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### (54) FIRE CONTROL SYSTEM WITH INTEGRATED REFLEX SIGHT

(57) The present disclosure relates to the field of weapon accessories and, in particular, to an improved accessory device that integrates a fire control system and a reflex sight. The integrated fire control system

and a reflex sight can advantageously be used in connection with a grenade launcher, although it will be recognized that use with other weapon and munition types are also contemplated

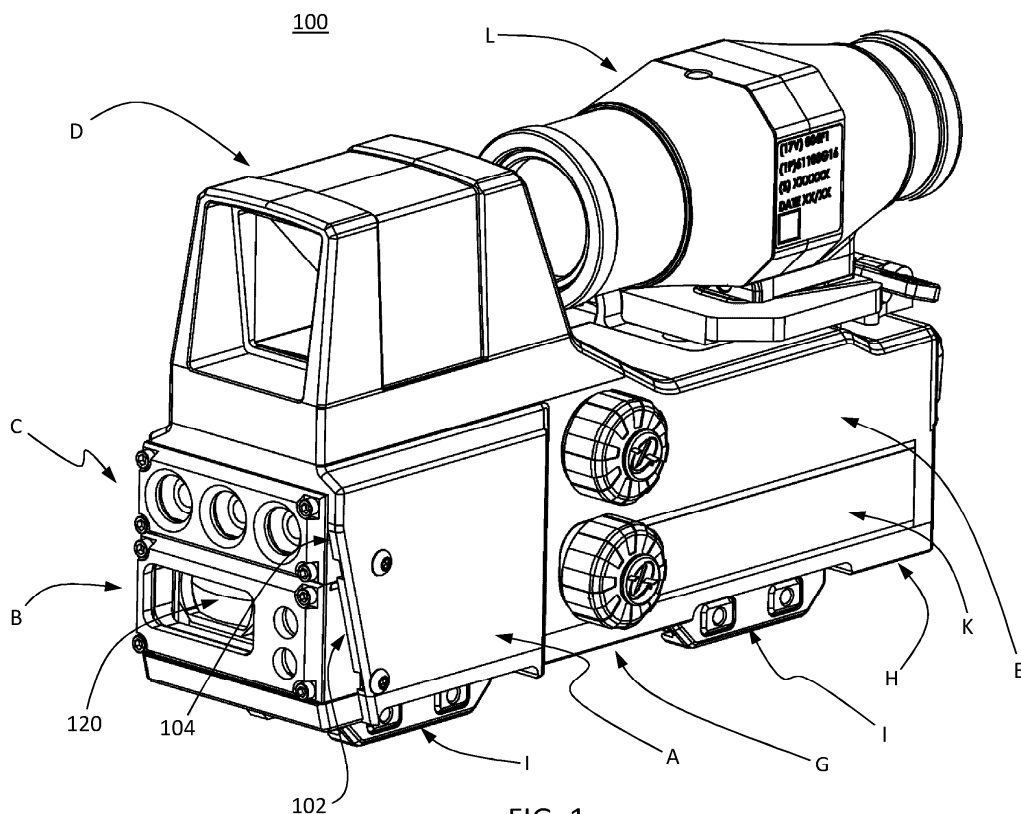


FIG. 1

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## Description

### CROSS REFERENCE TO RELATED APPLICATION

**[0001]** This application claims the priority benefit of U.S. Provisional Patent Application No. 63/771,463 filed March 13, 2025.

### BACKGROUND

**[0002]** The present disclosure relates to the field of weapon accessories and, in particular, to an improved accessory device that integrates a fire control system and a reflex sight. The integrated fire control system and a reflex sight can advantageously be used in connection with a grenade launcher, although it will be recognized that use with other weapon and munition types are also contemplated.

**[0003]** The integrated fire control system of the present disclosure is combined with an active smart reflex sight, a suite of calibrated cameras set to 3 different distances, a laser range finder managed by a visual augmentation processor, a ballistic computer, a sensor suite, and round programmer, and can be advantageously be used on grenade launcher and a large bore rifle designed to fire air busting ammunition to defeat targets hiding behind obstacles or to counter kamikaze drones because of the versatility of the present design. Because the components are modular, the presently disclosed system can easily be reconfigured based on mission-specific requirements or upgraded as technology advances.

**[0004]** In one aspect, a fire control system having an integral reflex sight comprising a modular enclosure having a housing and a laser range finder module disposed inside the modular enclosure. A camera module is disposed inside the modular enclosure and a reflex sight assembly is disposed on an exterior surface of the modular enclosure. An optical magnifier is coupled to an exterior surface of the housing. A processing system is disposed within the housing and includes at least one processor and memory storing executable instructions.

**[0005]** In a more limited aspect, the modular enclosure defines a first receptacle configured to receive the laser range finder module and a second receptacle configured to receive the camera module.

**[0006]** In another more limited aspect, the reflex sight assembly further includes a display and at least one optical element in communication, wherein the display is configured to display a display output.

**[0007]** In another more limited aspect, the camera module further comprises a plurality of camera assemblies.

**[0008]** In another more limited aspect, the plurality of camera assemblies include at least first, second, and third camera assemblies configured for short-range, intermediate-range, and long-range imaging, respectively.

**[0009]** In another more limited aspect, the processing system is configured to selectively switch between the plurality of camera assemblies to maintain a substantially full field of view on the display.

**[0010]** In another more limited aspect, the laser range module further comprises at least one optical emitter configured to emit a pulsed optical signal toward a target, and an optical receiver configured to detect a return signal reflected from the target.

**[0011]** In another more limited aspect, the integral reflex sight further comprises a pivot assembly coupled to the housing, wherein the optical magnifier is removably coupled to the pivot assembly and movable between a deployed position and a stowed position. When the optical magnifier is in the deployed position, an optical axis of the optical magnifier is in optical alignment with an optical axis of the reflex sight assembly and when the optical magnifier is in the stowed position, the optical axis of the optical magnifier is out of optical alignment with the optical axis of the reflex sight assembly.

**[0012]** In another more limited aspect, the integral reflex sight further comprises a switch assembly configured to detect whether the optical magnifier is in the deployed position or the stowed position.

**[0013]** In another more limited aspect, the processor is configured to modify the display output based on a detected position of the optical magnifier.

**[0014]** In another more limited aspect, the integral reflex sight further comprises at least one rail clamp assembly coupled to the housing, wherein the at least one rail clamp assembly is configured to detachably couple the integral reflex sight to a rail interface.

**[0015]** In another more limited aspect, the integral reflex sight further comprises a wireless communication interface, such as a wireless (e.g., radio frequency (RF)) transceiver, configured to exchange data and communication with at least one external device.

**[0016]** In another more limited aspect, the integral reflex sight further comprises at least one battery disposed in the housing.

**[0017]** In another more limited aspect, the processing system is configured to receive range data from the laser range module and calculate a distance to target based on the range data, select one of the plurality of camera assemblies based at least in part on the range data, and generate display output including an electronic reticle having a position adjusted according to a ballistic solution, and provide the display output for presentation on the display.

**[0018]** In another more limited aspect, the integral reflex sight further comprises a connector disposed on the housing and configured to operably couple a payload programming remote control unit.

**[0019]** In another more limited aspect, the payload programming remote control unit is configured to transmit programming information for setting a detonation distance of a programmable munition.

**[0020]** In another more limited aspect, the processing system is configured to set an initial detonation distance based on a distance determined by the laser range finder module and to permit incremental adjustment of the detonation distance via inputs received from the payload programming remote control unit.

**[0021]** In another more limited aspect, the reflex sight assembly further comprises a front mechanical sight and a rear mechanical sight.

**[0022]** In another more limited aspect, each of the front mechanical sight and the rear mechanical sight are pivotably coupled to a reflex sight housing of the reflex sight assembly and are configured to move between a deployed position configured for use as an aiming reference and a stowed position wherein the front mechanical sight and the rear mechanical sight are substantially out of a field of view of the reflex sight assembly.

**[0023]** In another more limited aspect, the front mechanical sight and the rear mechanical sight are manually movable to the deployed position to provide a back-up aiming mechanism when electronic display functionality is unavailable.

**[0024]** Various advantages and benefits of the present development will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0025]** The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating preferred embodiments and are not to be construed as limiting the invention.

FIG. 1 is an isometric view of a fire control system with integral reflex sight in accordance with an exemplary embodiment of the present disclosure, taken generally from the front and left side.

FIG. 2 is an isometric view of the fire control system with integral reflex sight appearing in FIG. 1, taken generally from the rear and right side.

FIG. 3 is a view of an exemplary menu-based user interface for navigating reflex sight settings, which is configured to be output to a display which is viewable through the reflex sight, as well as a reticle adjust mode for manually adjusting the weapon zero of the disturbed reticle.

FIG. 4 is an isometric view of the fire control system with integral reflex sight appearing in FIG. 1, taken generally from the front, left side, and above.

FIG. 5 is a right side view of the fire control system with integral reflex sight appearing in FIG. 1.

FIG. 6 is a front view of the fire control system with integral reflex sight appearing in FIG. 1.

FIG. 7 is a right side view of the fire control system with integral reflex sight appearing in FIG. 1.

FIG. 8 is an isometric view of the fire control system with integral reflex sight appearing in FIG. 1, taken generally from the rear and left side, showing the magnifier in the deployed position.

FIG. 9 is an isometric view of the fire control system with integral reflex sight appearing in FIG. 1, taken generally from the rear and left side, showing the magnifier in the stowed position.

FIG. 10 is an isometric view of the fire control system with integral reflex sight appearing in FIG. 1, taken generally from the rear and left side, with the magnifier removed.

FIG. 11 is a partially exploded isometric view of the fire control system with integral reflex sight appearing in FIG. 1.

FIG. 12 is a side cross sectional view of the fire control system with integral reflex sight appearing in FIG. 1.

FIG. 13 is an electrical block diagram of the fire control system with integral reflex sight appearing in FIG. 1.

FIG. 14 is an enlarged isometric view of the visual augmentation module.

FIG. 15 is an exploded isometric view of the visual augmentation module.

FIG. 16 is an enlarged isometric view of the laser rangefinder module.

FIG. 17 is an exploded isometric view of the laser rangefinder module.

FIG. 18 is an enlarged isometric view of the camera module.

FIG. 19 is an exploded isometric view of the camera module.

FIGS 1A-19A depict a fire control system with integral reflex sight in accordance with a second exemplary embodiment which are the same as described by way of reference to FIGS. 1-19, except as stated otherwise herein.

FIGS 20 and 21 are isometric views of a fire control system with integral reflex sight in accordance with a third exemplary embodiment having front and rear mechanical sights (iron sights) which may be used as a back sight in the event of malfunction of loss of battery power. The embodiment appearing in FIGS 20 and 21 may otherwise be as described herein by way of reference to the embodiment appearing in FIGS. 1-19 and/or the embodiment appearing in FIGS. 1A-19A.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

**[0026]** Reference will now be made in detail to presently preferred embodiments of the invention, one or more examples of which are illustrated in the accompanying drawings. Each example is provided by way of

explanation of the invention, not limitation of the invention, which may be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present inventive concept in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting but rather to provide an understandable description of the present development. In fact, it will be apparent to those skilled in the art that modifications and variations can be made in the present invention without departing from the scope or spirit thereof. For instance, features illustrated or described as part of one embodiment may be used on another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

**[0027]** The terms "a" or "an," as used herein, are defined as one or more than one. The term "another," as used herein, is defined as at least a second or more. The terms "including" and/or "having" as used herein, are defined as comprising (i.e., open transition). The term "coupled" or "operatively coupled," as used herein, is defined as indirectly or directly connected.

**[0028]** As used in this application, the terms "front," "rear," "upper," "lower," "upwardly," "downwardly," "left," "right," and other orientation descriptors are intended to facilitate the description of the exemplary embodiment(s) of the present invention, and are not intended to limit the structure thereof to any particular position or orientation.

**[0029]** All numbers herein are assumed to be modified by the term "about," unless stated otherwise. The recitation of numerical ranges by endpoints includes all numbers subsumed within that range (e.g., 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5).

**[0030]** Referring now to the drawing FIGS. 1-10, there is shown a fire control system with integral reflex sight **100** which includes a modular enclosure **A** which receives a laser range finder module **B** and a camera module **C**. A reflex sight assembly **D** is disposed on the modular enclosure **A**. A main housing **E** defines a main interior compartment **F** (see FIG. 12) and further includes a battery compartment portion **G**. The modular enclosure **A** and main housing **E** are closed on the bottom by a base plate **H**. The base plate **H** includes one or more, e.g., 2, rail clamp assemblies **I** configured to detachably secure the unit **100** to a weapon rail interface (not shown), such as a Picatinny rail interface (e.g., MIL-STD 1913 rail or NATO or STANAG equivalent) (not shown). The base plate **H** is secured to the main housing **E** via threaded fasteners **116** passing through clearance opening **118** and threadably engaging aligned tapped openings (not shown) in the main housing **E**.

**[0031]** The modular enclosure **A** includes a first receptacle or bay **102** configured to receive the laser range finder module **B**. In embodiments, the dimensions, electrical connection points, and the like of the bay **102** are specified in an associated interface control document (ICD), e.g., to allow for future upgrades, ease of repair, or exchanging with other laser range finder modules.

**[0032]** The modular enclosure **A** includes a second receptacle or bay **104** configured to receive the camera module **C**. In embodiments, the dimensions, electrical connection points, and the like of the bay **104** are specified in an associated interface control document (ICD), e.g., to allow for future upgrades, ease of repair, or exchanging with other camera modules.

**[0033]** The bays **102**, **104** may be separated by a partition, or alternatively, the bays **102**, **104** may be unpartitioned or contiguous, allowing for flexible configurations. A sealed connector **112** (see FIG. 17) on the back of the laser range finder module **B** makes electrical contact on the rear wall of the bay **102** to pass power to the unit **B** and data to and from the unit **B**. A sealed connector **114** (see FIG. 19) on the back of the camera module **C** makes electrical contact on the rear wall of the bay **104** to pass power to the unit **C** and data to and from the unit **C**.

**[0034]** The main housing **E** receives a main control board or motherboard **J** (see FIG. 12). The main housing board includes a processor and associated memory configured to execute an executable program of instructions. The main housing **E** also receives a visual processing module or visual augmentation module **K**. In embodiments, the visual processing module **K** is configured as a modular unit. In embodiments, the dimensions, electrical connection points, and the like of the visual processing module **K** are specified in an associated interface control document (ICD), e.g., to allow for future upgrades or exchanging with other visual processing modules. The visual processing module **K** is sandwiched between the base plate **H** and the motherboard **J**.

**[0035]** As used herein, the term "processor" refers to any one or more processing devices configured to perform described functions. A processor may include a signal processing unit or multiple processing components operating together, whether integrated on a common substrate or distributed across multiple hardware elements. For example, in some embodiments a processor may include a main processor and one or more specialized processing modules, e.g., the visual processing module **K**. The described functional modules need not correspond to physically distinct hardware components, and in the illustrated arrangement is provided for explanatory purposes only. It will be recognized that the executable instructions may be implemented in hardware, software, firmware, or any combination thereof.

**[0036]** Housed together with the main control board **J**

is a sensor suite comprising a plurality of sensors, including but not limited to a barometric pressure sensor, a temperature sensor, a humidity sensor, an inclinometer, such as a 2 or three axis accelerometer, Bluetooth or other RF communications interface, ballistics calculator, and the like.

[0037] As best seen in FIGS. 14 and 15, the visual processing or augmentation module

[0038] As best seen in FIG 11, the laser range finder module **B** and the camera module **C** are configured to slide into the respective bays **102**, **104**. In embodiments, the modules **B** and **C** are secured in place by threaded fasteners **106** passing through clearance openings **108** in the modular enclosure **A** and threadably engaging aligned openings **110** in the modules **B** and **C**.

[0039] The laser range finder module **B** includes an optical transmitter/receiver pair **120** configured to emit an optical signal, such as a pulse encoded signal, and sense a return signal reflected from a target, wherein a distance to the target is calculated based on the time of flight of the emitted signal and the return signal, as would be understood by persons skilled in the art.

[0040] The battery compartment portion **G** includes one or more battery compartments, each configured to receive one or more battery cells **123** (see FIG. 13). Each compartment is covered with a removable battery cap **122**. In embodiments, the battery compartment portion **G** includes two battery compartments. In embodiments, the unit **100** is configured to be powered by one battery at a time, with a second battery compartment being provided to allow for extended run time via manual and/or automatic switchover when the cell in one compartment is depleted.

[0041] The camera module **C** includes a plurality (three in the embodiment illustrated) of camera assemblies **124**. In embodiments each camera assembly is prefocused to a predetermined distance. For example, in embodiments, the camera module **C** includes three camera assemblies which are pre-focused to varying distances, e.g., 100 m, 250 m, and 500 m. In embodiments, the camera assemblies **124** may be miniature camera modules of the type used in mobile devices which comprise an image sensor (e.g., CMOS, CCD, or near infrared (NIR) sensor, or the like) and a lens assembly. In embodiments, the camera assemblies **124** also have different focal lengths, e.g., wherein the 100 m camera has a wider field of view/lower magnification, the 250 m camera has an intermediate field of view/lower magnification and the 500 m camera has a narrower field of view/higher magnification.

[0042] An optical magnifier/multiplier **L** is detachably coupled to a pivot assembly **M** (see FIG. 10) which, in turn, is coupled to the upper surface of the main housing **E**. The pivot assembly **M** includes a base **126** which is secured to the upper surface of the main housing **E**. A mounting shoe fastening arm **128** is pivotally coupled to the base **126** via a hinge assembly **130**. The mount-

ing shoe fastening arm **128** includes a fastening element **132**, such as a dovetail shoe receptacle or the like. The fastening element **132** detachably receives complementary fastening element **133** (see FIG. 12) such as a dovetail shoe. The hinge assembly defines a pivot axis **134** which extends in a direction parallel to a long axis of the unit **100** and parallel to an optical axis **136** of the optical magnifier **L**. In embodiments, the optical magnifier **L** has a magnification in the range of 4x to 10x, preferably 6x. In this manner, the operator can selectively pivot the magnifier **L** to the deployed position wherein the optical axis **136** of the magnifier **L** is in optical alignment with an optical axis **138** of the reflex sight module **D**, e.g., when it is desired to view a magnified image of the view through the reflex sight, e.g., for extended viewing/targeting range. Alternately, the operator can selectively pivot the magnifier **L** to the stowed position wherein the optical axis **136** of the magnifier **L** is out of optical alignment with the optical axis **138** of the reflex sight module **D**, e.g., when it is desired to view targeted scene through the reflex sight directly. For example, stowing the magnifier **L** allows the operator to use the reflex sight directly which may make it easier to engage a target in certain situations, such as when attempting to engage a target in flight, such as a drone or other unmanned aerial vehicle. The pivoting movement between the deployed and stowed position is indicated by the arrow **137** appearing in FIG. 8.

[0043] In embodiments, a latch assembly **140** is configured to releasably secure the fastening arm **128** in the stowed position. In embodiments, a switch assembly **142** is provided for sensing whether the magnifier **L** is in the stowed or deployed position, as will be described in further detail below. The switch assembly **142** is operably coupled to processing electronics on the main control board **J**. Alternately, the position of the magnifier may be determined using a proximity sensor. For example, the magnifier **L** or the mounting shoe fastening arm **128** may carry a magnet and a proximity sensor such as a Hall effect sensor or a magnetic reed switch may be disposed in the housing **E** such that an output signal is generated when the magnifier **L** is in the stowed position.

[0044] For example, as shown in FIG. 7B, which is equally applicable to the embodiments appearing in FIGS. 1-19, the sensor **142** may be a proximity sensor such as a Hall effect sensor or a magnetic reed switch. A magnet **143** is carried on the arm **128** so that the magnet **123** is in proximity with the proximity sensor switch **142** when the magnifier **L** is in the deployed position and is moved out of proximity with the switch **142** when the magnifier **L** is pivoted to the stowed position. Alternately, the switch **142** can be a mechanical switch incorporating a spring biased actuator as would be understood by persons skilled in the art. In either case, the switch **142** is operably coupled to processing circuitry on the main control board **J**, which monitors

the switch state by detecting its open or closed condition and thereby sensing the position of the magnifier **L**.

**[0045]** In embodiments, the hinge assembly is separable or detachable to that the magnifier **L** can be completely removed from the fastening arm **128** when it is not desired to use the magnifier **L**, as shown in FIG. 10.

**[0046]** The main housing **E** has a height **144** which is configured to allow the unit **100** to function as a riser to provide increased height between the rail the sight than conventional systems. This provides a better "cheek well" or "sight plan" when looking through the reflex sight and is particularly advantageous for an operator wearing bulky equipment such as a night vision goggles, gas mask or other nuclear, biological, and chemical (NBC) or chemical, biological, radiological, and nuclear (CBRN) equipment. This is in contrast to conventional systems wherein a user wearing such equipment may be required to position their head in an awkward in order to look through the sight.

**[0047]** As best seen in FIG. 12, the reflex sight module **D** includes a reflex sight housing **146** which houses a digital display **148** and one or more optical elements designated generally as **149**, including one or more prisms, wedges, lenses, waveguides, and/or other reflective, refractive, and/or diffractive optical elements configured direct images from the display **148** to the eye of the operator. In embodiments, the one or more optical elements includes a beam combiner **150** or similar optical element such as a partially reflective mirror, dichroic mirror, or the like, or a waveguide which is configured to reflect a portion of the rays from the display **148** to the user's eye while also being sufficiently transparent to permit rays from the targeted scene to pass therethrough to provide a direct view of targeted scene. In this manner, the output of the display **148** is superimposed onto the operator's view of the targeted scene. The display **148** is in operable communication with display driver electronics associated with the visual processing module **K**.

**[0048]** In embodiments the display **148** is configured to display a video image acquired by one of the camera modules **124**. In embodiments, the range to target distance as determined by the laser range finder **B** is used by the processing electronics on the main control board **J**, which may be implemented in hardware, software, firmware, or any combination thereof, to activate which ever camera is needed to provide a full field of view of the imaged scene in the digital display **148**.

**[0049]** In embodiments, when the optical magnifier **L** is in the stowed position the display output of the digital display **148** as detected by the sensor **142**, the output of the digital display is changed to match the optical power of the magnifier **L**. The change in output of the digital display may be accomplished by camera selection of the appropriate camera in the camera module **C**, a digital zoom function implemented in the video processor module **K**, or a combination thereof.

**[0050]** In embodiments, the output of the display **148**

includes visual indicia such as an electronic reticle **152** (see FIG. 6) and preferably includes a plurality of reticle types including but not limited to one or more types of dot reticles, cross hair reticles, and so forth. In embodiments, the type of reticle is selectable via the on board menu system. In embodiments, the unit **100** and video processing module **K** supports user-configurable reticle styles which can be programmed by the user and wirelessly transmitter to the unit via a wireless (RF) interface **257** (see FIG. 13).

**[0051]** In embodiments, the electronic reticle is a disturbed reticle showing the ballistic solution and point of aim data for a given target, e.g., based on range to target and other ballistic factors. In embodiments, the position of the electronic reticle **152** on the display is dynamically adjusted based on a ballistic solution calculated based on range and/or other ballistic information to improve alignment with the target, thereby enhancing accuracy and increasing the likelihood that the trajectory of a fired projectile will intersect with the position of the target. Other indicia for display using the display **148** include but are not limited to target range indicia based on output of the laser range finder module **B**, current time or mission duration, navigation data, sensor readings, battery status or battery life remaining, environmental data, warnings or alerts, data pertaining to situational awareness information, and other mission-relevant information.

