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**(54) ELECTRONIC SECURITY SYSTEM FOR BICYCLE**

ELEKTRONISCHES SICHERHEITSSYSTEM FÜR FAHRRAD  
SYSTÈME DE SÉCURITÉ ÉLECTRONIQUE POUR BICYCLETTE

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## Description

### TECHNICAL FIELD

[0001] The present invention relates to a security device for a bicycle and, more particularly, to an electronic security system for the bicycle.

### BACKGROUND

[0002] Conventionally, locks such as chains, foldable locks and cables are used to prevent theft of bicycles. Although, the chains are heavy and difficult to carry, they provide great security for bicycles while cables provide poor security but are lightweight and easy to carry.

[0003] Recently, electronic security devices have been employed to secure bicycles. However, employment of the electronic security devices is deterred by battery life-time and long charging time of the battery. Further, such electronic security devices have poor battery life and do not have an effective alternative charging means, thereby making the process of charging the security device a time consuming process for a rider/user of the bicycle. Moreover, unlocking bicycles when the environment is dark is difficult. Furthermore, insurance companies providing insurance coverage against theft of the bicycles are also interested in information of a type of security device and anchoring means used for parking the bicycle by the users. The current conventional and electronic security devices do not provide such information to an insurance company. US 2011/148346 A1 discloses an automatic cycle storage system, comprising (i) a plurality of cycles each comprising an electric power storage device, electrical contacts, and an electrical supply circuit connecting the electric power storage device to said electrical contacts, and (ii) a plurality of fixed docking structures to which said cycles can be fixed, each comprising at least one central processing unit, an electrical supply circuit connected to the central processing unit of the docking structure, and electrical contacts capable of coming into mutual contact with the respective electrical contacts on a cycle locked to the docking structure, while connecting the electrical supply circuit of the cycle to the electrical supply circuit of the docking structure, wherein the electrical supply circuits of the cycle and the docking structure are capable of allowing the electric power storage device on the cycle to supply the electrical supply circuit on the docking structure with power when the cycle is locked to the docking structure. FR 3 042 897 A1 discloses an electronic padlock comprising a secure box intended to form an access zone to a connection of a fastener of the padlock, said box comprising a first and a second cover intended to cooperate together and comprising at least one opening intended to receive a tip, the box further comprising: (i) a first locking system for locking the first cover with the second cover, said first locking system comprising a first element driven by a first motor actuating at least a first latch securing the two covers to each other, at least

one angular position of the first element defining a locking state of the first cover with the second cover; (ii) a second locking system for holding an end piece inserted in said at least one opening in a fixed position, the second locking system comprising a second element driven by the first motor actuating at least one second latch, at least one angular position of the second element defining a locking state of the tip; and (iii) a wireless link access interface capable of receiving an authentication data allowing to automatically activate the first motor to reach a combination of a given state of locking of the tip and a given state of locking of the covers.

[0004] In view of the above, there is a requirement for an electronic security system that ensures easy charging of the battery and provides high level of security for the bicycle in addition to being capable of providing information to the insurance companies regarding type of anchoring device used for parking the bicycle.

### SUMMARY

[0005] The invention is set out in the appended set of claims.

### BRIEF DESCRIPTION OF THE FIGURES

[0006] The invention itself, together with further features and attendant advantages, will become apparent from consideration of the following detailed description, taken in conjunction with the accompanying drawings. One or more embodiments of the present invention are now described, by way of example/s only, with reference to the accompanied drawings wherein like reference numerals represent like elements and in which:

FIG. 1 illustrates an environment related to at least some example embodiments of the present disclosure;

FIG. 2A illustrates a simplified schematic diagram of an electronic security system, in accordance with an example embodiment of the present disclosure;

FIG. 2B illustrates a schematic representation of an electronic security system in a bicycle, in accordance with another implementation, which is not part of the invention as claimed.

FIG. 3 illustrates schematic representation of a first connector, in accordance with an example embodiment of the present disclosure;

FIG. 4A illustrates schematic representation of a second connector, in accordance with an example embodiment of the present disclosure;

FIG. 4B illustrates a front portion of the second connector showing engagement member and an enlarged representation thereof, in accordance with an example embodiment of the present disclosure;

FIG. 4C illustrates a front portion of the second connector showing engagement member and an enlarged representation thereof, in accordance with

another example embodiment of the present disclosure;

FIG. 4D illustrates a front portion of the second connector showing engagement member and an enlarged representation thereof, in accordance with yet another example embodiment of the present disclosure;

FIG. 4E illustrates a schematic representation of components of the second connector, in accordance with another example embodiment of the present disclosure;

FIG. 5 illustrates a simplified schematic representation of engagement of the first connector and the second connector of the electronic security system, in accordance with an example embodiment of the present disclosure;

FIG. 6A illustrates a schematic configuration of the second connector connected to a first anchoring device, in accordance with an example embodiment of the present disclosure;

FIG. 6B illustrates a schematic configuration of the second connector, connected to a second anchoring device, in accordance with another example embodiment of the present disclosure;

FIG. 6C illustrates a schematic configuration of the second connector, connected to a third anchoring device, in accordance with another example embodiment of the present disclosure;

FIG. 6D illustrates another schematic configuration of the second connector connected to the fourth anchoring device, in accordance with another example embodiment of the present disclosure;

FIG. 6E illustrates a configuration of the second connector where the second connector is a battery pack, in accordance with an implementation, which is not part of the invention as claimed.

FIG. 6F illustrates a configuration of an anchoring device where the first connector and the second connector are configured on opposite ends of the anchoring device, in accordance with an example embodiment of the present disclosure; and

FIG. 7 illustrates a connection between the second connector and a docking station, in accordance with an example embodiment of the present disclosure.

**[0007]** The drawings referred to in this description are not to be understood as being drawn to scale except if specifically noted, and such drawings are only exemplary in nature.

## DETAILED DESCRIPTION OF THE FIGURES

**[0008]** While the invention is susceptible to various modifications and alternative forms. Specific embodiments thereof have been shown with the help of examples in the drawings and are described in detail below. It should be understood, however that it is not intended to limit the invention to the particular forms disclosed, but

on the contrary, the invention is to cover all modifications, and alternative fallings within the scope of the invention.

**[0009]** Reference in this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present disclosure. The appearance of the phrase "in an embodiment" in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments mutually exclusive of other embodiments. Moreover, various features are described which may be exhibited by some embodiments and not by others. Similarly, various requirements are described which may be requirements for some embodiments but not for other embodiments.

**[0010]** Moreover, although the following description contains many specifics for the purposes of illustration, anyone skilled in the art will appreciate that many variations and/or alterations to said details are within the scope of the present disclosure. Similarly, although many of the features of the present disclosure are described in terms of each other, or in conjunction with each other, one skilled in the art will appreciate that many of these features can be provided independently of other features. Accordingly, this description of the present disclosure is set forth without any loss of generality to, and without imposing limitations upon, the present disclosure. For the better understanding of this disclosure, reference will now be made to the embodiments illustrated in greater depth in the accompanying figures and description given below. In the following figures, the same reference numerals are used to identify the same components in various views.

**[0011]** Various embodiments provide different configurations of an electronic security system for a bicycle. The objective of the electronic security system is to protect the bicycle from theft, to communicate with an external system and/or include an alternative charging means. The external system is at least one of an external server of an insurance provider or a user device associated with a user of the bicycle. The electronic security system includes an electronic security device, a first connector and a second connector. For the purpose of the present disclosure, the terms 'user' and 'rider' have been used interchangeably throughout the present description and refer to a person accessing the electronic security system to lock/unlock the electronic security device that secures the bicycle.

**[0012]** The electronic security device is disposed on a frame of the bicycle. The electronic security device includes a first rechargeable battery, a first security circuit and an integrated bike lock. The first rechargeable battery acts as a power source for the electronic security device. The integrated bike lock is configured to assume an open position and a locked position, such that in the locked position the integrated bike lock restricts motion of the bicycle and in the open position the integrated bike lock allows free motion of the bicycle.

**[0013]** In an embodiment, the first connector is disposed on the electronic security device. Alternatively or additionally, the first connector is disposed on the frame of the bicycle and electrically coupled to the electronic security device. The first connector includes a first engagement member. The first engagement member includes a plurality of pin connectors and one or more notches for engaging with the second connector.

**[0014]** The second connector includes a second rechargeable battery, a second security circuit and a second engagement member. The second connector engages with the first connector to form an electro-mechanical connection between the first connector and the second connector by engaging the second engagement member with the first engagement member. The second rechargeable battery is configured to charge the first rechargeable battery of the electronic security device when the second connector is engaged with the first connector. The second connector is configured to be connected to an anchoring device of a plurality of types of the anchoring devices (e.g., a chain, a cable or a foldable lock) for tethering the bicycle to a dock. In a non-inventive example embodiment, the second connector can only act as a battery pack for charging the second rechargeable battery, since the second connector includes the rechargeable battery.

**[0015]** The first security circuit and the second security circuit determine the authenticity of the second connector when the second connector is brought into contact with the first connector for engagement purposes. Once the authentication is performed, the second connector is securely engaged with the first connector and thereby the bicycle is anchored. The security circuits are also configured to detect the type of anchoring device used to tether the bicycle, and a communication system provides information on the type of the anchoring device to the external system. The electronic security system includes one or more of various modules such as RFID module, Bluetooth module communicably coupled to the user device for locking and/or unlocking the electronic security system.

**[0016]** FIG. 1 shows an example representation of an environment 100, where at least some embodiments of the present disclosure can be implemented. The environment 100 shows a bicycle 105 in a tethered state. In the tethered state, the bicycle 105 is tethered to a dock 115 using an electronic security system 110 disposed on a frame such as a frame 140 of the bicycle 105. The electronic security system 110 may be tethered to the dock 115 using a variety of anchoring devices that are described later. The electronic security system 110 protects the bicycle 105 from theft, and is communicably linked with a user 125. The user 125 may have one or more devices such as a user device 120. Examples of the user device 120 are not limited to mobile phones only, and that the user device 120 may take examples of any portable electronic device (e.g., laptops, smartphones and tablets) having cellular communication capabilities.

For instance, the user device 120 may be equipped with subscriber identity module (SIM) or Removable User Identity Module (R-UIM) to enable cellular communication.

