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Scheffler et al.

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(54) **ELECTRONIC LOCK CORE REPLACEMENT SYSTEMS**

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(51) **Int. Cl.**
E05B 9/08 (2006.01)
E05B 17/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***E05B 9/084*** (2013.01); ***E05B 17/0004*** (2013.01); ***E05B 19/00*** (2013.01); ***G07C 9/00944*** (2013.01)

(58) **Field of Classification Search**
CPC . E05B 9/08; E05B 9/084; E05B 9/086; E05B 9/088; E05B 17/0004;
(Continued)

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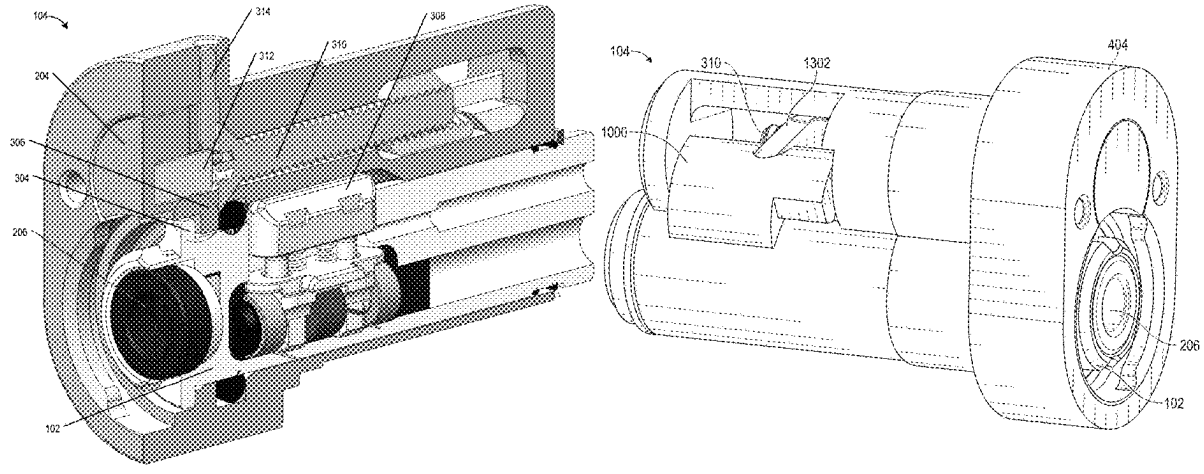
(57) **ABSTRACT**

Electronic locks can provide improved security over mechanical locks. Despite the improved security of electronic locks, there may be occasions where it is desirable to replace the electronic lock. Replacing an electronic lock can be expensive and challenging, particularly if the electronic lock is being replaced by a different electronic lock produced by a different manufacturer. The present disclosure relates to an electronic lock with a replaceable lock core that enables replacing the electronic lock core with a new electronic lock core without needing to replace the entire electronic lock. Further, through use of access controls managed by the electronic lock and electronic key combination, and the unique mechanical configurations disclosed herein, it is possible to replace an electronic lock core without compromising security of a device or location secured by the electronic lock.

25 Claims, 24 Drawing Sheets



(51) **Int. Cl.**
E05B 19/00 (2006.01)
G07C 9/00 (2020.01)

(58) **Field of Classification Search**
CPC E05B 17/0008; E05B 19/00; E05B 11/005; G07C 9/0094; G07C 2009/00952
USPC 70/283.1
See application file for complete search history.

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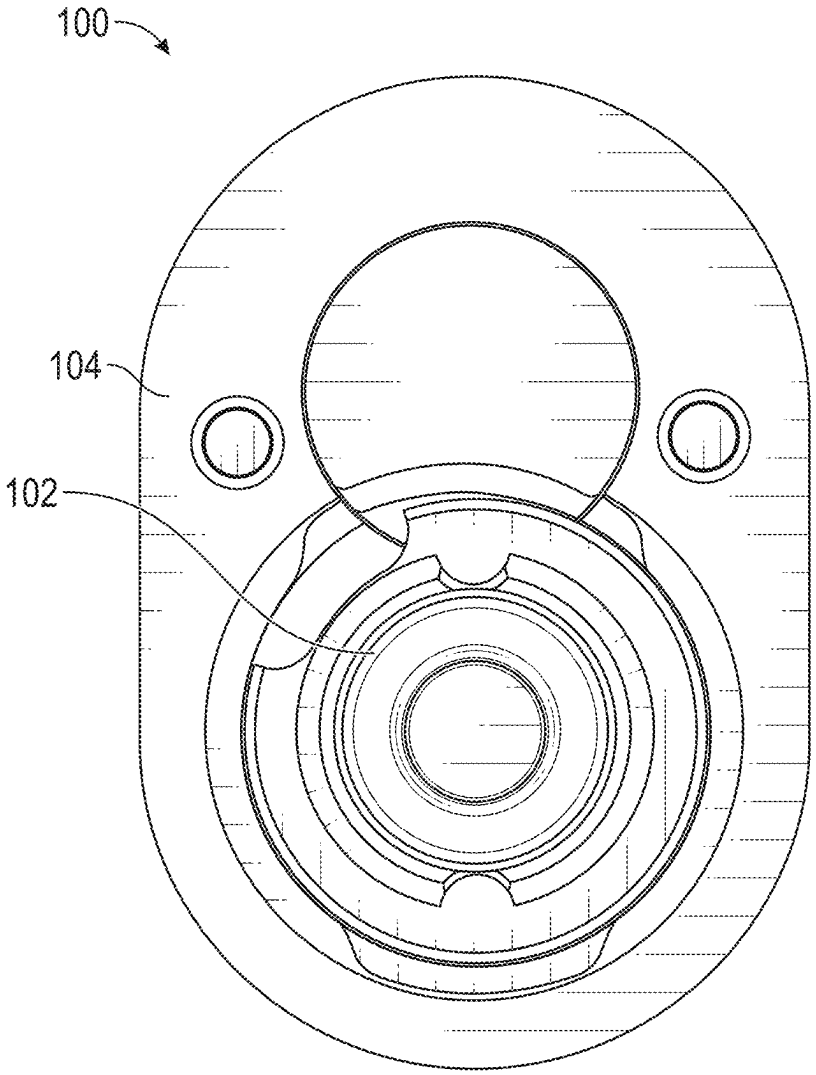