**[0052]** In certain embodiments, the wireless communication interface **257** is configured to interface the unit **100** with one other accessory devices (or a network of devices) for data exchange and communication. In embodiments, the wireless communication interface **257** is configured to connect wirelessly with a central hub or controller which, in turn, interfaces with one or wired devices coupled to the central hub or controlled through a wired connection, for example, a USB-C connection, thereby enabling data transmission and communication between the devices. In embodiments, the central hub or controller is a body worn device configured to attach to a back pack, tactical vest, or other garment of accessory worn by the user. In embodiments, the central hub or controller is a helmet worn device. In embodiments, the helmet worn device is configured to bridge or link various components in a helmet mounting system or helmet mount assembly. In embodiments, the helmet worn device is configured to bridge or link various components in a helmet mounting system or helmet mount assembly via a wired connection. In embodiments, the helmet worn device is configured to bridge or link various components in a helmet mounting system or helmet mount assembly via a wireless connection. In embodiments, the helmet worn device is configured to bridge or link various components in a helmet mounting system or helmet mount assembly via a combination of wired and wireless connections.

**[0053]** In certain embodiments, the wireless communication interface **257** is configured to establish a mesh

network connection with a plurality of devices in a mesh network. The plurality of devices may be helmet borne devices, weapon borne devices, body worn devices, end user devices such as a mobile phone (e.g., smart phone), smart watch, or other mobile device. In embodiments the wireless interface includes a 5G chip set configured for mesh connectivity with a 5G mesh network. It will be recognized that other communication standards, such as Wi-Fi, Bluetooth, 4G/LTE, or similar technologies, may also be employed to embody the present development without departing from its scope.

**[0054]** In embodiments, the wireless communication interface **257** is configured to wirelessly connect with an intra-soldier wireless (ISW) communication system, wireless sensor network (WSN), intra-wearable communication system (IWCS), integrated tactical networks (ITN) or future soldier systems (FSS), battlefield tactical automated communications (BTAC) or other soldier systems, tactical networks, or wearable communication systems for providing data transfer and communication equipment, soldiers, units, and/or command centers.

**[0055]** In embodiments, the central hub or controller is a helmet worn device configured to attach to a back pack, tactical vest, or other garment of accessory worn by the user.

**[0056]** As best seen in FIG. 5, the illustrated embodiment includes a battery selector switch or lever **154** disposed on a side of the main housing **E** for manually switching between the batteries in first and second battery compartments in the battery compartment portion **G**. The side of the main housing **E** also includes a keypad comprising a plurality of keys or buttons for navigating a user interface displayed on the display **148**. In the illustrated embodiment, as shown in FIGS. 3A and 3B, the user interface is a menu-based user interface. In the illustrated embodiment, the navigation keys or buttons of the keypad region include down and up directional arrow buttons **156** and **158**, respectively, a select button **160**, and left and right directional arrow buttons **162** and **164**, respectively.

**[0057]** For example, in one exemplary implementation as shown in FIG. 3, the user interface is a hierarchical menu-based user interface wherein the arrow buttons **156**, **158**, **162**, **164** are configured to progress through a plurality of menu items, e.g., **168a-168c** in the screen shot depicted on the left side. In embodiments, the menu item **168a** allows the user to navigate to a plurality of user selectable reticle settings or shapes. The menu item **168b** allows the user to navigate to a reticle adjustment interface as discussed below. The menu item **168c** allows the user to navigate to a menu system for adjusting one or more system settings.

**[0058]** In embodiments, the square button **160** is configured to enter a menu by selecting and holding for a preprogrammed period of time. In embodiments, a single quick press of the square button **160** is configured to select a menu item. In embodiments, when an

item is selected, the arrow keys may be used to adjust a setting. It will be recognized that other configurations are contemplated, including configuration involving multiple presses such as double press, etc., multiple long press durations, e.g., 2 seconds, 3 seconds, 5 seconds, etc.

**[0059]** Still referring to FIG. 3, the screen shot appearing on the right side depicts a reticle adjustment mode (e.g., by selecting the menu item **168b** on the left side screen shot appearing in FIG. 3) wherein the arrow buttons **156**, **158**, **162**, **164** may be used to zero the position of the disturbed reticle **152** to an on-screen position wherein the reticle position is aligned with actual shot placement at a specified range **172**.

**[0060]** As can be seen in FIG. 2, a secondary display screen **174** is disposed on the rearward facing end of the main housing **E**. The secondary display **174** may be utilized to display additional information such as whether a round is detected in the chamber or other information. The secondary display **174** may be an LED display, LCD display, OLED display, or the like. In embodiments, a hood or visor **176** extends at least partially around the secondary display **174** to reduce ambient light interference and enhance user visibility, and/or limit to external light leakage to prevent detection in low-light conditions.

**[0061]** Referring now to FIGS. 14 and 15, the visual processing/augmentation module **K** includes a housing shell **180** which cooperates with a bottom cover **182** to define an enclosure. The bottom cover **182** is secured to the housing shell **180** with threaded fasteners **184** which pass through clearance openings **186** in the bottom cover **182** and engage complementary openings in the housing shell **180**. One or more circuit boards **188** comprising video processing and driver electronics are stacked within the enclosure. A sealed electronic connector **190** passes through an opening **192** in the housing shell **180** and is configured to operably couple the module **K** to the main control board **J**. In embodiments, the dimensions, electrical connection points, and the like of the unit **K** are specified in an associated interface control document (ICD), e.g., to allow for future upgrades, ease of repair, or exchanging with other laser range finder modules.

**[0062]** Referring now to FIGS. 16 and 17, the laser range finder module **B** includes a housing shell **194** which cooperates with a top cover **196** to define an enclosure. The top cover **196** is secured to the housing shell **194** with threaded fasteners **196** which pass through clearance openings **198** in the top cover **196** and engage complementary openings **200** in the housing shell **194**. The front wall of the housing shell **194** includes emitter apertures **202** and a receiver aperture **204** which are covered by a window **206** which is transparent with respect to the emitted wavelength. A window cover or bezel **208** secures the window cover to the housing **194**. The window cover **208** includes emitter apertures **210** aligned with the apertures **202** and an

aperture **212** aligned with the aperture **204**. The window cover **208** is secured via threaded fasteners **214** passing through clearance openings **216** and threadably engaging threaded openings **218** in the front wall of the housing **194**.

**[0063]** A laser ranger finder assembly **220** is mounted within the housing **194**. The sealed electronic connector **112** passes through an opening **222** in the housing shell **194** and is configured to operably couple the module **B** to the main control board **J**. The laser range finder module **220** includes one or more emitters, e.g., laser diode packages **224**, and an optical receiver **226** assembly, which may be coaligned on an optical bench. Opposing slide rails **228** are disposed on the sides of the housing **194** and are configured to ensure proper alignment of the module **B** when it is inserted and removed from the bay receptacle **102**.

**[0064]** Referring now to FIGS. 18 and 19, the camera module **C** includes a housing shell **230** which cooperates with a top cover **232** to define an enclosure. The top cover **232** is secured to the housing shell **230** with threaded fasteners **234** which pass through clearance openings **236** in the top cover **232** and engage complementary openings **238** in the housing shell **230**. The front wall of the housing shell **230** includes three apertures **240** which are covered by a window **242**. A window cover or bezel **244** secures the window cover to the housing **230**. The window cover **244** includes apertures **246** aligned with the apertures **240**. The window cover **244** is secured via threaded fasteners **248** passing through clearance openings **250** and threadably engaging threaded openings **252** in the front wall of the housing **230**.

**[0065]** Three mini camera assemblies **124**, each comprising a lens assembly and a sensor array, are mounted on a circuit board **254** secured within the housing **230**. In the illustrated embodiment, a second camera circuit board **256** is secured via mounting bosses **258** and threaded fasteners (not shown). The second camera circuit board **256** may include digital signal processing electronics power distribution, wireless communication interface electronics (e.g., a Bluetooth interface) **257**, and so forth.

**[0066]** The sealed electronic connector **114** passes through an opening **260** in the housing shell **230** and is configured to operably couple the module **C** to the main control board **J**. Opposing slide rails **262** are disposed on the sides of the housing **230** and are configured to ensure proper alignment of the module **B** when it is inserted and removed from the bay receptacle **102**.

**[0067]** Referring now to FIGS. 1A-19A, there is shown a second embodiment's fire control system with integral reflex sight **100'**. The above description of the fire control system with integral reflex sight **100** in reference to FIGS. 1-19 is equally applicable to FIGS. 1A-19A, which description is incorporated by reference here, except as specifically stated otherwise herein.

**[0068]** FIG. 1A is an isometric view the fire control

system with integral reflex sight **100'**, taken generally from the front and left side. The unit **100'** differs from the unit **100** described above in that it further includes a connector assembly including a connector housing **271** (left side in the illustrated embodiment) having a connector **270** which is configured to receive a System A payload programming remote control unit **272** for sending program information to the weapon to determine the distance at which the round will air-burst. The remote control unit **272** includes a cable **274** having a connector end **276** which engages with the connector **270**. In embodiments, the connectors **270**, **276** are shown as complementary circular connectors, e.g., Fischer style connectors such as a 3 pin or 4 pin Fischer style connectors, although other connector types are also contemplated. It will be recognized that although a left side connector **270** receiving programming remote control is illustrated, right handed and ambidextrous embodiments are also contemplated.

**[0069]** In certain embodiments the remote control unit **272** includes a plurality of push buttons **275a-275d**. In the illustrated embodiment, the button **275a** is configured to actuate the laser range finder module **B** to initiate ranging to determine the distance to the target for calculating a ballistic solution. The button **275b** is configured to program a programmable airburst round. The buttons **275c** and **275d** are configured such that each button press increments the distance at which the airburst round will detonate up or down, respectively, by a preselected incremental distance, such as in 1 meter increments. In embodiments, the programmed detonation distance is overlaid on the display **148** and/or displayed on the secondary display **174**.

**[0070]** In one programming mode, the detonation distance for programming a programmable round is set initially by default to the target distance as calculated by the laser range finder module **B**. The detonation distance can then be increased or decreased in increments such as 1 meter to be greater or less than the calculated distance. For example, in the case of an enemy target which is hiding behind cover, the operator can program the airburst round to detonate at a distance just beyond the target (i.e., further past the enemy's position) so that the round bursts above or past the cover, thereby releasing shrapnel or fragmentation in a way that maximizes the impact on the enemy, even if they are shielded behind an object.

**[0071]** In another programming mode, the detonation distance for programming a programmable round is incremented based on the firing position of the operator using the buttons **275c** and **275d**. In embodiments, to streamline programming in this alternative mode, a hold the buttons **275c** and **275d** may include a hold function where holding the button **275c** or **275d** increases or decreases the value rapidly and/or in larger increments, such as 10 m, 50 m, 100 m, etc.

**[0072]** The unit **100'** also differs from the unit **100** described above in that the battery selector lever **154**

has been moved from the left side to the right side.

**[0073]** FIG. 2A is an isometric view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A, taken generally from the rear and right side.

**[0074]** FIG. 3A is a view of an exemplary menu-based user interface for navigating reflex sight settings, which interface is configured to be output to a display which is viewable through the reflex sight, as well as a reticle adjust mode for manually adjusting the weapon zero of the disturbed reticle.

**[0075]** FIG. 4A is an isometric view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A, taken generally from the front, left side, and above.

**[0076]** FIG. 5A is a right side view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A. As can be seen in FIG. 5A, the unit **100'** further includes a right side connector **270**, which is as described above by way of reference to the left side connector **270** and is likewise configured to be coupled to the remote control unit **272** as described above.

**[0077]** FIG. 6A is a front view of the fire control system with integral reflex sight appearing **100'** in FIG. 1A.

**[0078]** FIG. 7A is a right side view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A.

**[0079]** FIG. 8A is partial cutaway view illustrating the magnifier position sensor **142**, which may be a switch, magnetic proximity sensor, or the like as described above.

**[0080]** FIG. 9A is an isometric view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A, taken generally from the rear and left side, showing the magnifier in the deployed position.

**[0081]** FIG. 10A is an isometric view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A, taken generally from the rear and left side, showing the magnifier in the stowed position.

**[0082]** FIG. 11A is an isometric view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A, taken generally from the rear and left side, with the magnifier removed. FIG. 11A illustrates a visual processing module **K** which has been adapted to incorporate the connectors **270** but is as otherwise as described above.

**[0083]** FIG. 12A is a partially exploded isometric view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A.

**[0084]** FIG. 13A is a side cross sectional view of the fire control system with integral reflex sight **100'** appearing in FIG. 1A.

**[0085]** FIG. 14A is an enlarged isometric view of the visual augmentation module and illustrates a visual processing module **K** which has been adapted to incorporate the connectors **270**, including cutaway portions **280** in the housing **180**, but is as otherwise as described above.

**[0086]** FIG. 15A is an exploded isometric view of the visual augmentation module **K** which has been adapted

to incorporate the connectors **270** including cutaway portions **280** in the housing **180** but is as otherwise as described above.

**[0087]** FIG. 16A is an enlarged isometric view of the laser rangefinder module, which may be substantially as described above.

**[0088]** FIG. 17A is an exploded isometric view of the laser rangefinder module which may be substantially as described above.

**[0089]** FIG. 18A is an enlarged isometric view of the camera module which may be substantially as described above.

**[0090]** FIG. 19A is an exploded isometric view of the camera module which may be substantially as described above.

**[0091]** Referring now to FIGS. 20 and 21, there is shown a third embodiment fire control system with integral reflex sight **100''** wherein the reflex sight assembly includes an integral front iron (mechanical) sight **282** (see FIG. 20) and an integral rear iron (mechanical) sight **284** (see FIG. 21).

**[0092]** The front sight **282** includes a pivot plate **286** which is pivotally secured to a front surface of the housing of the reflex assembly **D**. The pivot plate **286** is secured in pivotable fashion via a threaded fastener **288** and is pivotable about a pivot axis **292** as indicated by the arrow **293** appearing in FIG. 20. In this manner the front sight **282** can be pivoted between a deployed position as illustrated and a stowed position where it is out of the view through the reflex sight **D** when not in use. A post **290** is coupled to the pivot plate which projects into the field of view of the direct view optics when pivoted to the operable position.

**[0093]** The rear sight **284** includes a rear sight housing **294** having a slot **297** formed therein. A rear sight member **295** includes a post **296** which is coupled at its lower end to a pivot rod **298** and which has a notch or aperture **300** at its upper end. The illustrated embodiment depicts a U-shaped notch, although other configurations are contemplated, such as a V-notch, an aperture or ring, and so forth. The pivot rod **298** passes through an opening in the reflex sight housing and includes a knob **304** at its distal end. The knob **304** is manually rotatable between a deployed position as illustrated and a stowed position where it is out of the field of view of the reflex sight **D** when not in use. During pivoting movement, the post **296** runs in the slot **297** to allow pivoting movement of the rear sight **274** about a pivot axis **302** as indicated by the arrow **304** appearing in FIG. 21. Either or both of the front and rear sights **282**, **284** may have a contrast feature to enhance visibility, e.g., on the post **290** and/or the notch or aperture **300**, which may be, for example, a feature that is painted with a contrasting color, luminescent paint, and so forth.

**[0094]** The inclusion of the iron sights **282**, **284** is advantageous in that it ensures continued aiming accuracy in the event of failure of the fire control system

with integral reflex sight. For example, the unit 100" were to become inoperative, e.g., due to battery depletion, damage, or a failure of the disturbed reticle display hardware or software, the operator could fall back on the iron sights 282, 294, aligning them within the direct-view optics to maintain effective targeting. This redundancy enhances reliability in critical scenarios, allowing for accurate engagement of targets even when the magnified and/or enhanced aiming features of the unit 100" system are compromised.

[0095] While the fire control system with integral reflex sight embodiments 100 and 100' are shown and described above without iron sights, it is contemplated that the iron sights 282, 284 of the unit 100" may also be incorporated into the embodiments 100 and 100'. In particular, the iron sights 282 and 284 appearing in FIGS. 20 and 21 may likewise be integrated into the systems 100 and 100' described above to provide a backup aiming mechanism in the event of failure of the magnified/disturbed sighting system. Such modifications fall within the scope of the present disclosure, and any features described with respect to one embodiment herein may be combined with any other embodiment unless otherwise indicated.

[0096] The invention has been described with reference to the preferred embodiment. Modifications and alterations will occur to others upon a reading and understanding of the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

## Claims

1. A fire control system with an integral reflex sight comprising:

a modular enclosure having a housing;  
a laser range finder module disposed inside the modular enclosure;  
a camera module disposed inside the modular enclosure;  
a reflex sight assembly disposed on an exterior surface of the modular enclosure;  
an optical magnifier coupled to an exterior surface of the housing; and  
a processing system disposed within the housing, the processing system including at least one processor and memory storing executable instructions.

2. The integral reflex sight of claim 1, wherein the modular enclosure defines a first receptacle configured to receive the laser range finder module and a second receptacle configured to receive the camera module.

3. The integral reflex sight of claim 1 or claim 2, wherein the reflex sight assembly further includes a display and at least one optical element in communication, wherein the display is configured to display a display output.
4. The integral reflex sight of any of the preceding claims, wherein the camera module further comprises a plurality of camera assemblies.
5. The integral reflex sight of claim 4, wherein the plurality of camera assemblies include at least first, second, and third camera assemblies configured for short-range, intermediate-range, and long-range imaging, respectively.
6. The integral reflex sight of claim 4 or claim 5, wherein the processing system is configured to selectively switch between the plurality of camera assemblies to maintain a substantially full field of view on the display.
7. The integral reflex sight of any of the preceding claims, the laser range module further comprises at least one optical emitter configured to emit a pulsed optical signal toward a target, and an optical receiver configured to detect a return signal reflected from the target.
8. The integral reflex sight of any of the preceding claims, further comprising:

a pivot assembly coupled to the housing, wherein the optical magnifier is removably coupled to the pivot assembly and movable between a deployed position and a stowed position, and  
wherein in the deployed position an optical axis of the optical magnifier is in optical alignment with an optical axis of the reflex sight assembly, and in the stowed position the optical axis of the optical magnifier is out of optical alignment with the optical axis of the reflex sight assembly.

9. The integral reflex sight of claim 8, further comprising a switch assembly configured to detect whether the optical magnifier is in the deployed position or the stowed position.
10. The integral reflex sight of any of the preceding claims, wherein the display output is modified based on the detected position of the optical magnifier.
11. The integral reflex sight of any of the preceding claims, further comprising at least one rail clamp assembly coupled to the housing, wherein the at

least one rail clamp assembly is configured to detachably couple the integral reflex sight to a rail interface.

12. The integral reflex sight of any of the preceding claims, further comprising a wireless communication interface configured to exchange data and communication with at least one external device. 5
13. The integral reflex sight of any of the preceding claims, further comprising at least one battery disposed in the housing. 10
14. The integral reflex sight of any of the preceding claims, wherein the processing system is configured to: 15
  - receive range data from the laser range module and calculate a distance to target based on the range data; 20
  - select one of the plurality of camera assemblies based at least in part on the range data;
  - generate display output including an electronic reticle having a position adjusted according to a ballistic solution; and 25
  - provide the display output for presentation on the display.
15. The integral reflex sight of any of the preceding claims, further comprising a connector disposed on the housing and configured to operably couple a payload programming remote control unit. 30
16. The integral reflex sight of claim 15, wherein the payload programming remote control unit is configured to transmit programming information for setting a detonation distance of a programmable munition. 35
17. The integral reflex sight of claim 16, wherein the processing system is configured to set an initial detonation distance based on a distance determined by the laser range finder module and to permit incremental adjustment of the detonation distance via inputs received from the remote control unit. 40 45
18. The integral reflex sight of any of the preceding claims, wherein the reflex sight assembly further comprises a front mechanical sight and a rear mechanical sight. 50
19. The integral reflex sight of claim 18, further comprising: 55

each of the front mechanical sight and the rear mechanical sight being pivotably coupled to a reflex sight housing of the reflex sight assembly;

bly; and

each of the front mechanical sight and the rear mechanical sight being configured to move between a deployed position configured for use as an aiming reference and a stowed position wherein the front mechanical sight and the rear mechanical sight are substantially out of a field of view of the reflex sight assembly.

