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# MERCHANDISE SECURITY DEVICES FOR USE WITH ELECTRONIC KEY

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# MERCHANDISE SECURITY DEVICES FOR USE WITH AN ELECTRONIC KEY

## FIELD OF THE INVENTION

[0001] Embodiments of the present invention relate generally to merchandise display security systems and methods for protecting an item of merchandise from theft. More particularly, embodiments of the present invention relate to merchandise security devices configured for use with an electronic key.

## BACKGROUND OF THE INVENTION

[0002] It is common practice for retailers to store and/or display items of merchandise on or within a merchandise security device, such as a security display (e.g. alarming stand), security fixture (e.g. locking hook, shelf, cabinet, etc.) or security packaging (e.g. merchandise safer). Regardless, the merchandise security device displays and/or stores an item of merchandise so that a potential purchaser may view, and in some instances, interact with the merchandise before making a decision whether to purchase the item. At the same time, the item is secured on or within the merchandise security device so as to prevent, or at least deter, theft of the item. The value of the item, however, may make it an attractive target for a shoplifter despite the presence of a merchandise security device. A determined shoplifter may attempt to detach the item from the security display, or attempt to remove the item from the security fixture or from the security packaging. Alternatively, the shoplifter may attempt to remove the security device, or at least a portion thereof, from the display area along with the item.

[0003] In the case of a security display or security fixture, the security device is oftentimes firmly attached to a support, such as a pegboard, wire grid, horizontal bar rack, slatwall (also known as slatboard), wall, table, desk, countertop or like structure. In some instances, the security device is secured to the support using a mechanical lock mechanism, for example a conventional tumbler lock or a magnetic lock, operated by a non-programmable key. In other instances, the security device is secured to the support using an electronic lock mechanism operated by a programmable electronic key.

[0004] Some types of security devices are configured to operate with only a mechanical key,

and as a result, may be less secure than security devices that operate with an electronic key. Accordingly, there exists a need for an improved merchandise security device configured for use with an electronic key.

## DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0005] Referring now to the accompanying drawing figures wherein like reference numerals denote like elements throughout the various views, one or more embodiments of a merchandise display security system and method are shown. In the exemplary embodiments shown and described herein, the system includes an electronic key and a security device configured for use with the electronic key. Security devices suitable for use with an electronic key include, but are not limited to, a security display (e.g. alarming stand or module), security fixture (e.g. locking hook, shelf, cabinet, etc.), security wraps or cables, garment tags, or security packaging (e.g. merchandise safer) for securing items from theft. The electronic key may be useable with any security device that utilizes power transferred from the key to operate a mechanical lock mechanism associated with the security device, and/or utilizes data transferred from the key to authorize the operation of a mechanical lock mechanism or an electronic alarm circuit. In other words, an electronic key according to embodiments of the invention is useable with any security device or lock mechanism that requires power transferred from the key to the device and/or data transferred between the key and the device. Further examples of security devices include, but are not limited to, a door lock, a drawer lock or a shelf lock, as well as any device that prevents an unauthorized person from accessing, removing or detaching an item from a secure location or position. Although the description is directed to merchandise display security devices for items of merchandise, it is understood that embodiments of the present invention are suitable for any number of types of security devices configured operate with an electronic key for protecting various items from theft.

[0006] It should be noted that although the invention is described with respect to embodiments including an electronic key for transferring both data and power to a merchandise security device to operate a mechanical lock mechanism, the invention is equally applicable to an electronic key for transferring only electrical power to a merchandise security device to operate any component of the merchandise security device (e.g., a lock mechanism, alarm circuit, etc.),

whether or not the security device includes an internal or external power source for operating another component of the device.

[0007] One embodiment of an electronic key for use with a merchandise display security system and method according to the invention is shown in FIGS. 1-6 and will be described in greater detail hereinafter. The merchandise display security system and method comprises the electronic key and a merchandise security device that is configured to be operated with the key. The system and method may further comprise an optional programming station that is operable for programming the electronic key with a security code, which is also referred to herein as a Security Disarm Code (SDC). A programming station suitable for use with the electronic key is shown and described in United States Patent No. 7,737,844 entitled Programming Station For a Security System For Protecting Merchandise, the disclosure of which is incorporated herein by reference in its entirety. It is to be understood that in other embodiments the electronic key may be programmed without the use of a programming station. For example, the key may be self-programming, input by a user, or may be pre-programmed with a predetermined SDC.

[0008] In addition to the programming station, the system and method may further comprise an optional charging station that is operable for initially charging and/or subsequently recharging an internal power source disposed within the key. The electronic key may be provisioned with a single-use (i.e. non-rechargeable) power source, such as a conventional or extended-life battery, or alternatively, the key may be provisioned with a multiple-use (i.e. rechargeable) power source, such as a conventional capacitor or rechargeable battery. In either instance, the internal power source may be permanent, semi-permanent (i.e. replaceable), or rechargeable, as desired. In the latter instance, the charging station is provided to initially charge and/or to subsequently recharge the internal power source disposed within the electronic key.

[0009] In certain embodiments, the merchandise security device is a passive device. As used herein, the term “passive” is intended to mean that the security device does not have an internal power source (e.g., a battery) sufficient to lock and/or unlock a mechanical lock mechanism. Significant cost savings are obtained by a retailer when the merchandise security device is passive since the expense of an internal power source is confined to the electronic key, and one such key is able to operate multiple security devices. In addition, the security device may not

require an electric motor, such as a DC stepper motor, solenoid, or the like, that is configured to lock or unlock the lock mechanism. As such, the security device may employ a simplified lock mechanism that does not require various components operated by its own source of electrical power.

[0010] Moreover, in certain embodiments the merchandise security device is not required to include a logic control circuit, while the electronic key includes such a logic control circuit. In this regard, some security devices include a logic control circuit adapted to perform a handshake communication protocol with the logic control circuit of the electronic key (e.g., using an SDC). Thus, the security device may or may not include a logic control circuit used to communicate with the electronic key in order to determine whether the merchandise security device is an authorized device. Likewise, the electronic key may or may not include a logic control circuit. Regardless of whether the electronic key includes a logic control circuit, an SDC may be unnecessary where the electronic key configured to transmit power to the security device is not readily duplicated by a potential thief. For example, where the electronic key is configured to transmit power inductively, the inductive signature may provide increased security relative to conventional lock mechanisms that utilize mechanical or magnetic actuators. For instance, the electronic key may be configured to transmit an inductive signature including a particular amplitude and/or frequency of a power signal that is not readily apparent to, or is not readily able to be duplicated by, a potential thief.

[0011] In some embodiments, the electronic key does not transmit an SDC to the security device. However, in other embodiments, the electronic key may be configured to transmit an SDC to the security device. In the latter embodiments, the security device may include a corresponding SDC. Thus, the electronic key may be configured to perform a handshake communication protocol with the security device. In the event that the SDC of the electronic key matches the SDC of the security device, the electronic key may then be configured to transmit electrical power to the security device.

[0012] However in other embodiments, the security device may not recognize the SDC transmitted by the electronic key, such as where the security device does not include a logic control circuit or a component including an SDC. If the electronic key does not receive a return

signal from the security device, the electronic key may nevertheless still transmit electrical power to the security device as described in further detail below. Thus, although the electronic key may transmit an SDC to the security device, the security device may not recognize or even receive the SDC and the SDC transmitted by the electronic key will not affect the operation of the security device. As will be readily apparent to those skilled in the art, the SDC may be transmitted from the electronic key to the merchandise security device by any suitable means, including without limitation, via one or more electrical contacts, or via optical, acoustic, electromechanical, electromagnetic or magnetic conductors, as desired. In certain embodiments, the SDC may be transmitted by inductive transfer of data from the electronic key to the merchandise security device.

[0013] In one embodiment, the logic control circuit of the electronic key is configured to cause the internal power source of the key to transfer electrical power to the security device to operate a lock mechanism of the security device. In one example, electrical contacts disposed on the electronic key electrically couple with cooperating electrical contacts on the merchandise security device to transfer power from the internal battery of the key to the merchandise security device. As such, electrical power may be transferred directly to the lock mechanism via one or more conductors. For example, a conductor may be coupled to a mechanical lock mechanism and when electrical power is conducted through the conductor a state change occurs, thereby resulting in operation of the lock mechanism. In the exemplary embodiments shown and described herein, the conductor is coupled to a shape memory material (e.g., Nitinol) such that electrical power transferred through the conductor results in a change in shape of the shape memory material. Such a change in shape may cause a mechanical actuation (e.g., linear, rotary, etc.) of the lock mechanism to lock or unlock the lock mechanism. In other embodiments, the conductor may couple with a motor or solenoid for operating the lock mechanism.

[0014] An available feature of a merchandise security system and method according to an embodiment of the invention is that the electronic key may include a time-out function. More particularly, the ability of the electronic key to transfer power and/or data to the merchandise security device is deactivated after a predetermined time period. By way of example, the logic control circuit of the electronic key may be deactivated after about six to about twelve hours

(e.g., about eight hours) from the time that the key was last fully charged, or last programmed or refreshed by the programming station. In this manner, an authorized sales associate typically must charge, program, re-program or refresh an electronic key assigned to him or her at the beginning of each work shift. Furthermore, the charging station may be configured to deactivate the logic control circuit of the key when the key is positioned within the charging station. In this manner, the charging station can be made available to an authorized sales associate in an unsecured location without risk that a charged key could be removed from the charging station and used to disarm and/or unlock a merchandise security device in an unauthorized manner. The electronic key would then have to be programmed, re-programmed or refreshed by the programming station, which is typically monitored or maintained at a secure location, in order to reactivate the logic control circuit of the key.

[0015] The merchandise security device may include a transfer port sized and shaped to receive a transfer probe of the electronic key. At least one, and sometimes, a plurality of magnets may be disposed within the transfer port for securely positioning and retaining the transfer probe of the key in physical contact with the transfer port of the merchandise security device. In certain embodiments, the magnet(s) securely retain one or more electrical contacts of the electronic key in electrical contact with one or more electrical contacts of the mechanical lock mechanism of the security device. In this instance, electrical power is transferred from the electronic key to the security device through the one or more electrical contacts disposed on the transfer probe of the key and the corresponding electrical contacts disposed within the transfer port of the security device.

