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(54) DRUG DELIVERY MANAGEMENT SYSTEMS AND METHODS

SYSTEME UND VERFAHREN FÜR WIRKSTOFFFREISETZUNGSMANAGEMENT

SYSTÈMES ET PROCÉDÉS DE GESTION DE DISTRIBUTION DE MÉDICAMENTS

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Description

[0001] This application claims the benefits of priority under 35 USC § 119 to Provisional Patent Application S.N. 61/156,386, filed on February 27, 2009, entitled "Medical Module for Drug Delivery Pen" with Attorney Docket No. LFS-5196USPSP; Provisional Patent Application S.N. 61/156,421, filed on February 27, 2009, entitled "Drug Delivery System" with Attorney Docket No. LFS-5196USPSP1; Provisional Patent Application S.N. 61/156,472 filed on February 27, 2009, entitled "Drug Delivery Management Systems and Methods" with Attorney Docket No. LFS-5196USPSP2; Provisional Patent Application S.N. 61/164,250 filed on March 27, 2009, entitled "DRUG DELIVERY MANAGEMENT SYSTEMS AND METHODS" with Attorney Docket No. LFS-5196USPSP3.

BACKGROUND

[0002] It is believed that five million people worldwide, or approximately 56% of all insulin users, use insulin pens to inject their insulin. Insulin pens are convenient, easy to use, and discrete compared to syringes and vials, resulting in improved adherence and better outcomes. In addition, insulin pens reduce the time required for health care practitioners to initiate insulin therapy.

[0003] US2008/0306434A1 describes an integrated system for monitoring and treating diabetes including an integrated receiver and hand-held medicament injection pen for use with a continuous glucose sensor. The receiver is configured to receive continuous glucose sensor data to calculate a medicament therapy and to automatically set a bolus dose of the hand-held medicament injection pen. The integrated receiver and hand-held medicament injection pen can be integrally formed, or detachably connected and communicate via mutually engaging electrical contacts or wireless communication.

SUMMARY OF THE DISCLOSURE

[0004] Embodiments of the present invention address key issues, including: bringing together insulin therapy and blood glucose monitoring into more integrated therapeutic/monitoring systems; simplifying insulin initiation and intensification protocols; making blood glucose values central in the management of diabetes; and providing diabetes system solutions for improved outcomes and lower costs. The embodiments of the present invention help the patient and care provider stay on top of insulin therapy by automatically communicating delivered doses to a data management unit, by recording the amount and time of insulin delivery, and by displaying a summary of a patient's blood glucose and insulin administration history. The embodiments of the present invention confirm whether the patient has already dosed, keeps track of the time and amount of insulin delivery, and eliminates the need to keep a manual logbook. Embodiments of the

present invention help health care practitioners keep track of patient compliance.

[0005] Not only will embodiments of the invention facilitate management of diabetes, the invention and its embodiments will also be applicable in any field where drug delivery to a patient is utilized. For example, in the field of pain management or arthritis management, anxiety or epilepsy management (e.g., Diazepam) and the like.

[0006] In view of the foregoing and in accordance with one aspect of the present invention, there is provided a diabetes management system that includes a data management unit and a drug delivery system. The data management unit includes: a memory; a processor coupled to the memory; a display coupled to the processor; and a transceiver to receive and transmit data. The drug delivery system includes: a drug delivery pen and an add-on communication module. The pen includes: a generally tubular pen housing that extends from a first end to a second end. The housing encloses at least a portion of a plunger rod coupled to a drug cartridge disposed proximate the first end. The pen housing has a dosage indicator window and a dosage selector coupled to the plunger rod. The add-on communication unit includes: an add-on housing extending along a first longitudinal axis from a first housing end to a second housing end. The add-on housing includes an engagement portion that circumscribes at least a portion of the pen housing and is capable of being separated from the drug delivery pen. The housing further includes: a memory unit; a processor coupled to the memory; an analog-to-digital converter coupled to a dosage sensor attached to the dosage selector of the pen, the converter being coupled to the processor so as to provide data upon displacement of the dosage selector; and a transceiver to transmit and receive data relating to dosage delivery of a drug dosage in the drug cartridge to the data management unit.

[0007] In yet a further embodiment, a method of delivering drug to a user with a drug delivery pen is provided. The drug delivery pen has a generally tubular pen housing that extends from a first end to a second end. The first end of the housing encloses a plunger coupled to a drug cartridge disposed proximate the second end of the housing. The first end of the pen housing has a dosage indicator window and a dosage selector coupled to the plunger. The method can be achieved by: mounting a data communication unit to one of the first and second ends of the drug delivery pen; delivering a dosage of drug to a user via activation of the plunger; measuring the actual dosage of the drug being delivered to the user; and storing data related to the actual dosage of a drug delivered from the drug cartridge in a memory of the data communication unit. The method may further include inserting the first end of the drug delivery pen into a hollow bore of the data communication unit; and coupling the dosage selector to a rotatable knob of the data communication unit. In this method, the measuring may include connecting the plunger to a displacement sensor dis-

posed in the data communication unit such that the displacement sensor and the plunger are configured to move as a single unit; and correlating the movement of the plunger to the dosage of a drug actually delivered to the user. The step of storing may include flagging a date and time to the dosage of drug actually delivered or transmitting the data to a remote receiver unit.

[0008] In yet an alternative embodiment, a method of managing diabetes of a user with a data management unit and a drug delivery pen is provided. The data management unit has a microprocessor, memory, display and a wireless transceiver of data. The drug delivery pen has a generally tubular pen housing that extends from a first end to a second end. The first end of the housing encloses a plunger coupled to a drug cartridge disposed proximate the second end of the housing. The first end of the pen housing has a dosage indicator window and a dosage selector coupled to the plunger. The method can be achieved by: loading a therapeutic administration protocol based on therapeutic requirements of the user into controller of the data management unit; storing in the controller of the data management unit a plurality of measured glucose level in the user's biological fluid; displaying a recommended drug dosage based on the plurality of measured blood glucose level; mounting a data communication unit to one of the first and second ends of the drug delivery pen, the data communication unit having a processing unit and a transceiver; delivering the recommended dosage of a drug to a user via activation of the plunger with respect to the drug cartridge; measuring the actual dosage of the drug being delivered to the user; and storing data related to the actual dosage of the drug with a memory of the data communication unit; transmitting the data to the data management unit via the transceiver of the data communication unit; and displaying information indicative of compliance to the therapeutic administration protocol. The step of mounting may include inserting the first end of the drug delivery pen into a hollow bore of the data communication unit; and coupling the dosage selector to a rotatable knob of the data communication unit. The step of measuring may include connecting the plunger to a portion of a displacement sensor disposed in the data communication unit such that the portion of the displacement sensor and the plunger are configured to move as a single unit; and correlating the movement of the plunger to the dosage of drug actually delivered to the user. The step of storing may include flagging a date and time to the dosage of drug actually delivered. The step of measuring may further include determining whether the drug delivery device has been primed or determining whether a mixture of drug in the drug delivery cartridge has been mixed. The method may further include warning the user that no priming of the drug delivery device has been made or warning the user to change needle. The method may further include timing a drug delivery event upon actuation of the dosage delivery button, counting down a predetermined time, and warning the user if a drug delivery time was

insufficient. Alternatively, the method may include reminding the user of when to perform a drug delivery; warning that a drug delivery has been missed; or warning of an inappropriate dosage. Additionally, the method may include tracking one of: a duration of a pen in use by the user; amount left of time until the drug cartridge will be expired; or amount of drug remaining in the drug cartridge. Furthermore, the method may include locating a misplaced data management unit by activation of a locate switch on the data communication unit; or locating a misplaced data communication unit by activation of a locate switch on the data management unit. In this method, the drug delivered is selected from a group consisting essentially of slow acting insulin, fast acting insulin, growth hormone, GLP-1 analogs, Symlin, or combinations thereof. Also, the method may include turning the meter the off; and upon turning the meter on, displaying information of the last dosage delivery and time of the last data communication from the communication module and the meter

[0009] These and other embodiments, features and advantages will become apparent when taken with reference to the following more detailed description of the embodiments of the invention in conjunction with the accompanying drawings that are first briefly described.

BRIEF DESCRIPTION OF THE FIGURES

[0010] The accompanying drawings, which are incorporated herein and constitute part of this specification, illustrate presently preferred exemplary embodiments of the invention, and, together with the general description given above and the detailed description given below, serve to explain features of the invention (wherein like numerals represent like elements), of which:

Figure 1 illustrates a system that includes a drug delivery pen, a plurality of data management units, and a first type of an add-on module, according to an exemplary embodiment described and illustrated herein.

Figure 2 illustrates a cross-sectional side view of a drug delivery pen where a dosage selector is in an initial state and after a dosage setting has been set, according to an exemplary embodiment described and illustrated herein.

Figure 3 illustrates a front view of a drug delivery pen and the first type of add-on module, where the module has been attached to the drug delivery pen, according to an exemplary embodiment described and illustrated herein.

Figure 4 illustrates a front view of a drug delivery pen module where a dosage selector is set to a zero dose and where the dosage selector has rotated such that a pen button has telescoped outwards, according to an exemplary embodiment described and illustrated herein.

Figure 5 illustrates a top portion of a circuit board of

the glucose meter of Figure 1, according to an exemplary embodiment described and illustrated herein.

Figure 6 illustrates a bottom portion of a circuit board of the glucose meter of Figure 1, according to an exemplary embodiment described and illustrated herein.

Figure 7 illustrates a front perspective view of the first type of add-on module, according to an exemplary embodiment described and illustrated herein.

Figure 8 illustrates a side perspective view of the first type of add-on module, according to an exemplary embodiment described and illustrated herein.

Figure 9 illustrates a top view of the first type of add-on module, according to an exemplary embodiment described and illustrated herein.

Figure 10 illustrates a simplified exploded perspective view of a mechanism for coupling the movement of the dosage selector cap with a follower and a rotating knob, according to an exemplary embodiment described and illustrated herein.

Figure 11 illustrates a simplified back view of the first type of add-on module with a cover removed to show internal components, according to an exemplary embodiment described and illustrated herein.

Figure 12 illustrates a close-up back view of Figure 11 with the follower removed to show internal components, according to an exemplary embodiment described and illustrated herein.

Figure 13 illustrates a system that includes a drug delivery pen, a data management unit and a second type of add-on module, according to an exemplary embodiment described and illustrated herein.

Figure 14 illustrates a front perspective view of a drug delivery pen and the second type of add-on module, where the module has been attached to the drug delivery pen, according to an exemplary embodiment described and illustrated herein.

Figure 15 illustrates a back perspective view of the drug delivery pen and the second type of add-on module, where the module has been attached to the drug delivery pen, according to an exemplary embodiment described and illustrated herein.

Figure 16 illustrates a front perspective view of the second type of add-on module, according to an exemplary embodiment described and illustrated herein.

Figure 17 illustrates a top view of the second type of add-on module, according to an exemplary embodiment described and illustrated herein.

Figure 18 illustrates an exploded perspective view of a primary housing module of the second type of add-on module, according to an exemplary embodiment described and illustrated herein.

Figure 19 illustrates a rear perspective view of Figure 15, where the rear cover of the add-on module has been removed, according to an exemplary embodiment described and illustrated herein.

DETAILED DESCRIPTION OF THE FIGURES

[0011] The following detailed description should be read with reference to the drawings, in which like elements in different drawings are identically numbered. The drawings, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of the invention. The detailed description illustrates by way of example, not by way of limitation, the principles of the invention. This description will clearly enable one skilled in the art to make and use the invention, and describes several embodiments, adaptations, variations, alternatives and uses of the invention, including what is presently believed to be the best mode of carrying out the invention.

FIRST TYPE OF ADD-ON MODULE

[0012] - Figure 1 illustrates a diabetes management system that includes a drug delivery pen 224, add-on medical communication module 202, and a data management unit DMU such as, for example, a glucose meter 300, a mobile phone 400, a personal computer 500 (including a mobile computer), or a network server 600 for communication directly with the add-on module or through a combination of the exemplary data management unit devices described herein. The add-on communication module 202 can be configured to monitor the activity of the drug delivery device 224. Add-on communication module 202 and drug delivery device 224 can both be configured to mate together as a single unit. As used herein, the reference "DMU" represents either individual unit 300, 400, 500, or 600 separately or all of the data management units 300-600 together in a disease management system.

[0013] Drug delivery device 224, which may also be referred to as a drug delivery pen, can have a generally tubular pen housing that extends from a first end 212 and a second end 213, as shown in Fig. 1A. Drug delivery device 224A is depicted in an initial state and drug delivery device 224B is depicted after a dosage setting was performed. The first end 212 of the housing can enclose a cartridge 222 that is configured to contain a drug such as, for example, insulin or other drugs. An end of cartridge 222 can be sealed by a piston 225 where movement of piston 225 causes the drug to be dispensed. The second end 213 of the pen housing can have a dosage selector 220 that is operatively coupled to piston 225. A pressing of pen button 216 (with the concomitant movement of dosage selector 220) can initiate the dispensing of the fluid using actuation unit 200. The dosage display 218 can output the amount of fluid dispensed on a display screen such as a printed display or a LCD, as illustrated in Figure 1. The dosage selector 220 can control a user selected amount of drug or bio-effective fluid to be dispensed.

[0014] The actuation unit 200 can include a mechanism to dispense a controlled volume of fluid from car-

tridge 222. Referring to Figure 2, actuation unit 200 can include a pen button 216, a dosage selector 220, an inner cylinder 23, a lead screw 25, a plunger rod 226, a plunger rod holder 27, and a first screw 35. The actuation unit 200 can include a mechanism (for brevity, shown as actuation shaft 190, plunger rod member 226) to dispense a controlled volume of fluid from cartridge 222. Rotation of dosage selector 220 in a clockwise or counterclockwise direction can cause dosage selector 220 to telescope in a linear direction 1 or 2 (see Figures 2 and 4). Dosage selector 220 can have a tubular portion that extends along an inner portion of the pen housing. An outer surface of the tubular portion can have a threaded assembly that is engaged to a first screw 35, which causes the telescoping motion of dosage selector 220. First screw 35 can be attached to an inner portion of the pen housing. Inner cylinder 23 can be concentrically assembled within an inner portion of dosage selector 220. Inner cylinder 23 can be coupled with a threaded assembly of lead screw 25. Note that inner cylinder 23 can also rotate with dosage selector 220 when setting a dosage amount. Pushing button 216 towards the first end 212 causes the dosage selector 220 to uncouple from inner cylinder 23 and move lead screw 25 axially so that plunger rod 226 and piston 225 dispense insulin.

[0015] Referring to Figure 1, a data management unit in communication with the add-on communication module can be in the form of any of the devices illustrated herein. In one embodiment, the data management unit DR is in the form of a glucose meter 300, which can include a housing 311, user interface buttons (316, 318, and 320), a display 314, a strip port connector 322, and a data port 313, as illustrated in Figures 1 and 5. User interface buttons (316, 318, 320) can be configured to allow the entry of data, navigation of menus, and execution of commands. Data can include values representative of analyte concentration, and/or information, which are related to the everyday lifestyle of an individual. Information, which is related to the everyday lifestyle, can include food intake, medication use, occurrence of health check-ups, and general health condition and exercise levels of an individual. Specifically, user interface buttons (316, 318, 320) include a first user interface button 316, a second user interface button 318, and a third user interface button 320.

[0016] The electronic components of meter 300 can be disposed on a circuit board 302 that is within housing 311. Figures 5 and 6 illustrate the electronic components disposed on a top surface and a bottom surface of circuit board 302. On the top surface, the electronic components include a strip port connector 322, an operational amplifier circuit 335, a microcontroller 338, a display connector 314a, a non-volatile memory 340, a clock 342, and a first wireless module 346. On the bottom surface, the electronic components include a battery connector 344a and a data port 313. Microcontroller 338 can be electrically connected to strip port connector 322, operational amplifier circuit 335, first wireless module 346, display 314,

non-volatile memory 340, clock 342, power supply 344, data port 313, and user interface buttons (316, 318, 320).

[0017] Operational amplifier circuit 335 can be two or more operational amplifiers configured to provide a portion of the potentiostat function and the current measurement function. The potentiostat function can refer to the application of a test voltage between at least two electrodes of a test strip. The current function can refer to the measurement of a test current resulting from the applied test voltage. The current measurement may be performed with a current-to-voltage converter. Microcontroller 338 can be in the form of a mixed signal microprocessor (MSP) such as, for example, the Texas Instrument MSP 480. The MSP 480 can be configured to also perform a portion of the potentiostat function and the current measurement function. In addition, the MSP 480 can also include volatile and non-volatile memory. In another embodiment, many of the electronic components can be integrated with the microcontroller in the form of an application specific integrated circuit (ASIC).

[0018] Strip port connector 322 can be configured to form an electrical connection to the test strip. Display connector 314a can be configured to attach to display 314. Display 314 can be in the form of a liquid crystal display for reporting measured glucose levels, and for facilitating entry of lifestyle related information. Data port 313 can accept a suitable connector attached to a connecting lead, thereby allowing glucose meter 300 to be linked to an external device such as a personal computer. Data port 313 can be any port that allows for transmission of data such as, for example, a serial, USB, or a parallel port. Clock 342 can be configured for measuring time and be in the form of an oscillating crystal. Battery connector 344a can be configured to be electrically connected to power supply 344.

[0019] In an embodiment, test strip 324 can be in the form of an electrochemical glucose test strip. Test strip 324 can include one or more working electrodes and a counter electrode. Test strip 324 can also include a plurality of electrical contact pads, where each electrode is in electrical communication with at least one electrical contact pad. Strip port connector 322 can be configured to electrically interface to the electrical contact pads and form electrical communication with the electrodes. Test strip 324 can include a reagent layer that is disposed over at least one electrode. The reagent layer can include an enzyme and a mediator. Exemplary enzymes suitable for use in the reagent layer include glucose oxidase, glucose dehydrogenase (with pyrroloquinoline quinone co-factor, "PQQ"), and glucose dehydrogenase (with flavin adenine dinucleotide co-factor, "FAD"). An exemplary mediator suitable for use in the reagent layer includes ferricyanide, which in this case is in the oxidized form. The reagent layer can be configured to physically transform glucose into an enzymatic by-product and in the process generate an amount of reduced mediator (e.g., ferrocyanide) that is proportional to the glucose concentration. The working electrode can then measure a con-

centration of the reduced mediator in the form of a current. In turn, glucose meter 300 can convert the current magnitude into a glucose concentration.

