



(51) International Patent Classification:

F41C 27/00 (2006.01) H01R 25/00 (2006.01)

F41A 35/00 (2006.01)

(21) International Application Number:

PCT/US2018/032792

(22) International Filing Date:

15 May 2018 (15.05.2018)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/506,533 15 May 2017 (15.05.2017) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: SYSTEM AND METHOD FOR NETWORKING FIREARM-MOUNTED DEVICES

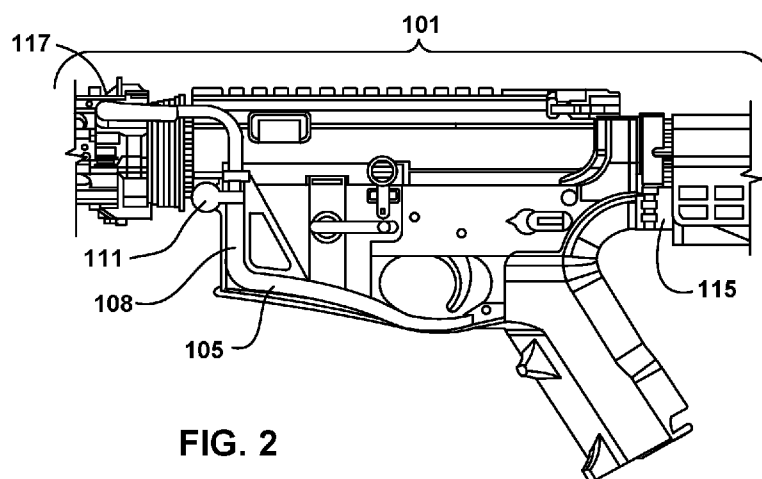


FIG. 2

(57) Abstract: An electronic system for a firearm includes a power source, one or more electrical conductors electrically connected to receive power from the power source, and a plurality of electronic devices. Each electronic device has an electrical input configured to receive power from the one or more electrical conductors to power the electronic device. A communication device is configured for data communication across the one or more electrical conductors. A method of communicating between electronic devices connected to a firearm includes powering a plurality of electronic devices connected to a firearm from a power source through one or more electrical conductors, and communicating data between the plurality of electronic devices across the one or more electrical conductors.

Published:

— *with international search report (Art. 21(3))*

SYSTEM AND METHOD FOR NETWORKING FIREARM-MOUNTED DEVICES

Cross-Reference to Related Applications

5 This application is being filed on 15 May 2018, as a PCT International patent application, and claims priority to and the benefit of U.S. Provisional Patent Application No. 62/506,533, filed May 15, 2017, entitled “SYSTEM AND METHOD FOR NETWORKING FIREARM-MOUNTED DEVICES, AND VIDEO CAPTURE AND TRANSMISSION FROM A FIREARM”, the disclosure
10 of which is hereby incorporated by reference herein in its entirety.

Introduction

Electronic devices such as lights, cameras, laser range finders, infrared sensors, displays, and radios are often added to firearms to improve the situational
15 awareness of the firearm user. However, these electronic firearm devices generally cannot interoperate and communicate with one another. Hence, there is a need for a secure and reliable communication system and method that allows electronic firearm devices to communicate with one another and to external devices for improving a
20 firearm user’s situational awareness.

Summary

In one aspect, the present disclosure relates generally to a system for networking firearm-mounted devices to one another and to an external device. In another aspect, the present disclosure relates to video capture and transmission from
25 a firearm.

In one aspect, the disclosed technology relates to an electronic system for a firearm. The electronic system includes a power source; one or more electrical conductors connected to receive power from the power source; and a plurality of electronic devices connected to the one or more electrical conductors. Each
30 electronic device includes an electrical input configured to receive power from the

one or more electrical conductors; and a communication device configured for data communication across the one or more electrical conductors.

In some examples, the electronic system further includes a controller node powered by the power source and configured to control the plurality of electronic
5 devices. In some examples, the controller node is configured to communicate data from the plurality of electronic devices to a portable electronic device. In some examples, the power source comprises AA batteries. In some examples, the electronic system is included in a firearm.

In another aspect, the disclosed technology relates an intelligent rail system
10 for a firearm. The intelligent rail system includes a power source; one or more electrical conductors electrically connected to receive power from the power source, at least part of the one or more electrical conductors being arranged on a rail; and a plurality of electronic devices, at least one electronic device is mounted to the rail. Each electronic device has an electrical input configured to receive power from the
15 one or more electrical conductors to power the electronic device; and a communication device for data communication across the one or more electrical conductors.

In some examples, the intelligent rail system further includes a controller node powered by the power source and configured to communicate data across the
20 one or more electrical conductors. In some examples, the controller node includes user adjustable switches. In some examples, the controller node is configured to transmit data from the plurality of devices to an external device. In some examples, the external device is a portable electronic device. In some examples, the controller node is configured to control power supply to the electronic devices. In some
25 examples, the power source comprises AA batteries. In some examples, the intelligent rail system is included in a firearm.

In another aspect, the disclosed technology relates to a method of communicating between electronic devices connected to a firearm. The method includes: powering a plurality of electronic devices connected to a firearm from a
30 single power source through one or more electrical conductors; and communicating data between the plurality of electronic devices across the one or more electrical conductors.

In some examples, the method further includes communicating data from the one or more electrical conductors to an external device. In some examples, the data communicated to the external device comprises a video stream captured from a video camera connected to the firearm.

5 In some examples, the method further includes embedding data from a first electronic device into a data stream of second electronic device. In some examples, the method further includes encapsulating the data in a packet structure of a communication protocol.

A variety of additional aspects will be set forth in the description that
10 follows. The aspects can relate to individual features and to combination of features. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the broad inventive concepts upon which the embodiments disclosed herein are based.

15 **Brief Description of the Drawings**

The following drawings are illustrative of particular embodiments of the present disclosure and therefore do not limit the scope of the present disclosure. The drawings are not to scale and are intended for use in conjunction with the explanations in the following detailed description. Embodiments of the present
20 disclosure will hereinafter be described in conjunction with the appended drawings.

FIG. 1 is a side view of a firearm with a power distribution system.

FIG. 2 is a detailed side view of the firearm with the power distribution system.

FIG. 3 is an isometric view of a power source for the power distribution
25 system.

FIG. 4 is a side view of the power source for the power distribution system.

FIG. 5 is an isometric view of an interconnection of a power rail connector to an intelligent rail in the power distribution system of the firearm.

FIG. 6 is an isometric view of the power rail connector.

30 FIG. 7 is a cross-sectional view of the power rail connector.

FIG. 8 is an exploded view of a handguard structure including the intelligent rail.

FIG. 9 is a top view of the handguard structure including the intelligent rail.

5 FIG. 10 is an end view of the handguard structure including the intelligent rail.

FIG. 11 is a plan view of a printed circuit board of the intelligent rail.

FIG. 12 is an isometric view of a printed circuit board of the intelligent rail.

FIG. 13 is an exploded isometric view of a printed circuit board.

10 FIG. 14 is an exploded view of an electrical interconnection for the intelligent rail.

FIG. 15 is an assembled view of an electrical interconnection for the intelligent rail.

FIG. 16 is a bottom isometric view of an electronic firearm device.

15 FIG. 17 is a cross-sectional view of the electronic firearm device connected to the intelligent rail.

FIG. 18 is a schematic diagram that illustrates a secure and reliable packet based communication system.

20 FIG. 19 is schematic diagram that illustrates an external communication interface.

FIG. 20 is schematic diagram that illustrates the intelligent rail and electronic firearm devices connected thereto.

FIG. 21 is a schematic illustration of a packet structure of a communication protocol.

25 FIG. 22 is an isometric view of a camera node.

FIG. 23 is an isometric view of a controller node.

FIG. 24 is a side view of a firearm with the intelligent rail and electronic firearm devices mounted thereto.

FIG. 25 is a side view of a firearm with the intelligent rail and electronic firearm devices mounted thereto.

FIG. 26 is a side view of a firearm with the intelligent rail and electronic firearm devices mounted thereto.

5 FIG. 27 is a side view of a firearm with the intelligent rail and electronic firearm devices mounted thereto.

FIG. 28 illustrates a method of communicating between electronic devices connected to a firearm.

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Detailed Description

Various embodiments will be described in detail with reference to the drawings, wherein like reference numerals represent like parts and assemblies throughout the several views. Reference to various embodiments does not limit the scope of the claims attached hereto. Additionally, any examples set forth in this
15 specification are not intended to be limiting and merely set forth some of the many possible embodiments for the appended claims.

FIG. 1 is a side view of a firearm 1 with a power distribution system 101. FIG. 2 is a detailed side view of the firearm 1 with the power distribution system 101. As shown in FIGS. 1 and 2, the firearm 1 includes a buttstock 21, a handguard
20 23, an upper receiver 27, a lower receiver 29, a barrel 31, a muzzle 33, a grip 35, and a front sight 37. While a military-style firearm is described herein, the power distribution system 101 can be added to a firearm, such as the firearm 1, as described herein as well as to other types of firearms, such as handguns, fixed-mount machine guns, bolt action rifles, etc.

25 The handguard 23 shrouds the barrel 31 of the firearm 1 to enable a user to grip the forward portion of the firearm 1. The handguard 23 mitigates the possibility of burning the user's hand when firing the firearm 1, while also providing adequate cooling for the barrel 31 of the firearm 1. The handguard 23 partially shields the barrel 31 like traditional Picatinny Rail.

The power distribution system 101 includes a power source 103 (shown in FIGS. 3 and 4), a power connector 105, an intelligent rail 107, and one or more electronic firearm devices 300 (shown in FIGS. 16 and 17) configured for attachment to the intelligent rail 107.

5 The handguard 23 and intelligent rail 107 are attached together to form a handguard structure which encircles the barrel 31 of the firearm 1. As used throughout this disclosure, the term "handguard structure" represents the sections of the handguard 23 and the intelligent rail 107 which encircle the barrel 31 as shown in FIG. 1. The intelligent rail 107 in effect forms facets around the periphery of the
10 resultant handguard structure.

In alternative examples, there is no requirement to include the handguard 23 as an integral component of the power distribution system 101. As such, the handguard 23 is optional, and the intelligent rail 107 can be attached to the firearm 1 in some other manner, such as by being attached to a rail on the upper receiver 27.

15 FIGS. 3 and 4 show the power source 103 of the power distribution system 101. In the example shown in FIGS. 3 and 4, the power source 103 is mounted inside a cavity 34 of the buttstock 21, and is a removable battery pack. In alternative examples, the power source 103 can be implemented in a number of assemblies and mounted on various portions of the firearm (such as in the handguard 23, in a pistol
20 grip, or in a remote power source, and the like).

The buttstock 21 includes a cam latch 32 for holding the power source 103. The buttstock 21 allows the power source 103 to be installed and removed through the rear of the firearm 1. The length of the buttstock 21 is adjustable such that the buttstock 21 can be extended in various multiple intermediate positions to provide
25 an adjustable length of the firearm 1. By moving the mass of the power source 103 to the rear on the firearm 1, the time to bring the firearm 1 to point, and to "stop" the muzzle when a target is acquired, are reduced.

Referring back to FIGS. 1 and 2, the power source 103 is electrically connected to the intelligent rail 107 via a wire routed inside a durable and impact
30 resistant polymer shroud 108 that conforms to the lower receiver 29. The shroud 108 is securely retained by a quick connect/disconnect pivot and takedown pin 111. The

wire in the shroud 108 runs from a power socket 115 at the power source 103 to a power rail connector 117 (shown in more detail in FIGS. 5-7). This configuration provides an easy access for replacing or repairing the cable assembly of the power distribution system 101, and eliminates snag hazards or interferences with the
5 firearm's operation, and requires no modification of the lower receiver 29.

FIG. 5 is an isometric view of an interconnection of the power rail connector 117 to the intelligent rail 107. FIG. 6 is an isometric view of the power rail connector 117. FIG. 7 is a cross-sectional view of the power rail connector 117. As shown in FIGS. 5-7, the power rail connector 117 has a housing 119 and
10 ruggedized power rail connector 121 where sealing integrity is maintained during exposure to adverse environmental conditions. The power rail connector 117 includes a metallic shell body, contact pin receptacle 123, with a multi-finger spring contact 125 assembled into the contact pin receptacle 123. The multi-finger spring contact 125 complies to variations in rail pin contacts 131 (shown in FIG. 15) to
15 ensure continuous current carrying capacity. The contact pin receptacle 123 includes a solder tail portion for soldering cable wires. A fastener 127 and retaining ring 129 can be used to secure the power rail connector 117 into the rail pin contacts 131 for supplying power to the intelligent rail 107.