[0016] Exemplary embodiments of a merchandise display security system and method according to the invention shown and described herein comprise an electronic key with inductive transfer capability and a merchandise security device that is configured to be operated by the key. However, the electronic key is useable with any security device or locking device with inductive transfer capability that requires power transferred from the key to the device by induction, or alternatively, requires data transferred between the key and the device and power transferred from the key to the device by induction. Examples of such security devices include, but are not limited to, locking hooks, a door lock, a drawer lock or a shelf lock, as well as any

device that prevents an unauthorized person from accessing, removing or detaching an item from a secure location or position. The merchandise display system and method may further comprise an optional programming station, as previously described, operable for programming the electronic key with an SDC. In addition to a programming station, the system and method may further comprise an optional charging station with electrical contact and/or inductive transfer capability that is operable for initially charging and subsequently recharging an internal power source disposed within the key.

[0017] In certain embodiments, the security device comprises an internal lock mechanism. A transfer port may be formed in the security device that is sized and shaped to receive a transfer probe or a portion of the electronic key. If desired, the transfer port may comprise mechanical or magnetic means for properly positioning and securely retaining the key within the transfer port. In one instance, it is necessary that an inductive transceiver of the electronic key is sufficiently aligned or proximate to a corresponding inductive transceiver of the security device. In another instance, it is only necessary that the transfer probe is proximate to the transfer port. Therefore, magnets are not required to position, align, retain and/or maintain the transfer probe of the electronic key in physical and/or electrical contact with the transfer port provided on the security device.

[0018] In some embodiments, data may be transferred from the electronic key to the security device by wireless communication, such as infrared (IR) optical transmission. Power may be transferred from the electronic key to the security device by induction across the transfer port of the security device using an inductive transceiver disposed within the transfer probe of the key that cooperates with a corresponding inductive transceiver disposed within the security device. For example, the transfer probe of the electronic key may comprise an inductive transceiver coil that is electrically connected to the logic control circuit of the key to provide electrical power from the internal battery of the key to an inductive transceiver coil disposed within the security device. The inductive transceiver coil of the security device may then transfer the electrical power from the internal battery of the key to the lock mechanism disposed within the security device. Thus, the security device may include at least one conductor configured as a coil having a plurality of continuous windings. As previously mentioned, the power transferred from the

electronic key may be used to unlock the lock mechanism without the need for various other electrically powered mechanisms, for example, an electric motor, DC stepper motor, solenoid, or the like.

[0019] According to one aspect, the electronic key does not require a physical force to be exerted by a user on the key to operate the lock mechanism of the merchandise security device. By extension, no physical force is exerted by the electronic key on the lock mechanism. As a result, the electronic key cannot be unintentionally broken off in the lock, as often occurs with conventional mechanical key and lock mechanisms. Furthermore, neither the electronic key nor the lock mechanism suffer from excessive wear as likewise often occurs with conventional mechanical key and lock mechanisms, and to a lesser extent, with electronic key and lock mechanisms having exposed electrical contacts. In addition, there is no required orientation of the transfer probe of the electronic key relative to a charging port of a charging station, a programming port of a programming station and/or the transfer port of the merchandise security device. Accordingly, any wear on the transfer probe of the key, the charging port of the charging station, the programming port of the programming station and/or the transfer port of the security device is avoided, or at the least minimized. As a further advantage, an authorized person is not required to position the transfer probe of the electronic key in a particular orientation relative to the transfer port of the security device, and thereafter exert a compressive and/or torsional force on the key to operate the mechanical lock mechanism of the security device.

[0020] FIGS. 1-6 show an electronic key 40 with inductive transfer capability according to an exemplary embodiment of the invention. As previously mentioned, the electronic key 40 is configured to transfer power and/or data to a merchandise security device that comprises a mechanical lock mechanism. Accordingly, electronic key 40 may be an active device. The term "active" is used herein to mean that an electronic key has an internal power source sufficient to cause operation of the lock mechanism of the merchandise security device. In one embodiment, the electronic key 40 may be configured to transfer both data and power from an internal source disposed within the key, for example, with a logic control circuit (e.g. data) and a battery (e.g. power).

[0021] As shown herein, the electronic key 40 comprises a housing 42 defining an internal

cavity or compartment 41 (see FIG. 6) that contains the internal components of the key, including without limitation a logic control circuit, memory, communication system and battery, as will be described. As previously mentioned, the electronic key 40 further comprises a transfer probe 44 located at an end of the housing 42 for transferring data and/or power to the merchandise security device. The transfer probe 44 may also be operable to transmit and receive the handshake communication protocol and the SDC from the programming station and to receive power from the charging station.

[0022] FIG. 2 shows an embodiment of an inductive coil 46 having high magnetic permeability that is adapted to be disposed within the housing 42 of the electronic key 40 adjacent the transfer probe 44. As shown herein, the inductive coil 46 comprises a highly magnetically permeable ferrite core 45 surrounded by a plurality of inductive core windings 47. The inductive core windings 47 consist of a length of a conductive wire that is wrapped around the ferrite core 45. Passing an alternating current through the conductive wire generates, or induces, a magnetic field around the inductive coil 46. The alternating current in the inductive core windings 47 may be produced by connecting the leads 47A and 47B of the conductive wire to the internal battery of the electronic key 40 through the logic control circuit.

[0023] FIG. 3 shows a similar inductive coil 146 that is adapted to be disposed adjacent to or within a transfer port provided on the merchandise security device. In one embodiment, the inductive coil 146 comprises a highly magnetically permeable ferrite core 145 surrounded by a plurality of inductive core windings 147 consisting of a length of a conductive wire that is wrapped around the ferrite core. Placing the transfer probe 44 of the electronic key 40 into, or adjacent to, the transfer port of the merchandise security device and passing an alternating current through the inductive core windings 47 of the inductive coil 46 generates a magnetic field within the transfer port of the security device in the vicinity of the inductive coil 146. As a result, an alternating current is generated, or induced, in the conductive wire of the inductive core windings 147 of inductive coil 146 having leads 147A and 147B that are connected to the logic control circuit of the security device and/or one or both ends of a shape memory material or wire. It is understood that depending on the placement of the inductive coil 146 relative to the transfer port of the merchandise security device (e.g., within, around, or adjacent to the transfer port), a

ferrite core 145 may not be necessary in some embodiments such that the inductive core winding 147 is configured to receive current directly from the inductive coil 46. Thus, in some embodiments, the inductive coil 146 may consist of only a winding of electrically conductive material. It is understood that the core windings 147 may be disposed at any desired location relative to the transfer port, such as within, adjacent to, or at least partially around the transfer port for receiving electrical power from the key 40. For example, a plurality of core windings 147 may be wrapped about the transfer port.

[0024] In one embodiment, an internal battery 48 and a logic control circuit, or printed circuit board (PCB) 50 are disposed within the housing 42 of the electronic key 40 (see FIG. 6). Battery 48 may be a conventional extended-life replaceable battery, or alternatively, a rechargeable battery suitable for use with the charging station. The logic control circuit 50 is operatively coupled and electrically connected to a switch 52 that is actuated by a control button 54 provided on the exterior of the key 40 and extending through the housing 42. Control button 54 in conjunction with switch 52 controls certain operations of the logic control circuit 50, and in particular, transmission of power between the key 40 and a merchandise security device. In one embodiment, actuation of the key 40 via the control button 54 results in the transfer of power for a predetermined duration (e.g., about 1-3 seconds) before power ceases being transferred.

[0025] In another embodiment, the logic control circuit 50 is further operatively coupled and electrically connected to a communication system, for example an optical transceiver 56 (see FIG. 6), for transferring the handshake communication protocol and SDC data. As a result, the transfer probe 44 of the key 40 may be provided with an optically transparent or translucent filter window 60 for emitting and collecting optical transmissions between the key 40 and a programming station, or between the key 40 and the merchandise security device, as required.

[0026] As previously mentioned, transfer probe 44 contains an inductive coil 46 comprising ferrite core 45 and inductive core windings 47 for transferring electrical power to the merchandise security device and/or receiving electrical power from the charging station to charge the internal battery 48, as required. Accordingly, the leads 47A and 47B of the inductive coil 46 are electrically connected to the logic control circuit 50, which in turn is electrically connected to the battery 48, in a suitable manner, for example by conductive insulated wires or

plated conductors. Alternatively, the optical transceiver 56 may be eliminated and data transferred between the electronic key 40 and the merchandise security device via magnetic induction through the inductive coil 46.

[0027] FIG. 7 shows a merchandise security device 100 configured for use with an electronic key 40 (e.g., FIG. 4) according to an exemplary embodiment of the invention. More particularly, the security device 100 is a locking hook configured to be secured to a display surface, such as slat wall, grid, or pegboard. The locking hook 100 generally includes a base 120 configured to be secured to the display surface and an end assembly 140 or housing configured to cooperate with the electronic key 40 for locking or unlocking the end assembly. The locking hook 100 may also include at least one elongate lower rod 130 configured to be selectively secured to the end assembly 140 and to support items of merchandise thereon. The end assembly 140 of the locking hook 100 may be configured to be locked or unlocked to the lower rod 130 using power transfer. For example, an inductive coil may be configured to be energized inductively through a transfer port 144 provided on the end assembly 140 using the electronic key 40. In one embodiment, the transfer probe 44 of the key 40 and associated inductive coil 46 is configured to be positioned within the transfer port 144 such that the inductive coil of the end assembly at least partially surrounds the inductive coil 46. Thus, the transfer port 144 may define a recess for receiving the transfer probe 44 of the key 40.

[0028] FIGS. 8A-8B illustrate operation of a locking hook 100 according to one embodiment. As shown, the locking hook 100 includes a lock mechanism 150. A shape memory material may be employed in conjunction with power transfer to operate the lock mechanism 150 of the locking hook 100. For example, the shape memory material may be in electrical communication with an inductive coil and configured to change in shape in response to electrical current being transmitted through the shape memory material. A change in the shape of the shape memory material may, in turn, result in actuation of the lock mechanism 150. As such, the locking device 100 may also not require a rectifier for converting the alternating current into direct current for operating the lock mechanism 150. In this regard, some merchandise security devices require that the alternating current induced in an inductive coil be transformed into a direct current, such as via a bridge rectifier or a logic control circuit, to provide direct current (DC) power to the

security device. Such a conversion is not required by the present invention, as the alternating current may be used to actuate the lock mechanism. Indeed, the security device may also not require a battery, motor, solenoid, and/or any other electrical component as discussed above. Therefore, the lock mechanism is simplified for use with a variety of different security devices.