**[0017]** In a tethered state, the electronic security system 110 sends tethering data based on a type of anchoring device used with the electronic security system 110, to an external system. The external system is at least one of an external server (such as a sever 135) of an insurance provider or even the user device 120 associated with the user 125 of the bicycle 105. This data is transmitted to the server 135 over a network 130. The network 130 may be a centralized network or may include a plurality of sub-networks that may offer a direct or indirect communication between the electronic security system 110 and the server 135 and communication between the electronic security system 110 and the user device 120. Examples of the network 130 include, but are not limited to, the Internet, local area network (LAN), wide area network (WAN), wireless, wired, and the like.

**[0018]** The server 135 may be located at one place or may be distributed at multiple locations. The server 135 is configured to receive tethering data from such electronic security systems (e.g., the electronic security system 110) used by various users. Information related to tethering data of the bicycle 105 can be retrieved by Insurance companies for determining insurance premiums or for determining awards in case of theft of the bicycle 105. Various components of the electronic security system 110 are described with reference to FIGS. 2 to 7.

**[0019]** FIG. 2A illustrates a simplified schematic representation of the electronic security system 110, according to an example embodiment of the present disclosure. The electronic security system 110 includes an electronic security device 150, a first connector 250 embedded within the electronic security device 150, and a second connector 300 connected to an anchoring device 205 (not shown in entirety).

**[0020]** The electronic security device 150 is disposed on a frame (see, frame 140) of a bicycle such as the bicycle 105. It must be noted that the electronic security device 150 can be disposed on any frame of the bicycle 105 as long as the electronic security device 150 is able to immobilize the bicycle 105 in a locked state of the electronic security device 150. The electronic security device 150 includes a first rechargeable battery 260, a first security circuit 255 and an integrated wheel lock 280. In an embodiment, the first security circuit 255 is a printed circuit board assembly. The first rechargeable battery 260 acts as a power source for the electronic security device 150. In an embodiment, the battery 260 may also electro-mechanically operate the wheel lock 280 to immobilize wheels of the bicycle 105.

**[0021]** The wheel lock 280 is disposed on relatively lower portion of the electronic security device 150. The wheel lock 280 is configured to assume an open position and a locked position. In the locked position, the wheel lock 280 restricts motion of the wheel of the bicycle 105

and there is no such restriction in the open position of the wheel lock 280. The wheel lock 280 may be configured in a variety of ways. For instance, in the illustrated embodiment, the wheel lock 280 includes a motor 285, a worm gear 290 and a locking shackle 295. The motor 285 is powered by the battery 260 and is configured to provide rotational motion to the worm gear 290. The worm gear 290 is configured to actuate motion of the locking shackle 295, through worm threads of predetermined length disposed on a portion of circumference of the locking shackle 295. In one non-limiting implementation, the wheel lock 280 is in the locked position (restricting cycle movement) when the locking shackle 295 moves in a clockwise direction, and movement of the locking shackle 295 in an anti-clockwise direction opens the locking shackle 295 keeping the wheel lock 280 in the open position. Alternatively, the locking shackle 295 can be configured to open (open position) when the locking shackle 295 moves in clockwise direction and the locking shackle 295 can be configured to close (closed position) when the locking shackle 295 moves in anti-clockwise direction.

**[0022]** In an embodiment, the first connector 250 is disposed in the electronic security device 150. In another implementation, which is not part of the invention as claimed, the first connector 250 can be disposed anywhere on the frame of the bicycle 105. The first connector 250 entails a port connection to the first rechargeable battery 260 of the electronic security device 150 (refer FIG. 2A). The first connector 250 includes an engagement member (e.g., a first engagement member 270 shown in FIG. 3) that is configured to be disengageably engaged with corresponding complementary engagement member of the second connector 300. An example of the complementary engagement member is a second engagement member 315 described with reference to FIG. 4A to 4C. The second engagement member 315 is configured to engage with the first engagement member 270 for charging the first rechargeable battery 260 by a rechargeable battery contained within the second connector 300. An example of the rechargeable battery is a second rechargeable battery 305 described with reference to FIG. 4A to 4C. In an embodiment, the first connector 250 is a female connector (herein interchangeably referred to as the 'female connector 250') and the second connector 300 is a male connector (herein interchangeably referred to as the 'male connector 300'). Alternatively, the first connector 250 can be a male connector and the second connector 300 can be a female connector disposed on the dock 115. It should be noted that such examples of the first connector 250 and the second connector 300 as male/female connector should not limit the scope of the present invention, and they can be configured vice versa.

**[0023]** Referring now to FIG. 2B, an electronic security system fitted on the bicycle 105 is illustrated in accordance with another implementation, which is not part of the invention as claimed. The electronic security system

includes an electronic security device 150, a first connector 250 and a second connector 300. The electronic security device 150 includes a first rechargeable battery (not shown in FIG. 2B) for powering the electronic security device 150 and is disposed on the frame 140 of the bicycle 105 for securing the bicycle 105. The first connector 250 is disposed on the frame 140 of the bicycle 105 and is electrically coupled (not shown in FIG. 2B) to the electronic security device 150. The second connector 300, including the second rechargeable battery (e.g., the rechargeable battery 305 shown in FIGS. 4A-4C), is configured to engage with the first connector 250 to charge the first rechargeable battery using the second rechargeable battery.

**[0024]** FIG. 3 illustrates a schematic representation of the first connector (or the female connector) 250, according to an example embodiment of the present disclosure. In an embodiment, the female connector 250 is disposed in the electronic security device 150. Alternatively, the female connector 250 can be built into or on the frame such as the frame 140 of the bicycle 105 at any of the suitable locations. In an embodiment, the female connector 250 can be built into a bicycle docking station, such as, the dock 115 (shown in FIG. 1). The female connector 250 entails a port connection to a first rechargeable battery, such as, the first rechargeable battery 260 inside the electronic security device 150. The female connector 250 is a ball bearing type connector. The female connector 250 includes the first engagement member 270 and a plurality of pin connectors 265. In an embodiment, each of the plurality of pin connectors 265 is a pogo pin connector. The first engagement member 270 includes one or more notches 275 configured to accept a male connector, such as, the male connector 300 of ball bearing type connector. The notches 275 may be provided on two or more sides of the first engagement member 270 to accommodate corresponding ball bearings of the male connector (shown in FIGS. 4A-4C).

**[0025]** At least some example embodiments of the male connector 300 are hereinafter described with reference to FIGS. 4A - 4C. The connector 300 includes a first end portion 300a, a second end portion 300b and the second rechargeable battery 305 disposed between the first end portion 300a and the second end portion 300b. The second rechargeable battery 305 is removably positioned within the male connector 300, such that the second rechargeable battery 305 can be removed for external charging. The second rechargeable battery 305 is configured to recharge the first rechargeable battery 260 of the electronic security device 150 when the male connector 300 is engaged with the female connector 250. The rechargeable battery 305 may be any suitable battery such as Lithium ion (Li-ion) battery, Lithium polymer (Li-Po) battery, a Nickel metal hydride battery, or any other secondary battery. The male connector 300 includes a second engagement member 315 disposed on the first end portion 300a for engaging with complementary engagement member (e.g., first engagement mem-

ber 270) of the female connector 250. The second end portion 300b is configured to be connected to an anchoring device that may be one of a plurality of types of the anchoring devices (such as a chain, a cable or a foldable lock) for tethering the bicycle 105. It should also be understood that if the user may not want to carry anchoring device (tethering means), the male connector 300 can also be used as a battery pack (a power bank) for charging the rechargeable battery 305.

**[0026]** Referring to FIGS. 4A to 4B, the male connector 300 includes a motor 310, a push rod 320, a lead screw 325, a second security circuit 340, a push button 345, LED lights 350, a communication module 355 and a pod charger 360. The pod charger 360 is configured to charge the second rechargeable battery 305. In an embodiment, the pod charger 360 includes pogo pin connectors for connecting to an external power source. Alternatively, the pogo pin connectors can charge through a USB, Micro-USB, USB-C or similar connectors. The second security circuit 340 and the first security circuit 255 (present in the electronic security device 150) detect and verify authenticity of the male connector 300 and are configured to send a message to the external system (e.g., user device 120 or server 135) specifying the type of anchoring device connected to the second end portion 300b of the male connector 300. Some examples of the anchoring devices are described with reference to FIGS. 6A to 6D. In an embodiment, the second security circuit 340 is a printed circuit board assembly.

**[0027]** The motor 310 provides rotational motion to the lead screw 325 on actuation. A first end portion 325a of the lead screw 325 is coupled to the motor 310 and the second end portion 325b is coupled to the push rod 320. A rotation of the lead screw 325 actuates the push rod 320, and the motion of the push rod 320 actuates the second engagement member 315 to engage or disengage with the first engagement member 270 of the female connector 250.

**[0028]** Referring now to FIGS. 4C-4D, a front portion of the second connector 300 showing the second engagement member 315 and an enlarged representation thereof are illustrated in accordance with another example embodiment of the present disclosure. In this embodiment, the male connector 300 includes a shaft 332 that is coupled to the motor 310. For instance, the shaft 332 has a first end 332a and a second end 332b, where the first end 332a is connected to the motor 310. The connector 300 also includes a cam 334 connected to the second end 332b of the shaft 332. The motor 310 turns the shaft 332 thereby rotating the cam 334. The cam 334 has a profile such that one quarter turn of the cam 334 pushes (for example, as shown in FIG. 4D) the ball bearings 330a and 330b of the second engagement member 315 away so as to engage with the first engagement member 270. The ball bearings 330a and 330b move into corresponding notch 275 of the first connector 250 thereby establishing an electro-mechanical contact between the first connector 250 and the second connector

300.

**[0029]** Referring now to FIG. 4E, a schematic representation of components of the second connector 300 is illustrated in accordance with another example embodiment of the present disclosure. The second connector 300 includes LED lights 350 that are configured to be switched ON by pressing push button 345. The LED lights 350 provide visibility in a dark environment when switched ON. In an embodiment, the LED lights 350 are also configured to display level of charge on the second rechargeable battery 305. The communication module 355 is configured to relay the data corresponding to the type of anchoring device (i.e. a chain, cable or foldable lock) coupled to the second end portion 300b to a server such as the server 135. The male connector 300 further includes an identifier tag 370, a pairing module 375 and a location service module 380. The identifier tag 370 disposed on the male connector 300 is communicably coupled to the user device 120 and allows access to the second connector 300 for locking and unlocking the electronic security device 150. Examples of the identifier tag 370 may include but not limited to RFID tags or may employ techniques such as barcode or quick response code. The pairing module 375 is securely paired with the user device 120 through at least one of a Global System for Mobile Communication (GSM) protocol, Long Term Evolution (LTE) protocol, Bluetooth protocol or narrowband communication protocol for actuating the male connector 300 to engage/disengage from the female connector 250. For example, the pairing module 375 is securely paired with a Bluetooth module of the user device 120 for actuating the male connector 300 to disengage from the female connector 250. The actuation of the male connector 300 activates the motor 310 that provides rotation motion to the lead screw 325 or the shaft 332. The location service module 380 is configured to determine location data and provide the location data to the user device 120.