[0020] Add-on communication module 202 can have a first end 232 and second end 280. Add-on communication module 202 can include a primary module housing 208 and a secondary module housing 209, as illustrated in Figures 7 to 9. Together the primary module housing and the secondary module housing can form an add-on module housing that attaches to a drug delivery device. Secondary module housing 209 can have a generally cylindrical structure with an outer surface 210 and a hollow bore 248. A longitudinal axis L2 can extend along a center point of a circular portion of hollow bore 248, as illustrated in Figures 7 to 9. Primary module housing 208 can have a generally crescent shaped structure that partially circumscribes around an outer portion of secondary module housing 209. Primary module housing 208 can be in the form of a casing that includes three wall surfaces that together with the outer surface 210 of housing 209 provide for enclosure of certain components. Primary module housing 208 encloses a circuit board 270 (shown in Figure 11), sensor 214 (which includes a sensor slider 215), and power supply 276, which are disposed over an outer surface 210 of housing 209, as illustrated in Figures 7 and 11. Power supply 276 is accessible through power supply compartment door provided on casing 208. A longitudinal axis L2 can extend along an approximate mid-way point of a plane of symmetry P1, as illustrated in Figure 9. The longitudinal axes L1 and L2 can be approximately parallel.

[0021] Electrical circuit components (not shown due to placement of components in the drawings) disposed on board 270 can include, a microprocessor, a microcontroller, an analog-to-digital converter, a speaker, a display, a memory, a display driver, a user interface driver, a second wireless module in the form of a transmitter, a receiver or a transmitter-receiver (e.g., a wireless transceiver using infrared light, radio-frequency, or optical waves) to communicate with first wireless module 346 of the data management unit DMU, an inertial or acceleration sensor, and an antenna to send and receive wireless signals to and from the add-on module 202, process input from the sensor, turn the device on and off, put the device into sleep mode, wake the device up, regulate power from battery 276, and store and retrieve information to and from memory, as examples.

[0022] Dosage sensor 214 is preferably a linear potentiometer and is used to measure the position of dosage selector 220 for determining the size of the bolus injected by the user. Sensor 214 is electrically coupled to an analog-to-digital converter, which is coupled to microprocessor board 270 to provide data on the position of dosage selector 220 and dosage actuator 216. Other sensors that may be used with the exemplary embodiments include rotational potentiometers, linear, or rotational encoders. Linear potentiometers are preferred in the operational prototypes built by applicants. Another alternative

which is also preferred can be a capacitive sensor. However, the embodiments described herein may utilize means for determining displacement of a dosage selector of a drug delivery pen in which the means include a follower, longitudinal member, and a dosage sensor (which may include rotary potentiometer, linear potentiometer, capacitive displacement sensor, optical displacement sensor, magnetic displacement sensor, encoder type displacement sensor, or combinations and equivalents thereof) and equivalents to these components described herein.

[0023] Casing 208 is located asymmetrically with respect to longitudinal axis L2 of secondary module housing 209 because casing 208 is disposed over outer surface 210 of housing 209. To further reduce the offset profile of casing 208, power supply 276 may be located proximate to knob 278 instead of inside casing 208. Power supply can be in the form of a disk shape similar to button 251 and disposed proximate to button 251 in a stacking relationship. As with the primary module housing and secondary module housing, the hollow bore is adapted to be coupled to a drug delivery pen in one operative mode and to be separated from the pen in another operative mode. In an embodiment, hollow bore 248 may have proximity detector 233 where the coupling or uncoupling of the drug delivery pen can be detected when it is mated, as illustrated in Figure 1. Actuation of proximity detector 233 can be detected using the microprocessor. In another embodiment, the coupling or uncoupling of the drug delivery pen can be detected when it is mated by using an optical reader for detector 233 that is integrated with module 202. Further, the optical reader for detector 233 can be configured to recognize the type of insulin being coupled to module 202. Upon separation from the pen, the add-on module is no longer coupled to the actuation mechanism of the pen and in fact is lacking in an actuation mechanism, e.g., a plunger rod, push rod, or the like to dispense insulin, such that an internal surface of the hollow bore is exposed to the ambient environment so as to be visible to an ordinary observer or user.

[0024] Housing 209 extends from a first end 232 to second end 280 along longitudinal axis L2 to define at least a portion of a hollow bore 248 formed from continuous surface 210 of housing 209, as illustrated in Figures 7 and 8. Continuous surface 210 is provided with a scallop portion 211 (Figures 7 and 8) that is distinct from other embodiments. While a housing 209 can be formed from a transparent or translucent material, such material can cause visual distortion of printed indicia on drug delivery pen 224. As such, scalloped opening 211 allows for printed identification on drug delivery device 224 to be visible to the user once unit 204 has been coupled to pen 224. Module 202 is coupled to drug delivery pen 224 by inserting bore 248 with scallop 211 closest to dosage selector 220 of pen 224 (Figures 1 and 3). As module 202 is inserted onto pen 224, a groove 210a on module 204 (Figures 1 and 3) is aligned with a raised ridge 210b on

pen 224 to fix module 202 rotationally with respect to pen 224. In addition, a tang 236 may be used to engage to a recess in pen 224.

[0025] Add-on module 202 can be configured to monitor the amount of insulin dialed in by the user and also the time in which the user injected the insulin. A user can rotate dosage selector 220 in a clockwise or counter clockwise manner that causes dosage selector 220 and pen button 216 to telescope outwards 1 or inwards 2 (Figure 4). Drug delivery pen 224a shows an example where no dosage amount has been dialed in with dosage selector 220. In contrast, drug delivery pen 224b shows an example where dosage selector has been rotated such that a predetermined amount of insulin has been set. The user can then depress pen button 216 causing dosage selector to move inwards, which in turn causes a plunger to dispense insulin. In an embodiment, communication module 202 can monitor both the inward and outward movement of dosage selector 220 for monitoring the activity of the drug delivery pen.

[0026] The following will describe an exemplary mechanism for monitoring the activity of a drug delivery device by coupling the movement of the dosage selector cap to a follower portion 240 contained within communication module 202. A linear movement of the follower portion can then be measured with a sensor. Figure 10 illustrates a simplified exploded perspective view of the mechanism for coupling the movement of dosage selector cap 220. Note that, for purpose of illustration, only the dosage selector cap 220 of drug delivery device 224 is depicted in Figure 10.

[0027] Coupled to housing 209 are a follower portion 240, and rotatable knob 278, as illustrated in Figures 3, 7, and 8. Both of follower portion 240 and knob 278 are preferably continuous through-bores that are in alignment with bore 248 (see Figures 7, 8, and 10). Bore 248 is configured to allow actuation unit 200 of drug delivery pen 224 to be slipped into bore 248 until actuation pen button 216 abuts with a button 251 of module 202 (see Figures 1, 3, and 7). In the preferred embodiment of Figures 7 and 10, bore 248 is a through bore which is contiguous with bore of rotatable knob 278 and continuous surface 210 of housing 209 and defines a generally tubular member. As noted earlier, secondary housing 209 is preferably formed from a substantially transparent or translucent material while casing 208 may be formed with any suitable color or combination of colors to indicate the type of drugs being utilized or to personalize the module. The colors may include blue, red, yellow, green, black, pink, shades or combinations of the colors thereof. As used herein, the actuation unit 200 of a drug delivery pen is that portion of the pen on which at least the dosage selector, actuator and actuation button are provided for attachment to a drug cartridge 222.

[0028] As shown in Figure 10, follower 240 is coupled to capture ring 244 via a retention system having a groove 244d on follower member 240 and a corresponding ridge 244c on capture ring 244. Follower 240 and capture ring

244 can be coupled together such that capture ring 244 is rotatable around second longitudinal axis L2 and that follower 240 does not rotate, but moves in a linear manner parallel to second longitudinal axis L2.

[0029] Capture ring 244 may include longitudinal slits 244a that extend along longitudinal axis L2 to provide flexibility in the magnitude of the diameter of capture ring 244, which allows inner undulating surfaces 244b of capture ring 244 to frictionally couple to raised ribs 221 of dosage selector 220 (of pen 224). Inner undulating surfaces 244b may be configured to allow for a taper converging towards axis L2 to ensure little or no interference when ribs 221 first engage undulation 244b yet with frictional engagement upon full insertion of module 204 into pen 224. Capture ring 244 may be provided with external splines or teeth 245a that are in engagement with internal splines or teeth 245b of a coupling ring 245. Coupling ring 245 can couple together rotatable knob 278 and capture ring 244. The mechanical assembly of capture ring 244, coupling ring 245, and rotatable knob 278 causes dosage selector 220 to rotate as a result of a rotation of rotating knob 278 when the dosage selector 220 is frictionally engaged.

[0030] Actuation button 251 is also coupled to knob 278 so that button 251 of module 202 may, under certain configurations, be in contact with pen button 216 once both components are assembled together. A spring 246 can be located on an outer surface of capture ring 244 and an inner surface of knob 278. Spring 246 can be configured to bias coupling ring 245 against capture ring 244 such that when teeth 245a are engaged, turning knob 278 causes dosage selector 220 to turn. During an injection, pressing button 251 can compress spring 246, allowing coupling ring 245 to disengage from capture ring 244. It should be noted that rotatable knob 278 disengages from capture ring 244 during actual injection so that the knob does not rotate under the user's thumb while drug is being delivered, i.e., during the injection. After injecting, teeth 245a re-engage with teeth 245b, allowing the user to dial in a new dosage on the pen. Knob 278, however, may need to be rotated slightly before the teeth re-engage if they are not properly lined up after the injection.

[0031] Follower 240 can include a longitudinal member 254, as illustrated in Figure 10. Longitudinal member can have a tubular structure where one end is coupled to a ring portion of the follower 240. A hollow portion 294c of the tubular structure is depicted in Figure 10. The other end of longitudinal member can have a protrusion plate 294d and two slider fingers 294a and 294b.

[0032] Referring to Figure 11, longitudinal member 254 may be configured to slide axially along axis L2. Follower portion 240 is constrained to move with knob 278 as knob 278 is moved axially by rotating knob 278 about axis L2. As knob 278 is rotated, capture ring 244 is constrained to also rotate, which causes the rotational motion of capture ring 244 to be transferred to dosage selector 220. Since any rotary motion of selector 220 will result in in-

ward or outward axial movement along axis L2, capture ring 244, follower 240, and knob 278 are constrained to move in the same manner as dosage selector 220 (axially for follower 240, and both axially and rotationally for capture ring 244 and knob 278). Hence, movements of the dosage selector 220 are determined via a dosage sensor as proportional to a dosage quantity to be delivered or injected. In the preferred embodiments, the dosage sensor, which provides dosage amount information, is a potentiometer. In the embodiment of Figure 4, the drug delivery pen may be a Lantus SoloStar manufactured by Sanofi Aventis.

[0033] Figure 11 illustrates a simplified back view of certain components contained within primary module housing 208 where some of the walls were removed. To reduce the profile of module 202, applicants have utilized a sliding potentiometer configuration, as illustrated in Figure 11. Module 202 also utilizes a slider 215 on potentiometer tracks 294, where slider 215 is coupled in between both slider fingers 294a and 294b. Conductive contacts (not shown) can be disposed on a surface of slider 215 to allow an electronic circuit to determine the position of the slider on the potentiometric tracks 294. The tracks 294 may be conductive polymer tracks or cermet tracks or alternatively tracks formed from carbon, gold or a mixture thereof. Hollow portion 294c (see Figure 10) of longitudinal member 254 can be configured to couple to an activation shaft 297 (see Figure 12) to ensure that the slider is constrained for translation along axis L1 and also for switching a micro switch 268.

[0034] Referring to Figure 12, longitudinal member 254 is removed to show activation shaft 297 that was disposed inside longitudinal member 254. Activation shaft 297 is connected to a separator member 255c, which interacts with fingers 269a of micro switch 268. Hollow portion 294c and protrusion plate 294d can be keyed to correspond to separator member 255c so that separator member moves along axis L1 when button 251 is depressed. Activation shaft 297 may be coupled with a spring 255a and a setscrew 255b for adjustment of the position of separator 255c with respect to fingers 269a of micro switch 268. Because fingers 269a are normally out of contact with conductive tracks 269b, switch 268 is normally-open whenever button 251 is not depressed fully (e.g., during a dosage selection or adjustment). Upon button 251 being fully depressed, such as during a dosage injection, longitudinal member 254, activation shaft 297, and separator 255c are constrained to move along longitudinal axis L1 until setscrew 255b abuts against retainer wall 255d. As setscrew 255b approaches retainer wall 255d, separator 255c lowers fingers 269a of micro switch 268 onto conductive tracks 269b, creating a closed circuit. Further movement of dosage button 251 causes hollow longitudinal member 254 to continue axially to take up any slack provided between an end of a rod portion of activation shaft and setscrew 255b.

[0035] By virtue of the configurations described exemplarily herein, applicants have now been able to provide

the means for determining the difference between either or both of a dosage delivery event and duration of such dosage delivery or injection event. Specifically, where a user is merely rotating knob 278 to thereby move knob 278 longitudinally along axis L2 in either direction to select dosages, there is no contact of fingers 269a of switch 268 and hence no determination that a dosage event is taking place. Except for a determination that a dosage selection is being made, no recording is made in the memory of processor board 270 regarding a dosage delivery. Only upon the full depression of button 251 would there be contact of fingers 269a with tracks 269b, (Figures 11 and 12) triggering a determination that dosage delivery is taking place. In an embodiment, the electronics can be configured to go into "sleep" mode, until button 251 is depressed, which reduces the power consumption of the module. As used herein, the "sleep" mode is one in which all functionalities of the module are at minimal or virtually zero power consumption but which does not require a system boot up in the event that the pen is taken out of sleep mode.

[0036] It should be noted that the micro-switch 268 also enables tracking of the injection start point and the injection end point, so the volume of the injection can be calculated, even if the user does not press the injector button all the way to the zero or initial dosage position. While the ability to determine when a dosage delivery has been made is valuable to a user in managing diabetes, applicants believe that it is the ability to determine and confirm the duration of such dosage delivery (and in particular, the volume of the dosing which is dependent upon the duration of how long the actuation button is held down) for later analysis with a compliance regiment that is a step forward in the art of diabetes management. That is, where a patient is injecting insulin per a protocol as prescribed by a health care provider, such patient may not be in full compliance if the patient fails to deliver a complete prescribed dosage, which typically requires fully depressing button 251 for four (4) to ten (10) seconds. By recording the dosage, time and duration in a memory of processor board 270 for display on the module itself, the data management unit DMU or even for transfer to a health care provider's computer, the health care provider is able to take steps, after review of data or even in real-time, to ensure that full compliance of the prescribed protocol is followed. In the preferred embodiments, a warning or reminder to the patient on proper pen usage technique can be displayed as a message on the data management unit, which in one embodiment includes a glucose meter. Thus, the means for determining one or more of dosage delivery (time & date of injection and volume) or duration of dosage delivery of a drug delivery pen include, follower 240, longitudinal member 254, spring 255a, separator 269a, switch 268, a processor coupled to switch 268, in which processor is programmed to operate in the manner described herein, and equivalents thereof to these components.

SECOND TYPE OF MEDICAL ADD-ON MODULE

[0037] Recognizing that different drug delivery devices (e.g., insulin pens) may require alternative coupling techniques, applicants have provided for an alternative that is designed to be attached from the side rather than being inserted over one end of the drug delivery device, as in the prior embodiments. Figure 13 illustrates a system that includes a drug delivery pen 124 and an add-on communication module 102 for use with DMU 300. It should be understood that other DMUs such as a mobile phone (or a computing platform like, for example, the Apple iPhone) 400, personal computer 500, or network 600 may be utilized separately with the modules described herein or in combination with all of the DMUs and the like. Add-on module 102 and drug delivery pen 124 can be mated together, as illustrated in Figures 13, 14, and 15.

[0038] Drug delivery pen 124 can have a first end 112 and a second end 113, as illustrated in Figure 13. Note that drug delivery pens 124 and 224 can be similar in function for helping a user inject a controlled amount of insulin. At proximate first end 112, drug delivery pen can include a cartridge 122 that is configured to contain a drug such as insulin. At about the second end 113, drug delivery pen can include an actuation unit 100, a pen button 116, a dosage display 118, and a dosage selector 120. In the embodiment of Figure 13, the drug delivery pen may be a NovoLog® Flex-Pen manufactured by Novo Nordisk.

[0039] Add-on module 102 can have a first end 132 and second end 180. Add-on module 102 can include a primary module housing 108 and a secondary module housing 109, as illustrated in Figures 16 and 17. Secondary module housing 109 can have a generally cylindrical structure with an outer surface 110 and a hollow bore 148 (Figure 17). Secondary module housing 109 can include first and second extension portions 130 and 134 that circumscribe about second axis L2 to define at least a portion of hollow bore 148. A longitudinal axis L2 can extend along a center point of a circular portion of hollow bore 148, as illustrated in Figures 16 and 17. In one embodiment, each of extensions 130 and 134 extends in a generally circular path about axis L2 of about 30 degrees. Where greater security of engagement between the extensions and the pen is needed, each of extensions 130 and 134 may be increased to define any ranges from generally 30 degrees to generally 250 degrees (or even 360 degrees to provide for a continuous bore) about axis L2.

[0040] Primary module housing 208 can have a generally kidney shaped cross-sectional structure (Fig. 17) that partially circumscribes around an outer portion of secondary module housing 109. A longitudinal axis L2 can extend along an approximate mid-way point of a plane of symmetry P2, as illustrated in Figure 17. The longitudinal axis' L1 and L2 can be generally parallel.

[0041] Primary module housing 108 is preferably located asymmetrically with respect to longitudinal axis L2

of secondary module housing 109 because housing 108 is disposed over outer surface 110 of housing 109. As with the primary module housing and secondary module housing, the hollow bore 148 is adapted to be coupled to a drug delivery pen in one operative mode and to be separated from the pen in another operative mode. In one embodiment, shown here in Fig. 10, hollow bore 148 may have proximity detector 133 (e.g., switch, ultrasound, infrared or visible light detector) where the coupling or uncoupling of the drug delivery pen can be detected when the add-on module 102 is mated to the pen 224. Actuation of proximity detector 133 can be detected using a microprocessor of the add-on module 102. In another embodiment, the coupling or uncoupling of the drug delivery pen can be detected when it is mated by using an optical reader for detector 133 that is integrated with module 102. Further, the optical reader for detector 133 can be configured to recognize the type of insulin being coupled to module 102. Further, the optical reader for detector 133 can be configured

to recognize the type of insulin being coupled to module 102. Upon separation from the pen, the add-on module is no longer coupled to the actuation mechanism of the pen and in fact is lacking in an actuation mechanism, e.g., a plunger, push rod, or the like to dispense insulin, such that an internal surface of the hollow bore is exposed to the ambient environment so as to be visible to an ordinary observer or user.