FIG. 1

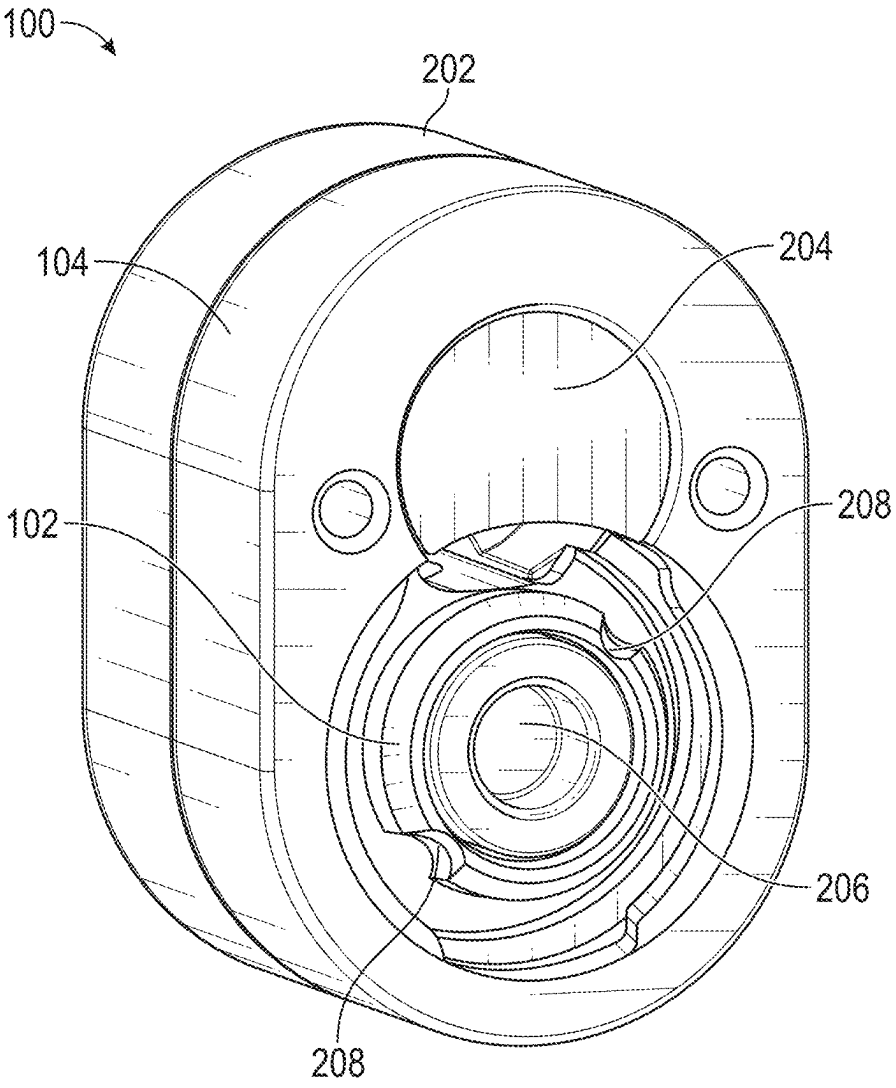
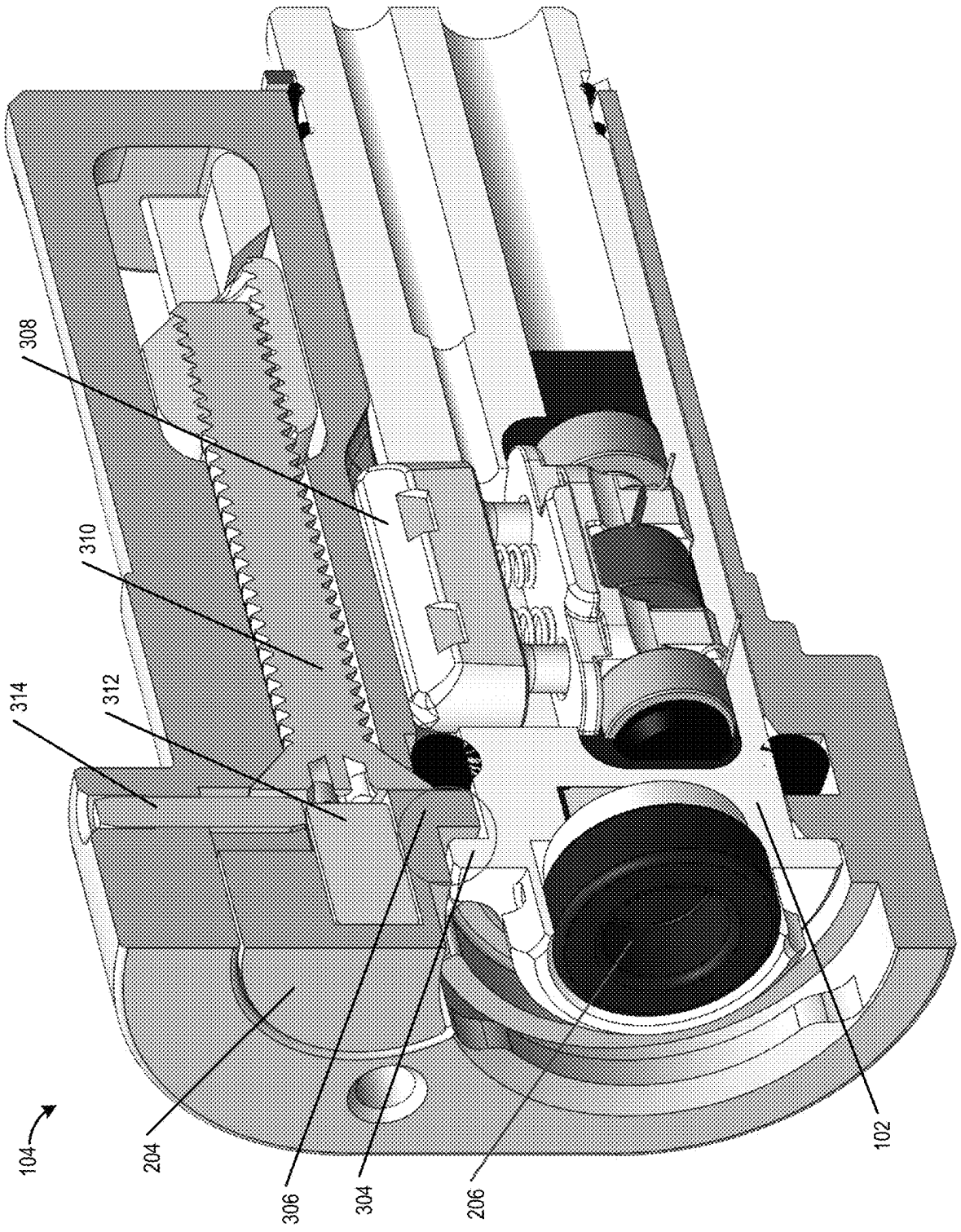