The intelligent rail 107 electrically interconnects the power source 103
20 with various electronic firearm devices that can be mounted onto the intelligent rail 107. In some examples, the intelligent rail 107 can provide both mechanical support and electrical power to each firearm device. In these examples, the intelligent rail 107 can be attached to and be coextensive with the handguard 23 sections, such that the mounting of a power-consuming electronic firearm device on the intelligent rail
25 107 results in simultaneous mechanical and electrical interconnection.

FIG. 8 is an exploded view of the handguard structure including the intelligent rail 107. FIG. 9 is a top view of the handguard structure including the intelligent rail 107. As shown in FIGS. 8 and 9, the handguard structure includes a series of ridges with a T-shaped cross-section interspersed with flat "locking slots".
30 In this example, the handguard structure is a modified Picatinny Rail which has milling slots along the length of the mechanical accessory attachment points 23R in

the upper handguard section 23U and the lower handguard section 23L in order to install one or more power distribution printed circuit boards 60-1...60-4.

FIG. 10 is an end view of the handguard structure including the intelligent rail 107. FIG. 10 shows the slots formed in the various facets F1-F4 of the intelligent rail 107. As with a Picatinny Rail, apertures 25 (shown in FIG. 8) are provided along the length of the intelligent rail 107 to enable the barrel 31 of the firearm 1 to be cooled by air circulation from the ambient environment. Other intelligent rail configurations are possible, and the configuration shown in FIGS. 8-10 is provided as one example of the power distribution system 101.

One or more of the printed circuit boards 60-1...60-4 can be inserted into the respective slots formed in the intelligent rail 107, such as on the corresponding facets F1...F4 of the handguard 23, thereby enabling power-consuming electronic firearm devices 300 to be attached to the handguard 23 via the intelligent rail 107 and to be powered by a corresponding printed circuit board 60-1...60-4 of the intelligent rail 107.

FIG. 11 is a plan view of a printed circuit board 60-1 of the intelligent rail 107. FIG. 12 is an isometric view of another printed circuit board 60-2 of the intelligent rail 107. FIGS. 11 and 12 illustrate the architecture of the printed circuit boards 60-1 and 60-2 where power is applied via the positive connector contact 61P and the negative connector contact 61N. Power is routed by electrical traces on the printed circuit boards 60-1 and 60-2. The positive current from positive connector contact 61P is routed to the center of the printed circuit board where it is switched via operation of a switch (such as the snap dome switch 64 shown in FIG. 13) to contact 62P-5, while the negative current from the negative connector contact 61N is routed to a negative bus 62N (shown in the printed circuit board 60-1 of FIG. 11) or negative bus contact pads such as negative bus contact pads 62N-3, 62B-8 (shown in the printed circuit board 60-2 of FIG. 12). In the example printed circuit boards 60-1, 60-2 depicted in FIGS. 11 and 12, notches 68 are points of attachment which can be used to secure the printed circuit boards 60-1, 60-2 in a corresponding slot of the intelligent rail 107 via a pin clip arrangement.

In the example printed circuit boards 60-1, 60-2 of FIGS. 11 and 12, there are thirteen positions where a power-consuming electronic firearm device can be attached to contact the power contacts of the intelligent rail 107. For example, there are thirteen positive contacts 62P-1 to 62P-13. Also, as described above, in some examples, a continuous negative bus 62N is provided as the other power source connection (e.g., FIG. 11), and in other examples, negative power source connections are provided by individual negative bus contact pads 62N-1 to 62N-13 (e.g., FIG. 12). In other examples, there could be more than thirteen positions or fewer than thirteen positions where a power-consuming electronic firearm device can be attached to the intelligent rail 107, and the number of attachment points may vary as needed or required.

The positive contacts 62P-1, 62P-5 and negative contacts 62N-3, 62N-8 can be continuously powered, such as in the case where only one set of contacts is provided. In other examples, the positive contacts 62P-1, 62P-5 and the negative contacts 62N-3, 62N-8 can be switch activated by snap dome switches 64 placed over the positive and negative contacts.

The snap dome switches 64 can each have a pair of conductive contacts which are normally in the open mode. When the cover of the metallic snap dome switch 64 is depressed via a projection on the exterior surface of the power-consuming electronic firearm device, the conductive contacts mate and provide an electrical connection. The snap dome switches 64 have a curved metal dome that spans the positive and negative contacts such that when depressed, the dome snaps downward to electrically bridge the contacts. The positive contacts 62P and the negative contacts 62N can both be implemented using a low reflectivity contact.

FIG. 13 illustrates an exploded view of a power distribution printed circuit board assembly where a non-conductive layer 61 prevents the metal firearm rail from electrically shorting the power distribution printed circuit board 60-1. Spacer layer 63 is a non-conductive element which holds the snap dome switches 64 in place so they do not move laterally during assembly. Snap dome switches 64 provide the electrical switching action to the mounted rail devices. Top cover layer

65 provides environmental protection to the printed circuit board 60-1 and the snap dome switches 64 when the aforementioned layers are assembled.

FIGS. 14 and 15 show the printed circuit boards 60-1 to 60-4 soldered to interconnected conductive busses 72, 74. As shown in FIG. 14, the power rail connector 117 can be pressed into rail pin contacts 131 in the conductive buses 72, 74. Retaining clips 71 made from a resilient metallic spring material are anchored on an upper rail connector 75, and are used to securely hold the upper rail connector 75 together with a lower rail connector 76.

FIG. 16 is a bottom isometric view of an electronic firearm device 300. The electronic firearm device 300 has a rail grabber 301, spring contacts 302, spring plungers 303, and face seals 304. The spring plungers 303 depress the snap dome switches 64, the spring contacts 302 provide electrical contact with the fixed electrical bus contacts 62N and 62P on the intelligent rail 107, and the face seals 304 provide environmental protection.

FIG. 17 is a cross-sectional view of the electronic firearm device 300 connected to the intelligent rail 107. The electronic firearm device 300 can be mechanically attached to the intelligent rail 107 via a screw clamp 306 as shown. As described above, the electronic firearm device 300 includes a pair of spring contacts 302 which contact corresponding low reflectivity contacts 62N and 62P mounted on the printed circuit board 60-3. Similarly, the electronic firearm device 300 has a spring plunger 303 which contacts a corresponding snap dome switch 64 mounted on printed circuit board 60-3.

A challenge of mounting the electronic firearm device 300 to the intelligent rail 107 is that it may not readily interoperate with other electronic firearm devices on the intelligent rail 107, which may use different communication protocols. Thus, the following describes a secure and reliable packet based communication system and method for electronic firearm devices, such as the electronic firearm device 300, and including but not limited to video cameras, lights, laser range finders, radios, night vision products, displays, and computers to communicate with each other and to communicate with external devices when mounted to a firearm.

The communication protocol makes use of the intelligent rail 107 described above, which supplies power from power source 103 to the electronic firearm devices. Because of the shared physical power connection in the intelligent rail 107, data can be shared reliably and securely between the electronic firearm devices. The communication method allows the firearm-mounted devices to interoperate, and through encrypted RF, communicate to remote devices. The medium of the intelligent rail 107 can be used to share data such as commands and controls, configurations, software updates, and sensor data, and also provides for remote operation. In one embodiment, a through-scope video camera communicates over the intelligent rail 107 to a controller module 400. The controller module 400 then uses a communication means, such as Wi-Fi, to communicate a live video stream to an external device 401, such as a smart phone.

FIG. 18 shows an architecture of the intelligent rail 107 that allows data to be transferred between electronic firearm devices mounted to the intelligent rail 107. FIG. 19 shows an external communication interface for the intelligent rail 107. In some embodiments the intelligent rail 107 superimposes (sums) two voltages including the static voltage that provides the power for powering the electronic firearm devices mounted to the intelligent rail 107, and a second dynamic, time-varying voltage that encodes and transfers data between the electronic firearm devices. In some examples, the (nominally) static voltage for power is coupled from the power source to nodes (i.e., electronic firearm devices), such as via one or more or a series of conductors or inductors. Further, in some examples, the dynamic (signal) voltage is coupled from node to node via a series of capacitors. The ability to transfer data on the intelligent rail 107 facilitates the networking of the electronic firearm devices, including interoperation of video capture and transmission devices.

FIG. 20 shows a topology of the intelligent rail 107 and the electronic firearm devices 300 connected thereto. As described above, the power source 103 provides power to the electronic firearm devices 300 via the power distribution system 101. The electrical interconnection for each electronic firearm device 300 on the intelligent rail 107 is also used as the communication medium between each of the electronic firearm devices 300.

The communication protocol provides for full support of industry standard TCP/IP, UDP/IP, and ICMP/IP packet based communication protocols. The packet transmissions are “reliable” in that cyclic redundancy check (CRC) is used, and a sending device receives an acknowledgement packet from a receiving device. Packet
5 retrievers are also supported. In one example, streaming video is supported using UDP/IP and the “sliding window protocol.” Communications are secure using encryption and the network is scalable and extensible.

FIG. 21 shows the packet structure 403 of the communication protocol. The IP packets are encapsulated with a preamble (used to recover timing
10 information) and a start byte for synchronization. Node address, packet length, and cyclic redundancy check (CRC) bytes are added to ensure reliable transmission.

The packet flow is as follows: industry standard IP packets are placed in a transmitter of a communication module of an electronic firearm device 300 by a microcontroller in the electronic firearm device 300. The communication module
15 comprises a receiver and a transmitter. In one example, the receiver and the transmitter of the communication module are first in, first out (FIFO) components. The packet is then encapsulated with a preamble, start byte, node destination address, packet length, and CRC bytes. This forms a packet for communication between the electronic firearm devices 300 on the intelligent rail 107. The packet is
20 then converted from bytes to bits, modulation encoded, and then broadcast over the intelligent rail 107 to all electronic firearm devices 300 connected thereto. In one embodiment, Manchester encoding is used as the modulation scheme.

The received packets are demodulated by each electronic firearm device 300 on the intelligent rail 107. Next, an electronic firearm device 300 determines if
25 its address matches the destination address in the packet. If there is an address match, the electronic firearm device 300 converts the packet from bits to bytes, de-encapsulates the packet’s header and CRC. The bytes are loaded into the receiver of the communication module of the electronic firearm device 300, and the device’s microcontroller is notified. In one example embodiment, the packets are modulated
30 and demodulated by each electronic firearm device 300 according to time-domain multiplexing techniques, but other methods such as frequency-division multiplexing

and code division multiplexing or some combination of all the above may be employed.

Communication between electronic firearm devices 300 from different manufactures is accomplished by an established protocol standard. In one
5 embodiment, JSON messages are used as the standard communication protocol between the electronic firearm devices. Where the firearm's communication channel is found to be unreliable or noisy, the packet encapsulation can be extended to include forward error correction (FEC), Viterbi decoding, and ECC. This communication method leverages industry standard Ethernet stack, supports
10 collision detection with retransmission of packet, and provides timing recovery from packet data.

In one example, the communication method described above can be used for video collection and transmission by a video capture and transmission devices that are mounted to a firearm. By communicating on the intelligent rail 107, multiple
15 video capture and transmission devices may be coordinated to deliver a multitude of video streams or to aggregate supplementary data into the video stream and/or to permit coordinated command and control of the video capture and transmission devices.

The intelligent rail 107 permits the use of video capture and transmission
20 devices that can transmit video data externally. For example, this could be of particular value for the collection of and dissemination of video data from armed services or law enforcement. As an example, armed services or law enforcement may seek to gather reconnaissance data for various reasons such as for conducting operations, tactics, and/or combat.

25 Likewise, video data may be useful for historic records of events. A forward soldier or officer has a privileged position to witness vital information, and the ability to convey that information from his or her environment would provide a wealth of knowledge to peers and commanders. At the same time, the soldier or officer in the field of operation should not be unduly burdened with heavy and/or
30 bulky video equipment. Thus, fitting on a firearm small, lightweight devices of

video capture and transmission that are configured to communicate with an external device would provide significant advantages.

The intelligent rail 107 is a medium for digital data exchange between electronic firearm devices as well as a power supply for each device. This reduces the weight and bulk of each video capture and transmission device because each device does not need to have its own power source. The video data is digitized so that it may be compressed and exchanged efficiently with other devices on the intelligent rail 107 and externally to devices separate from the firearm via standardized networking protocols. Furthermore, digitization permits encryption of the data.