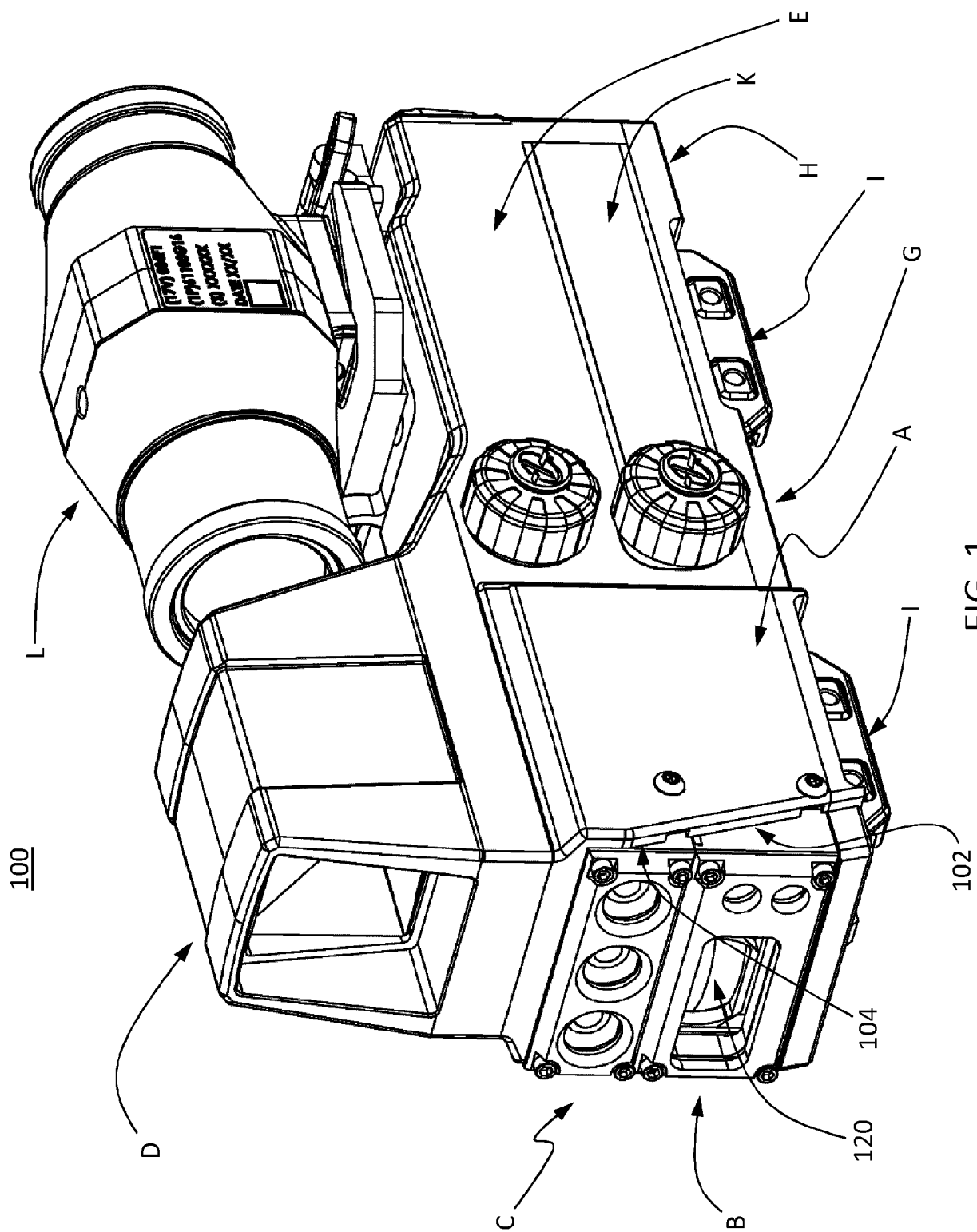


FIG. 1

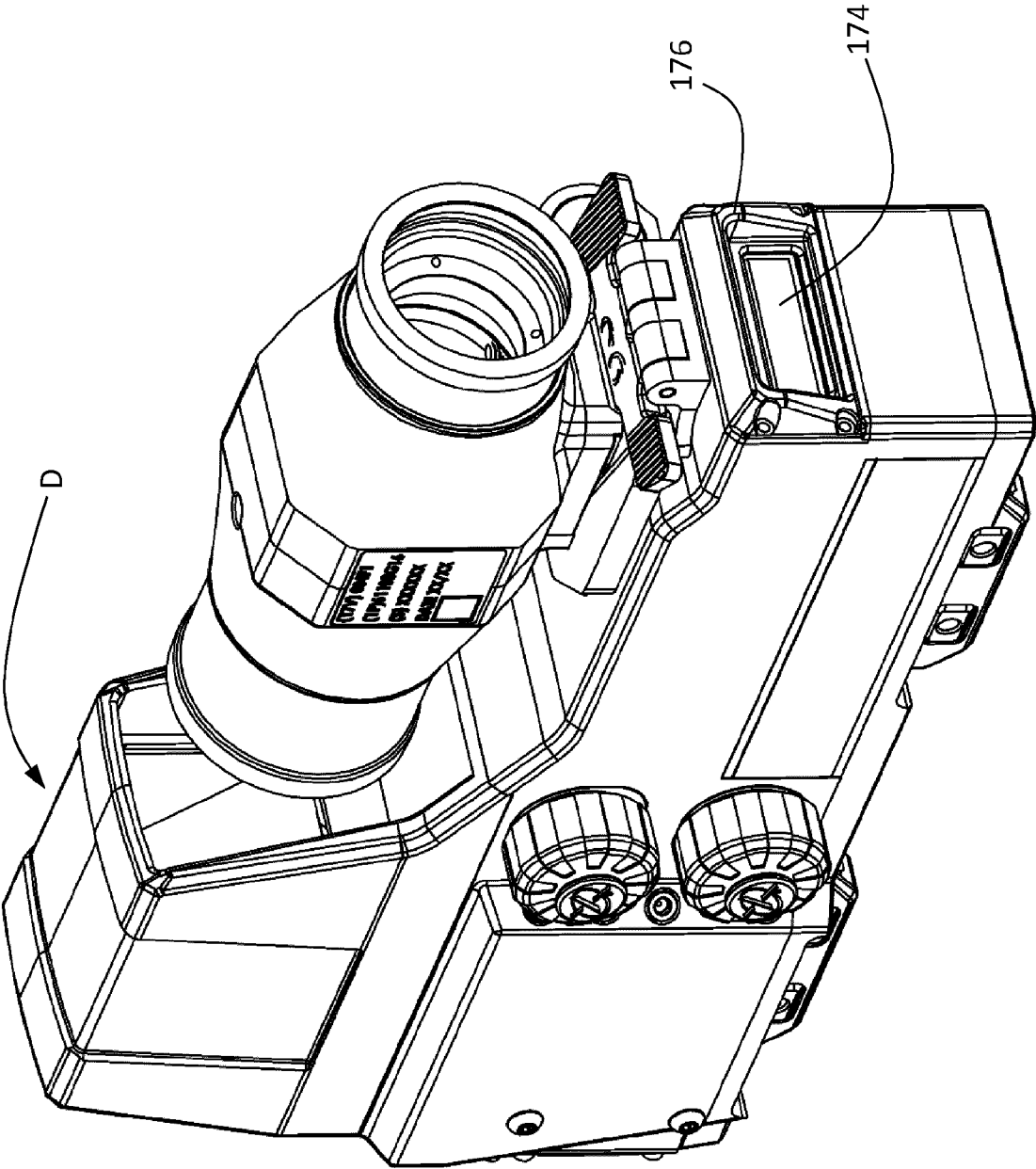


FIG. 2

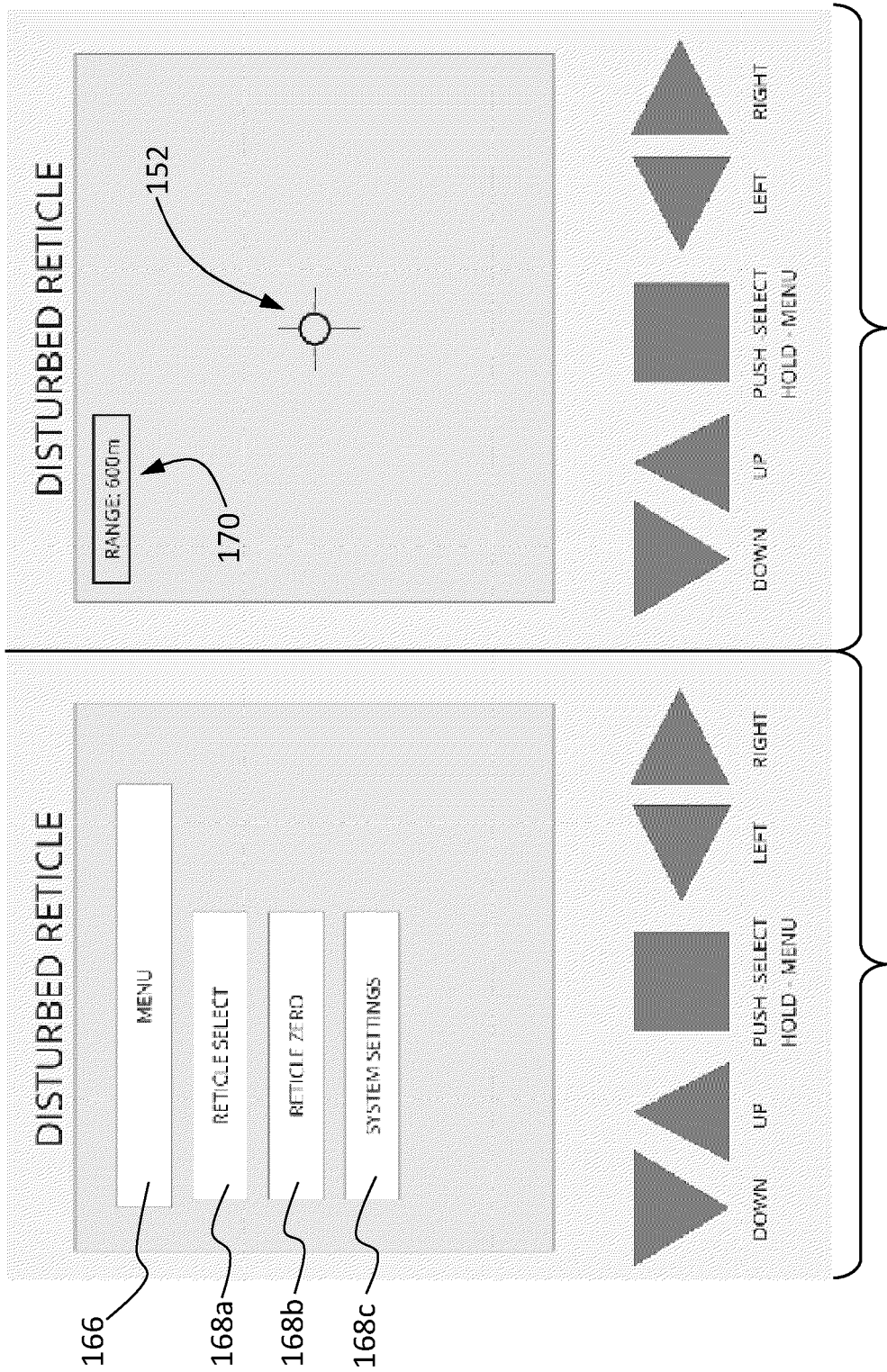


FIG. 3

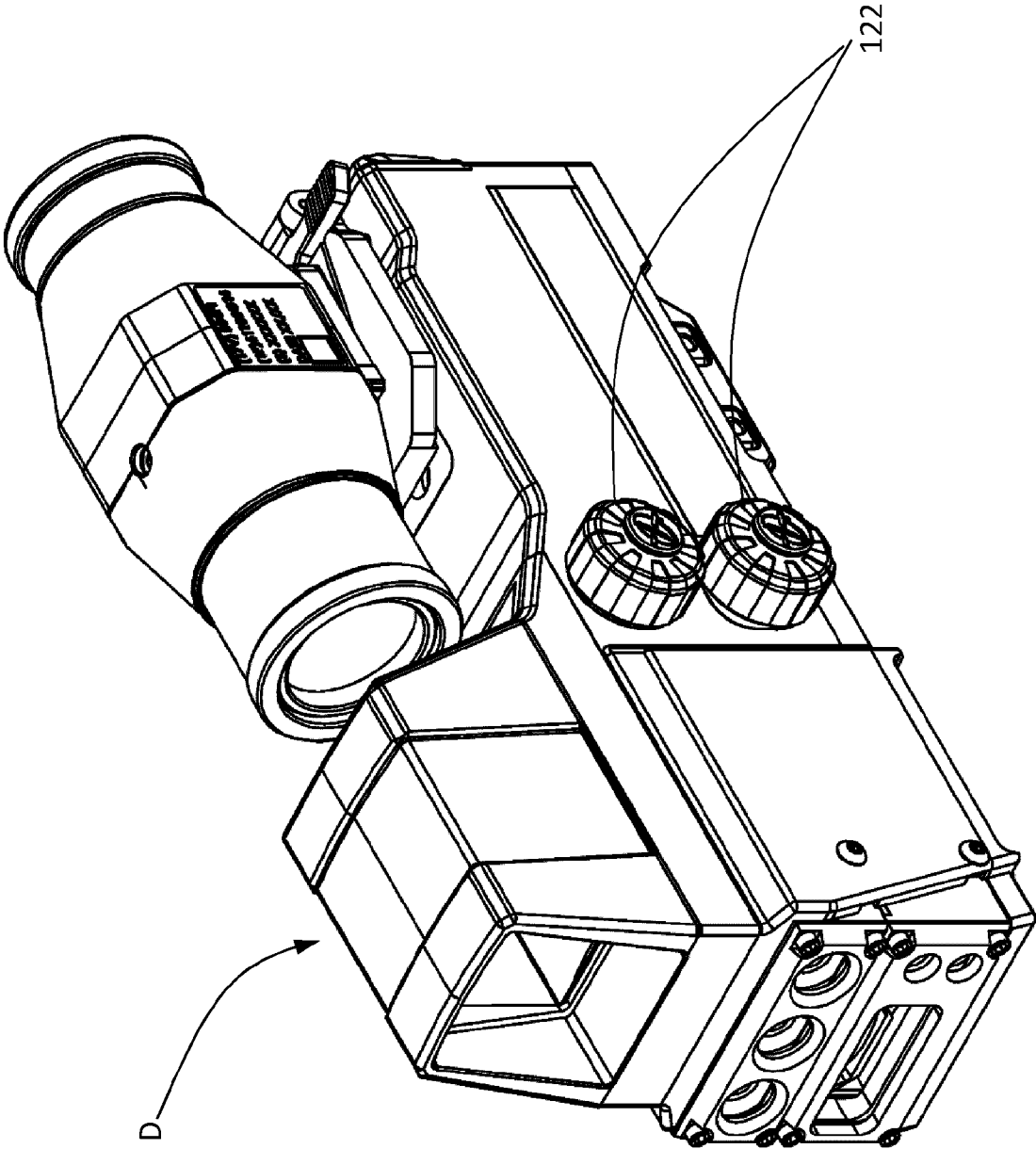


FIG. 4

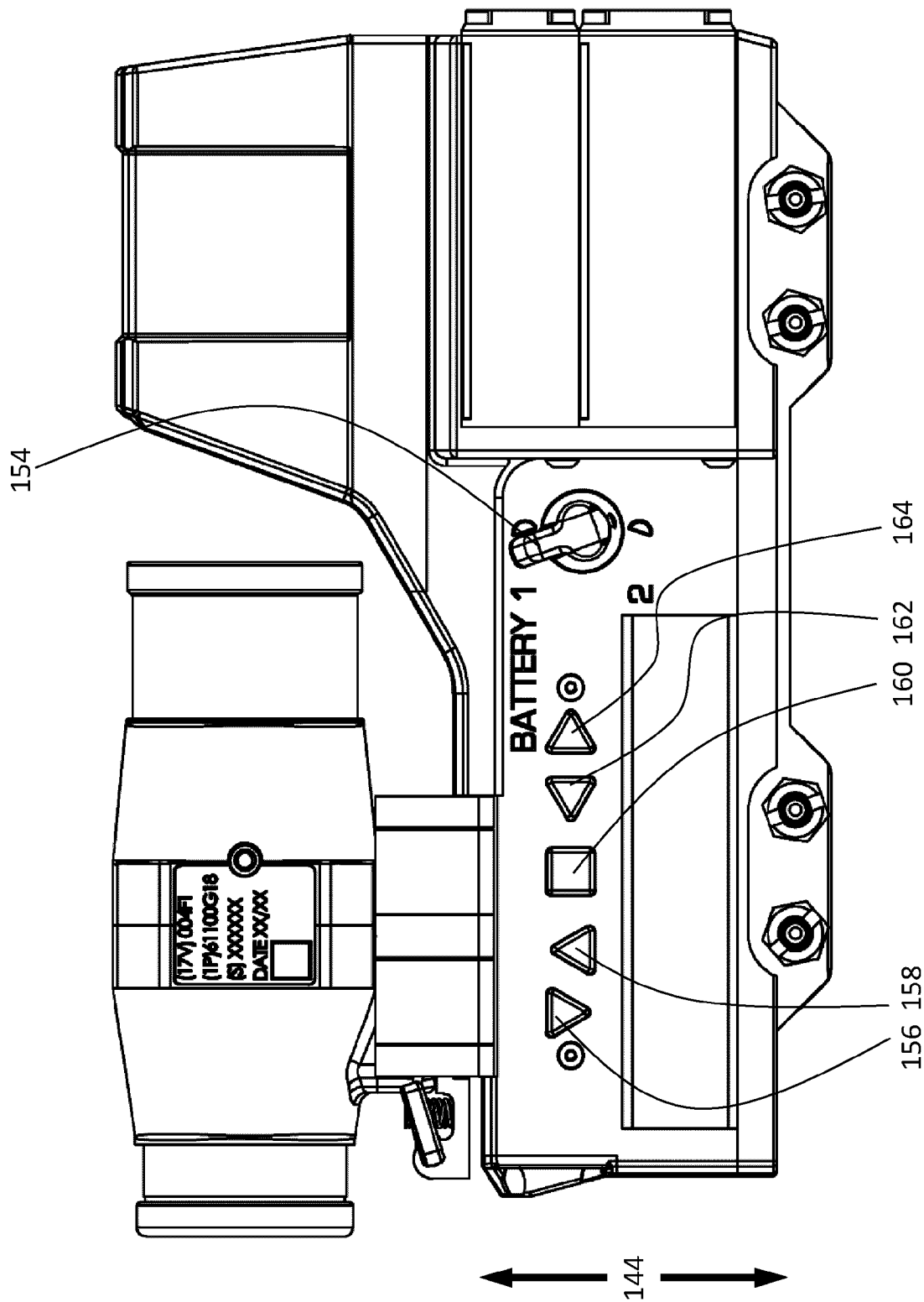


FIG. 5

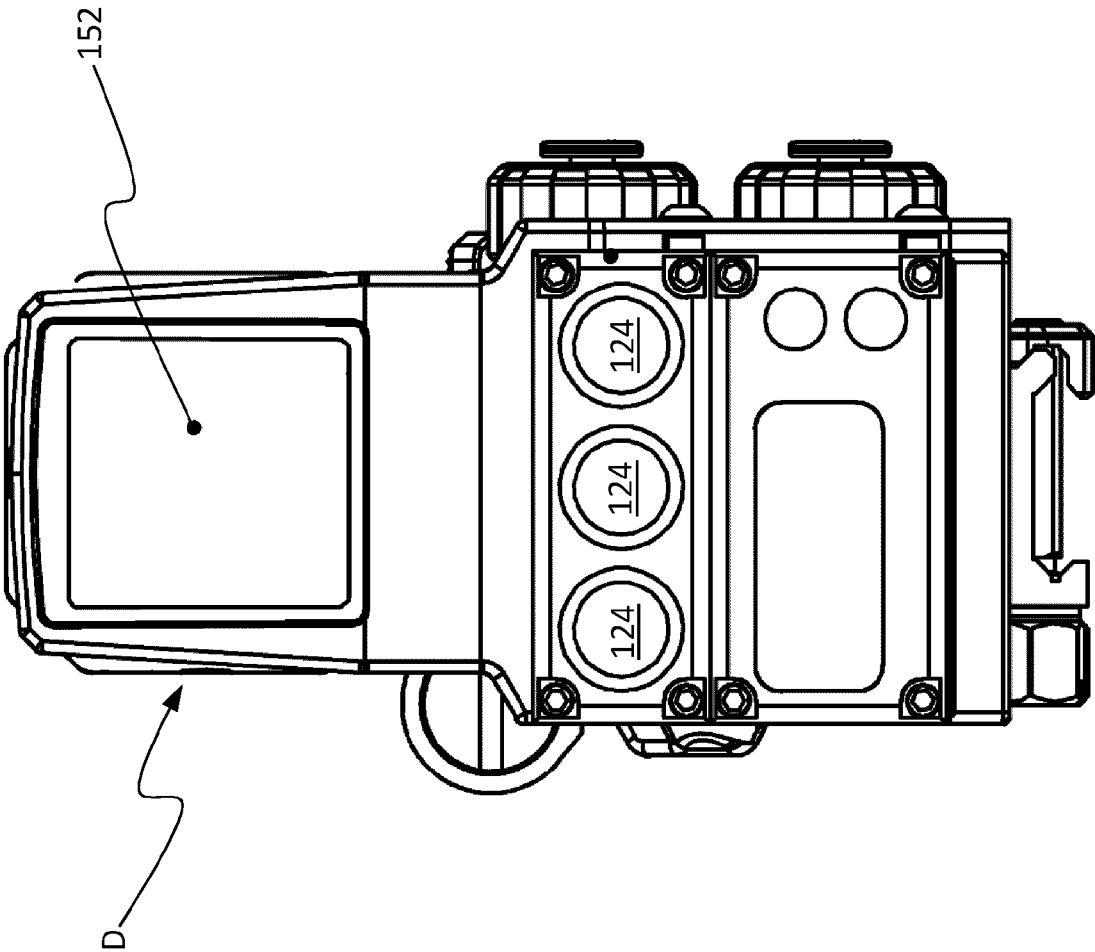


FIG. 6

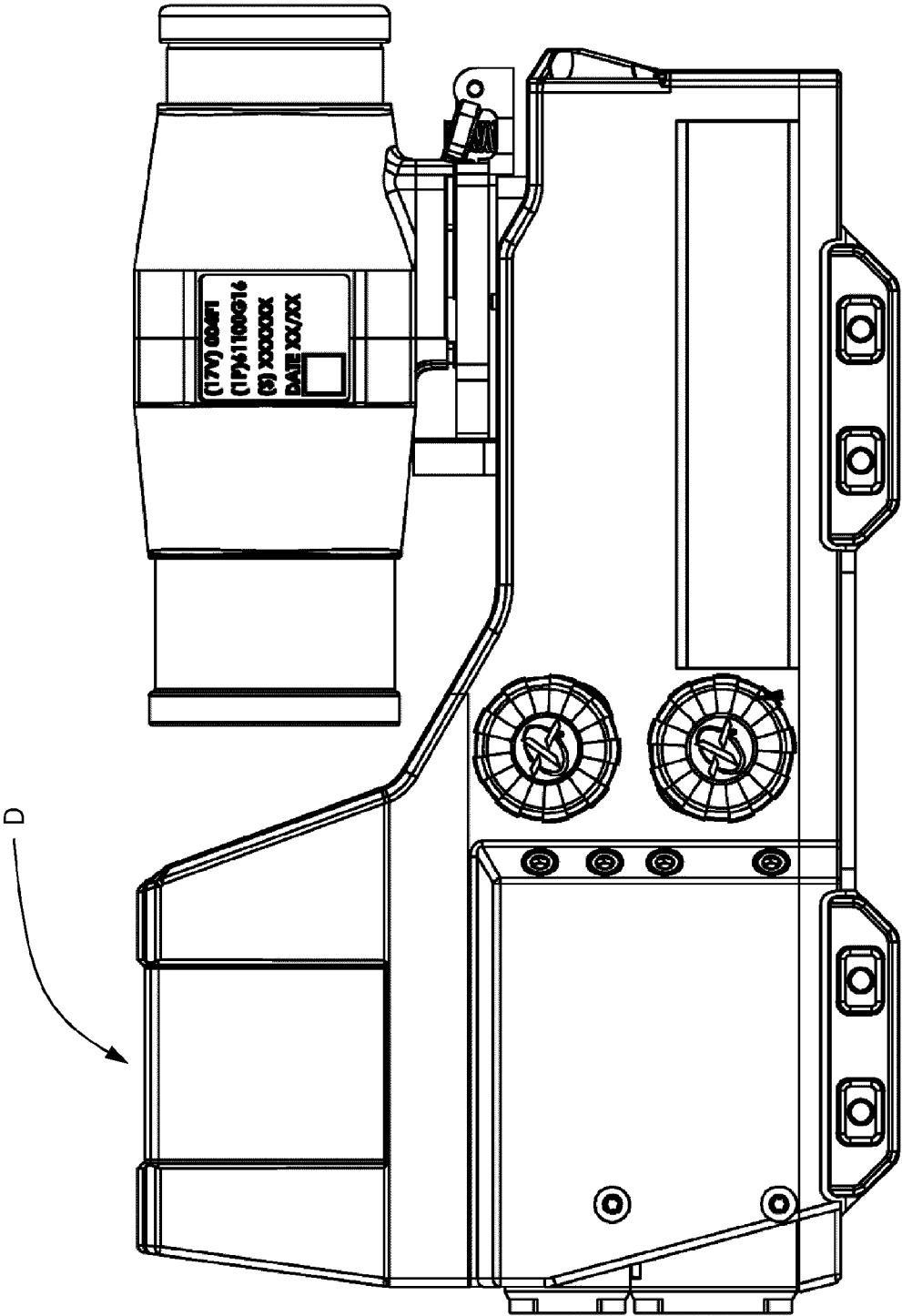


