosure may be configured to facilitate docking (and various functionality associated therewith) of various types of locating equipment, examples of which

include marking devices, locate devices, and combined locate and marking devices (as described in various U.S. publications incorporated herein by reference).

**[00151]** Figure 1 illustrates a docking station 100 and a marking device 150, removed from docking station 100, according to one embodiment of the present invention. 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.

**[00152]** 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 Figure 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.

**[00153]** 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 Figures 5A, 5B, 6A, 6B, and 7.

**[00154]** 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 Figure 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.

**[00155]** 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.

**[00156]** 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.

**[00157]** 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. In this manner, the power source of a vehicle may in turn be used to charge the battery of marking device 150 coupled to the docking station 100.

**[00158]** Additionally, as shown in Figure 1, 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.

**[00159]** 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 September 18, 2008, filed March 13, 2007, and entitled "Marking System and Method With Location and/or Time Tracking;" U.S. publication no. 2008-0245299-A1, published October 9, 2008, filed April 4, 2007, and entitled "Marking System and Method;" and U.S. publication no. 2009-0204238-A1, published August 13, 2009, filed February 2, 2009, and entitled "Electronically Controlled Marking Apparatus and Methods;" which are incorporated by reference herein in their entirety.

**[00160]** 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.

**[00161]** 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.

**[00162]** 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.

**[00163]** 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).

**[00164]** Docking station interface 174 of the marking device 150 is a mechanism that is designed to fit the cradle 118 of docking station 100 so as 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 Figures 5A, 5B, 6A, 6B, and 7.

**[00165]** Figure 2 is a schematic diagram of marking device 150 attached to docking station 100, according to embodiments of the invention. More specifically, Figure 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.

**[00166]** The docking station 100 shown in Figures 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. Accordingly, in additional figures discussed below, generic examples of docking stations and/or marking devices may be indicated using different reference numerals than those used for similar components/features illustrated in Figures 1 and 2.

**[00167]** Referring to Figure 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, in the embodiment of Figure 3A, 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.

**[00168]** Referring to Figure 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 Figures 1 and 2 may be of the type shown in Figure 3B.

**[00169]** Referring to Figure 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 Figure 3C, an electronic connection is not provided between docking station 220 and marking device 222. Instead, 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 Figures 1 and 2, with most or all electronic components omitted.

**[00170]** In each of Figures 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.

**[00171]** In the embodiments of Figures 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.

**[00172]** A block diagram of docking control electronics 250 in accordance with embodiments of the invention is shown in Figure 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.

**[00173]** 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.

**[00174]** 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.

**[00175]** 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.

**[00176]** 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 module 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.

**[00177]** 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 802.1 1 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.

**[00178]** 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.

**[00179]** 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.

**[00180]** 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.

**[00181]** 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.

**[00182]** 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.

**[00183]** 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.

**[00184]** 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.

**[00185]** 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.

**[00186]** 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.

**[00187]** 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.

**[00188]** 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.

**[00189]** 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.

**[00190]** 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.

**[00191]** 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.

**[00192]** 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.

**[00193]** Diagnostics module 286 may also be configured to perform self-diagnostics of the docking station. In this case, diagnostics 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.

**[00194]** 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.

**[00195]** 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.

**[00196]** 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.

**[00197]** 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.

**[00198]** 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.

**[00199]** 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 Figure 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.

**[00200]** Figures 5A and 5B are top and side views, respectively, of a portion of docking station 100. Figures 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 and/or the marking device 150 to be docked. Similarly, the dimensions of

cradle 118 and female alignment feature 310 may vary according to the requirements of docking station 100 and/or the marking device 150 to be docked.

**[00201]** Figures 6A and 6B are side and bottom views, respectively, of a portion of marking device 150. Figure 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, Figures 6A and 6B show that the geometry of docking station interface 174 is complementary to the geometry of cradle 118 of Figures 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 Figures 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 Figure 7.

**[00202]** While Figures 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 Figures 5A, 5B, 6A, 6B and 7, or can be separate coupling elements.

**[00203]** As illustrated in Figure 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.

**[00204]** Figure 8A is a top view of an exemplary configuration incorporating docking station 100. More specifically, Figure 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 maybe 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.

**[00205]** 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.

**[00206]** Additionally, Figure 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.

**[00207]** Figure 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 Figure 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 maybe 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.

**[00208]** Figures 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.

**[00209]** 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.

**[00210]** Figure 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 Figures 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.

**[00211]** 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 802.1 1 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.

**[00212]** Figure 9 is a flow diagram of a method 700 of using a docking station according to embodiments of the invention. In particular, Figure 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.

**[00213]** In act 710, the docking station receives power. For example, when docking station 100 is installed in a vehicle, as shown in Figures 8A and 8B, docking station 100 receives direct current (DC) power when the vehicle key is in the accessory, power, start, or run position.

**[00214]** 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.

**[00215]** 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.

**[00216]** 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.

**[00217]** 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.

**[00218]** Referring again to method 700 of Figure 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.

**[00219]** A data synchronization operation is described above in connection with Figure 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.

**[00220]** Figure 10 is a flow diagram of another method of using a docking station. In particular, Figure 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.

**[00221]** In act 810, the docking station receives power. For example, when docking station 100 is installed in a vehicle, as shown in Figures 8A and 8B, docking station 100 receives DC power when the vehicle key is in the accessory, power, start, or run position.

**[00222]** 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 Figure 9.

**[00223]** 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.

**[00224]** 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.

**[00225]** 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.

**[00226]** 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.

**[00227]** 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 Figure 9.

**[00228]** 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.

**[00229]** 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.

**[00230]** In act 854, an indicator 130 is deactivated. For example, the orange synchronization status indicator may be turned off.

**[00231]** Figure 11 is a schematic diagram of a marking device attached to a docking station. In particular, Figure 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 Figure 11. In one embodiment, locking mechanism 910 may be a suitably rigid, strong, and tamperproof 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.

**[00232]** Figure 12 is a flow diagram of a method of using a docking station. In particular, Figure 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.

**[00233]** 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 Figures 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.

**[00234]** 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 Figure 9.

**[00235]** 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.

**[00236]** 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.

**[00237]** 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.

**[00238]** Figure 13 is a schematic diagram of an exemplary configuration incorporating docking stations. In particular, Figure 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, Figure 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 Figures 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.

**[00239]** 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.

**[00240]** 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 Figure 9 and described above.

**[00241]** 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 Figure 10 for docking station 100.

**[00242]** 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.

**[00243]** Figures 14, 15, and 16 are perspective views of another embodiment of the docking station according to the present invention. Figure 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.

**[00244]** 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 Figures 1 through 13. Docking station 1200 of Figures 14, 15, and 16 differs primarily from docking station 100 and docking station 1100 of Figures 1 through 13 in its physical attributes.

**[00245]** 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 Figures 1 through 13. Marking device 1250 of Figures 14, 15, and 16 differs primarily from marking device 150 of Figures 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 Figure 1, docking station interface 174 of marking device 150 is incorporated on the same side of shaft 154 as handle 158.

**[00246]** With reference to Figures 14 and 16, respectively, marking device 1250 is shown separated from and attached to docking station 1200. Figure 15 shows further details of docking station 1200. More specifically, Figure 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.

**[00247]** 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.

**[00248]** 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.

**[00249]** 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.

**[00250]** 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.

**[00251]** 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.

**[00252]** Figure 17 is a perspective view of a marking device docking station 1300 that has processing and communications capability. Docking station 1300 maybe 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.

**[00253]** Docking station 1300 may include a base 1310 and a body 1312. Additionally, a cradle 13 14 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.

**[00254]** 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.

**[00255]** 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.

**[00256]** 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.

**[00257]** 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.

**[00258]** 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.

**[00259]** 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.

**[00260]** 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.

**[00261]** 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.

**[00262]** 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.

**[00263]** 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, Figure 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.

**[00264]** 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.

**[00265]** 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.

**[00266]** 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 maybe 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 Figures 18 through 21.

**[00267]** Figure 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.

**[00268]** In particular, Figure 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 Figure 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.

**[00269]** 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 maybe, 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.

**[00270]** By way of example and referring again to Figure 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.

**[00271]** 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;

**[00272]** no marking device 1350 is present in docking station 1300b, no rechargeable batteries 1342 are present in docking station 1300b;

**[00273]** 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;

**[00274]** 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;

**[00275]** 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;

**[00276]** no marking device 1350 is present in docking station 1300f, no rechargeable batteries 1342 are present in docking station 1300f;

**[00277]** 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;

**[00278]** 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

**[00279]** 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.

**[00280]** Figure 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, Figure 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 maybe, 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 maybe designed and constructed to utilize the DC power of a vehicle. Alternatively, instead of multiple docking stations 1300 in

multiple vehicles 1510, there maybe multiple docking stations 1300 in a one vehicle 1510.

**[00281]** 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.

**[00282]** As described with reference to Figure 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.

**[00283]** Figure 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 Figure 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 Figure 19.

**[00284]** 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®.

**[00285]** 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.

**[00286]** Figure 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.

**[00287]** 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 Figure 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.

**[00288]** In further embodiments, a docking station may be equipped with or otherwise communicatively coupled to a mobile/portable device (hereafter a "mobile device"), such as a cellular phone or personal digital assistant (PDA), which are typically hand-sized or smaller. Such a mobile/portable device provides processing, electronic storage, electronic display, user interface, communication facilities and/or other functionality for the docking station. Communicative coupling of a mobile device with a docking station may allow the intelligence and/or various functionality of the mobile device to be used in place of, or in addition to, an onboard processor and/or other onboard components (e.g., such as those included in control electronics 128, 250 or 1320). The docking station communicatively coupled to a mobile/portable device may be configured for docking of a marking device or for docking of a combination locate and marking device. The docking station may be configured for mechanical and/or electronic docking of locating equipment.

**[00289]** More specifically, in some embodiments a mobile device may be employed to implement the various functionality discussed above in connection with the processor 266, the memory 270, the communication interfaces 252, 254, the power source 274, the user interface 256, and in some instances the timing system 260 and/or the location tracking system 262 of an exemplary docking station. To this end, the mobile device itself may include one or more of a processor, memory, communication interface, power source, user interface, timing system and/or location tracking system (e.g., to facilitate GPS-enabled functionality). In some exemplary implementations, the mobile device may provide essentially all of the processing and related functionality required to operate the docking station, while in other implementations the mobile device may provide only some portion of the overall functionality (e.g., a GPS-enabled mobile device may be employed primarily for obtaining geo-location data, but not necessarily relied on substantively for processing power and/or memory).

**[00290]** In yet other implementations, the mobile device may provide redundant, shared and/or backup functionality for the docking station to enhance robustness. For example, even though a docking station may include one or more of a processor,

memory, communication interface, power source, user interface, timing system and/or location tracking system, a mobile device communicatively coupled to or otherwise integrated with the docking station may include one or more corresponding components to provide redundant, shared and/or backup components and functionality. Examples of enhanced robustness provided by redundant components and/or functionality of a mobile device include, but are not limited to: providing for data comparison to establish data integrity (e.g., validation of geo-location data by comparing data obtained by a location tracking system in the docking station to geo-location data provided by a mobile device equipped with its own location tracking system); calibration of various parameters; power for various components (e.g., a first power source of the docking station may be used to power/recharge a second power source of the mobile device, or vice versa); backup memory storage; backup communication interfaces; support for multiple different communication protocols, communication channels, and/or communication media.

[00291] In various examples, a mobile device may be mechanically and electronically coupled to a docking station via an appropriate mobile device cradle and/or connector, or otherwise integrated with or communicatively coupled to the docking station, so as to permit one or more electronic signals to be communicated between the mobile device and the docking station (e.g., one or more signals indicative of operation of the docking station may be supplied to the mobile device). In some implementations, a mobile device cradle may be appropriately configured such that one or more of a power connector and an I/O connector on the mobile device engage with one or more complimentary connectors on the mobile device cradle upon insertion/engagement of the mobile device in the mobile device cradle. The one or more complimentary connectors on the mobile device cradle in turn may be coupled to various signals provided by the docking station (e.g., to a docked marking device). Additionally, in some embodiments the mobile device cradle and/or the docking station itself may include a battery pack and/or any other power source for supplying power to and/or for assisting the battery of the mobile device

while the mobile device is connected to the docking station. In one example, the local power pack may be used to prolong the battery life of the mobile device.

**[00292]** Various methods and apparatus for communicatively coupling mobile devices to locating equipment in accordance with the present invention may allow different brands and/or types of mobile devices to be physically secured to and/or electrically coupled to a docking station. In various implementations, a mobile device cradle integrated into a docking station may be mobile device-specific; i.e., the mobile device cradle may be particularly configured such that the size and/or connector positions are appropriate for a particular brand/model of mobile device. Alternatively, a universal mobile device cradle with an adjustable size and/or adjustable connector locations (e.g., sliding connectors along one or more sides of the cradle that may be mechanically locked in place) may be coupled to the docking station so as to accommodate a variety of different mobile devices. In other examples, a mobile device cradle may not require electrical connections integrated therein, and one or more signals provided by the docking station may be communicated to the mobile device, and vice-versa, via one or more wired connections (e.g., a cable or wire) or a wireless connection (e.g., a Bluetooth® connection). In yet other examples, the mobile device need not be physically secured to the docking station, but may be communicatively coupled to the docking station via one or more wired and/or wireless connections.

**[00293]** Figures 22A through 22D are perspective views of examples of mobile device-specific cradles 1612-1618 that maybe integrated with (e.g., installed on) a docking station according to some embodiments. For purposes of the following discussion, docking station 1200 is illustrated in the figures as an exemplary docking station with which the mobile/portable device may be coupled/integrated. However, it should be appreciated that the concepts discussed below apply similarly to other docking stations. Furthermore, as noted above, it should be appreciated that in some implementations various components and/or functionality of the control electronics of the docking station may be provided, in whole or in part, by the mobile device engaged in the cradles 1612-1618.

**[00294]** Device-specific cradles 1612-1618 may each be configured for holding a particular type of mobile device. The mobile device may be any mobile device that has at least a processing unit and a communication interface, and preferably a user interface mechanism. Examples of mobile devices include, but are not limited to, any of a wide variety of mobile phones, personal digital assistants (PDA), and/or any other personal communication and/or media devices, such as the iPod® Touch device.

**[00295]** In Figures 22A through 22D, each device-specific cradle may be associated with a certain brand and/or style of mobile device. For example, device-specific cradle 1612 of Figure 22A may be configured for holding a certain type of mobile device 1630; device-specific cradle 1614 of Figure 22B may be configured for holding a different type of mobile device 1632; and device-specific cradle 1616 of Figure 22C may be configured for holding yet another type of mobile device 1634. Once a mobile device is inserted in its corresponding device-specific cradle on the docking station, its processing capabilities, user interface capabilities, communication capabilities, data storage capabilities, and/or any other capabilities may be used in combination with components of the docking station to perform various functions discussed elsewhere herein.

**[00296]** Each device-specific cradle may be electrically coupled to one or more components of the docking station. To this end, each device-specific cradle may include an input/output (I/O) connector for electrically connecting to its corresponding mobile device when the mobile device is secured within its device-specific cradle. Alternatively, a wireless communication link may be provided between the docking station and the mobile device that is secured within its device-specific cradle.

**[00297]** Figures 23A and 23B are perspective views of an example of a mobile device universal cradle 1640 that may be integrated with (e.g., installed on) a docking station. Universal cradle 1640 may include adjustable elements 1642 that allow substantially any size, brand, and/or style of mobile device to be secured

therein. Because the locations and types of I/O connectors on mobile devices may differ from one brand and/or style of mobile device to another, in one aspect a docking station having a universal cradle 1640 may utilize a cable, such as cable 1650, to facilitate the electrical connection between the docking station and the mobile device. The cable may be configured to provide an electrical connection between an I/O connector type of the docking station and a device-specific I/O connector type of the mobile device. In one example, cable 1650 may include a standard universal serial bus (USB) connector at one end for connecting the cable 1650 to the docking station and a device-specific connector at the opposite end for connecting the cable 1650 to mobile device 1652.

**[00298]** Figure 23A shows an empty universal cradle 1640, without a mobile device secured therein. Figure 23B shows universal cradle 1640 with a mobile device (e.g., mobile device 1652) secured therein by, for example, adjustable elements 1642 being squeezed against the sides of mobile device 1652. Figure 23B also shows cable 1650 plugged into mobile device 1652, such that the docking station and the mobile device 1652 are electrically connected.

**[00299]** Again, once a mobile device is installed in universal cradle 1640 on the docking station, its processing capabilities, user interface capabilities, communication capabilities, data storage capabilities, and/or any other capabilities may be used in combination with components of the docking station to perform various functions discussed elsewhere herein. As noted above, the mobile device may provide essentially all of the processing and related functionality required to operate the docking station, or may provide only a portion of the overall functionality. Also, the mobile device may provide redundant, shared and/or backup functionality for the docking station to enhance robustness.

**[00300]** In some embodiments, any mobile device-specific cradles and/or universal cradles provided in connection with the docking station may be removable, replaceable and/or exchangeable. For example, the mobile device-specific cradles

1612-1618 and/or universal cradle 1640 may be removed from the docking station and then reattached as desired.

**[00301]** In other embodiments, a mobile device may be connected to a docking station through mechanisms requiring less external hardware to be attached to the docking station. For example, Figures 24A and 24B are perspective views of a slot, pocket, and/or pouch in a docking station for holding mobile devices. In one example, Figure 24A shows a slot 1670 integrated into docking station 1200 into which a mobile device, such as mobile device 1672, may be inserted. An electrical connection (not shown) maybe integrated into a portion of slot 1670 (e.g., along one or more sides and/or the bottom of slot 1670) for connecting to mobile device 1672.

**[00302]** In another example, Figure 24B shows a holder 1680 that is secured, for example, to the side of the docking station 1200. A mobile device, such as mobile device 1672, may be inserted into holder 1680. Holder 1680 may be ruggedized for protection of mobile device 1672 and/or may be sealable for weatherproof operation. A cable (not shown), such as cable 1650 of Figures 23A and 23B, may pass through the walls or through the seal of holder 1680 for providing an electrical connection between the docking station 1200 and mobile device 1672.

**[00303]** When a cable, such as cable 1650, is to be used to facilitate a connection between a mobile device and a docking station, as shown for example in Figures 23A, 23B and 24B, the cable may be configured to provide a connection between the I/O connector type of the docking station and the device-specific I/O connector type of the mobile device. For example, the cable may be in the form of a phone adaptor, with one end configured to connect to the I/O connector of the docking station, and the other end configured to connect to the I/O connector of a specific type of mobile device. Figure 25 illustrates perspective views of examples of device-specific phone adaptors 1710 for use in facilitating wired communication with a docking station.