Use of the intelligent rail 107 further permits integration of command and control of the video capture and transmission devices by other devices operated by the firearm user, or even by remote operators such as those located at central command or headquarters.

FIG. 22 depicts a camera node 500. The camera node 500 includes a lens and integrated image sensor 503, and microprocessors 502 which convert digital video data captured from the lens and integrated image sensor 503 into compressed digital data. The compressed digital data can be used for networked video streams, and in one example, the camera node 500 uses an H.264 for the encoder and MPEG-TS packetization.

A microcontroller and analog interface 501 transfers the compressed data from the camera node 500 to the intelligent rail 107, and transfers data from the intelligent rail 107 to the camera node 500 to control the operation of the camera node 500. The camera node 500 connects to the intelligent rail 107 physically using mechanical and electrical contacts 504.

Multiple camera nodes may be connected to the intelligent rail 107. For example, multiple camera nodes may be used to capture visible light, or infrared light for night vision. The multiple camera nodes may be positioned to aim along the rail of the firearm. Also, by the use of lenses, a camera node may capture an image directly from of the scope of the firearm.

FIG. 23 depicts a controller node 600. The controller node 600 has operator buttons 604 and circuits 603 typical of the other electronic firearm devices connected to the intelligent rail 107, such as a microcontroller to operate the controller node 600 and an analog interface to the intelligent rail 107. The controller node 600 also includes mechanical and electrical interfaces 601 to mechanically and electrically connect the controller node 600 to the intelligent rail 107. The controller node 600 includes an RF (radio frequency) interface 602 which has an antenna and an RF transceiver. The RF interface 602 permits the transfer of data on and off the intelligent rail 107 with external networks. In one example, WiFi is used as an external network for transferring data from the intelligent rail 107 to an external device, such as a smartphone device.

The operation of the camera node 500 and the controller node 600 makes use of the communication protocol described above which utilizes packet transmissions. When power is applied to the intelligent rail 107, electronic firearm devices connected to the intelligent rail 107, including the camera node 500 and the controller node 600, establish network communications amongst themselves. Thus, when a firearm is configured with the intelligent rail 107, one or more camera nodes 500 and the controller node 600 can be operated by a user as follows.

The user can manipulate the operator buttons 604 to select which camera nodes 500 to activate. When activated, the one or more camera nodes 500 capture video data from the lens and integrated image sensor 503. Each of the one more camera nodes 500 convert the video data to digital video data, compress the digital video data according to industry-standard CODEC's, and encapsulate the digital video data into network packets. In one example, each of the one or more camera nodes 500 uses an H.264 for the encoder and MPEG-TS packetization.

The network packets are then transferred to the intelligent rail 107 via the network protocol described above. While the digital video data is being generated, other nodes (i.e., devices) on the intelligent rail 107 may be collecting other types of data, such as position of the user, the bearing of the firearm, range to target, timestamps, etc. This data can be sent from the collecting node (i.e., the device that

captures this data) to the camera node 500 or to the controller node 600, where the data may be inserted into the video data stream.

In one example, Key-Length-Value (KLV) is used to embed the data from a collecting node into the video data stream. The data may be encrypted at the camera node 500, or the data may be encrypted at the controller node 600. In one example, encryption is done on the WiFi link using Advanced Encryption Standard (AES). Finally, the video data can be transferred from the intelligent rail 107 of the firearm through an RF interface on the controller node 600 so that the data can be sent to an external device, such as a smartphone device.

FIGS. 24-27 show example implementations of the intelligent rail 107 on a firearm 700. In these examples, the firearm 700 is a carbine assault rifle, however, as discussed above, the intelligent rail 107 is not limited to rifles, and can be implemented on a variety of firearms including handguns. FIG. 24 shows the firearm 700 equipped with a 3-button control pad 701, a master on/off switch 702, and a battery pack 703 which is used in this example as the power source for powering an intelligent rail 107.

FIG. 25 shows close-up views of the 3-button control pad 701 and the master on/off switch 702. The 3-button control pad 701 can be used by the firearm user to activate the one or more electronic devices mounted to the firearm 700 as well as to send data from the one or more electronic devices to an external device such as a smartphone device. The master on/off switch 702 is for turning on or off the intelligent rail 107, and hence, turning on or off the electronic devices mounted to the firearm 700.

FIG. 26 shows multiple electronic firearm devices can be mounted to the intelligent rail 107 on the firearm 700 having an adjustable buttstock 721. For example, electronic firearm devices such as a through-scope camera 705, an optic riflescope 707 such as an M150 ACOG 4x32, an aiming & range-finding laser 709, a white light 711, a wide-angle camera 713, etc. can be mounted to the intelligent rail 107 on the firearm 700.

FIG. 27 shows close-up views of the through-scope camera 705, the optic riflescope 707, the aiming & range-finding laser 709, the white light 711, and the

wide-angle camera 713. The electronic firearm devices shown in FIGS. 26 and 27 are just some examples of the devices that can be mounted to the firearm 700 and it is intended that many more types of electronic firearm devices can be mounted to the intelligent rail 107 of the firearm 700.

5 FIG. 28 illustrates a method 500 of communicating between electronic devices connected to a firearm. The method 500 includes a step 502 of powering a plurality of electronic devices connected to a firearm from a single power source through one or more electrical conductors. The method 500 further includes a step 504 of communicating data between the plurality of electronic devices across the
10 one or more electrical conductors.

 In some examples, the method 500 further includes communicating data from the one or more electrical conductors to an external device. In some examples, the data communicated to the external device is a video stream captured from a video camera connected to the firearm.

15 In some examples, the method 500 further includes embedding data from a first electronic device into a data stream of second electronic device. In some examples, the method 500 includes encapsulating the data in a packet structure of a communication protocol.

 The various embodiments described above are provided by way of
20 illustration only and should not be construed to limit the claims attached hereto. Those skilled in the art will readily recognize various modifications and changes that may be made without following the example embodiments and application illustrated and described herein, and without departing from the true spirit and scope of the following claims.

25

What is claimed is:

1. An electronic system for a firearm, the electronic system comprising:
a power source;
5 one or more electrical conductors connected to receive power from the power source; and
a plurality of electronic devices connected to the one or more electrical conductors, each electronic device having:
an electrical input configured to receive power from the one
10 or more electrical conductors; and
a communication device configured for data communication across the one or more electrical conductors.
2. The electronic system of claim 1, further comprising a controller node
15 powered by the power source and configured to control the plurality of electronic devices.
3. The electronic system of claim 2, wherein the controller node is configured to communicate data from the plurality of electronic devices to a portable electronic
20 device.
4. The electronic system of claim 1, wherein the power source comprises AA batteries.
- 25 5. A firearm comprising the electronic system of claim 1.
6. An intelligent rail system for a firearm, the intelligent rail system comprising:
a power source;
30 one or more electrical conductors electrically connected to receive power from the power source, at least part of the one or more electrical conductors being arranged on a rail; and

a plurality of electronic devices, at least one electronic device is mounted to the rail, and each electronic device having:

- an electrical input configured to receive power from the one or more electrical conductors to power the electronic device; and
- 5 a communication device configured for data communication across the one or more electrical conductors.

7. The system of claim 6, further comprising a controller node powered by the power source and configured to communicate data across the one or more electrical
10 conductors.

8. The system of claim 7, wherein the controller node includes user adjustable switches.

15 9. The system of claim 7, wherein the controller node is configured to transmit data from the plurality of devices to an external device.

10. The system of claim 9, wherein the external device is a portable electronic device.

20 11. The system of claim 7, wherein the controller node is configured to control power supply to the electronic devices.

12. The system of claim 6, wherein the power source comprises AA batteries.

25 13. A firearm comprising the electronic system of claim 6.

14. A method of communicating between electronic devices connected to a firearm, the method comprising:

30 powering a plurality of electronic devices connected to a firearm from a single power source through one or more electrical conductors; and

communicating data between the plurality of electronic devices across the one or more electrical conductors.

15. The method of claim 14, further comprising communicating data from the
5 one or more electrical conductors to an external device.

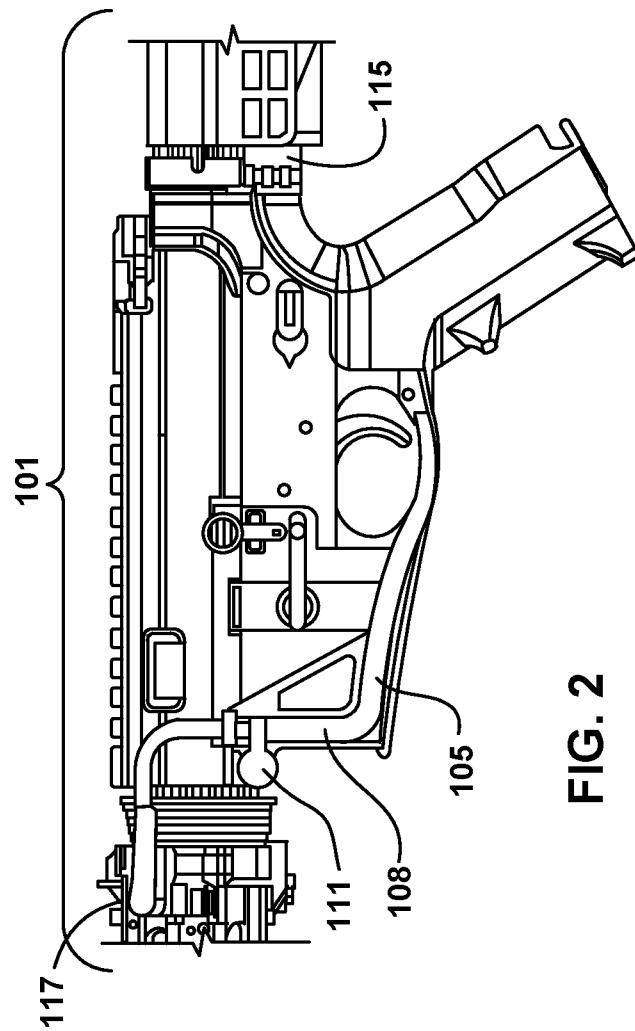
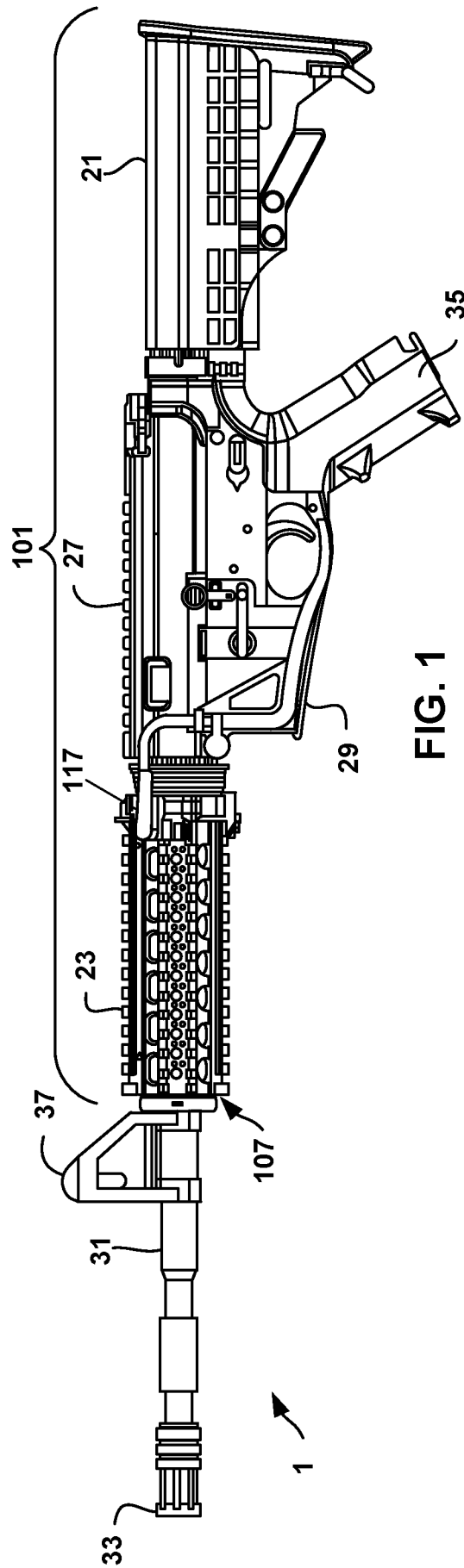
16. The method of claim 15, wherein the data communicated to the external device comprises a video stream captured from a video camera connected to the firearm.