FIG. 2

FIG. 3A



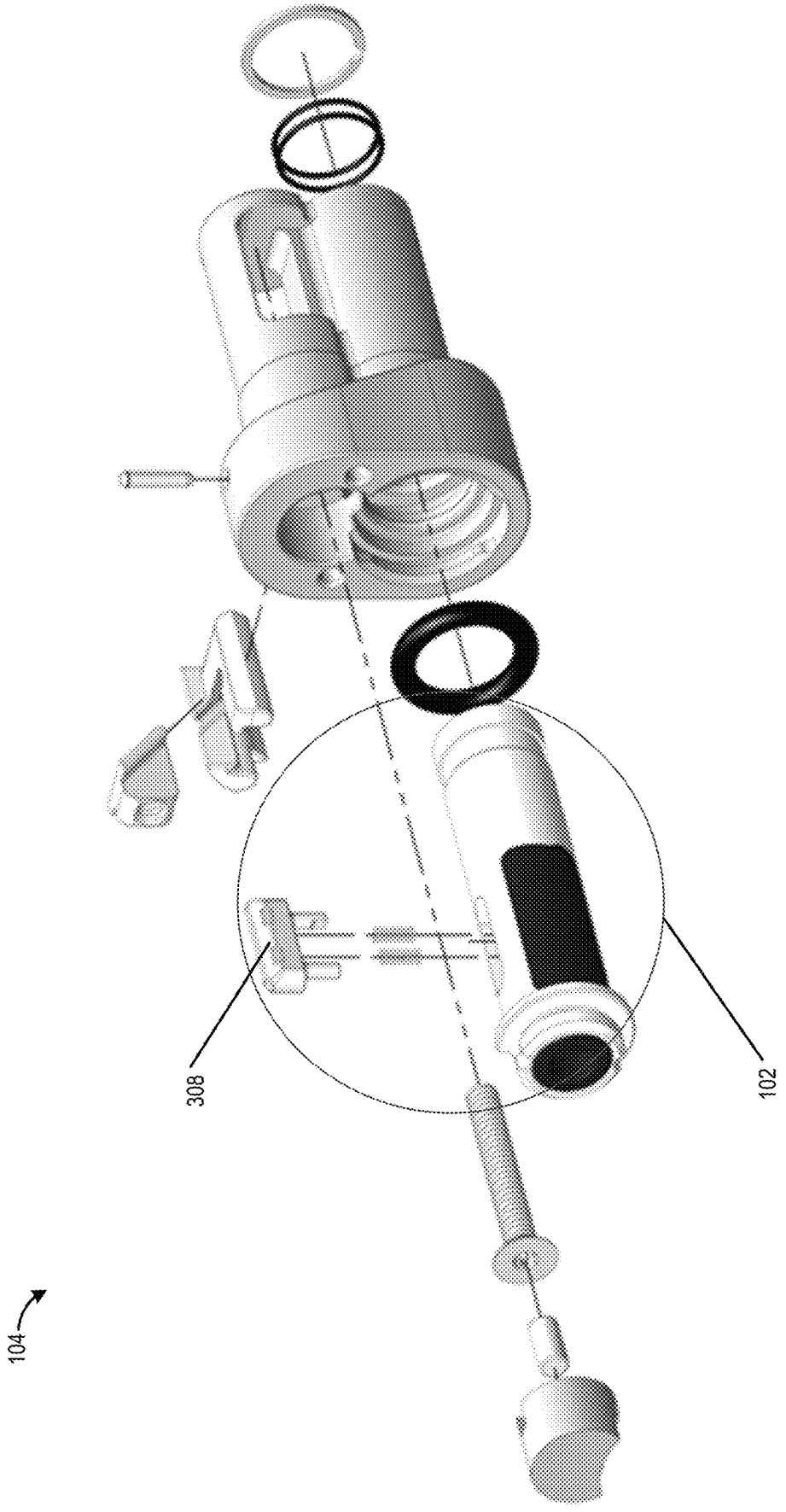


FIG. 3B

FIG. 4

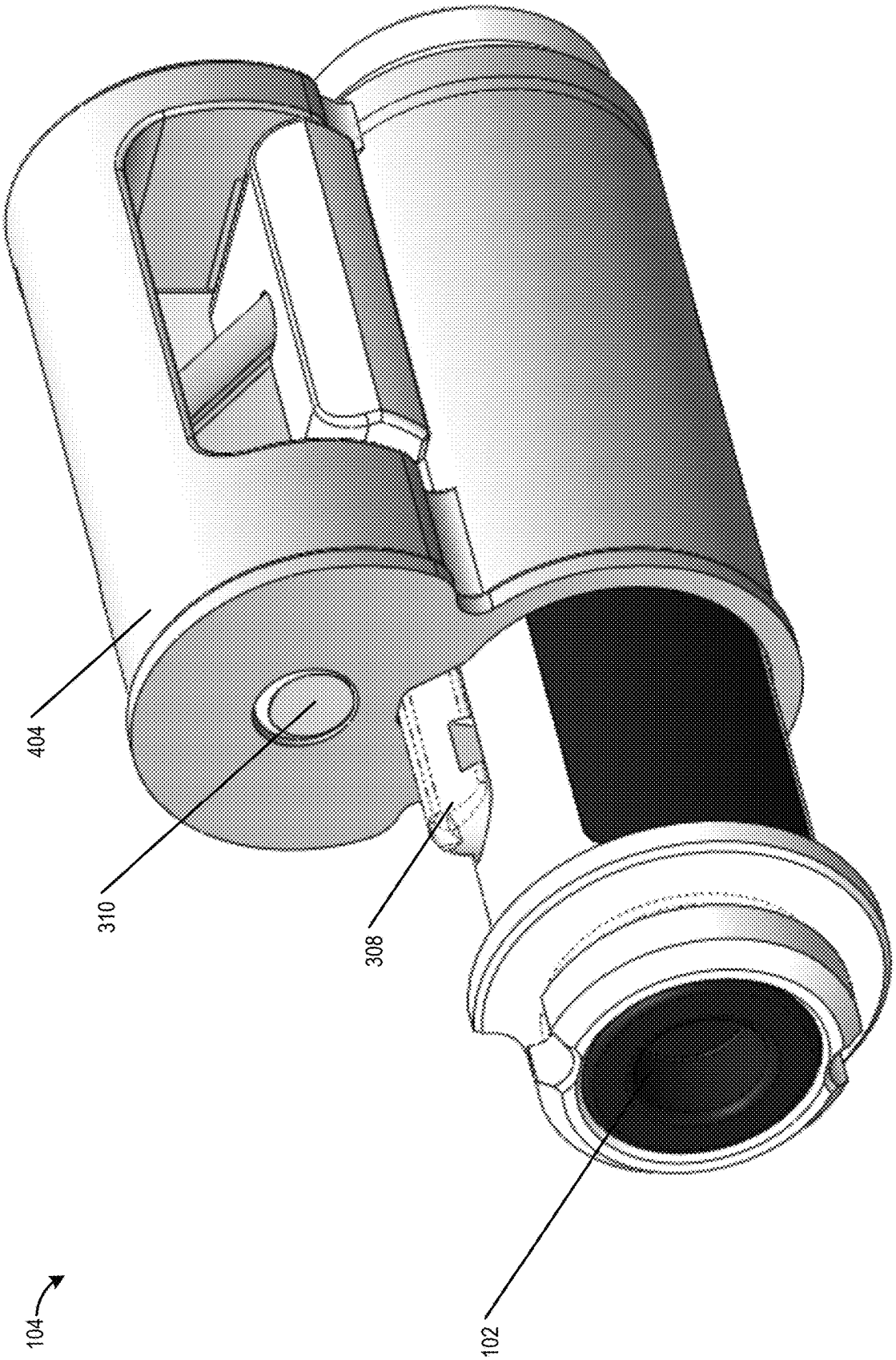
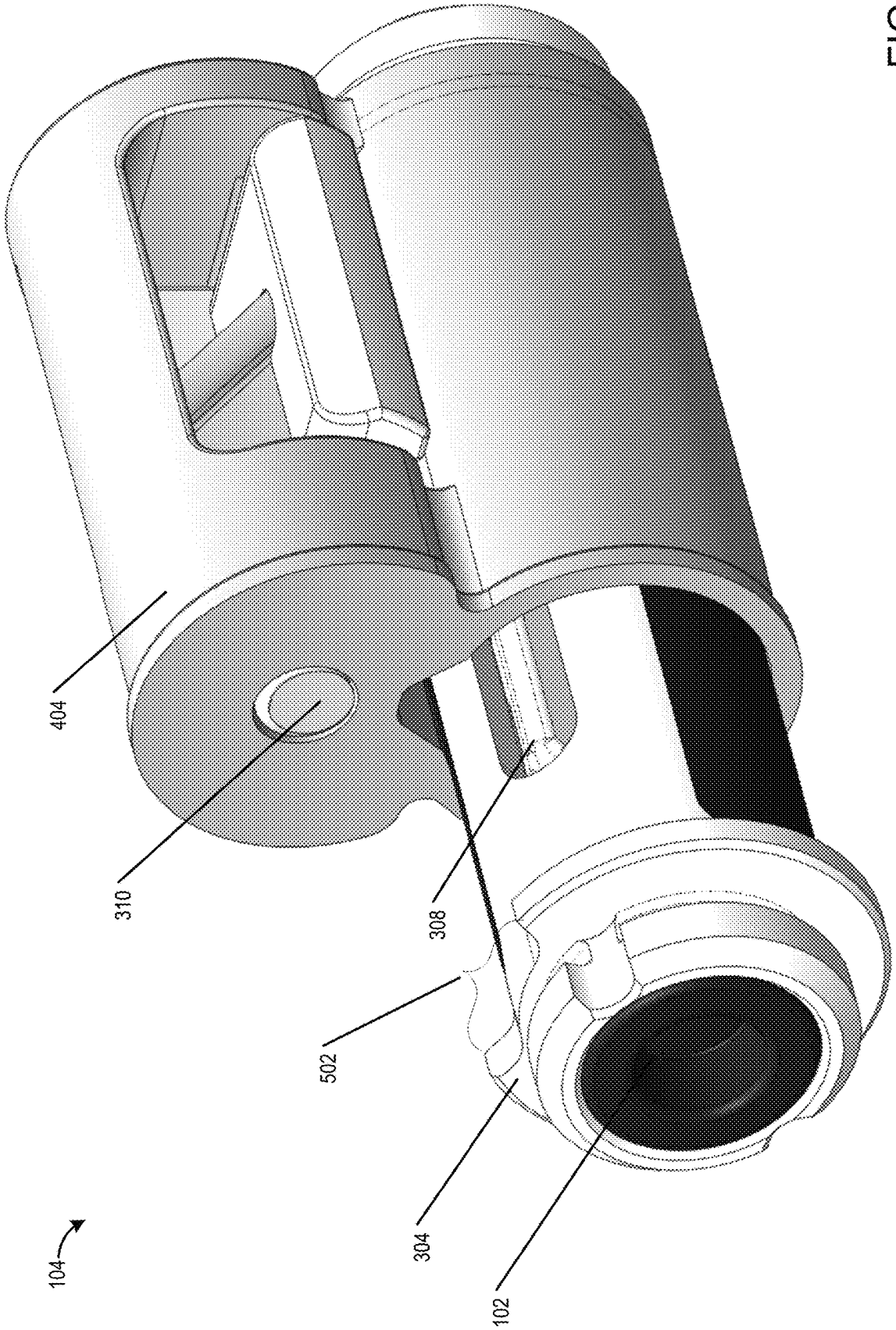
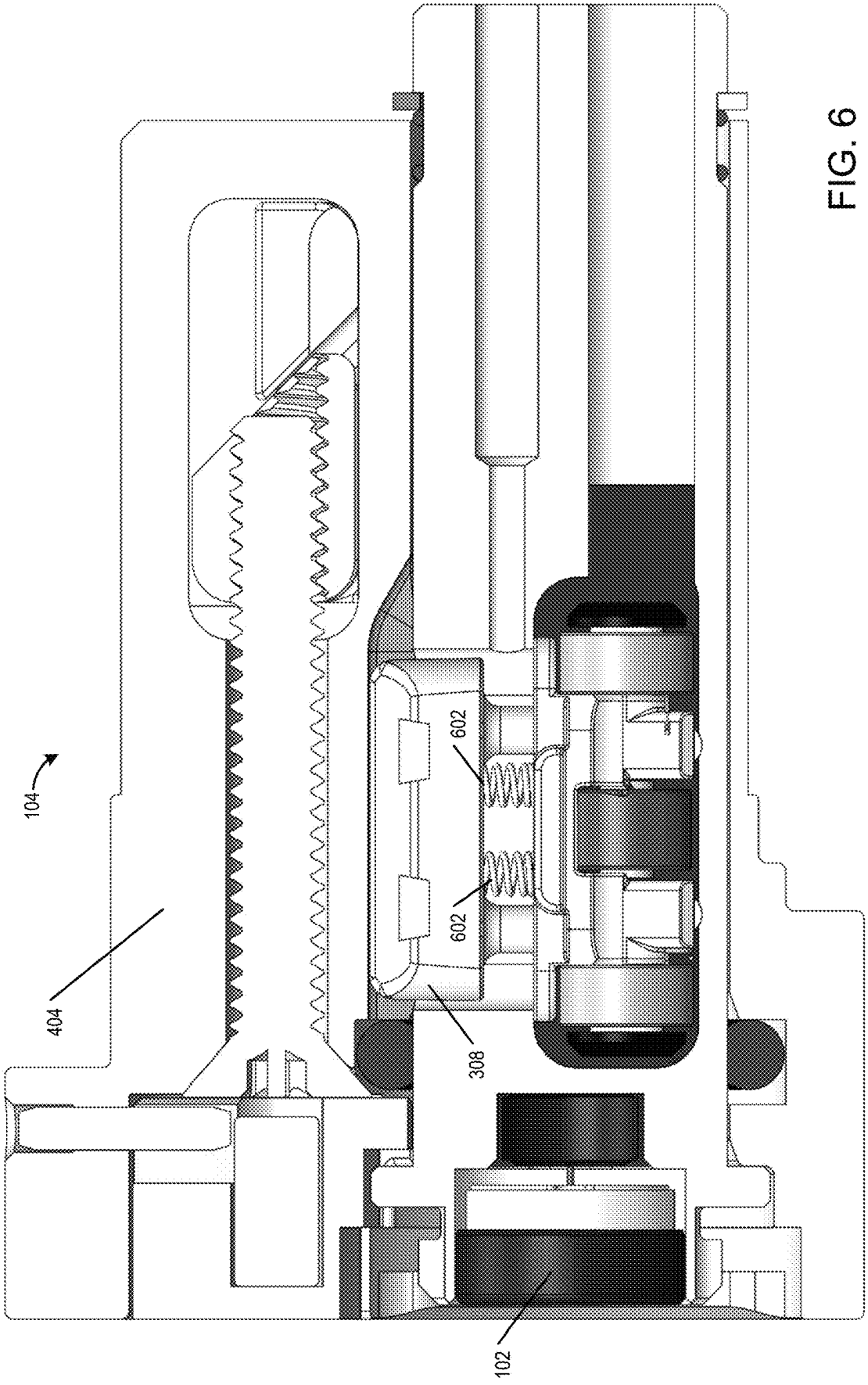