**[00304]** Docking station 1200 may include a standard I/O connector 1720 into which any phone adaptor 1710 may be plugged. For example, each phone adaptor 1710, such as phone adaptor 1722, 1724, or 1726, may include a standard I/O connector 1730 that is the counterpart to I/O connector 1720 of the docking station. For example, if I/O connector 1720 of the docking station is a male I/O connector, I/O connector 1730 of phone adaptor 1710 can be a corresponding female I/O connector. Conversely, if I/O connector 1720 of the docking station is a female I/O connector, I/O connector 1730 of phone adaptor 1710 can be a corresponding male I/O connector.

**[00305]** In a specific example, phone adaptor 1710 may be a USB-based adaptor; i.e., I/O connector 1720 on the docking station, may be a standard USB port and I/O connector 1730 of phone adaptor 1710 may be a USB connector.

**[00306]** At the other end of phone adaptor 1710, an I/O connector may be configured to connect with a certain type of mobile device. For example, phone adaptor 1722 may include a device-specific I/O connector 1740 for connecting to a certain brand and/or style of mobile device (not shown). Phone adaptor 1724 may include a device-specific I/O connector 1742 for connecting to a different brand and/or style of mobile device (not shown). Phone adaptor 1726 may include a device-specific I/O connector 1744 for connecting to a yet another brand and/or style of mobile device (not shown).

**[00307]** Alternatively, wired communication may be complemented or replaced with any of various forms of wireless communication between a mobile device and a docking station. For example, Figure 26 illustrates a user-worn mobile device 1760 that is in communication with docking station 1200. The docking station 1200 may include a communication interface 1762, which may be any wired and/or wireless communication interface, as described above. Figure 26 also shows a locate technician 1770 having a belt-worn mobile device, such as mobile device 1760. That is, mobile device 1760 may be installed in a standard belt-worn holster. In this example, mobile device 1760 may communicate with the docking station via, for

example, Wi-Fi communication, such as Bluetooth® communication. In various implementations, the control electronics of the docking station may or may not include processor, memory and/or user-interface components; if any of these are included, similar components of the mobile device 1760 nonetheless may provide advantageous redundancy (e.g., for convenience of the technician 1770).

**[00308]** Any mobile device used in connection with a docking station, and optionally the docking station itself, may include a communication interface. For example, the communication interfaces of the mobile device and the docking station 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 802.1 1 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.

**[00309]** It should be understood that the foregoing figures and descriptions illustrate non-limiting examples, and any suitable mechanism may be used for securing a mobile device to a docking station and for establishing a communication link. Additionally, any mechanism for holding a mobile device may be ruggedized and/or weatherproof.

**[00310]** With reference again to Figure 4, a mobile device used in connection with docking station 1200 or another docking station may be appropriately programmed to log and generate electronic records of various marking information, which records may be formatted in various manners, processed and/or analyzed on the mobile device, and/or transmitted to another device (e.g., a remote computer/server) for storage, processing and/or analysis. In one example, one or more pieces of geo-location data (e.g., from a GPS receiver, which may be

integrated with the mobile device) may be collected and logged on the mobile device per actuation of a marking device (e.g., a trigger-pull to dispense marking material) in response to receipt by the mobile device of marking information. Furthermore, a computer-generated image or other visual representation of the marking operation may be electronically rendered in a display field of the mobile device based on logged marking information, essentially in real time as the marking operation is performed, and/or recreated thereafter based on one or more stored electronic records. Various algorithms according to the concepts discussed herein may be available as "applications" that may be downloaded to the mobile device and selectable/operable from the user interface of the mobile device, such that the mobile device may also be used for other (more conventional) functions (e.g., telephone calls, email, web access/browsing, etc.) in addition to specific functionality pursuant to execution of docking station applications.

**[00311]** Figures 22A-26 and the corresponding portions of the specification describe embodiments wherein a mobile computing device is communicatively coupled to a docking station. The docking station may be configured for mechanical and/or electronic docking of locating equipment, such as a marking device or a combination locate and marking device. In further embodiments, the mobile computing device itself serves as a docking station and performs one or more functions associated with operation of the marking device. In these embodiments, the mobile computing device is communicatively coupled to the marking device.

**[00312]** Referring to Figure 27, a system including marking device 1250 and a mobile computing device 1800 is shown. Mobile computing device 1800 is communicatively coupled to marking device 1250 by a cable 1810. In other embodiments, mobile device 1800 may utilize wireless communication with marking device 1250. In further embodiments, the system includes a marking device or a combination locate and marking device having electronic capabilities.

**[00313]** Mobile device 1800 may be programmed to perform one or more functions of a docking station. For example, the mobile computing device 1800 may transfer data, including but not limited to marking information, to and from the marking device, may log data received from the marking device in a memory of the mobile computing device 1800, may process and/or analyze the data received from the marking device, may communicate with a remote computing device, including transfer of data to and from the remote computing device, may perform data synchronization between the mobile computing device 1800 and the marking device 1250, may serve as a terminal for user control of the marking device 1250, may display marking device information, such as for example status and job information, may record a date and time of marking device operations, may record geographical coordinates, may execute a diagnostics routine for testing of the marking device, may execute a calibration routine for calibration of the marking device, may determine a charge state of the battery in the marking device, may determine and verify an identity of the marking device, and/or may perform any other function associated with the marking device. These embodiments enable the mobile computing device to function as a docking station, without the mechanical docking function described above. The mobile computing device 1800 may be programmed to perform one or more of the functions described above and to thereby function as a docking station. It will be understood that any of the mobile devices described herein, including but not limited to mobile devices 1630, 1632, 1634, 1652, 1672, 1760 and 1800, may be programmed to perform one or more of the functions described above.

**[00314]** Examples of mobile devices, such as cellular phones/PDAs, that are suitable for purposes of embodiments using such mobile devices in connection with docking stations include, but are not limited to, various models of the Apple iPhone (e.g., iPhone 3G S), various models of Blackberry® PDAs, various models of Windows® mobile phones by different manufacturers, and various Android-based devices ("Android" is a mobile operating system running on the Linux kernel; it was initially developed by Google and later the Open Handset Alliance and allows

developers to write managed code in the Java language, controlling the device via Google-developed Java libraries) available from a variety of conventional mobile device suppliers (e.g., Motorola, Samsung, Sony-Ericsson). The connector for most Android-based devices typically is a standard micro USB connector. Connectors for other cellular phone/PDAs noted above may have various proprietary formats/pin layouts; an exemplary pin layout for an Apple iPhone is given in the following table (back side of dock connector; 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30; 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29; Pins 1,2 connected on motherboard; Pins 15,16 connected on motherboard; Pins 19,20 connected on motherboard; Pins 29,30 connected on motherboard):

| Pin | Signal | Description |
|---|---|---|
| 1 | GND | Ground (-), internaly connected with Pin 2 on iPod motherboard |
| 2 | GND | Audio & Video ground (-), internaly connected with Pin 2 on iPod motherboard |
| 3 | Right | Line Out - R (+) (Audio output, right channel) |
| 4 | Left | Line Out - L(+) (Audio output, left channel) |
| 5 | Right In | Line In - R (+) |
| 6 | Left In | Line In - L (+) |
| 8 | Video Out | Composite video output (only when slideshow active on iPod Photo) |
| 9 | S-Video Chrominance output | For iPod Color, Photo only |
| 10 | S-Video Luminance | For iPod Color, Photo only |

| | | |
|---|---|---|
| | output | |
| 11 | GND | Serial GND |
| 12 | Tx | ipod sending line, Serial TxD |
| 13 | Rx | ipod receiving line, Serial RxD |
| 14 | RSVD | Reserved |
| 15 | GND | Ground (-), internaly connected with pin 16 on iPod motherboard |
| 16 | GND | USB GND (-), internaly connected with pin 15 on iPod motherboard |
| 17 | RSVD | Reserved |
| 18 | 3.3V | 3.3V Power (+)<br>Stepped up to provide +5 VDC to USB on iPod Camera Connector. If iPod is put to sleep while Camera Connector is present, +5 VDC at this pin slowly drains back to 0 VDC. |
| 19,20 | +12V | Firewire Power 12 VDC (+) |
| 21 | Accessory Indicator/Serial enable | Different resistances indicate accessory type:<br>1kOhm - iPod docking station, beeps when connected<br>10kOhm - Takes some iPods into photo import mode<br>68kOhm - makes iPhone 3g send audio through line-out without any messages<br>500kOhm - related to serial communication / used to enable serial communications Used in Dension Ice Link Plus car interface<br>1MOhm - Belkin auto adaptor, iPod shuts down automatically when power disconnected Connecting pin 21 to ground with a 1MOhm resistor does stop the ipod when power (i.e. Firewire-12V) is cut. Looks to be that |

| | | |
|---|---|---|
| | | when this pin is grounded it closes a switch so that on loss of power the Ipod shuts off. Dock has the same Resister. |
| 22 | TPA (-) | FireWire Data TPA (-) |
| 23 | 5 VDC (+) | USB Power 5 VDC (+) |
| 24 | TPA (+) | FireWire Data TPA (+) |
| 25 | Data (-) | USB Data (-) |
| 26 | TPB (-) | FireWire Data TPB (-) |
| 27 | Data (+) | USB Data (+)<br>Pins 25 and 27 may be used in different manner. To force the iPod 5G to charge in any case, when "USB Power 5 VDC" (pin 23) is fed, 25 must be connected to 5V through a 10kOhm resistor, and 27 must be connected to the Ground (for example: pin 1) with a 10kOhm resistor.<br>iPod 5G can also be forced to charge by attaching the data + and the data - pins to the 5v via a 10k Ohm resistor ( BOTH PINS) and connecting pin 16 to the 5v (ground). (Confirmed working with iPod 5G 20GB)<br>To charge an iPhone 3G / iPod Touch 2nd gen, usb data-(25) should be at 2.8v, usb data+(27) should be at 2.0v. This can be done with a few simple resistors: 33k to +5v (23) and 22k to gnd(1 6) to obtain 2v and 33k to +5v and 47k to gnd to obtain 2.8v. This is a "notification" to the iphone that it is connected to the external charger and may drain amps from the usb. |
| 28 | TPB (+) | FireWire Data TPB (+) |
| 29,30 | GND | FireWire Ground (-) |

[00315] While various inventive embodiments have been described and illustrated herein, those of ordinary skill in the art will readily envision a variety of other means and/or structures for performing the function and/or obtaining the results and/or one or more of the advantages described herein, and each of such variations and/or modifications is deemed to be within the scope of the inventive embodiments described herein. More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the inventive teachings is/are used. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific inventive embodiments described herein. It is, therefore, to be understood that the foregoing embodiments are presented by way of example only and that, within the scope of the appended claims and equivalents thereto, inventive embodiments may be practiced otherwise than as specifically described and claimed. Inventive embodiments of the present disclosure are directed to each individual feature, system, article, material, kit, and/or method described herein. In addition, any combination of two or more such features, systems, articles, materials, kits, and/or methods, if such features, systems, articles, materials, kits, and/or methods are not mutually inconsistent, is included within the inventive scope of the present disclosure.

[00316] The above-described embodiments can be implemented in any of numerous ways. For example, the embodiments may be implemented using hardware, software or a combination thereof. When implemented in software, the software code can be executed on any suitable processor or collection of processors, whether provided in a single computer or distributed among multiple computers.

[00317] Further, it should be appreciated that a computer may be embodied in any of a number of forms, such as a rack-mounted computer, a desktop computer, a laptop computer, or a tablet computer. Additionally, a computer may be embedded in a device not generally regarded as a computer but with suitable processing

capabilities, including a Personal Digital Assistant (PDA), a smart phone or any other suitable portable or fixed electronic device.

**[00318J** Also, a computer may have one or more input and output devices. These devices can be used, among other things, to present a user interface. Examples of output devices that can be used to provide a user interface include printers or display screens for visual presentation of output and speakers or other sound generating devices for audible presentation of output. Examples of input devices that can be used for a user interface include keyboards, and pointing devices, such as mice, touch pads, and digitizing tablets. As another example, a computer may receive input information through speech recognition or in other audible format.

**[00319]** Such computers may be interconnected by one or more networks in any suitable form, including a local area network or a wide area network, such as an enterprise network, and intelligent network (IN) or the Internet. Such networks may be based on any suitable technology and may operate according to any suitable protocol and may include wireless networks, wired networks or fiber optic networks.

**[00320]** A computer/computing device employed to implement various functionality described herein according to various embodiments may comprise a memory, one or more processing units(also referred to herein simply as "processors"), one or more communication interfaces, one or more display units, and one or more user input devices. The memory may comprise any computer-readable media, and may store computer instructions (also referred to herein as "processor-executable instructions") for implementing the various functionalities described herein. The processing unit(s) may be used to execute the instructions. The communication interface(s) may be coupled to a wired or wireless network, bus, or other communication means and may therefore allow the computer to transmit communications to and/or receive communications from other devices. The display unit(s) may be provided, for example, to allow a user to view various information in connection with execution of the instructions. The user input device(s) may be provided, for example, to allow the user to make manual adjustments, make

selections, enter data or various other information, and/or interact in any of a variety of manners with the processor during execution of the instructions.

**[00321]** 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.

**[00322]** 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 non-transitory medium or 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.

**[00323]** 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.

**[00324]** 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.

**[00325]** 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.

**[00326]** 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.

**[00327]** 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.

**[00328]** 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."

**[00329]** 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.

[00330] 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.

[00331] 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.

**[00332]** 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, respectively, as set forth in the United States Patent Office Manual of Patent Examining Procedures, Section 2111.03.

**[00333]** What is claimed is:

CLAIMS

1. An apparatus, comprising:

a docking station to dock locating equipment for locating and/or marking a presence or an absence of an underground facility, the docking station comprising a mobile device interface to facilitate mechanical, electrical and/or communicative coupling of a mobile or portable computing device to the docking station.

2. A docking system comprising:

the docking station of claim 1; and

the mobile or portable computing device communicatively coupled to the docking station via the mobile device interface.

3. The system of claim 2, wherein the mobile or portable computing device comprises a cellular telephone.

4. The system of claim 2, wherein the mobile or portable computing device comprises a personal digital assistant.

5. The system of claim 2, wherein the mobile or portable computing device serves as a user interface of the docking station.

6. The system of claim 2, wherein the docking station includes:

a locating equipment interface to facilitate mechanical and/or electrical coupling of the locating equipment to the docking station.

7. The system of claim 6, further comprising the locating equipment, wherein the locating equipment includes a marking device.

8. The system of claim 6, further comprising the locating equipment, wherein the locating equipment includes a locate device.

9. The system of claim 6, further comprising the locating equipment, wherein the locating equipment includes a combined locate and marking device.

10. The system of claim 6, wherein the mobile device interface facilitates at least the electrical coupling of the mobile or portable computing device to the docking station, and wherein the mobile or portable computing device receives power from the docking station via the mobile device interface.

11. The system of claim 2, wherein the mobile or portable computing device is mechanically coupled to or integrated with the docking station.

12. The system of claim 11, wherein the mobile or portable computing device includes a mechanical coupling to facilitate removal and reattachment of the mobile or portable computing device to the mobile device interface of the docking station.

13. The system of claim 2, wherein the mobile or portable computing device includes one or more of:

at least one first processor;

at least one first memory;

at least one first communication interface; and

at least one first user interface.

14. The system of claim 13, wherein the mobile or portable computing device includes the at least one first communication interface, and wherein the at least one first communication interface includes a wired interface for wired communication with the docking station.

15. The system of claim 13, wherein the mobile or portable computing device includes the at least one first communication interface, and wherein the at least one first communication interface includes a wireless interface for wireless communication with the docking station.

16. The system of claim 13, wherein the mobile or portable computing device includes the at least one first communication interface, and wherein the at least one first communication interface facilitates transfer of locating equipment information to and from the docking station.

17. The system of claim 16, wherein the at least one first processor of the mobile or portable computing device controls the at least one first memory and the at least one first communication interface of the mobile or portable computing device so as to log at least some of the locating equipment information transferred from the locating equipment docked in the docking station.

18. The system of claim 13, wherein the mobile or portable computing device includes the at least one first user interface, and wherein the at least one first user interface includes a touch screen to receive user inputs and to display information to a user.

19. The system of claim 13, wherein the mobile or portable computing device includes the at least one first user interface, and wherein the at least one first user interface includes a display device to display information associated with docking station operation.

20. The system of claim 13, wherein the mobile or portable computing device further includes a location tracking system to determine geographical coordinates for use by the docking station.

21. The system of claim 13, wherein:

the at least one first memory stores processor-executable instructions; and

via execution by the at least one first processor of the processor-executable instructions, and/or via retrieval of external instructions, external applications, and/or other external information via the at least one first communication interface, the mobile or portable device provides essentially all processing and related functionality required to operate the docking station.

22. The system of claim 13, wherein:

the at least one first memory stores processor-executable instructions; and

via execution by the at least one first processor of the processor-executable instructions, and/or via retrieval of external instructions, external applications, and/or other external information via the at least one first communication interface, the mobile or portable device provides only some portion of functionality required to operate the docking station.

23. The system of claim 13, wherein:

the at least one first memory stores processor-executable instructions; and

via execution by the at least one first processor of the processor-executable instructions, and/or via retrieval of external instructions, external applications, and/or other external information via the at least one first communication interface, the mobile or portable device provides redundant, shared, and/or backup functionality for the docking station.

24. The system of claim 13, wherein the mobile or portable computing device includes a timing system to provide a current date and time for logging of docking station operations.

25. The system of claim 13, wherein:

the at least one first memory stores processor-executable instructions; and

via execution by the at least one first processor of the processor-executable instructions, and/or via retrieval of external instructions, external applications, and/or other external information via the at least one first communication interface, the mobile or portable device implements a diagnostics routine for testing of the docking station.

26. The system of claim 13, wherein:

the at least one first memory stores processor-executable instructions; and

via execution by the at least one first processor of the processor-executable instructions, and/or via retrieval of external instructions, external applications, and/or other external information via the at least one first communication interface, the mobile or portable device implements a diagnostics routine for testing of the locating equipment.

27. The system of claim 13, wherein:

the at least one first memory stores processor-executable instructions; and

via execution by the at least one first processor of the processor-executable instructions, and/or via retrieval of external instructions, external applications, and/or other external information via the at least one first communication interface, the mobile or portable device implements a calibration routine for calibration of the locating equipment.