[0029] In this embodiment, the shape memory material is Nitinol in the form of a wire. The shape memory material changes length, and in particular, contracts when an electrical current is transferred from the inductive coil in response to actuation of the electronic key 40. A change in length of the wire causes disengagement of a latch 158 from a retracted position to an extended position (see FIG. 8A). When latch 158 is extended, the end assembly 140 is configured to be rotated about the upper rod 131 away from the lower rod 130 to permit items of merchandise to be loaded onto or removed from the lower rod in the unlocked configuration (see FIG. 8B). Thereafter, the end assembly 140 may be rotated back onto the lower rod 130 and the lock mechanism 150 returned to the locked configuration by moving latch 158 vertically upward.

[0030] FIGS. 9-14 illustrate another merchandise security device 300 configured for use with an electronic key 40 (e.g., FIG. 4) according to an exemplary embodiment of the invention. In this embodiment, the security device 300 is a lockable enclosure commonly referred to in the art as a "safer." The security device 300 includes a housing 320 defining a generally hollow interior compartment 321 configured to receive an item of merchandise M therein. The security device 300 also includes a lid 340 engaged with the housing 320 that is configured to move between opened and closed positions relative to the housing. A lock mechanism 350 is operably engaged with the lid 340 and the housing 320 to lock the lid 340 onto the housing 320 in the closed position. As previously described, the security device 300 may include a shape memory material that is operably engaged with the lock mechanism 350 and configured to change shape in response to the lock mechanism receiving electrical power from the electronic key 40. In particular, the shape memory material is operable for unlocking the lid 340 from the housing 320 so that the item of merchandise may be removed from the housing in the opened position. The security device 300 may include a transfer port 344 on the lid 340 or the housing 320 that is operably engaged with the shape memory material. As discussed above, the transfer port 344 is configured to receive electrical power, for example from the electronic key 40, and to transfer

the electrical power via an electrical conductor (e.g., a coil) to the shape memory material.

[0031] In one embodiment, the housing 320 also includes a removable hang tag 324 operably engaged with the housing. The hang tag 324 may be defined on an upper surface 322 of the housing 320 opposite the lid 340. The hang tag 324 may include an opening 326 configured to receive a rod therethrough for hanging one or more of the security devices 300 on the rod in a display orientation. The hang tag 324 may be configured to pivot between an upright position (FIG. 10) and a folded position (FIG. 9).

[0032] As shown herein, the lid 340 is pivotally attached to the housing 320 (FIG. 9). Thus, the lid 340 pivots between opened and closed positions relative to the housing 320. The lid 340 may be pivotally connected to the housing 320 such that the outer surface of the lid 340 and housing 320 are substantially flush with the pivot connection 330. Thus, unlike conventional safers, the pivot connection 330 may be at least partially recessed within the housing 320. The pivot connection 330 may be any suitable connection, such as a barrel hinge on the housing 320 and/or the lid 340, and the housing 320 or the lid 340 may include a pin for engaging the barrel hinge. In the instance where the pivot connection 330 is not flush with the outer surface of the housing 320, it extends only negligibly (e.g., less than about 2 mm). As such, the flush or nearly flush pivot connection 330 facilitates stacking of multiple safers as well as more compact placement of adjacent safers.

[0033] In this embodiment, the lid 340 of the security device 300 includes a movable latch 345. As illustrated in FIG. 11 and FIG. 12, the movable latch 345 is configured to move relative to the lid 340 between a retracted (locked) configuration (FIG. 11) and an extended (unlocked) configuration (FIG. 12). FIGS. 13 and 14 show that the latch 345 is moveable between a retracted configuration that is substantially flush with the lid 340 (FIG. 13), and an extended configuration relative to the lid 320 (FIG. 14). In the retracted configuration, the lid 340 is closed and locked to the housing 320 in the closed position. In the extended configuration, the lid 340 is unlocked from the housing 320 and may be moved (e.g. pivoted) to the opened position. The latch 345 may be biased, for example with one or more elastic, linear springs, such that unlatching the latch from the lid 340 allows the latch to move outwardly of the lid, and in some cases, automatically outward due to the biasing force pushing the latch outwardly of the

lid. In addition, the latch 345 may be configured to move outwardly of a front edge 342 of the lid 340. However, the latch 345 could be located at other positions on the lid 340 as desired. Moreover, the latch 345 may not latch automatically when the lid 340 is closed on the housing 320. Thus, the lock mechanism 350 may only lock when the lid 340 is in the closed position on the housing 320 and the latch 345 is pushed inwardly within the lid 340.

[0034] In some embodiments, the lock mechanism 350 comprises a plurality of engagement features 360 (e.g., pins, protrusions, or the like) and the housing 320 comprises a plurality of retaining features 359 (e.g., holes, openings, slots, or the like) (see, e.g., FIG. 12), and each of the engagement features are configured to engage a respective retaining feature with the lid 340 in the closed position and the latch 345 in the retracted (locked) configuration. Thus, when the engagement features 360 are engaged with the retaining features 359, the lid 340 cannot be removed from the housing 320 without first unlocking the lock mechanism 350. The engagement features 360 and retaining features 359 may be arranged in any suitable manner and include any desired number. In the illustrated embodiment, the retaining features 359 extend along a linear axis and are disposed on a front surface of the housing 320 proximate a lower edge. Similarly, the engagement features 360 may extend along a linear axis on the latch 345 adjacent the front edge 342 of the lid 340. Where the latch 345 extends within a plane, the engagement features 360 are configured to move parallel to one another and within a generally parallel plane. Moreover, FIG. 12 shows that the engagement features 360 and the retaining features 359 have a generally rectangular cross section. However, the engagement features 360 and corresponding retaining features 359 may have any desired shape (e.g., circular in cross section). As such, it is understood that the engagement features 360 may have a variety of sizes and configurations suitable for engaging correspondingly shaped retaining features 359 defined in the housing 320.

[0035] FIGS. 15-20 show one embodiment of a lock mechanism 350 suitable for use with any of the security devices discussed above. In the illustrated embodiments, the lock mechanism 350 is shown in conjunction with security device 300, wherein a portion of the lid 340 has been removed for purposes of clarity. FIG. 15 shows the lock mechanism 350 in a locked configuration, while FIG. 16 shows the lock mechanism 350 in an unlocked configuration. In

this embodiment, the lock mechanism 350 comprises a shape memory material 354 in the form of a Nitinol wire, as previously described. The shape memory wire 354 is attached to a moveable retaining member 356 that is configured to engage a corresponding retaining feature 358 provided on the latch 345. In this embodiment, the retaining feature 358 is suitable for retaining the latch 345 in the retracted, or closed, position against the biasing force exerted on the latch by the springs 348. An inductive coil 346 disposed within or proximate to the transfer port 344 receives and transfers an electric current in the manner previously described. The inductive coil 346 is in electrical communication with and transmits the electrical current through the shape memory wire 354 resulting in contraction of the wire.

[0036] As the shape memory wire 354 contracts, the retaining member 356 is configured to move, and in particular, flex about an attachment point, such as a retaining pin 355 to release the retaining member 356 from the retaining feature 358 such that the latch 345 moves outwardly to the extended (unlocked) configuration. In one embodiment, the retaining member 356 is flexible and configured to flex or bend relative to its attachment point in response to a change in length of the shape memory wire 354. The retaining member 356 will return into engagement with the retaining feature 358 as the latch 345 is moved inwardly against the biasing force of the spring 348 to the retracted (locked) configuration. With the latch 345 in the extended (unlocked) configuration, one or more engagement features 360 provided on the latch are disengaged from corresponding retaining features 359 provided on the housing 320 such that lid 340 can be moved, and in particular, rotated about pivot connection 330 from a closed position to an opened position to access the interior compartment 321 of the housing 320. It should be noted that the lid 340 may be opened manually, or the lid could be biased towards an open position such that when the engagement features 360 on the lid disengage from the retaining features 359 on the housing 320, the lid is configured to at least partially open. In addition, the latch 345 may be manually retracted relative to the housing 320 to return the lock mechanism 350 to a locked configuration. Alternatively, the lock mechanism 350 could be configured to automatically lock when the lid 340 is returned to a closed position on the housing 320.

[0037] FIGS. 18-20 show the lock mechanism 350 in more detail. As mentioned above, the retaining member 356 may be flexible in some embodiments. In one example, the retaining

member 356 is in the form of a printed circuit board ("PCB") such as, for example, a fiberglass PCB. The PCB is in electrical communication with both the inductive coil 346 and the shape memory wire 354. The inductive coil 346 and the shape memory wire 354 may be soldered and/or crimped to the PCB at one or more locations 362 in some embodiments. The PCB may have one or more electrical conductors or traces extending at least partially along its length to facilitate an electrical connection between the inductive coil 346 and the shape memory wire 354. In some embodiments, the PCB may further include a capacitor for tuning the resonance of the circuit to maximize the power transferred from the electronic key 40. The shape memory wire 354 may be attached at or near a free end of the PCB such that contraction of the shape memory wire causes the PCB to flex or cantilever towards the housing 370 of the lock mechanism 350. In some ways, the PCB flexes similarly to a diving board whereby the PCB flexes relative to housing 370 and about its attachment point, which in some cases is a location where the PCB is fixed to the housing. The construction and elasticity of the PCB eliminates the need for various additional mechanism components since it functions as both a spring and latch, such as rotation latches, axle pins, and springs, thereby simplifying the lock mechanism 350. The free end or edge of the PCB is configured to engage the retaining feature 358 as shown in FIG. 17. It is understood that any number of retaining members 356 and retaining features 358 according to additional embodiments of the present invention. In addition, the PCB may be any desired shape and should not be limited by the illustrated embodiments.