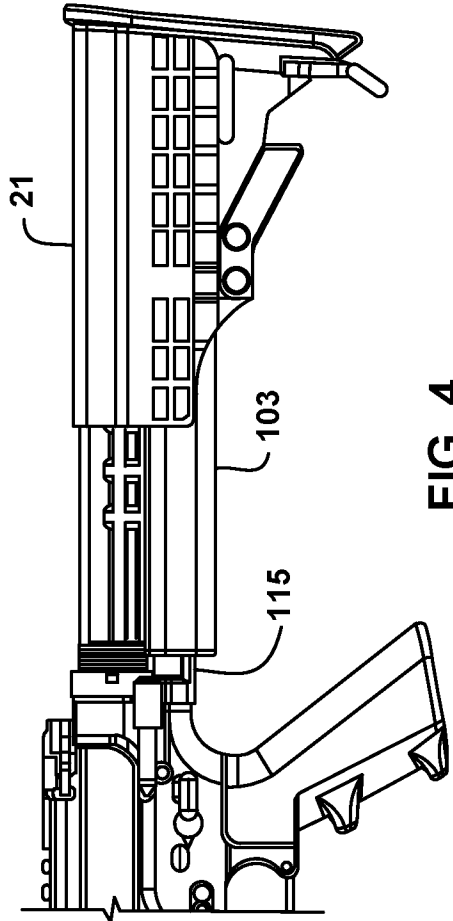
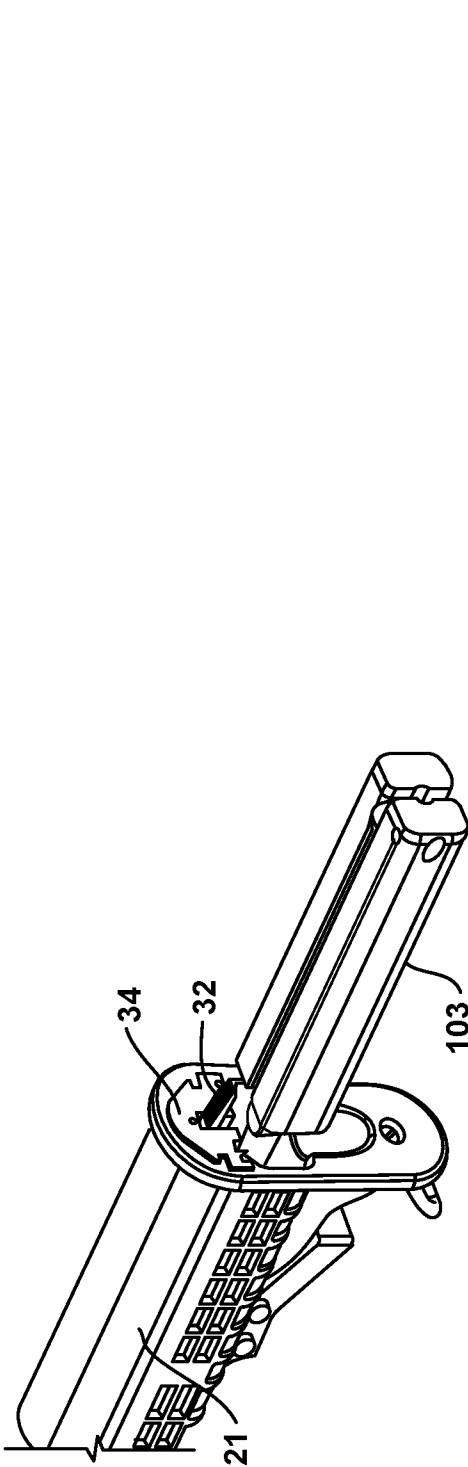
10

17. The method of claim 14, the method further comprising embedding data from a first electronic device into a data stream of second electronic device.

18. The method claim 14, further comprising encapsulating the data in a packet
15 structure of a communication protocol.

20





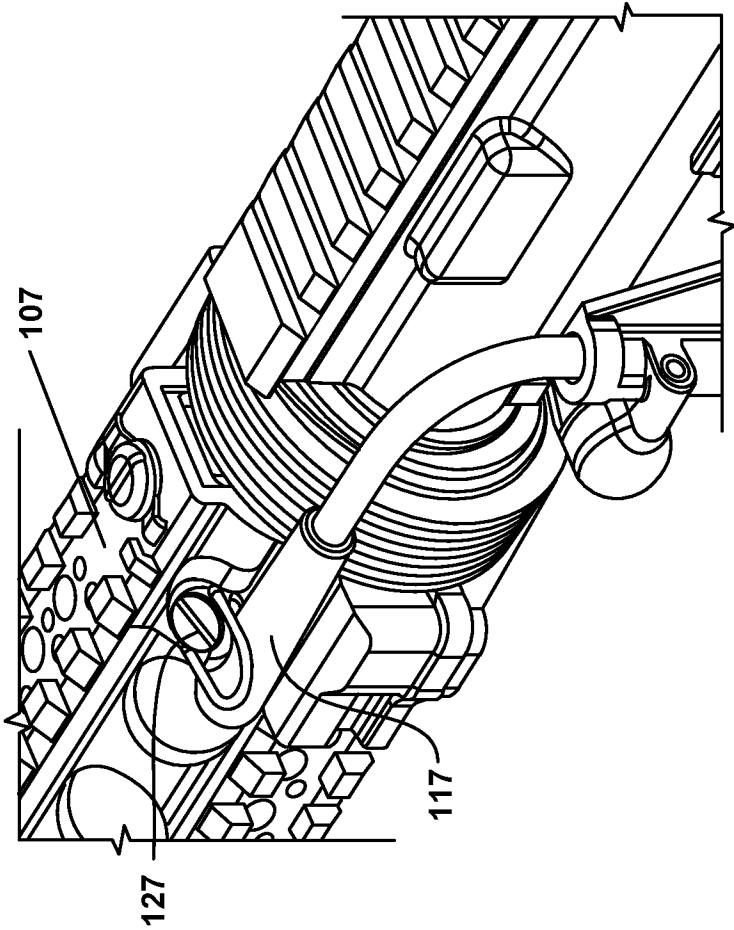


FIG. 5

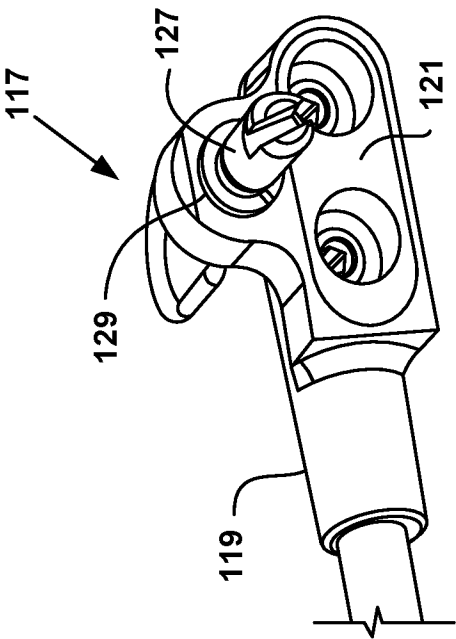


FIG. 6

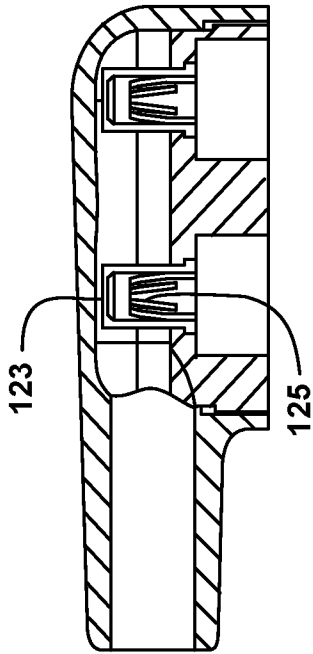


FIG. 7

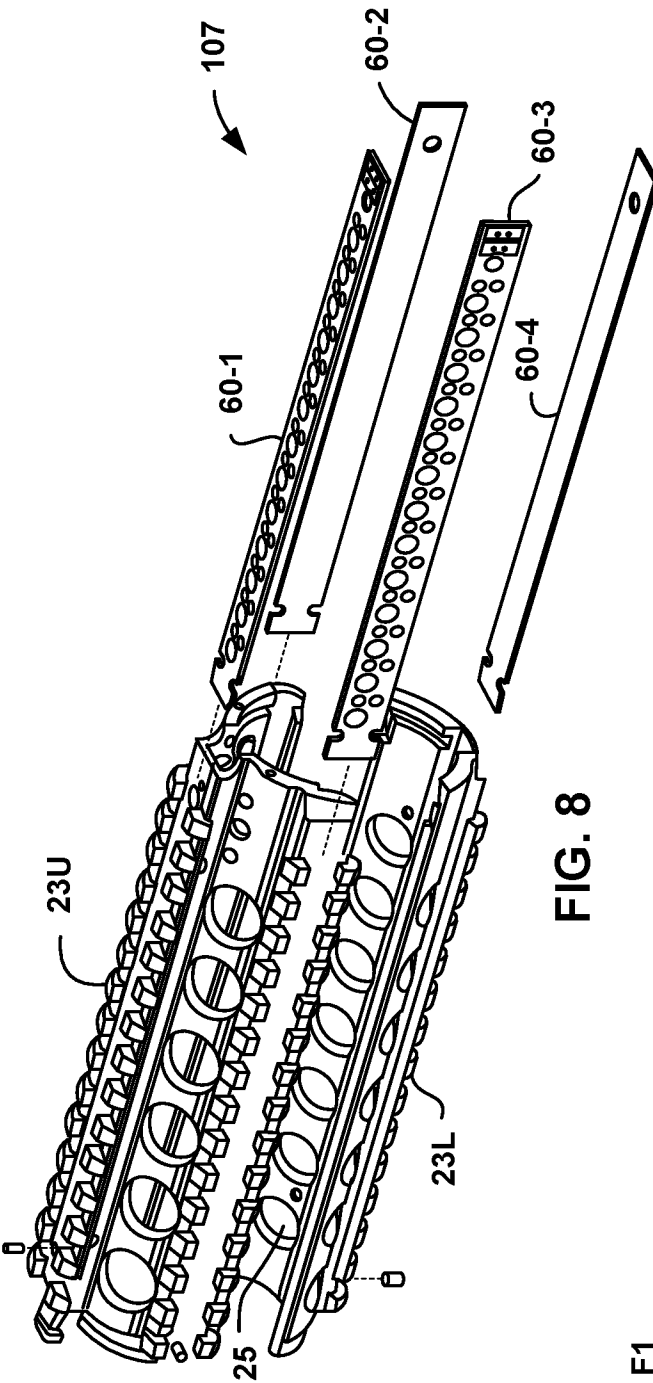


FIG. 10

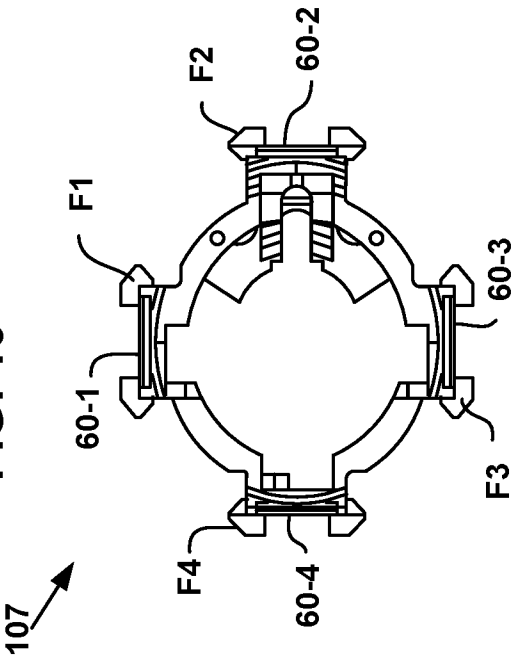
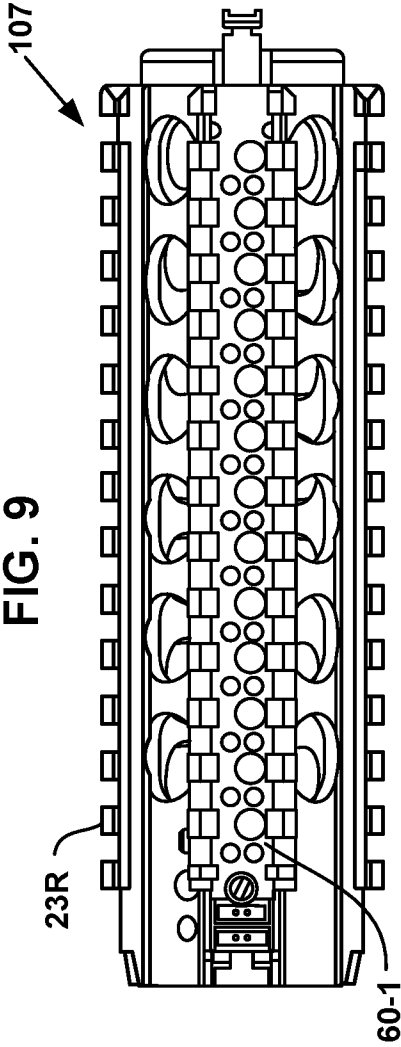