[0042] Figure 16 illustrates primary module housing 108 that includes locator tangs 136 and 184 (which are offset longitudinal with respect to each other along axis L2), locator forks 152a and 152b with follower portion 140 that may reciprocate longitudinally along a longitudinal axis L1. Referring to Figures 18 and 19, follower portion 140 is configured to be physically connected directly to sensor 114 and permitted to rotate about its own axis. A power source 176 is also provided in a location preferably spaced apart from dosage sensor 114 (Figure 18). A microcontroller, depicted here as a controller board 170 in Figure 18, is coupled to both sensor 114 and power source 176 to allow for a determination of position, movements or even direction of movement of a dosage selector 120 (see Figures 18 and 19).

[0043] Figure 14 shows locator tabs 136 and 184 for aligning communication module 102 with dosage display window 118 of the pen. Locator tabs 136 and 184 align snap-on unit 102 with drug delivery device 124 and prevent unit 102 from rotating and obscuring dosage display window 118 of drug delivery device 124. For module 102, extensions 130 and 134, with locating tangs 136 and 184, allow communication module 102 to snap on over pen 124. After inserting drug delivery pen 124, locating tangs 136 and 184 engage dosage indicator window 118, and can secure add-on communication module 102 to drug delivery pen 124. Dosage selector 120 engages follower portion 140, allowing dosage selector 120 to move along its axis as dosage is adjusted, as illustrated in Figure 19. Extensions 130 and 134 leave an opening through which

the user may view dosage indicator window 118 and labeling on the drug delivery pen 124. As shown in Figure 19, locator forks 152a and 152b are coupled to dosage selector 120 such that follower portion 140 follows the axial movement of dosage

selector 120 (which itself is rotational to allow for axial motion of dosage selector) or delivery button 116 (which is axial).

[0044] Figure 18 shows an exploded perspective view of communication module 102 with the top housing removed to reveal the internal components. Figure 19 shows the location of a longitudinal member 154 and locator forks 152a and 152b prior to injection with follower 140 extended to a selected dosage. Add-on communication module 102 includes housing 108, battery 176, microprocessor circuit board 170, dosage sensor 114, and longitudinal member 154. Dosage sensor 114 is used to measure the injected dose. Longitudinal member 154 moves parallel to the longitudinal axis L2 of the pen, tracking with dosage selector 120 as it moves in and out with an actuation shaft 190 (Fig. 19) of drug delivery pen 124.

[0045] Electrical circuit components (not shown due to placement of components in the drawings) are provided on board 170 such as, for example, microprocessor, microcontroller, analog-to-digital converter, speaker, display, memory, display driver, user interface driver, transmitter, receiver or transmitter-receiver (e.g., a wireless transceiver using infrared light, radio-frequency, or optical waves) and antenna to send and receive wireless signals to and from the meter, process input from the sensor, turn the device on and off, put the device into sleep mode, wake the device up, regulate power from battery 176, and store and retrieve information to and from memory, as examples.

[0046] As shown in Figure 19, dosage sensor 114 is preferably a linear potentiometer and is used to measure the position of dosage selector 120 for determining the size of the bolus injected by the user. Sensor 114 is electrically coupled to an analog-to-digital converter, which is coupled to microprocessor board 170 to provide data on the position of dosage selector 120 and dosage actuator 116. A micro-switch (similar to microswitch 268 of Fig. 11) is provided at a position proximate housing end 132 to provide an indication of drug delivery upon button 116 being fully depressed to push shaft 190 towards cartridge 122. Other sensors that may be used with the exemplary embodiments include rotational potentiometers, linear, or rotational encoders. Linear potentiometers are preferred in the operational prototypes built by applicants. However, the embodiments described herein may utilize means for determining displacement of a dosage selector of a drug delivery pen in which the means include a follower, longitudinal member, and a dosage sensor (which may include rotary potentiometer, linear potentiometer, capacitive displacement sensor, optical displacement sensor, magnetic displacement sensor, encoder type displacement sensor, or combinations and

equivalents thereof) and equivalents to these components described herein. Additional embodiments of the medical module are shown and described in related application entitled "Medical Module for Drug Delivery Pen" with Attorney Docket No. LFS-5196USPSP, filed on the same filing date as this application, and related application entitled "Drug Delivery System" with Attorney Docket No. LFS-5196USPSP1, filed on the same date.

10 OPERATION OF THE EXEMPLARY EMBODIMENTS

[0047] The system described herein can be used to provide clinical benefit for persons with diabetes. In one example, a health care provider ("HCP") can set up a therapeutic protocol in the DMU 300 by logging in to an HCP selection menu by entry of a password, or for greater security, via the use of a cryptographic security key such as, for example, a USB security PKI token. Alternatively, the logging in process can be conducted via a secure remote terminal or mobile phone 400, computer 500, or network server center 600 and performing the menu selection remotely. Upon successful log in, the HCP can select one of a plurality of therapeutic protocols, such as, for example "Long-Acting" protocol; "Mix" protocol or Multiple Daily Injection ("MDI") protocol.

[0048] Where the protocol selected is the Long-Acting protocol, the HCP would select the weight range of the user and confirm that the starting and maximum doses are correct with the preferred blood glucose test being performed after fasting and the insulin being delivered to the user's body at bedtime. Thereafter, the protocol is then transferred, by cables or via short or long-range wireless connection to the user's DMU 300.

[0049] Where the protocol selected is the Mix protocol, the HCP would select the frequency of insulin delivery over a fixed time period. Here, the HCP would need to confirm the insulin regimen as being of the selected frequency over a fixed duration but at specified time in a day. Thereafter, the protocol is then transferred, by cables or via short or long-range wireless connection to the user's DMU 300.

[0050] Where the protocol selected is the MDI protocol, the HCP would select the largest meal that the user would have during the day and confirm the regimen with the required dosages for rapid acting at specified daily event and rapid acting at a different daily event. Thereafter, the protocol is then transferred, by cables or via short or long-range wireless connection to the user's DMU 300.

[0051] At DMU 300, the user whose HCP has selected a Long-Acting protocol would see a series of interactive screens. The processor of the DMU 300 would generate a greeting message and a reminder consistent with the protocol, which has been transferred from the HC's computer 500 or network server center 600 to the memory. At this point the user should perform a blood glucose test using a test strip 324. Upon analysis, the device would provide an output of the measured glucose concentration on the display screen 314. Thereafter, the processor

would generate a message on display 314 indicating the dosage needed for the physiological requirements of the user. At this stage, the user is given the option of selecting a reminder of when to take the required dosage of therapeutic agent. Here, it is preferred that the default selection is that of a reminder being activated. At the option of the user, various screens can be generated to provide a summary of blood glucose test, trends, therapeutic type and dosage taken. In one example, a summary of the therapeutic agent and the type of therapeutic agent taken at a particular time and date can be displayed.

[0052] At DMU 300, the user whose HCP has selected a Mix protocol would see a series of interactive display messages. In one message, the processor 1706 would generate a greeting message and a reminder consistent with the protocol, which has been transferred from HCP's computer 500 or network server center 600 to the memory of the sensor 300. At this point the user should perform a blood glucose test using a test strip 324. Upon analysis, the device would provide an output of the measured glucose concentration on display 314. Thereafter, the processor would generate a message at the display 314 indicating the dosage needed for the physiological requirements of the user. Here, the user is given the option of selecting a reminder of when to take the required dosage of therapeutic agent. At this point, it is preferred that the default selection is that of a reminder being activated. At the option of the user, various display screens can be generated to provide a summary of blood glucose test, trends, therapeutic type and dosage taken. In one example, a summary of the therapeutic agent and the type of therapeutic agent taken at a particular time and date can be provided.

[0053] At DMU 300, the user whose HCP has selected a MDI protocol would see a series of interactive display screens. At one screen, the processor of the sensor 300 would generate a greeting message and a reminder consistent with the protocol, which has been transferred from HCP's computer 500 or network server center 600 to the memory of the sensor 300. At this point the user should perform a blood glucose test using test strip 324. Upon analysis, the device would provide an output of the measured glucose concentration on display screen 314. Thereafter, the processor would generate a message indicating the dosage needed for the physiological requirements of the user. Here, the user is given the option of selecting a reminder of when to take the required dosage of therapeutic agent. At this point, it is preferred that the default selection is that of a reminder being activated. At the option of the user, various screens can be generated to provide a summary of blood glucose test, trends, therapeutic type and dosage taken. In one example, a summary of the therapeutic agent and the type of therapeutic agent taken at a particular time and date can be provided.

[0054] To ensure that the user follow the therapeutic regimen, the DMU 300 in conjunction with the drug delivery pen and add-on communication module can be used to ensure compliance of the regimen by reminding

the user of the therapeutic agent dosage needed based on the measured pre-meal blood glucose value or prompting the user at the specified time to deliver the required dosage for the user. The DMU 300 can be configured to detect activation of the drug delivery pen via the add-on communication module. Upon detection of activation or actual delivery of the therapeutic agent by the drug delivery pen via the add-on communication module via transmission of a wireless signal from the add-on communication module to the DMU 300, a message can be provided on the sensor 300 (or mobile phone 400, computer 500, and network server center 600) to indicate the dosage and time of the administration of the therapeutic agent.

[0055] To utilize the drug delivery pen and communication module in the method described above, a user would couple (e.g., snap-on, slide on, close a clam-shell) the add-on communication module (102, 202) over actuation end 100 (or 200) of a drug delivery pen 124 (or 224), as shown in Figures 1 and 13. Once the add-on communication module (102, 202) has been coupled to drug delivery pen 124 (or 224), turning dosage selector 120 (or rotating knob 278) allows the user to dial in a dosage for injection. The selected dosage appears in dosage indicator window 118 (or 218) of the pen 124 or 224. As dosage selector 120 rotates, it extends shaft 190 within drug delivery pen 124, illustrated in Figure 19, causing longitudinal member 154 to extend as well. Similarly, as knob 278 rotates, it extends longitudinal member 254 within the primary module housing 208, as illustrated in Figure 11. The amount of insulin to be injected is proportional to the extension of shaft 190 (Fig. 19) of pen 124 and longitudinal member 154, which is measured by dosage sensor 114. Similarly, the amount of insulin to be injected is proportional to the extension of follower 240 of module 202 and longitudinal member 254, which is measured by dosage sensor 214. Dosage selector 120 (or knob 278) may be rotated in either direction, increasing or decreasing the selected dosage.

[0056] A suitable needle (not shown) can be attached to the insulin cartridge 122 or 222. Before injecting, the user primes drug delivery pen 124 or 224 by ejecting a small dose (typically 2 Units) before inserting a needle subcutaneously. Priming drug delivery pen 124 or 224 eliminates bubbles. While priming, drug delivery pen 124 or 224 should be held with needle pointing upwards. Add-on communication module 102 may distinguish between primes and injections by two exemplary techniques: (1) it may determine via an inertial or acceleration sensor disposed in the housing of the add-on module if drug delivery pen 124 or 224 is held with needle pointing upward (in relation to the ground) during an injection, and (2) it may use software to determine if one or more small doses of approximately 2 Units are followed by a larger dose. In some cases, a separate glucose meter may ask the user to confirm whether a dose was a prime or an injection. In an embodiment, the inertial sensor can also be used to wake up the device if it is in sleep mode when

the device is picked up by the user. In the dosing history menu on the glucose meter (not shown), it is possible for the user to toggle entries between prime and injection. As an example, the meter can display primes by indicating with the symbol "*" (for example) which injections were preceded by a prime. Applicant believes that this allows the displaying of as much information as possible on one screen on the meter without confusing the user by showing all the primes and injection doses together in one list.

[0057] After dialing in the desired dose, the injection is performed by inserting the needle into the skin and with the user's thumb fully depressing actuation button 116 of pen 124 (for module 102), button 216 of pen 224, or button 251 (for module 202). Once the actuation button is fully depressed, the button must be held down for a predetermined period of time for the selected dosage to be fully injected. As provided in the means for determining dosage injection event and duration thereof, the add-on module records such an event and the duration of the event into its memory. The user may perform this sequence until the cartridge 222 is depleted.

[0058] After insulin cartridge 222 is depleted, communication module is removed from disposable drug delivery pen 124 (or 224), disposable drug delivery pen 124 or 224 (e.g., an insulin pen) is thrown away, and communication module 102 is re-attached to a new disposable drug delivery device 124 or 224 (e.g., an insulin pen). Alternatively, where the user is using a reusable pen, the empty drug cartridge could be thrown away and replaced with a new cartridge attached to the actuation portion of the reusable pen.

[0059] As noted earlier, the single glucose meter may communicate with multiple add-on communication modules. For example, glucose meter may communicate with an add-on communication module (102, 202) attached to a rapid acting insulin drug delivery pen and another unit (102, 202) with a long acting insulin drug delivery pen. Add-on communication modules (102, 202) may be color coded to match the color of drug delivery pens 124 or 224, identifying the type of insulin that it contains. This feature will help prevent accidental injections of the wrong type of insulin. In an embodiment, the module can be configured to attach to a specific type of pen housing in order to identify the type of insulin. In this embodiment the insulin pen manufacturer provides different type of pen housing shapes for specific types of insulin.

[0060] While some features have been described, other variations on the exemplary embodiments may be utilized in various combinations. For example, instead of a potentiometer, the add-on modules may use an encoder to measure angular position and rotation of dosage selector. A switch may be used with the encoder to detect when the user presses on dosage actuation button of the add-on module (102, 202) to inject a drug, such as, for example, insulin, and allows for differentiation between dosage adjustments and injections. Such switch also detects how long the user continues to press on the dosage

actuation button after injecting an insulin shot, as described earlier. In another example, when the switch is activated and after the encoder determines that dosage selector dial has returned to the zero position, the add-on module (102, 202) may communicate this information to the data management unit to initiate a timer on the meter that counts down the period of time that the user should keep the dial depressed. If the user releases pressure on the switch prematurely, a warning may be announced or displayed on the data management unit. Alternatively or in addition, a small display or LEDs on the snap-on pen module (102, 202) may be used to cue the user as to how long to press on the dial. It is noted, however, that a display is not absolutely necessary-the device could just track the time that the button is depressed and display a message/warning on the meter if the user does not hold down the button for a sufficient amount of time. The switch may also be configured to work with sensors other than encoders, for example the linear potentiometer as shown exemplarily in Figures 11, 12, 18, and 19. Add-on communication module (102, 202) may include various features that guide users in the proper use of drug delivery pens 124 or 224. For example, add-on communication module (102, 202) can: alert the user if they have not primed drug delivery pen 124 or 224 using the inertial sensor; alert the user if a mixing step has not been performed (applicable to mixed insulins) using the inertial sensor; warn the user if the injection is incomplete (i.e., dosage delivery button is not pressed all the way to zero); provide a timer that reminds the user to hold dosage delivery button 116 down for several seconds during an injection; keep track of remaining insulin in drug delivery pen 124 or 224; remind user when it is time to inject; alert the user if injections have been missed or duplicated; alert the user if insulin is about to expire.

[0061] In addition, add-on communication module (102, 202) may include a micro switch in communication module housing 108 to allow for activation of certain features. For example, the insertion of drug delivery pen 124 or 224 into add-on communication module (102, 202) triggers the micro switch. Triggering the micro switch serves two purposes: first, it signals when a new drug delivery pen 124 or 224 is inserted, which allows add-on communication module (102, 202) to track how much insulin is left in drug delivery pen 124 or 224; and second, it ensures that drug delivery pen 124 or 224 is inserted correctly, and is properly aligned with add-on communication module.

[0062] Another feature that may be included in communication module is a technique for distinguishing a priming dose from a dose that is injected into the user. For example, a gravity or inertial sensor may be used to determine if the device is pointing upwards when dial 3 is pressed, indicating a priming shot since the device is held in an inverted position when purging bubbles. The add-on module is able to distinguish priming shots from actual drug delivery. For example, priming shots are typically two units or less, making them distinguishable from

larger injected shots, and a priming shot will typically be followed by an injected shot, a pattern that may be distinguished in software. Similarly, it is useful to be able to distinguish between dosage size adjustments in which the user turns the dial backwards and/or forwards to dial in a specific dosage vs. movement of the dial position from the user injecting a shot. This is detectable by the microcontroller via the dosage sensor as well, since injections into the user should end with the dial returned to the initial, or home position, whereas adjustments of the dial to modify the dosage typically occur when the dial is set at a larger dosage and do not terminate in the initial, or home position of the dial.

[0063] Several features may be utilized to reduce inaccuracies in the use of insulin pens. These include missing injections, duplicating injections, and improper priming. Improper priming is especially problematic if a needle (not shown) was left on between doses, allowing air to enter drug cartridge 122. Some insulins, such as 70/30 pre-mix, must be mixed prior to injection. Neglecting to mix or improperly mixing 70/30 pre-mix before injection is a source of inaccuracy. Dosage delivery button 116 should be held for approximately 6 seconds during an injection to ensure the entire dose enters the body. Not holding dosage delivery button 116 long enough results in a partial dose. Add-on communication module alerts the user to these inaccuracies and thus helps to reduce them.

[0064] As mentioned previously, the add-on communication module (102, 202) may be used to measure insulin doses and transfer that information to a data management unit, which may be a glucose meter or a suitable data communication unit such as a mobile phone, mobile computer. The information that is transferred from add-on communication module to the data management unit may be used to help master the use of drug delivery pen 124 or 224. Large potential sources of inaccuracy in the use of drug delivery pen 124 or 224 are missed doses and double doses. Add-on communication module, as embodied herein, may help eliminate these sources of error by reminding the user of their dosing history. The complete dosing history (including doses and time and date the doses were delivered) may be made available to the user by selecting this option from the data management unit's menu. In addition, by having the most recent dosing information (time and amount) on a meter's display when the data management unit turns on, the user will immediately see if they have forgotten an injection every time they take a blood glucose measurement. In the same way that a data management unit may be used to alert a user when it's time to test blood glucose, the data management unit may also alert the user when to take insulin, or if an insulin injection has been missed. This information may also be displayed when the data management unit turns on.

[0065] Another source of inaccuracy when using drug delivery pens 124 or 224 is improper priming technique (or failing to prime altogether). The purpose of priming

(sometimes called a test injection) is to remove air bubbles from drug cartridge 122 and needle, which would reduce the volume of an injection. Drug delivery pen 124 or 224 should be held vertically during priming so bubbles rise to the top of drug cartridge 122 (the end closest needle) and may be expelled by a priming dose. The priming is successful if the user sees a drop of insulin appear at the needle tip. If the user does not see a drop of insulin, the priming step is repeated. An inertial sensor is disposed in the module housing or located on the processor board 170 or 270 to detect if drug delivery pen 124 or 224 is held vertically during priming, and this information may be sent wirelessly to the data management unit. Low cost microelectromechanical systems (MEMS) inertial sensor chips are widely available, accurate, low cost, and small in size. Preferred inertial sensor may include Analog Devices model ADXL322 accelerometer (available at <http://www.analog.com/en/mems-and-sensors/imems-accelerometers/ADXL322/product/product.html#pricing>). The data management unit may remind the user to hold drug delivery pen 124 or 224 vertically when priming, if they are not doing so. In addition, if the user skips the priming step altogether, this will be apparent from the information collected by add-on communication module 102, 202, or 204, and a visual or auditory warning, reminder, and/or instructions may be given to the user by the add-on module or the data management unit.