**[0030]** The second connector 300 includes a biometric sensor module 385 (shown in FIG. 4E) that is electrically coupled to the second security circuit 340. In an embodiment, the biometric sensor module 385 is configured to authenticate identity of the user (e.g., user 125) accessing the male connector 300 for engaging/disengaging the male connector 300 and the female connector 250. For instance, one or more fingerprints of the user are acquired in prior and stored for verification when the user tries to access the male connector 300. When the user intends to disengage (or engage) the male connector 300 from the female connector 250, the user places his/her fingerprint on the biometric sensor module 385 (shown in FIG. 4E). On authentication of the user's identity (based on the fingerprint), the second security circuit 340 actuates the motor 310. The motor 310 provides rotational motion to the lead screw 325 that moves the push rod 320 coupled to the lead screw 325 to actuate the second engagement member 315 (of the male connector 300) to engage or disengage with the first engagement member 270 of the female connector 250.

**[0031]** As shown in FIG. 4B, the second engagement member 315 includes a plurality of pin connectors 335 and one or more ball bearings 330a, 330b. In an embodiment, each of the pin connectors 335 is a pogo pin connector. The ball bearings 330a and 330b are engagement provisions for sliding into the notches 275 of the female connector 250. The ball bearings 330a and 330b are configured to protrude from the second engagement member 315 and move into the notches 275 of the female connector 250, thereby electro-mechanically locking the male connector 300 and the female connector 250 configured within the electronic security device 150 or on the frame (e.g., the frame 140) of the bicycle 105. One simplified schematic representation of engagement (locked state) of the male connector 300 and the female connector 250 of the electronic security device 150 is shown in FIG. 5, in accordance with an example embodiment of the present disclosure. When the pin connectors 265 of the female connector 250 and the pin connectors 335 of the male connector 300 come in contact with each other, the first security circuit 255 and the second security circuit 340 verify the authenticity of the male connector 300 and detect the type of anchoring device attached to the second end portion 300b of the male connector 300. Thereafter, an information of the type of the anchoring device that is currently used, is provided to the external system.

**[0032]** Upon authentication, the motor 310 is activated thereby rotating the lead screw 325. The translational motion of the lead screw 325 is transferred to the push rod 320 thereby allowing the push rod 320 to move forward. The forward motion of the push rod 320 pushes the ball bearings 330a, 330b outward and the ball bearings 330a, 330b protrude from the second engagement member 315. The ball bearings 330a, 330b that are protruding from the second engagement member 315 move into the notches 275 of the female connector 250, thereby establishing the electro-mechanical locking between the male connector 300 and the electronic security device 150. Alternatively, in the configurations shown in FIGS. 4C and 4D, a rotation of the motor 310 causes the shaft 332 to rotate which thereby rotates the cam 334, and due to the profile of the cam 334, the ball bearings 330a, 330b are pushed into the notches 275 of the female connector 250.

**[0033]** When the pin connector 335 of the male connector 300 and the pin connector 265 of the female connector 250 are in an engaged state, the second rechargeable battery 305 of the male connector 300 charges the first rechargeable battery 260 of the electronic security device 150. To unlock the electronic security device 150, the male connector 300 has to be actuated to disengage. In an embodiment, the male connector 300 is actuated to disengage from the female connector 250 through the pairing module 375 (shown in FIG. 4E). The pairing module 375 implements at least one of a Bluetooth protocol, GSM protocol, LTE protocol or narrowband communication protocol. For instance, the male connector 300 is actuated to disengage by establishing a secure Bluetooth

pairing between the electronic security device 150 and the user device 120. Once the devices are paired, the user (e.g., user 125) sends an unlock call from an associated user device such as the user device 120 to the electronic security device 150. On receiving the unlock call, the motor 310 is actuated to retract the ball bearings 330a, 330b back into the male connector 300 and the user is able to remove the male connector 300 from the electronic security device 150.

**[0034]** Referring now to FIGS. 6A-6D, various configurations of anchoring device coupled to the second connector 300 are shown. FIG. 6A represents a noose ended chain 602 coupled to the second portion 300b of the connector 300 for tethering the bicycle 105 (shown in FIG. 1) to a docking station such as the dock 115. As shown in FIG. 6B, a noose ended cable 604 is configured to couple the second portion 300b of the second connector 300 to the dock 115 for tethering the bicycle 105. FIG. 6C represents a noose ended folding lock 606 in a retracted state coupled to the second portion 300b of the second connector 300 for tethering the bicycle 105 to the dock 115. FIG. 6D represents the noose ended folding lock 606 in an expanded state.

**[0035]** FIG. 6E represents the second connector 300 that is not connected to any anchoring device according to a reference example which is not according to the invention. In this configuration, the second connector 300 acts as a battery pack for recharging the second rechargeable battery 305 disposed in the electronic security device 150. For instance, when the user 125 has a need of charging the battery 305 of the electronic security device 150, the user engages the second connector 300 to the first connector 250 of the electronic security device 150 to charge the battery 305. Also, the user 125 can carry the second connector 300, which is portable, home to recharge the battery 305 inside the second connector 300 using a power supply outlet at home.

**[0036]** Referring now to FIG. 6F, a configuration of an anchoring device 608 where the anchoring device 608 includes the first connector 250 and the second connector 300 on opposite ends of the anchoring device 608, is illustrated in accordance with an example embodiment of the present disclosure. The anchoring device 608 has a first end and a second end opposite to the first end. The first connector 250 is coupled at the first end of the anchoring device 608 and the second connector 300 at the second end of the anchoring device 608. The anchoring device 608 can be used with various embodiments of the electronic security device 150 disclosed herein and/or any suitable docking station. In an embodiment, the anchoring device 608 can have a port (e.g., USB port) that can be connected to another port of the electronic security device 150 for charging the battery (e.g., the first rechargeable battery 260) of the electronic security device 150 from the second rechargeable battery 305 present inside the anchoring device 608.

**[0037]** FIG. 7 represents the second connector 300 connected to the docking station or the dock 115. The

dock 115 is a stationary fixture or a rack configured to hold the second connector 300 via the anchoring device 702, such as a chain, cable or foldable lock disposed at the second end portion 300b of the second connector 300.

**[0038]** Various embodiments of the present disclosure advantageously provide an electronic security system that provides an effective means for charging the electronic security device. Further, the electro-mechanical locking between the electronic security device and the male connector provides efficient security to the bicycle. Furthermore, the male connector is designed such that it can be coupled to different types of locks. Moreover, the electronic security device notifies the user and/or servers about the type of connection used to tether the bicycle. Insurance providers can access the servers to retrieve the type of connection used to tether the bicycle. It should also be appreciated that the embodiments of the present disclosure can be applied to the existing bicycles. The electronic security system further provides LED lights on the connector to enable easy engagement of the connector and the electronic security device in dark conditions.

**[0039]** While few embodiments of the present disclosure have been described above, it is to be understood that the disclosure is not limited to the above embodiments and modifications may be appropriately made thereto within the scope of the disclosure.

**[0040]** The above description is given by way of example only and various modifications may be made by those skilled in the art. The above specification, examples and data provide a complete description of the structure and use of exemplary embodiments.

**Claims**

1. An electronic security system (110) for a bicycle (105), the electronic security system (110) comprising:

an electronic security device (150) disposable on a frame (140) of the bicycle (105) for securing the bicycle (105), the electronic security device (150) comprising a first rechargeable battery (260), an integrated bike lock (280) and a first security circuit (255), wherein the first rechargeable battery (260) acts as a power source for the electronic security device (150);  
a first connector (250) disposed on the electronic security device (150), the first connector (250) comprising a first engagement member (270); and  
a second connector (300) comprising:

a first end portion (300a) and a second end portion (300b), the second end portion (300b) being connected to an anchoring de-

vice (205, 602, 604, 606, 702) of a plurality of types of anchoring devices (205, 602, 604, 606, 702) for tethering the bicycle (105) to a dock (115);

a second rechargeable battery (305) disposed between the first end portion (300a) and the second end portion (300b);

a second engagement member (315) configured on the first end portion (300a), the second engagement member (315) configured to securely engage with the first engagement member (270) to form an electro-mechanical connection between the first connector (250) and the second connector (300) for charging the first rechargeable battery (260) by the second rechargeable battery (305) and for tethering the bicycle (105) to a dock (115); and

a second security circuit (340), wherein the first security circuit (255) and the second security circuit (340) are configured to:

detect a type of the anchoring device (205, 602, 604, 606, 702) when the second engagement member (315) engages with the first engagement member (270); and

provide information of the type of the anchoring device (205, 602, 604, 606, 702) to an external system (135, 120).

2. The electronic security system (110) as claimed in claim 1, wherein the external system (135, 120) is at least one of:

an external server (135) of an insurance service provider; and  
a user device (120) associated with a user (125) of the bicycle (105).

3. The electronic security system (110) as claimed in claim 1, wherein the first engagement member (270) comprises one or more notches (275);

wherein the second engagement member (315) comprises one or more ball bearings (330a, 330b) movably disposed in the second engagement member (315); and

wherein the second connector (300) further comprises a motor (310) configured to be actuated upon authentication of the second connector (300) when the second connector (300) comes in contact with the first connector (250), wherein upon actuation the motor (310) enables a movement of the one or more ball bearings (330a, 330b) to engage with the one or more notches (275) of the first engagement member (270) thereby connecting the first connector (250) and the second connector (300).



4. The electronic security system (110) as claimed in claim 3, wherein the first security circuit (255) and the second security circuit (340) are configured to authenticate the second connector (300) when the second connector (300) comes in contact with the first connector (250).