FIG. 9



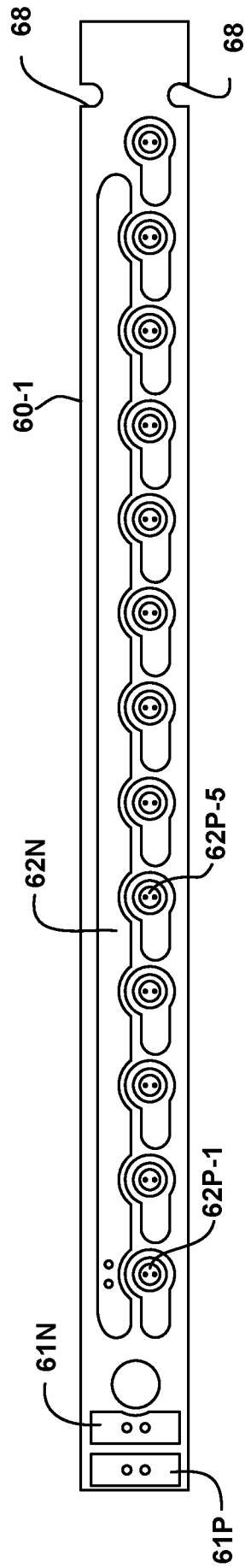
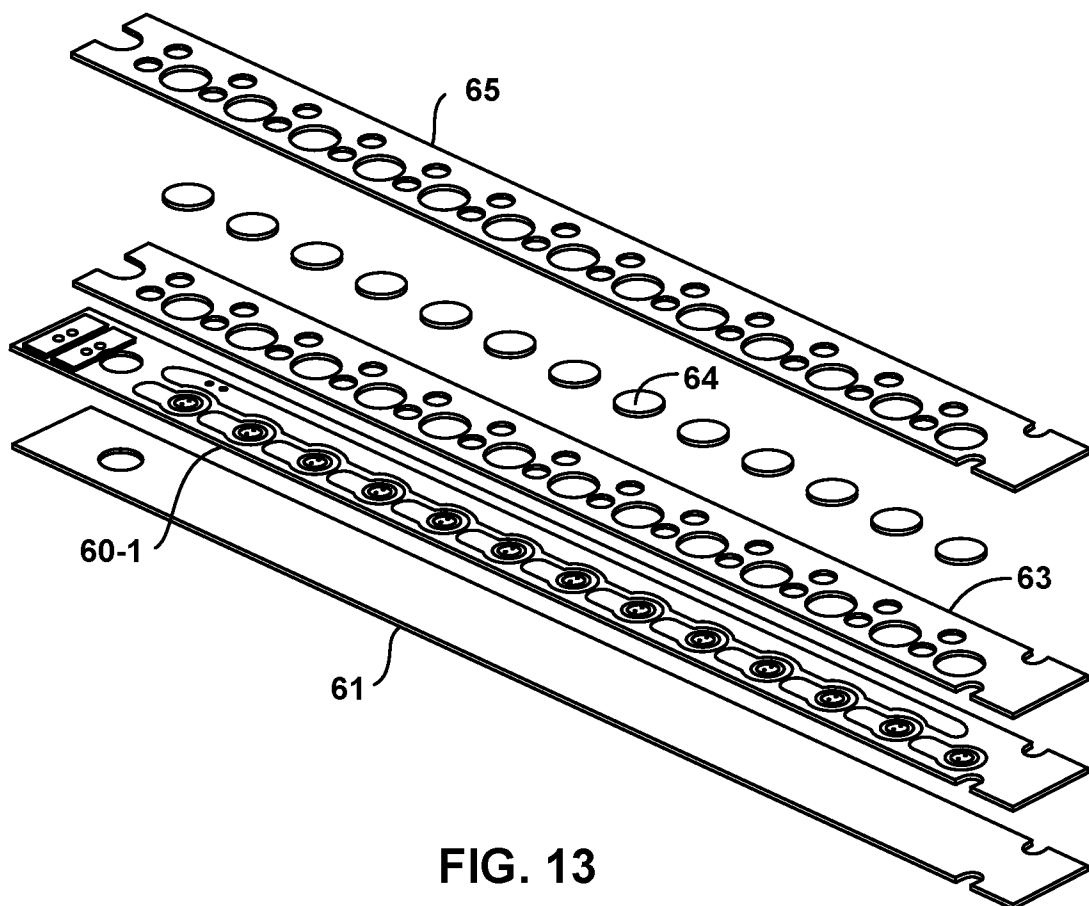
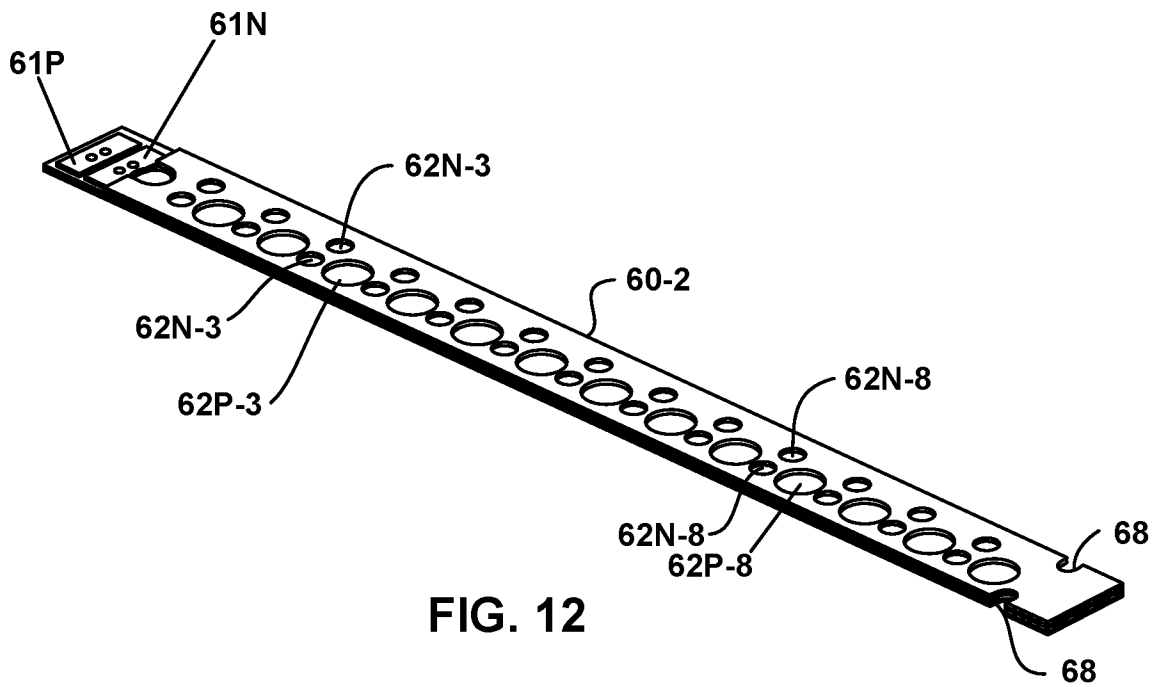


FIG. 11



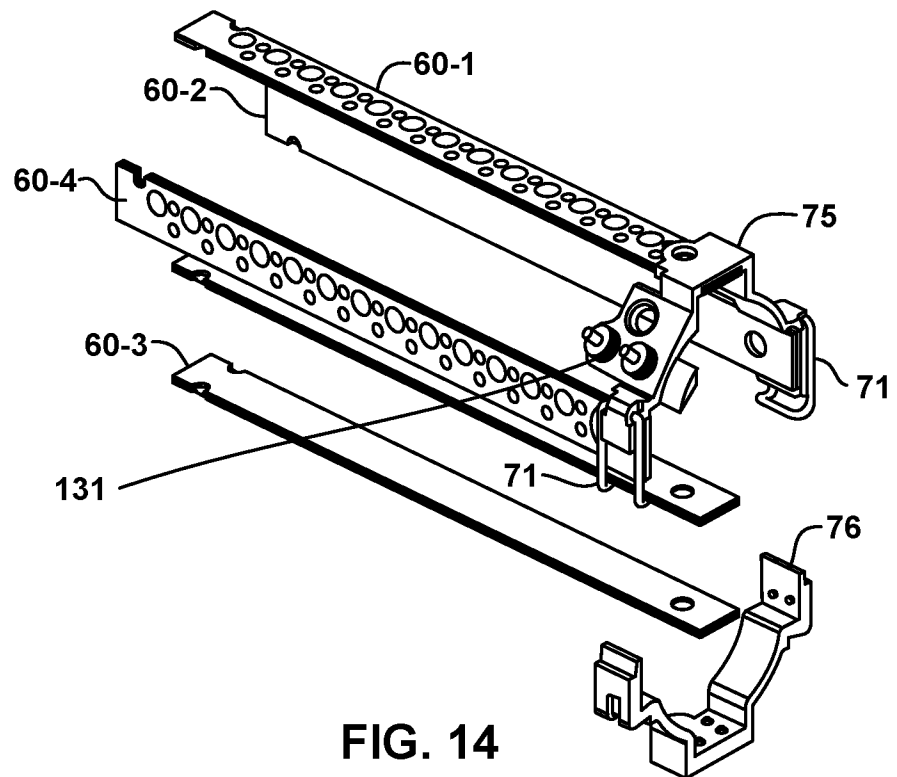
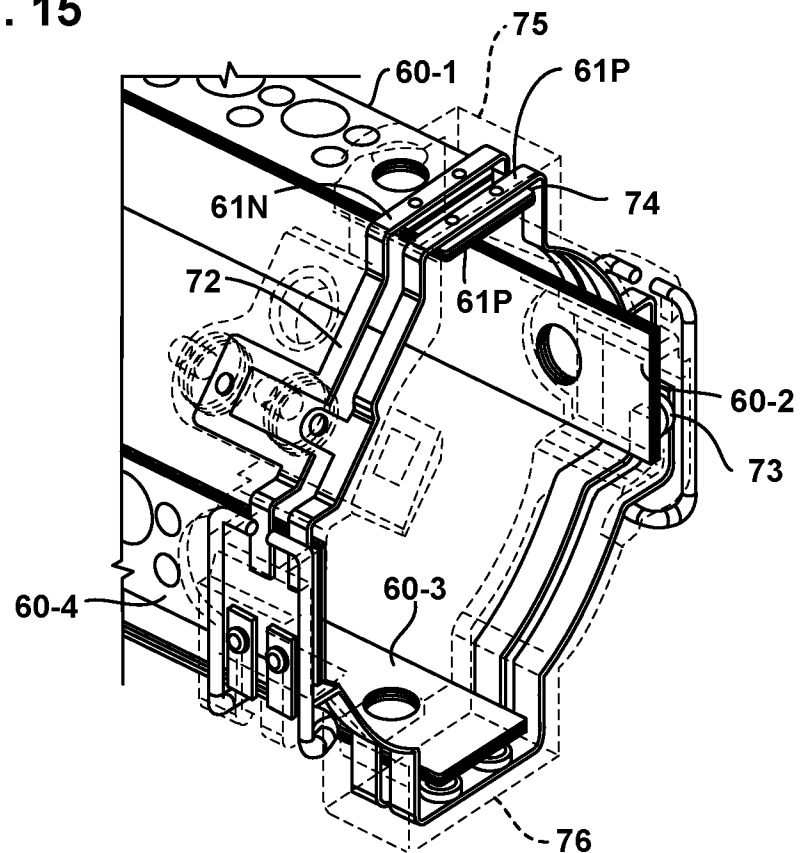