[0066] The inertial sensor is also utilized to determine if the user is performing the proper mixing technique before injecting insulin, another source of error in using drug delivery pen 124 or 224. Some insulins must be mixed prior to use, such as 70/30 pre-mixed insulin. Mixing typically involves moving drug delivery pen 124 or 224 from straight up to straight down ten times, an action that is easily detectable by an inertial sensor (located in an attached add-on communication module 102, 202, or 204). A message may be displayed on the data management unit to remind the patient how to mix their insulin if they are using insulin that requires mixing prior to use.

[0067] Another source of error related to priming is that of neglecting to remove and dispose of needles after each injection. The meter, in one embodiment, would provide a display to generate a reminder stating that the needle should be removed with every use. Alternatively, the speaker mounted in the add-on module can be utilized to prompt the user with tones or prestored phrases configured for specific geographical areas (e.g., German for modules distributed in Germany, French for modules distributed in France and so on). Additionally, the speaker in the add-on module may be configured to allow a user to locate a misplaced pen and module. Specifically, the add-on module may respond to an inquiry signal from a data management unit (or any electronic devices paired to the add-on module) to cause the speaker in the add-on module to emit tones or beeps in the event that the user has misplaced the pen and module. This method also can be used to confirm that a particular communi-

cation module is paired with a particular data management unit such as a glucose meter.

[0068] When injecting insulin with drug delivery pen 124 or 224, it is important to hold down on dosage delivery button 116 with needle inserted for approximately six seconds, to ensure that the entire dose is delivered below the skin. The optimal amount of time is usually spelled out in drug delivery pen 124 or 224 user's manual. A message may be displayed on either or both of the add-on module or the data management unit, reminding the user of proper technique if they are releasing dosage delivery button 116, 216 or 251 prematurely. The data management unit or the add-on module may display a countdown timer or emit a count down tone or signals, initiated when dosage delivery button 116 is first pressed, letting the user know when they should release dosage delivery button 116.

[0069] Other pen-related usage reminders, such as the amount of time a pen may be used after removed from refrigeration, also may be incorporated into the smart pen module and displayed on the data management unit as an aide to the user. To track the time a particular pen has been in use, the user would need to indicate the initiation of a new pen on the meter. In such embodiment, a switch is provided in the hollow bore of the smart pen module that is activated when it is attached to a pen, signaling the initiation of a new pen. The user may be asked to confirm on the meter when a new pen is initiated by pressing a button and possibly entering some information, such as the amount of insulin in the new pen.

[0070] In the examples given above, the add-on module (102, 202) is provided with a transceiver to allow receipt and transmission of information collected by the smart pen module to a cell phone or computer for easy look up or prominent display.

[0071] These features described and illustrated may be incorporated into a re-usable pen, in addition to a conventional disposable pen.

[0072] To our knowledge, no other device has sought to address the problems recognized here by applicants, with the exception of conventional digital insulin pens that display the last few injection amounts.

[0073] Several prototypes have been built that measure the amount of each dose and transmit this information to a meter for display. During evaluation of the prototypes, it was recognized by applicants that it would be useful to have the device communicate with multiple pens, since users often use one pen for long acting insulin and a separate pen for rapid acting insulin. In addition, some patients use more than one pen of the same type of insulin, placing them in different convenient locations (for example, at home, at work, in the car, etc.). Hence, applicants have realized that multiple communication modules may communicate with the data management unit for each of these pens to ensure that all insulin injections are captured. Also, it was further realized by applicants that the communication modules may be color-coded so that they would match the color of the drug delivery pen

they are designed to work with. This feature is believed to be useful to users because insulin companies use the same pen to deliver different insulins, and they use color-coding to help the users distinguish between different pens. The communication modules may alert the user via a message, visual warning, or alarm on the add-on module(s) or data management unit as to the type of insulin they are injecting, helping them catch a potential error in which they might be injecting the wrong insulin - an error that may cause hypoglycemia or hyperglycemia.

[0074] While the invention has been described in terms of particular variations and illustrative figures, those of ordinary skill in the art will recognize that the invention is not limited to the variations or figures described. In addition, where methods and steps described above indicate certain events occurring in certain order, those of ordinary skill in the art will recognize that the ordering of certain steps may be modified and that such modifications are in accordance with the variations of the invention. Additionally, certain of the steps may be performed concurrently in a parallel process when possible, as well as performed sequentially as described above.

Claims

1. A diabetes management system comprising:

a data management unit (300, 400, 500, 600) including:

a memory (340);
a processor coupled to the memory (340);
a display (314) coupled to the processor;
and
a transceiver to receive and transmit data;
and

a drug delivery system including:

a drug delivery pen (124, 224) comprising:

a generally tubular pen housing that extends from a first end (112, 212) to a second end (113, 213), the housing enclosing at least a portion of a plunger rod coupled to a drug cartridge disposed proximate the first end, the pen housing having a dosage indicator window (118, 218) and a dosage selector (120, 220) coupled to the plunger rod, such that rotation of the dosage selector (120, 220) can cause said dosage selector (120, 220) to telescope in a linear direction;
an add-on communication unit (102, 202) comprising:

an add-on housing extending along a first longitudinal axis from a first housing end (132, 232) to a second housing end (180, 280), the add-on housing including an engagement portion (108, 208) that circumscribes at least a portion of the pen housing and capable of being separated from the drug delivery pen (124, 224), in which the add-on housing includes:

a memory unit;

a processor (170, 270) coupled to the memory; and **characterized by:**

an analog-to-digital converter coupled to a dosage sensor (114, 214) attached to the dosage selector (120, 220) of the pen, further in which the dosage sensor (114, 214) comprises a longitudinal member (154, 254) slidable along the longitudinal axis, the longitudinal member (154, 254) connected to a follower portion (140, 240) that extends from the add-on housing proximate the second housing end (280), and the follower portion (140, 240) being coupled to the dosage selector (120, 220) of the drug delivery pen so as to move longitudinally upon rotation of the dosage selector (120, 220) with respect to the pen housing, the converter being coupled to the processor (170, 270) so as to provide data upon displacement of the dosage selector (120, 220); and
a transceiver to transmit and receive data relating to dosage delivery of a drug dosage in the drug cartridge to the data management unit (300, 400, 500, 600).

2. The system of claim 1, in which the engagement portion (108, 208) comprises first and second extensions (130, 134), each of the extensions having first and second locating tangs (136, 184), each locating tang protrudes beyond each of the first and second

extensions to fix the add-on housing to the dosage indicator window (118, 218).

3. The system of claim 2, in which the dosage sensor (114, 214) is disposed in the add-on housing and located on one side of the first longitudinal axis; a power source (176, 276) disposed in the add-on housing, located on another side of the first longitudinal axis and spaced apart from the dosage sensor (114, 214); and a micro-controller disposed in the add-on housing proximate the first longitudinal axis and located between dosage sensor (114, 214) and the power source (176, 276).
4. The system of claim 1, in which the follower portion (140, 240) comprises a locator fork (152a, 152b).
5. The system of claim 1, in which the follower portion (140, 240) comprises a rotary knob (278), wherein the follower portion (140, 240) and rotary knob (278) form a continuous through bore (248), and the pen housing is positioned within the continuous through bore (248) such that rotary knob (278) is in a nested configuration with the dosage selector (120, 220).
6. The system of claim 1, in which the add-on housing comprises:
first and second extensions (130, 134) that partially circumscribe a second longitudinal axis generally parallel to the first longitudinal axis so that the first and second extensions (130, 134) are in contact with the outer surface of the drug delivery pen.
7. The system of claim 1, in which the add-on housing comprises a generally tubular extension (209) circumscribing a second longitudinal axis to define a hollow bore (248) that extends through a portion of the generally tubular extension (209) of the housing to allow the drug delivery pen to be inserted into the hollow bore (248).
8. The system of claim 1, in which the drug delivery pen (124, 224) comprises a disposable insulin pen.
9. The system of claim 1, in which the drug delivery pen (124, 224) comprises a reusable insulin pen.
10. The system of claim 1, in which the dosage sensor (114, 214) is selected from a group consisting of resistance, capacitance, optical, magnetic or combination thereof.
11. The system of claim 1, further comprising an inertial sensor disposed in the add-on housing to determine the orientation of the drug cartridge (122, 222).

12. The system of claim 1, further comprising a micro-switch (268) disposed in the add-on housing to allow a determination of replacement and/or correct positioning of the drug delivery pen (124, 224). 5
13. The system of claim 1, in which the drug cartridge (122, 222) contains a drug selected from a group consisting essentially of long acting insulin, rapid acting insulin, long and rapid acting mixed insulin, NPH, growth hormone, GLP-1 analogs, Symlin, or combinations thereof. 10
14. The system of claim 1, in which the data management unit (300, 400, 500, 600) further comprises an analyte sensor coupled to the processor to provide signals indicative of analyte value in a user's biological fluid. 15
15. The system of claim 1, in which the data management unit comprises a mobile phone (400). 20
16. The system of claim 1, in which the data management unit comprises a mobile computer (500). 25
17. The system of claim 1, in which the data management unit comprises a network server (600) located at a remote location from the communication module. 30

Patentansprüche

1. Diabetesmanagementsystem, umfassend:

eine Datenmanagementschaltung (300, 400, 500, 600), umfassend: 35

einen Speicher (340);
einen Prozessor, der mit dem Speicher (340) gekoppelt ist; 40
eine Anzeige (314), die mit dem Prozessor gekoppelt ist;
und
einen Sendeempfänger, um Daten zu empfangen und zu senden; und 45

ein Wirkstofffreisetzungssystem, umfassend:

einen Wirkstofffreisetzungspen (124, 224), umfassend: 50

ein im Allgemeinen röhrenförmiges Pengehäuse, das sich von einem ersten Ende (112, 212) bis zu einem zweiten Ende (113, 213) erstreckt, wobei das Gehäuse mindestens einen Abschnitt einer Druckstange umschließt, die mit einer Wirkstoffkartusche gekoppelt 55

ist, die unmittelbar am ersten Ende angeordnet ist, wobei das Pengehäuse ein Dosierungsindikatorfenster (118, 218) und einen Dosierungswähler (120, 220) aufweist, der derart mit der Druckstange gekoppelt ist, dass eine Drehung des Dosierungswählers (120, 220) bewirken kann, dass der Dosierungswähler (120, 220) in einer linearen Richtung teleskopiert; eine Zusatzkommunikationseinheit (102, 202), umfassend:

ein Zusatzgehäuse, das sich entlang einer ersten Längsachse von einem ersten Gehäuseende (132, 232) bis zu einem zweiten Gehäuseende (180, 280) erstreckt, wobei das Zusatzgehäuse einen Eingriffsabschnitt (108, 208) umfasst, der mindestens einen Abschnitt des Pengehäuses umschreibt und von dem Wirkstofffreisetzungspen (124, 224) getrennt werden kann, wobei das Zusatzgehäuse umfasst:

eine Speichereinheit;

einen Prozessor (170, 270), der mit dem Speicher gekoppelt ist; und **gekennzeichnet ist durch:**

einen Analog-Digital-Wandler, der mit einem Dosierungssensor (114, 214) gekoppelt ist, der an dem Dosierungswähler (120, 220) des Pens angebracht ist, wobei ferner der Dosierungssensor (114, 214) ein Längselement (154, 254) umfasst, das entlang der Längsachse verschiebbar ist, wobei das Längselement (154, 254) mit einem Mitnehmerabschnitt (140, 240) verbunden ist, der sich von dem Zusatzgehäuse unmittelbar an dem zweiten Gehäuseende (280) erstreckt, und wobei der Mitnehmerabschnitt (140, 240) mit dem Dosierungswähler (120, 220) des Wirkstofffreisetzungspens gekoppelt ist, um sich bei Drehung des Dosierungswählers (120, 220) mit Bezug auf das Pengehäuse in Längsrichtung zu bewe-

- gen, wobei der Wandler mit dem Prozessor (170, 270) gekoppelt ist, um bei Verlagerung des Dosierungswählers (120, 220) Daten zu liefern; und
5 einen Sendeempfänger, um Daten bezogen auf die Wirkstofflieferung einer Wirkstoffdosis in der Wirkstoffkartusche an die Datenmanagements-
10 einheit (300, 400, 500, 600) zu senden und an derselben zu empfangen.
2. System nach Anspruch 1, in dem der Eingriffabschnitt (108, 208) eine erste und eine zweite Verlängerung (130, 134) umfasst, wobei jede der Verlängerungen eine erste und eine zweite Positionierangel (136, 184) aufweist, wobei jede Positionierangel
20 über jede der ersten und zweiten Verlängerung hinaus vorspringt, um das Zusatzgehäuse an dem Dosierungsindikatorfenster (118, 218) zu fixieren.
3. System nach Anspruch 2, in dem der Dosierungssensor (114, 214) in dem Zusatzgehäuse angeordnet ist und sich auf einer Seite der ersten Längsachse befindet;
25 eine Stromquelle (176, 276), die in dem Zusatzgehäuse angeordnet ist, die sich auf einer anderen Seite der ersten Längsachse befindet und von dem Dosierungssensor (114, 214) beabstandet ist; und
30 einen Mikrocontroller, der in dem Zusatzgehäuse unmittelbar an der ersten Längsachse angeordnet ist und sich zwischen dem Dosierungssensor (114, 214) und der Stromquelle (176, 276) befindet.
4. System nach Anspruch 1, in dem der Mitnehmerabschnitt (140, 240) eine Positioniergabel (152a, 152b) umfasst.
40
5. System nach Anspruch 1, in dem der Mitnehmerabschnitt (140, 240) einen Drehknopf (278) umfasst, wobei der Mitnehmerabschnitt (140, 240) und der Drehknopf (278) eine durchgehende Bohrung (248) bilden, und das Pengehäuse derart innerhalb der durchgehenden Bohrung (248) positioniert ist, dass der Drehknopf (278) mit dem Dosierungswähler (120, 220) verschachtelt ausgelegt ist.
45
6. System nach Anspruch 1, in dem das Zusatzgehäuse umfasst:
50 eine erste und zweite Verlängerung (130, 134), die teilweise eine zweite Längsachse im Allgemeinen parallel zu der ersten Längsachse derart umschreiben, dass die erste und die zweite Verlängerung (130, 134) mit der Außenfläche des
- Wirkstofffreisetzungspens in Kontakt sind.
7. System nach Anspruch 1, in dem das Zusatzgehäuse eine im Allgemeinen röhrenförmige Verlängerung (209) umfasst, die eine zweite Längsachse umschreibt, um eine hohle Bohrung (248) zu definieren, die sich durch einen Abschnitt der im Allgemeinen röhrenförmigen Verlängerung (209) des Gehäuses erstreckt, um zu erlauben, dass der Wirkstofffreisetzungspen in die hohle Bohrung (248) eingesetzt werden kann.
8. System nach Anspruch 1, in dem der Wirkstofffreisetzungspen (124, 224) einen Einweg-Insulinpen umfasst.
15
9. System nach Anspruch 1, in dem der Wirkstofffreisetzungspen (124, 224) einen wiederverwendbaren Insulinpen umfasst.
10. System nach Anspruch 1, in dem der Dosierungswähler (114, 214) aus einer Gruppe bestehend aus Widerstand, Kapazität, optisch, magnetisch oder einer Kombination davon ausgewählt ist.
11. System nach Anspruch 1, ferner umfassend einen Trägheitssensor, der in dem Zusatzgehäuse angeordnet ist, um die Ausrichtung der Wirkstoffkartusche (122, 222) zu bestimmen.
12. System nach Anspruch 1, ferner umfassend einen Mikroschalter (268), der in dem Zusatzgehäuse angeordnet ist, um eine Bestimmung des Austauschs und/oder korrekte Positionierung des Wirkstofffreisetzungspens (124, 224) zu erlauben.
13. System nach Anspruch 1, in dem die Wirkstoffkartusche (122, 222) einen Wirkstoff enthält, der aus der Gruppe im Wesentlichen bestehend aus lang wirkendem Insulin, schnell wirkendem Insulin, lang und schnell wirkendem Mischinsulin, NPH, Wachstumshormon, GLP-1-Analoga, Symlin oder Kombinationen davon ausgewählt ist.
14. System nach Anspruch 1, in dem die Datenmanagements-
55 einheit (300, 400, 500, 600) ferner einen Analysensor umfasst, der mit dem Prozessor gekoppelt ist, um Signale zu liefern, die einen Analytwert im biologischen Fluid eines Anwenders anzeigen.
15. System nach Anspruch 1, in dem die Datenmanagements-
einheit ein Mobiltelefon (400) umfasst.
16. System nach Anspruch 1, in dem die Datenmanagements-
einheit einen mobilen Computer (500) umfasst.
17. System nach Anspruch 1, in dem die Datenmanagements-
einheit einen Netzwerks-
server (600) umfasst,

der sich an einem von dem Kommunikationsmodul entfernten Standort befindet.

un processeur (170, 270) couplé à la mémoire ; et **caractérisé par** :

Revendications

5

1. Système de gestion du diabète comprenant :

une unité de gestion de données (300, 400, 500, 600) comportant :

10

une mémoire (340) ;
un processeur couplé à la mémoire (340) ;
un écran (314) couplé au processeur ;
et
un émetteur-récepteur pour recevoir et transmettre des données ; et

15

un système de délivrance de médicament comportant :

20

un stylo de délivrance de médicament (124, 224) comprenant :

une coque de stylo généralement tubulaire qui s'étend d'une première extrémité (112, 212) à une deuxième extrémité (113, 213), la coque enfermant au moins une partie d'une tige de piston couplée à une cartouche de médicament disposée à proximité de la première extrémité, la coque de stylo ayant une fenêtre d'indication de dose (118, 218) et un sélecteur de dose (120, 220) couplé à la tige de piston, de telle sorte qu'une rotation du sélecteur de dose (120, 220) peut conduire ledit sélecteur de dose (120, 220) à se replier dans une direction linéaire ;
une unité de communication complémentaire (102, 202) comprenant :

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une coque complémentaire s'étendant le long d'un premier axe longitudinal d'une première extrémité de coque (132, 232) à une deuxième extrémité de coque (180, 280), la coque complémentaire comportant une partie d'engagement (108, 208) qui circonscrit au moins une partie de la coque de stylo et est susceptible d'être séparée du stylo de délivrance de médicament (124, 224), la coque complémentaire comportant :