28. The system of claim 13, wherein:

the at least one first memory stores processor-executable instructions; and

via execution by the at least one first processor of the processor-executable instructions, and/or via retrieval of external instructions, external applications, and/or other external information via the at least one first communication interface, the mobile or portable device determines a charge state of a battery in the locating equipment.

29. A method for docking locating equipment of the type used to locate and/or mark a presence or an absence of an underground facility, the method comprising:

mechanically, electronically and/or communicatively coupling the locating equipment to a docking station; and

performing one or more operations of the docking station using a mobile or computing device communicatively coupled to the docking station.

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

a mobile computing device including an electronic interface configured to transfer information to and from the marking device, the mobile computing device programmed to perform at least one operation involving communication with the marking device and functioning as a docking station for the marking device.

31. A method for operating a marking device of the type used to mark a presence or an absence of an underground facility, the method comprising:

electronically coupling a mobile computing device to the marking device; and

transferring information to and between the marking device and the mobile computing device, wherein the mobile computing device functions as a docking station for the marking device.

32. A system, comprising:

a marking device configured to mark a presence or an absence of an underground facility; and

a mobile computing device communicatively coupled to the marking device, wherein the mobile computing device functions as a docking station for the marking device.

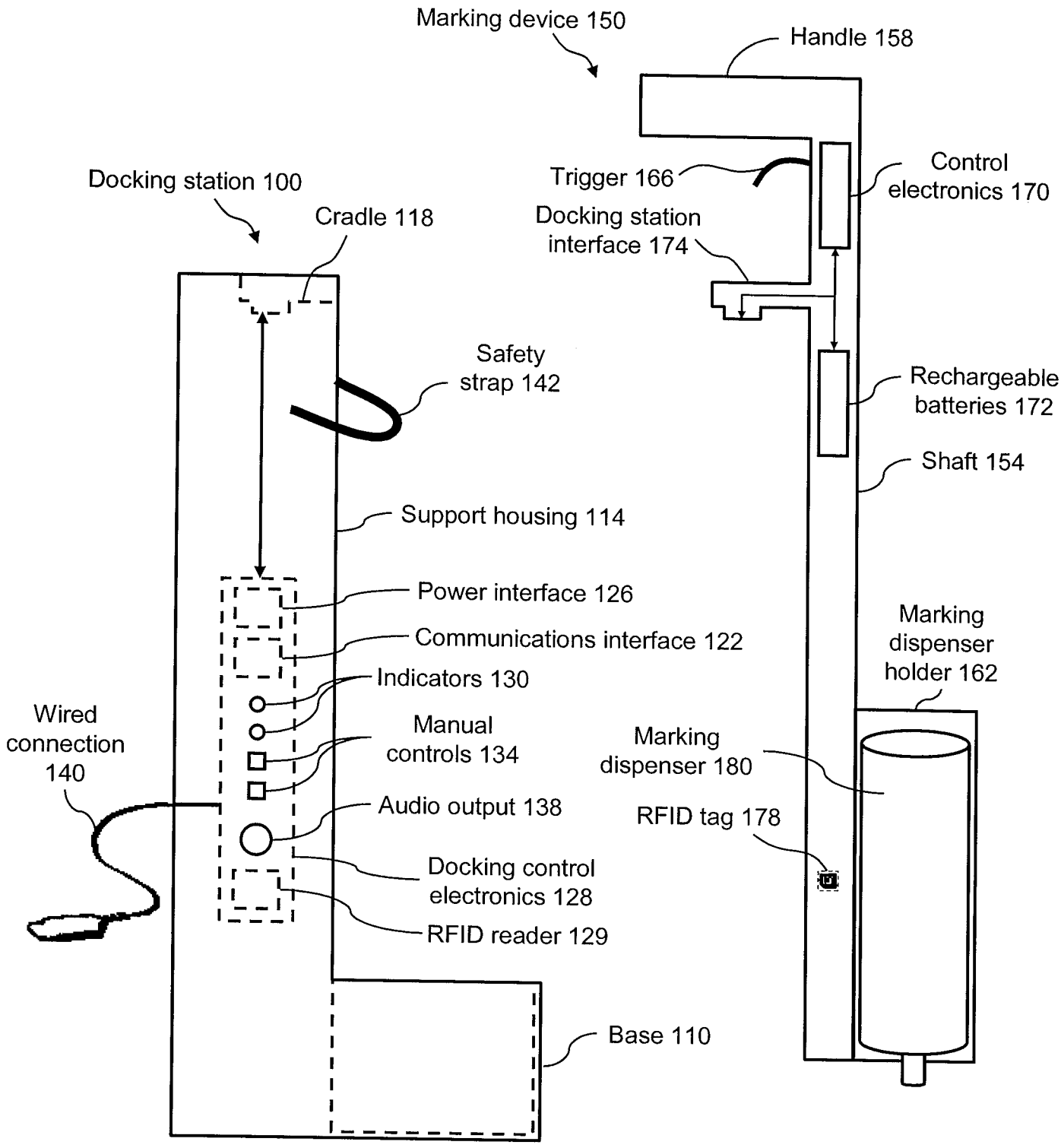
Marking device 150
Handle 158
Docking station 100
Trigger 166
Control electronics 170
Cradle 118
Docking station interface 174
Safety strap 142
Rechargeable batteries 172
Shaft 154
Support housing 114
Power interface 126
Marking dispenser holder 162
Communications interface 122
Indicators 130
Wired connection 140
Manual controls 134
Marking dispenser 180
Audio output 138
RFID tag 178
Docking control electronics 128
RFID reader 129
Base 110

FIG. 1

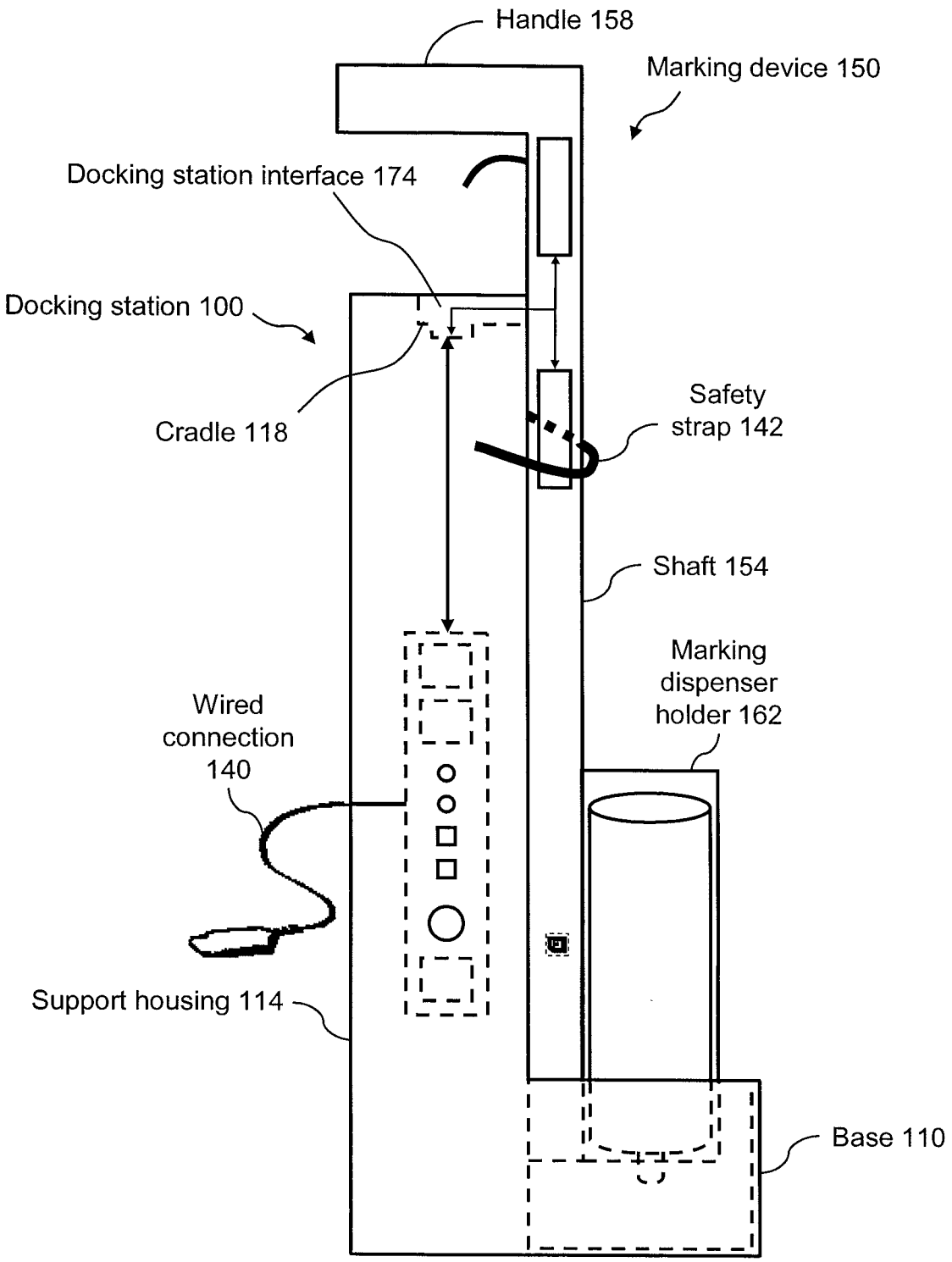
Handle 158
Marking device 150
Docking station interface 174
Docking station 100
Cradle 118
Safety strap 142
Shaft 154
Marking dispenser holder 162
Wired connection 140
Support housing 114
Base 110

FIG. 2

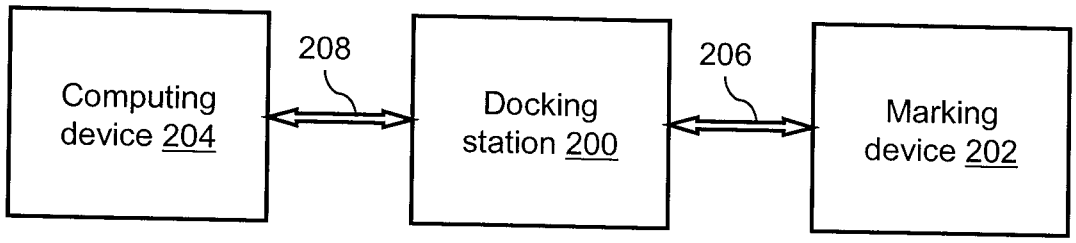


FIG. 3A

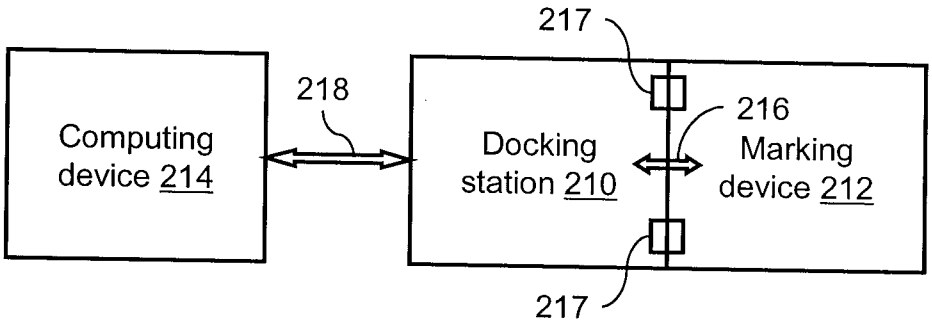


FIG. 3B

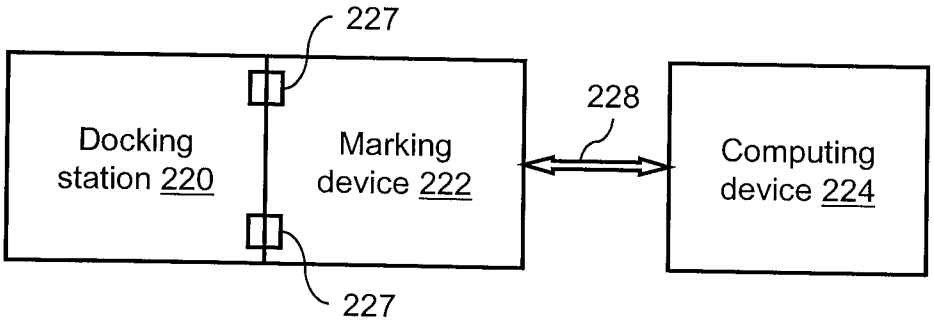


FIG. 3C

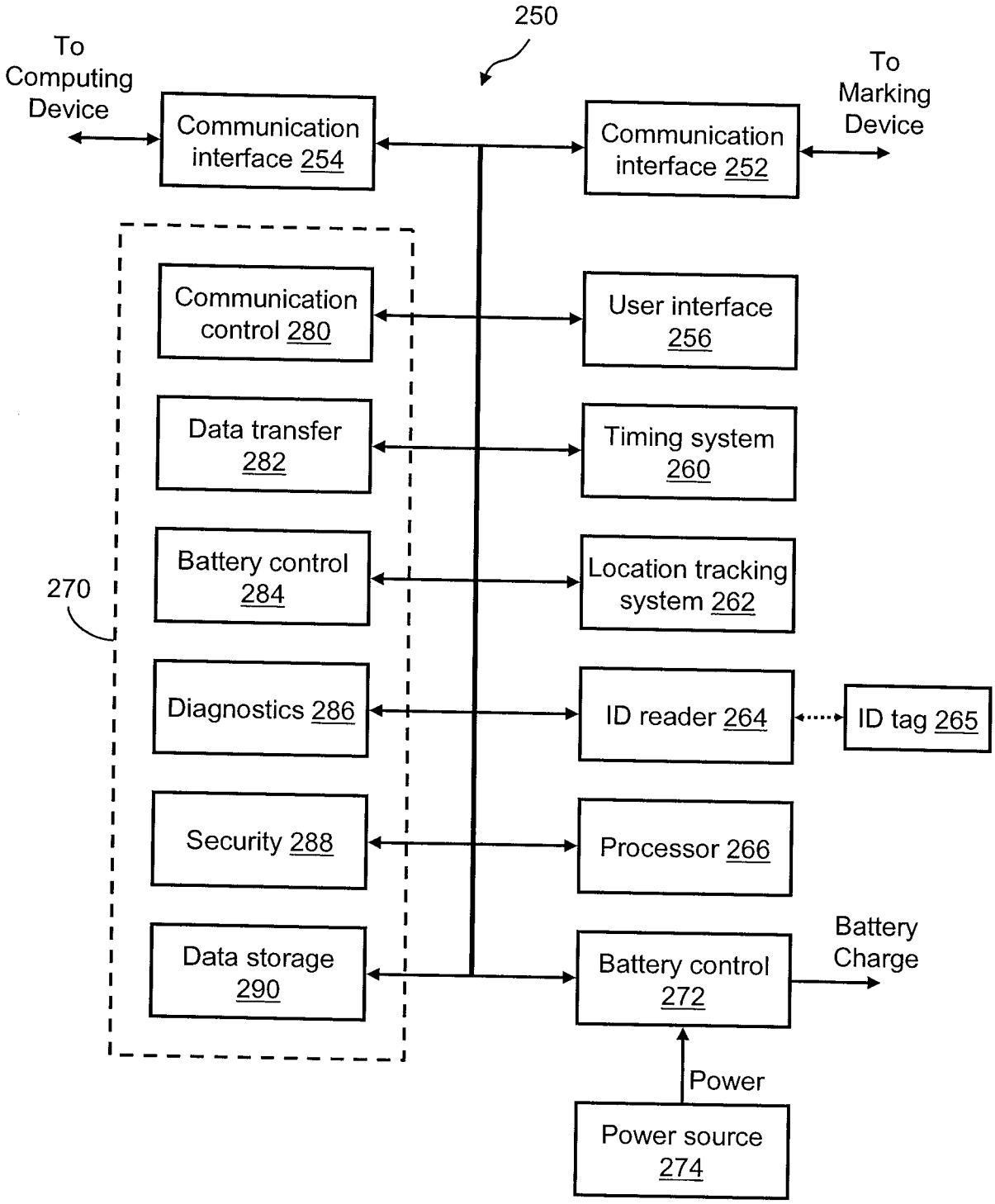
250
To Computing Device
Communication interface 254
Communication interface 252
To Marking Device
Communication control 280
User interface 256
Data transfer 282
Timing system 260
Battery control 284
Location tracking system 262
270
Diagnostics 286
ID reader 264
ID tag 265
Security 288
Processor 266
Data storage 290
Battery control 272
Battery Charge
Power
Power source 274

FIG. 4

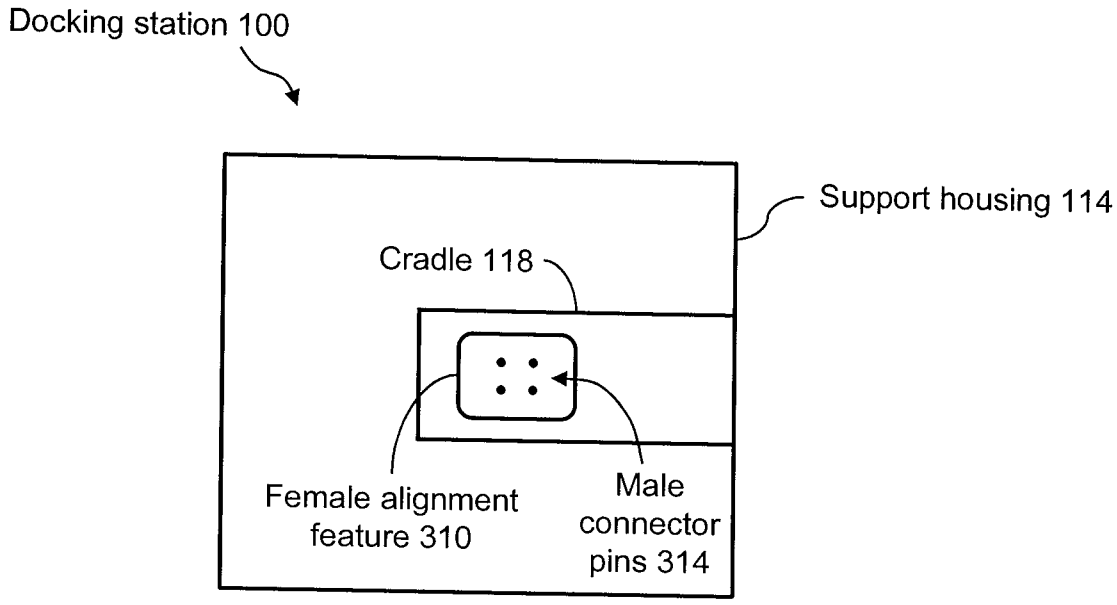
Docking station 100
Support housing 114
Cradle 118
Female alignment feature 310
Male connector pins 314