FIG. 14

FIG. 15



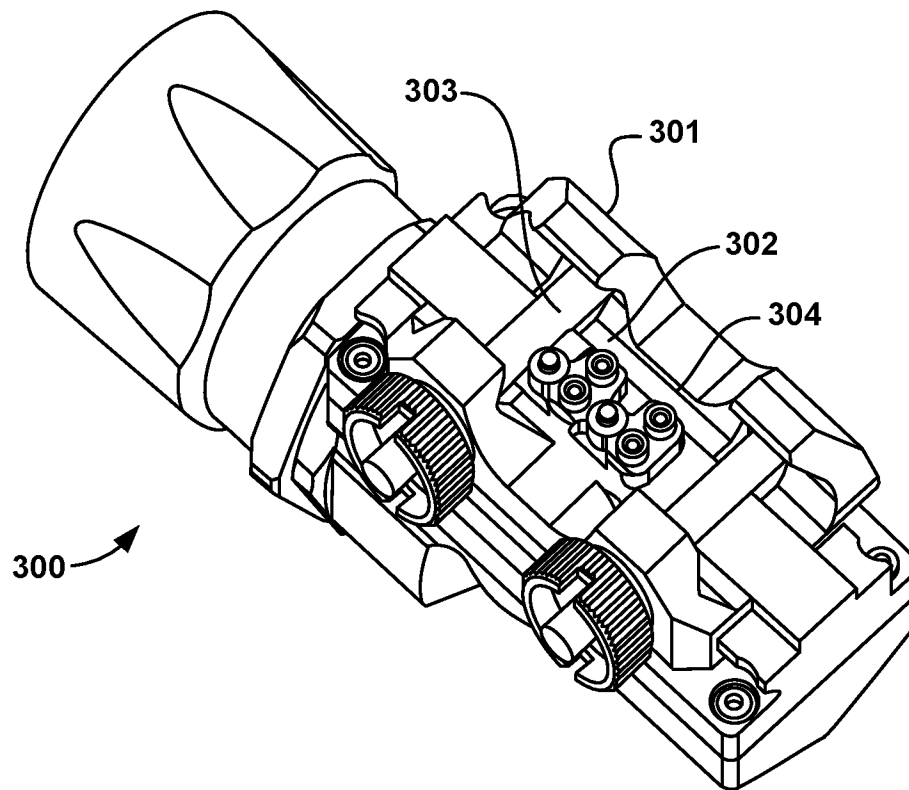


FIG. 16

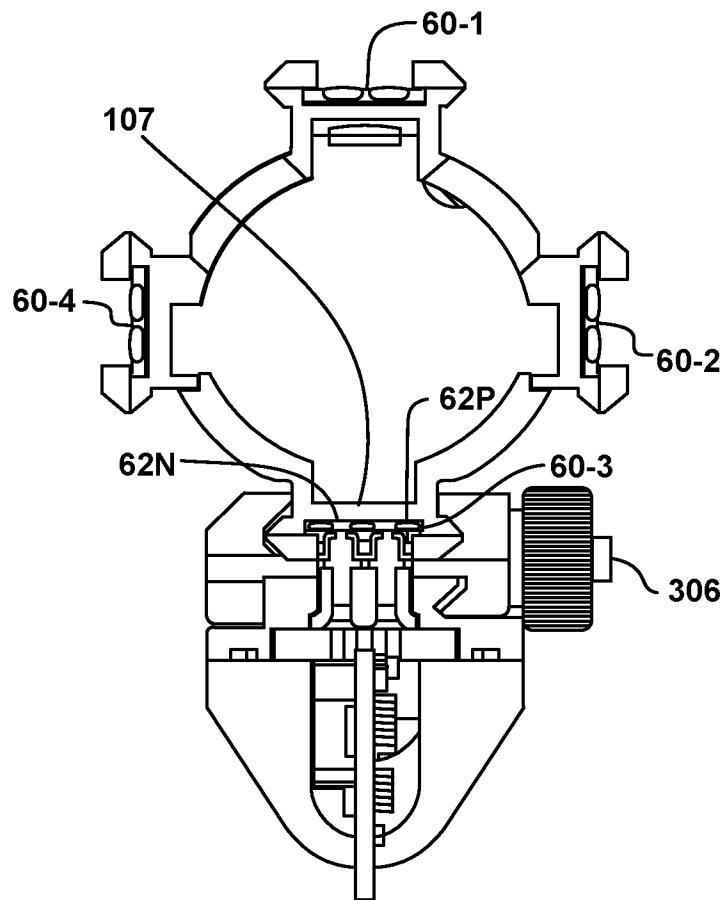
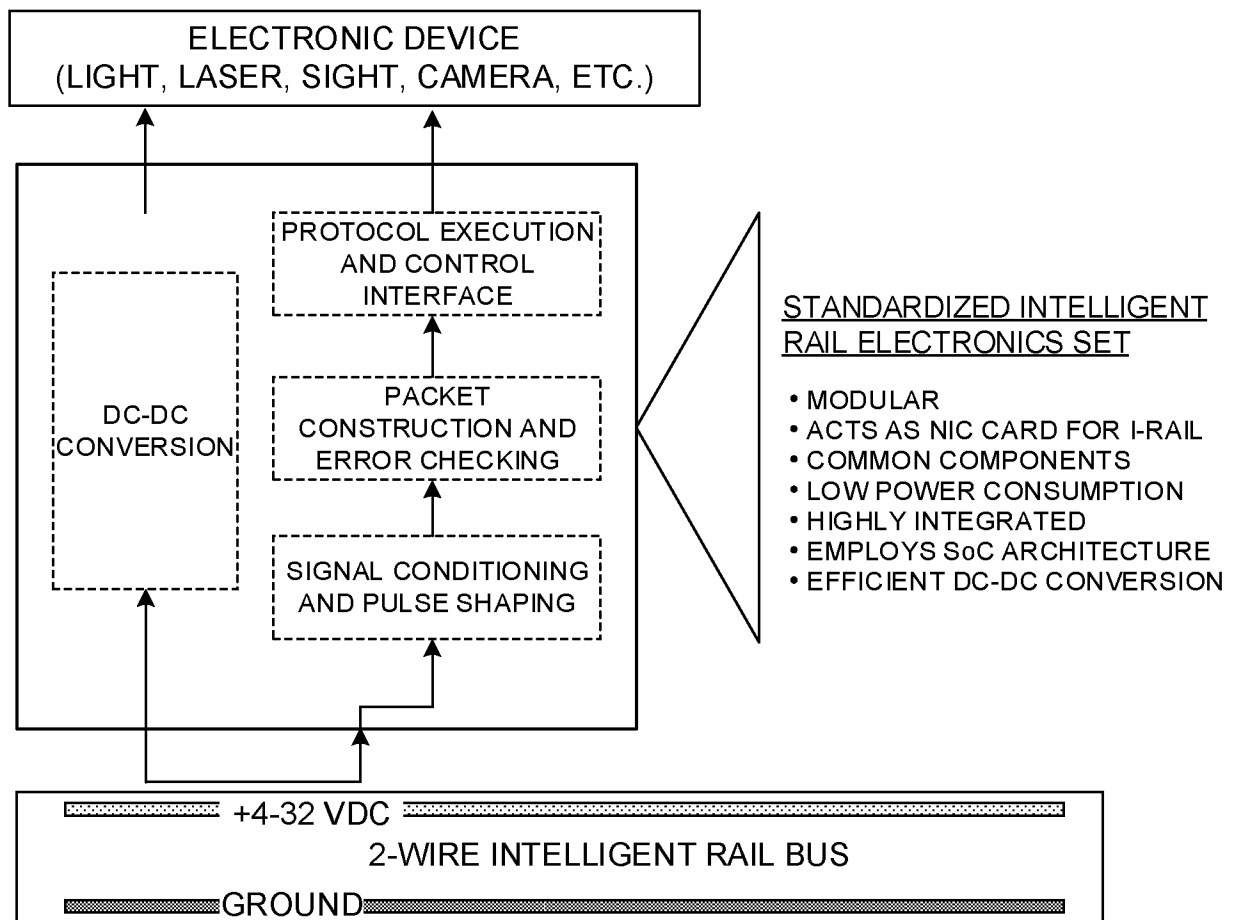
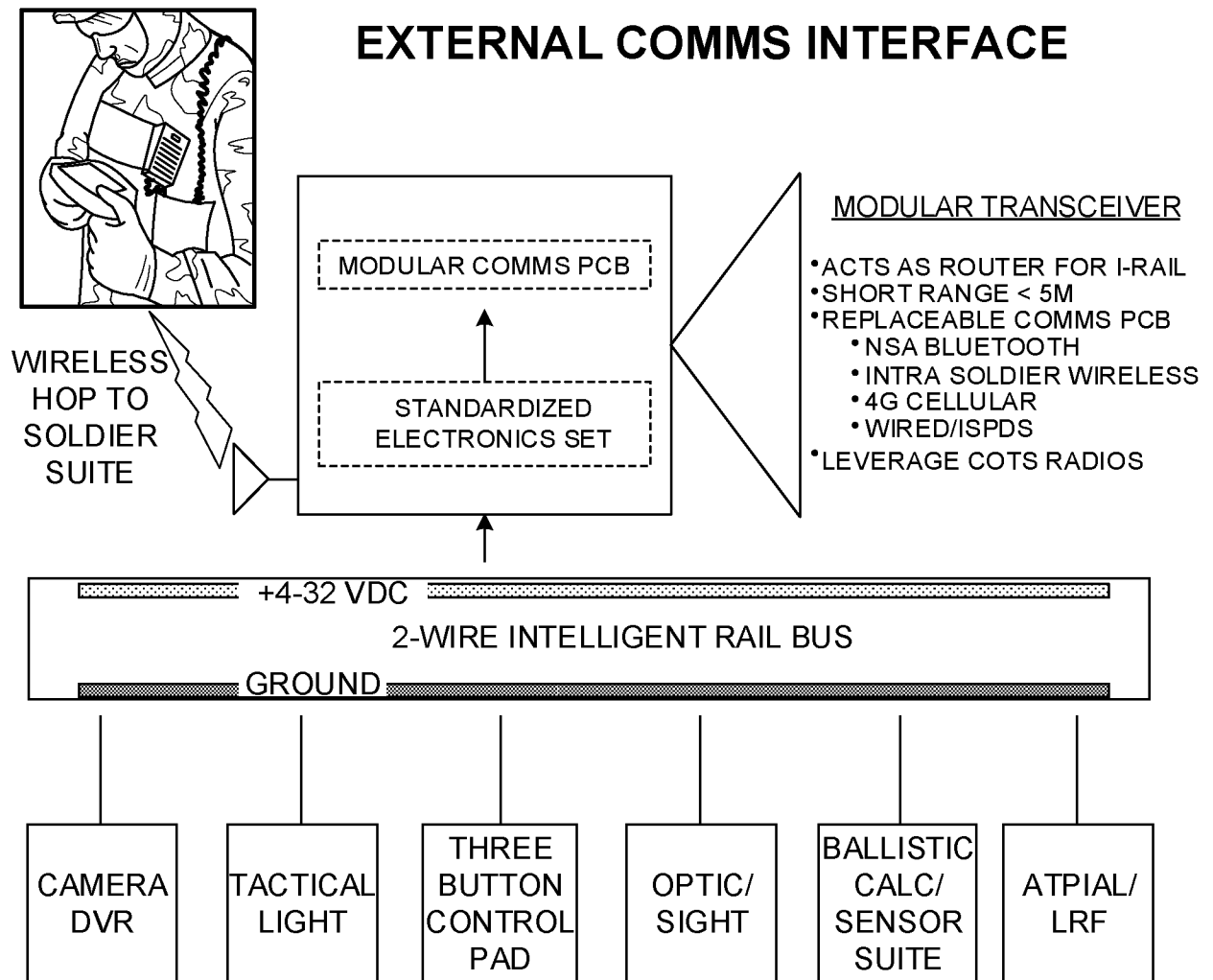