5. The electronic security system (110) as claimed in claim 3, wherein the second connector (300) further comprises:

a lead screw (325) comprising a first end (325a) and a second end (325b), wherein the first end (325a) of the lead screw (325) is coupled to the motor (310) and rotates on actuation of the motor (310); and  
a push rod (320) coupled to the second end (325b) of the lead screw (325), the push rod (320) configured to push the one or more ball bearings (330a, 330b) of the second engagement member (315) into corresponding notches (275) of the one or more notches (275) of the first engagement member (270) for engaging the second connector (300) with the first connector (250).

6. The electronic security system (110) as claimed in claim 3, wherein the second connector (300) further comprises:

a shaft (332) comprising a first end (332a) and a second end (332b), wherein the first end (332a) of the shaft (332) is coupled to the motor (310) and rotates on actuation of the motor (310); and  
a cam (334) coupled to the second end (332b) of the shaft (332), the cam (334) configured to push the one or more ball bearings (330a, 330b) of the second engagement member (315) into corresponding one or more notches (275) of the first engagement member (270) for engaging the second connector (300) with the first connector (250).

7. The electronic security system (110) as claimed in claim 3, wherein the second connector (300) further comprises a biometric sensor module (385) electrically coupled to the second security circuit (340), the biometric sensor module (385) configured to:

acquire fingerprint of a user (125) for verifying identity of the user (125) accessing the second connector (300); and  
communicate with the second security circuit (340) to actuate the motor (310), upon verification of the identity of the user (125) by the biometric sensor module (385).

8. The electronic security system (110) as claimed in claim 1, wherein the second connector (300) further comprises:

a pairing module (375) securely paired with a user device (120) for actuating the second connector (300) to disengage from the first connector (250);  
a communication module (355) for providing information of the type of the anchoring device (205, 602, 604, 606, 702) to a user device (120);  
a location service module (380) for determining location data, wherein the location service module (380) is adapted to provide the location data to the user device (120);  
a plurality of light emitting diodes (350) for at least one of:

displaying a charge level in the second rechargeable battery (305); and  
providing light for surroundings of the bicycle (105) when activated by a push button (345) in the second connector (300); and

an identifier tag (370) communicably coupled to the user device (120) for identifying the second connector (300), the identifier tag (370) configured to provide access to the second connector (300) for locking and unlocking the electronic security device (150).

9. The electronic security system (110) as claimed in claim 1, wherein each of the first security device (255) and the second security device (340) is a printed circuit board assembly.

10. The electronic security system (110) as claimed in claim 1, wherein the plurality of anchoring devices (205, 602, 604, 606, 702) is at least one of: a cable (604), a chain (602), and a foldable lock (606).

11. The electronic security system (110) as claimed in claim 1, wherein the second connector (300) further comprises a charging port for charging the second rechargeable battery (305).

#### Patentansprüche

1. Elektronisches Sicherheitssystem (110) für ein Fahrrad (105), wobei das elektronische Sicherheitssystem (110) aufweist:

eine elektronische Sicherheitsvorrichtung (150), die an einem Rahmen (140) des Fahrrads (105) zum Sichern des Fahrrads (105) anordenbar ist, wobei die elektronische Sicherheitsvorrichtung (150) eine erste wiederaufladbare Bat-

terie (260), ein integriertes Fahrradschloss (280) und eine erste Sicherheitsschaltung (255) aufweist, wobei die erste wiederaufladbare Batterie (260) als eine Stromquelle für die elektronische Sicherheitsvorrichtung (150) dient; einen ersten Verbinder (250), der an der elektronischen Sicherheitsvorrichtung (150) angeordnet ist, wobei der erste Verbinder (250) ein erstes Eingriffselement (270) aufweist; und einen zweiten Verbinder (300), der aufweist:

einen ersten Endabschnitt (300a) und einen zweiten Endabschnitt (300b), wobei der zweite Endabschnitt (300b) mit einer Verankerungsvorrichtung (205, 602, 604, 606, 702) einer Vielzahl von Typen von Verankerungsvorrichtungen (205, 602, 604, 606, 702) zum Anbinden des Fahrrads (105) an ein Dock (115) verbunden ist; eine zweite wiederaufladbare Batterie (305), die zwischen dem ersten Endabschnitt (300a) und dem zweiten Endabschnitt (300b) angeordnet ist; ein zweites Eingriffselement (315), das am ersten Endabschnitt (300a) konfiguriert ist, wobei das zweite Eingriffselement (315) konfiguriert ist, sicher mit dem ersten Eingriffselement (270) in Eingriff zu treten, um eine elektromechanische Verbindung zwischen dem ersten Verbinder (250) und dem zweiten Verbinder (300) zum Laden der ersten wiederaufladbaren Batterie (260) durch die zweite wiederaufladbare Batterie (305) und zum Anbinden des Fahrrads (105) an ein Dock (115) zu bilden; und eine zweite Sicherheitsschaltung (340), wobei die erste Sicherheitsschaltung (255) und die zweite Sicherheitsschaltung (340) konfiguriert sind:

einen Typ der Verankerungsvorrichtung (205, 602, 604, 606, 702) zu erfassen, wenn das zweite Eingriffselement (315) mit dem ersten Eingriffselement (270) in Eingriff tritt; und Informationen des Typs der Verankerungsvorrichtung (205, 602, 604, 606, 702) an ein externes System (135, 120) zu liefern.

2. Elektronisches Sicherheitssystem (110) nach Anspruch 1, wobei das externe System (135, 120) mindestens eines ist von:

einem externen Server (135) eines Versicherungsdienstleisters; und einer Benutzervorrichtung (120), die mit einem Benutzer (125) des Fahrrads (105) verknüpft ist.

3. Elektronisches Sicherheitssystem (110) nach Anspruch 1, wobei das erste Eingriffselement (270) eine oder mehrere Kerben (275) aufweist; wobei das zweite Eingriffselement (315) ein oder mehrere Kugellager (330a, 330b) aufweist, die beweglich im zweiten Eingriffselement (315) angeordnet sind; und wobei der zweite Verbinder (300) ferner einen Motor (310) aufweist, der konfiguriert ist, bei der Authentifizierung des zweiten Verbinders (300) betätigt zu werden, wenn der zweite Verbinder (300) mit dem ersten Verbinder (250) in Kontakt kommt, wobei die Betätigung des Motors (310) eine Bewegung des einen oder der mehreren Kugellager (330a, 330b) ermöglicht, um mit dem einen oder den mehreren Kerben (275) des ersten Eingriffselements (270) in Eingriff zu treten, wodurch der erste Verbinder (250) und der zweite Verbinder (300) verbunden werden.

4. Elektronisches Sicherheitssystem (110) nach Anspruch 3, wobei die erste Sicherheitsschaltung (255) und die zweite Sicherheitsschaltung (340) konfiguriert sind, den zweiten Verbinder (300) zu authentifizieren, wenn der zweite Verbinder (300) mit dem ersten Verbinder (250) in Kontakt kommt.

5. Elektronisches Sicherheitssystem (110) nach Anspruch 3, wobei der zweite Verbinder (300) ferner aufweist:

eine Gewindespindel (325), die ein erstes Ende (325a) und ein zweites Ende (325b) aufweist, wobei das erste Ende (325a) der Gewindespindel (325) mit dem Motor gekoppelt ist (310) und sich bei der Betätigung des Motors (310) dreht; und eine Schubstange (320), die mit dem zweiten Ende (325b) der Gewindespindel (325) gekoppelt ist, wobei die Schubstange (320) konfiguriert ist, das eine oder die mehreren Kugellager (330a, 330b) des zweiten Eingriffselements (315) in entsprechende Kerben (275) der einen oder der mehreren Kerben (275) des ersten Eingriffselements (270) zu drücken, um den zweiten Verbinder (300) mit dem ersten Verbinder (250) in Eingriff zu bringen.

6. Elektronisches Sicherheitssystem (110) nach Anspruch 3, wobei der zweite Verbinder (300) ferner aufweist:

eine Welle (332), die ein erstes Ende (332a) und ein zweites Ende (332b) aufweist, wobei das erste Ende (332a) der Welle (332) mit dem Motor (310) gekoppelt ist und sich bei der Betätigung des Motors (310) dreht; und einen Nocken (334), der mit dem zweiten Ende (332b) der Welle (332) gekoppelt ist, wobei der

Nocken (334) konfiguriert ist, das eine oder die mehreren Kugellager (330a, 330b) des zweiten Eingriffselements (315) in eine oder mehrere entsprechende Kerben (275) des ersten Eingriffselements (270) zu drücken, um den zweiten Verbinder (300) mit dem ersten Verbinder (250) in Eingriff zu bringen.

7. Elektronisches Sicherheitssystem (110) nach Anspruch 3, wobei der zweite Verbinder (300) ferner ein biometrisches Sensormodul (385) aufweist, das elektrisch mit der zweiten Sicherheitsschaltung (340) gekoppelt ist, wobei das biometrische Sensormodul (385) konfiguriert ist:

einen Fingerabdruck eines Benutzers (125) zum Verifizieren der Identität des Benutzers (125) zu erfassen, der auf den zweiten Verbinder (300) zugreift; und  
mit der zweiten Sicherheitsschaltung (340) zu kommunizieren, um bei der Verifikation der Identität des Benutzers (125) durch das biometrische Sensormodul (385) den Motor (310) zu betätigen.

8. Elektronisches Sicherheitssystem (110) nach Anspruch 1, wobei der zweite Verbinder (300) ferner aufweist:

ein Paarungsmodul (375), das sicher mit einer Benutzervorrichtung (120) gepaart ist, um den zweiten Verbinder (300) zu betätigen, um sich vom ersten Verbinder (250) zu lösen;  
ein Kommunikationsmodul (355) zum Liefern von Informationen über den Typ der Verankerungsvorrichtung (205, 602, 604, 606, 702) an eine Benutzervorrichtung (120);  
ein Ortungsdienstmodul (380) zum Bestimmen von Ortungsdaten, wobei das Ortungsdienstmodul (380) eingerichtet ist, die Ortungsdaten an die Benutzervorrichtung (120) zu liefern;  
mehrere lichtemittierende Dioden (350) für mindestens eines von:

Anzeigen eines Ladepegels der zweiten wiederaufladbaren Batterie (305); und  
Bereitstellen von Licht für die Umgebung des Fahrrads (105), wenn sie durch einen Druckknopf (345) im zweiten Verbinder (300) aktiviert werden; und  
ein Identifizierungskennzeichen (370), das kommunikativ mit der Benutzervorrichtung (120) zum Identifizieren des zweiten Verbinders (300) gekoppelt ist, wobei das Identifizierungskennzeichen (370) konfiguriert ist, einen Zugriff auf den zweiten Verbinder (300) zum Verriegeln und Entsperren der elektronischen Sicherheitsschaltung

(150) bereitzustellen.