[0038] In another embodiment, the PCB and the inductive coil 346 may be combined into a single component. For example, the PCB may have conductive traces that function as the inductive coil and that electrically connect to the shape memory wire 354. In some cases, the PCB could include circular conductive traces configured to be positioned about the transfer port 344. Thus, the PCB may allow for the elimination of a separate inductive coil in some embodiments.

[0039] Moreover, in one embodiment, the housing 370 may be constructed of a polymeric material. For example, a high-temperature plastic (e.g., polyoxymethylene or "POM") may be employed to account for the heat generated in the shape memory wire 354. The high-temperature plastic may allow for the shape memory wire 354 to directly contact the housing

370, which may in turn allow the shape memory wire to be routed within the housing at sharper turn points and in a more compact manner than would otherwise be required with conventional plastics where the shape memory wire could melt the plastic. Without the use of a high-temperature plastic, additional metal components and pulleys are required to route the shape memory material and ensure that the shape memory wire is not touching certain portions of the housing 370.

[0040] In one embodiment, the lock mechanism 350 may be configured to be manufactured and assembled independently of the remaining components of the security device 300. For example, the housing 370 may be inserted within the lid 340 and secured into position, and the inductive coil 346 may be positioned around the transfer port 344. Thus, the lock mechanism 350 may be configured to be secured to any particular lid 340 or other security device and may be readily removed and replaced if needed. The lid 340 may include one or more alignment or locating members 349 for aligning the lock mechanism 350 on the lid. The lock mechanism 350 may be secured to the lid 340 using any desired technique, such as adhesives, welding, and/or fasteners. Thus, the lock mechanism 350 is "modular" in that it is able to be used with any number of security devices and may be easily installed and replaced.

[0041] The aforementioned "safer" type security devices 300 may be formed of any desired material such as a clear polymeric material so that an item of merchandise can be seen through the housing. The housing may be any desired shape, such as a housing with a bottom surface and four sidewalls extending from the bottom surface to an open end. In other embodiments, the security device is an alarming stand, display, or module. For example, the security device may be similar to that disclosed in U.S. Patent No. 9,761,101, entitled Recoiler for a Merchandise Security System, the disclosure of which is incorporated herein by reference in its entirety. The security device may include a base operably engaged with a sensor, and the sensor may in turn be secured to an item of merchandise. The base may be operably engaged with the sensor via a cable extending between and coupled to each of the sensor and the base, while the sensor may be removably disposed on the base such that the sensor and the item of merchandise may be removed and replaced on the base.

[0042] In one embodiment, the alarm stand may include a lock mechanism similar to that

discussed above that is configured to lock and/or unlock the sensor engaged with the item of merchandise via an electronic key. For example, an authorized user may unlock the lock mechanism to readily remove the sensor from the item of merchandise, unlike conventional systems that utilize mechanical fasteners. Similarly, the cable may be removably attached to the sensor and also or alternatively include a lock mechanism similar to that discussed above that allows the cable to be locked and/or unlocked from the sensor via an electronic key. For example, a connector on the end of the cable may be configured to cooperate with a lock mechanism in the sensor. In other embodiments, the lock mechanism may be used to lock the sensor onto the base such that the sensor cannot be removed from the base without first unlocking the lock mechanism.

[0043] In another embodiment, the security device may be configured to be locked to a support surface or device. For instance, a locking hook may be configured to lock to a support surface (e.g., pegboard or slat wall) and utilize a lock mechanism similar to that described above for locking and/or unlocking the locking hook from the support surface. Likewise, the security device may be configured to be locked or unlocked to a table, counter, shelf, wall, or the like and utilize a similar lock mechanism as discussed above that is operable via an electronic key.

[0044] Therefore, it is apparent that any number of security devices may be employed in conjunction with various forms of power transfer for actuating a lock mechanism (e.g., electrical, inductive, capacitive, etc.). For example, where a shape memory material is utilized, a change in shape of the shape memory material may cause mechanical actuation (e.g., linear and/or rotary movement) of the lock mechanism. The shape memory material may be operably engaged with a lock mechanism in any number of configurations to facilitate such actuation. Moreover, the shape memory material may be any suitable material, such as a metal, a polymer, or a combination thereof, that is configured to change its shape (e.g., length, area, etc.) in response to an electric current or a change in temperature and to return to its original shape after the electric current is no longer transferred therethrough. For example, transferring current through the shape memory material may cause the material to be heated and thereby contract. Upon removal of the current, the shape memory material may return to its original shape. In addition, other mechanisms may be utilized for actuating a lock mechanism, including mechanical, electrical,

and/or chemical state changes. As such, the security devices and associated lock mechanisms should not be limited in light of the exemplary embodiments shown and described herein.

[0045] In some embodiments, the security device and the electronic key are similar to those disclosed in U.S. Patent No. 9,133,649, U.S. Patent Publication No. 2013/0081434, entitled Cabinet Lock for Use with Programmable Electronic Key and filed September 28, 2012, U.S. Patent Publication No. 2012/0047972, entitled Electronic Key for Merchandise Security Device and filed August 31, 2011, and U.S. Patent Publication No. 2011/0254661, entitled Programmable Security System and Method for Protecting Merchandise and filed June 27, 2011, each of the disclosures of which is incorporated herein by reference in its entirety. In other embodiments, the security device and the electronic key are similar to those manufactured by InVue Security Products Inc. of Charlotte, North Carolina, USA, including the Plunger Locks, Smart Locks, and IR2 and IR2-S Keys.

[0046] The foregoing has described one or more exemplary embodiments of a merchandise display security system and method for use with an electronic key. Embodiments of a merchandise display security system have been shown and described herein for purposes of illustrating and enabling one of ordinary skill in the art to make, use and practice the invention. Those of ordinary skill in the art, however, will readily understand and appreciate that numerous variations and modifications of the invention may be made without departing from the spirit and scope thereof. Accordingly, all such variations and modifications are intended to be encompassed by the appended claims.

That which is claimed is:

1. A lock mechanism for use with a security device for protecting an item from theft, the lock mechanism comprising:

a flexible retaining member; and

a shape memory material operably engaged with the flexible retaining member and configured to receive electrical power for unlocking the lock mechanism,

wherein the shape memory material is configured to change in shape in response to receiving electrical power and cause the flexible retaining member to flex to thereby unlock the lock mechanism.

2. The lock mechanism of Claim 1, further comprising at least one conductor operably engaged with the flexible retaining member and in electrical communication with the shape memory material.

3. The lock mechanism of Claim 2, wherein the at least one conductor is configured to receive electrical power inductively.

4. The lock mechanism of Claim 2, wherein the at least one conductor comprises a coil having a plurality of continuous windings.

5. The lock mechanism of Claim 4, wherein the flexible retaining member comprises the plurality of continuous windings.

6. The lock mechanism of Claim 2, wherein the shape memory material comprises a wire in electrical communication with the at least one conductor.

7. The lock mechanism of Claim 2, wherein the shape memory material is configured to change in length in response to the at least one conductor receiving electrical power.

8. The lock mechanism of Claim 2, wherein the at least one conductor is configured to receive electrical power wirelessly.

9. The lock mechanism of Claim 1, wherein the flexible retaining member is a printed circuit board.

10. The lock mechanism of Claim 9, wherein the printed circuit board comprises one or more conductive traces for electrically connecting to the shape memory material.

11. The lock mechanism of Claim 1, wherein the shape memory material is electrically connected to the flexible retaining member.

12. A security system for protecting an item from theft, the security system comprising:

an electronic key; and

a security device comprising a lock mechanism that is operated by electrical power transferred from the electronic key to the lock mechanism, the lock mechanism comprising a flexible retaining member and a shape memory material operably engaged therewith,

wherein the flexible member is operably engaged with the shape memory material that is configured to change in shape in response to receiving electrical power from the electronic key and cause the flexible retaining member to flex to thereby unlock the lock mechanism.

13. The security system of Claim 12, wherein the electronic key is configured to transfer power inductively to the lock mechanism.

14. The security system of Claim 12, further comprising at least one conductor in electrical communication with the flexible retaining member and the shape memory material.

15. The security system of Claim 14, wherein the security device further comprises a transfer port, wherein the at least one conductor is disposed adjacent to or at least partially around the transfer port, and wherein the transfer port is configured to receive electrical power from the electronic key and transfer the power to the flexible retaining member and the shape memory material.

16. The security system of Claim 12, wherein the shape memory material is electrically connected to the flexible retaining member.

17. The security system of Claim 12, wherein the flexible retaining member is a printed circuit board.

18. A method for protecting an item from theft, the method comprising:

receiving electrical power from an electronic key at a lock mechanism, the lock mechanism comprising a flexible retaining member and a shape memory material operably engaged therewith; and

causing the flexible retaining member to flex to unlock the lock mechanism in response to a change in shape of the shape memory material.

19. A security device for protecting an item from theft, the security device comprising:

a lock mechanism that is operated by electrical power transferred from an electronic key to the lock mechanism, the lock mechanism comprising a flexible retaining member and a shape memory material operably engaged therewith,

wherein the flexible member is operably engaged with the shape memory material that is configured to change in shape in response to receiving electrical power and cause the flexible retaining member to flex to thereby unlock the lock mechanism.

ABSTRACT

Locking mechanisms, security devices, and security systems are provided. The security device may include a lock mechanism that is operated by electrical power transferred from an electronic key to the lock mechanism. The lock mechanism may include a flexible retaining member and a shape memory material operably engaged therewith. The flexible member is operably engaged with the shape memory material that is configured to change in shape in response to receiving electrical power and cause the flexible retaining member to flex to thereby unlock the lock mechanism.