FIG. 5





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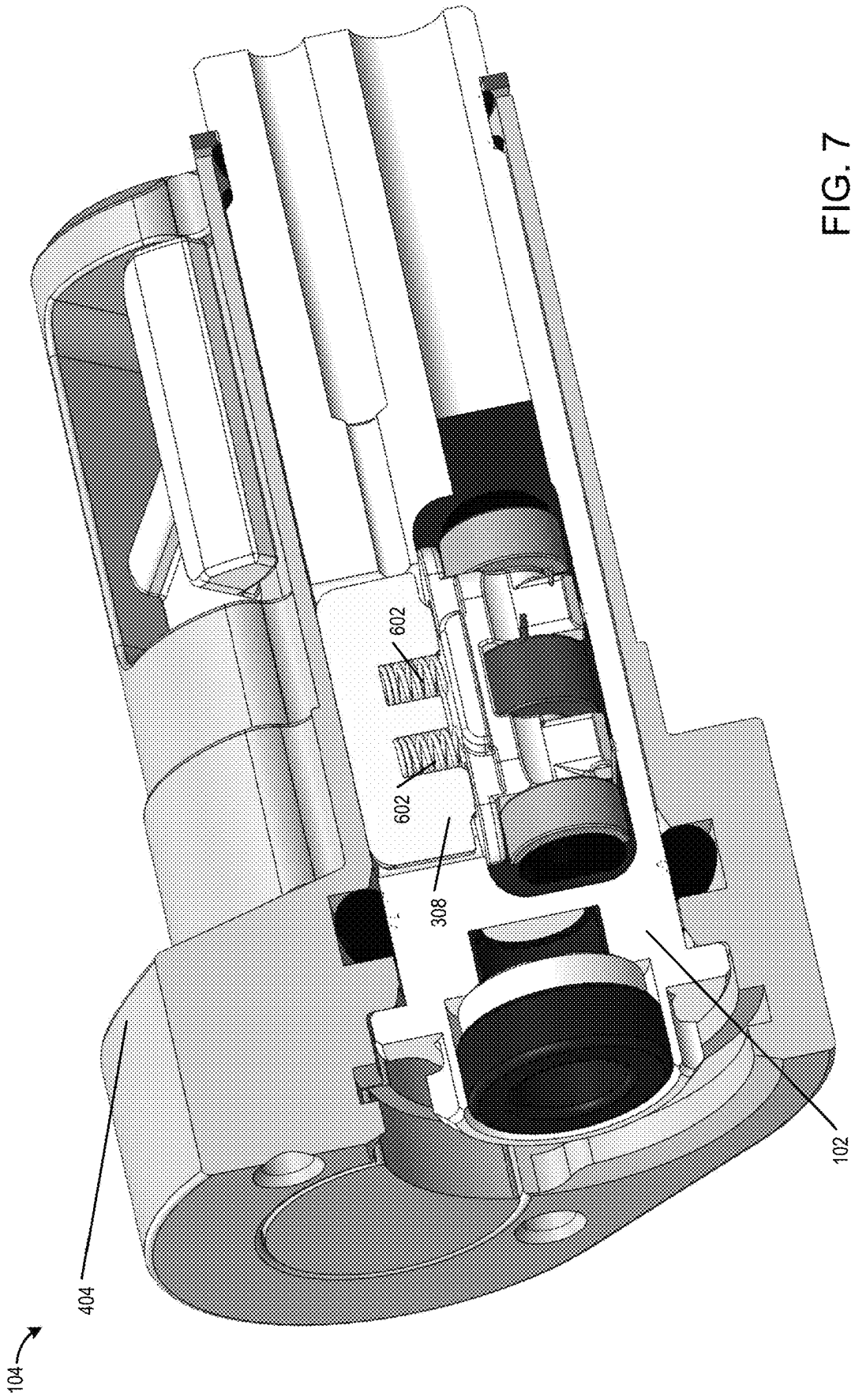

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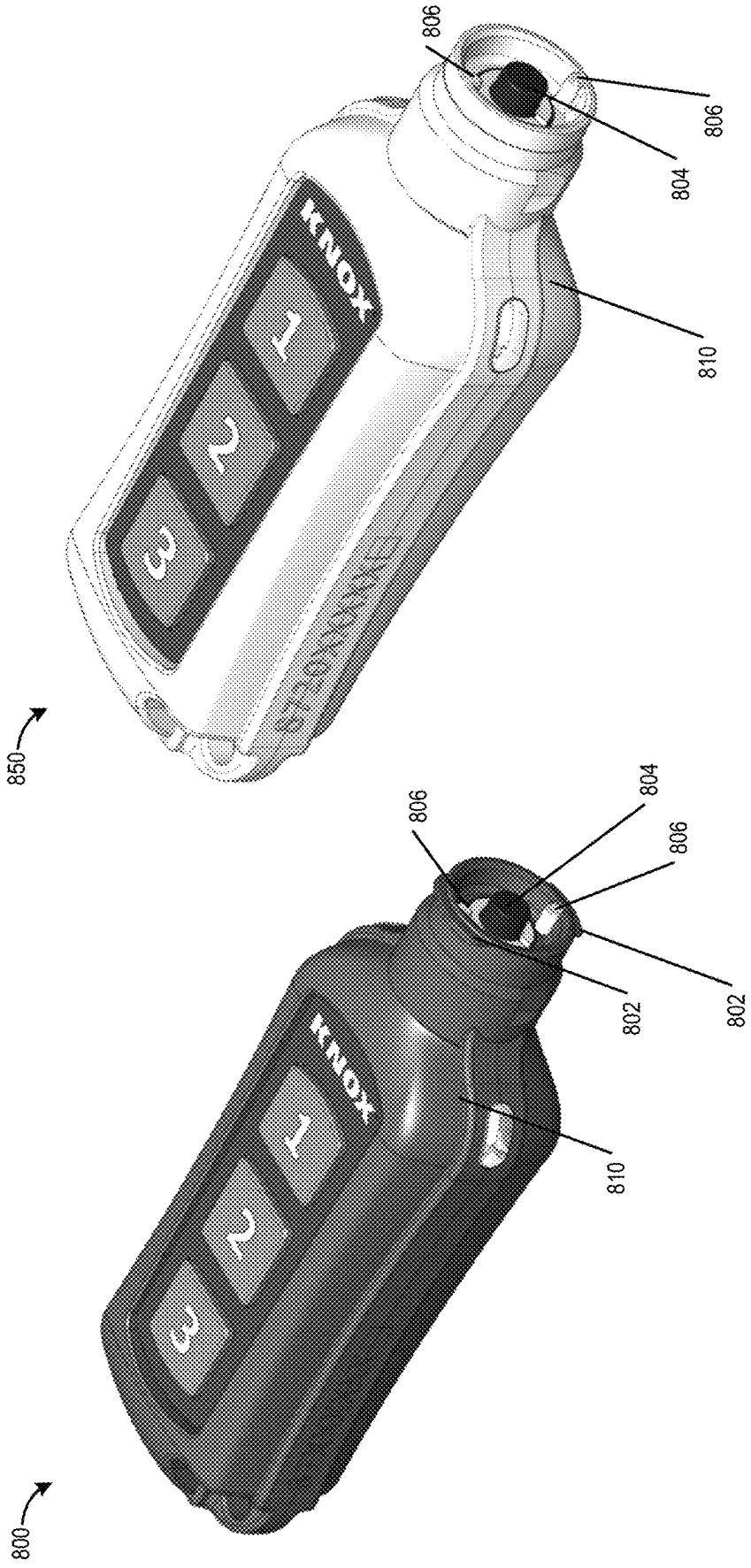
806
806
804
810
KNOX
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2
3
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806
802
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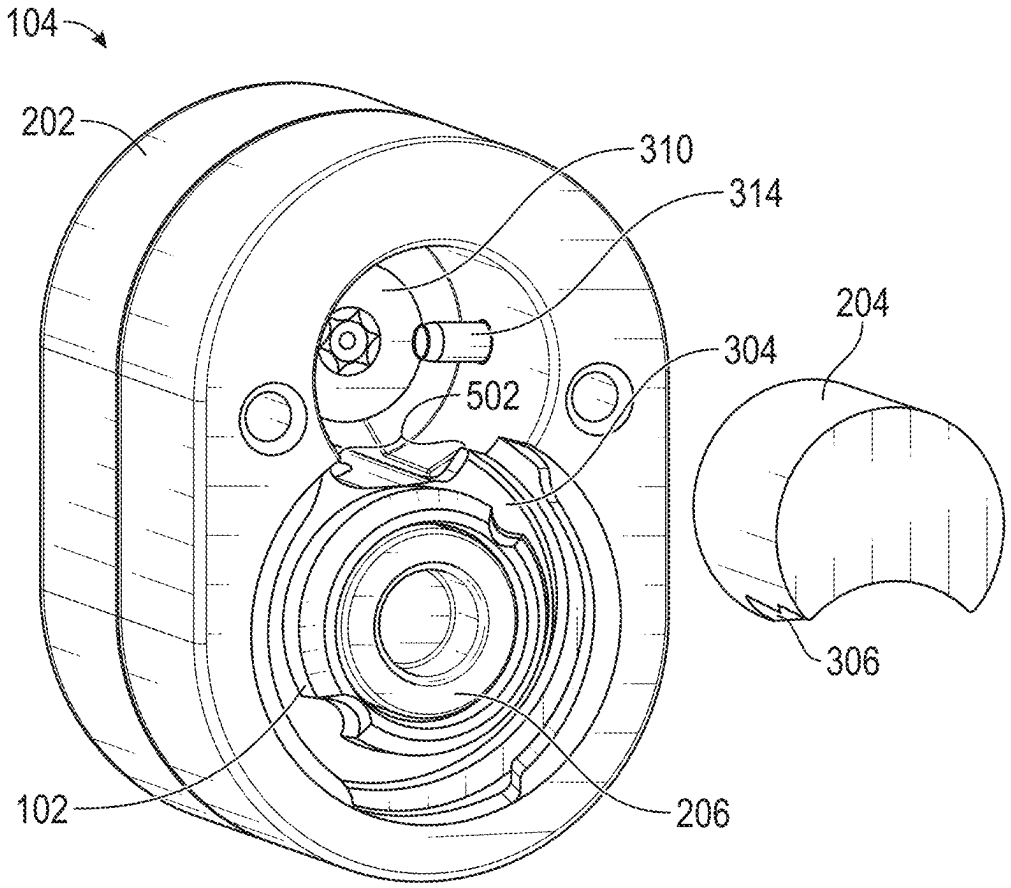
3
810
800