FIG. 7

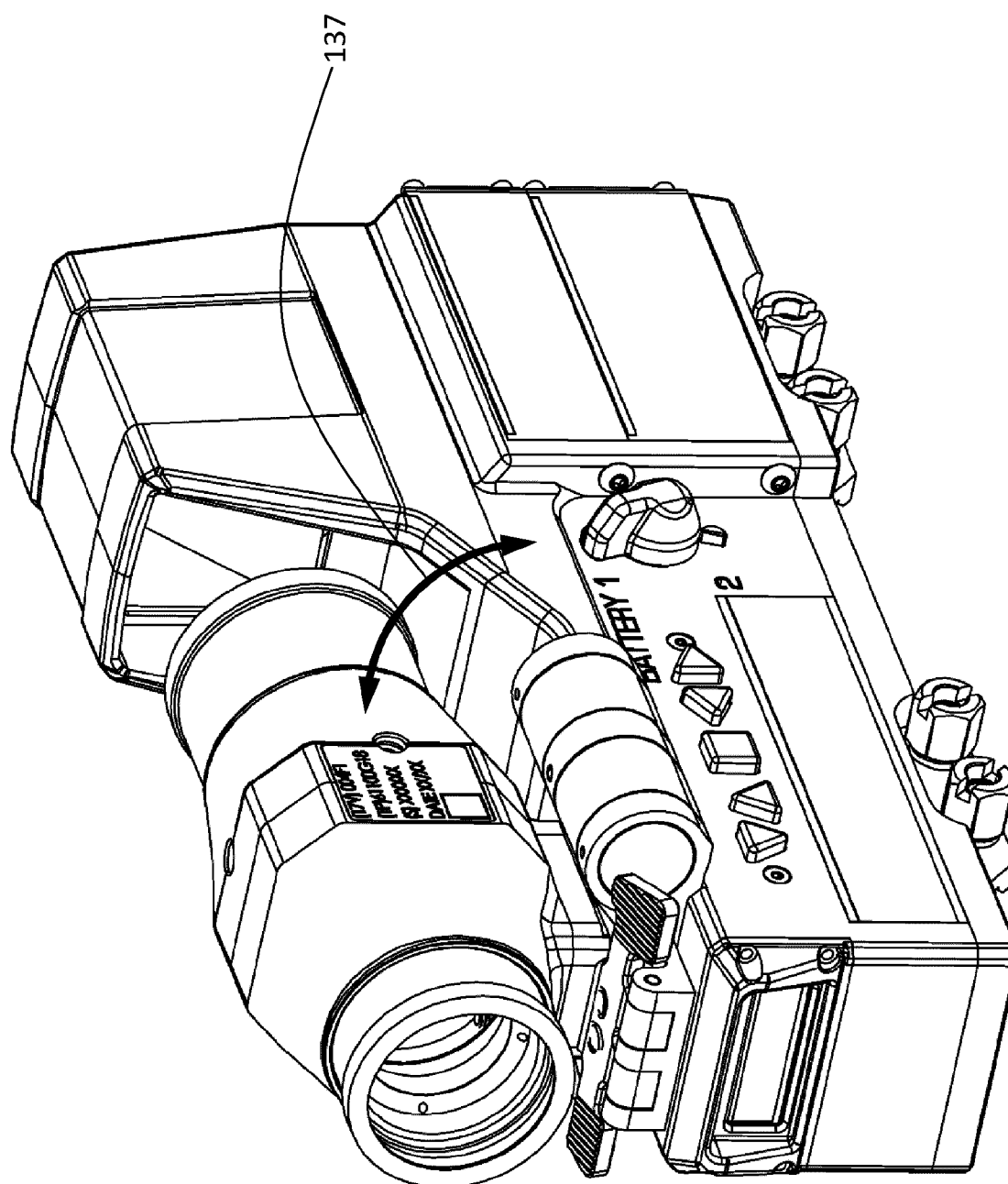


FIG. 8

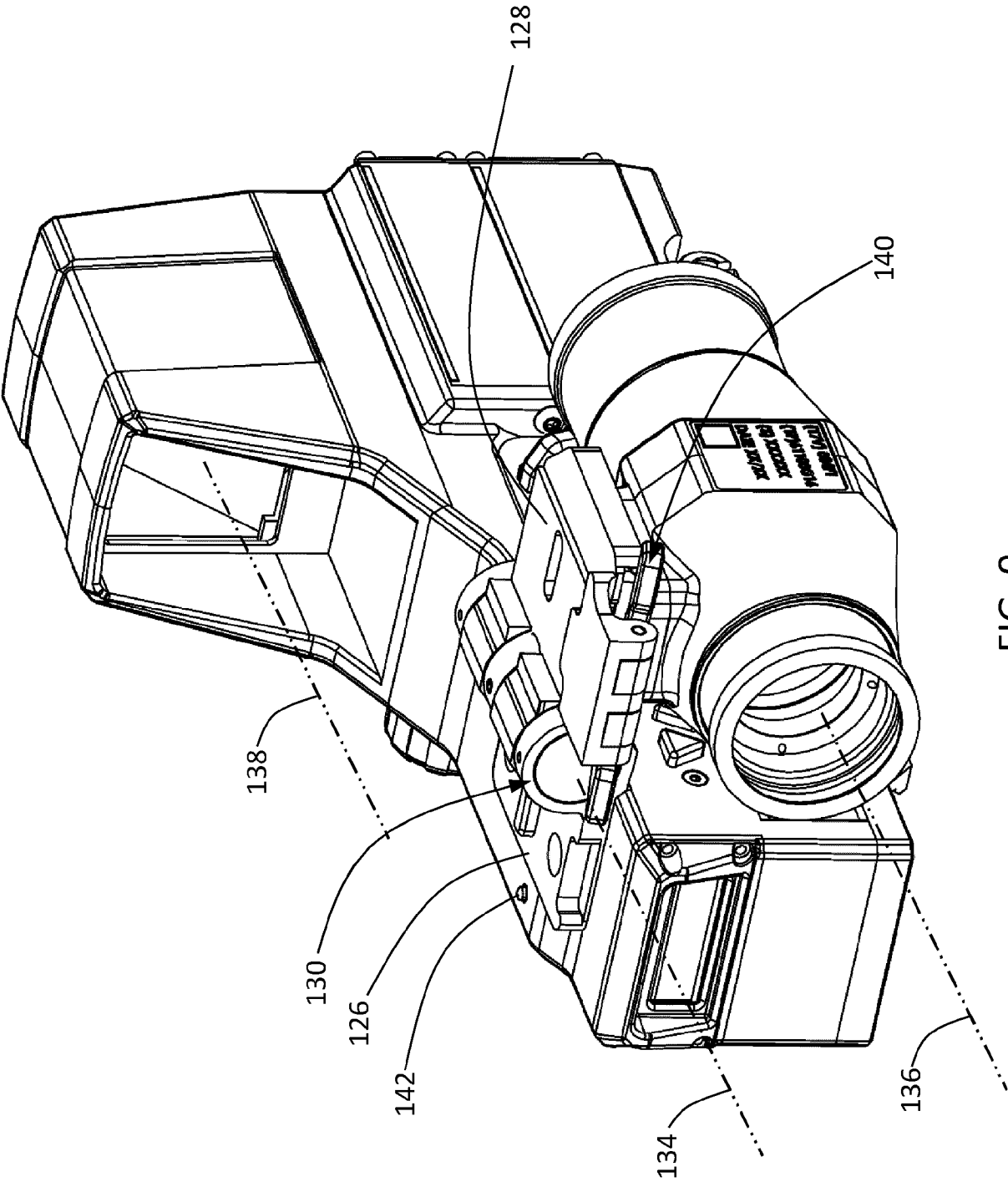


FIG. 9

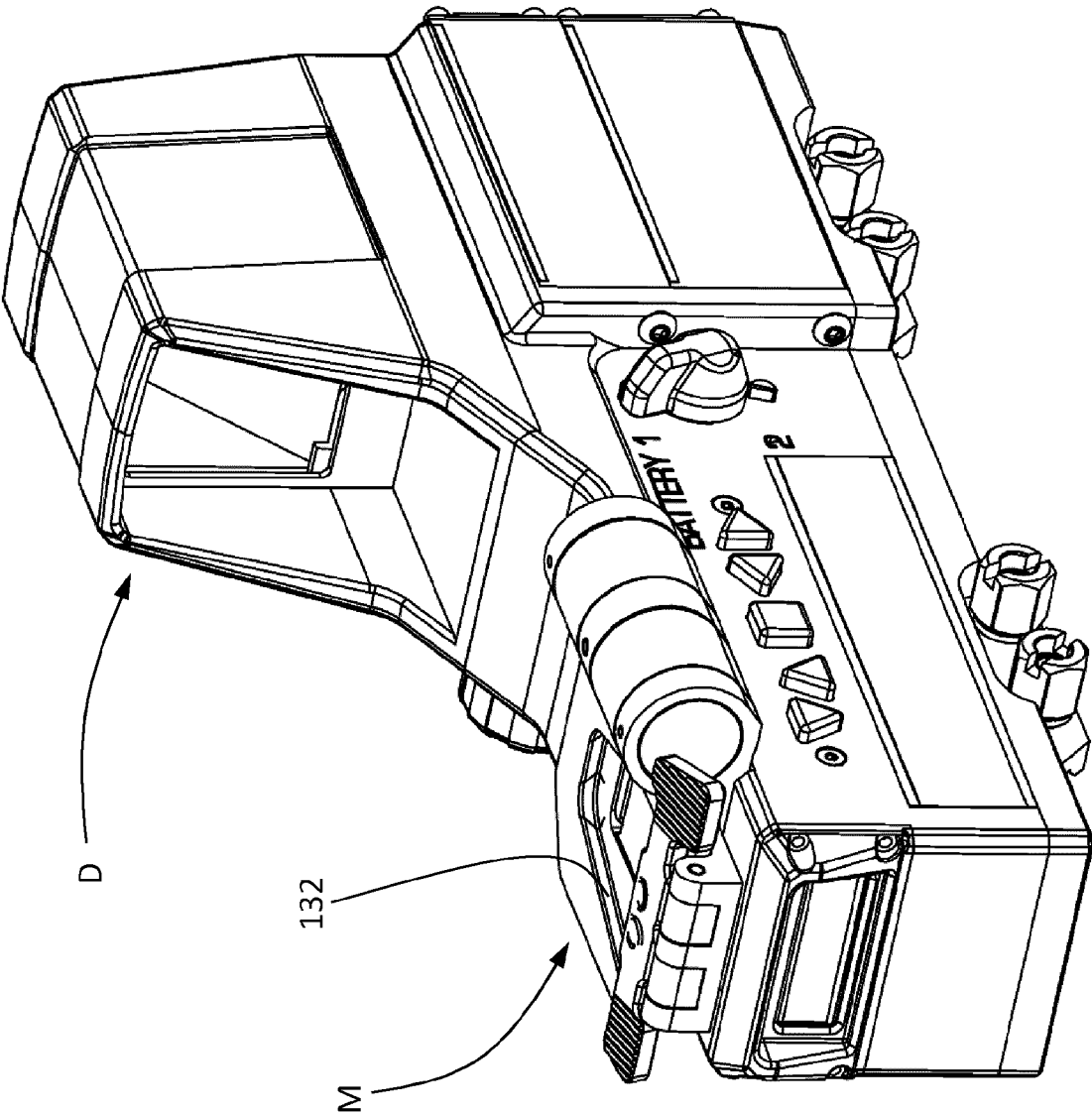


FIG. 10

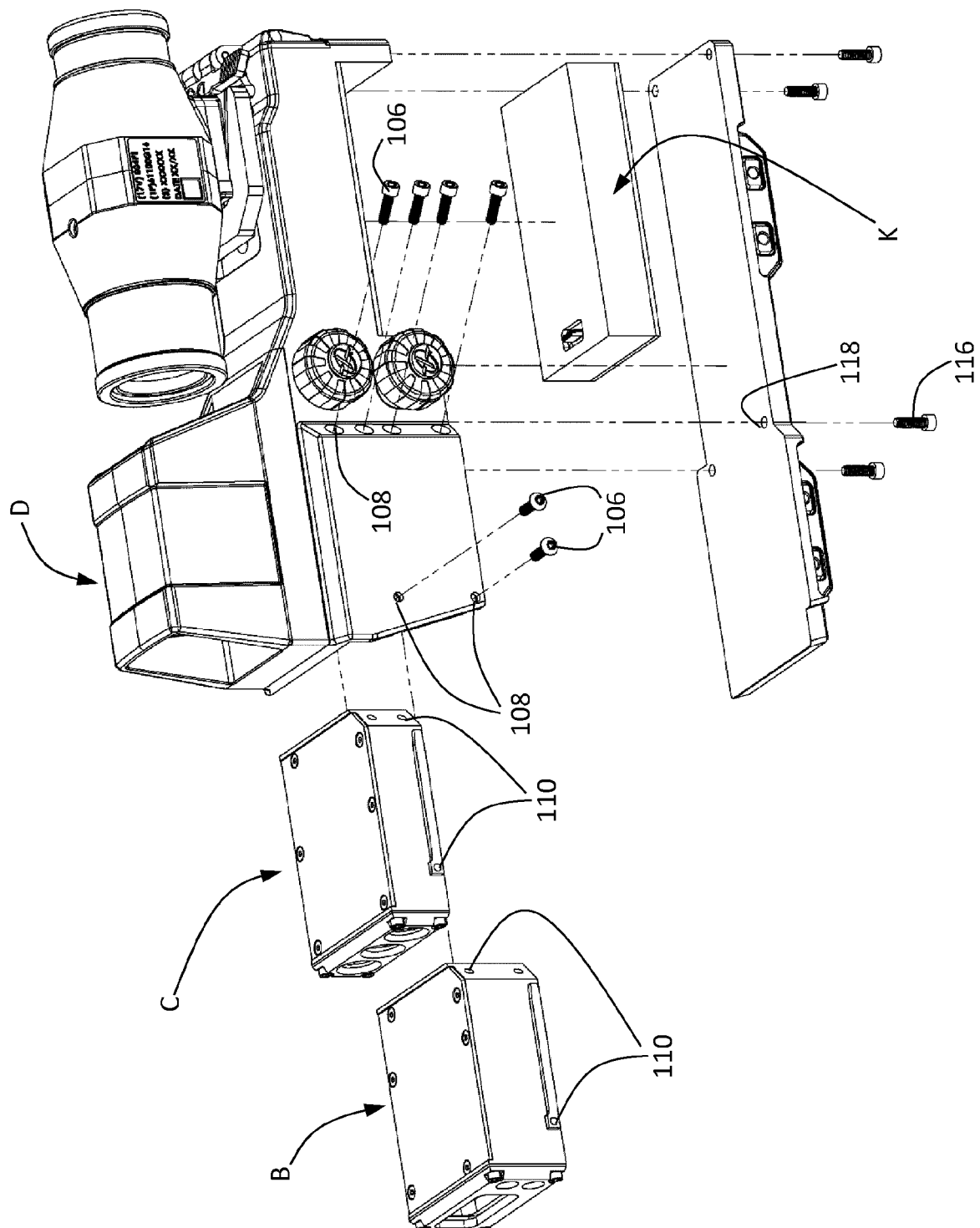


FIG. 11

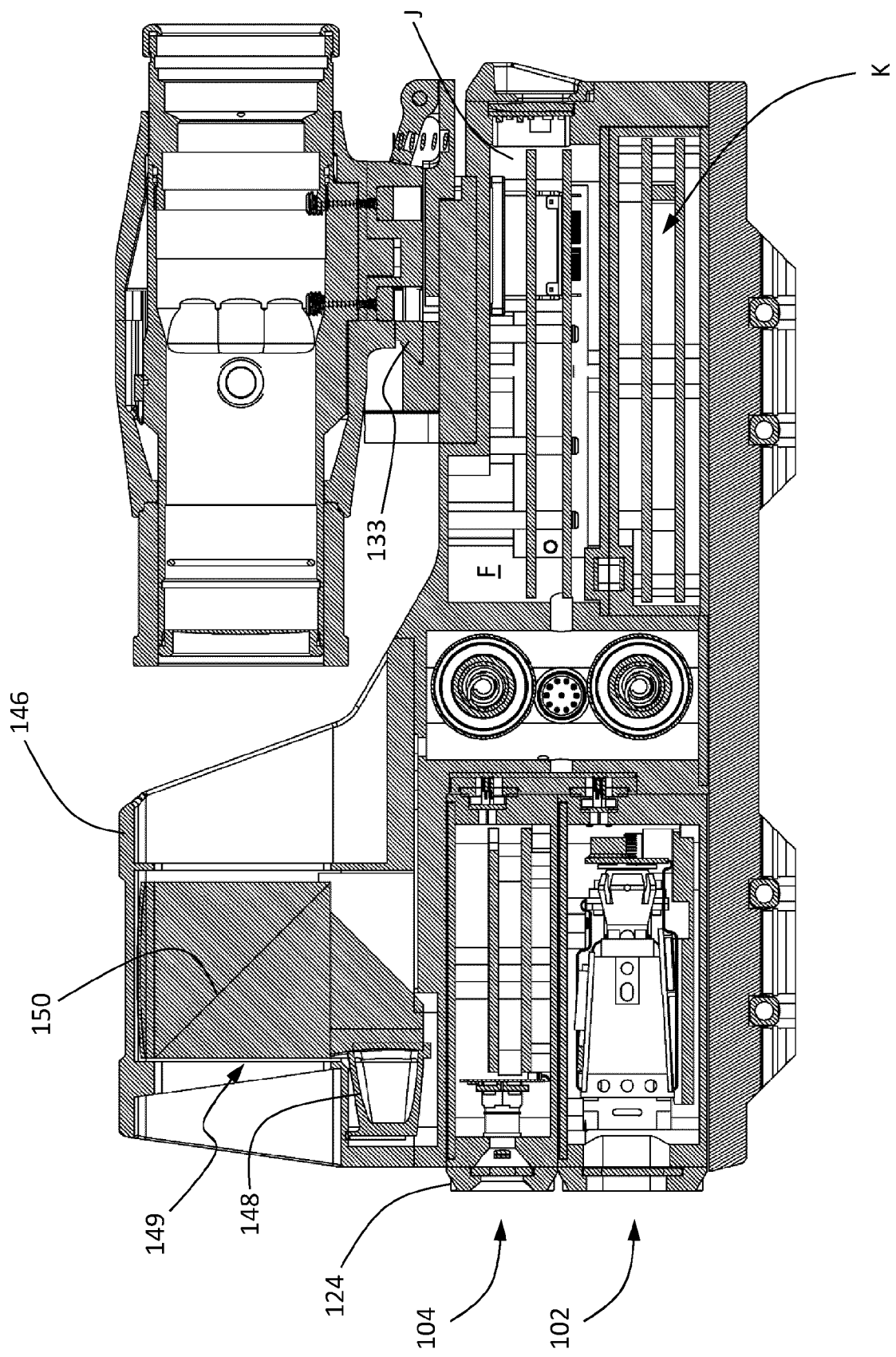


FIG. 12

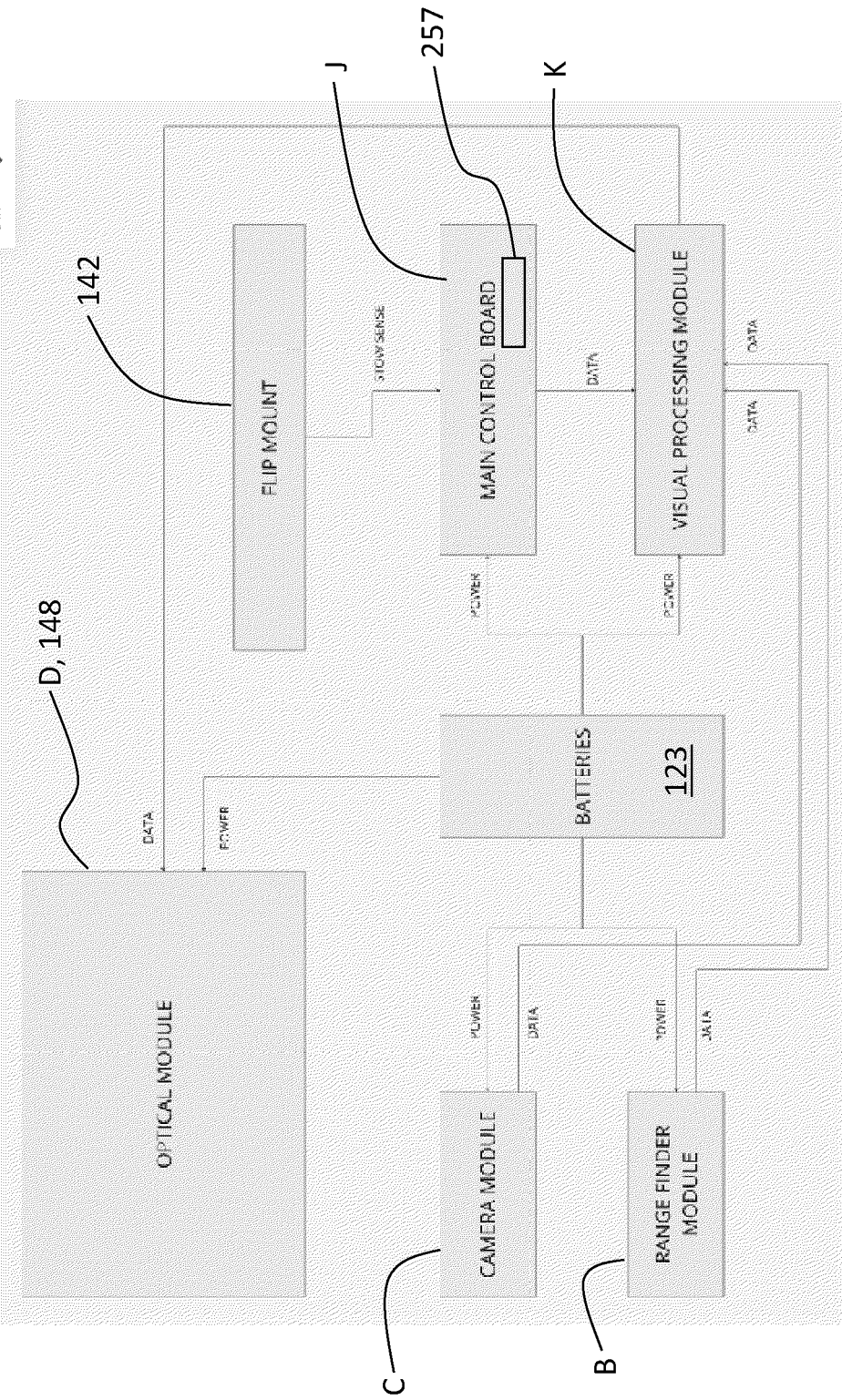


FIG. 13

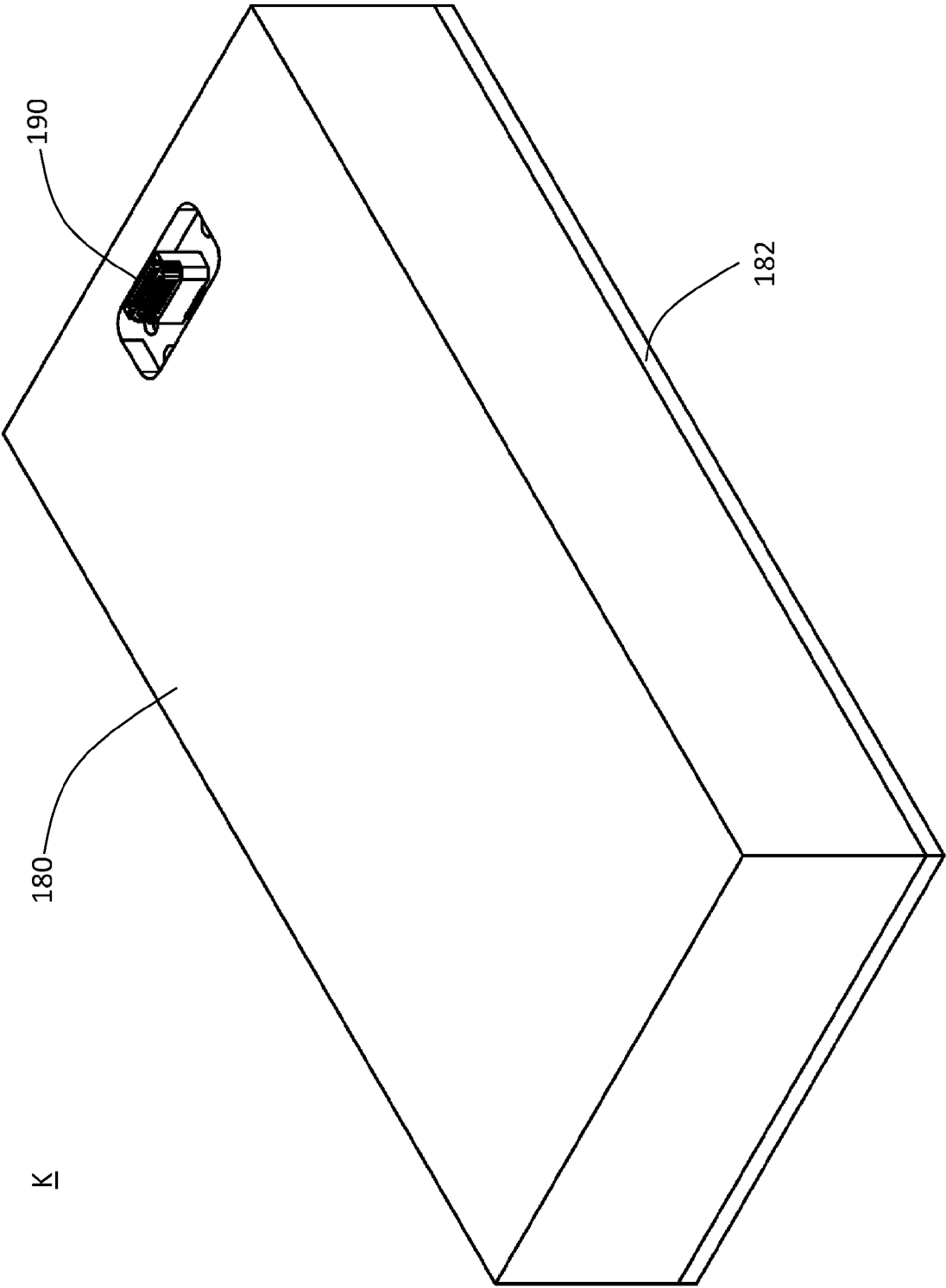