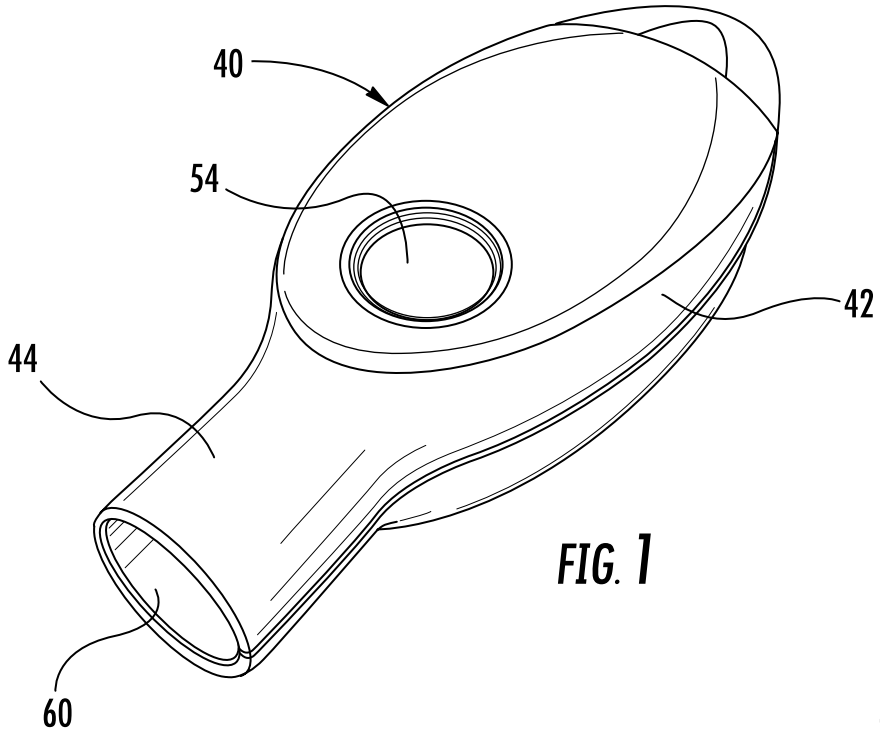


FIG. 1

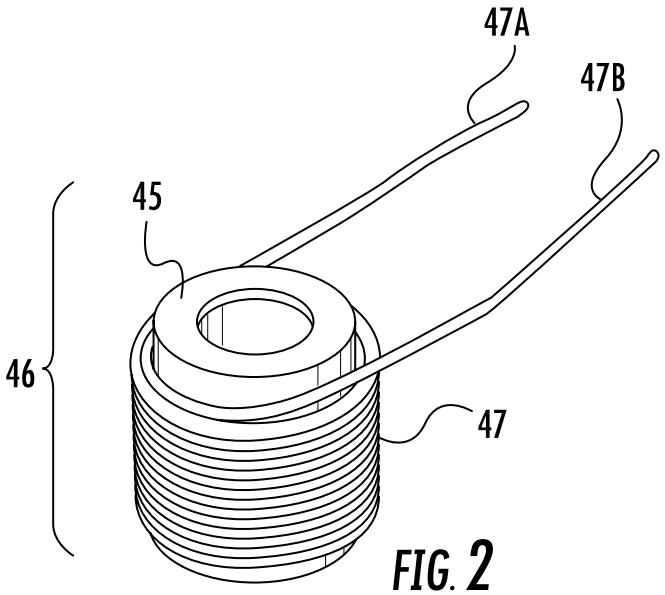


FIG. 2

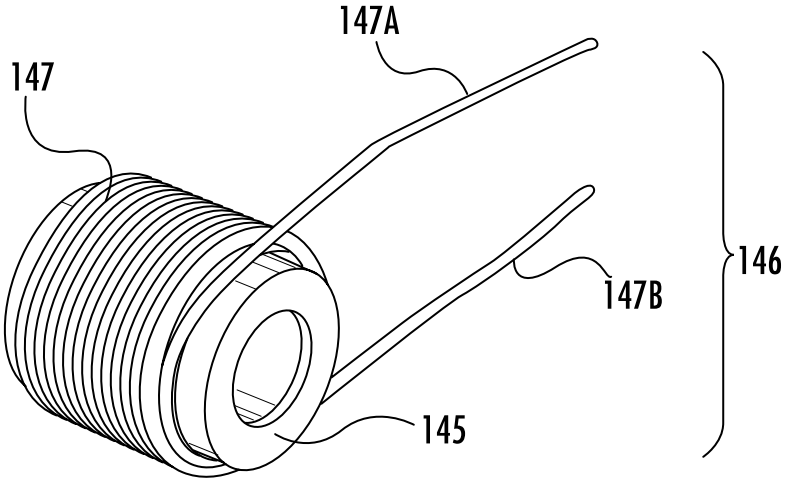


FIG. 3

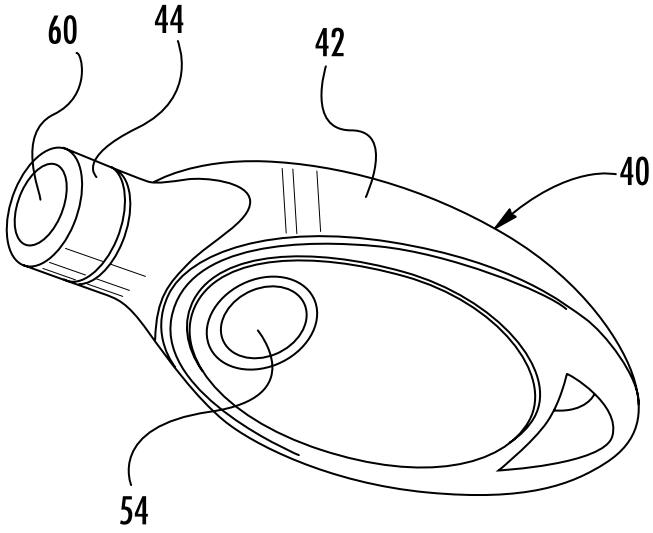


FIG. 4

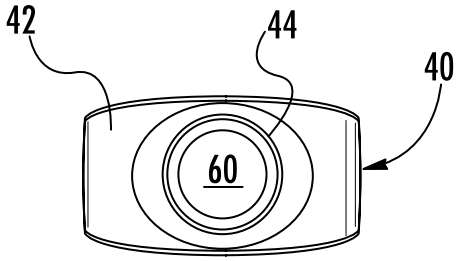


FIG. 5

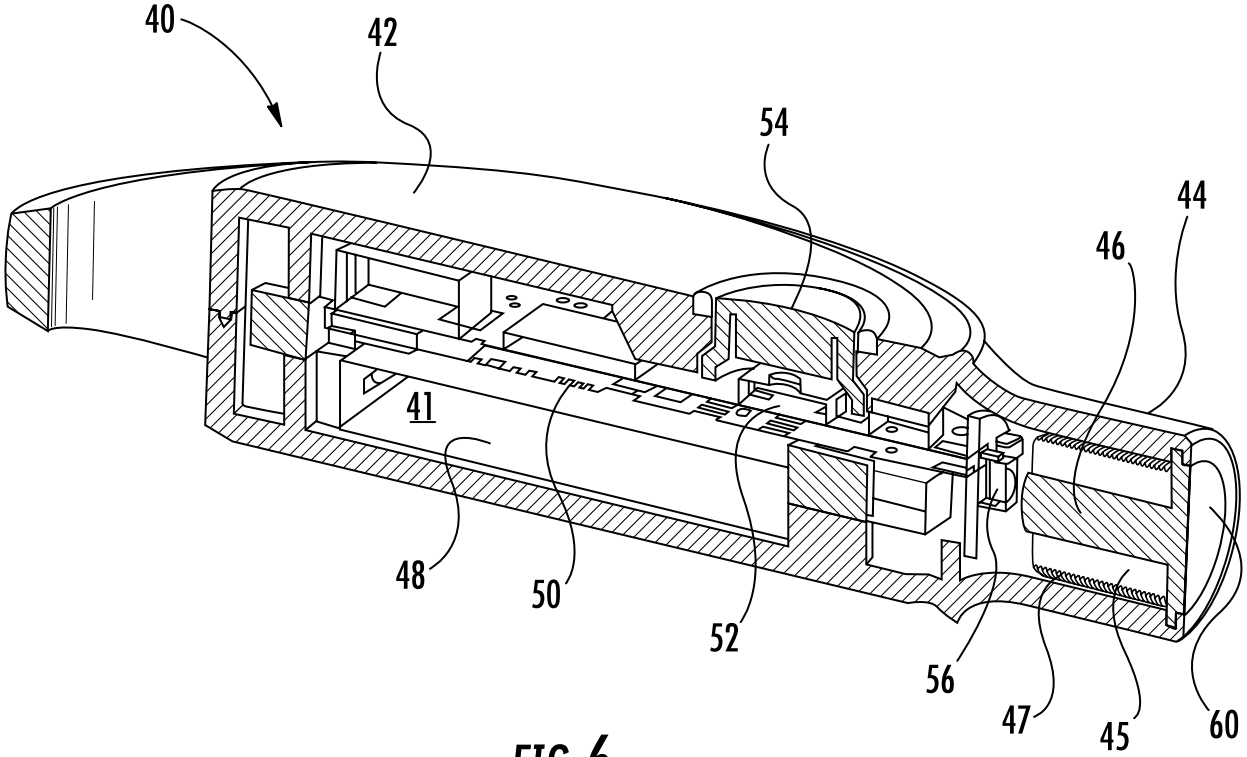


FIG. 6

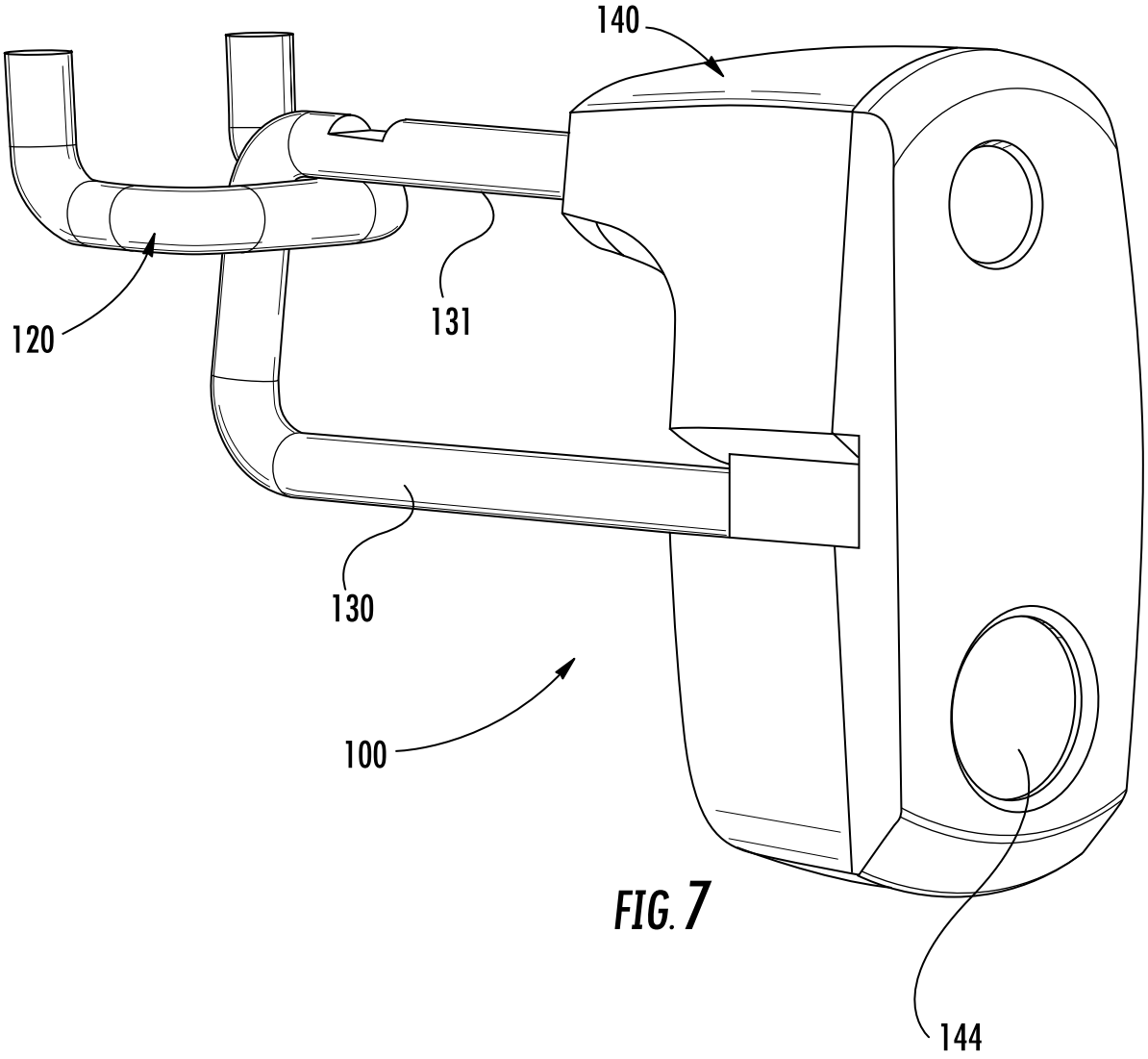