FIG. 8



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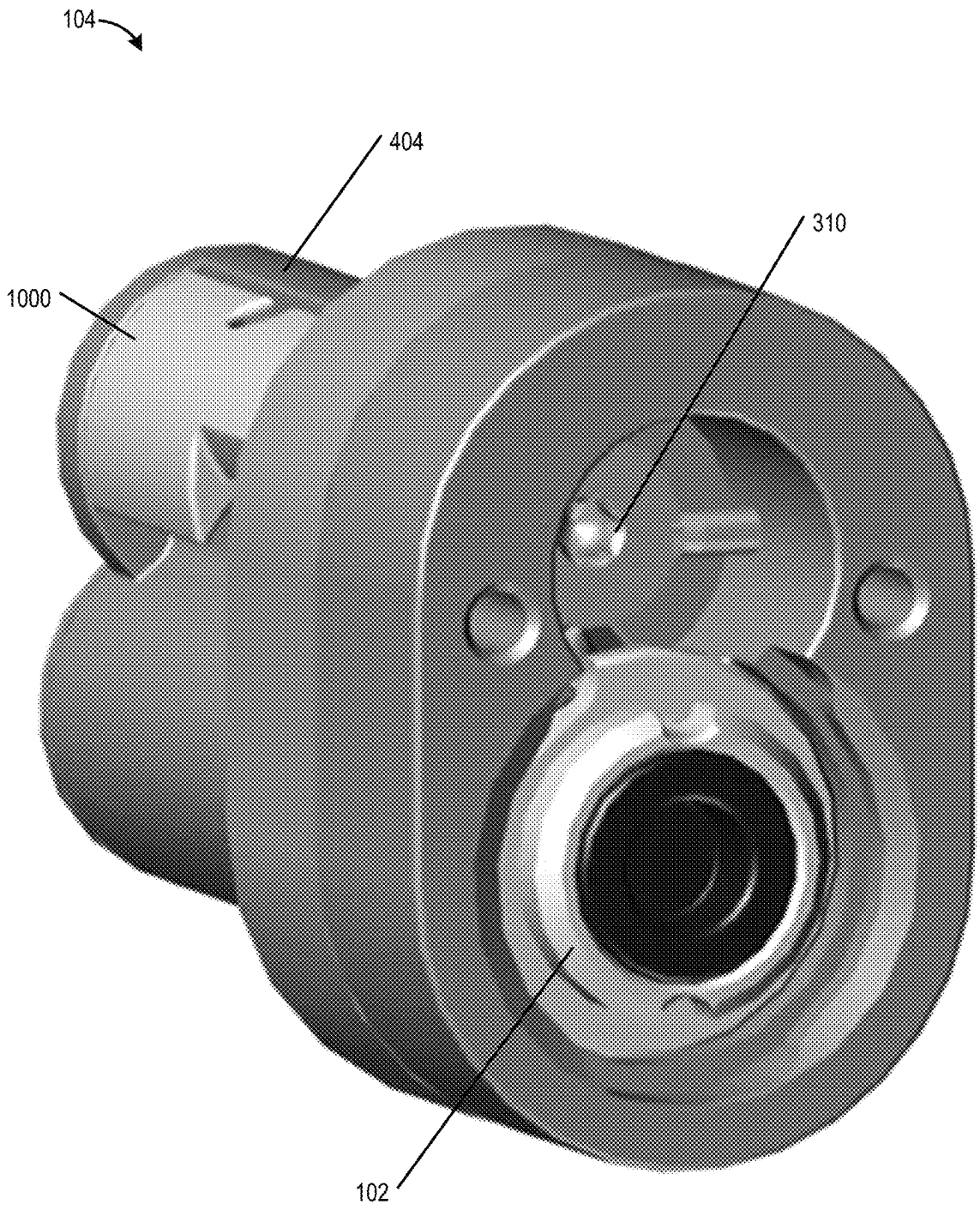

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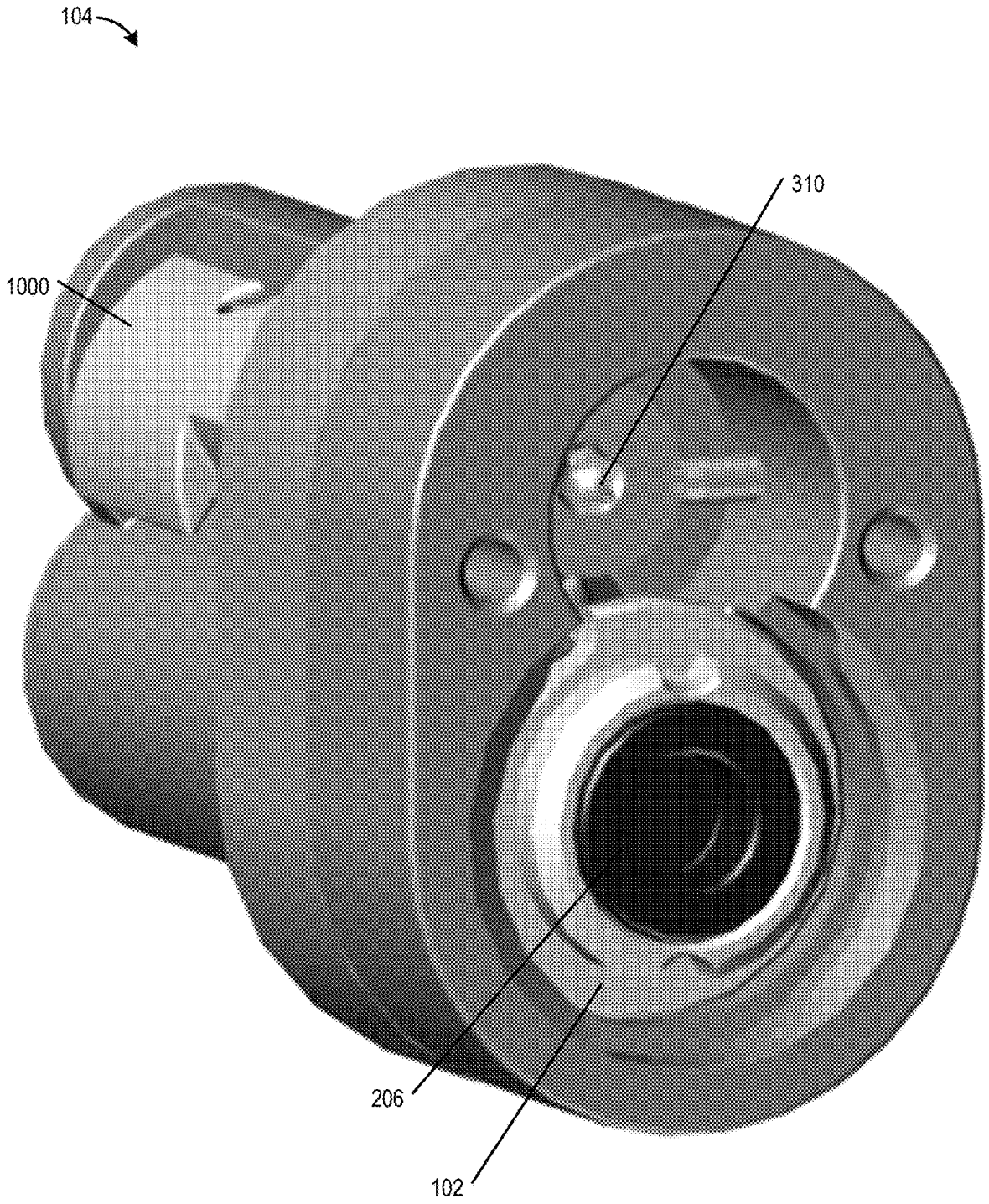