FIG. 14

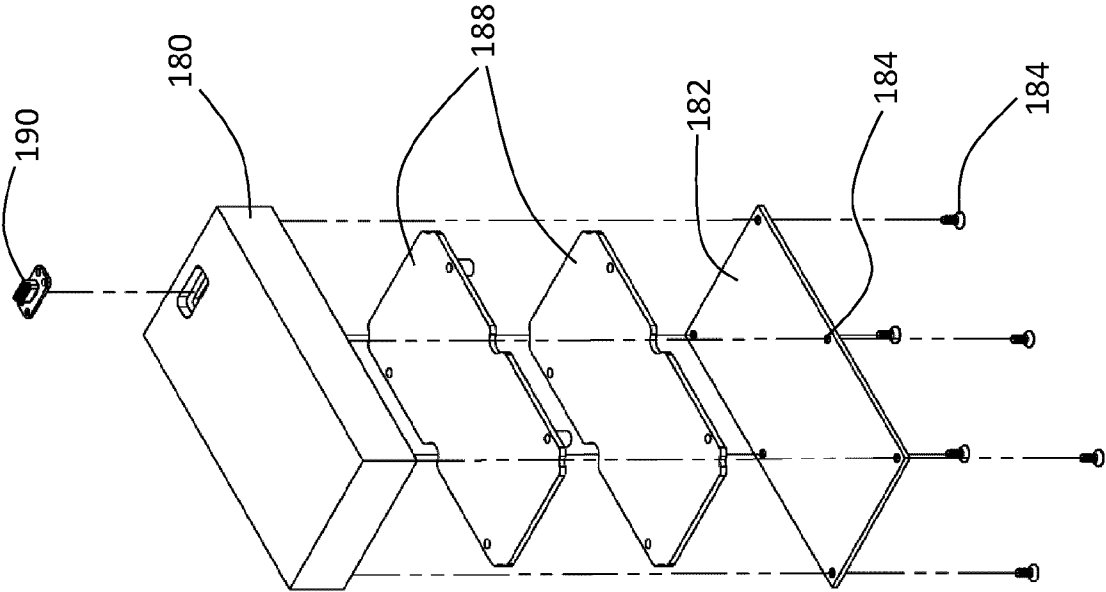


FIG. 15

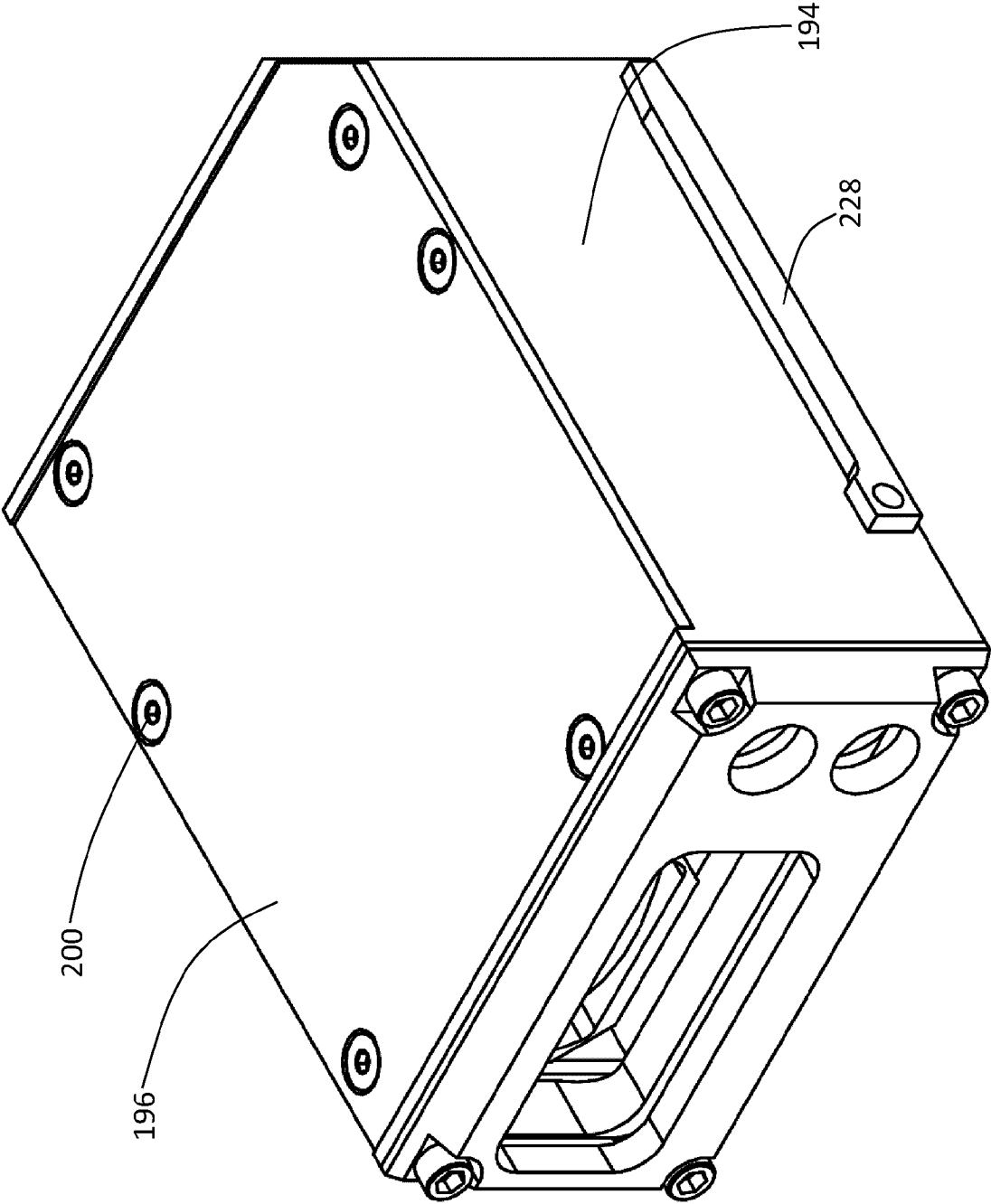


FIG. 16

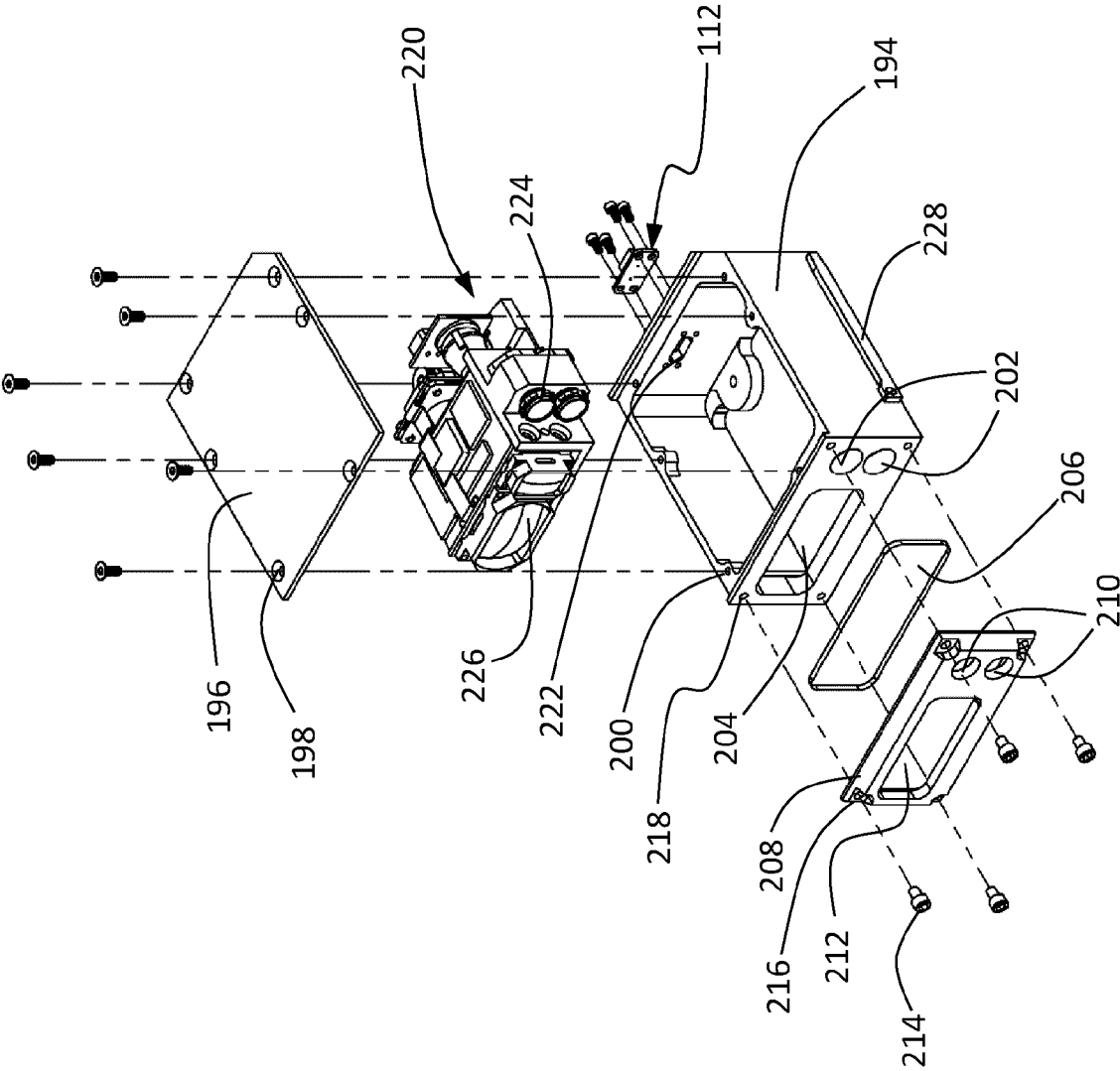


FIG. 17

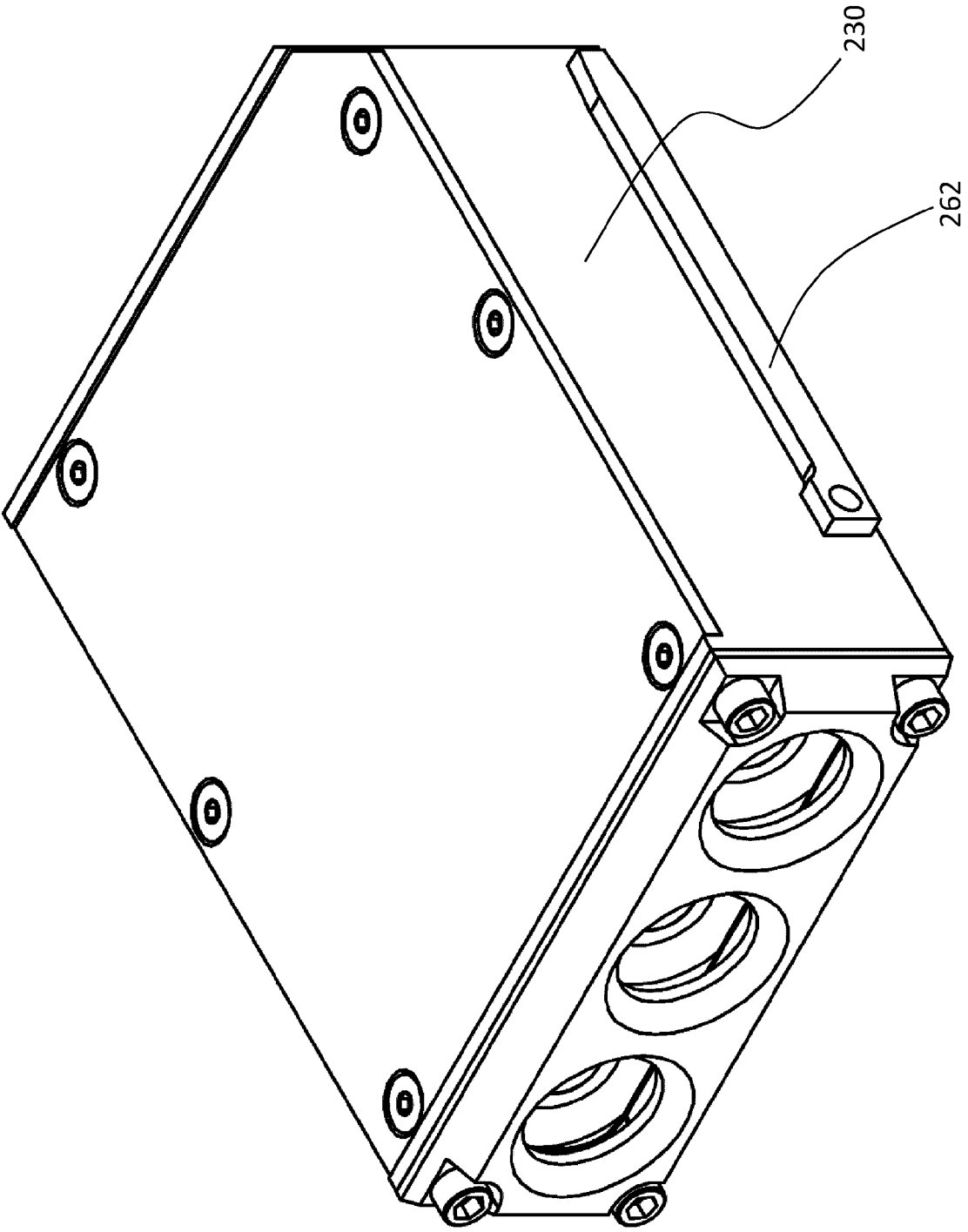


FIG. 18

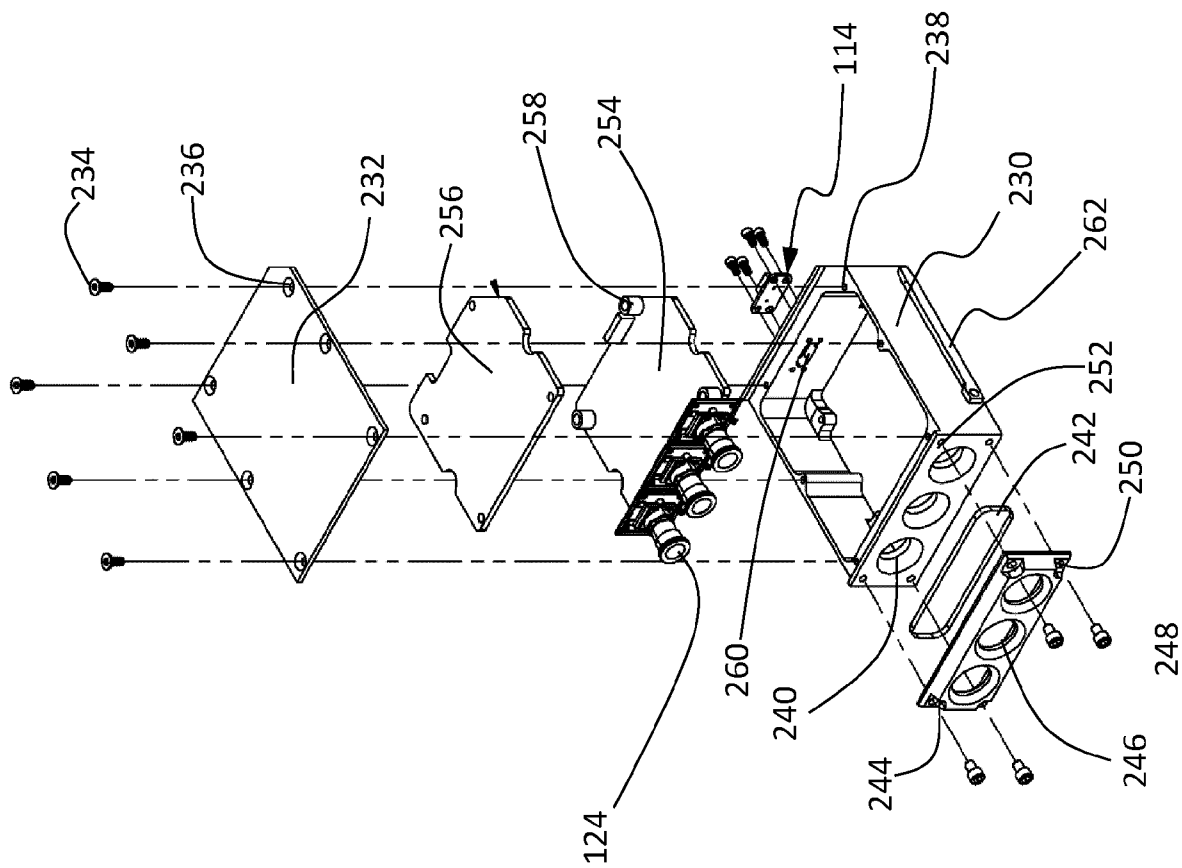


FIG. 19

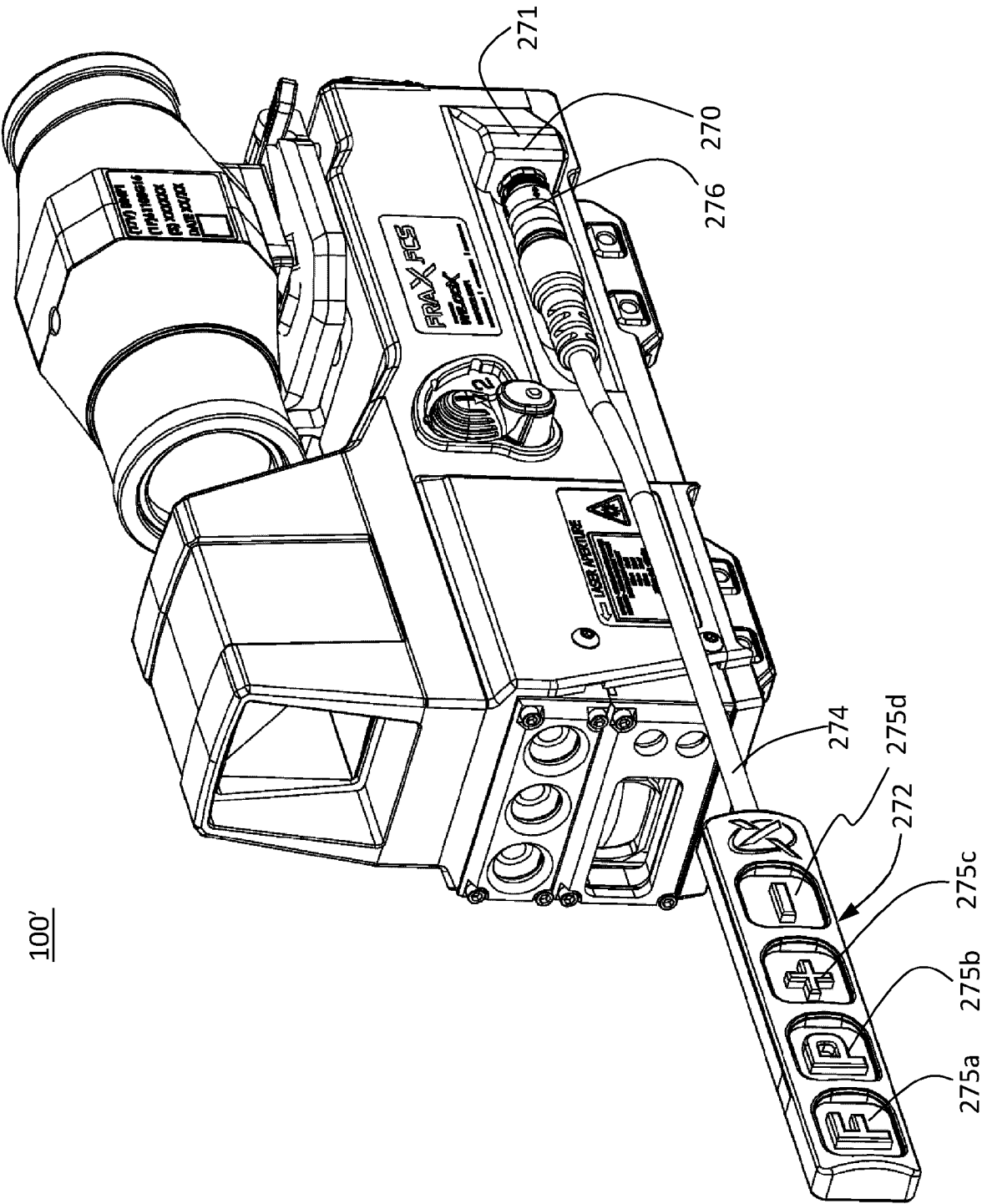


FIG. 1A

100'