FIG. 5A

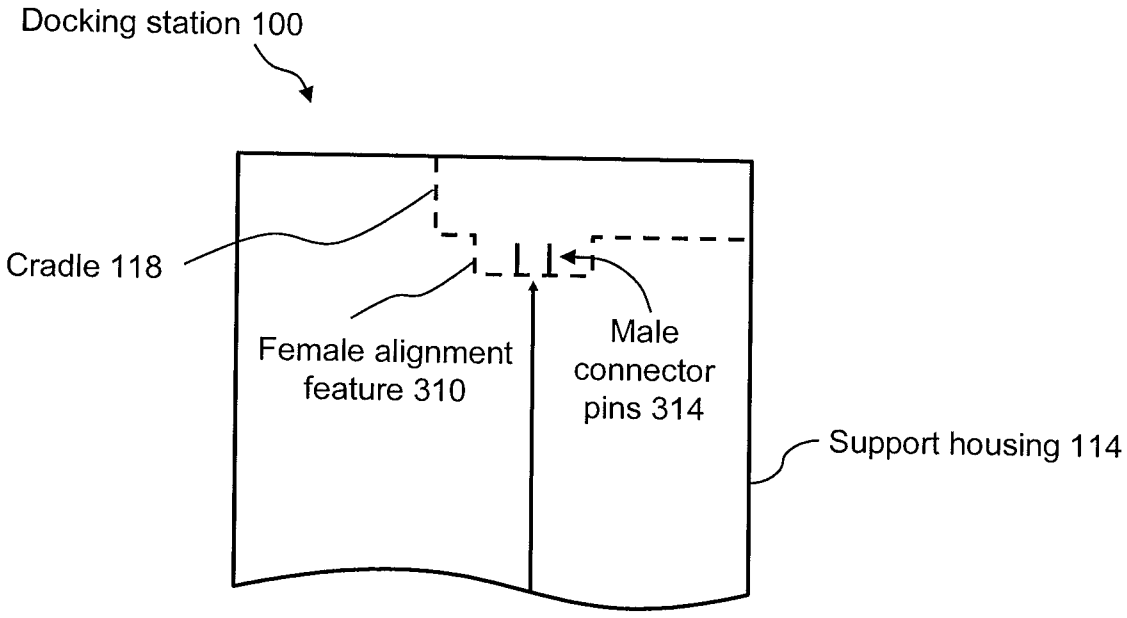
Docking station 100
Cradle 118
Female alignment feature 310
Male connector pins 314
Support housing 114

FIG. 5B

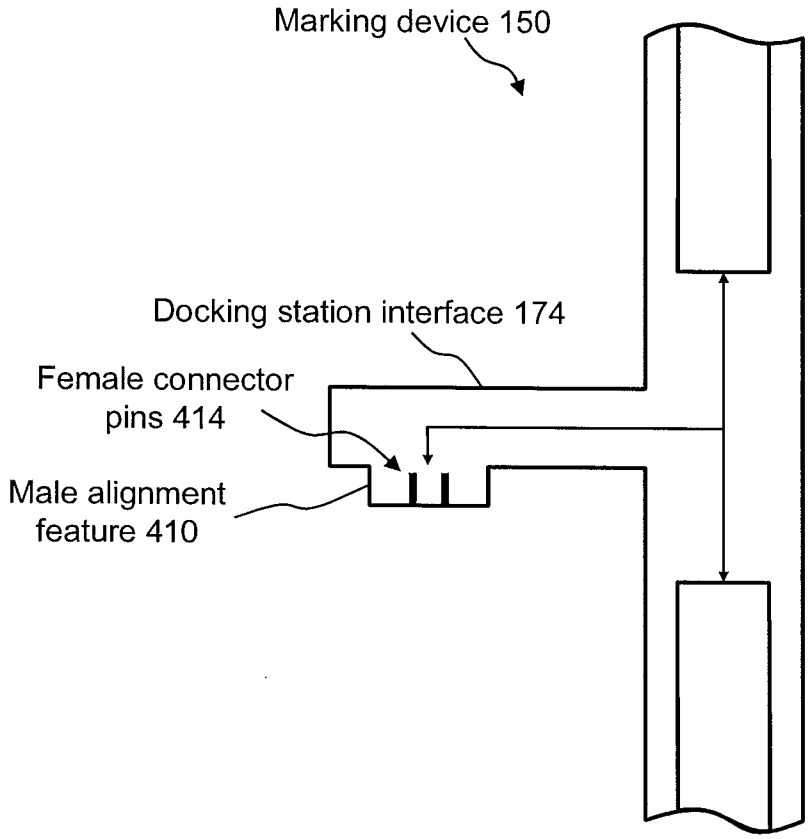
Marking device 150
Docking station interface 174
Female connector pins 414
Male alignment feature 410

FIG. 6A

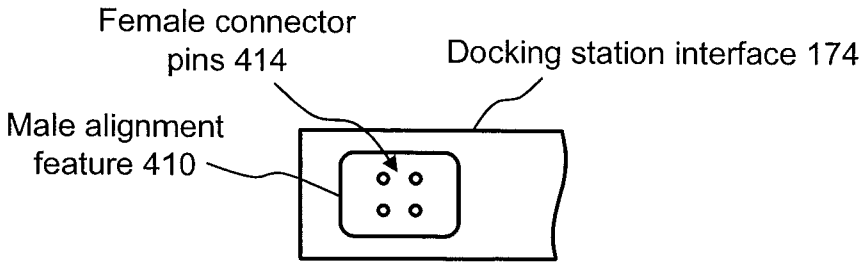
Female connector pins 414
Docking station interface 174
Male alignment feature 410

FIG. 6B

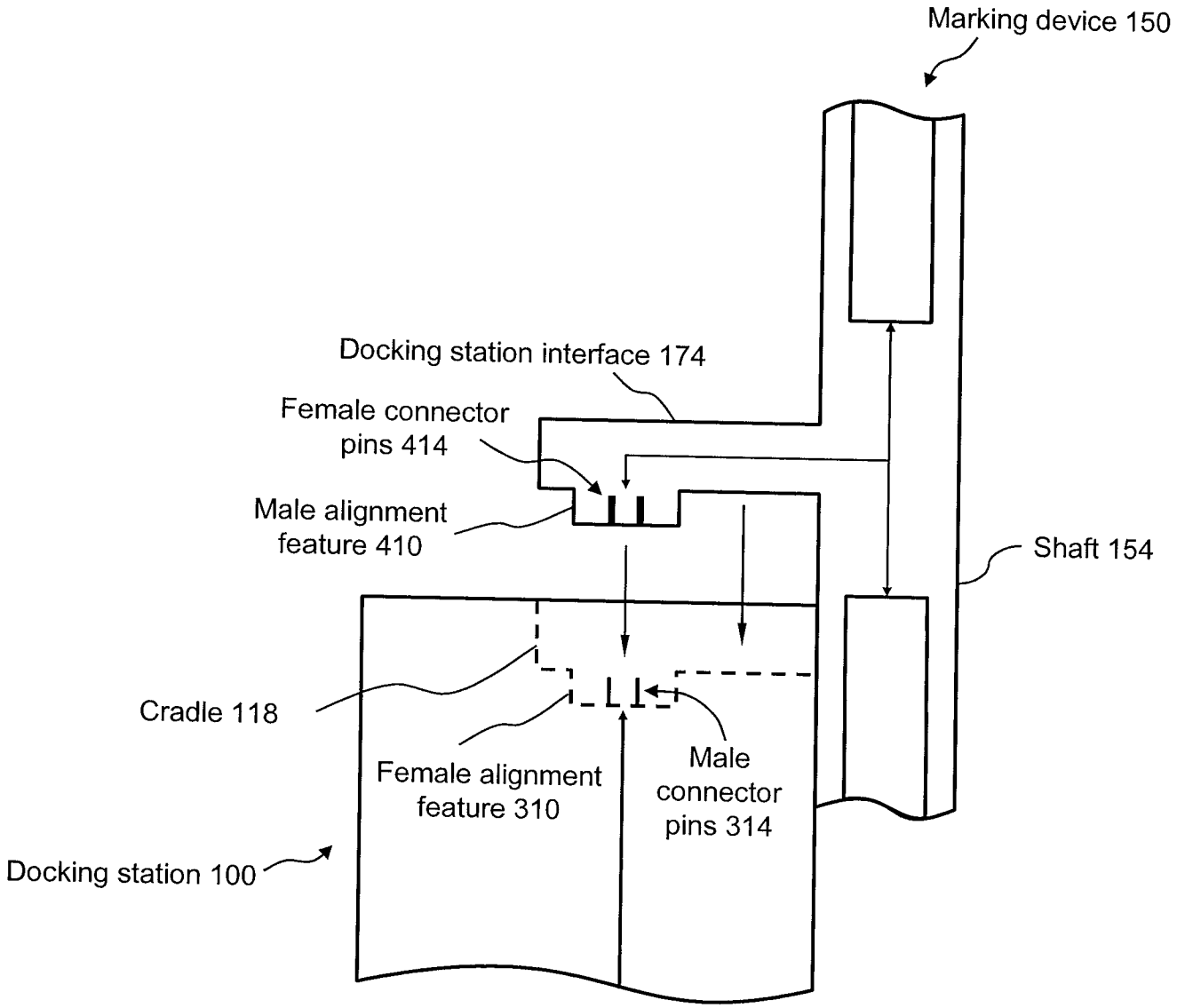
Marking device 150
Docking station interface 174
Female connector pins 414
Male alignment feature 410
Shaft 154
Cradle 118
Female alignment feature 310
Male connector pins 314
Docking station 100

FIG. 7

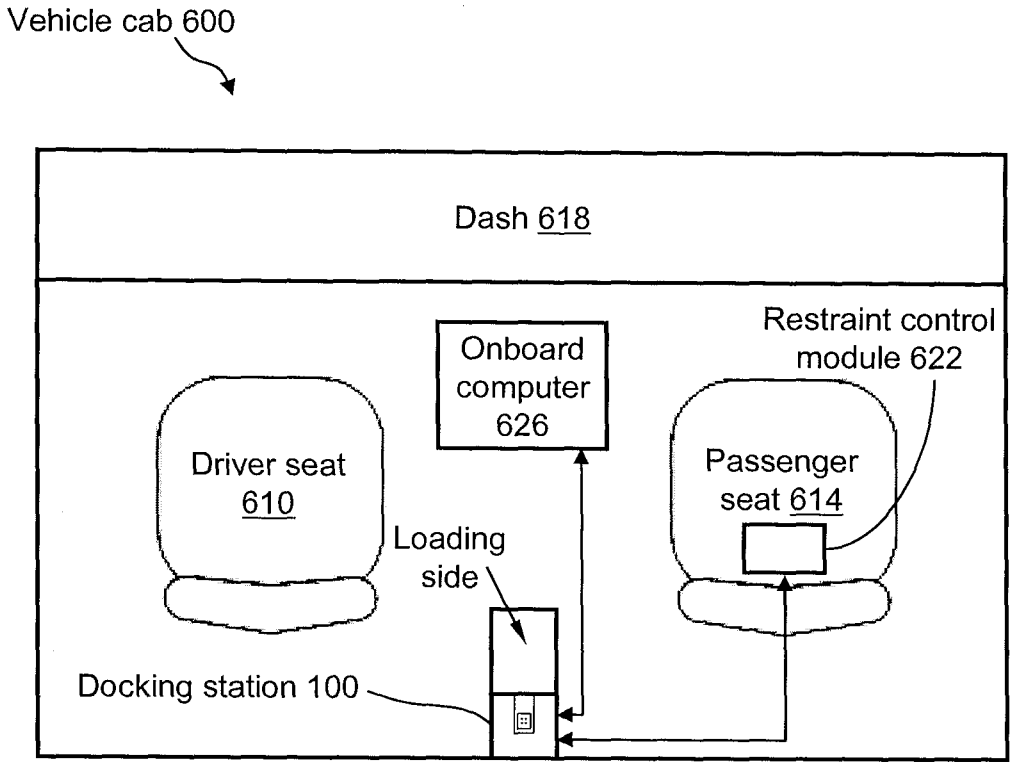
Vehicle cab 600
Dash 618
Onboard computer 626
Restraint control module 622
Driver seat 610
Passenger seat 614
Loading side
Docking station 100

FIG. 8A

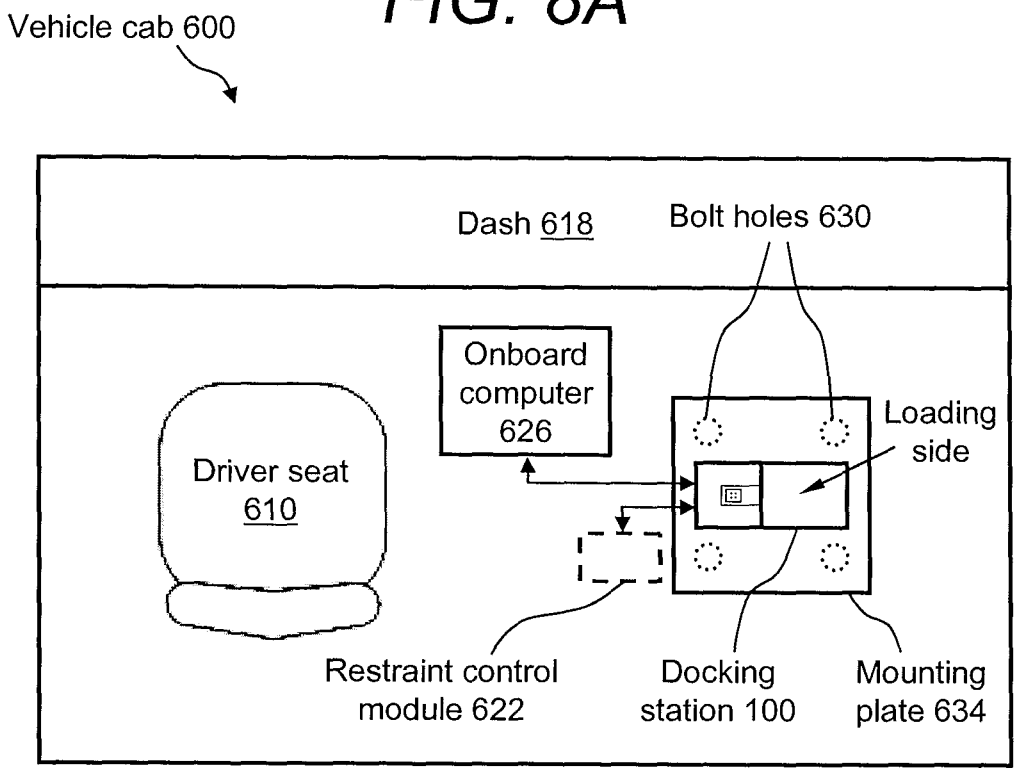
Vehicle cab 600
Dash 618
Bolt holes 630
Onboard computer 626
Loading side
Driver seat 610
Restraint control module 622
Docking station 100
Mounting plate 634

FIG. 8B

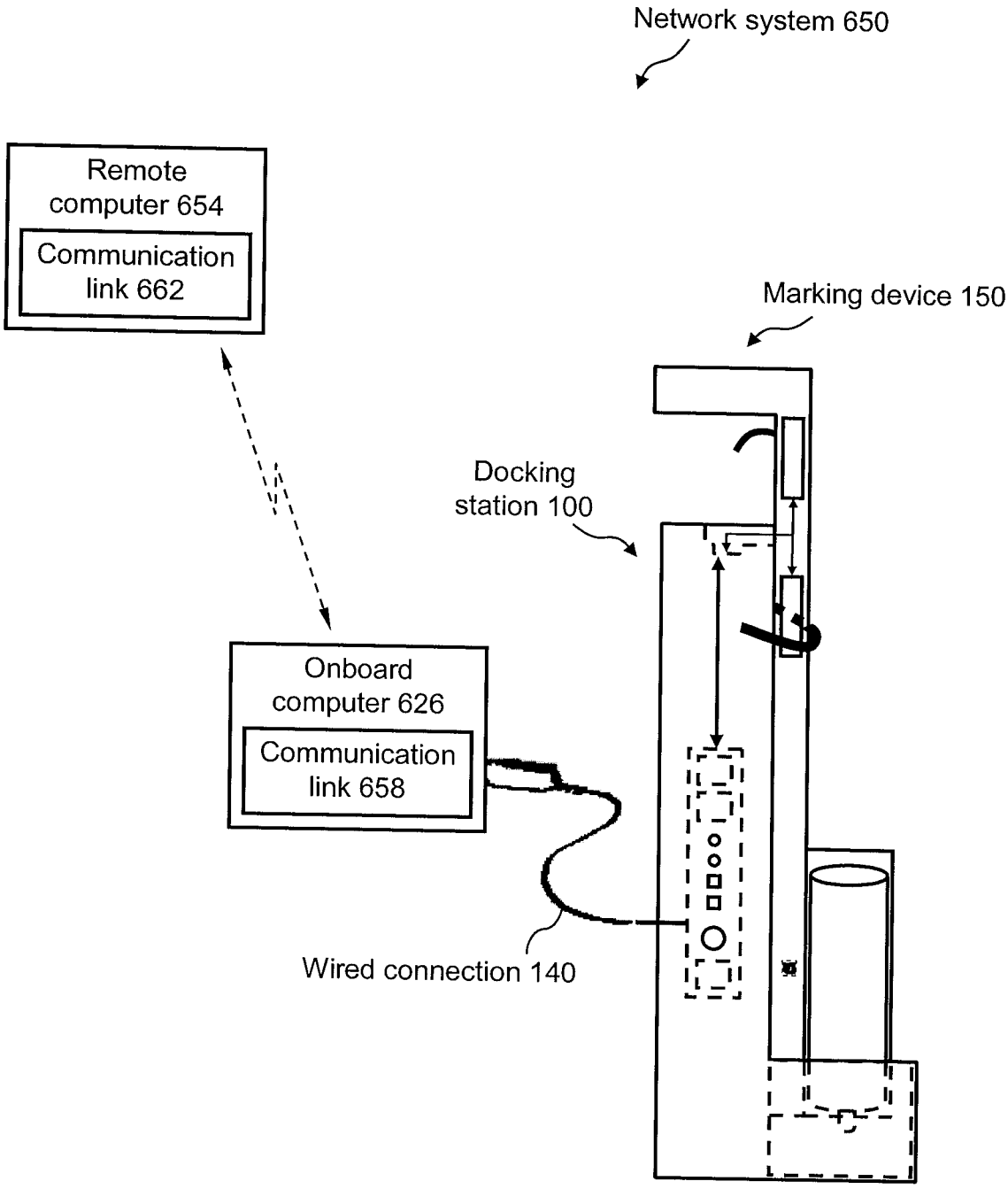
Network system 650
Remote computer 654
Communication link 662
Marking device 150
Docking station 100
Onboard computer 626
Communication link 658
Wired connection 140