FIG. 7

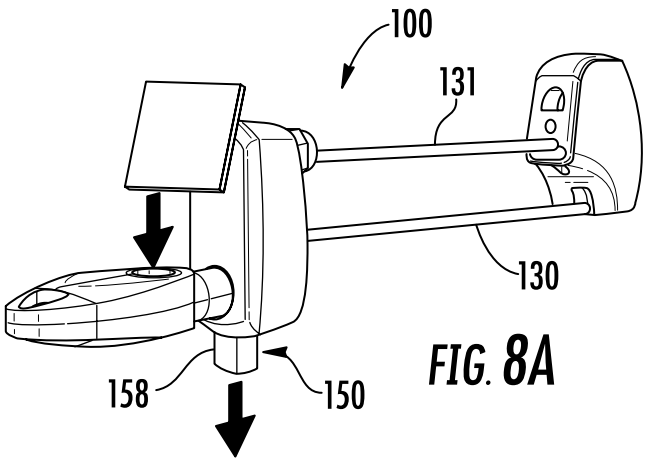


FIG. 8A

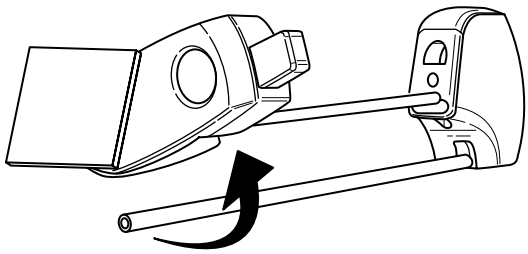

FIG. 8B

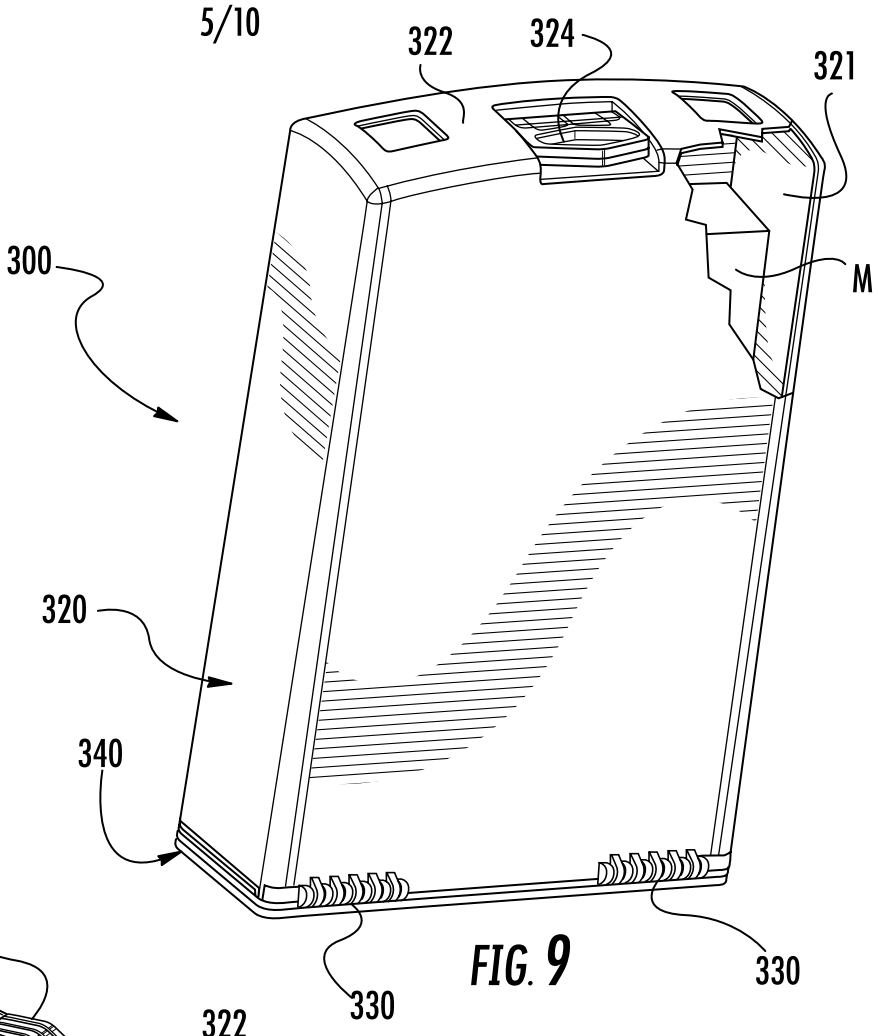
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FIG. 9

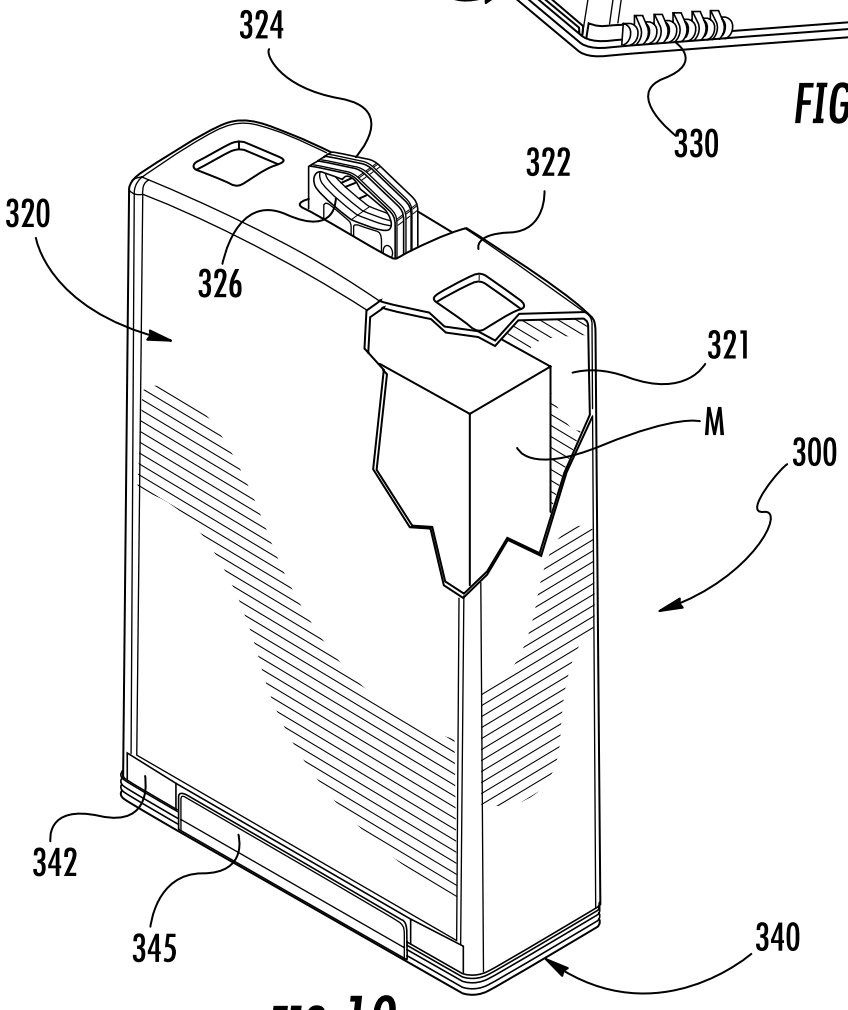
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FIG. 10