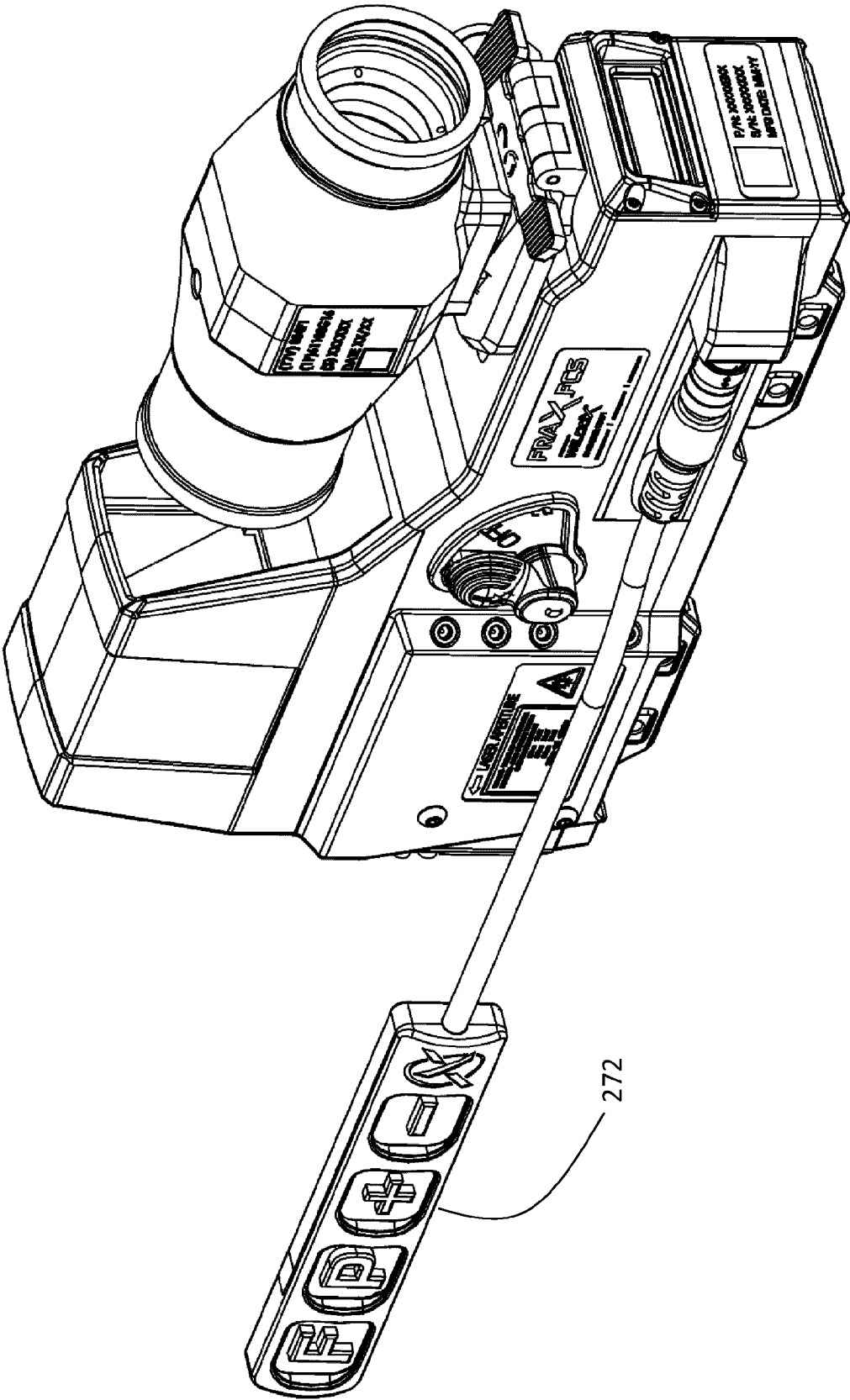


FIG. 2A

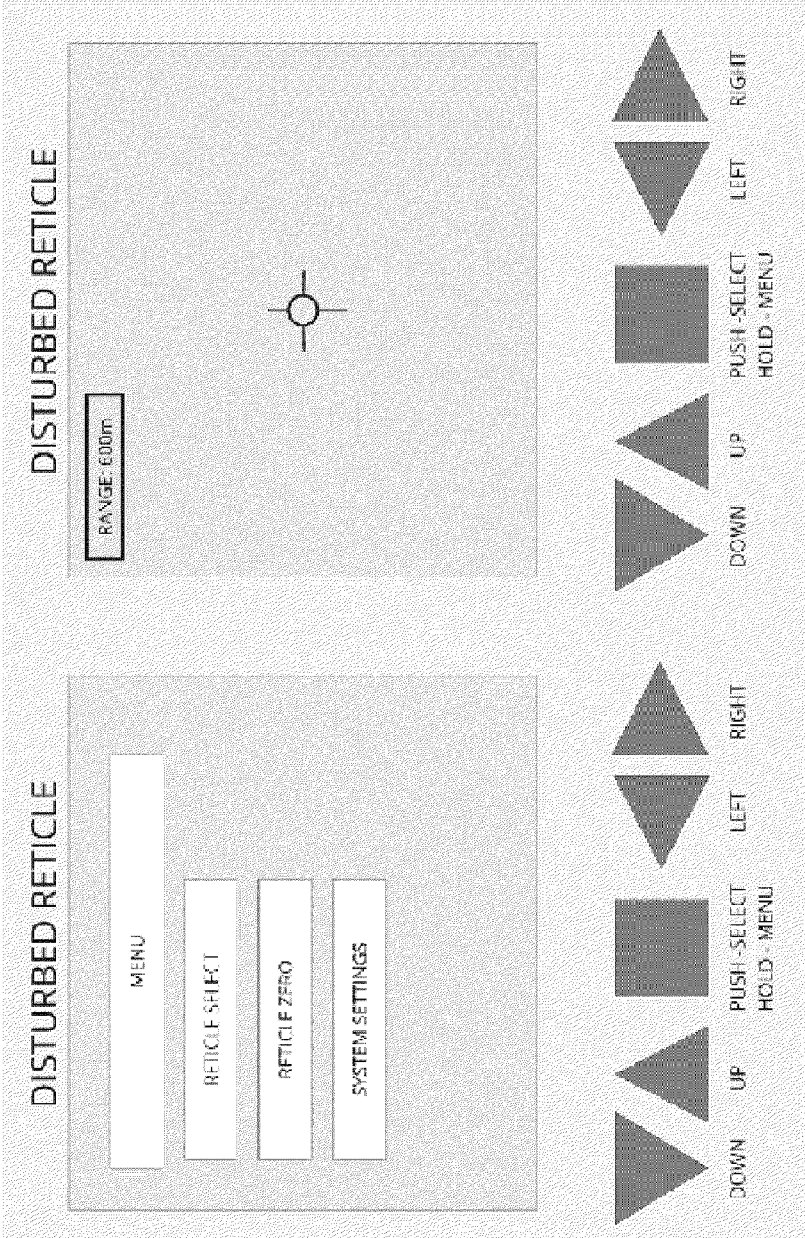


FIG. 3A

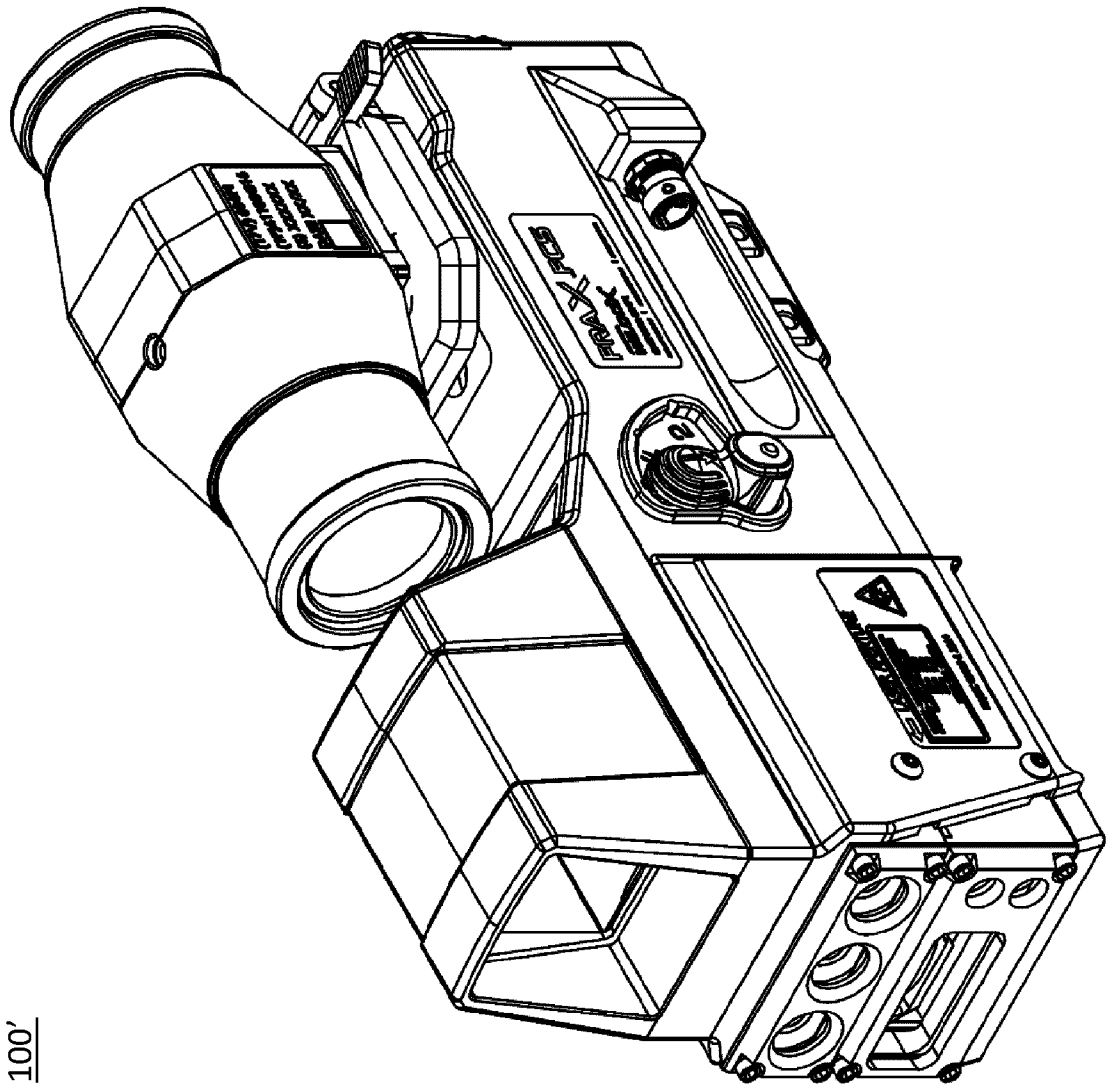
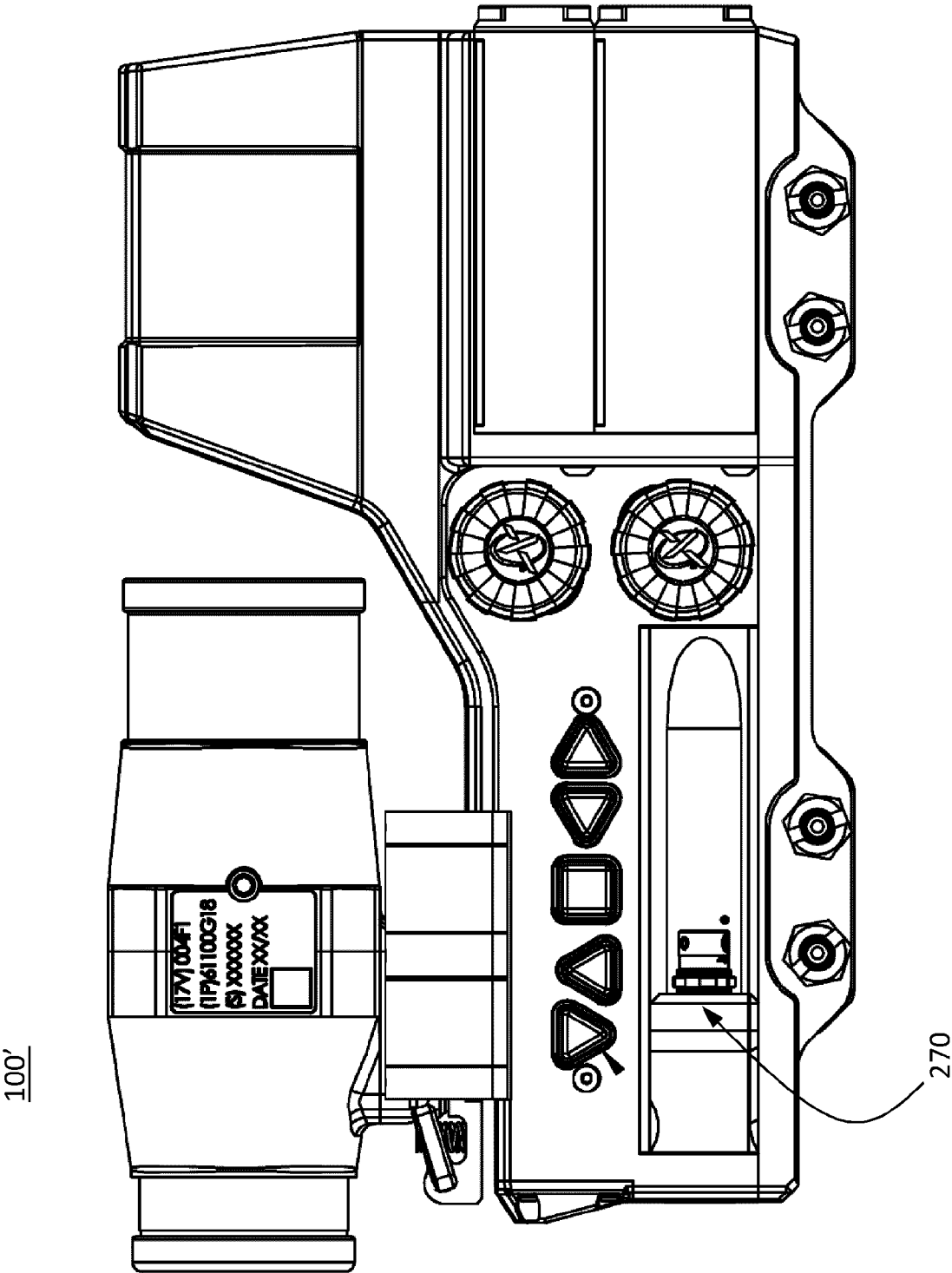


FIG. 4A

100'



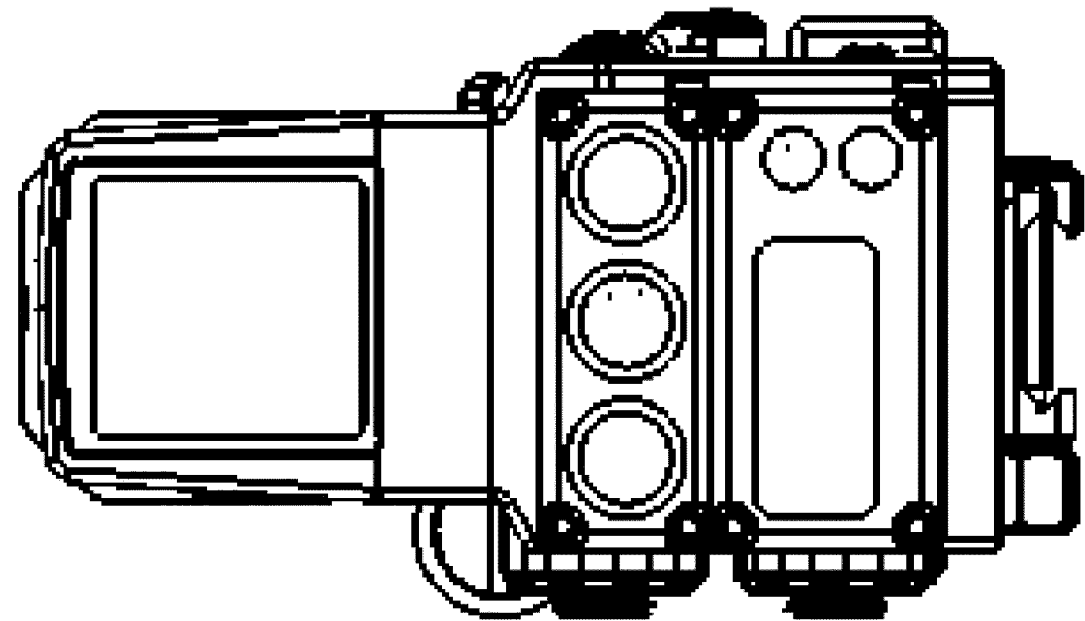


FIG. 6A

100'

100'