FIG. 8C

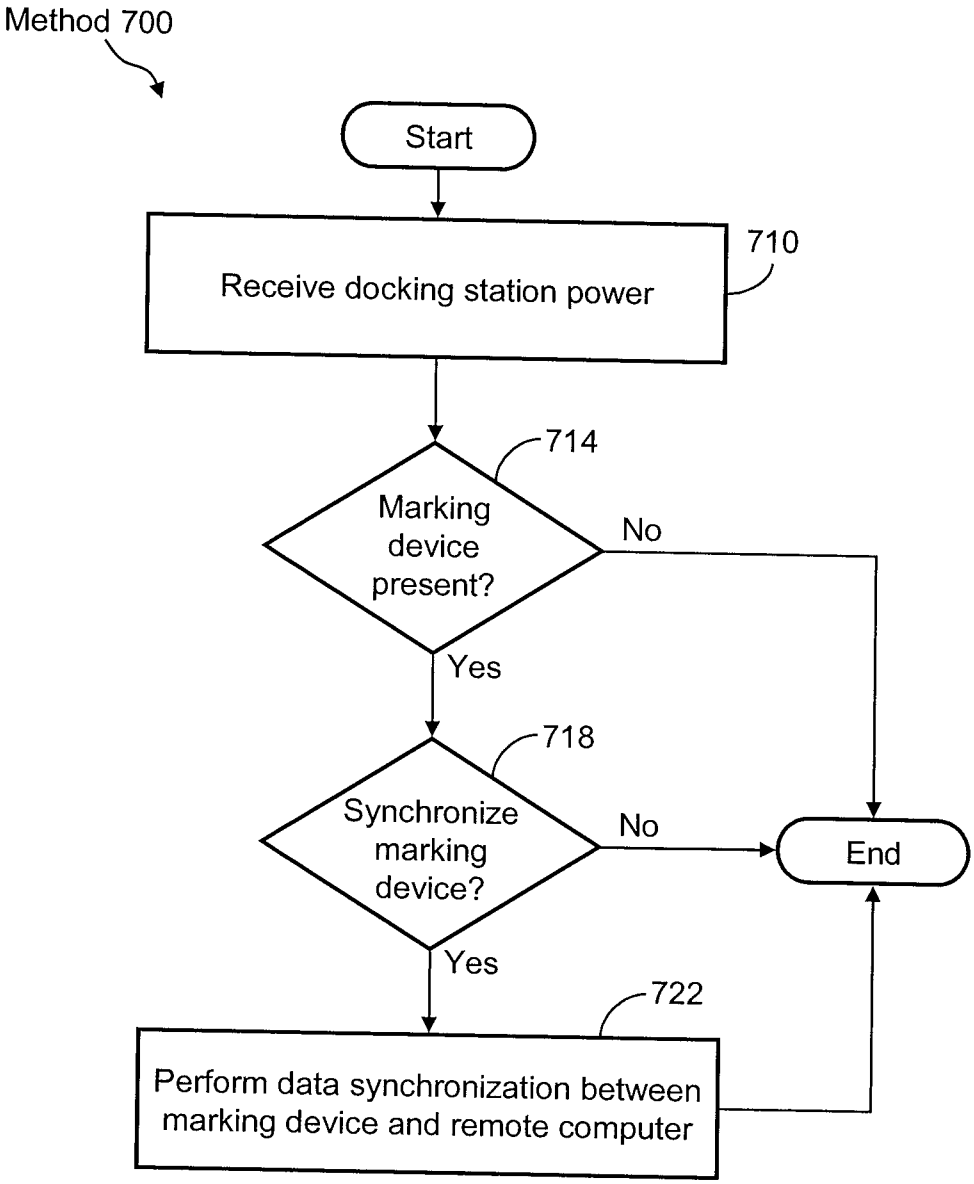
Method 700
Start
Receive docking station power
710
714
Marking device present?
No
Yes
718
Synchronize marking device?
No
End
Yes
722
Perform data synchronization between marking device and remote computer

FIG. 9

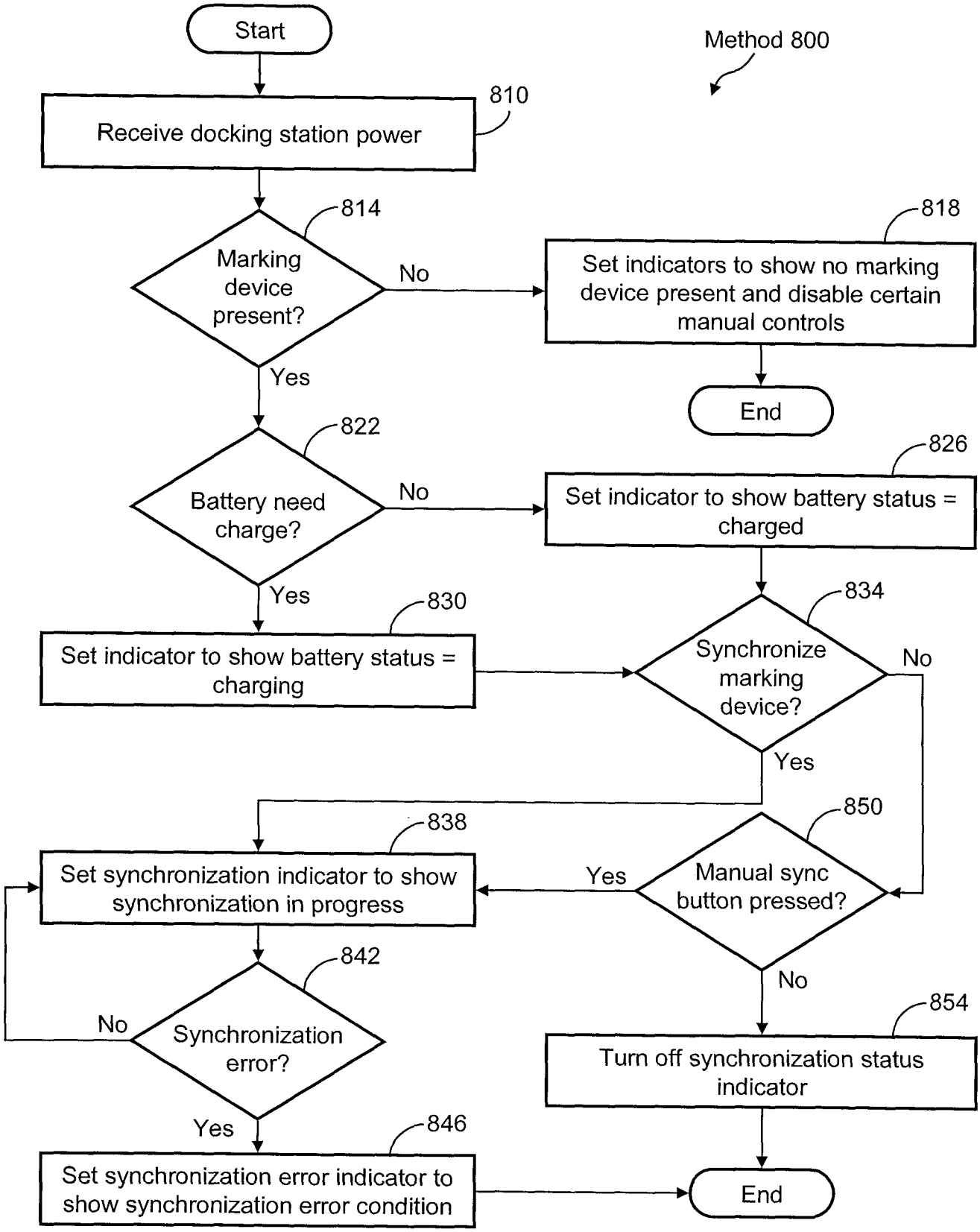
Start
Method 800
Receive docking station power
810
Marking device present?
814
No
Set indicators to show no marking device present and disable certain manual controls
818
End
Yes
Battery need charge?
822
No
Set indicator to show battery status = charged
826
Yes
Set indicator to show battery status = charging
830
Synchronize marking device?
834
No
Yes
Manual sync button pressed?
850
Yes
Set synchronization indicator to show synchronization in progress
838
No
Synchronization error?
842
No
Turn off synchronization status indicator
854
Yes
Set synchronization error indicator to show synchronization error condition
846
End

FIG. 10

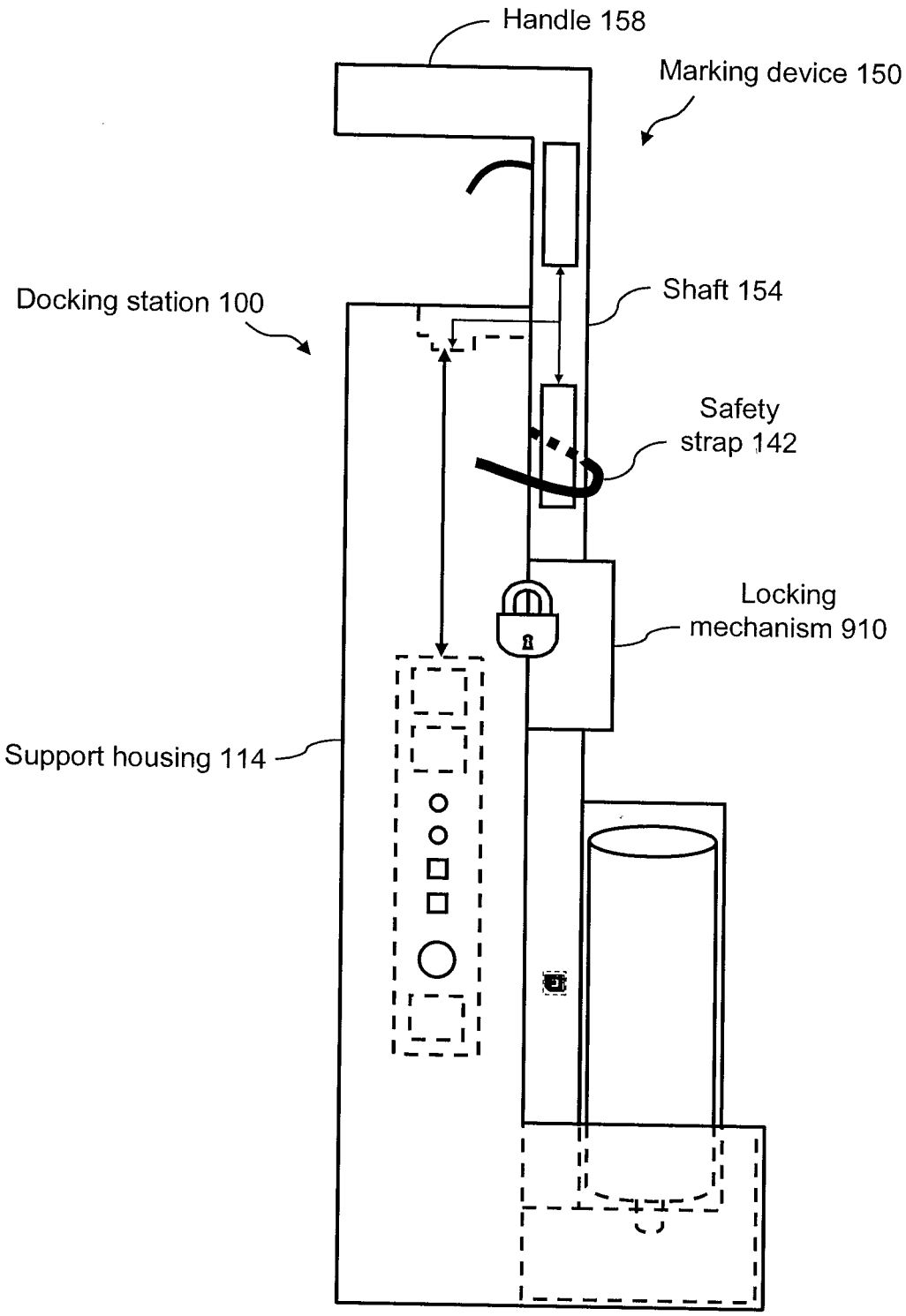
Handle 158
Marking device 150
Docking station 100
Shaft 154
Safety
strap 142
Locking
mechanism 910
Support housing 114

FIG. 11

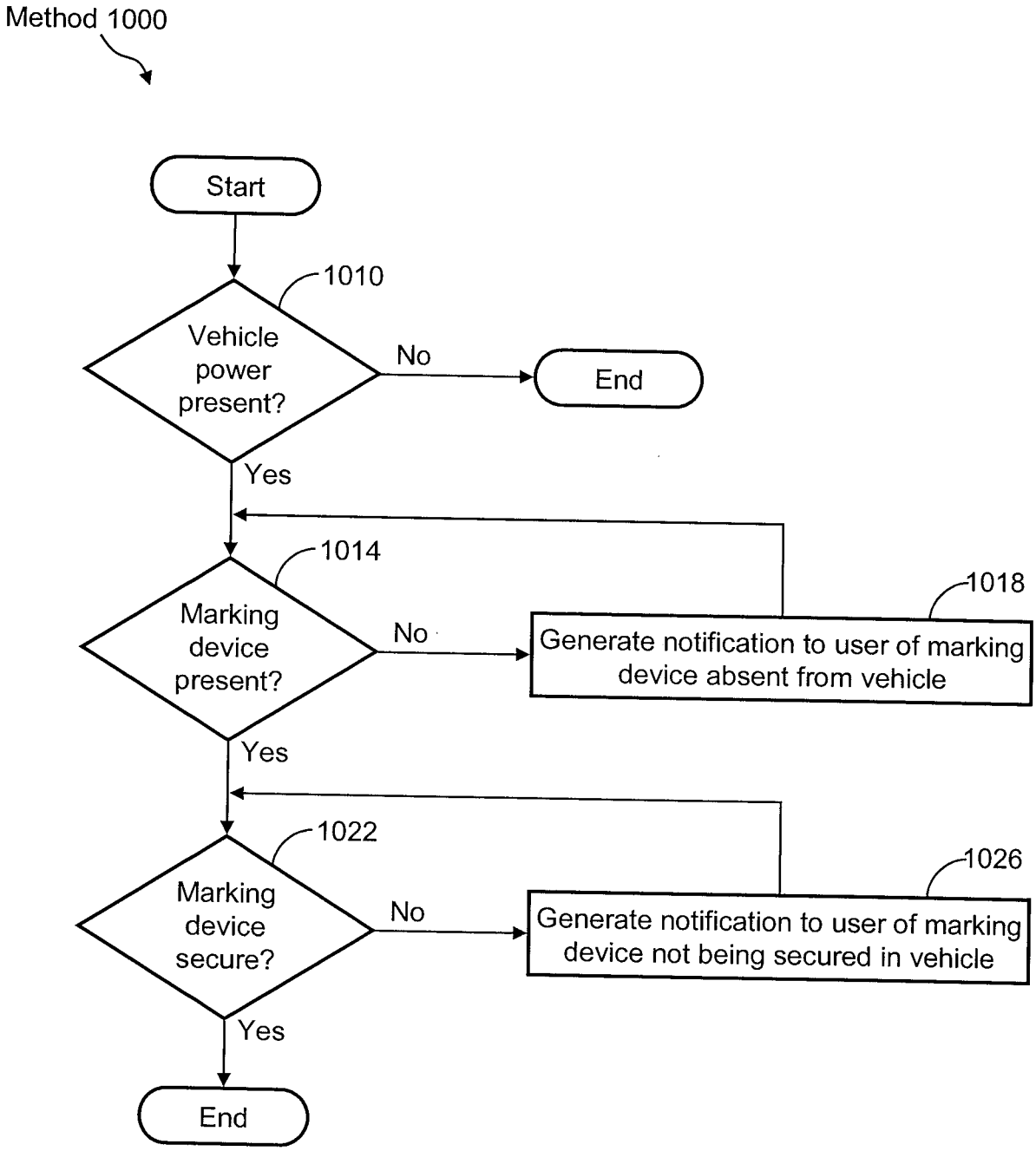
Method 1000
Start
1010
Vehicle power present?
No
End
Yes
1014
Marking device present?
No
1018
Generate notification to user of marking device absent from vehicle
Yes
1022
Marking device secure?
No
1026
Generate notification to user of marking device not being secured in vehicle
Yes
End

FIG. 12

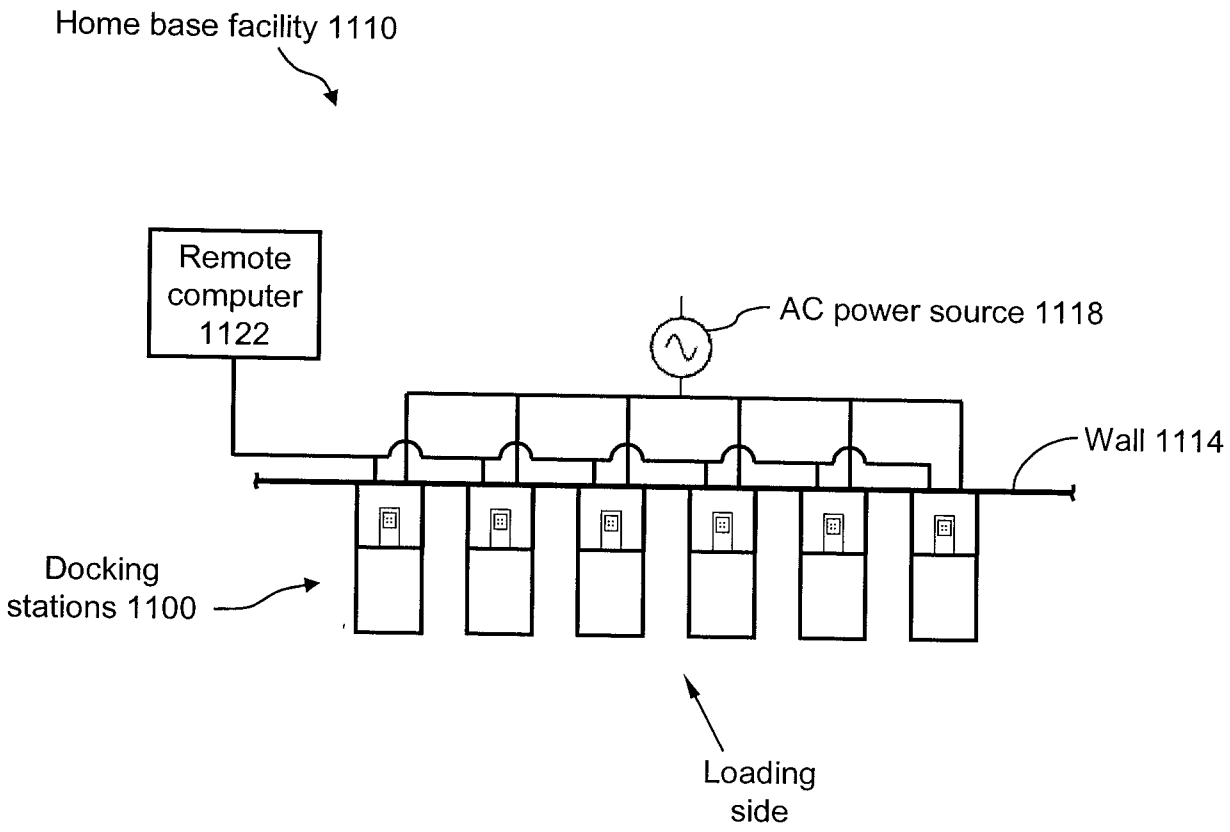
Home base facility 1110
Remote computer 1122
AC power source 1118
Wall 1114
Docking stations 1100
Loading side