9. Elektronisches Sicherheitssystem (110) nach Anspruch 1, wobei jeweils die erste Sicherheitsvorrichtung (255) und die zweite Sicherheitsvorrichtung (340) aus einer Leiterplattenanordnung bestehen.

10. Elektronisches Sicherheitssystem (110) nach Anspruch 1, wobei die mehreren Verankerungsvorrichtungen (205, 602, 604, 606, 702) aus mindestens einem bestehen von: einem Kabel (604), einer Kette (602) und einem faltbaren Schloss (606).

11. Elektronisches Sicherheitssystem (110) nach Anspruch 1, wobei der zweite Verbinder (300) ferner einen Ladeanschluss zum Laden der zweiten wiederaufladbaren Batterie (305) aufweist.

## Revendications

1. Système de sécurité électronique (110) pour un vélo (105), ledit système de sécurité électronique (110) comprenant :

un dispositif de sécurité électronique (150) pouvant être mis en place sur un cadre (140) du vélo (105) pour bloquer le vélo (105), ledit dispositif de sécurité électronique (150) comprenant une première batterie rechargeable (260), un cadenas de vélo (280) intégré et un premier circuit de sécurité (255), la première batterie rechargeable (260) fonctionnant comme source d'énergie pour le dispositif de sécurité électronique (150) ;  
un premier connecteur (250) disposé sur le dispositif de sécurité électronique (150), ledit premier connecteur (250) comprenant un premier élément de prise (270) ; et  
un deuxième connecteur (300) comprenant :

une première partie d'extrémité (300a) et une deuxième partie d'extrémité (300b), la deuxième partie d'extrémité (300b) étant raccordée à un dispositif d'ancrage (205, 602, 604, 606, 702) d'une pluralité de types de dispositifs d'ancrage (205, 602, 604, 606, 702) destinés à attacher le vélo (105) à un arceau (115) ;  
une deuxième batterie rechargeable (305) disposée entre la première partie d'extrémité (300a) et la deuxième partie d'extrémité (300b) ;  
un deuxième élément de prise (315) prévu sur la première partie d'extrémité (300a), ledit deuxième élément de prise (315) étant prévu pour venir fermement en prise avec le premier élément de prise (270) pour réa-

- liser une connexion électromécanique entre le premier connecteur (250) et le deuxième connecteur (300) pour charger la première batterie rechargeable (260) par la deuxième batterie rechargeable (305) et pour attacher le vélo (105) à un arceau (115) ; et un deuxième circuit de sécurité (340), où le premier circuit de sécurité (255) et le deuxième circuit de sécurité (340) sont prévus pour :
- détecter un type du dispositif d'ancrage (205, 602, 604, 606, 702) lorsque le deuxième élément de prise (315) vient en prise avec le premier élément de prise (270) ; et délivrer des informations sur le type du dispositif d'ancrage (205, 602, 604, 606, 702) à un système externe (135, 120).
2. Système de sécurité électronique (110) selon la revendication 1, où le système externe (135, 120) est un serveur externe (135) d'un fournisseur de services d'assurance ; et/ou un dispositif d'utilisateur (120) associé à un utilisateur (125) du vélo (105).
3. Système de sécurité électronique (110) selon la revendication 1, où le premier élément de prise (270) présente une ou plusieurs rainures (275) ; où le deuxième élément de prise (315) présente un ou plusieurs roulements à billes (330a, 330b) disposés de manière amovible dans le deuxième élément de prise (315) ; et où le deuxième connecteur (300) comprend en outre un moteur (310) prévu pour être actionné par identification du deuxième connecteur (300) lorsque le deuxième connecteur (300) vient en contact avec le premier connecteur (250), l'actionnement du moteur (310) permettant un mouvement du ou des roulements à billes (330a, 330b) pour venir en prise avec la ou les rainures (275) du premier élément de prise (270) en raccordant ainsi le premier connecteur (250) et le deuxième connecteur (300).
4. Système de sécurité électronique (110) selon la revendication 3, où le premier circuit de sécurité (255) et le deuxième circuit de sécurité (340) sont prévus pour identifier le deuxième connecteur (300) lorsque le deuxième connecteur (300) vient en contact avec le premier connecteur (250).
5. Système de sécurité électronique (110) selon la revendication 3, où le deuxième connecteur (300) comprend en outre :
- une tige filetée (325) présentant une première extrémité (325a) et une deuxième extrémité (325b), la première extrémité (325a) de la tige filetée (325) étant raccordée au moteur (310) et étant rotative par actionnement du moteur (310) ; et une tige de poussée (320) raccordée à la deuxième extrémité (325b) de la tige filetée (325), ladite tige de poussée (320) étant prévue pour pousser le ou les roulements à billes (330a, 330b) du deuxième élément de prise (315) dans une ou des rainures (275) correspondantes entre la ou les rainures (275) du premier élément de prise (270) pour la mise en prise du deuxième connecteur (300) avec le premier connecteur (250).
6. Système de sécurité électronique (110) selon la revendication 3, où le deuxième connecteur (300) comprend en outre :
- un arbre (332) présentant une première extrémité (332a) et une deuxième extrémité (332b), la première extrémité (332a) de l'arbre (332) étant raccordée au moteur (310) et étant rotative par actionnement du moteur (310) ; et une came (334) raccordée à la deuxième extrémité (332b) de l'arbre (332), ladite came (334) étant prévue pour pousser le ou les roulements à billes (330a, 330b) du deuxième élément de prise (315) dans une ou plusieurs rainures (275) correspondantes du premier élément de prise (270) pour mettre en prise le deuxième connecteur (300) avec le premier connecteur (250).
7. Système de sécurité électronique (110) selon la revendication 3, où le deuxième connecteur (300) comprend en outre un module de capteur biométrique (385) relié électriquement au deuxième circuit de sécurité (340), ledit module de capteur biométrique (385) étant prévu pour :
- acquérir l'empreinte digitale d'un utilisateur (125) afin de vérifier l'identité de l'utilisateur (125) accédant au deuxième connecteur (300) ; et communiquer avec le deuxième circuit de sécurité (340) afin d'actionner le moteur (310) par vérification de l'identité de l'utilisateur (125) par le module de capteur biométrique (385) .
8. Système de sécurité électronique (110) selon la revendication 1, où le deuxième connecteur (300) comprend en outre :
- un module d'accouplement (375) fermement ac-

couplé à un dispositif d'utilisateur (120) pour actionner le deuxième connecteur (300) afin de le dégager du premier connecteur (250) ;  
 un module de communication (355) pour la délivrance d'informations du type du dispositif d'ancrage (205, 602, 604, 606, 702) à un dispositif d'utilisateur (120) ;  
 un module de service de localisation (380) pour déterminer des données de localisation, ledit module de service de localisation (380) étant prévu pour délivrer les données de localisation au dispositif d'utilisateur (120) ;  
 une pluralité de diodes électroluminescentes (350) pour au moins une des destinations suivantes :

affichage d'un niveau de charge de la deuxième batterie rechargeable (305) ; et  
 fourniture de lumière dans l'environnement du vélo (105) par activation par un bouton-poussoir (345) du deuxième connecteur (300) ; et  
 une étiquette d'identification (370) reliée en communication au dispositif d'utilisateur (120) pour identifier le deuxième connecteur (300), ladite étiquette d'identification (370) étant prévue pour donner accès au deuxième connecteur (300) pour verrouiller et déverrouiller le dispositif de sécurité électronique (150).

9. Système de sécurité électronique (110) selon la revendication 1, où le premier dispositif de sécurité (255) et le deuxième dispositif de sécurité (340) sont chacun un ensemble carte de circuit imprimé.
10. Système de sécurité électronique (110) selon la revendication 1, où la pluralité de dispositifs d'ancrage (205, 602, 604, 606, 702) est : un câble (604) et/ou une chaîne (602) et/ou un antivol pliant (606).
11. Système de sécurité électronique (110) selon la revendication 1, où le deuxième connecteur (300) comprend en outre un port de chargement pour la charge de la deuxième batterie rechargeable (305).

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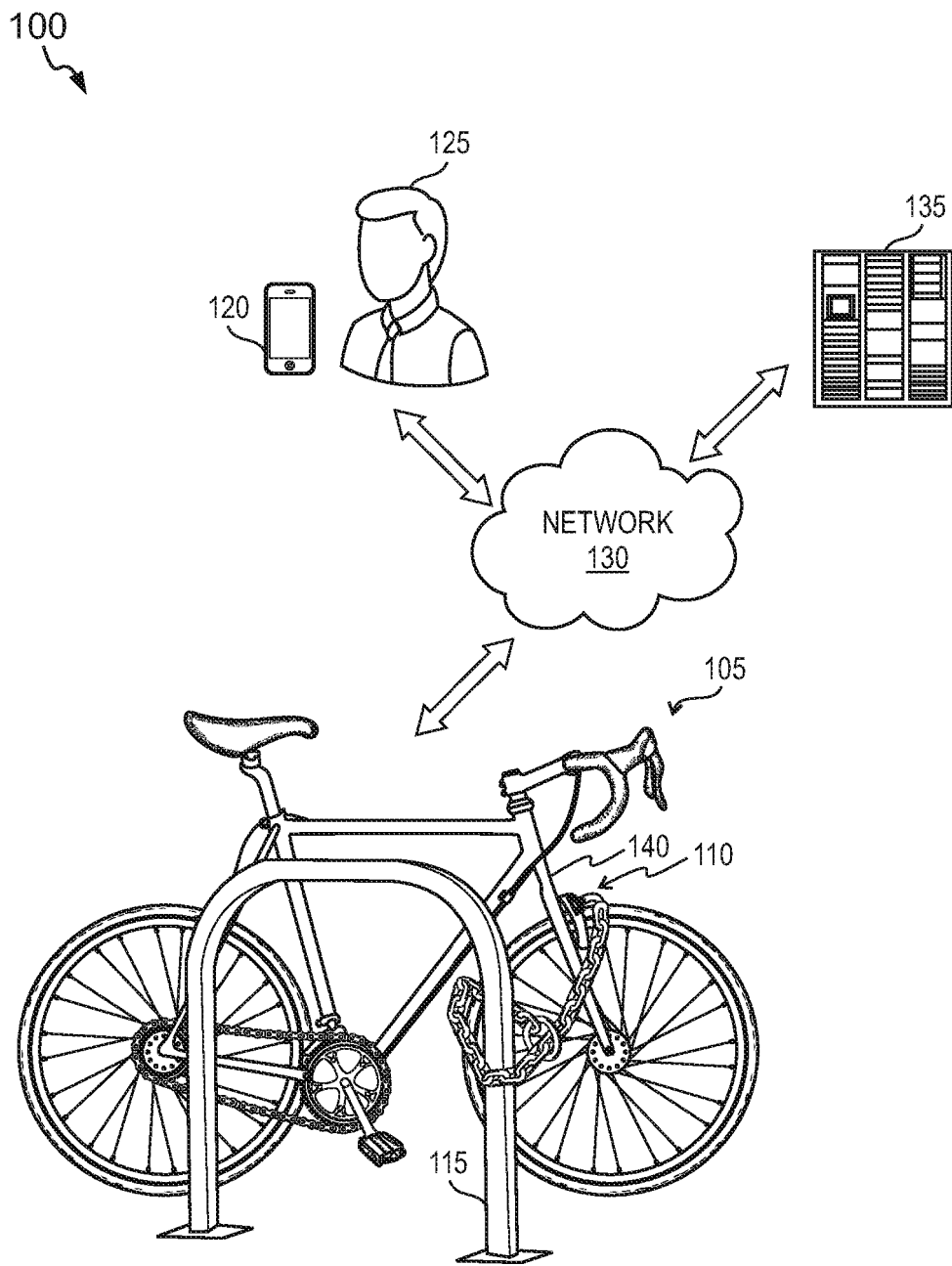