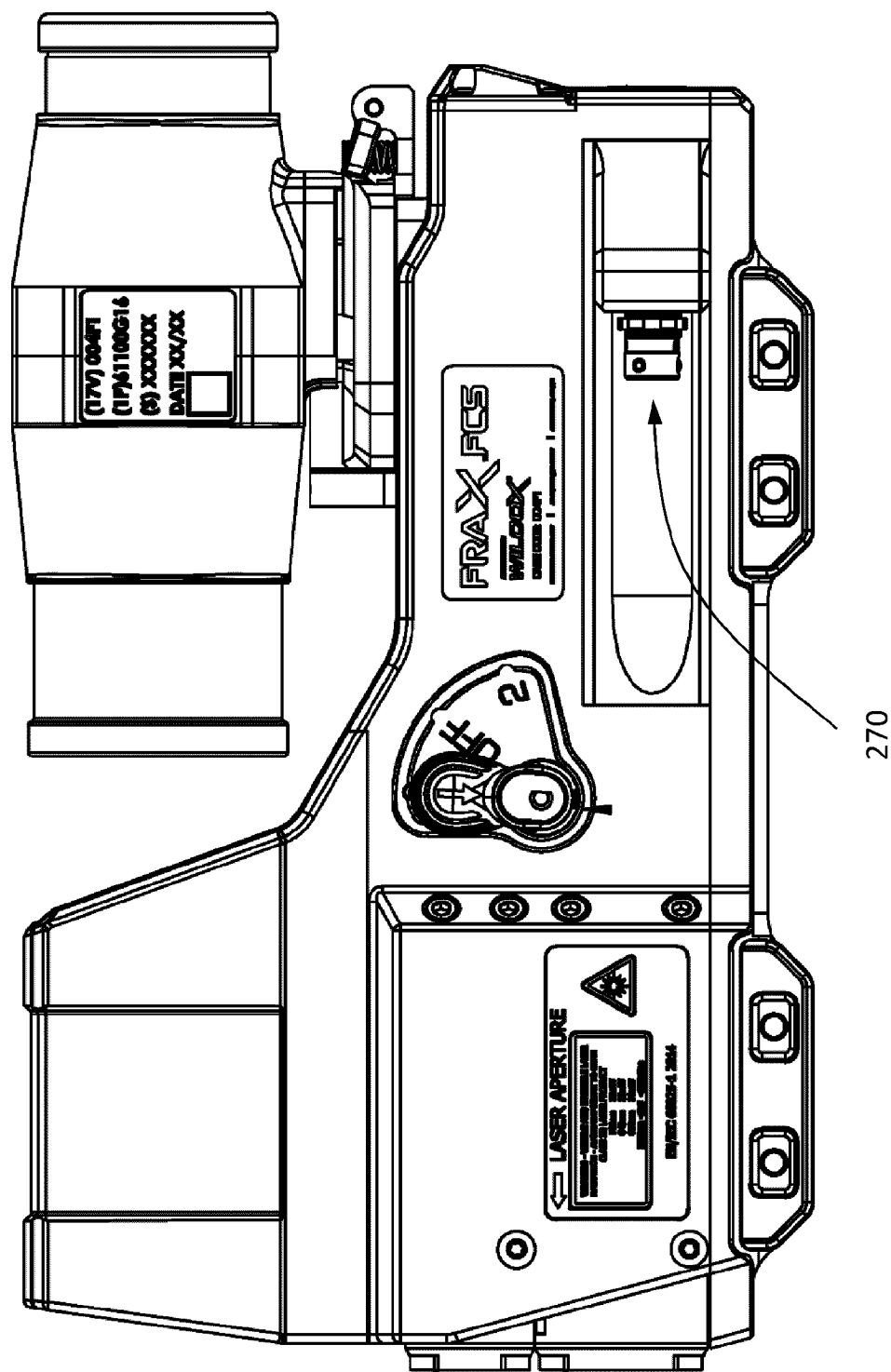


FIG. 7A

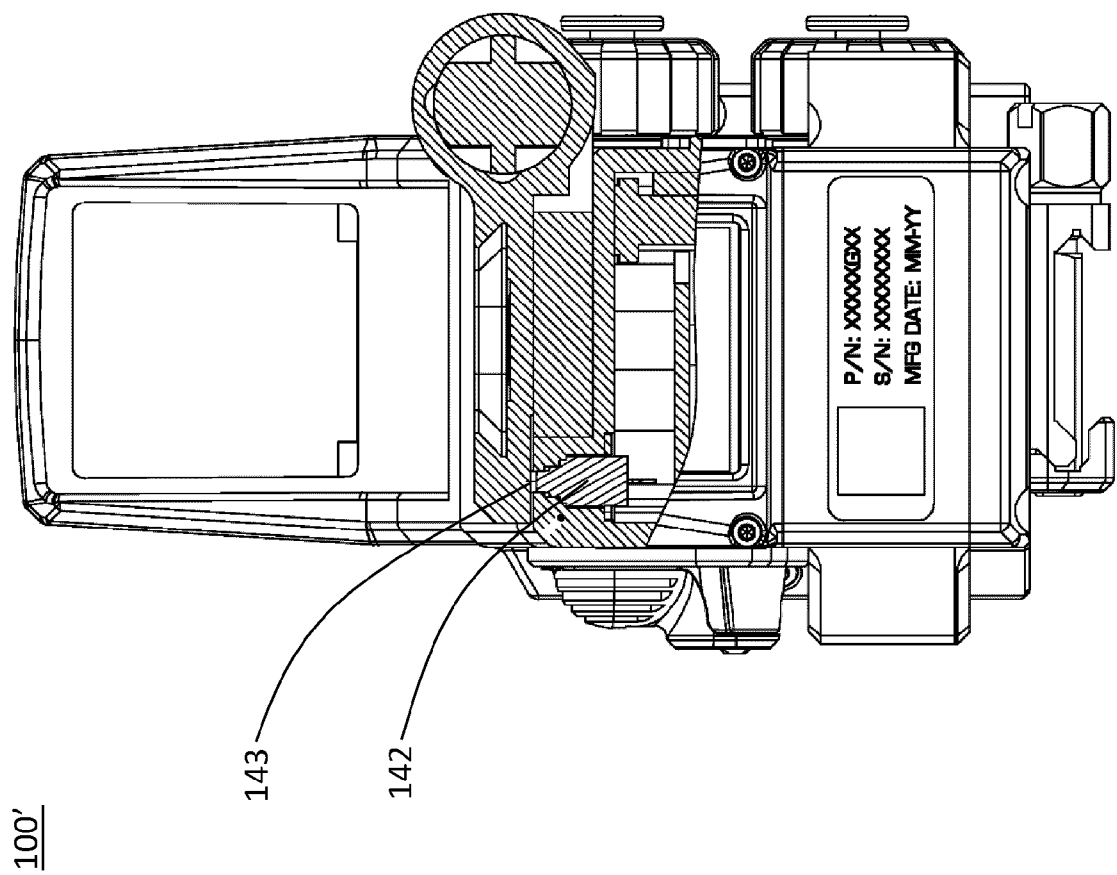
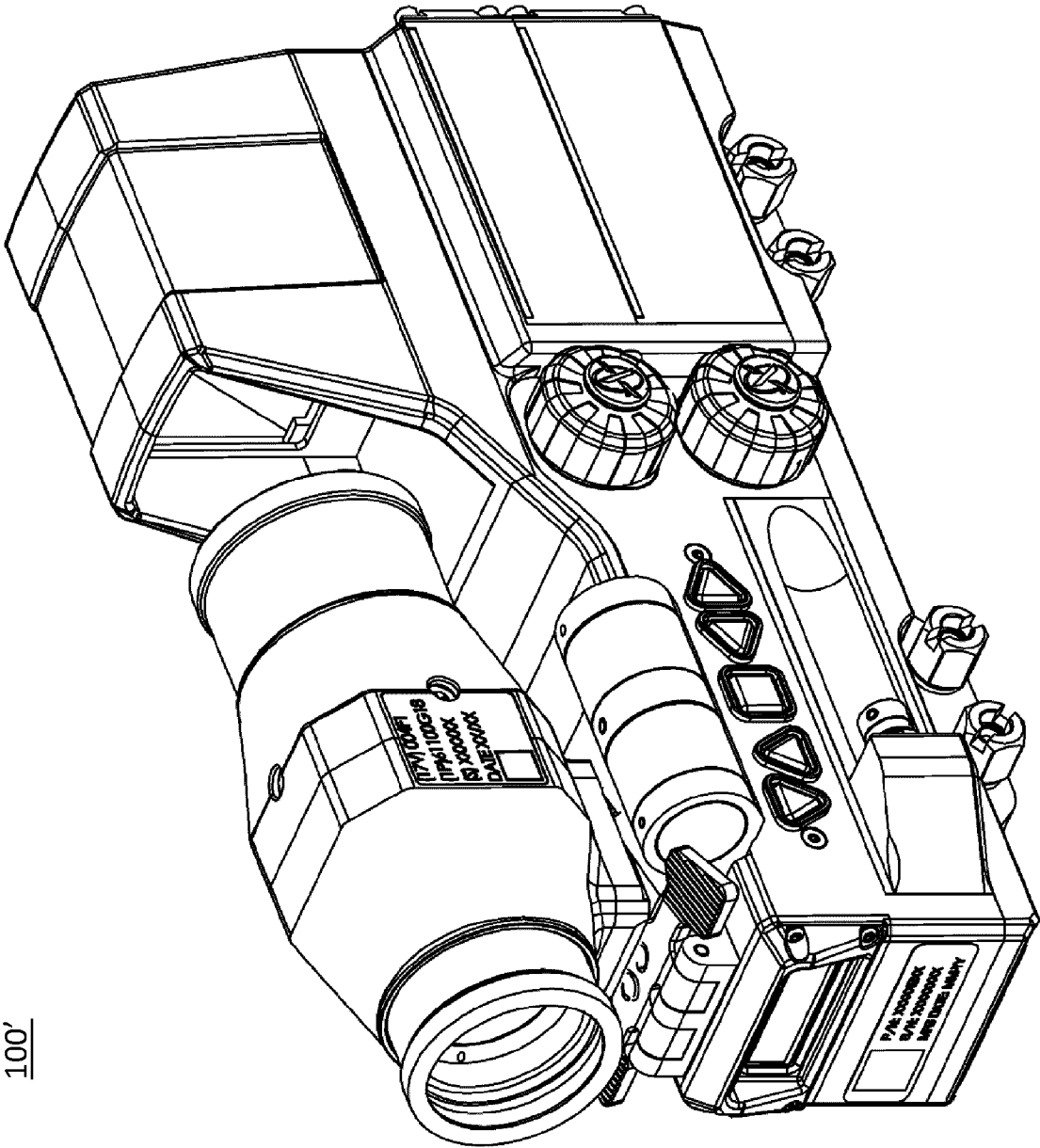
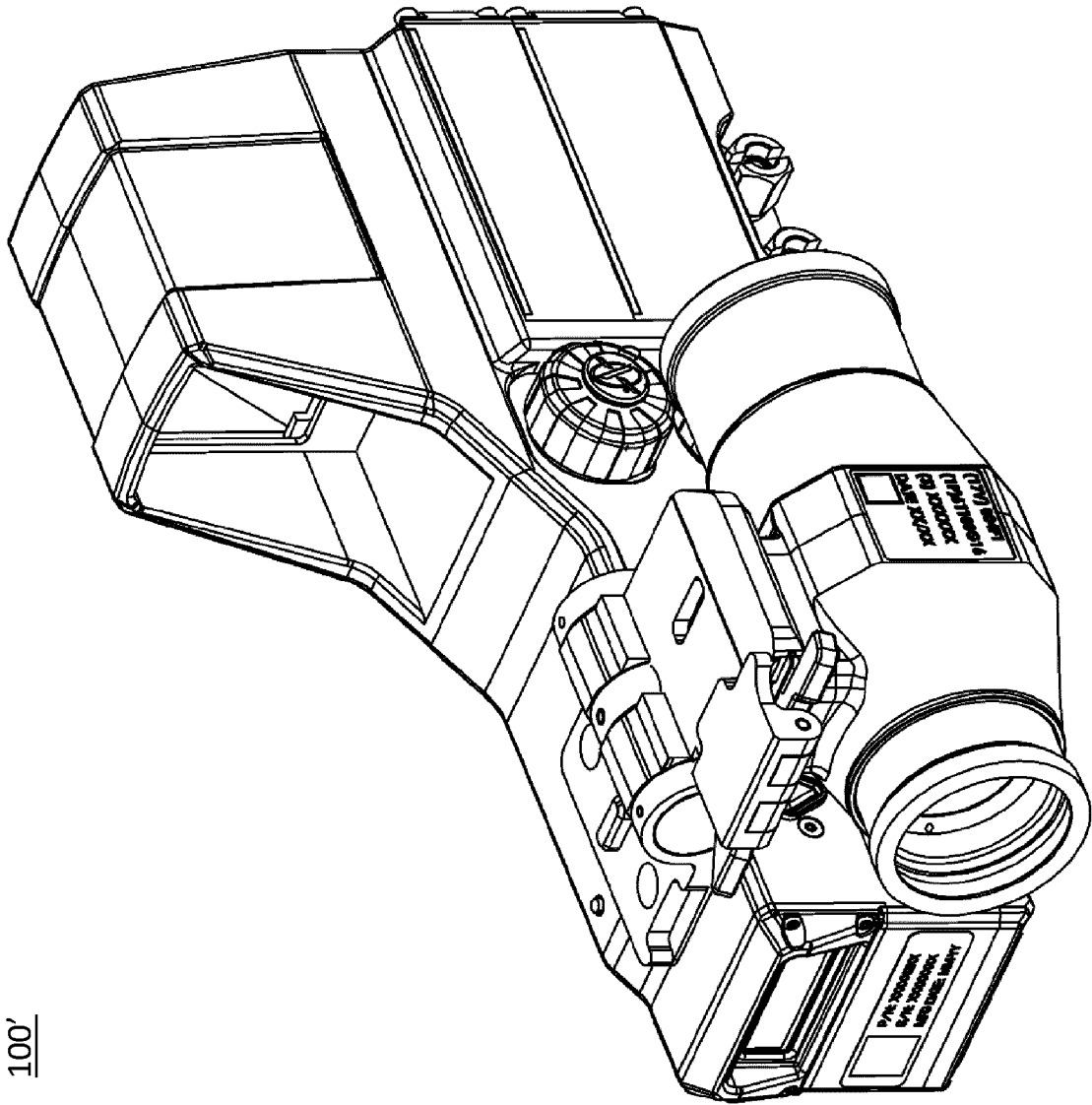


FIG. 8A





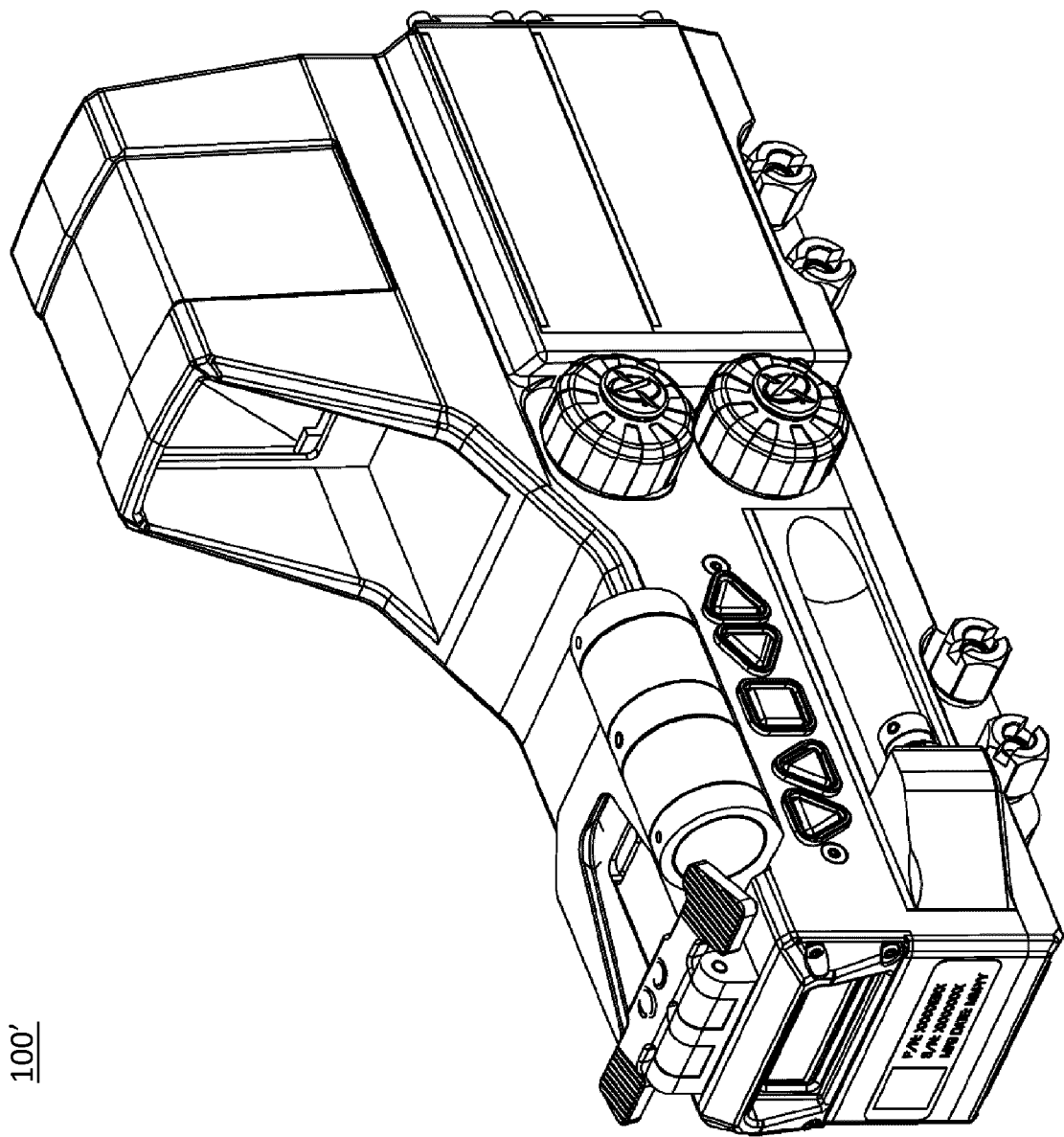


FIG. 11A

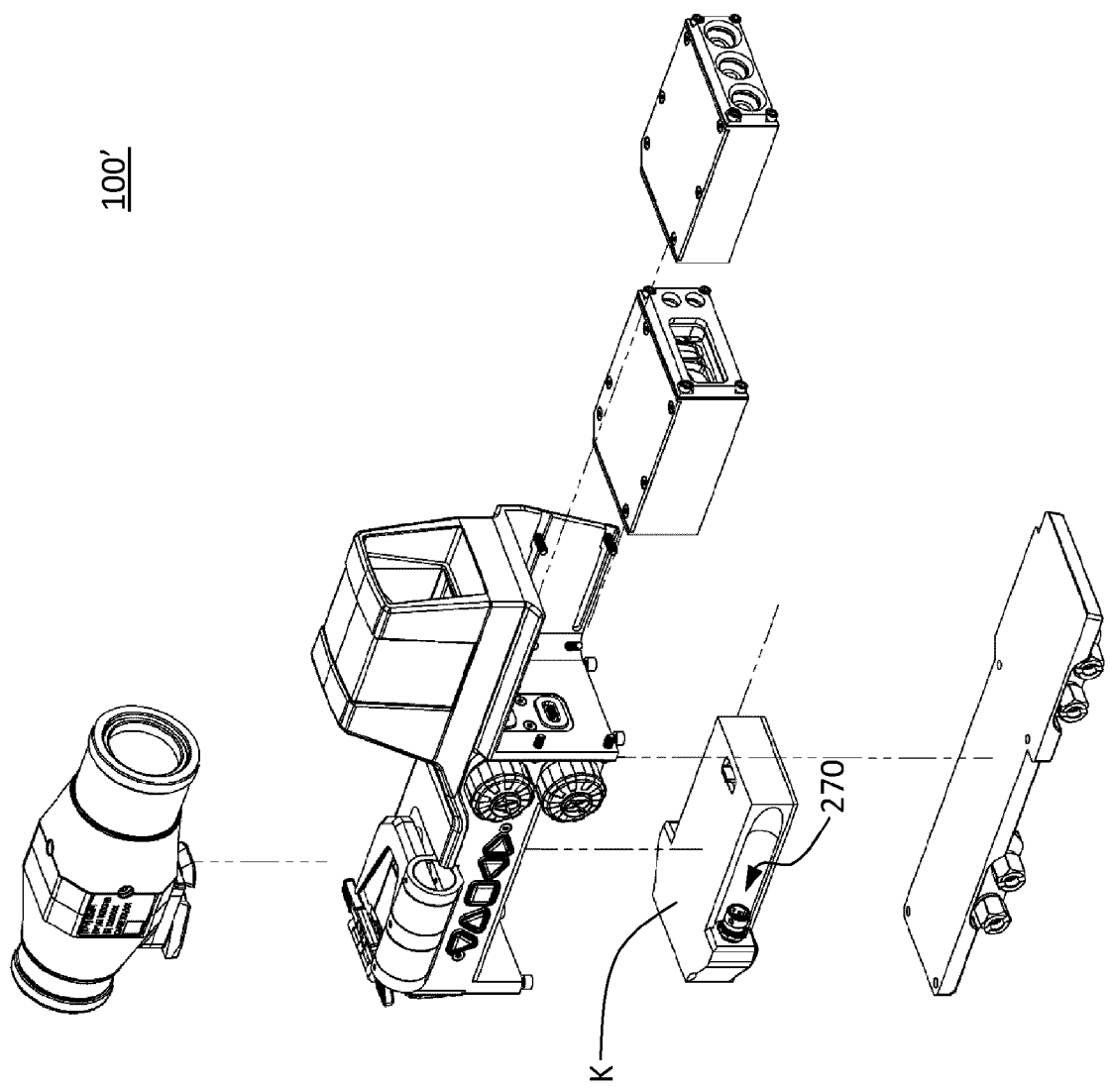


FIG. 12A

100'