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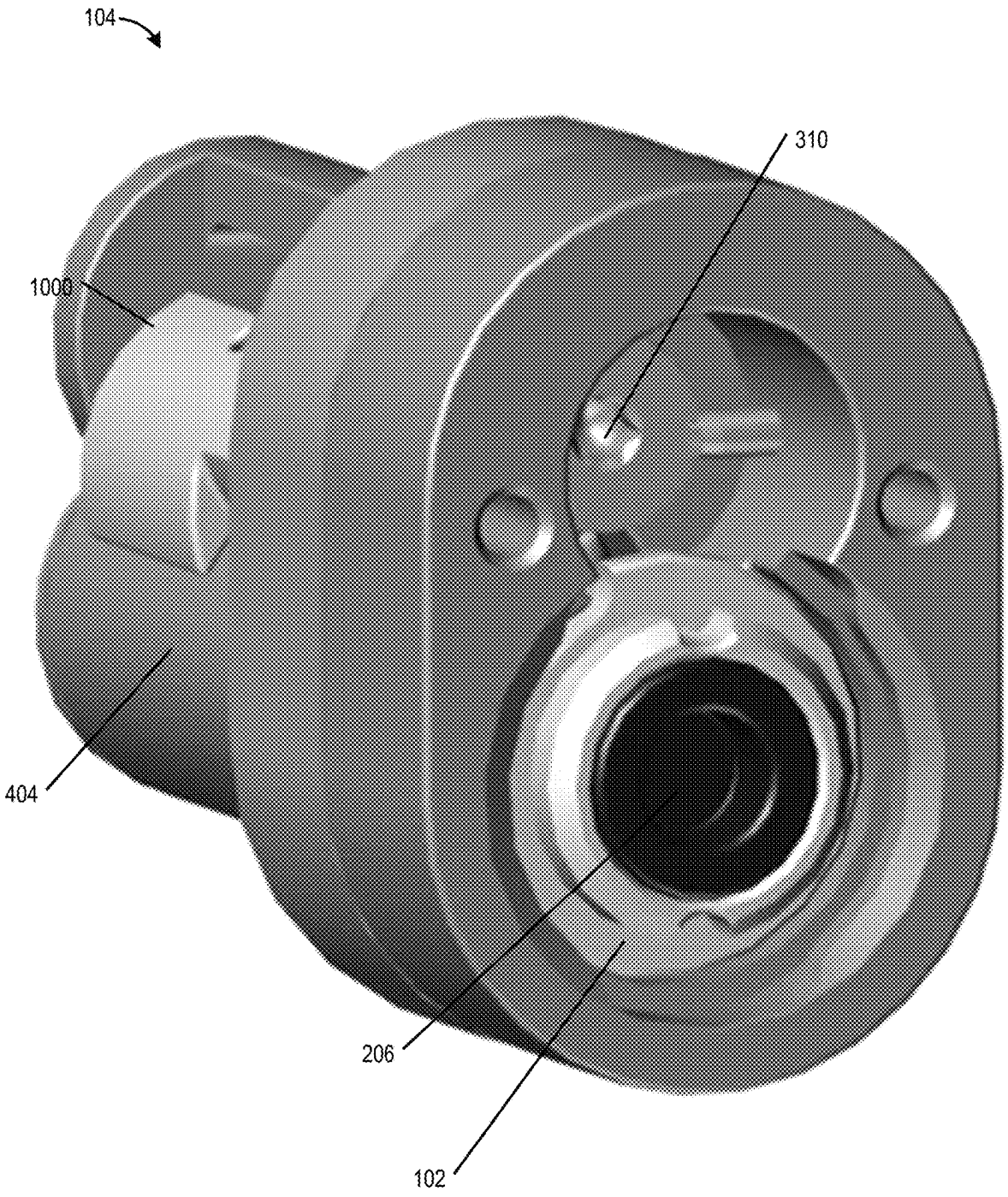