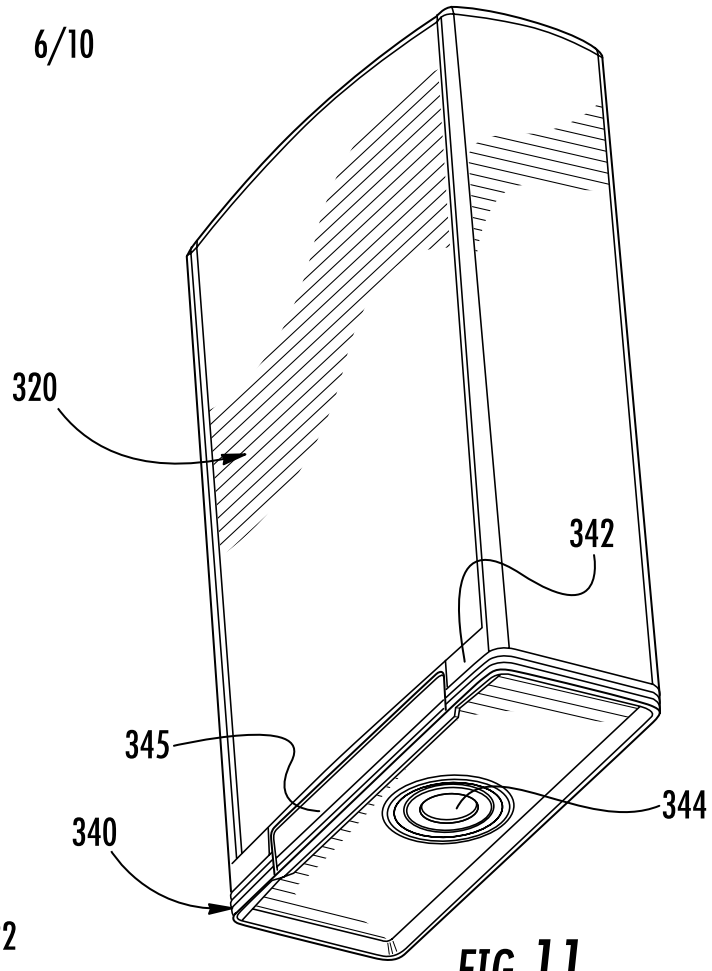


FIG. 11

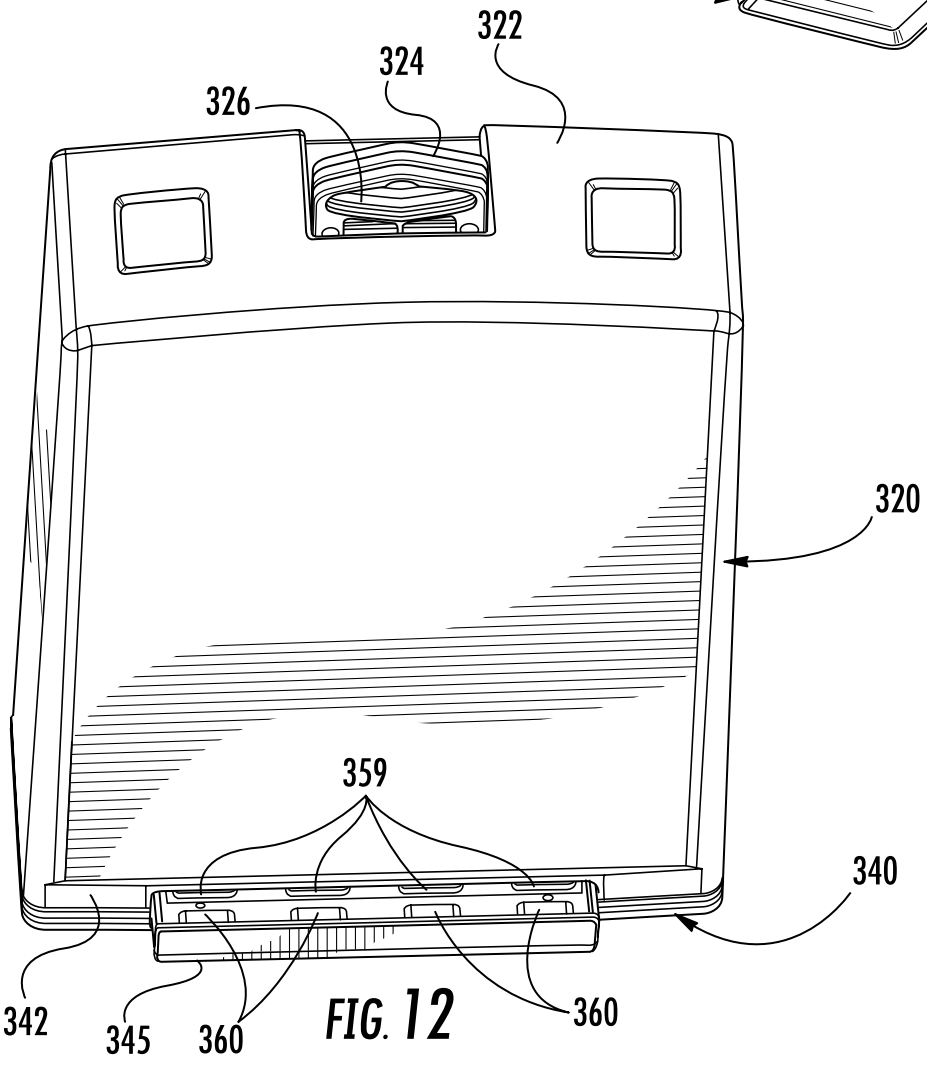


FIG. 12

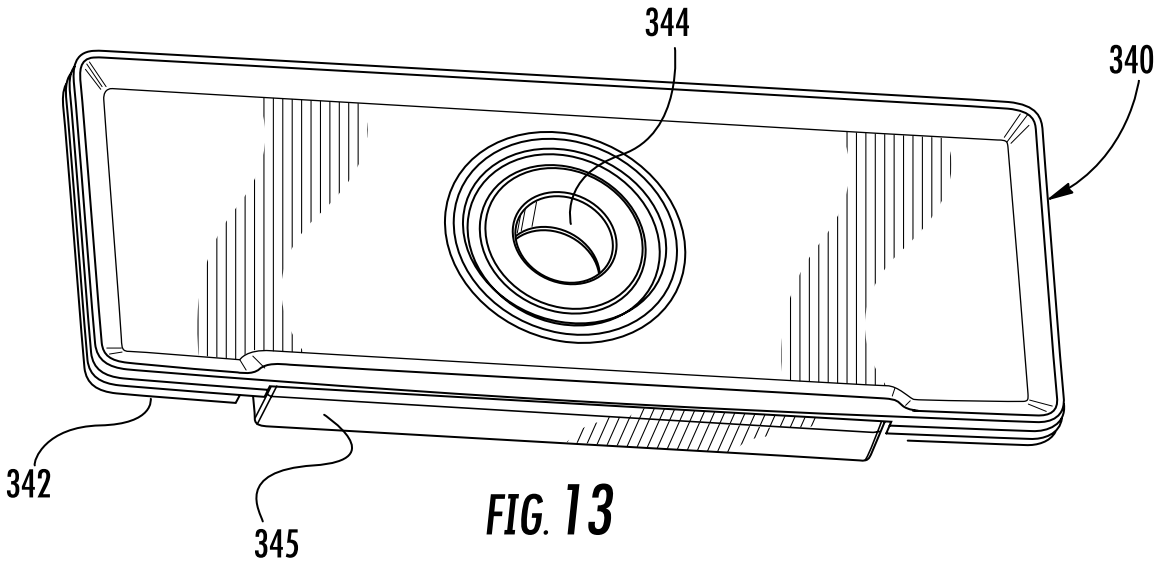


FIG. 13

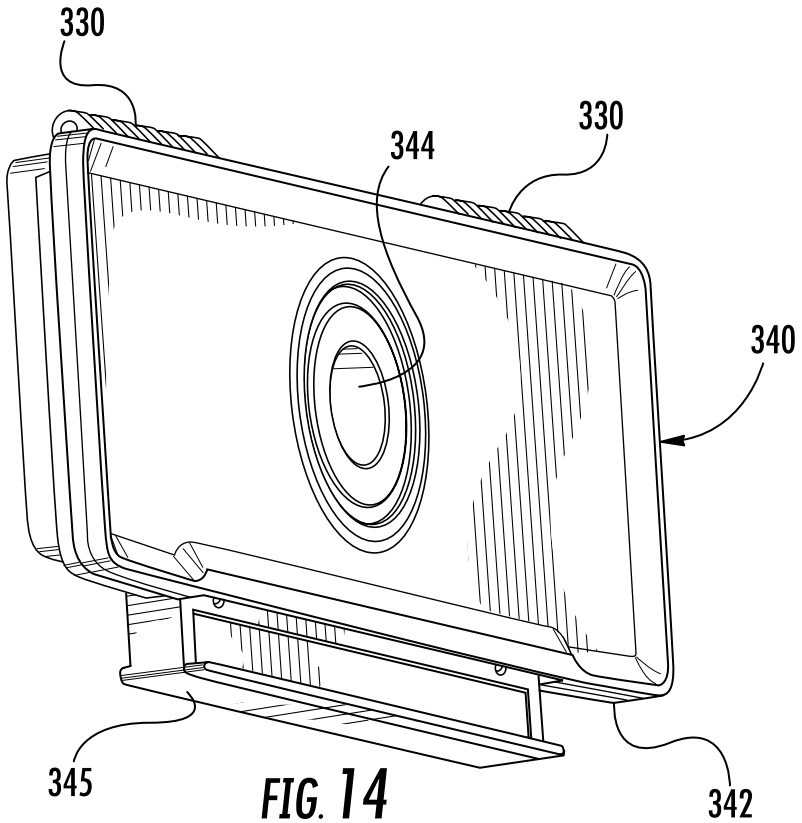


FIG. 14

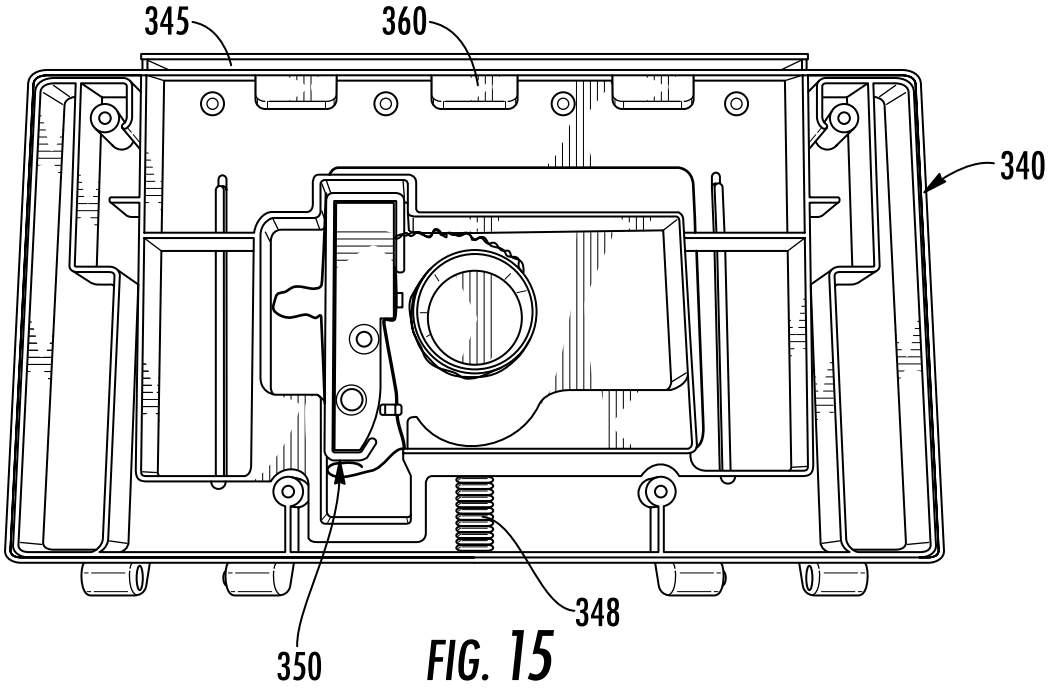


FIG. 15