45

50

55

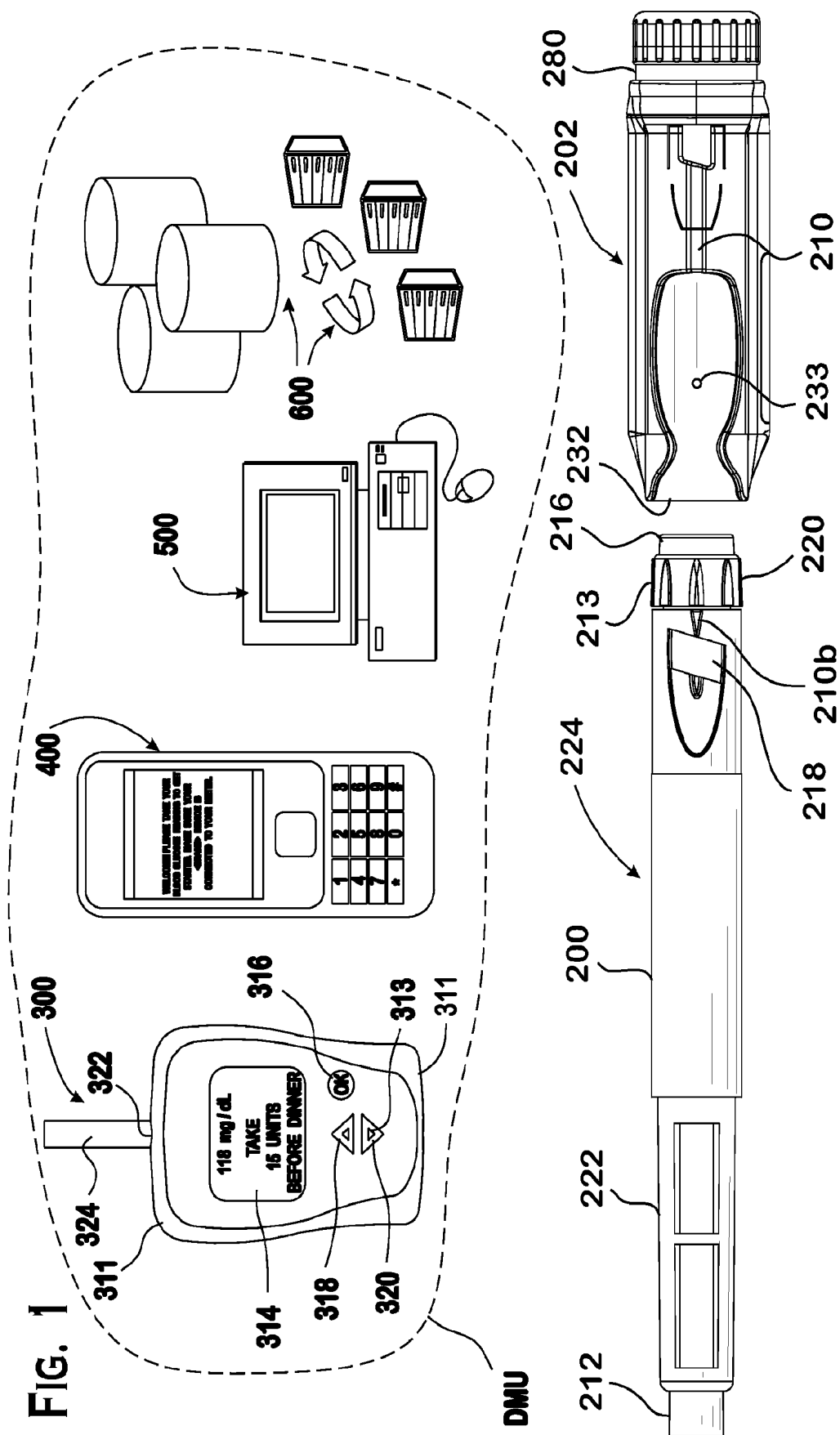
une unité de mémoire ;

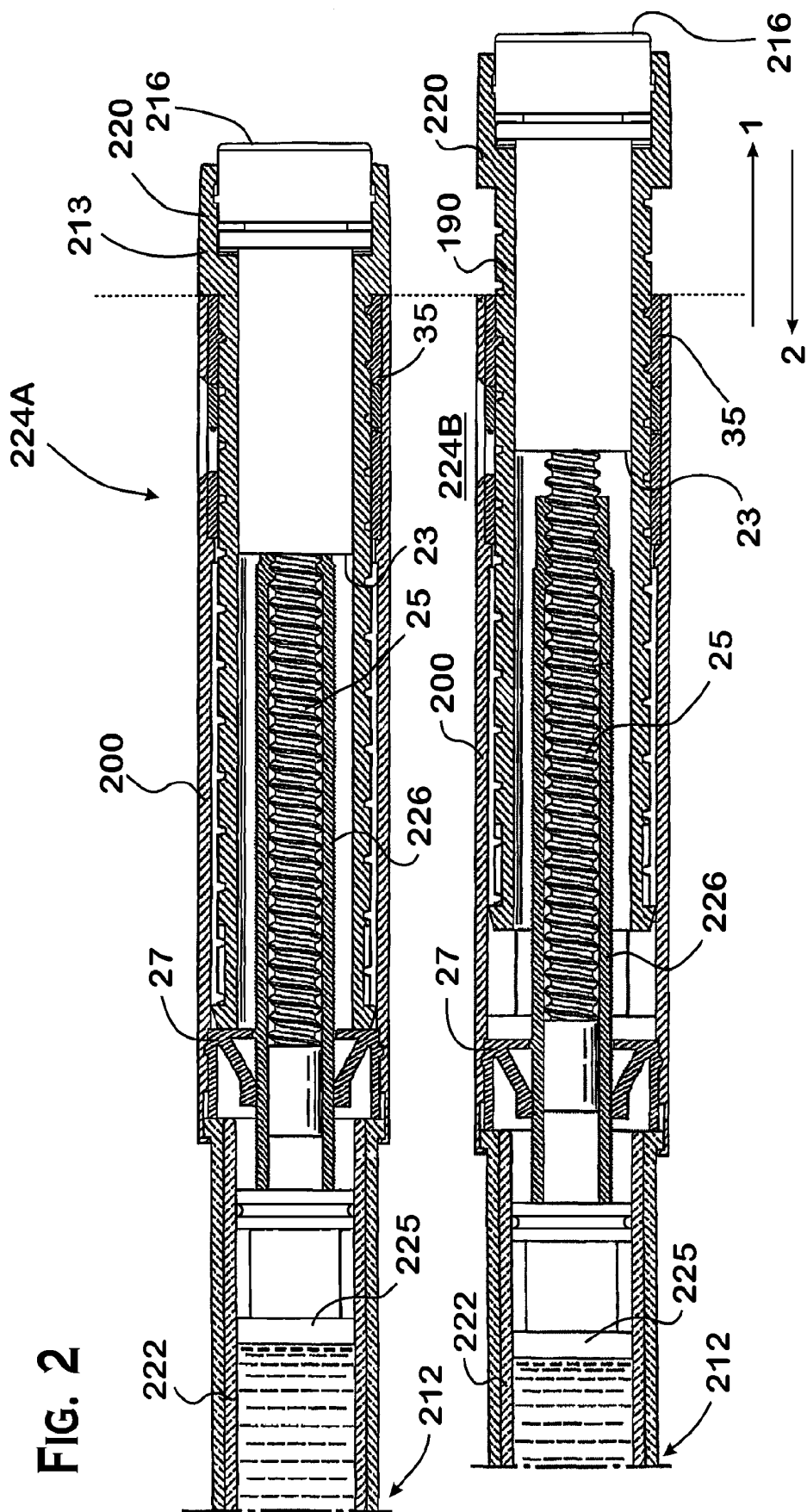
un convertisseur analogique-numérique couplé à un capteur de dose (114, 214) attaché au sélecteur de dose (120, 220) du stylo, le capteur de dose (114, 214) comprenant en outre un élément longitudinal (154, 254) que l'on peut faire glisser le long de l'axe longitudinal, l'élément longitudinal (154, 254) étant relié à une partie suiveuse (140, 240) qui s'étend depuis la coque complémentaire à proximité de la deuxième extrémité de coque (280), et la partie suiveuse (140, 240) étant couplée au sélecteur de dose (120, 220) du stylo de délivrance de médicament de manière à se déplacer longitudinalement lors d'une rotation du sélecteur de dose (120, 220) par rapport à la coque de stylo, le convertisseur étant couplé au processeur (170, 270) de manière à fournir des données lors d'un déplacement du sélecteur de dose (120, 220) ; et
un émetteur-récepteur pour transmettre et recevoir des données concernant la délivrance dosée d'une dose de médicament dans la cartouche de médicament à l'unité de gestion de données (300, 400, 500, 600).

2. Système de la revendication 1, dans lequel la partie d'engagement (108, 208) comprend des premier et deuxième prolongements (130, 134), chacun des prolongements ayant des premier et deuxième tenons de positionnement (136, 184), chaque tenon de positionnement faisant saillie au-delà de chacun des premier et deuxième prolongements pour fixer la coque complémentaire à la fenêtre d'indication de dose (118, 218).

3. Système de la revendication 2, dans lequel le capteur de dose (114, 214) est disposé dans la coque complémentaire et situé sur un côté du premier axe longitudinal ;
une source d'alimentation (176, 276) disposée dans la coque complémentaire, située sur un autre côté du premier axe longitudinal et espacée du capteur

- de dose (114, 214) ; et
un microcontrôleur disposé dans la coque complémentaire à proximité du premier axe longitudinal et situé entre le capteur de dose (114, 214) et la source d'alimentation (176, 276).
- 5
4. Système de la revendication 1, dans lequel la partie suiveuse (140, 240) comprend une fourche de positionnement (152a, 152b).
- 10
5. Système de la revendication 1, dans lequel la partie suiveuse (140, 240) comprend un bouton rotatif (278), la partie suiveuse (140, 240) et le bouton rotatif (278) formant un alésage continu débouchant (248), et la coque de stylo étant positionnée à l'intérieur de l'alésage continu débouchant (248) de telle sorte que le bouton rotatif (278) est dans une configuration emboîtée avec le sélecteur de dose (120, 220).
- 15
6. Système de la revendication 1, dans lequel la coque complémentaire comprend :
- 20
- des premier et deuxième prolongements (130, 134) qui circonscrivent partiellement un deuxième axe longitudinal généralement parallèle au premier axe longitudinal de telle sorte que les premier et deuxième prolongements (130, 134) sont en contact avec la surface externe du stylo de délivrance de médicament.
- 25
7. Système de la revendication 1, dans lequel la coque complémentaire comprend un prolongement généralement tubulaire (209) circonscrivant un deuxième axe longitudinal pour définir un alésage creux (248) qui s'étend à travers une partie du prolongement généralement tubulaire (209) de la coque pour pouvoir insérer le stylo de délivrance de médicament dans l'alésage creux (248).
- 30
8. Système de la revendication 1, dans lequel le stylo de délivrance de médicament (124, 224) comprend un stylo d'insuline jetable.
- 35
9. Système de la revendication 1, dans lequel le stylo de délivrance de médicament (124, 224) comprend un stylo d'insuline réutilisable.
- 40
10. Système de la revendication 1, dans lequel le capteur de dose (114, 214) est choisi dans un groupe constitué par un capteur résistif, capacitif, optique, magnétique ou une combinaison de ceux-ci.
- 45
11. Système de la revendication 1, comprenant en outre un capteur inertiel disposé dans la coque complémentaire pour déterminer l'orientation de la cartouche de médicament (122, 222).
- 50
12. Système de la revendication 1, comprenant en outre un microcommutateur (268) disposé dans la coque complémentaire pour permettre une détermination de remplacement et/ou de bon positionnement du stylo de délivrance de médicament (124, 224).
- 55
13. Système de la revendication 1, dans lequel la cartouche de médicament (122, 222) contient un médicament choisi dans un groupe essentiellement constitué par l'insuline à action prolongée, l'insuline à action rapide, l'insuline mixte à action prolongée et rapide, la NPH, l'hormone de croissance, les analogues du GLP-1, la Symlin, ou les combinaisons de ceux-ci.
14. Système de la revendication 1, dans lequel l'unité de gestion de données (300, 400, 500, 600) comprend en outre un capteur d'analyte couplé au processeur pour délivrer des signaux représentatifs d'une valeur d'analyte dans un fluide biologique d'un utilisateur.
15. Système de la revendication 1, dans lequel l'unité de gestion de données comprend un téléphone mobile (400).
16. Système de la revendication 1, dans lequel l'unité de gestion de données comprend un ordinateur portable (500) .
17. Système de la revendication 1, dans lequel l'unité de gestion de données comprend un serveur réseau (600) situé à un emplacement distant du module de communication.