FIG. 12

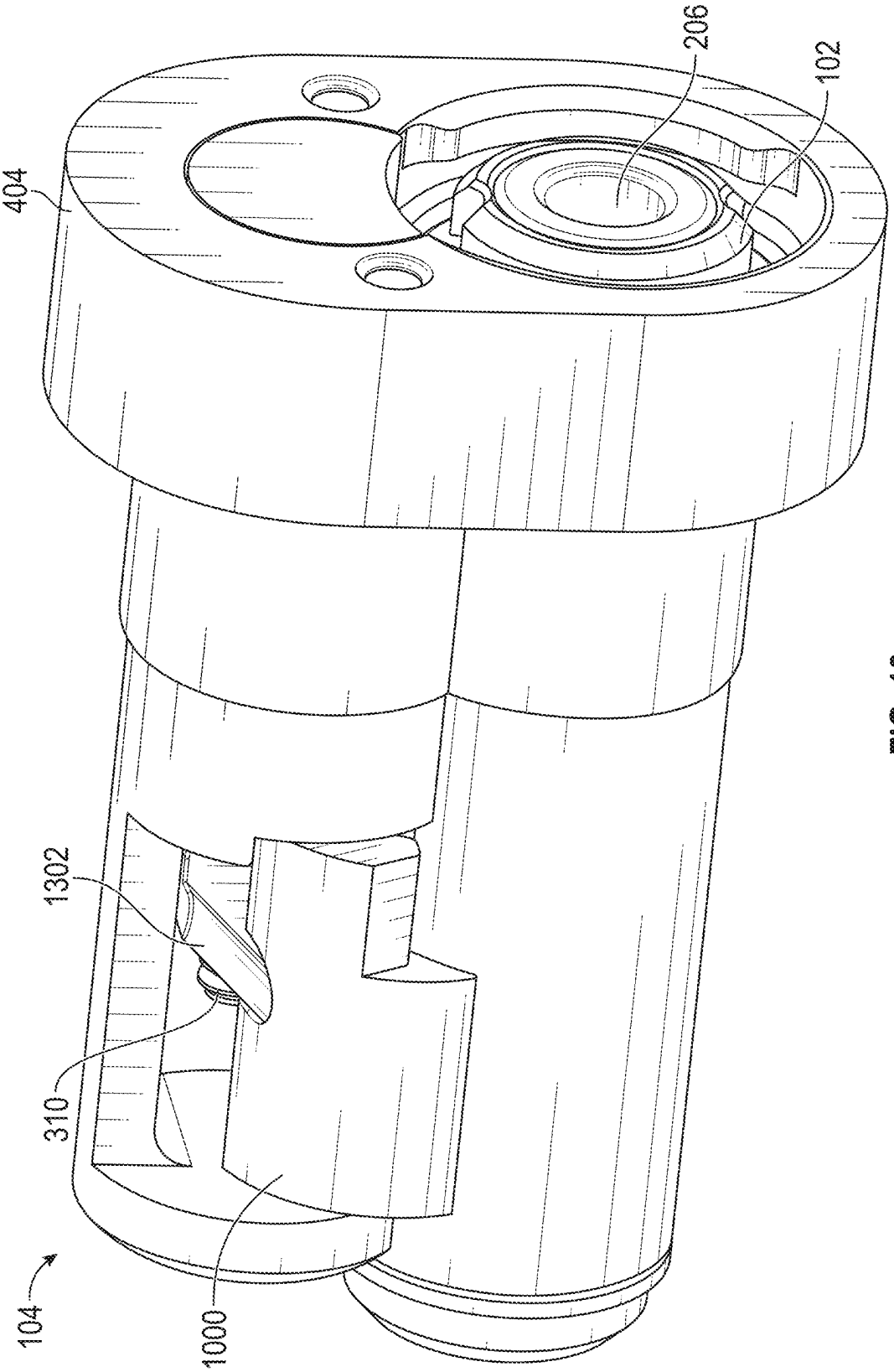

FIG. 13

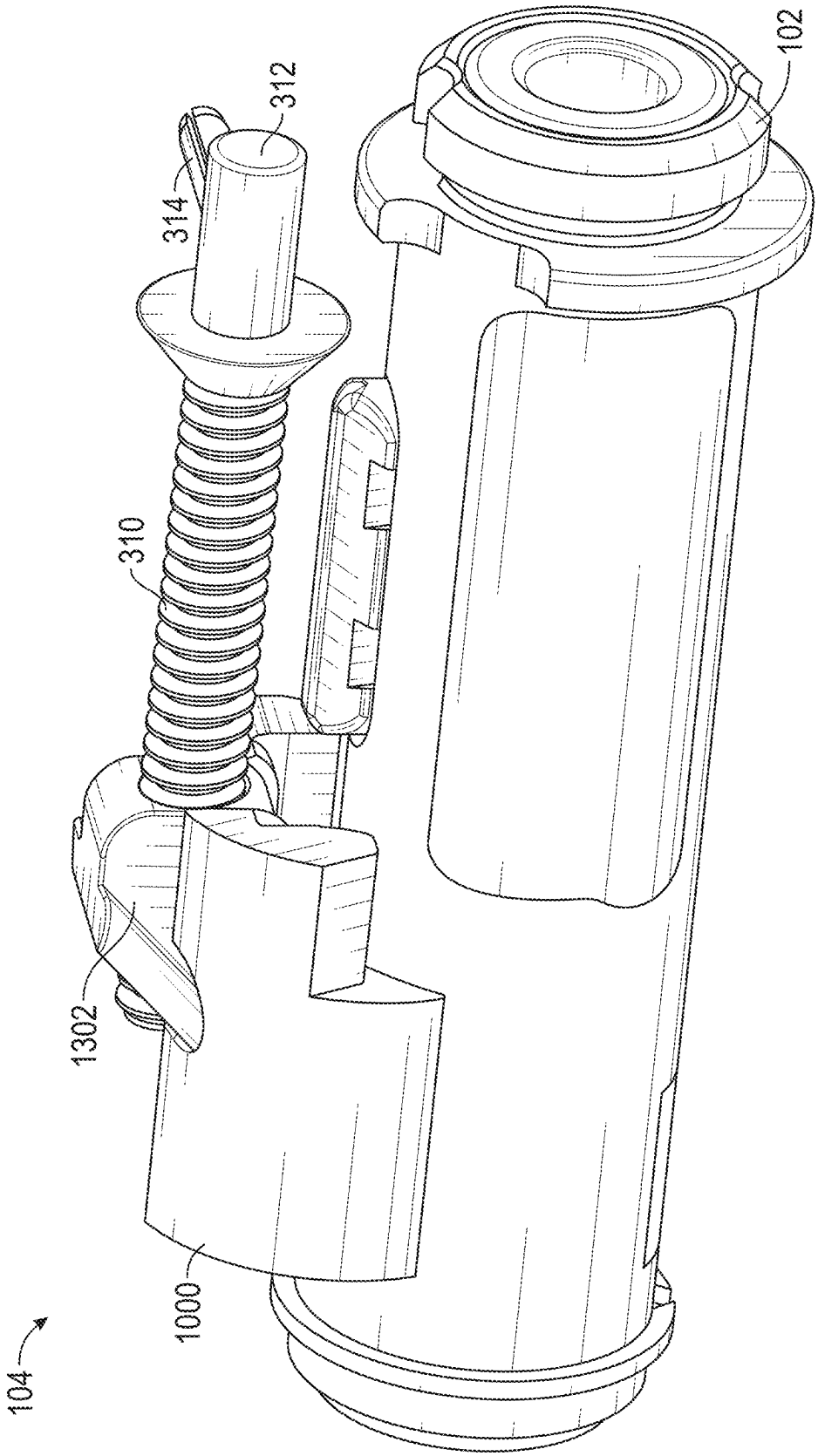

FIG. 14

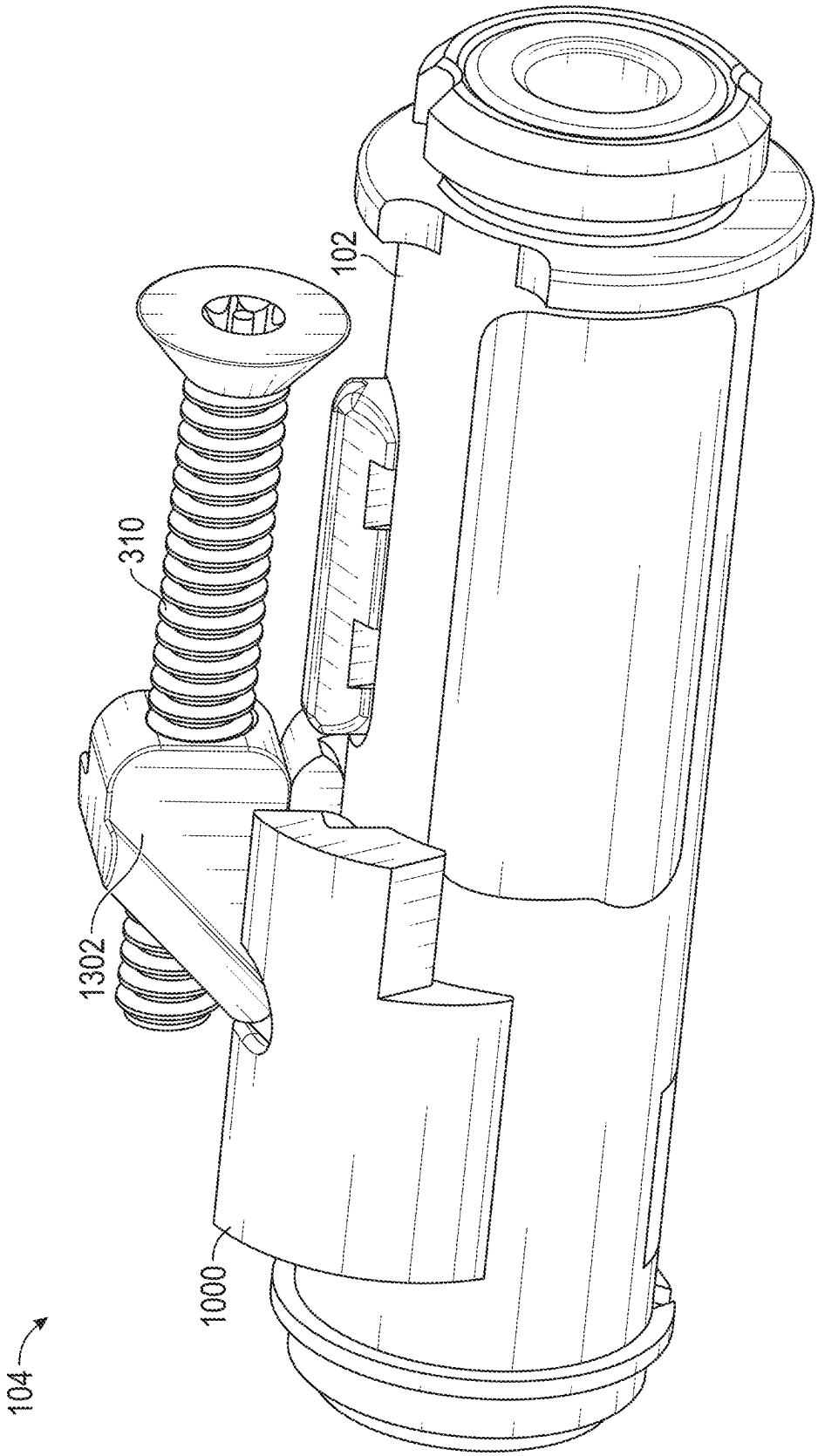

FIG. 15

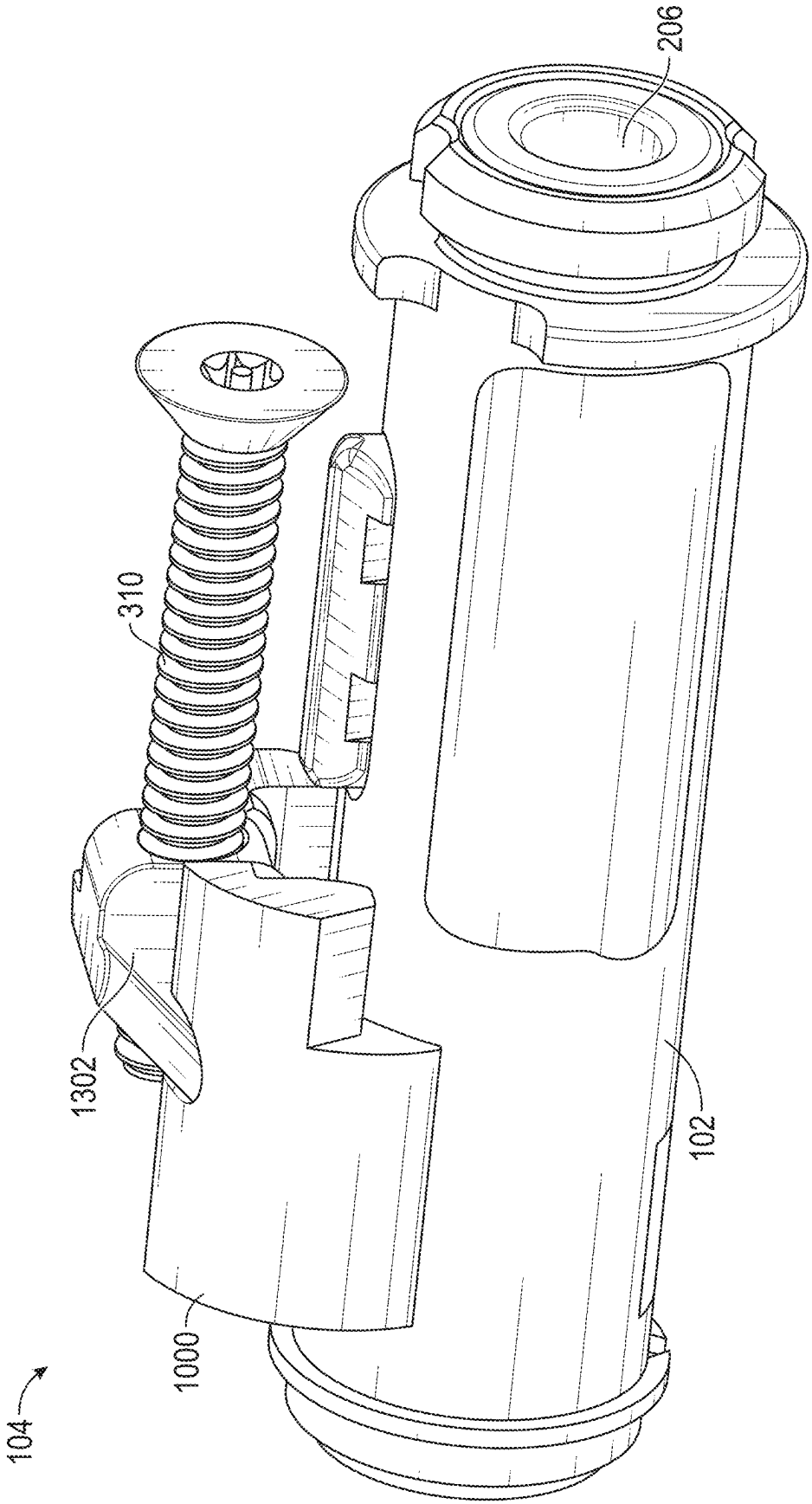