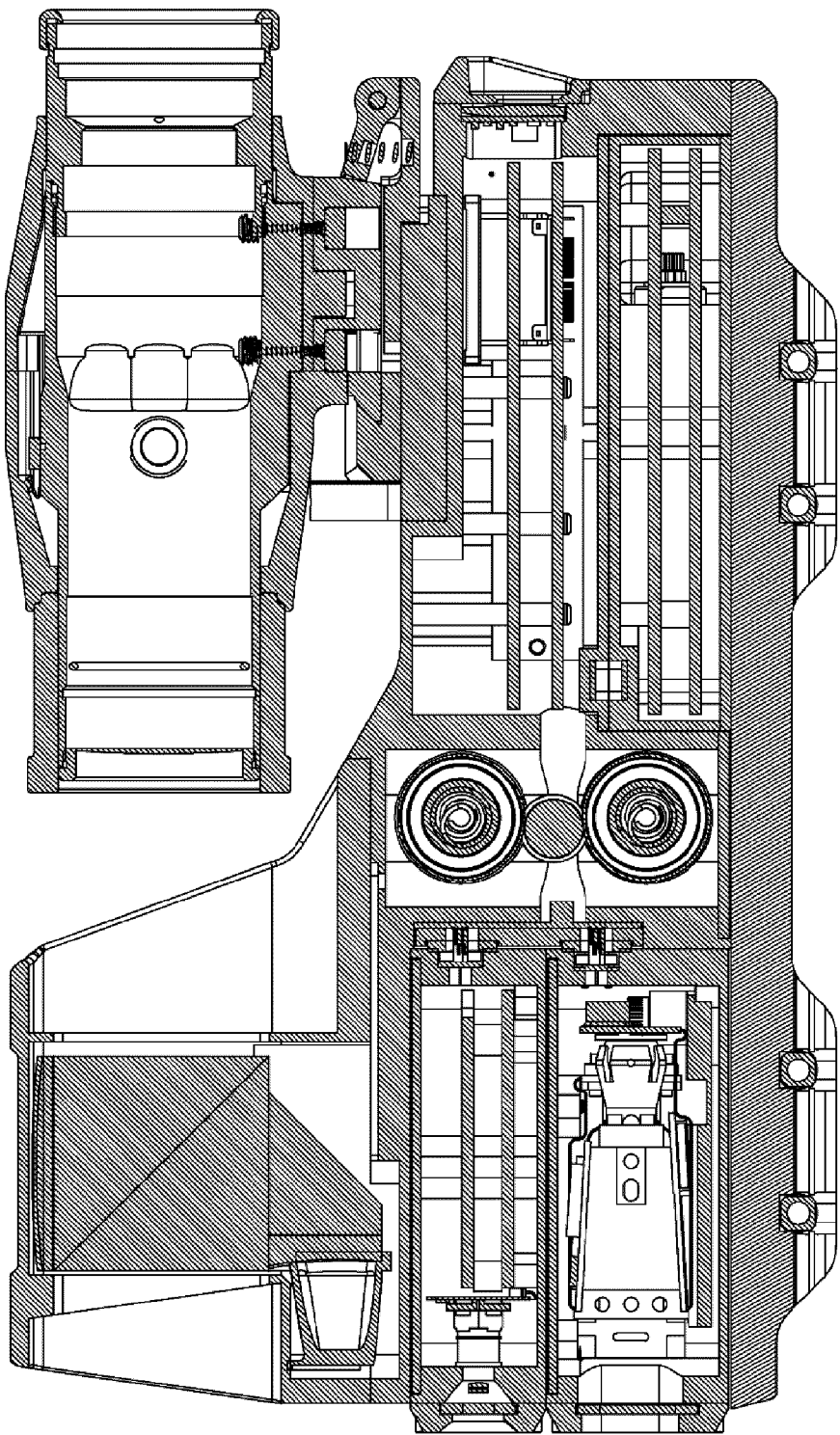


FIG. 13A

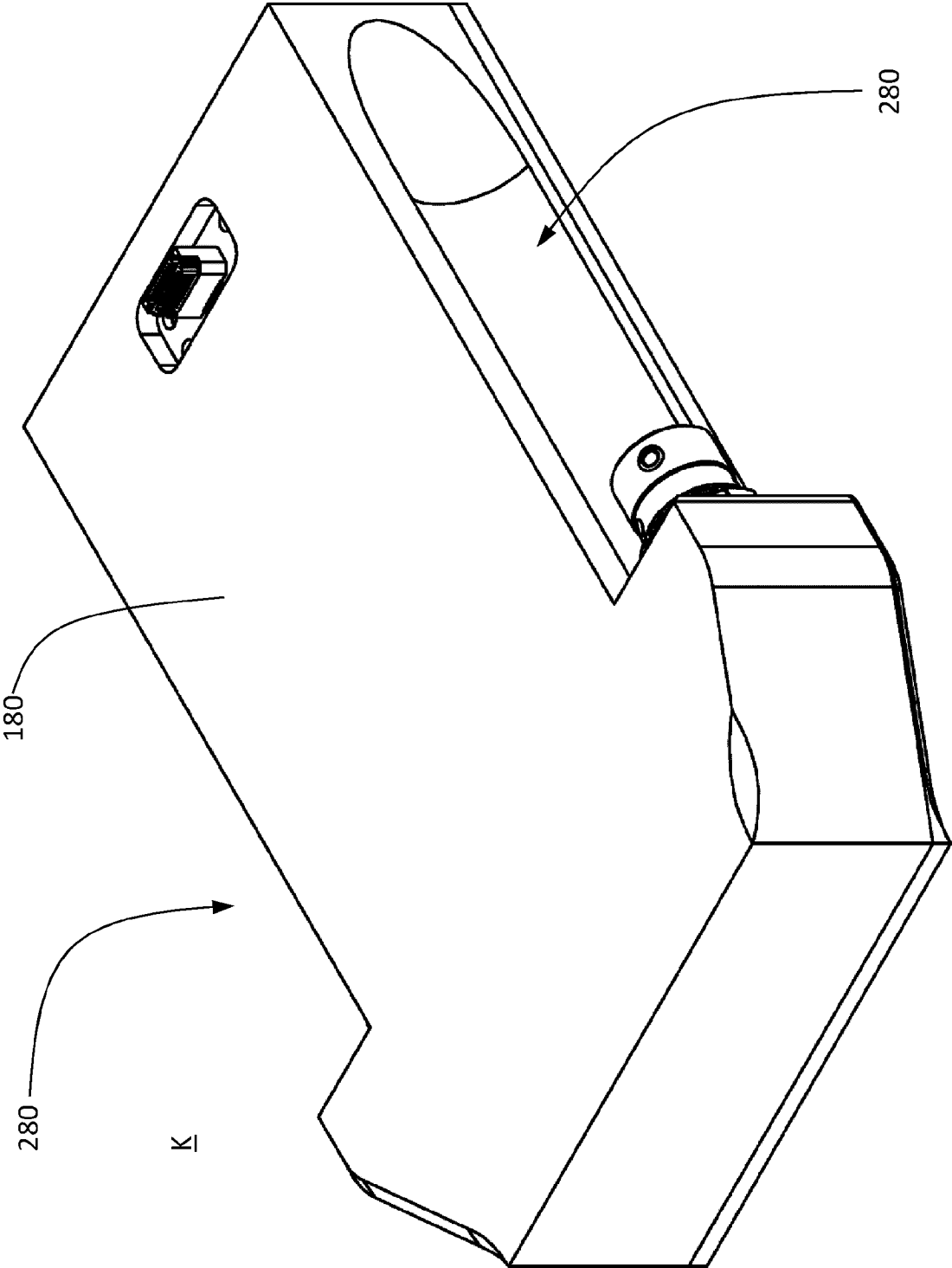


FIG. 14A

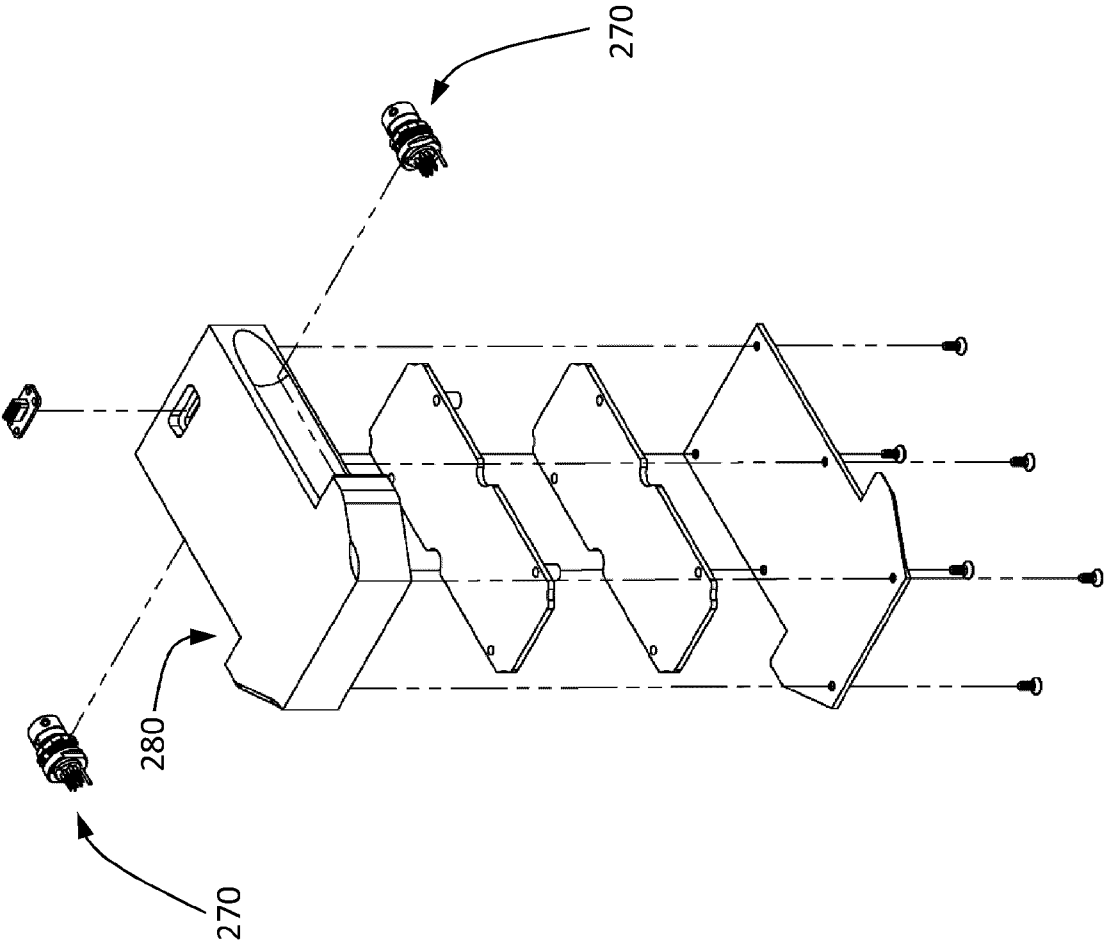


FIG. 15A

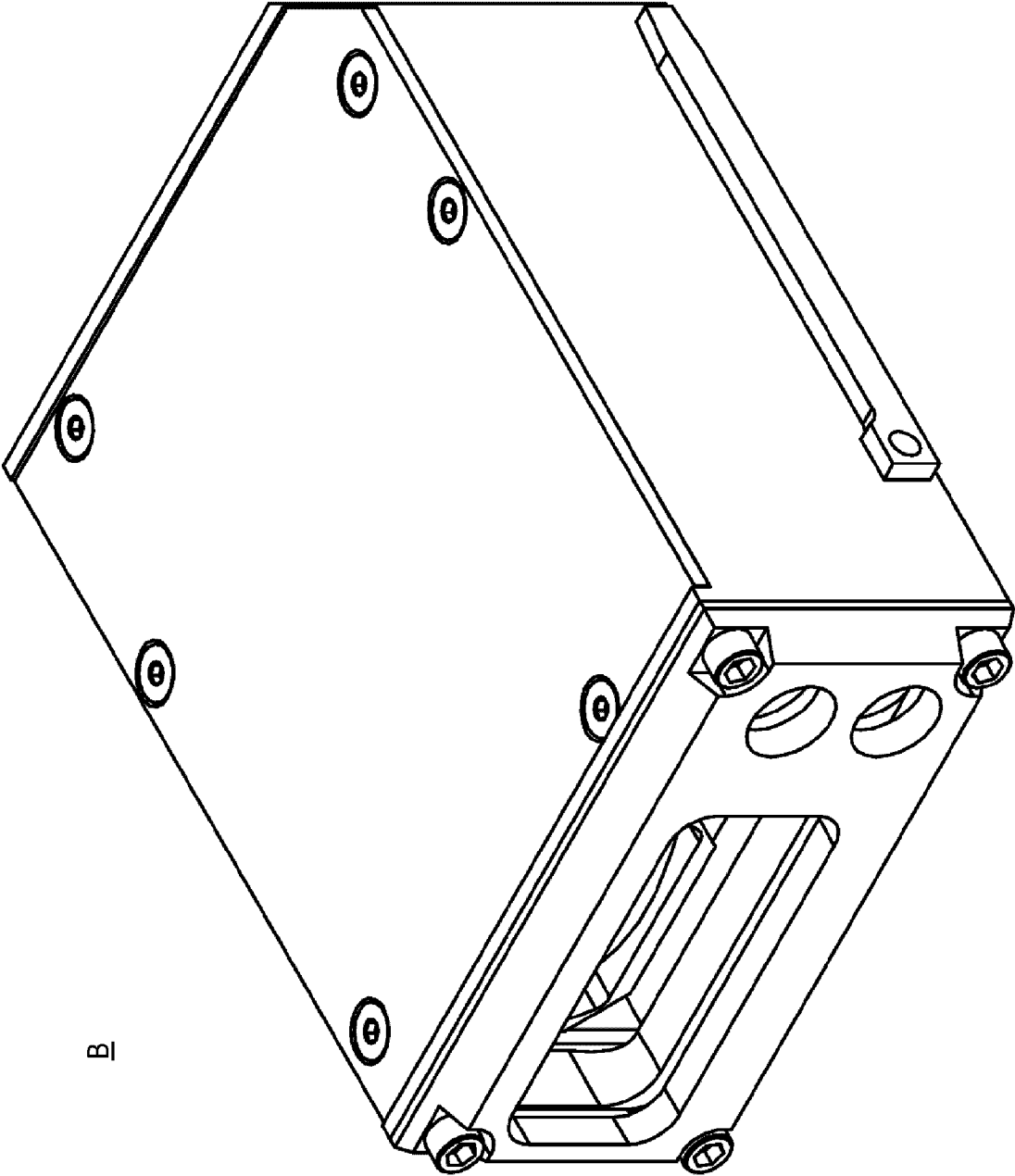


FIG. 16A

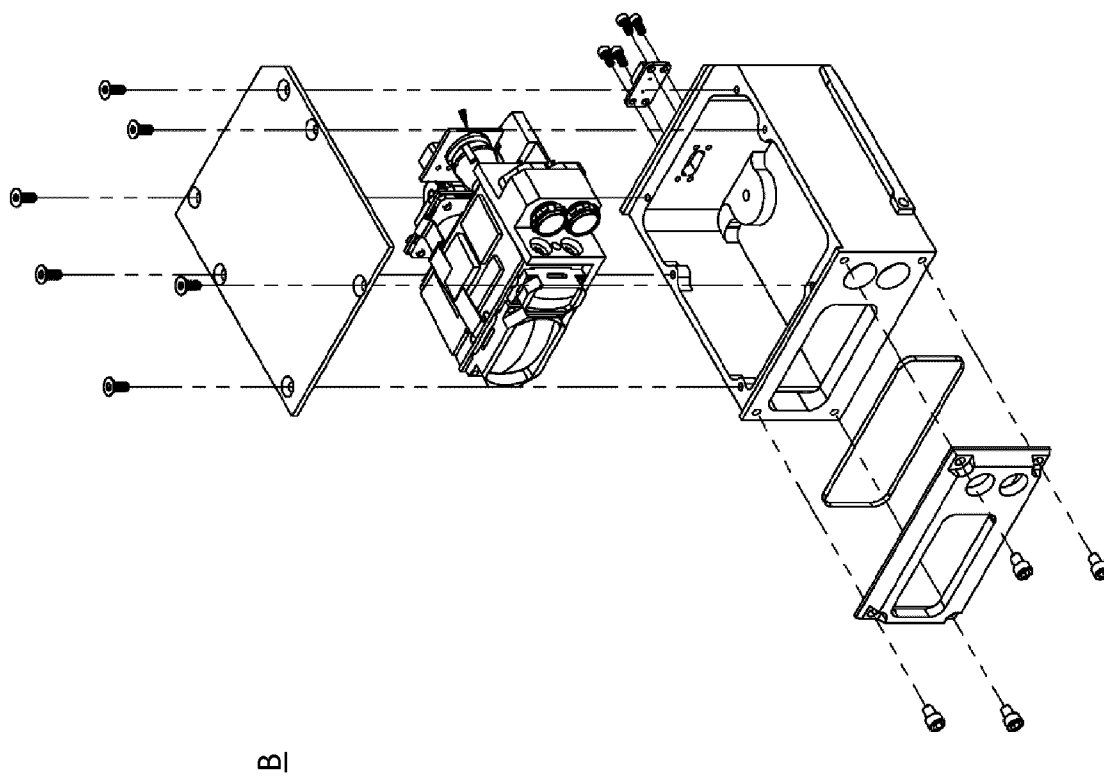


FIG. 17A

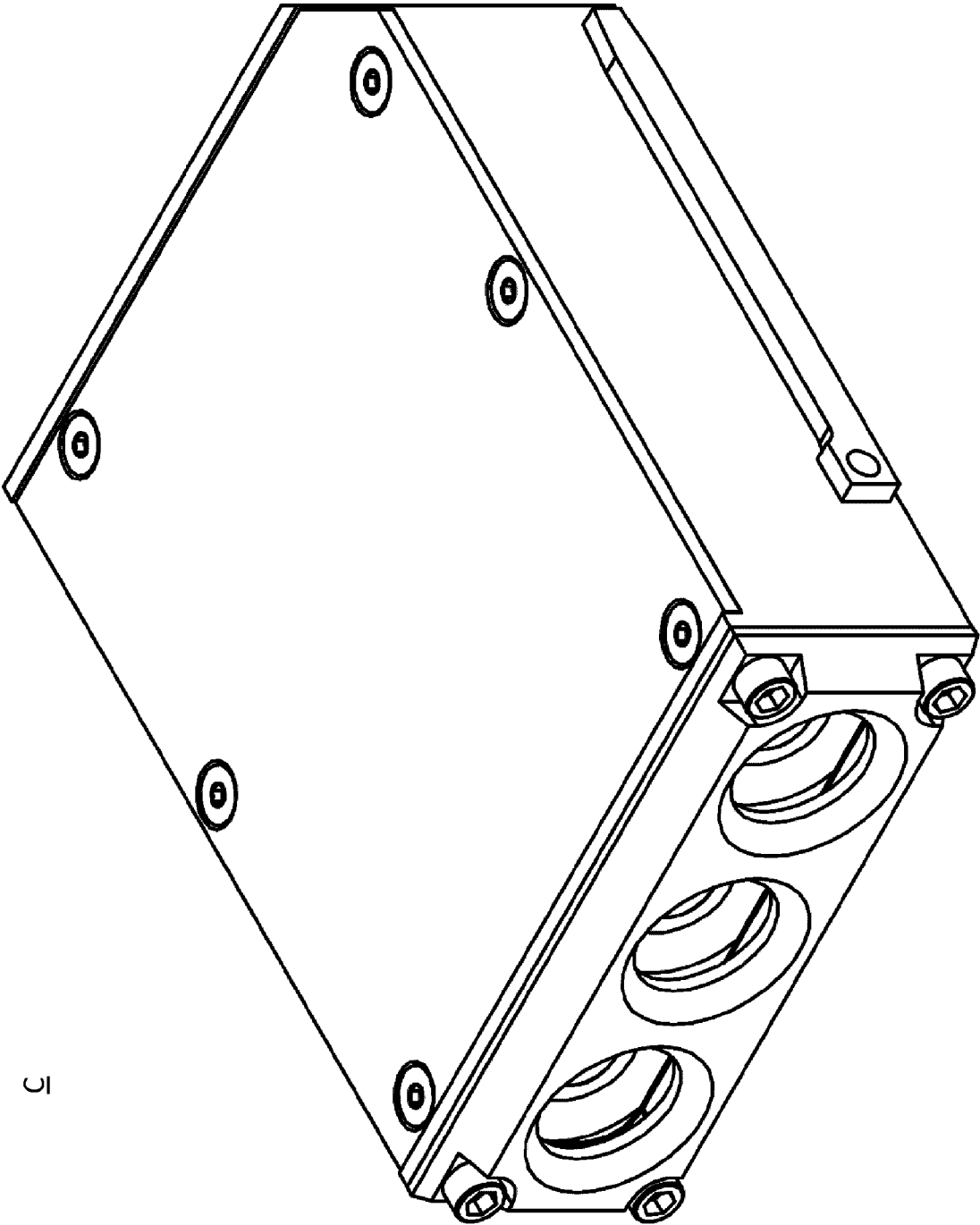


FIG. 18A

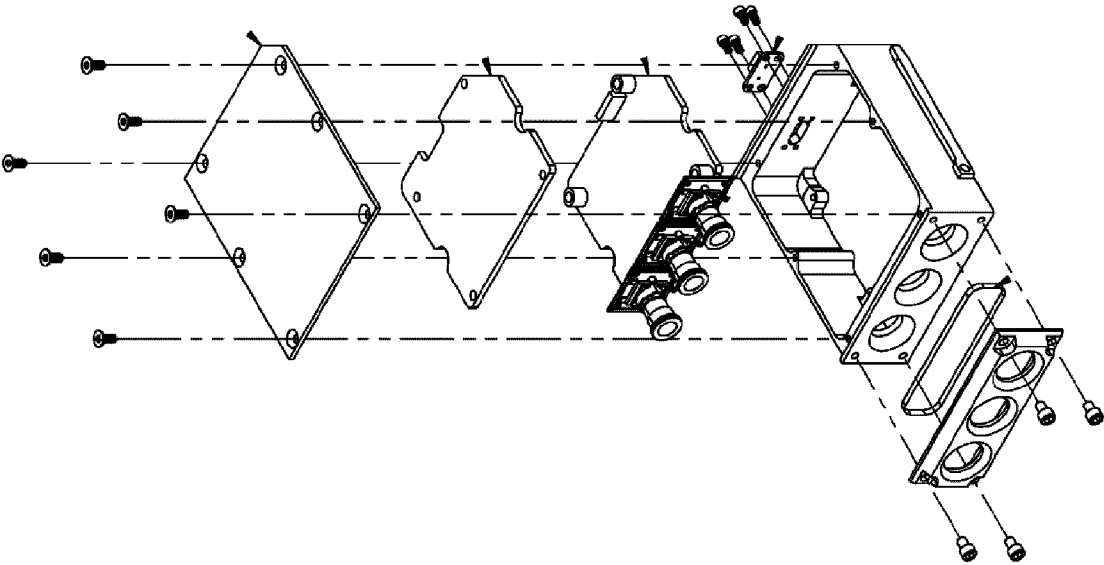


FIG. 19A

CI

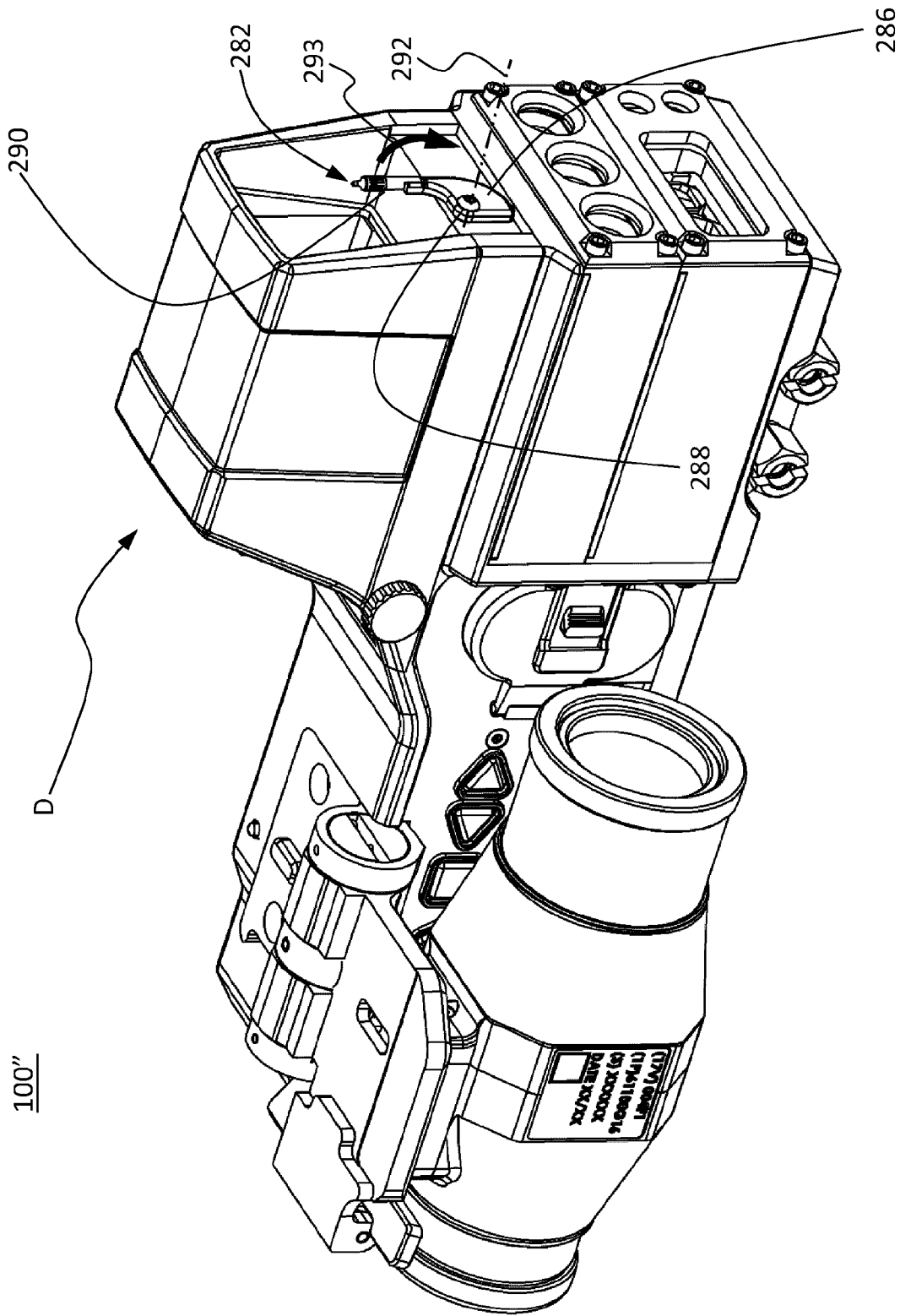


FIG. 20

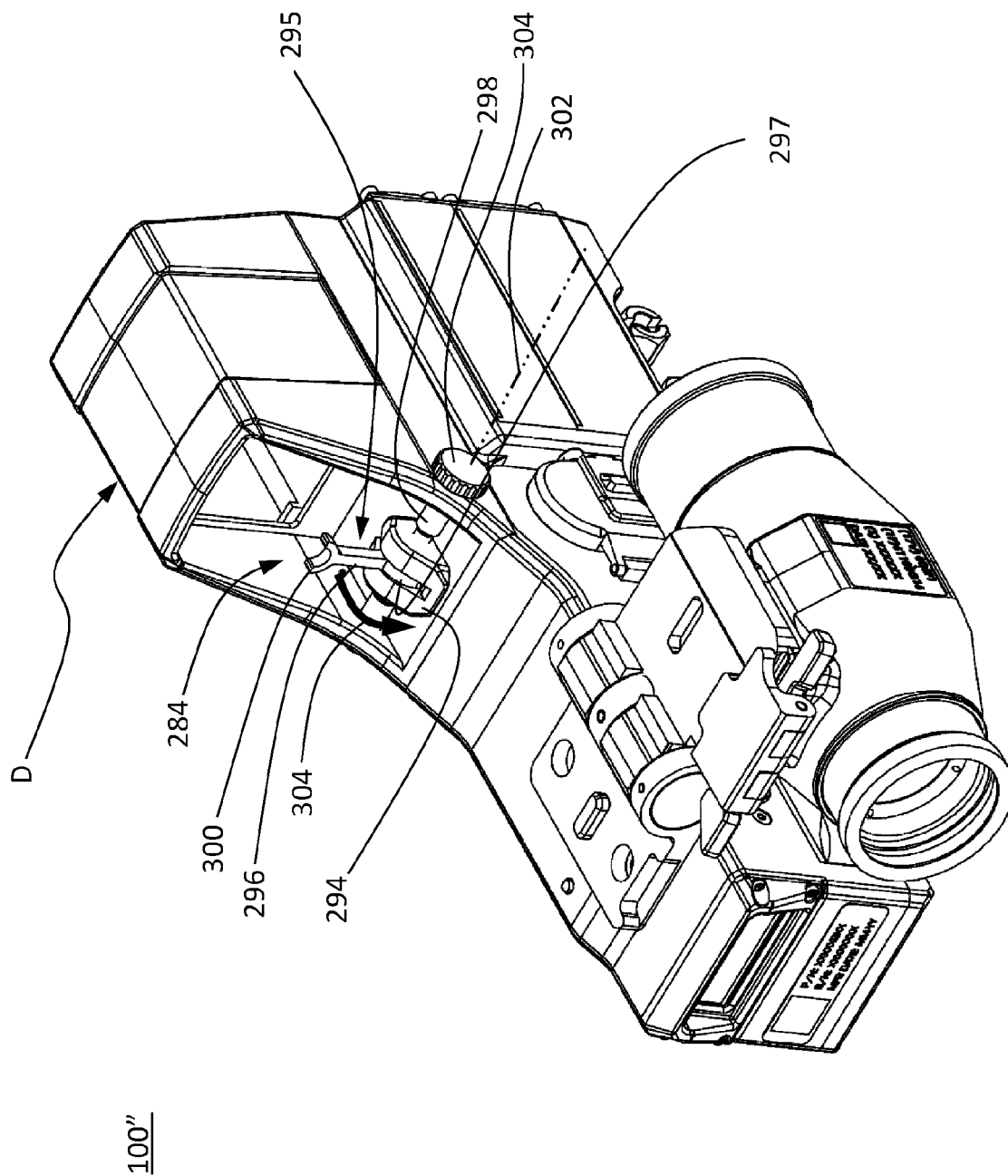


FIG. 21



## EUROPEAN SEARCH REPORT

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