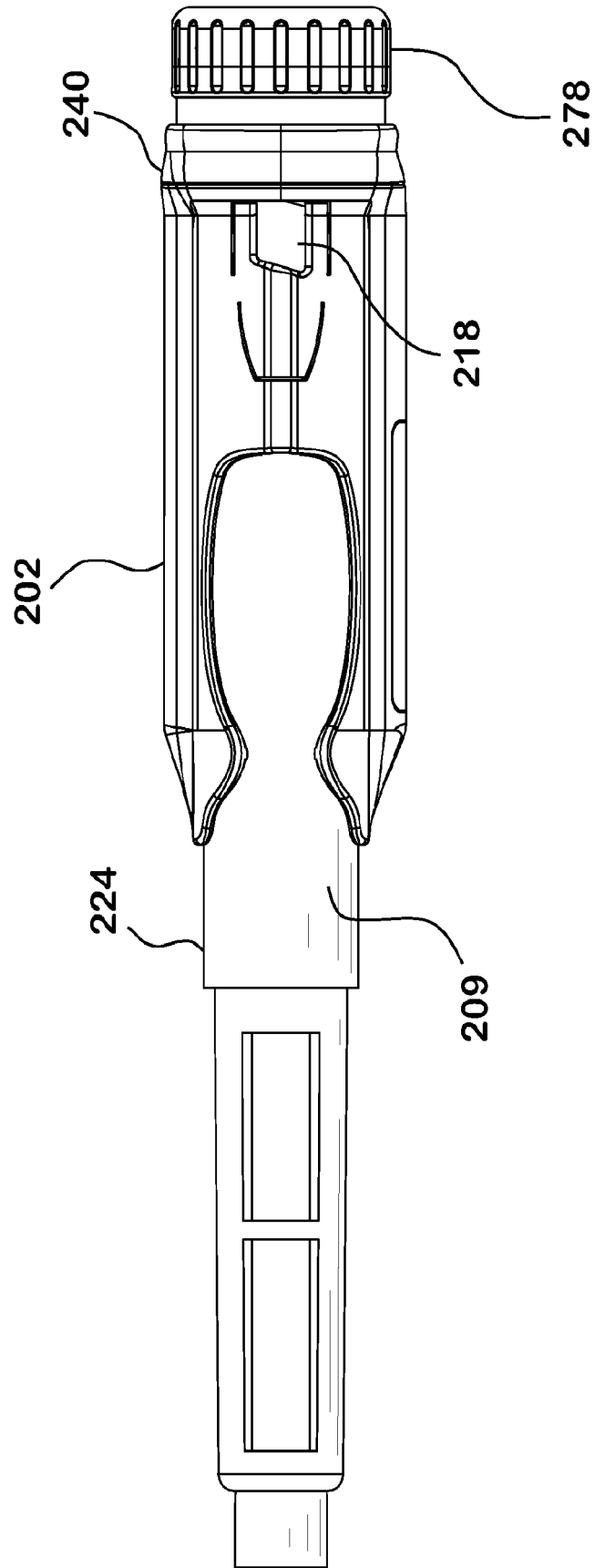


FIG. 3

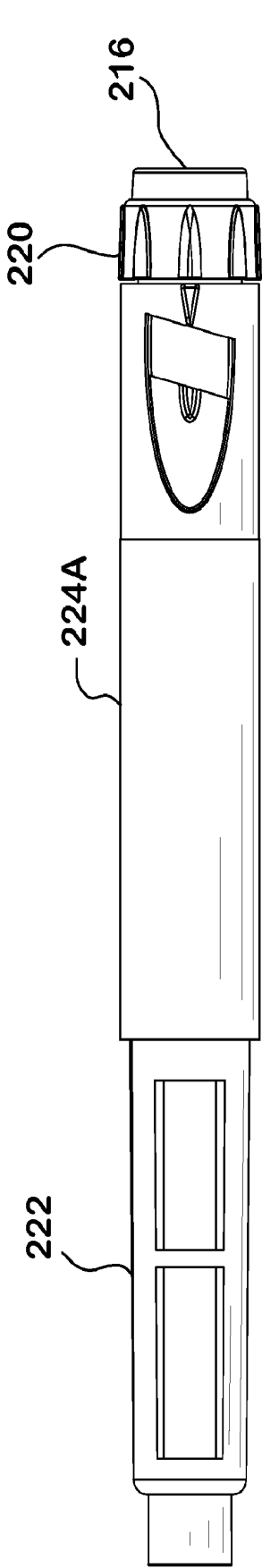


FIG. 1C1

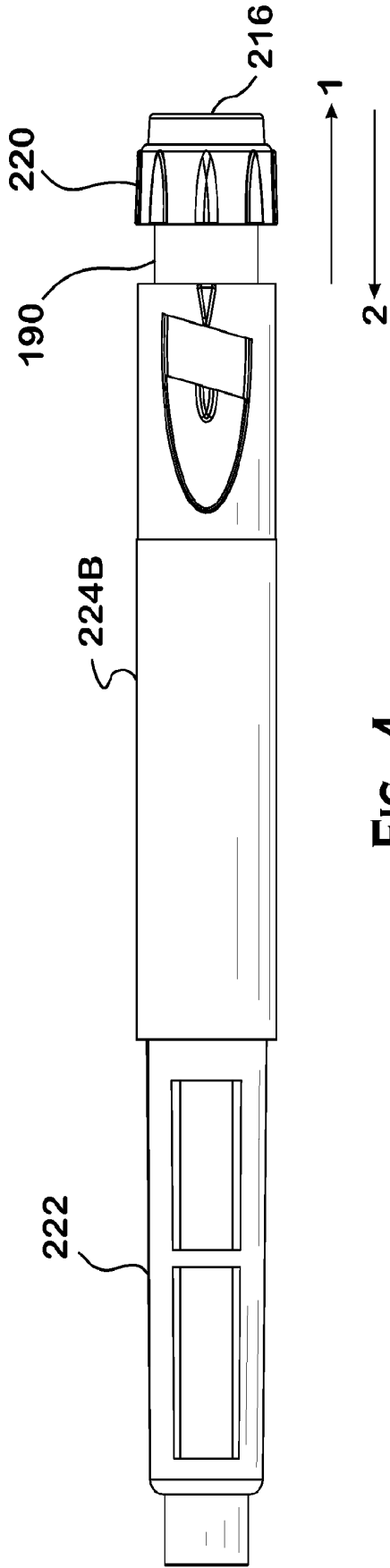


FIG. 4

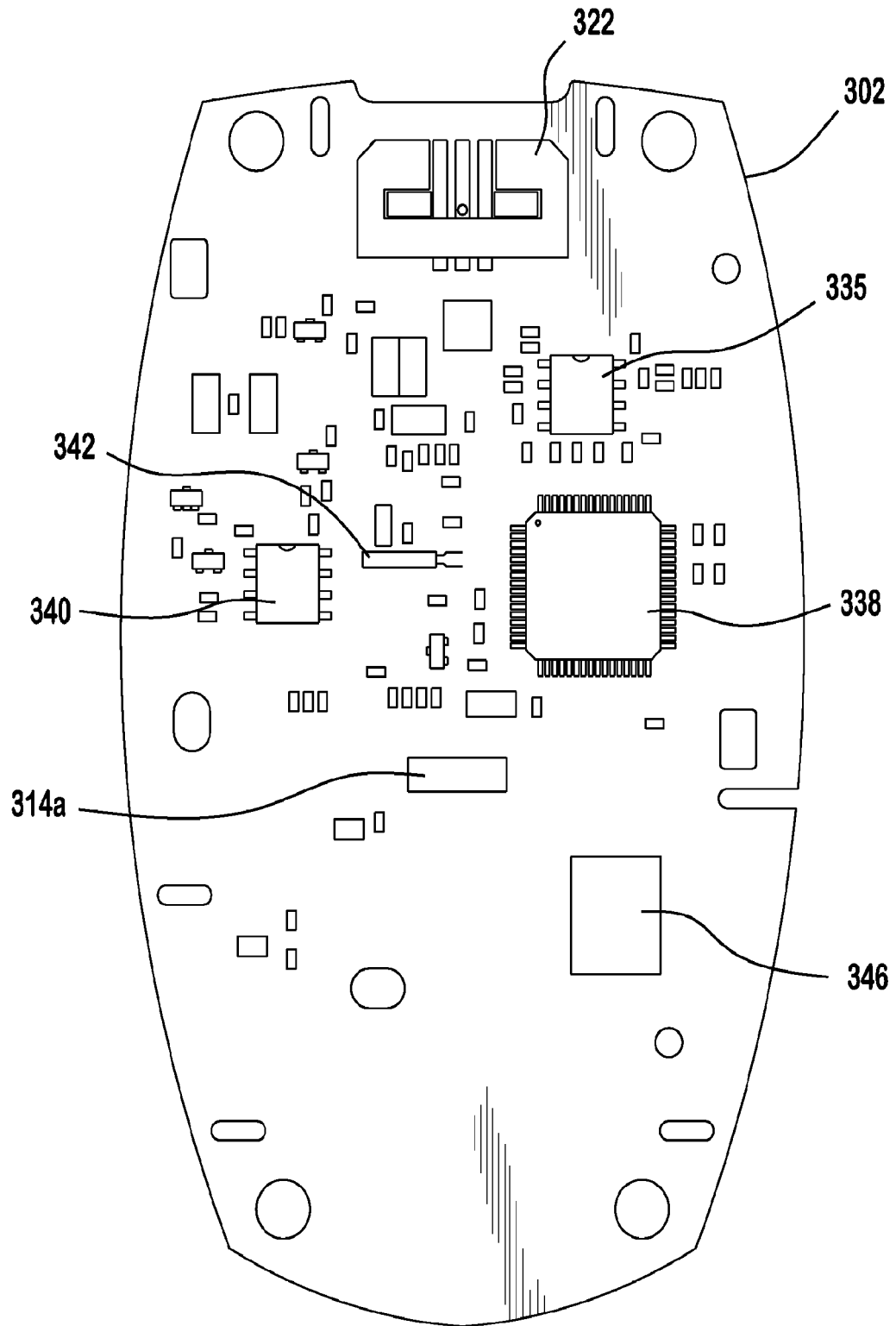


FIG. 5

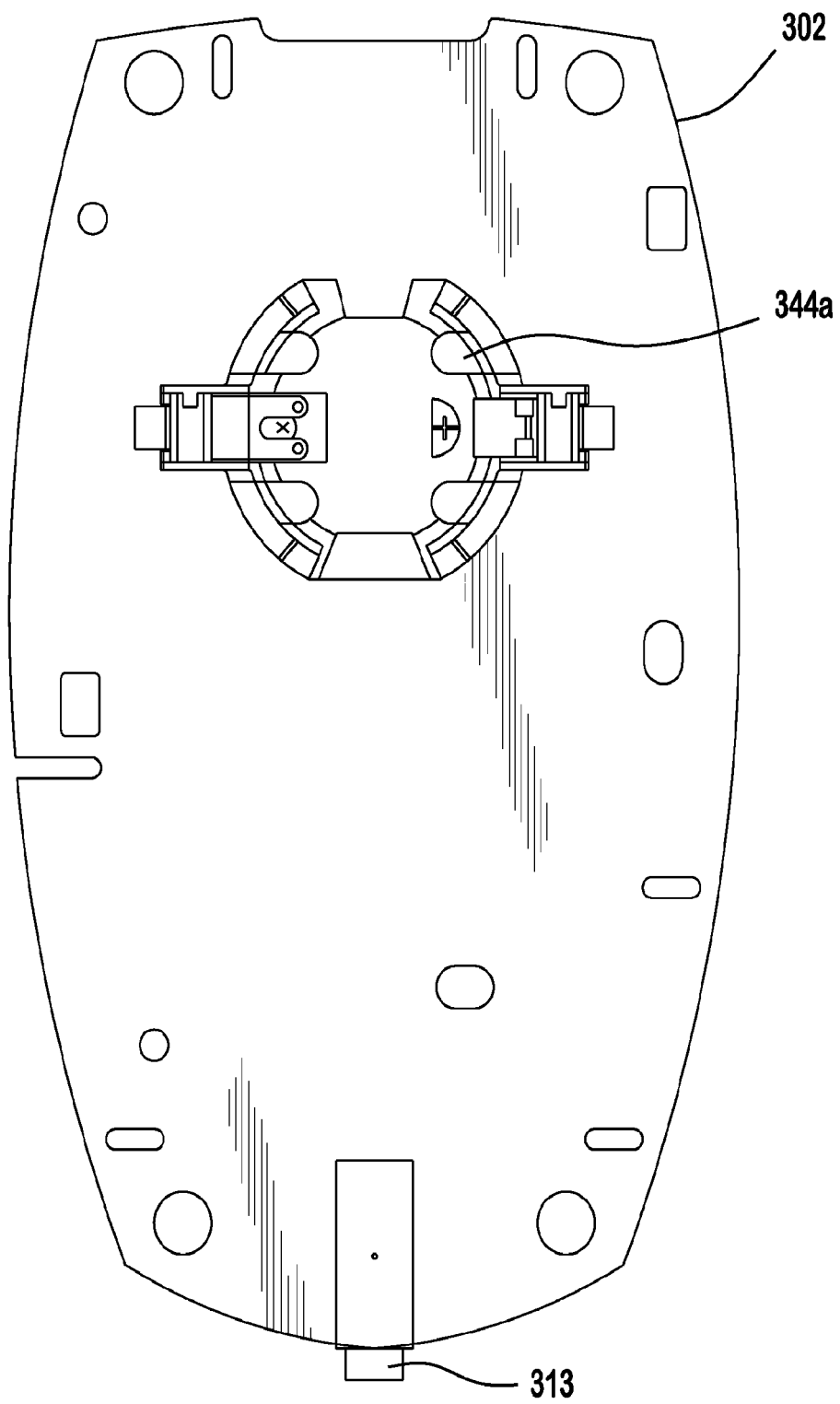


FIG. 6

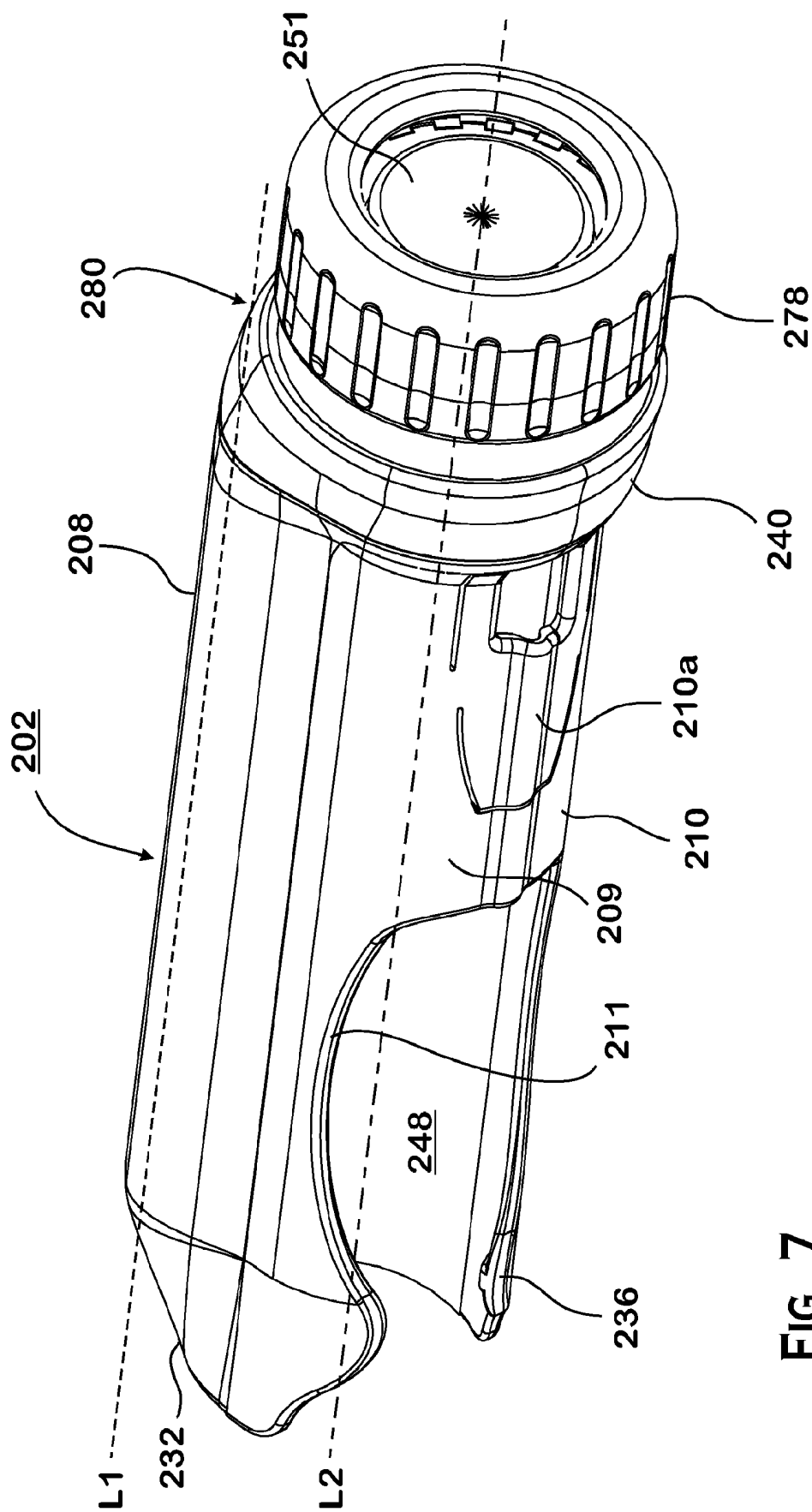