FIG. 17

**FIG. 18**

**FIG. 19**

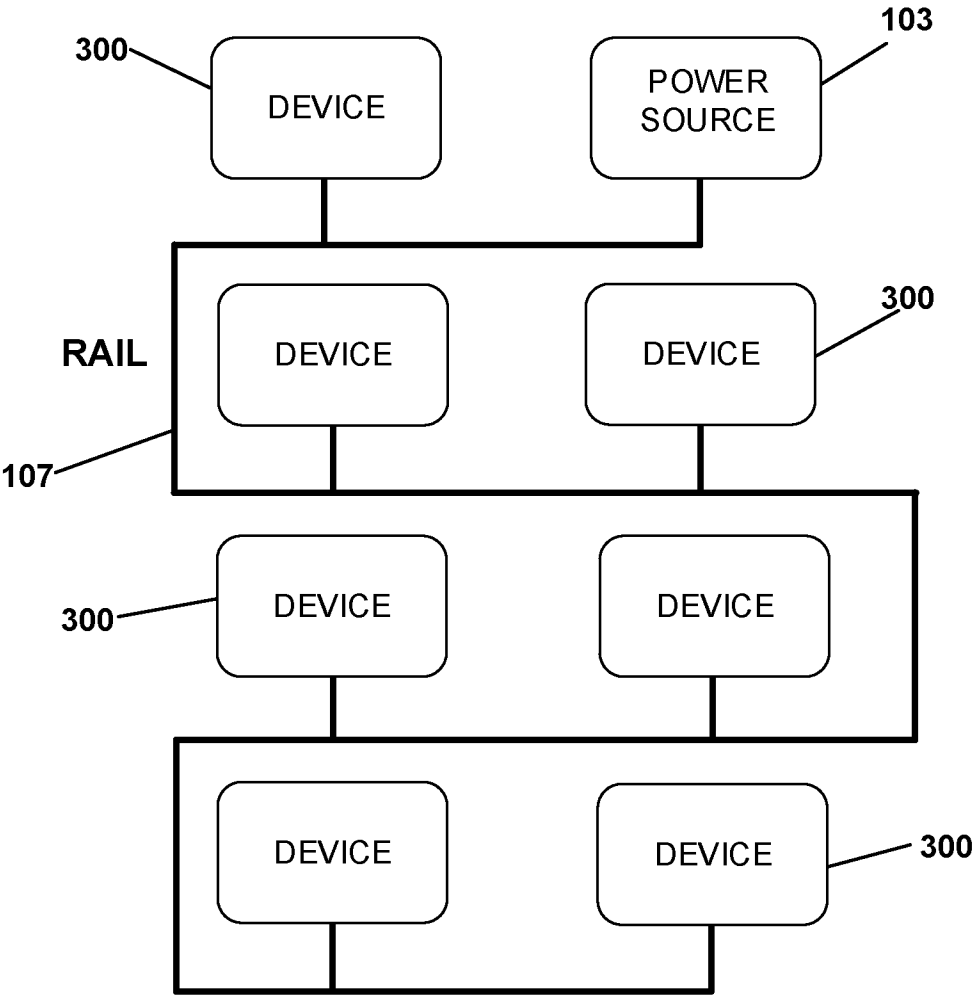


FIG. 20

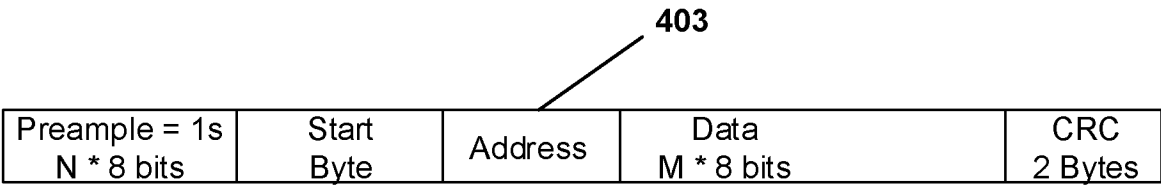


FIG. 21

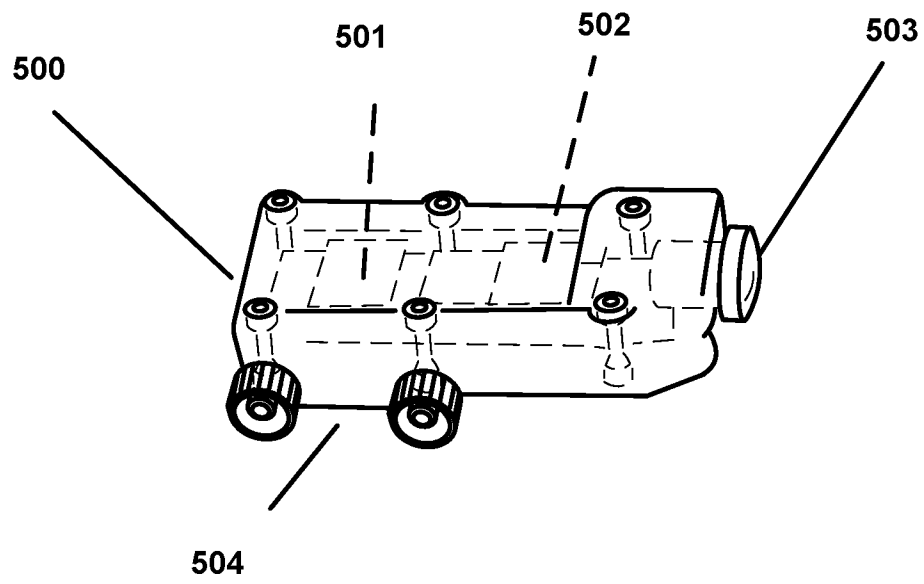


FIG. 22

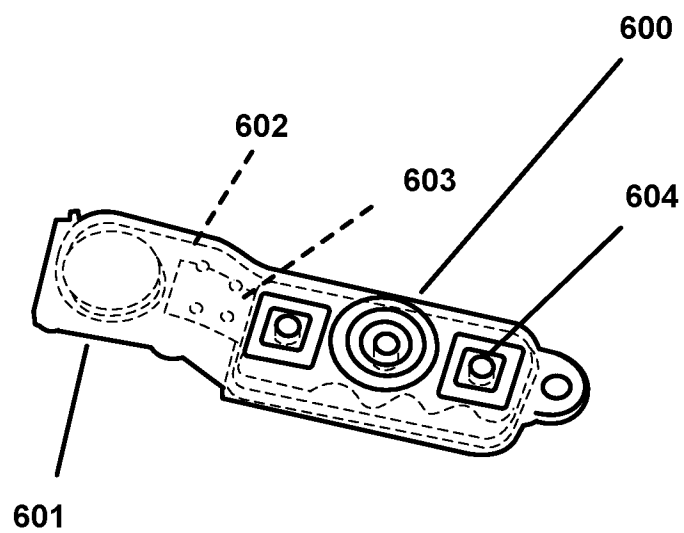


FIG. 23

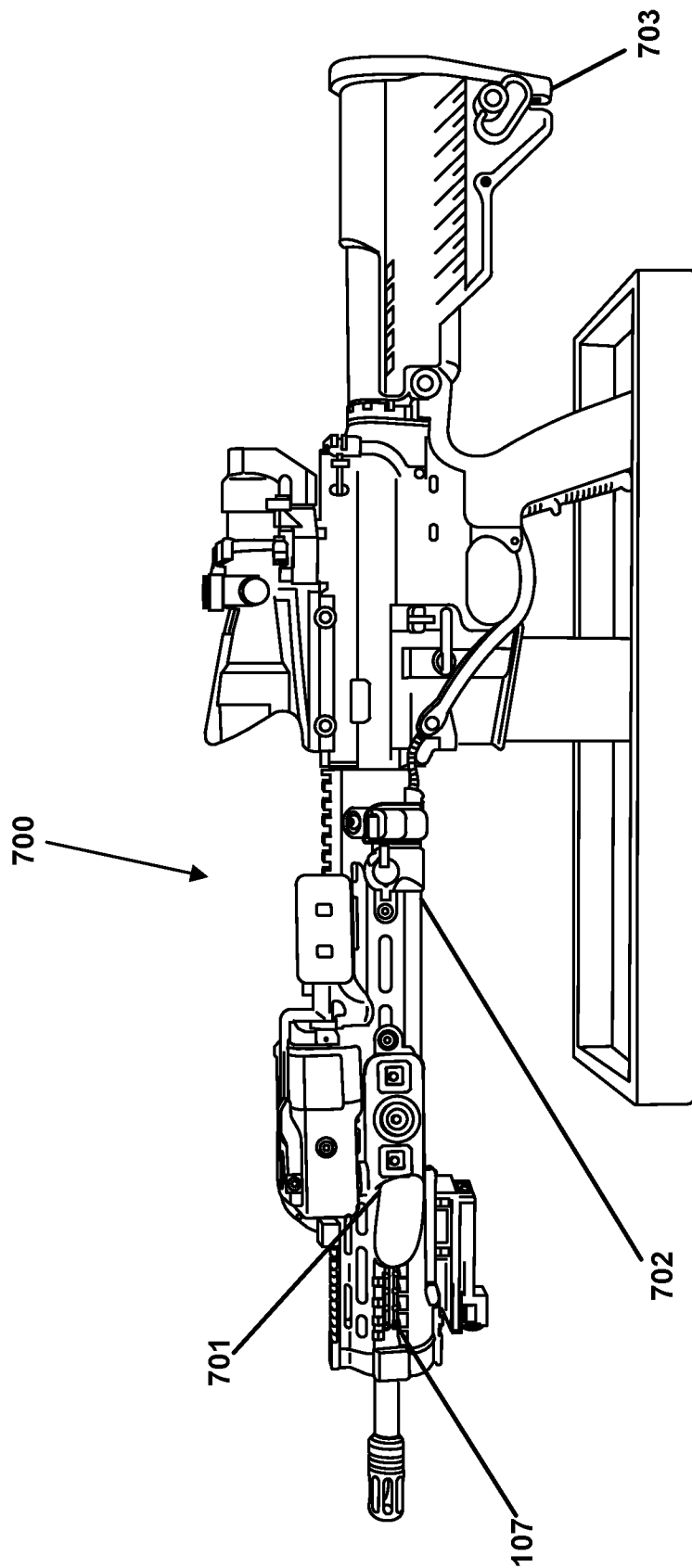
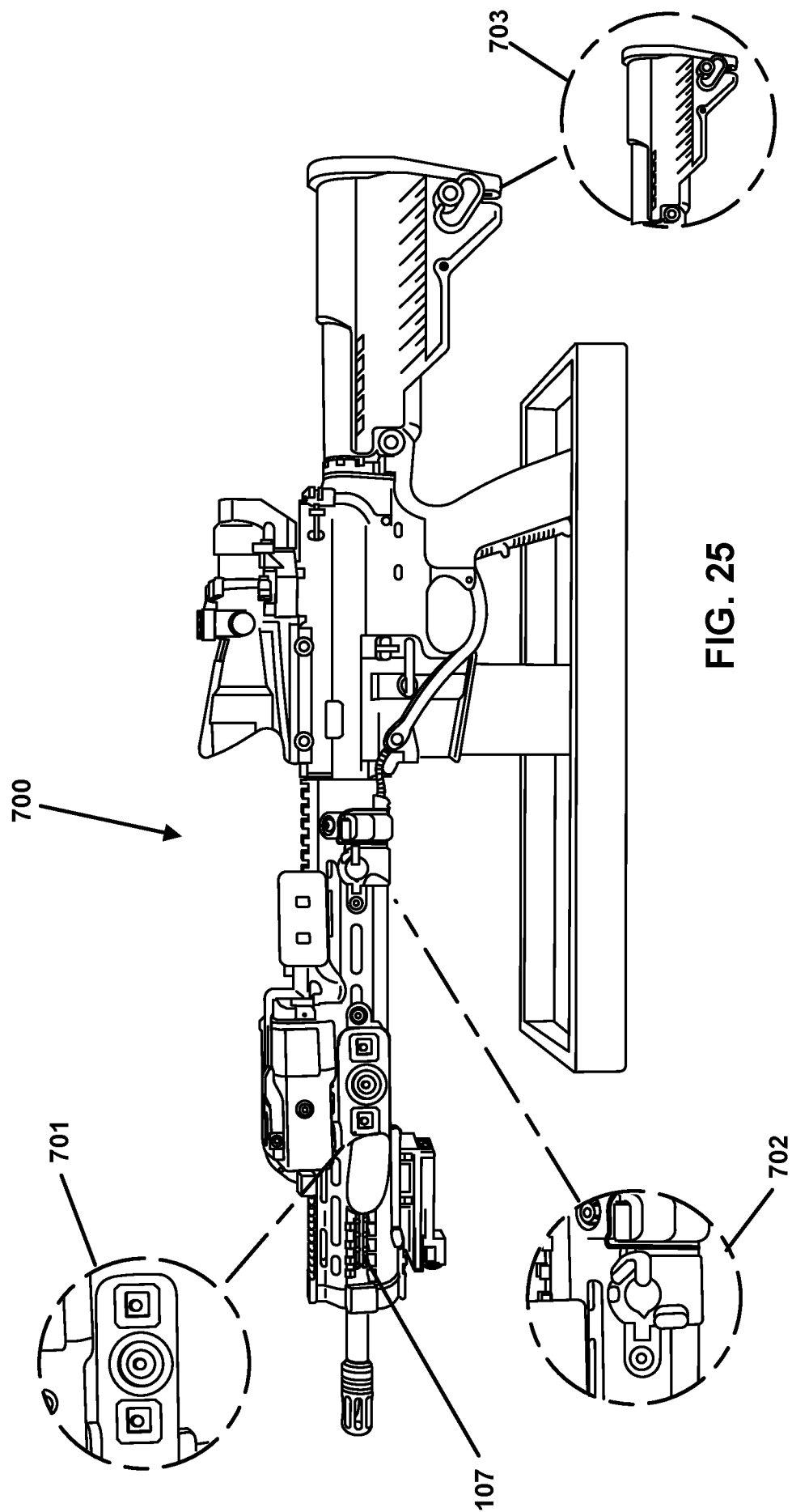