FIG. 13

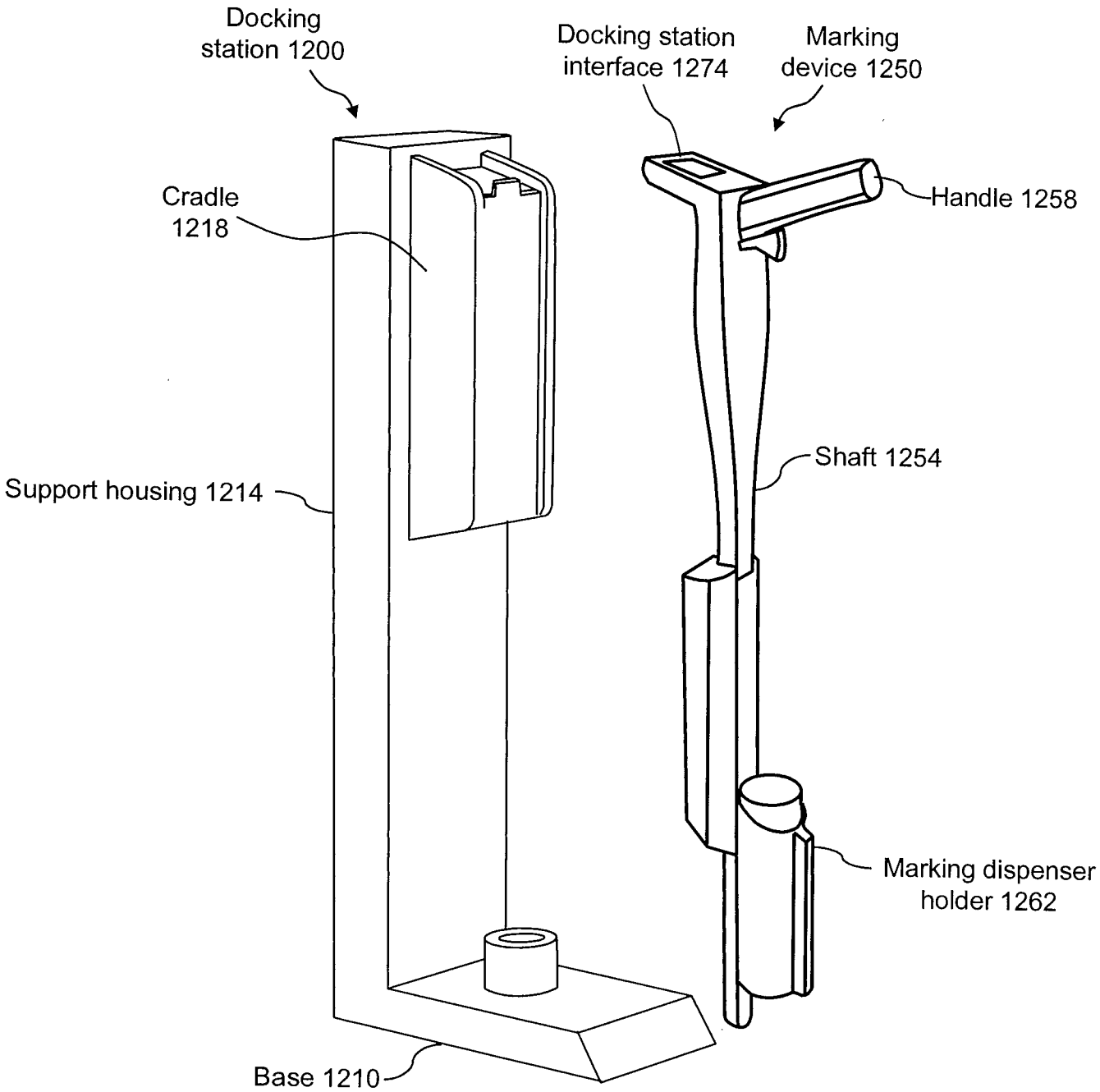
Docking station 1200
Docking station interface 1274
Marking device 1250
Handle 1258
Cradle 1218
Shaft 1254
Support housing 1214
Marking dispenser holder 1262
Base 1210

FIG. 14

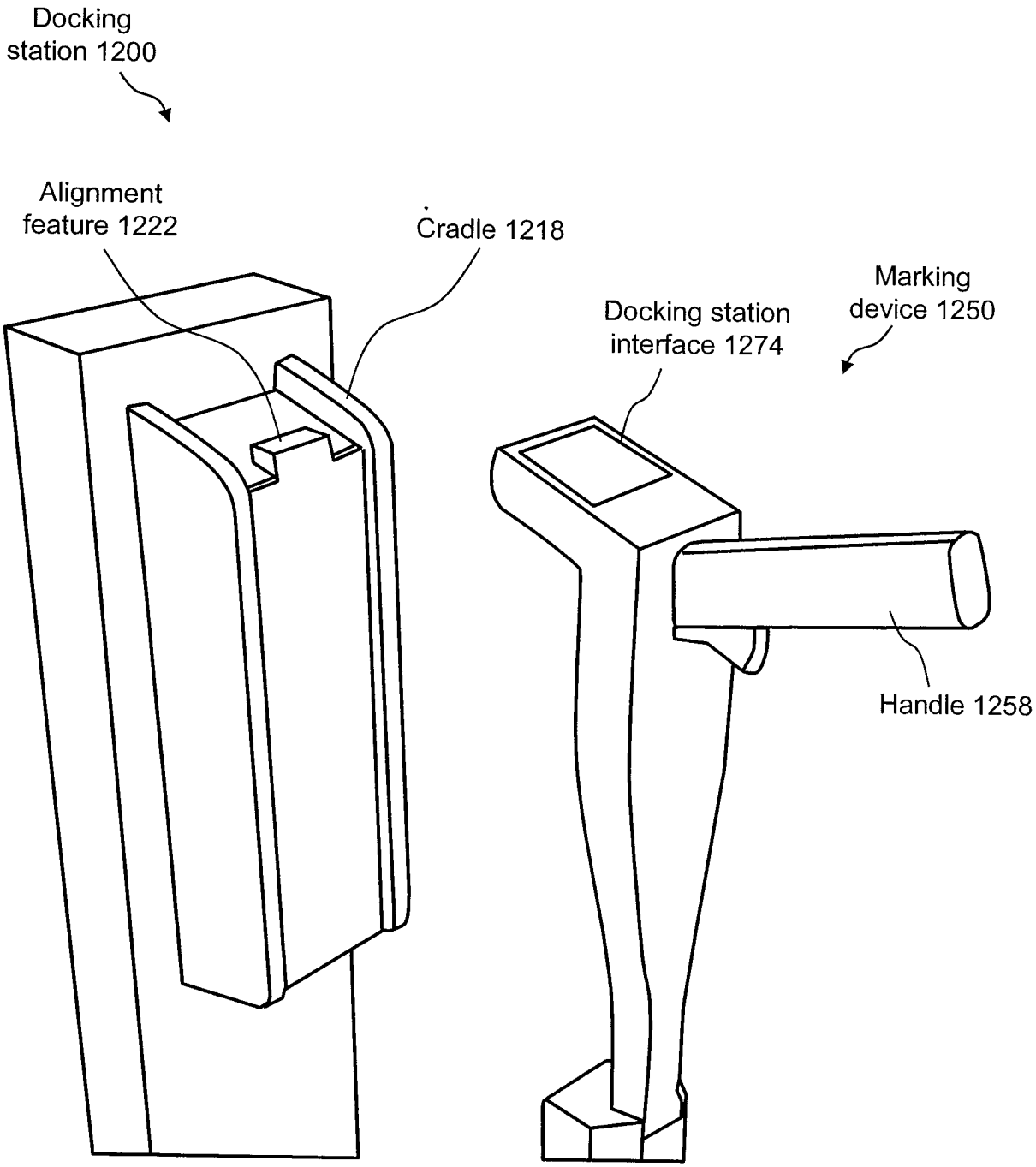
Docking station 1200
Alignment feature 1222
Cradle 1218
Docking station interface 1274
Marking device 1250
Handle 1258

FIG. 15

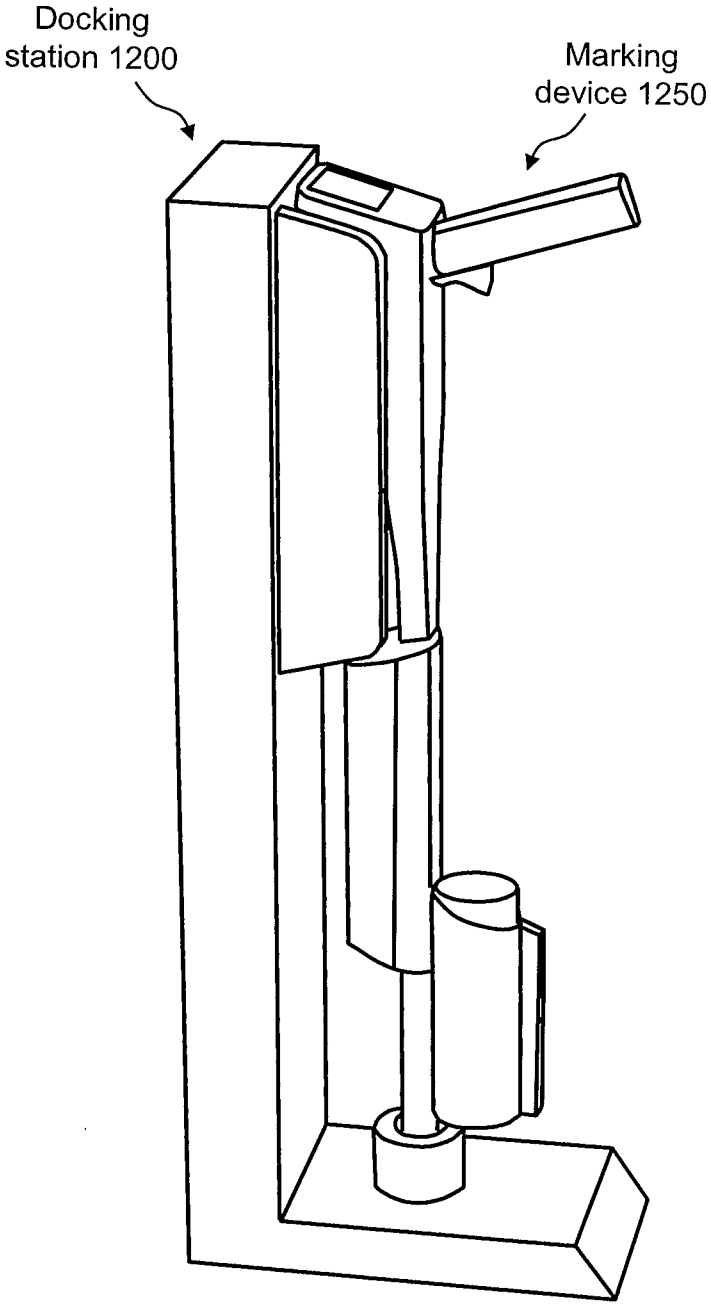


FIG. 16

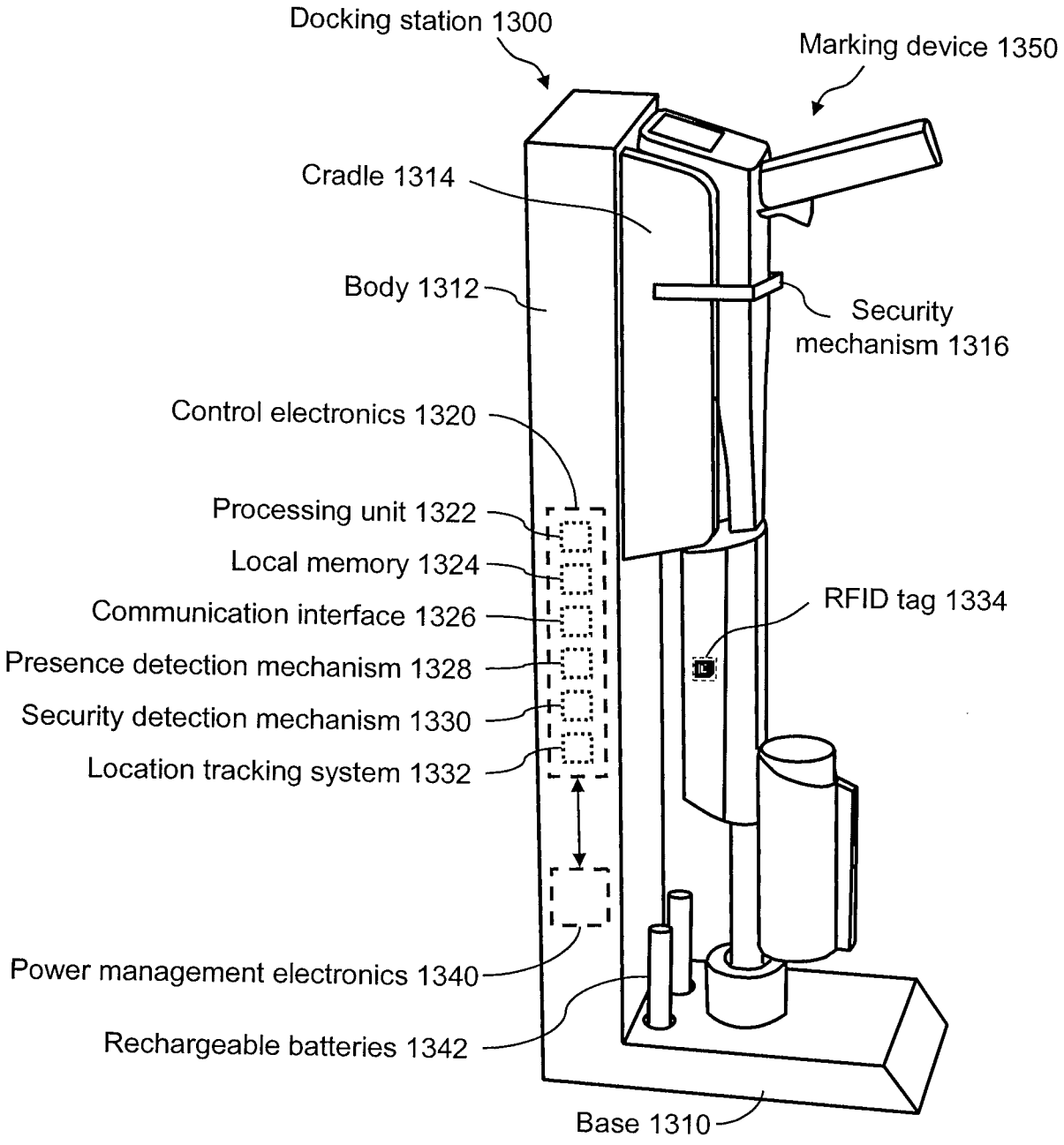
Docking station 1300
Marking device 1350
Cradle 1314
Body 1312
Security mechanism 1316
Control electronics 1320
Processing unit 1322
Local memory 1324
Communication interface 1326
Presence detection mechanism 1328
Security detection mechanism 1330
Location tracking system 1332
RFID tag 1334
Power management electronics 1340
Rechargeable batteries 1342
Base 1310