FIG. 7

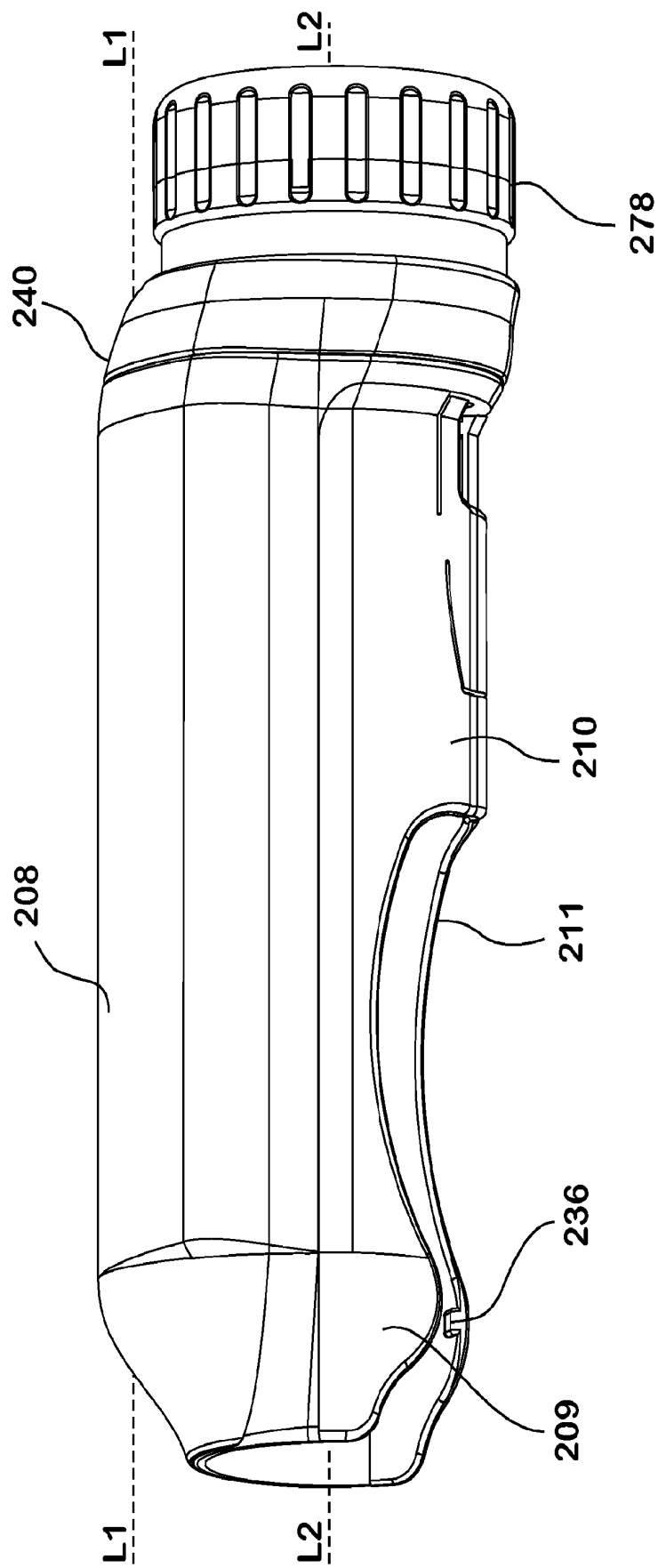


FIG. 8

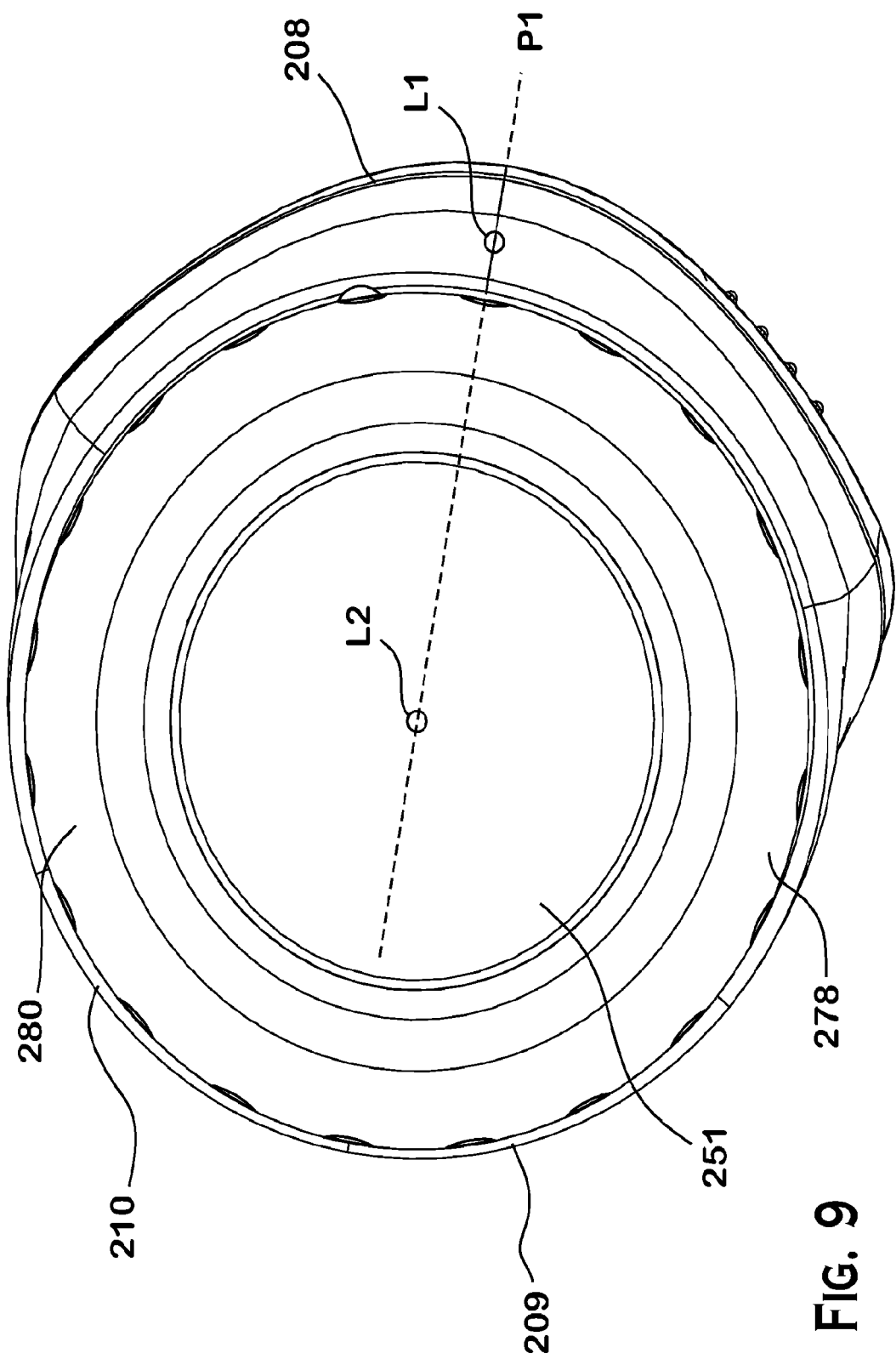


FIG. 9

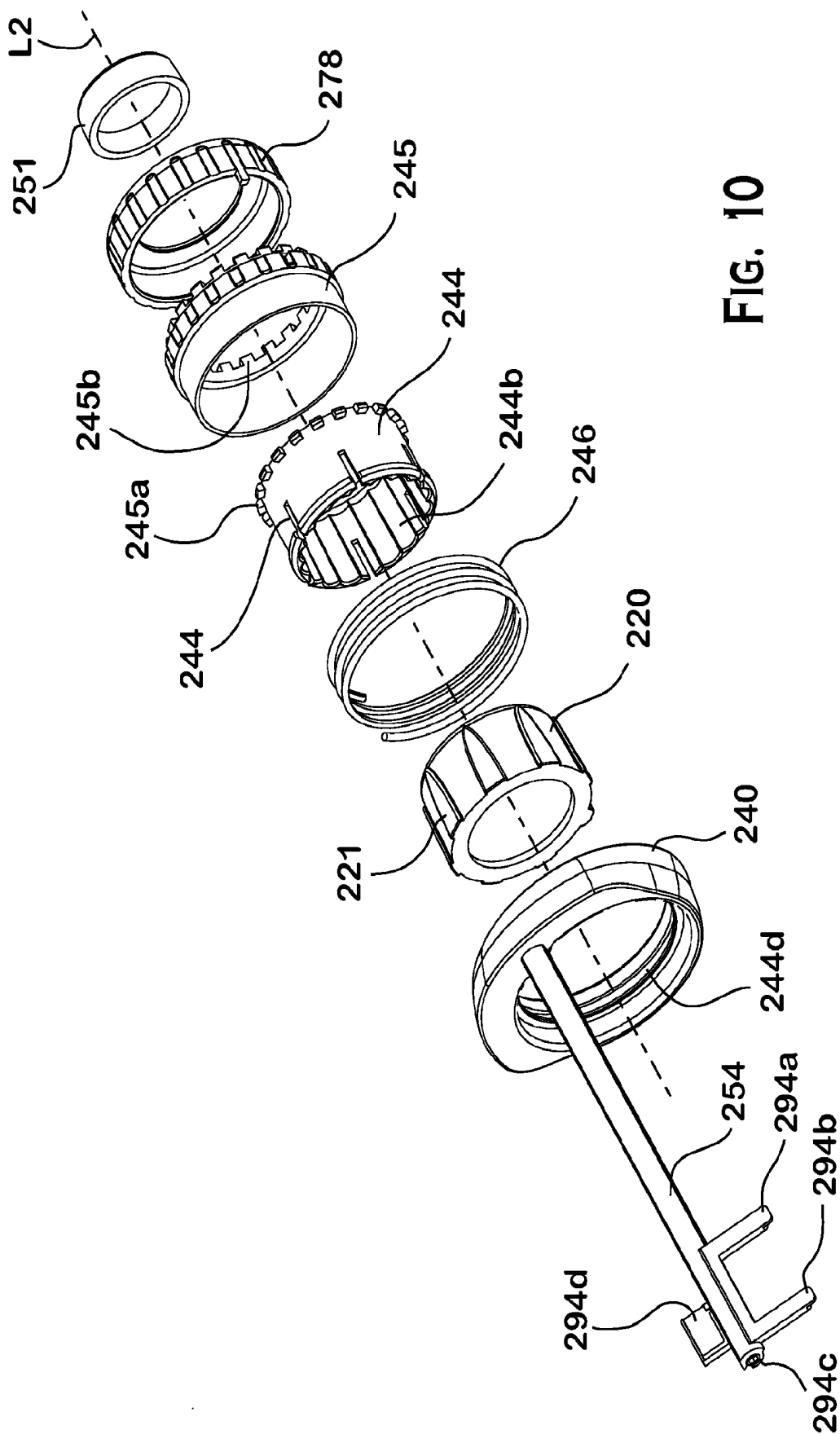


FIG. 10

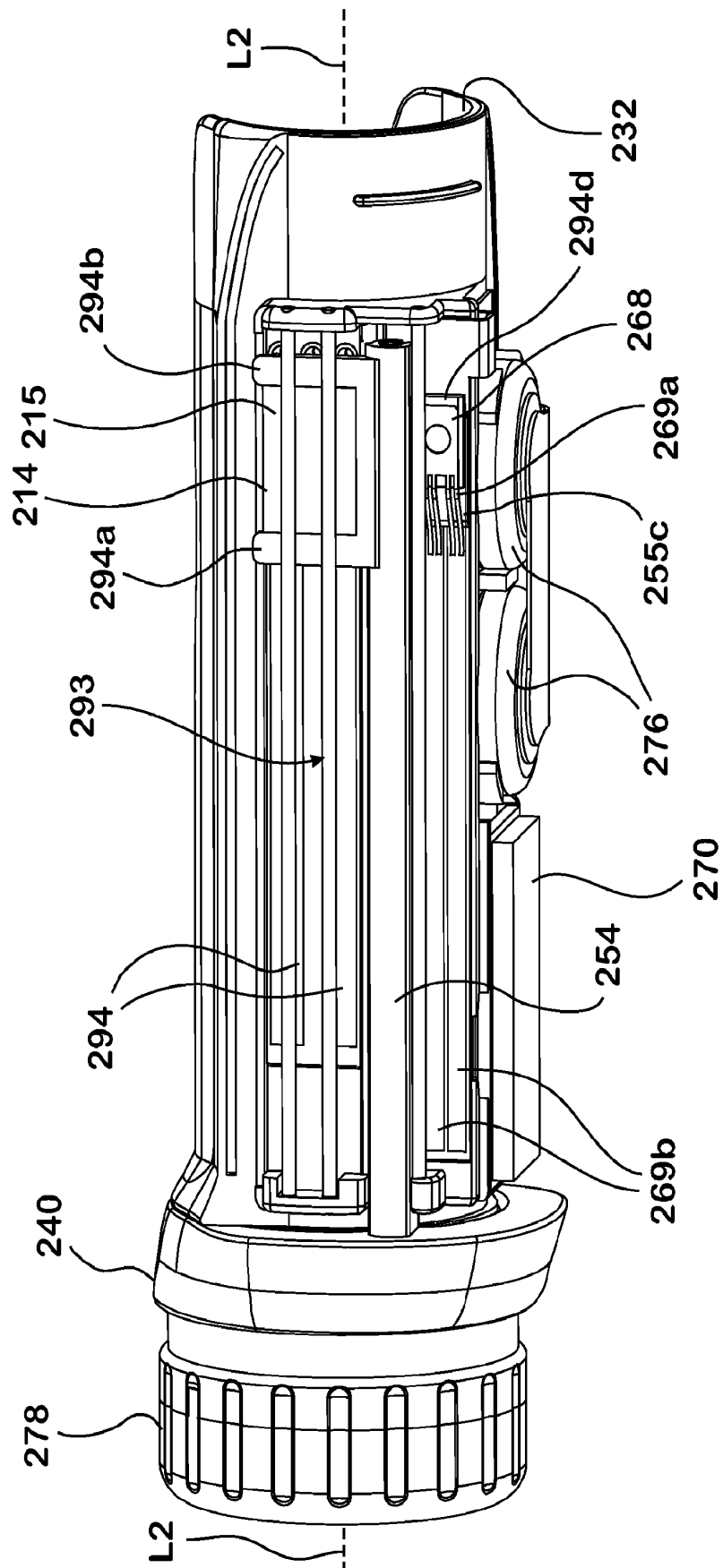


FIG. 11

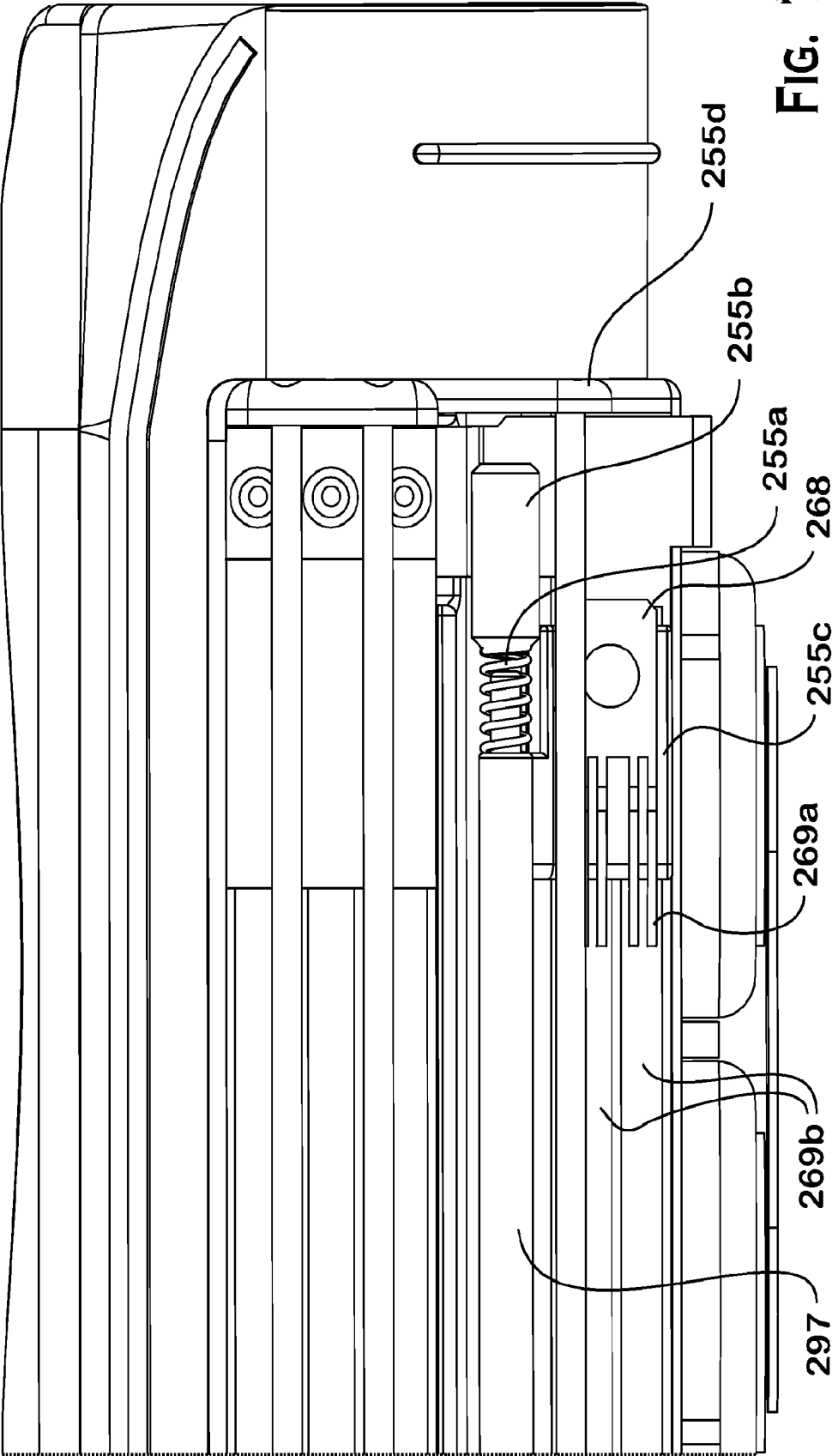
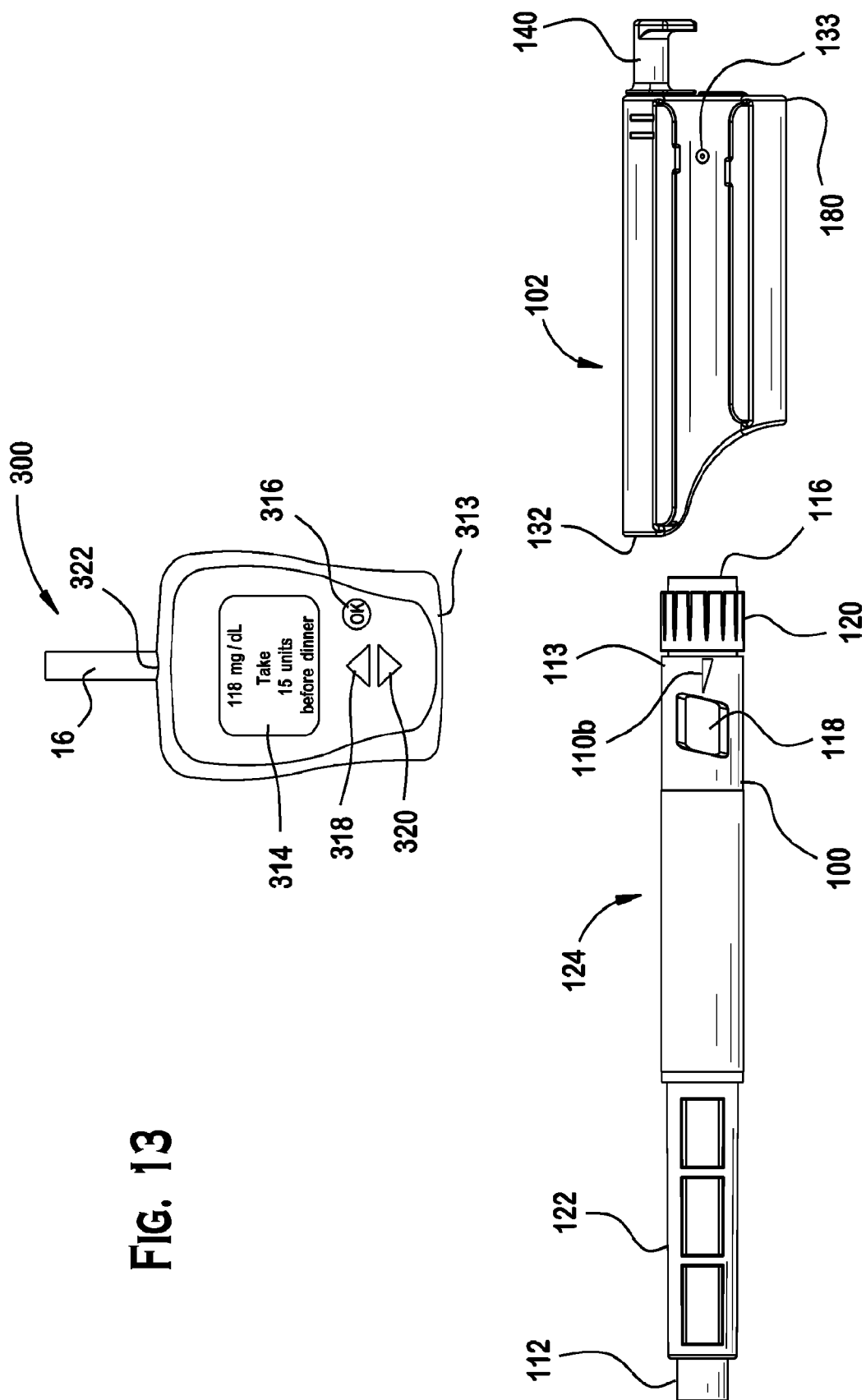