FIG. 1

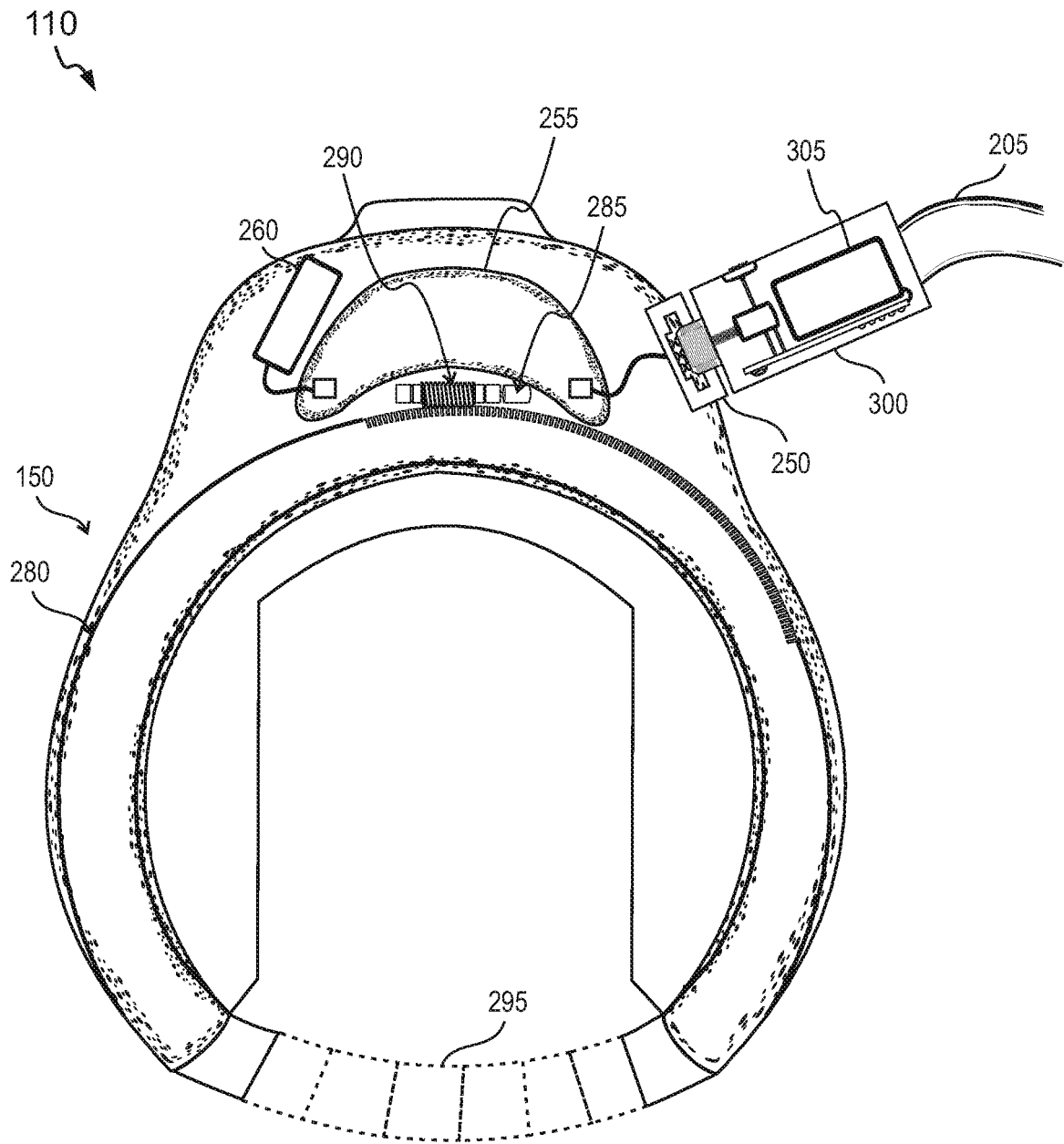


FIG. 2A

105  
↘

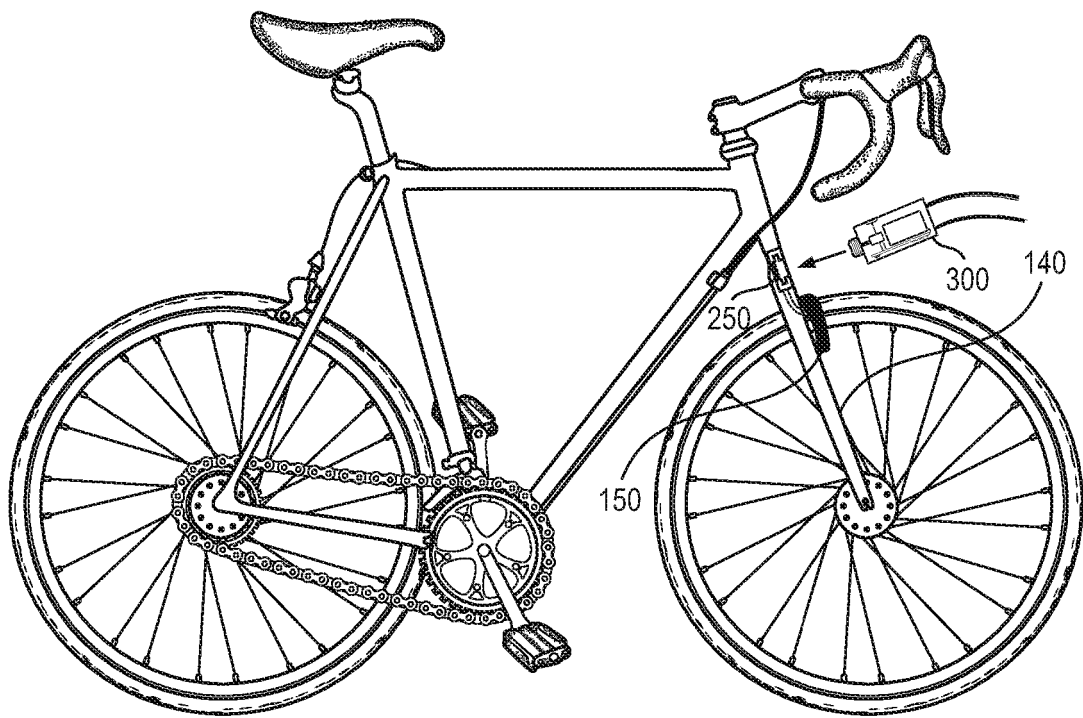


FIG. 2B



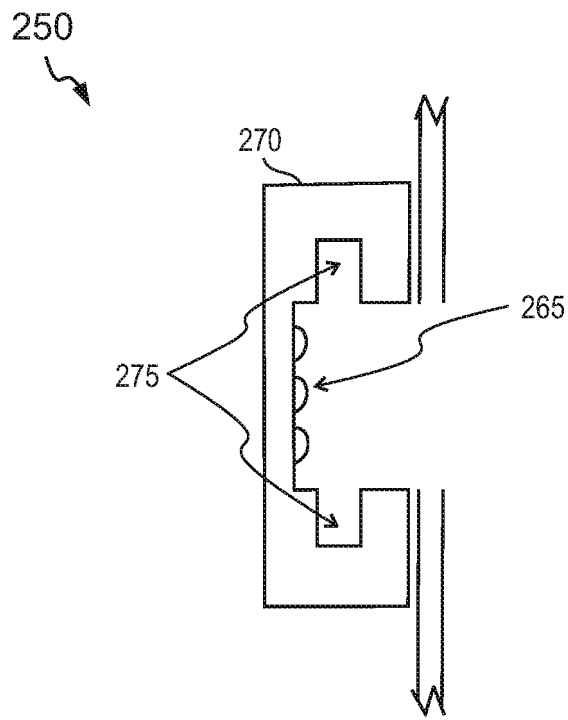


FIG. 3

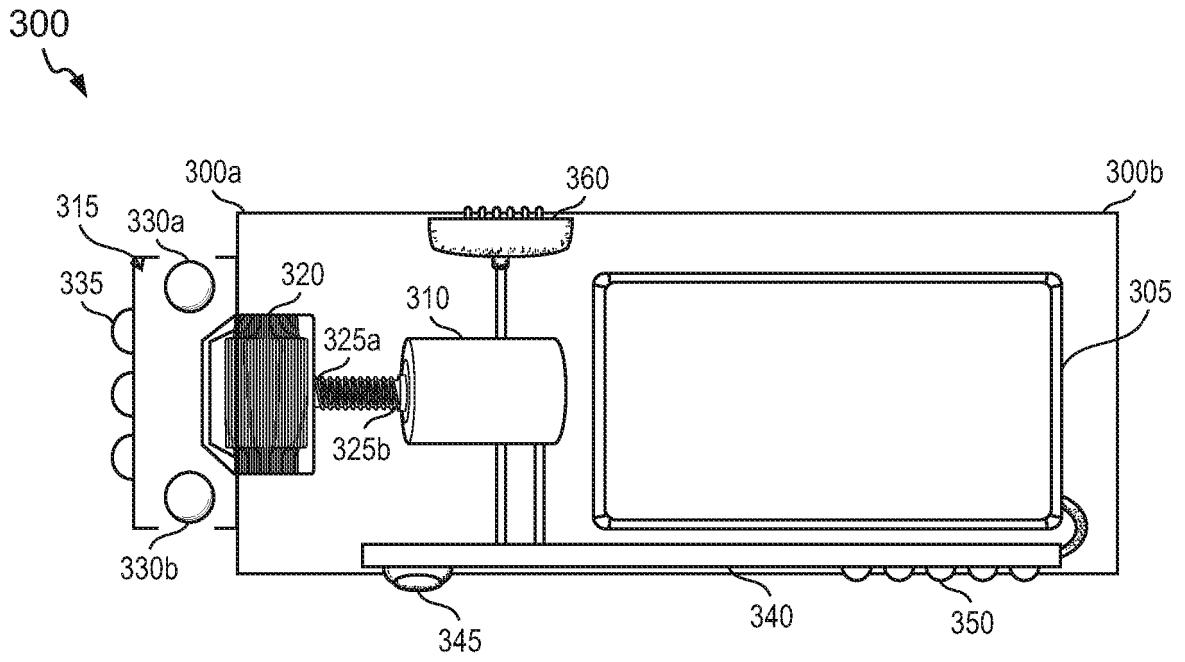


FIG. 4A

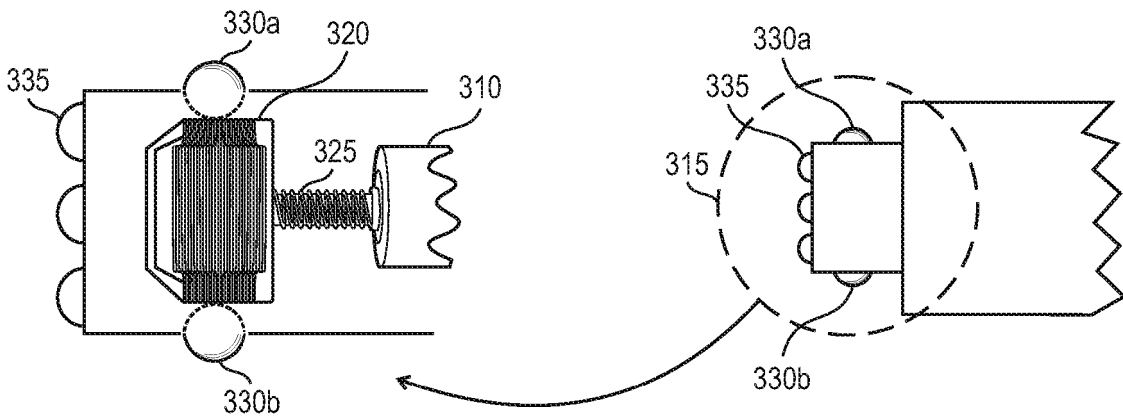


FIG. 4B

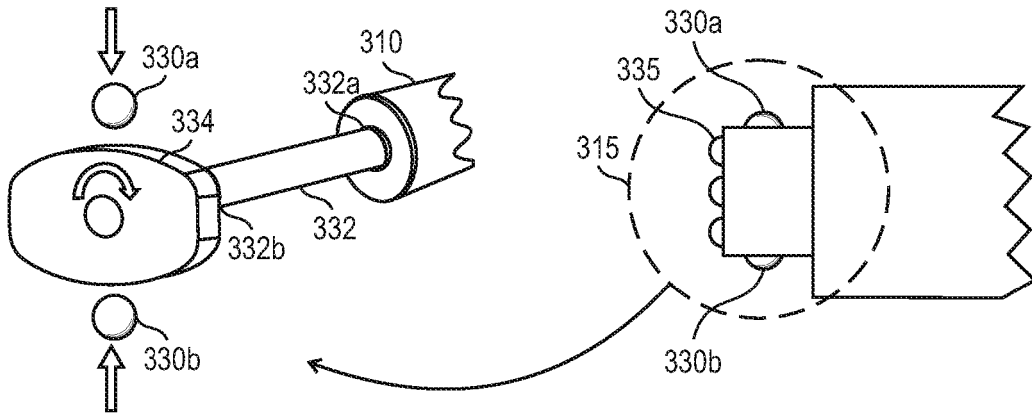