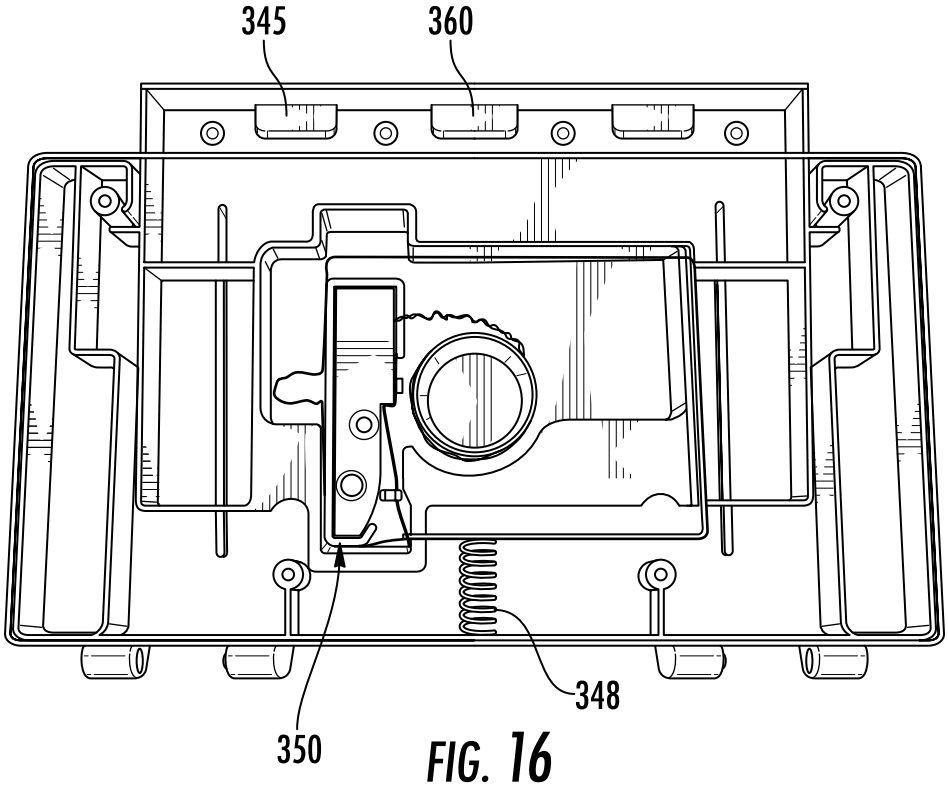


FIG. 16

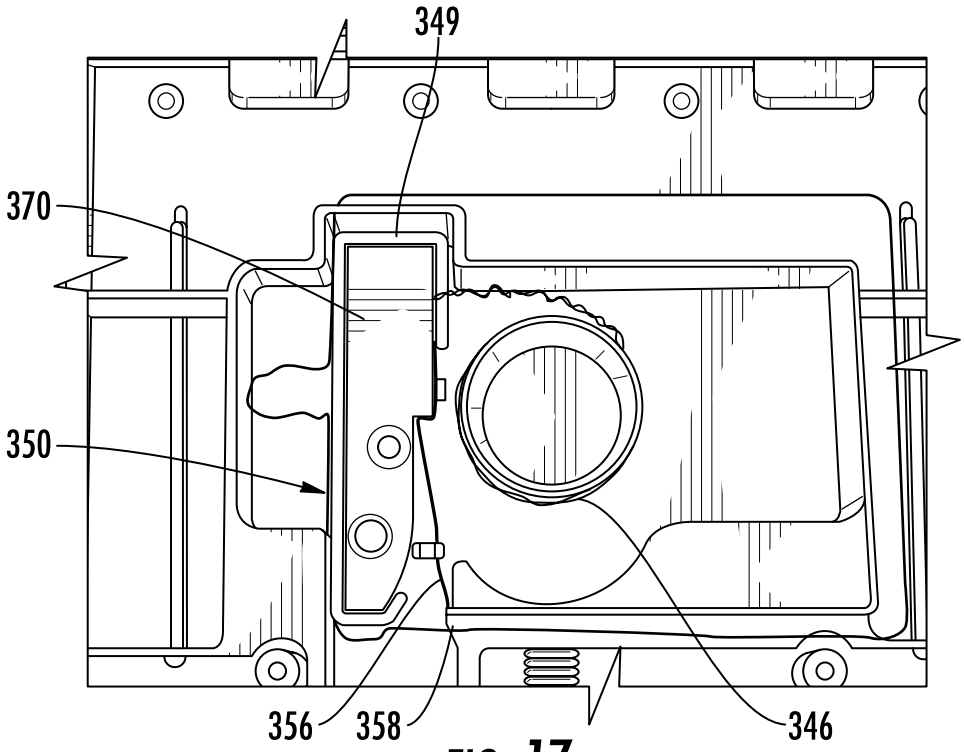


FIG. 17

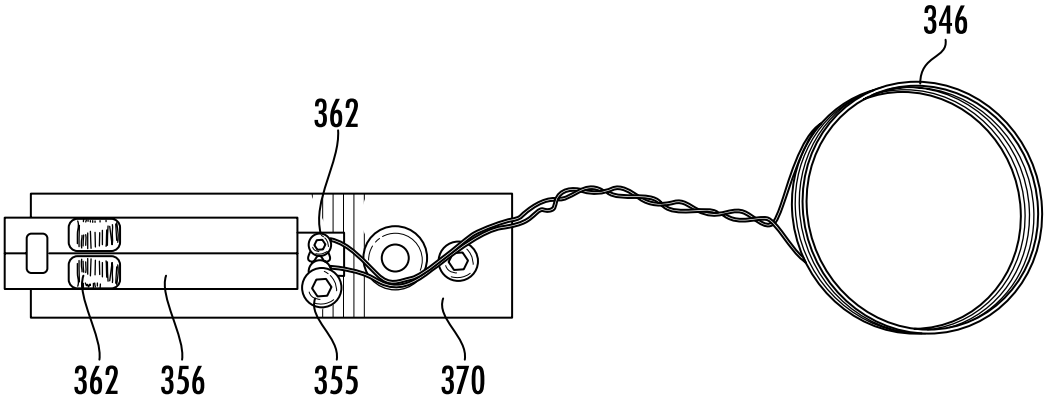


FIG. 18

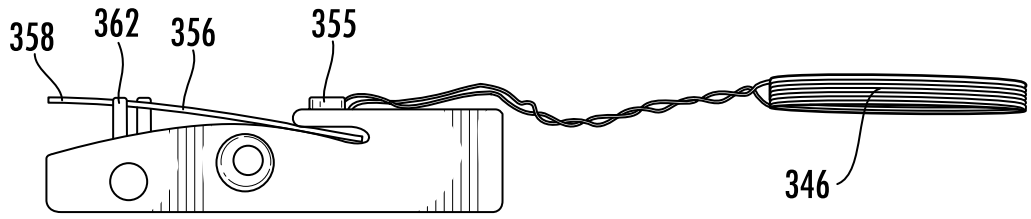


FIG. 19

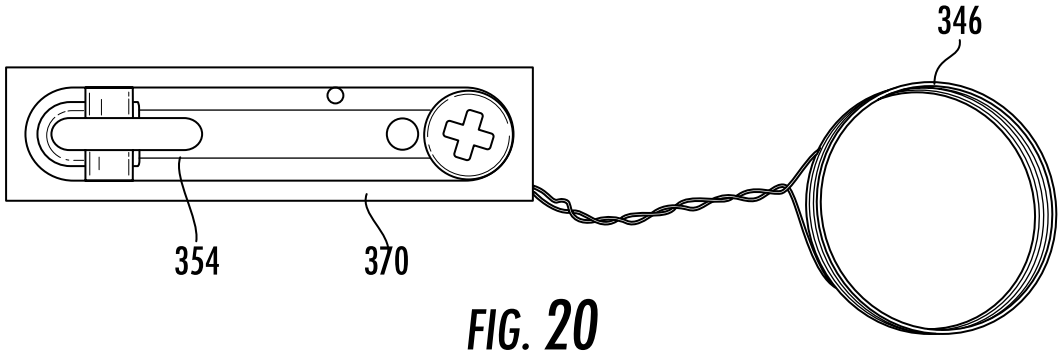


FIG. 20