FIG. 24



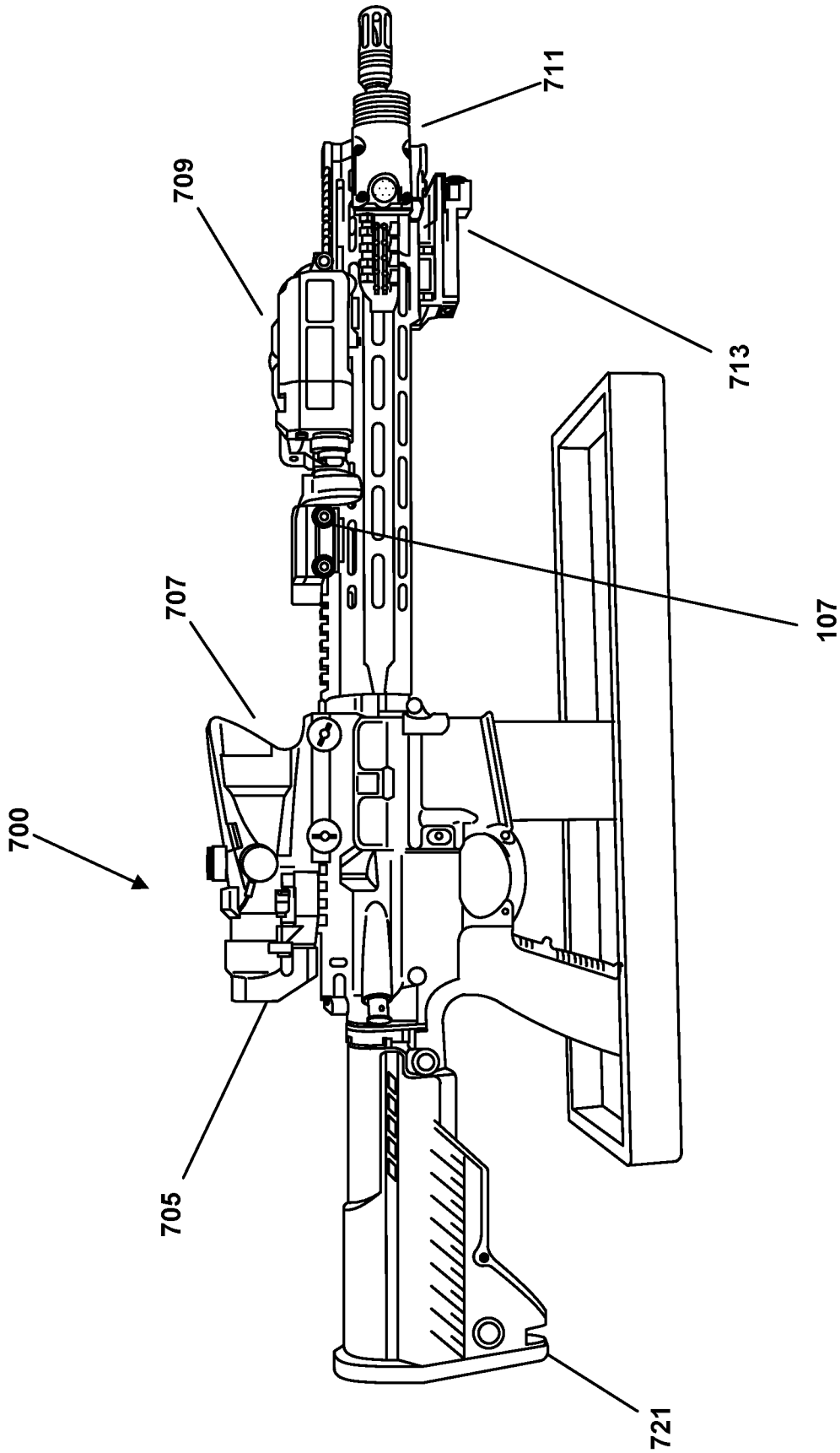


FIG. 26

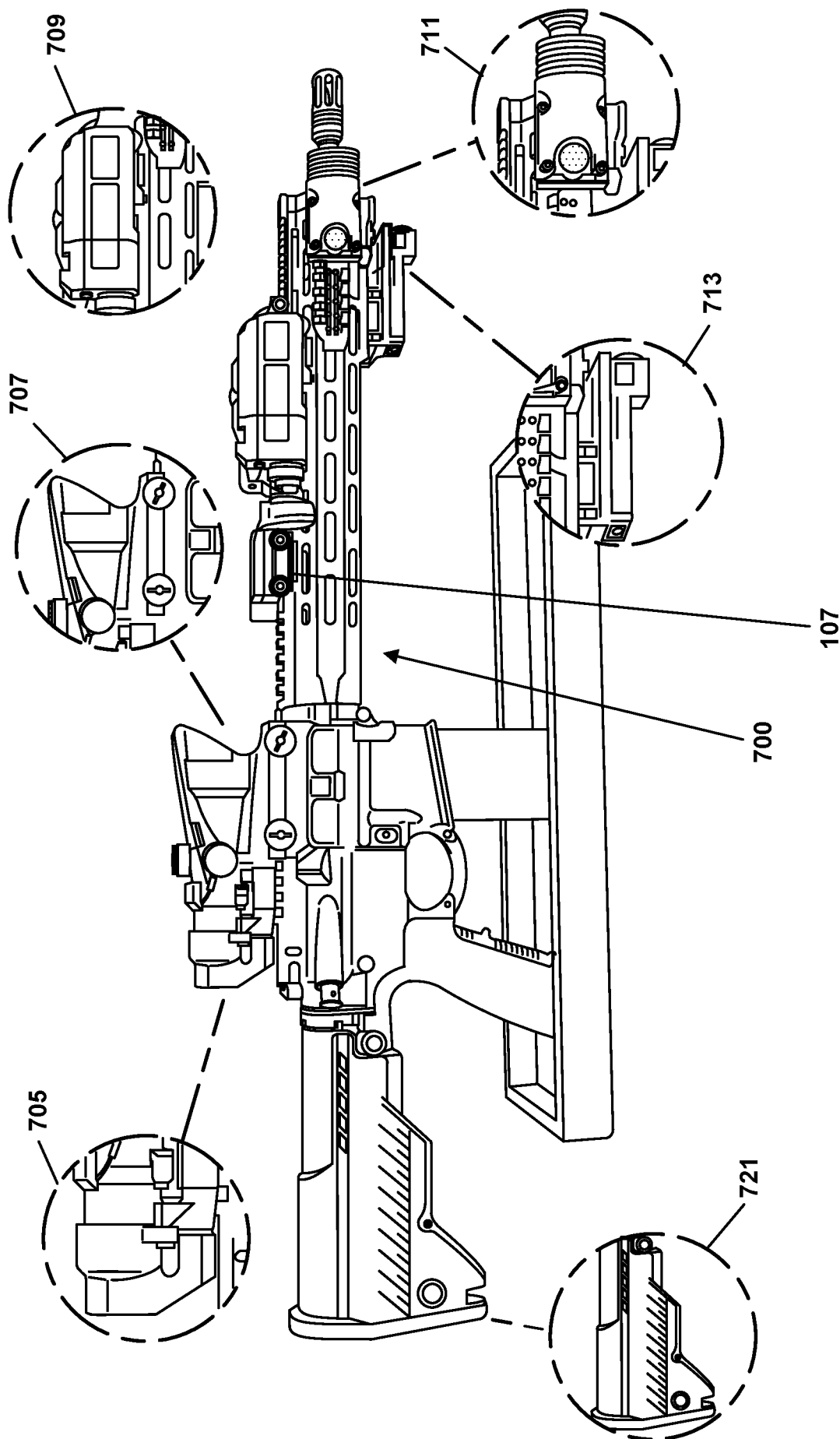


FIG. 27

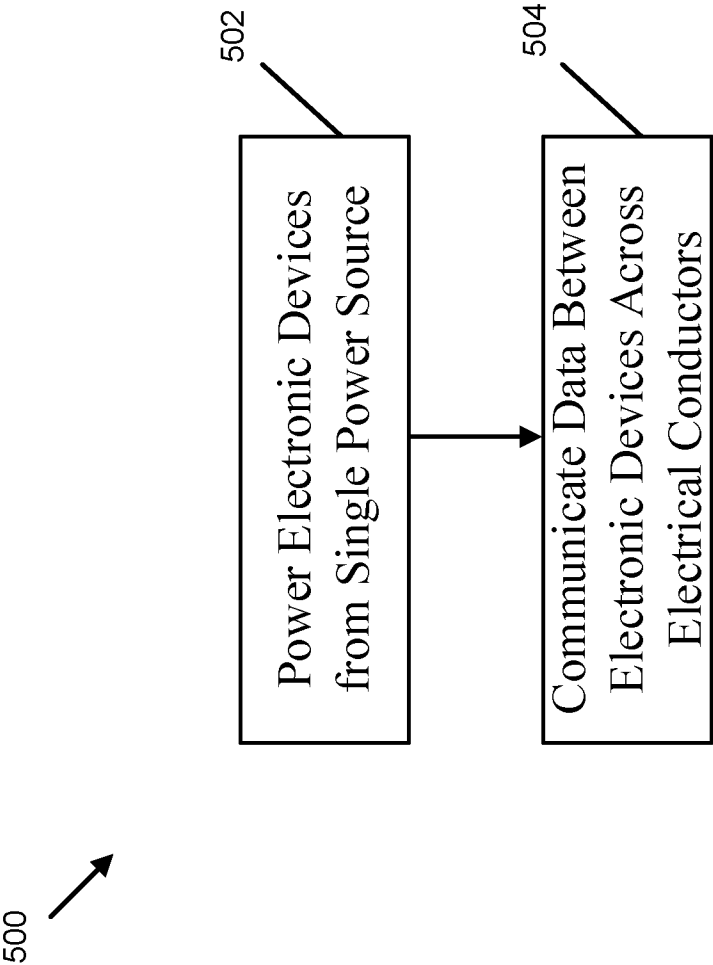


FIG. 28

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/032792**A. CLASSIFICATION OF SUBJECT MATTER****F41C 27/00(2006.01)i, F41A 35/00(2006.01)i, H01R 25/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F41C 27/00; F41G 11/00; H02J 7/00; F41A 35/00; F41C 23/16; F41A 21/00; H01R 25/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: firearm, electronic system, power source, conductor, communication device, controller node

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015-0041538 A1 (WILCOX INDUSTRIES CORP.) 12 February 2015 See paragraphs [0015], [0025] and figures 1, 5-6.	1,4-6,12-14,17-18
Y		2-3,7-11,15-16
Y	US 2014-0360077 A1 (MILLER et al.) 11 December 2014 See paragraphs [0032]-[0033] and figure 11.	2-3,7-11,15-16
A	US 2012-0144716 A1 (CABAHUG et al.) 14 June 2012 See paragraphs [0067]-[0069] and figure 13.	1-18
A	US 9472971 B2 (CYNETIC DESIGNS LTD.) 18 October 2016 See claim 1 and figures 2-3.	1-18
A	US 2016-0061560 A1 (FXD, LLC) 03 March 2016 See paragraphs [0132]-[0137] and figure 32.	1-18



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

29 August 2018 (29.08.2018)

Date of mailing of the international search report

29 August 2018 (29.08.2018)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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