FIG. 17

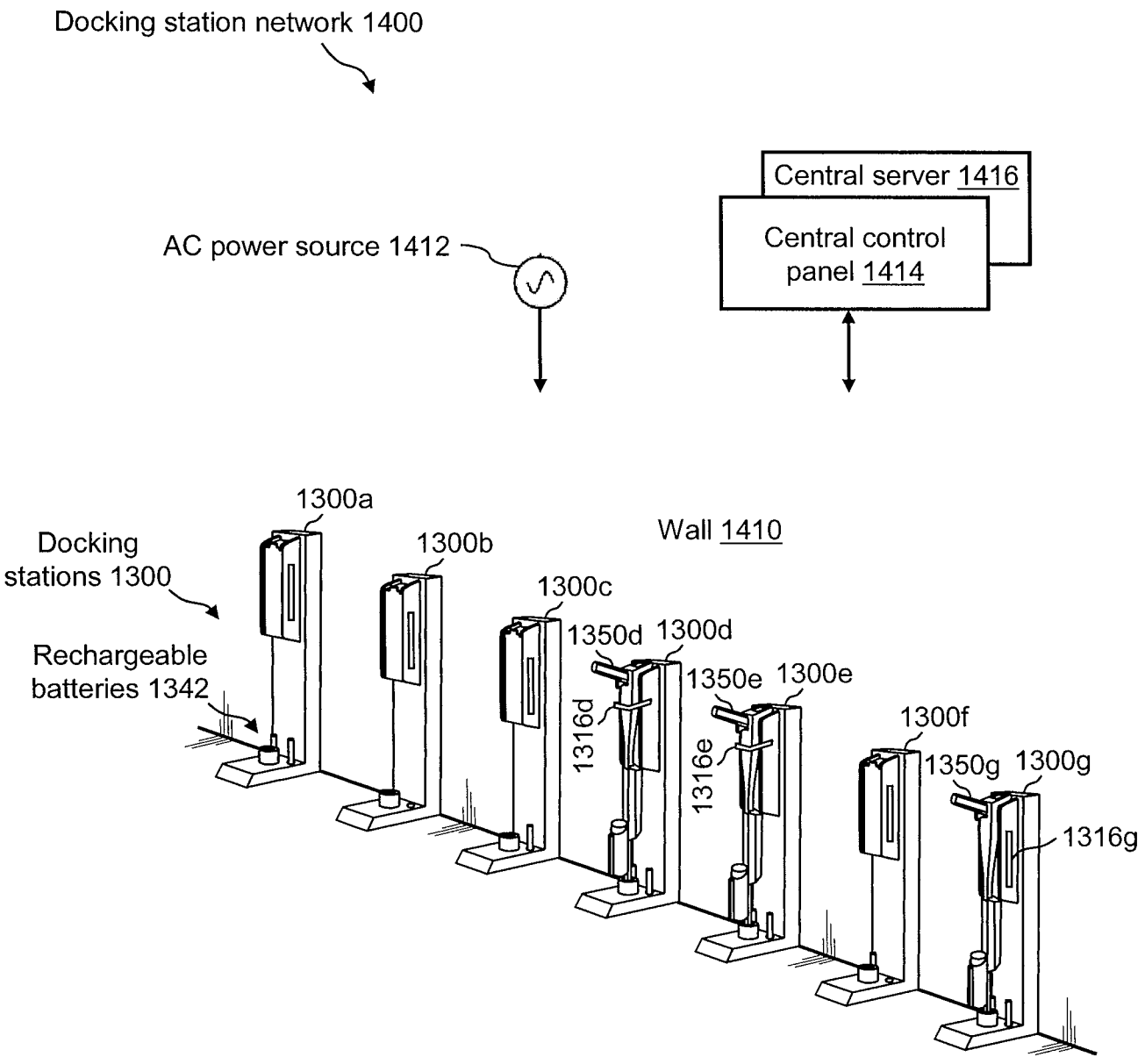
Docking station network 1400
Central server 1416
Central control panel 1414
AC power source 1412
1300a
Docking stations 1300
1300b
Wall 1410
1300c
1350d
1300d
Rechargeable batteries 1342
1350e
1300e
1316d
1316e
1300f
1350g
1300g
1316g

FIG. 18

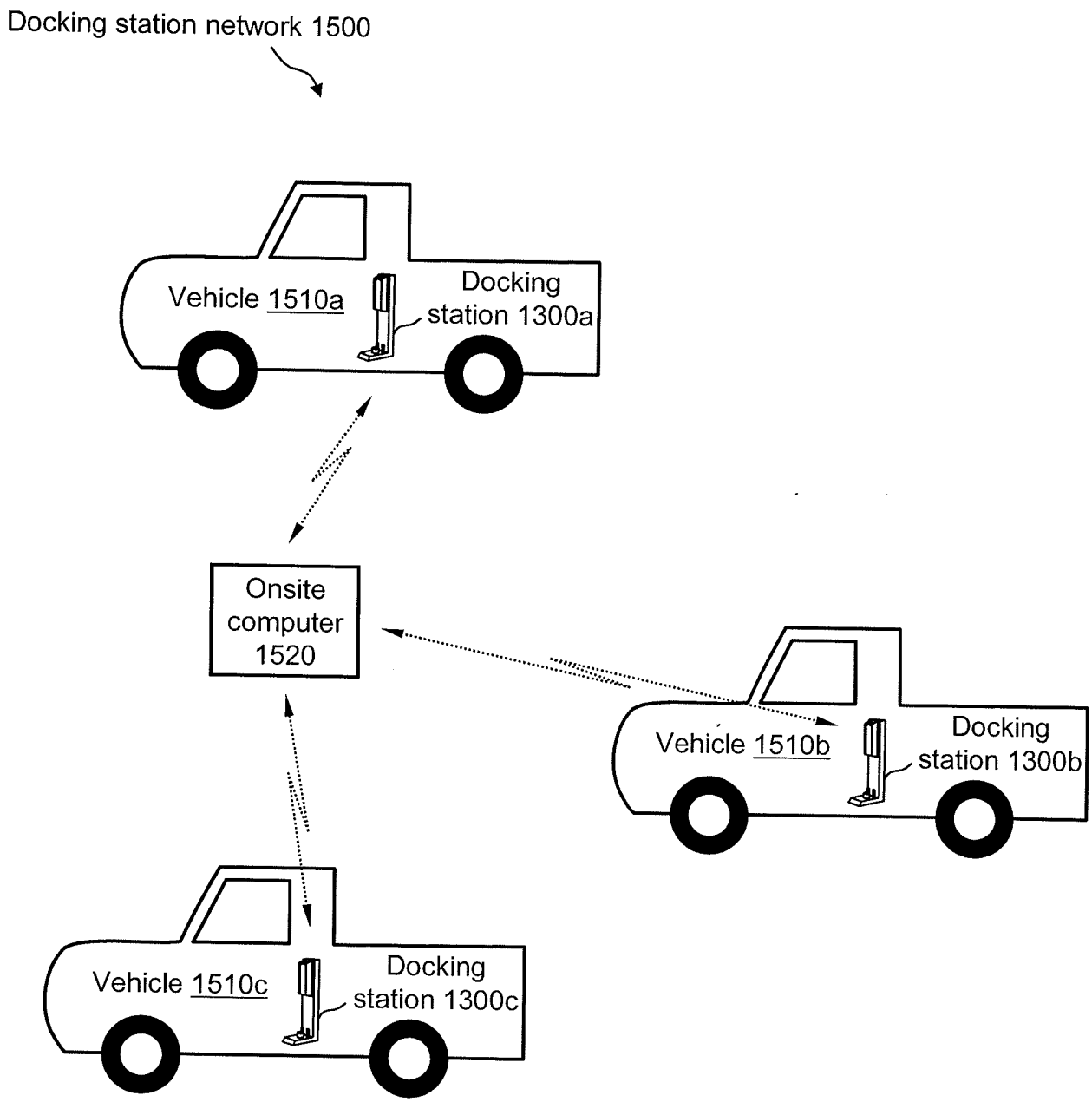
Docking station network 1500
Vehicle 1510a
Docking station 1300a
Onsite computer 1520
Vehicle 1510b
Docking station 1300b
Vehicle 1510c
Docking station 1300c

FIG. 19

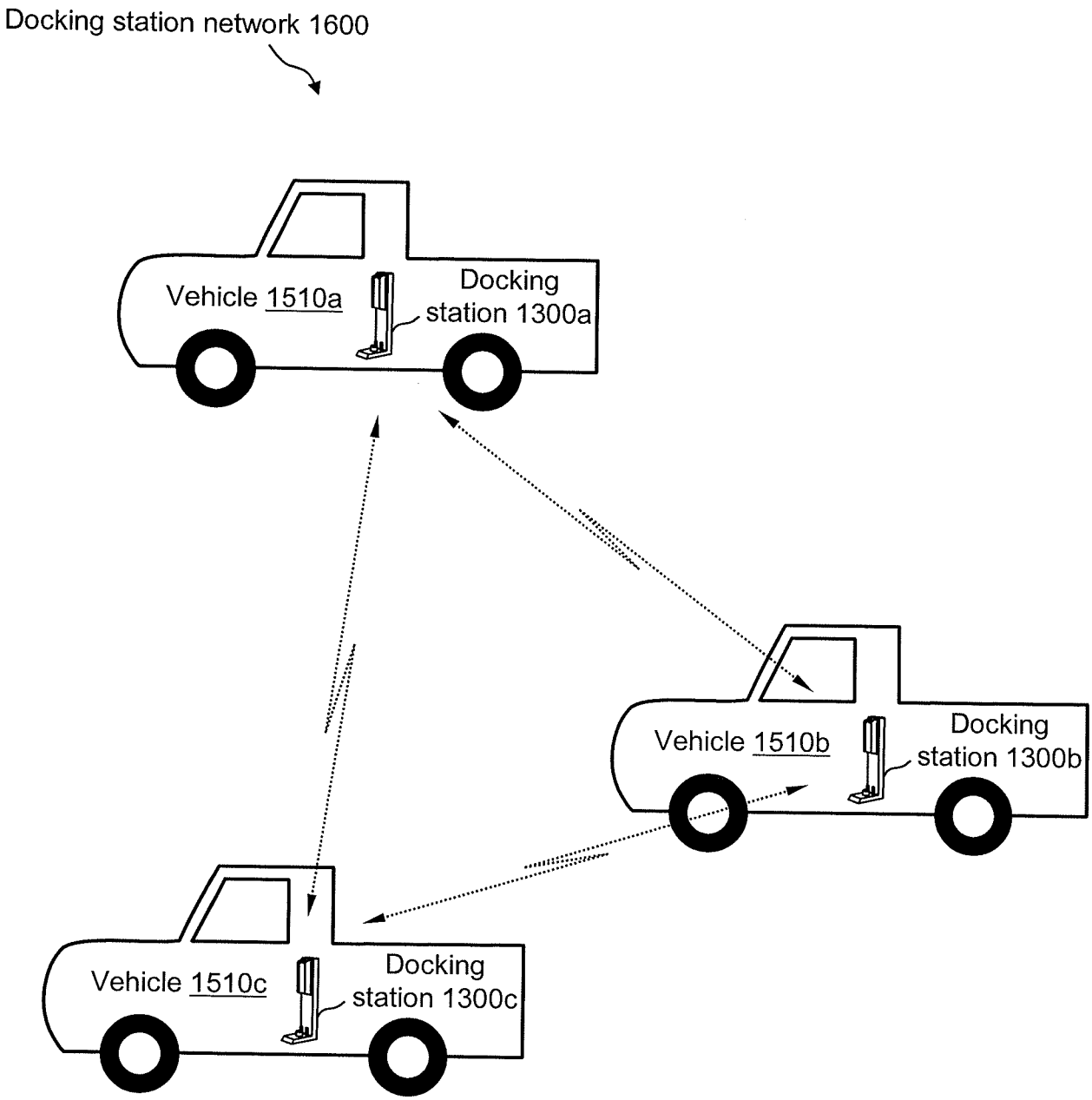
Docking station network 1600
Vehicle 1510a
Docking station 1300a
Vehicle 1510b
Docking station 1300b
Vehicle 1510c
Docking station 1300c

FIG. 20

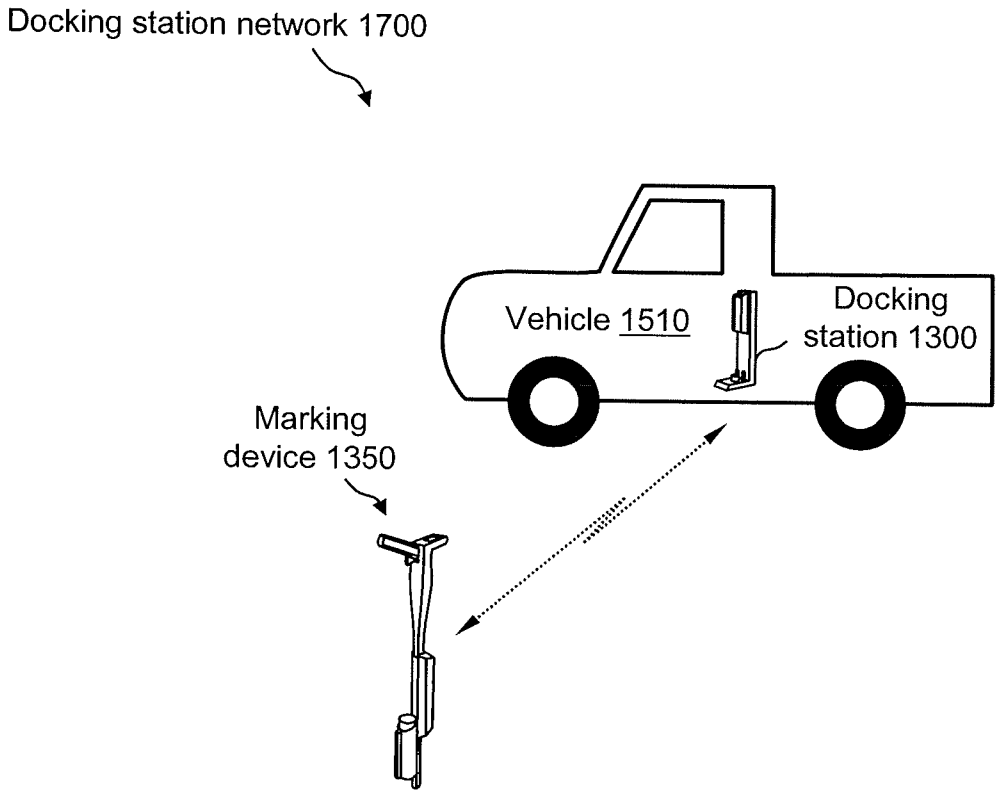
Docking station network 1700
Vehicle 1510
Docking station 1300
Marking device 1350