FIG. 4C

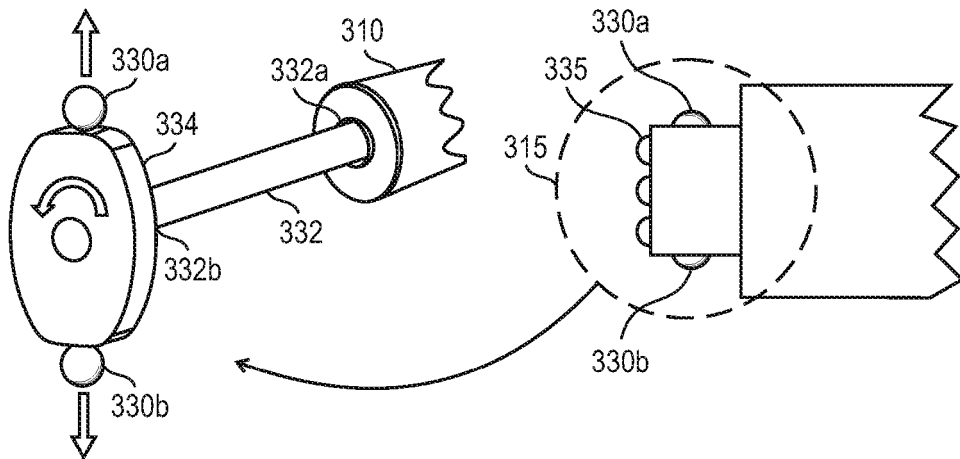


FIG. 4D

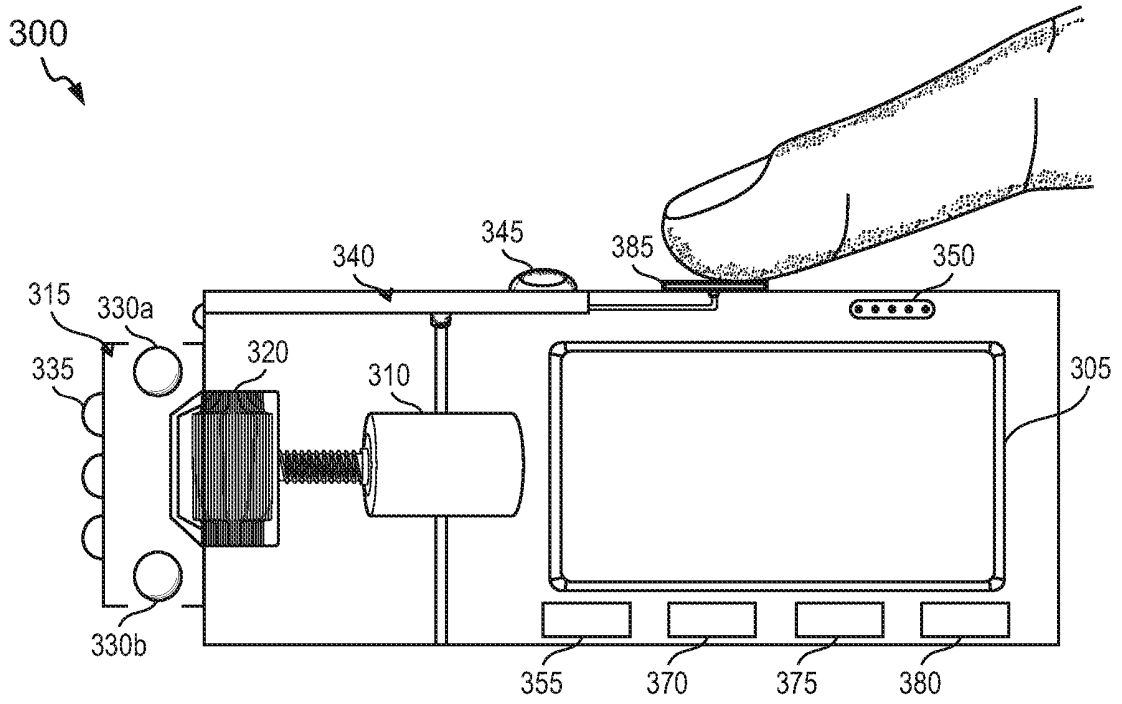


FIG. 4E

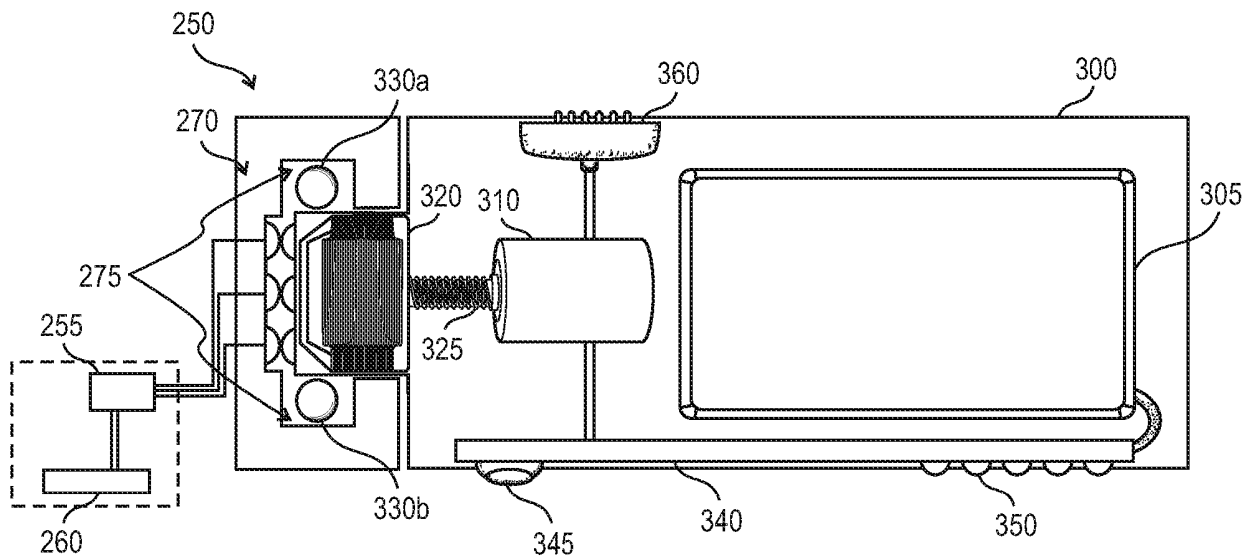


FIG. 5

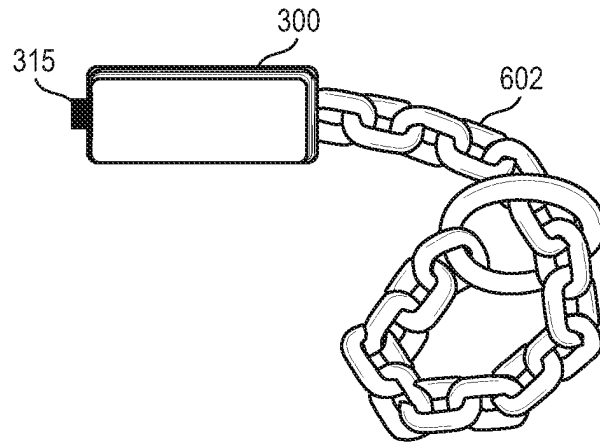


FIG. 6A

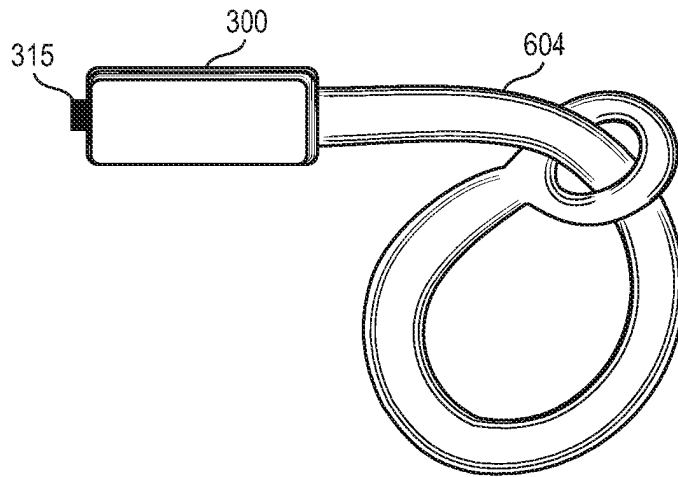


FIG. 6B

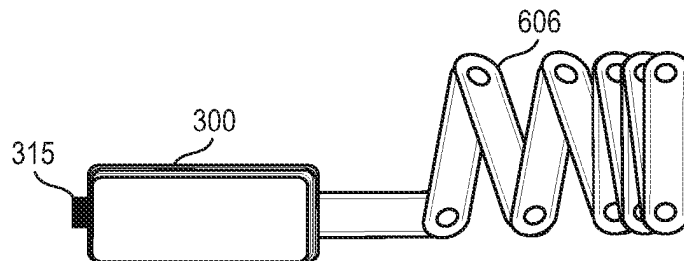