FIG. 12

FIG. 13



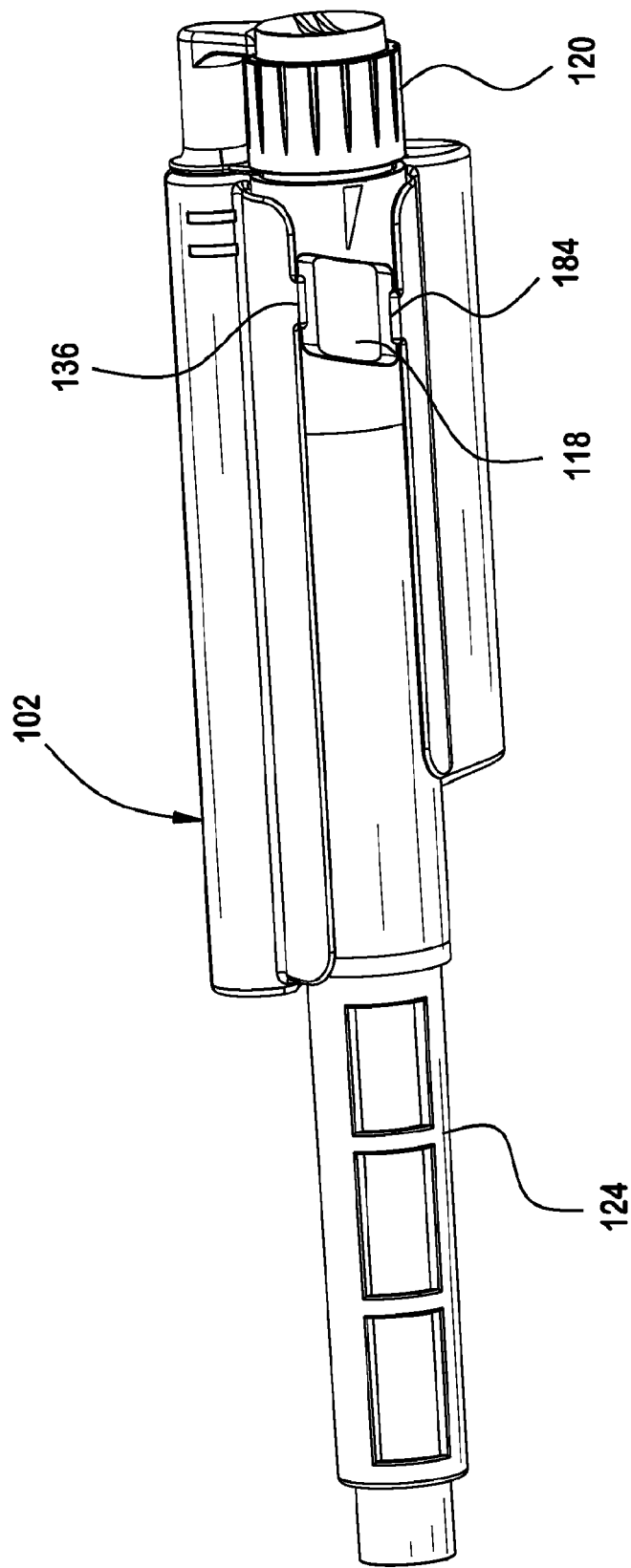


FIG. 14

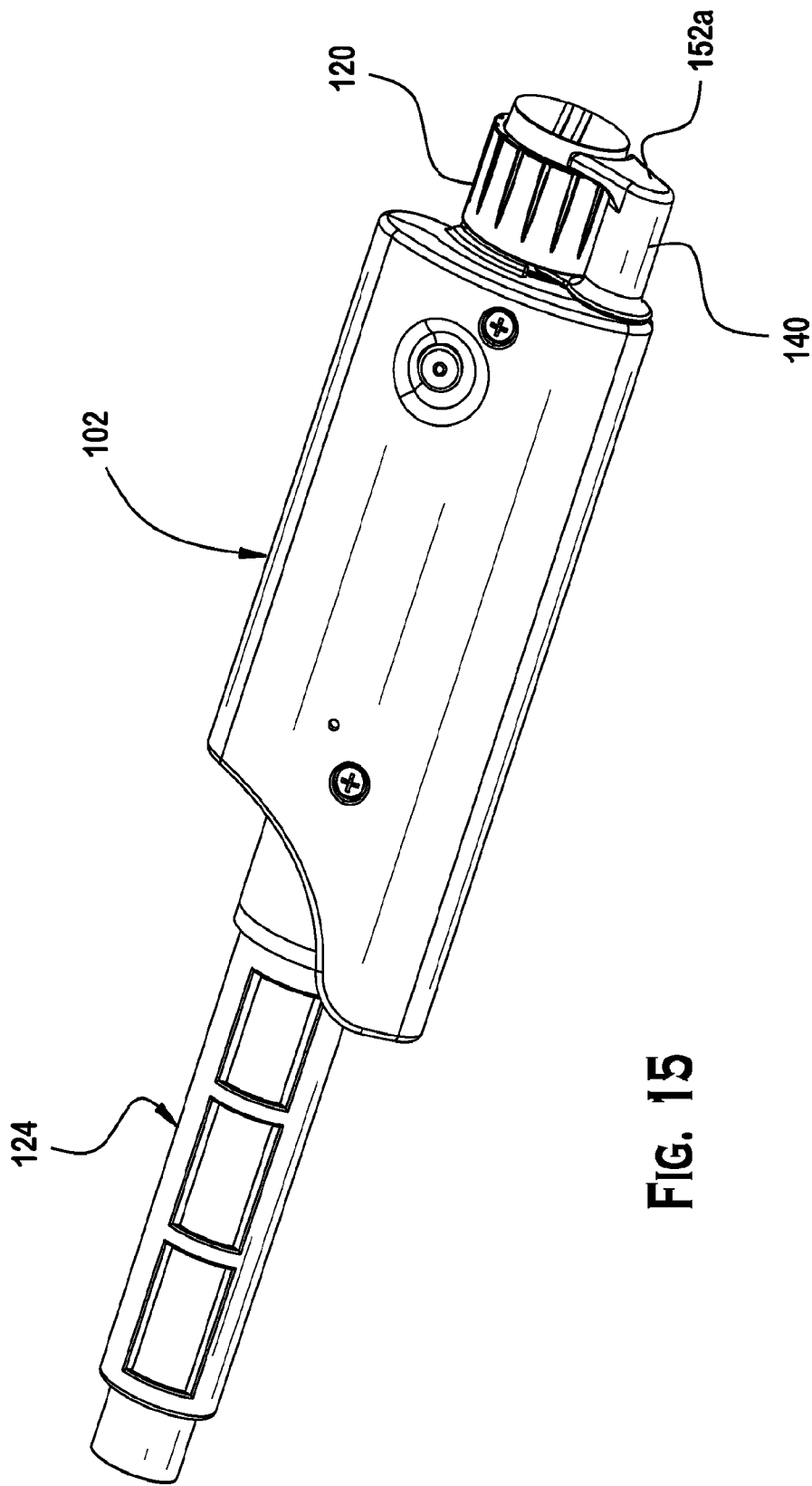


FIG. 15

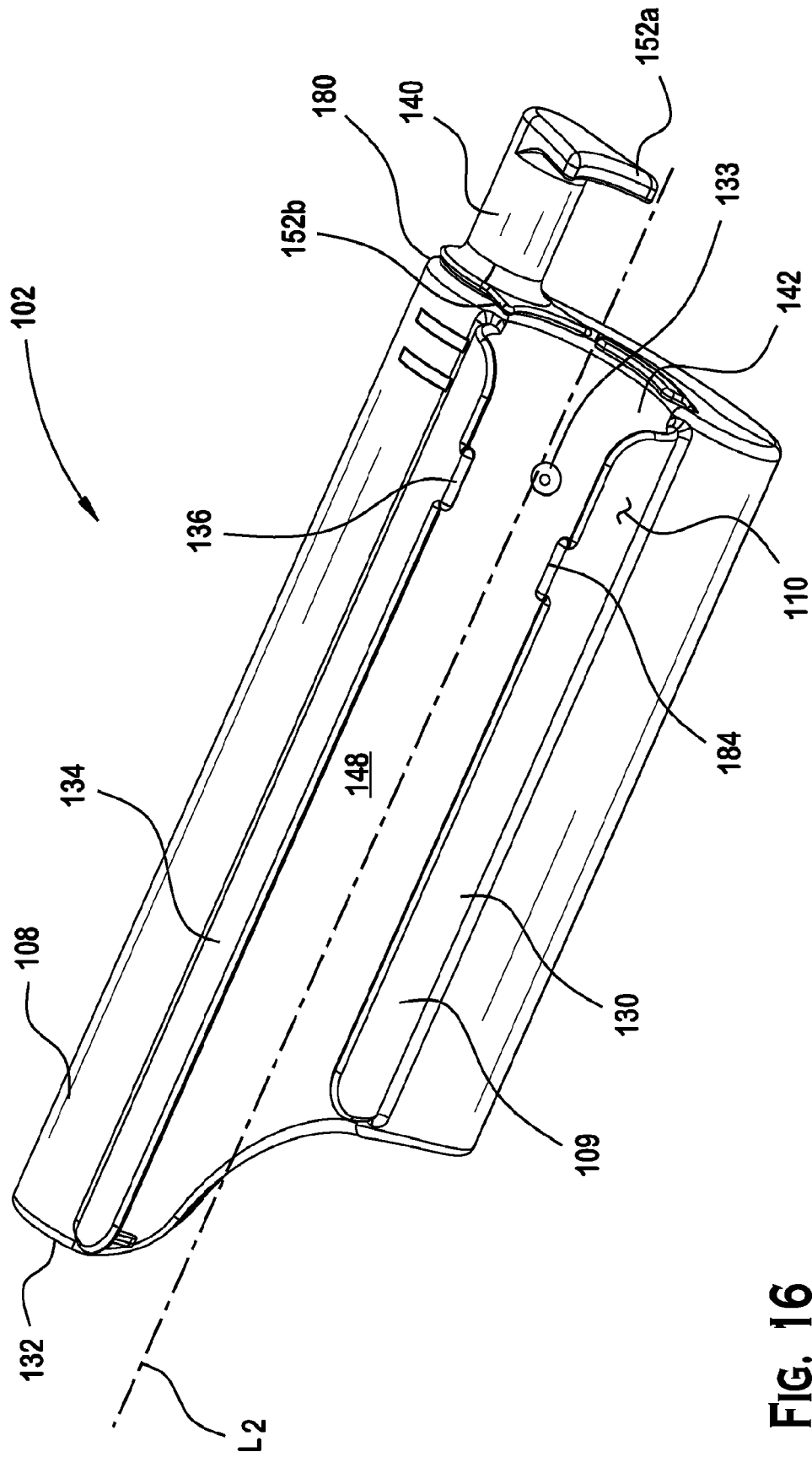


FIG. 16

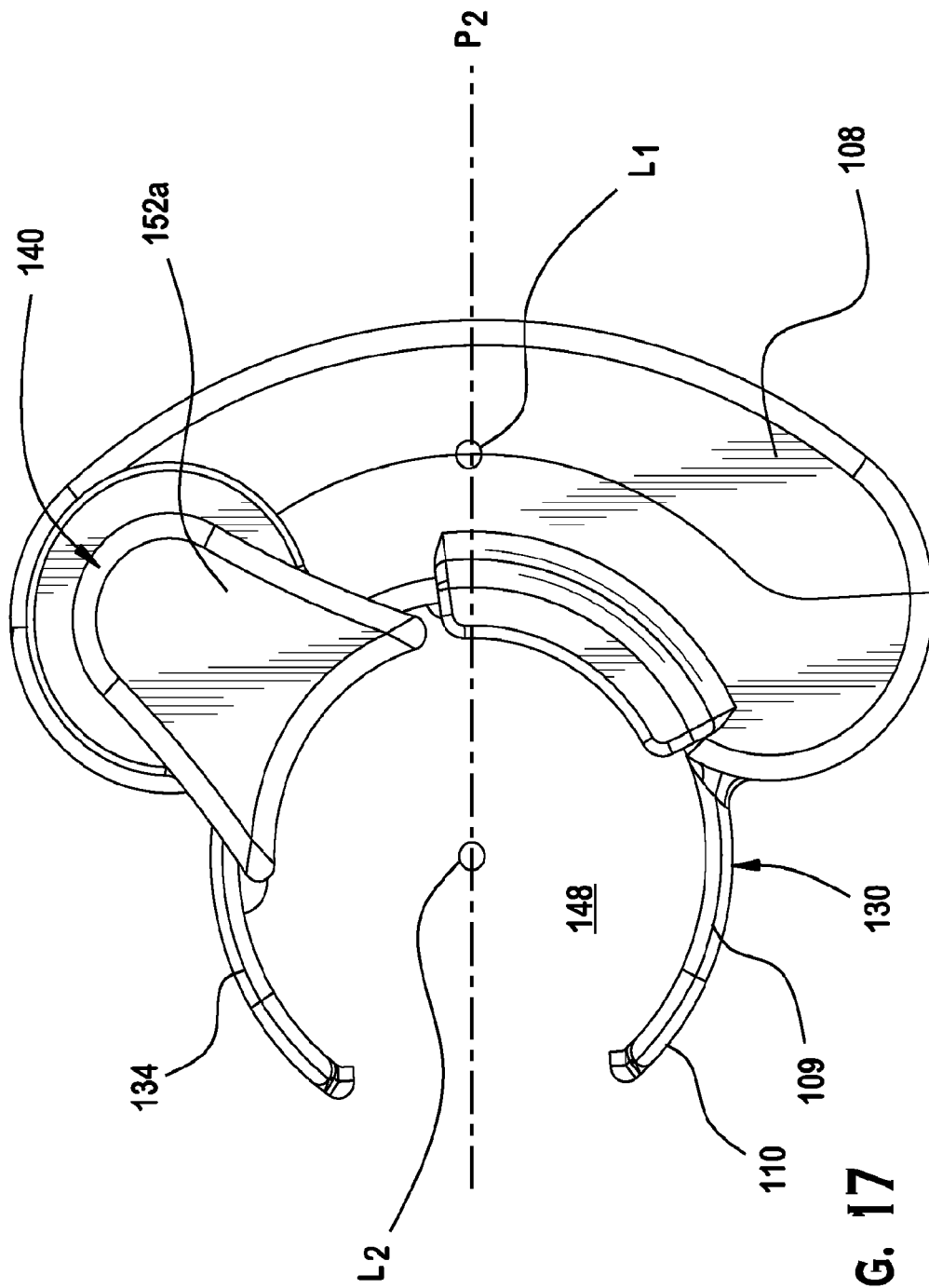


FIG. 17

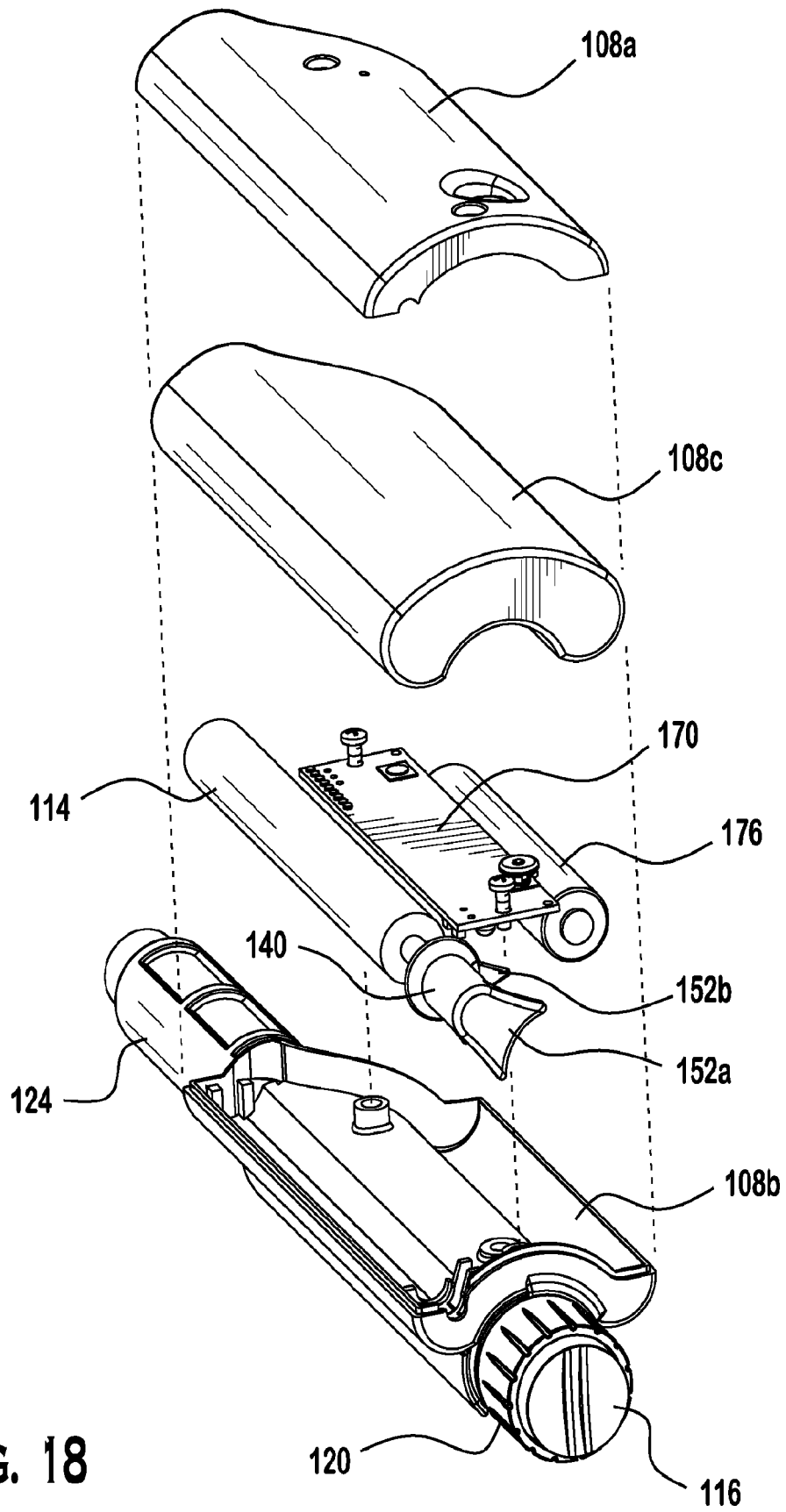


FIG. 18

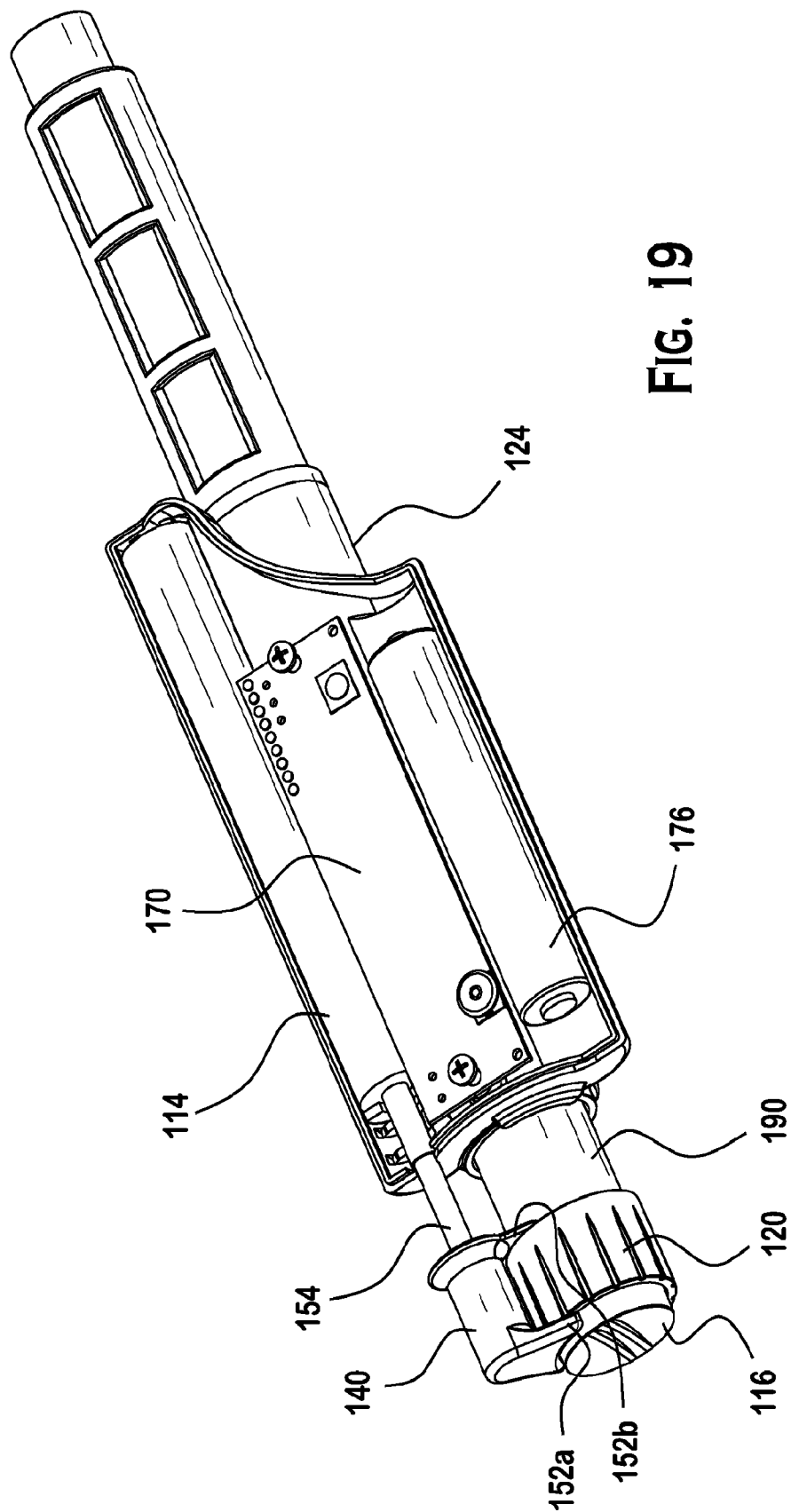


FIG. 19

REFERENCES CITED IN THE DESCRIPTION

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摘要(译)

提供了“智能”药物输送笔的各种实施例，其包括具有惯性传感器或加速计276的药物输送笔。还提供了一种系统，其包括智能药物笔和数据管理单元DMU。药物输送笔还包括瞬时微动开关267，其中按下注射旋钮204激活瞬时开关以将装置从睡眠模式唤醒。此外，微动开关的致动持续时间提供了剂量是否已被准确递送的指示