FIG. 21

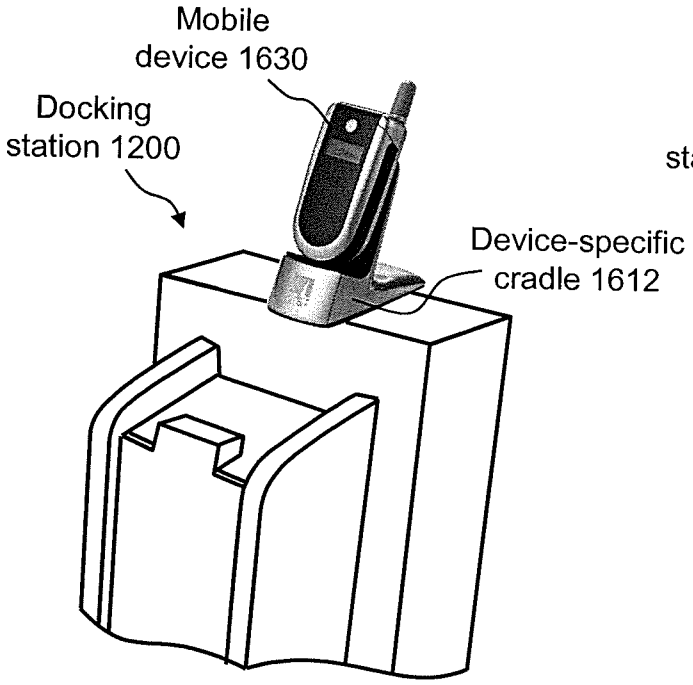


FIG. 22A

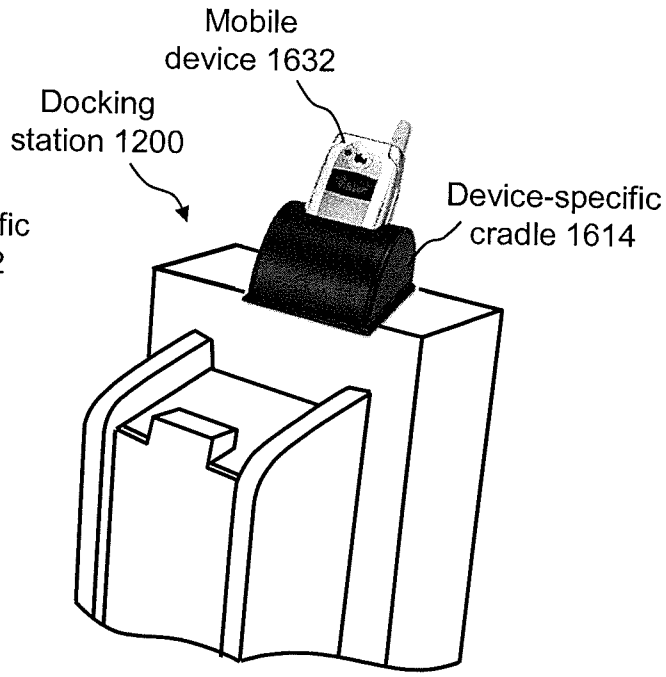


FIG. 22B

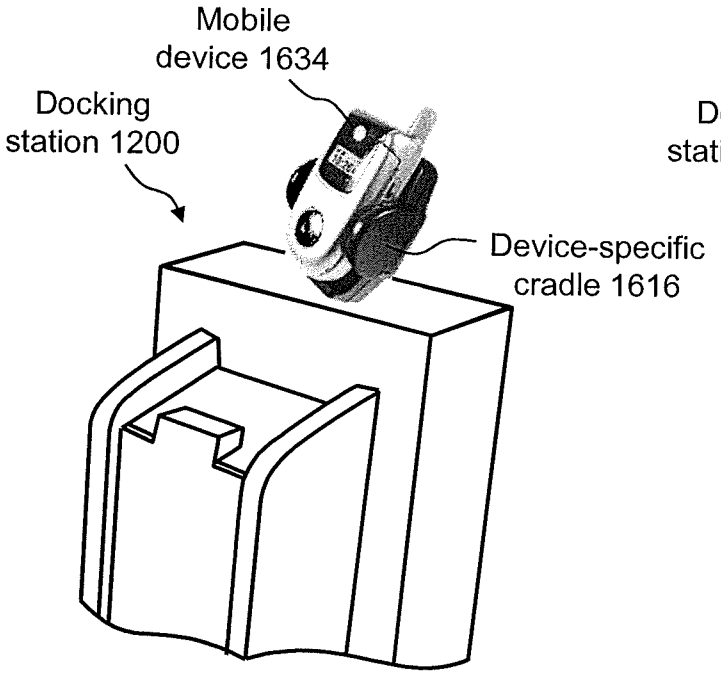


FIG. 22C

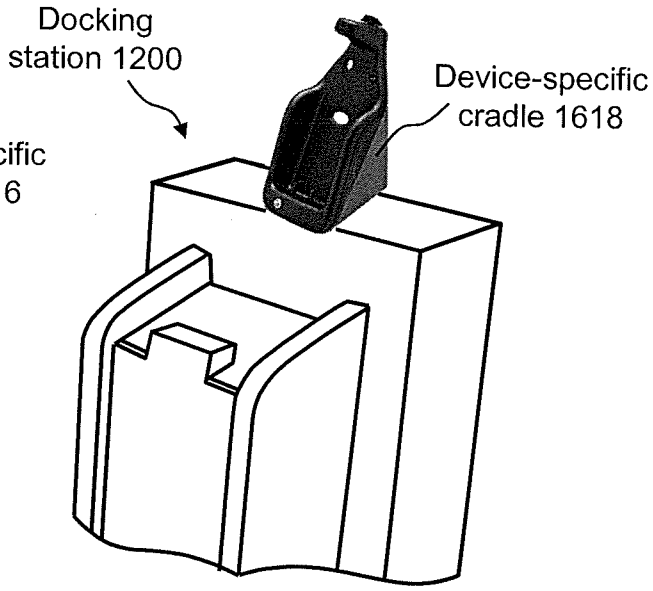


FIG. 22D

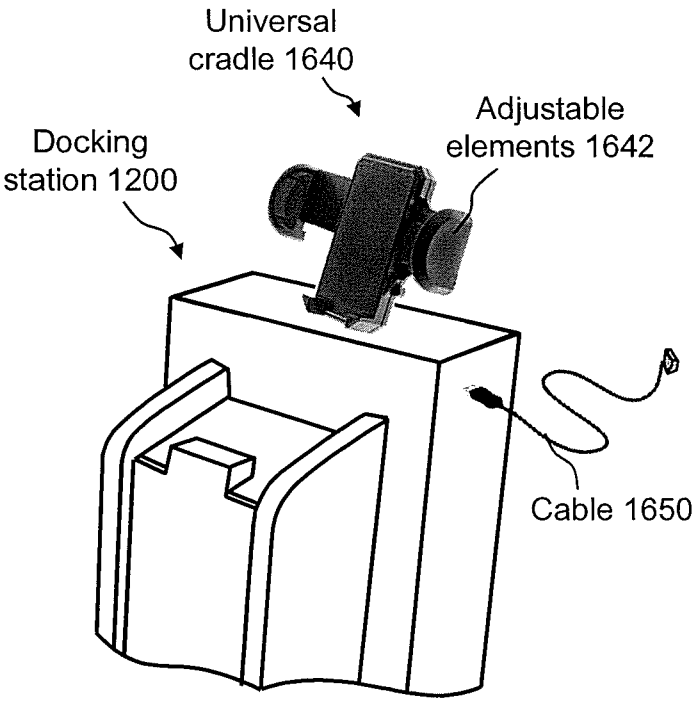


FIG. 23A

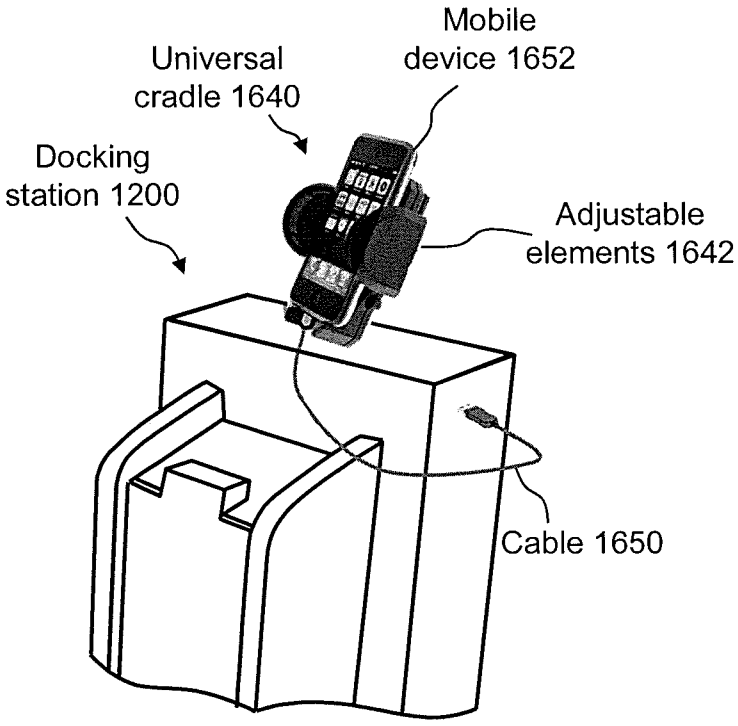


FIG. 23B

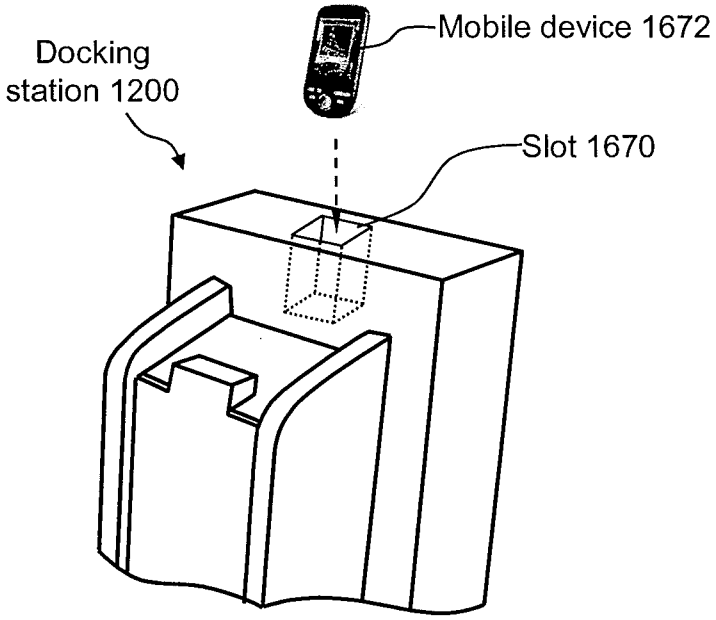


FIG. 24A

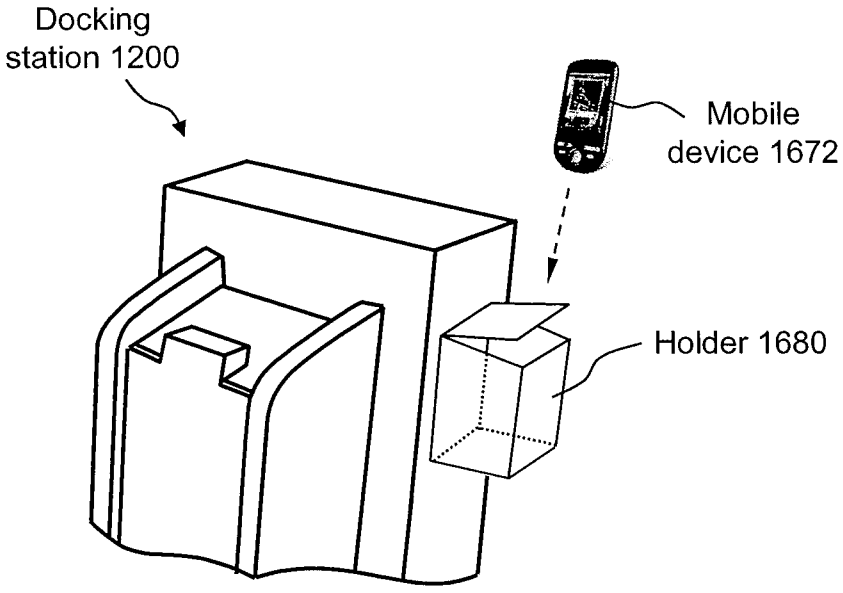


FIG. 24B

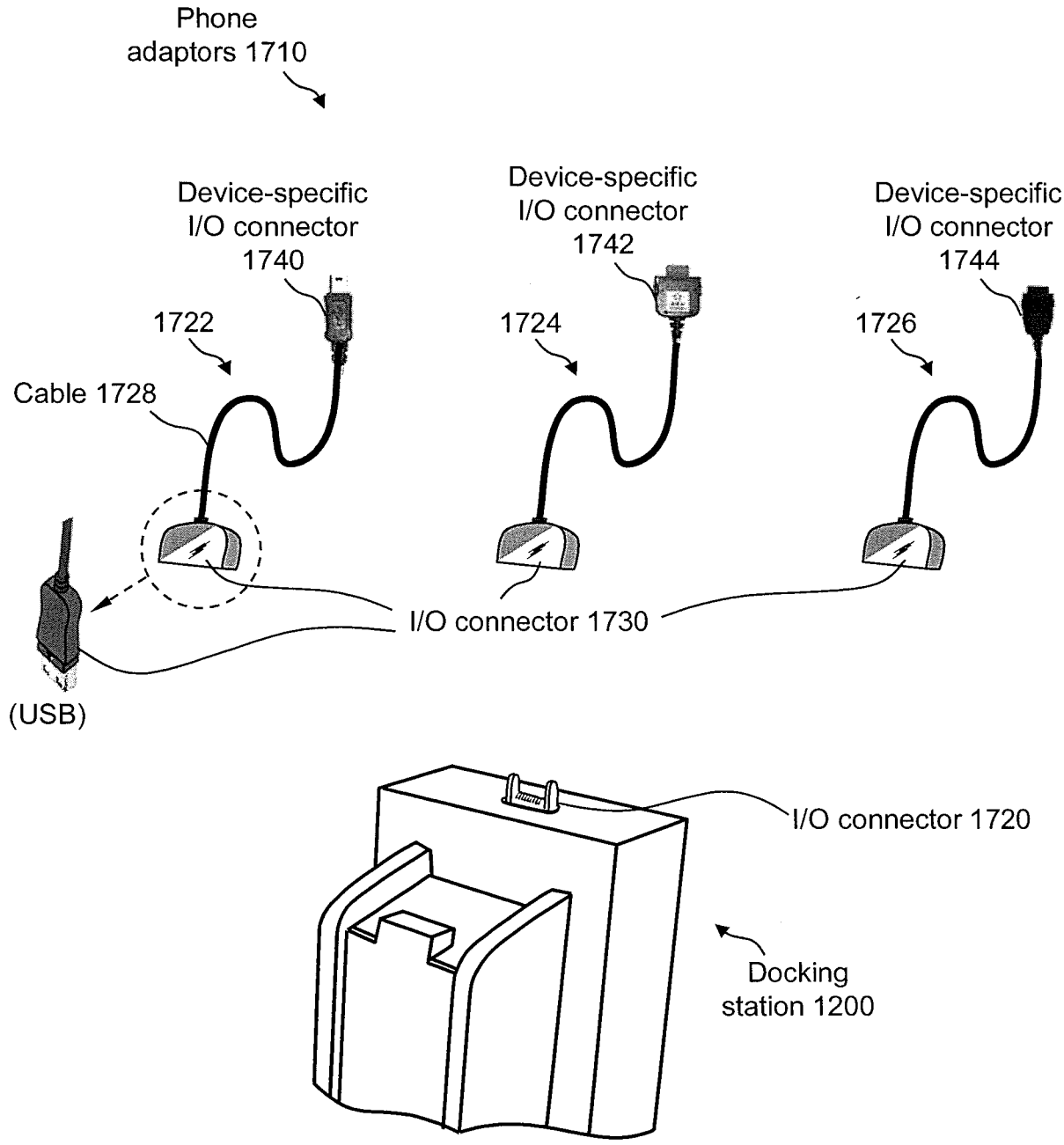
Phone
adaptors 1710
Device-specific
I/O connector
1740
Device-specific
I/O connector
1742
Device-specific
I/O connector
1744
1722
1724
1726
Cable 1728
I/O connector 1730
(USB)
I/O connector 1720
Docking
station 1200

FIG. 25

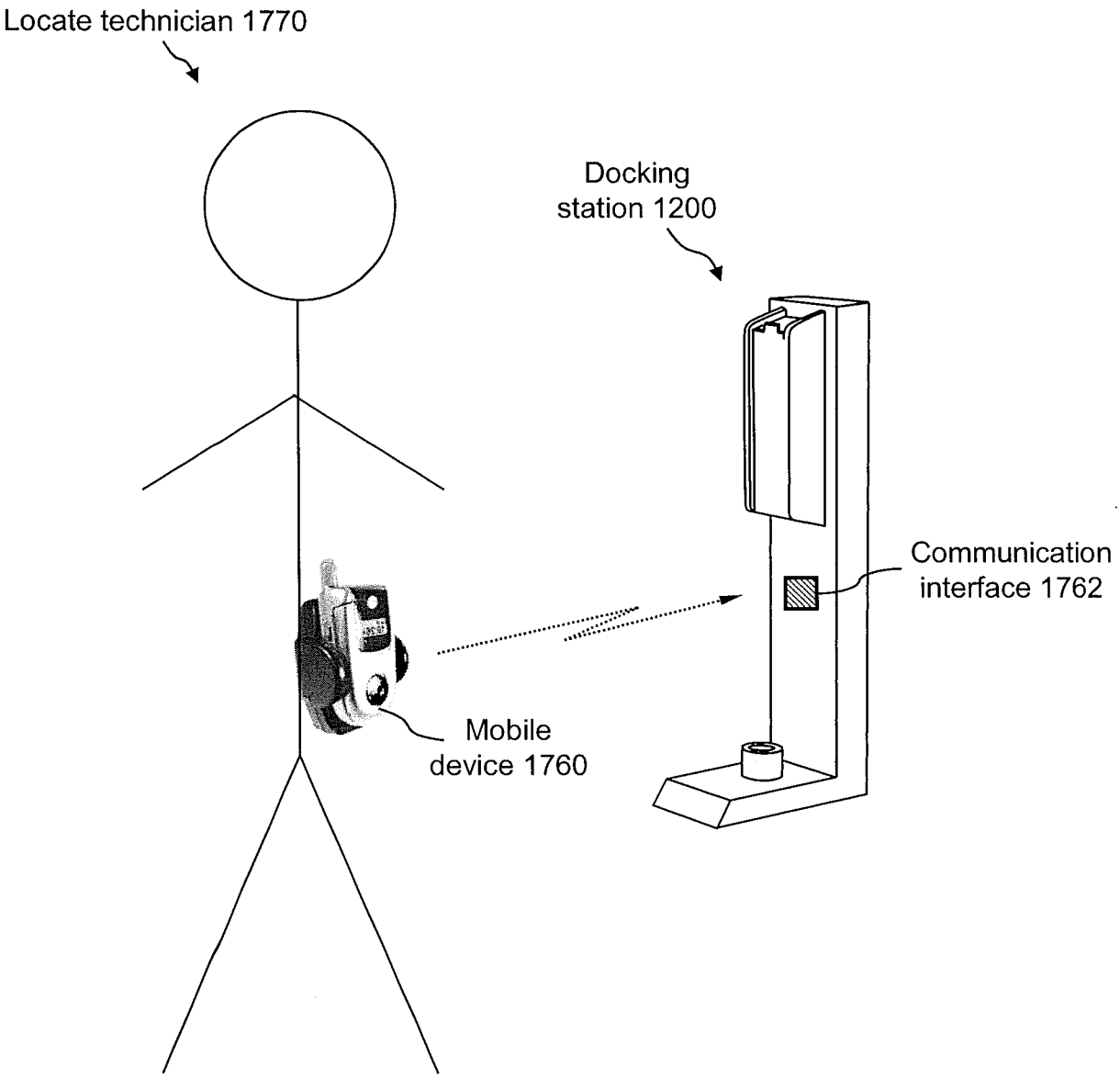
Locate technician 1770
Docking station 1200
Communication interface 1762
Mobile device 1760

FIG. 26

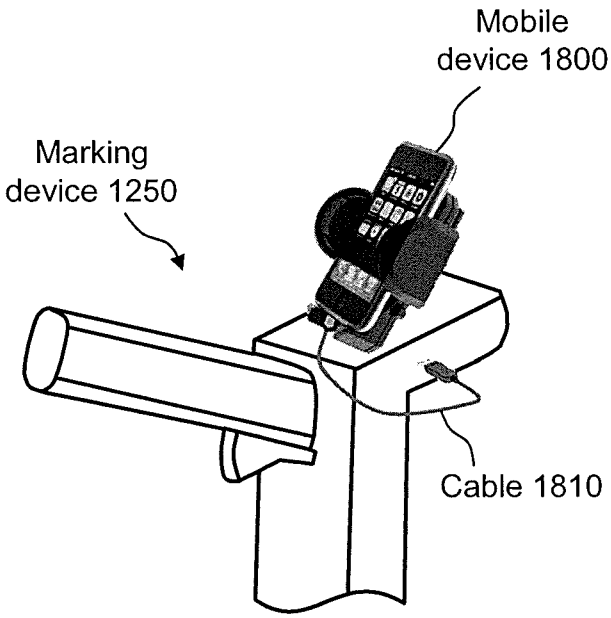


FIG. 27

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/23208

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H05K 5/00 (2011.01)
USPC - 361/679.01
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC - 361/679.01; IPC - H05K 5/00 (2011.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 361/600, 679.02, 679.08, 679.21, 679.31 , 679.4, 679.41; 320/107; 342/352, 357.39 (Keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(PGPB,USPT,USOC,EPAB,JPAB); Google Scholar. Terms: docking station interface connector mark locat operat mobile portable diagnos test equipment device apparatus instrument tool calibrat comput process interfac coupl communicat executable instruction touch screen PDA cell cellular phone telephone underground

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>-<br>Y | US 2010/0006667 A1 (Nielsen et al.) 14 January 2010 (14.01.2010) para [0006], [0007], [0023], [0025]-[0027], [0030], [0076] | 1, 30-32<br>----------<br>2-29 |
| Y | US 2010/0010883 A1 (Nelsen et al.) 14 January 2010 (14.01 .2010) Fig 19, para [0022], [0166], [0192], [0233], [0237], [0269], [0271], [0272] | 2-29 |
| Y | US 2008/0228294 A1 (Nielsen et al.) 18 September 2008 (18.09.2008) para [0005] | 9 |
| Y | US 2009/020131 1 A1 (Nielsen et al.) 13 August 2009 (13.08.2009) para [0026], [0056] | 21-23 |
| Y | US 2009/0149894 A1 (Merry et al.) 11 June 2009 (11.06.2009) para [0103] | 25 |
| Y | US 2008/0084212 A1 (Wieland) 10 April 2008 (10.04.2008) para [0020], [0045] | 26 |
| Y | US 2010/0002365 A1 (Mulcahey) 07 January 2010 (07.01.2010) para [0014]-[0015] | 27 |
| P/X | US 2010/0085694 A1 (Nielsen et al.) 08 April 2010 (08.04.2010) entire document | 1-32 |
| P/X | US 2010/0085701 A1 (Nielsen et al.) 08 April 2010 (08.04.2010) entire document | 1-32 |

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 16 March 2011 (16.03.2011) | 25 MAR 2011 |

| Name and mailing address of the ISA/US | Authorized officer: |
|---|---|
| Mail Stop PCT, Attn: ISA/US, Commissioner for Patents<br>P.O. Box 1450, Alexandria, Virginia 22313-1450<br>Facsimile No. 571-273-3201 | Lee W. Young<br>PCT Helpdesk: 571-272-4300<br>PCT OSP: 571-272-7774 |