FIG. 6C

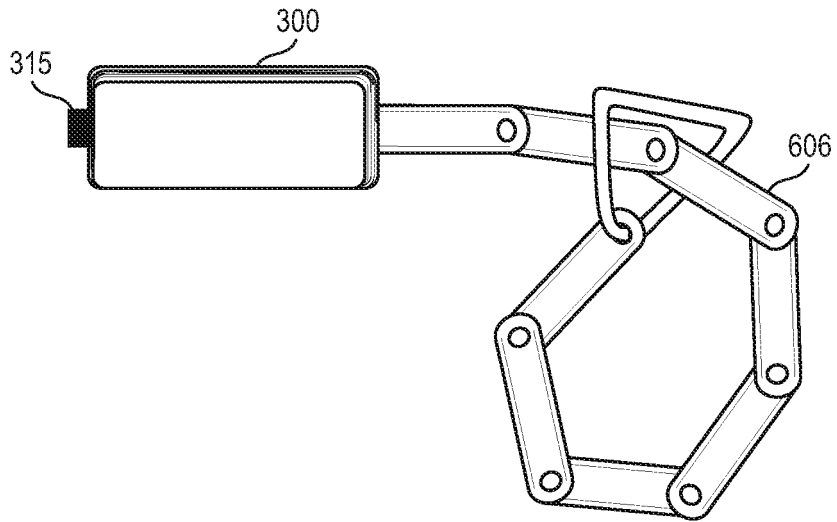


FIG. 6D

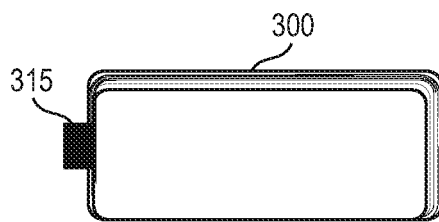


FIG. 6E

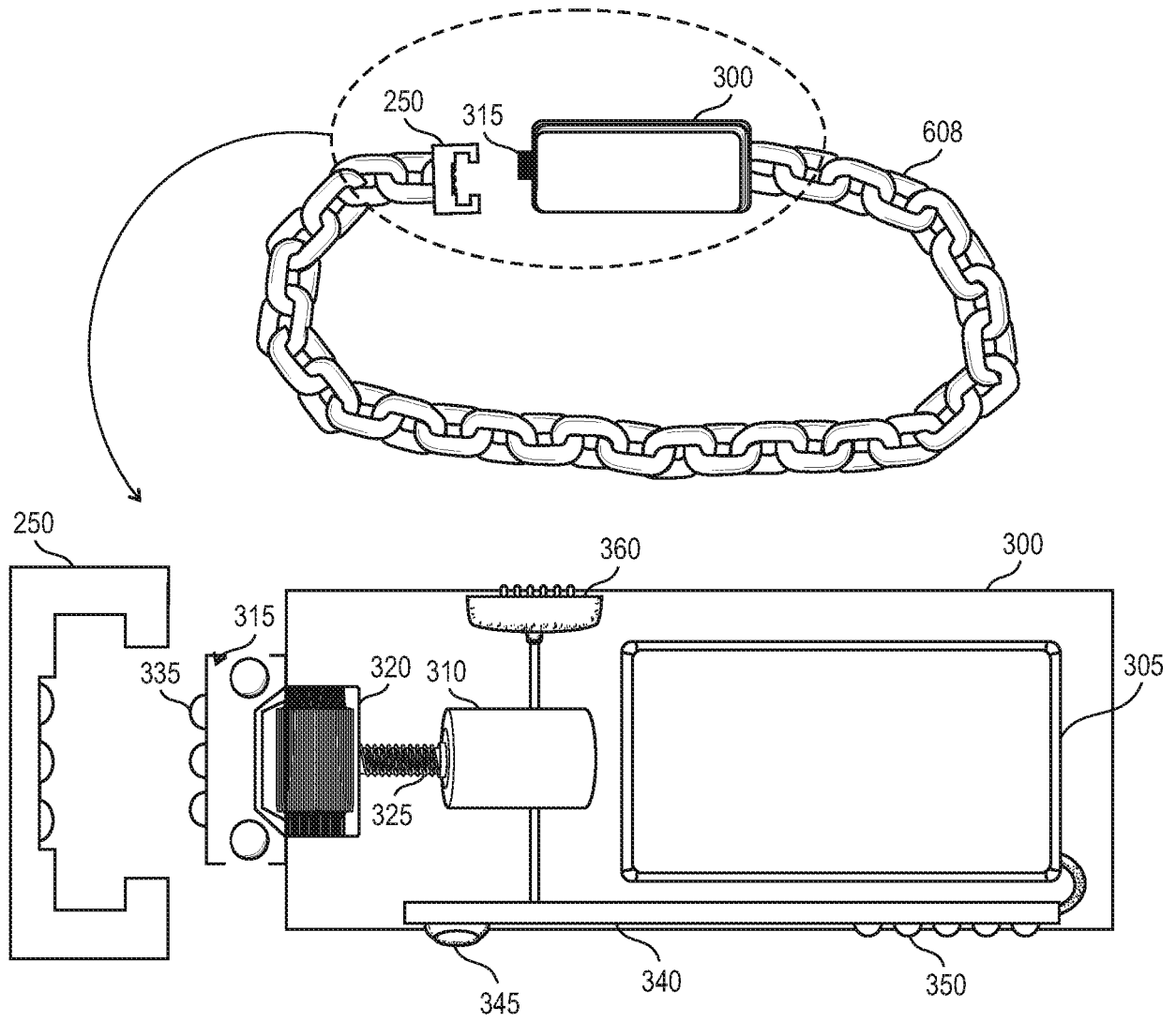


FIG. 6F

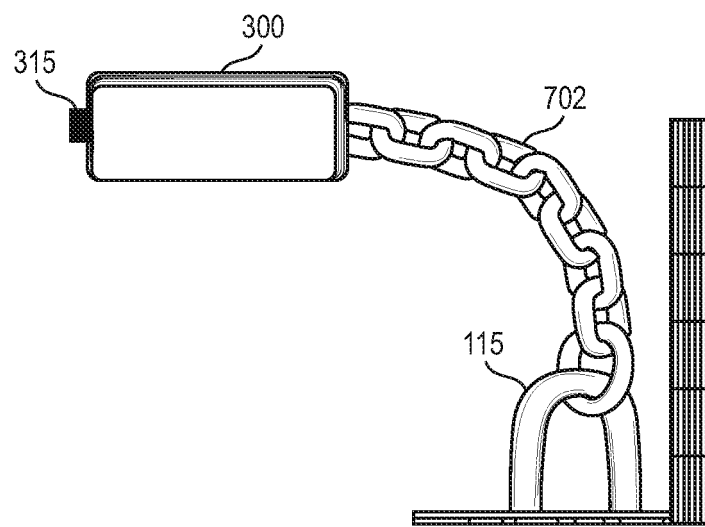


FIG. 7



**REFERENCES CITED IN THE DESCRIPTION**

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