FIG. 16

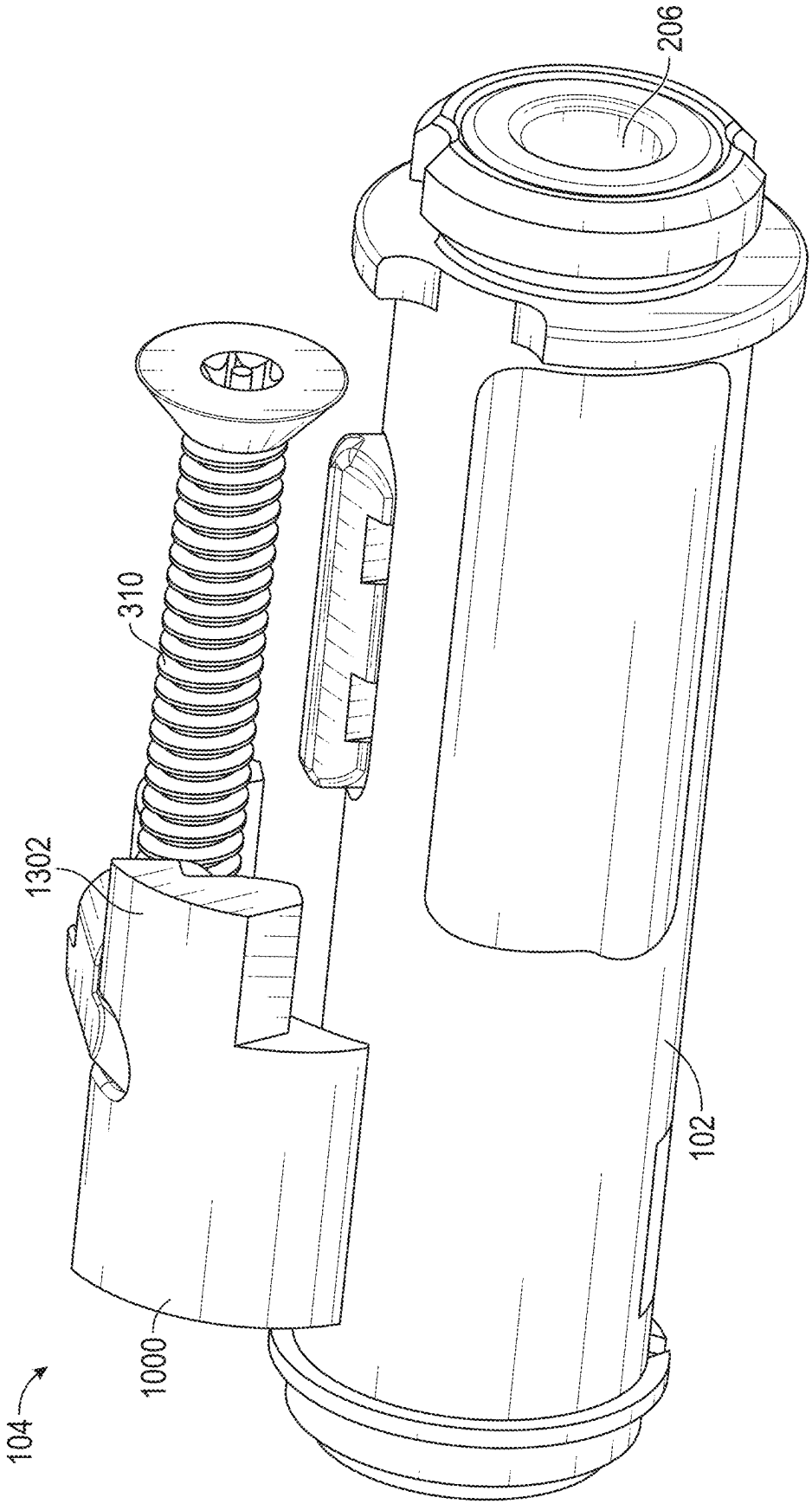

FIG. 17

FIG. 18

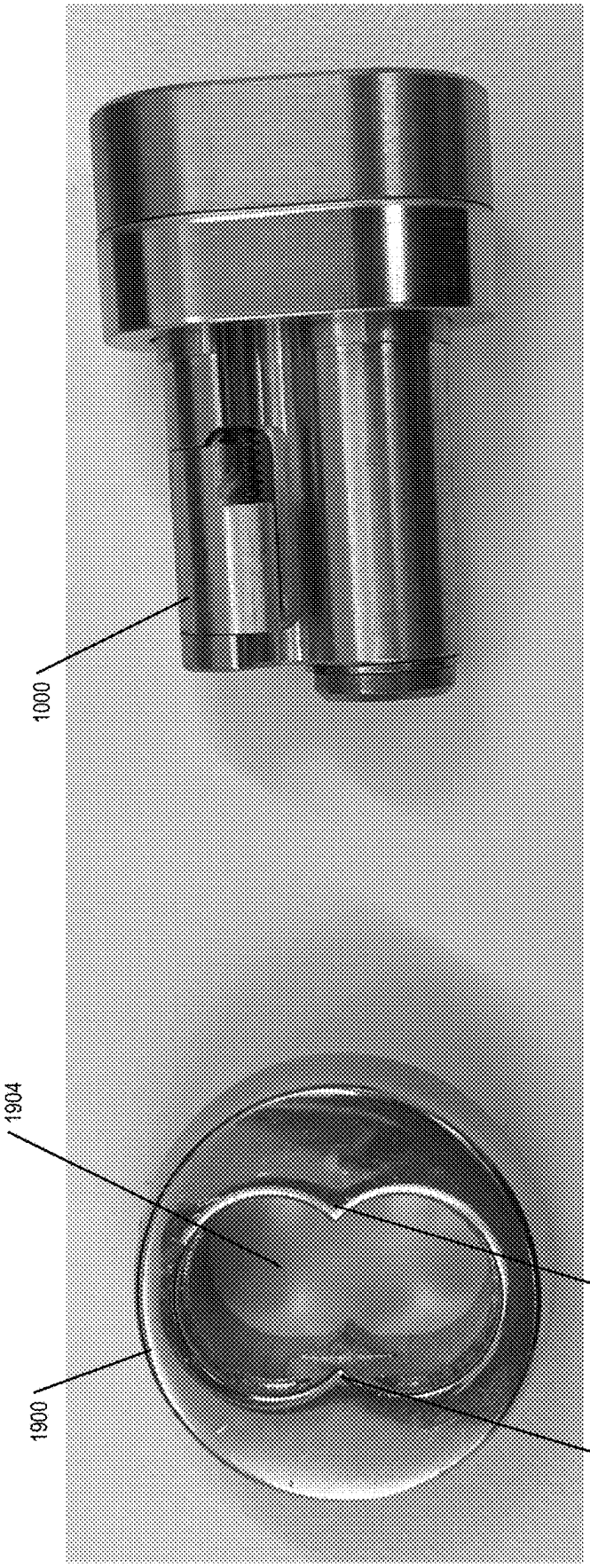

FIG. 19A

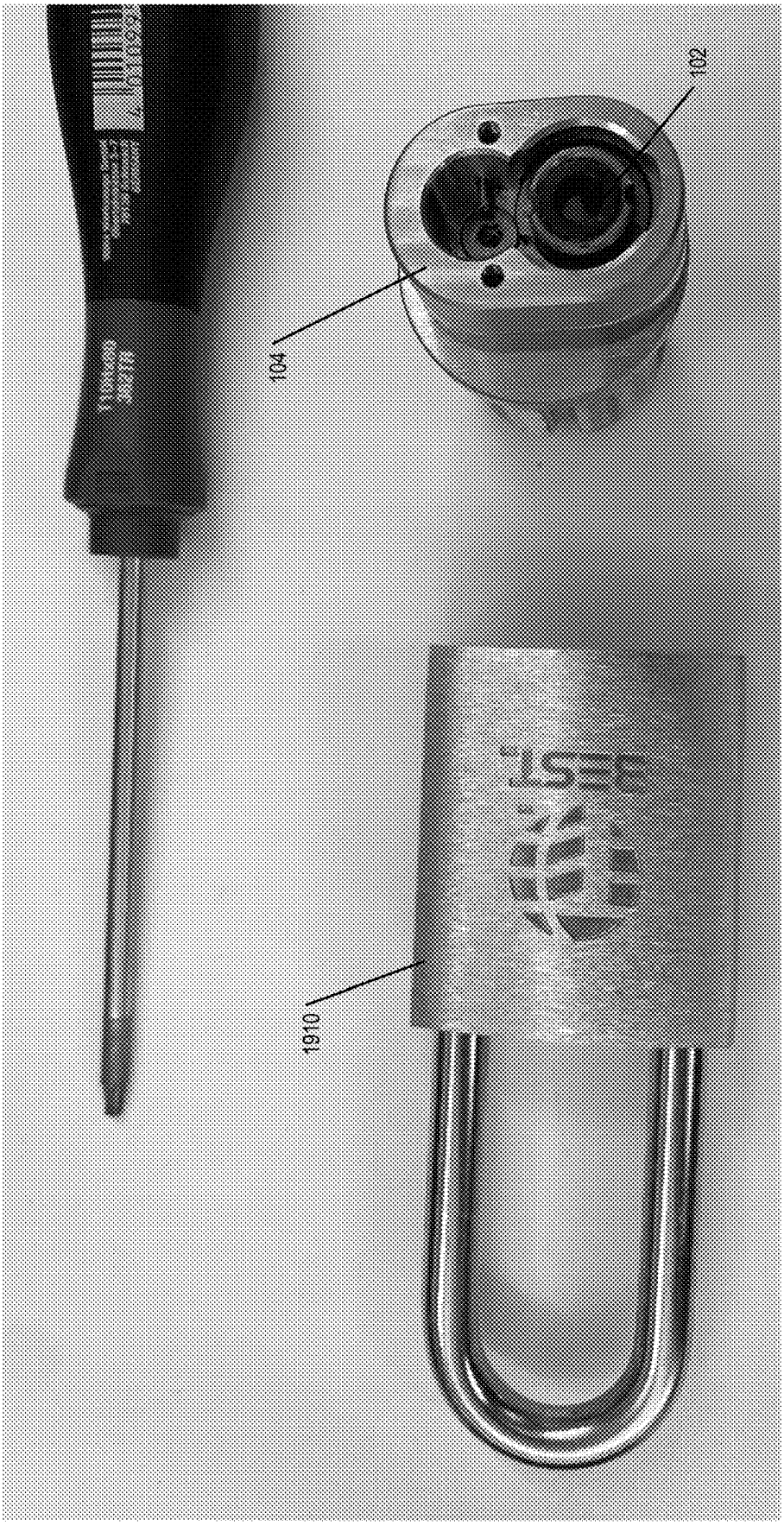

FIG. 19B

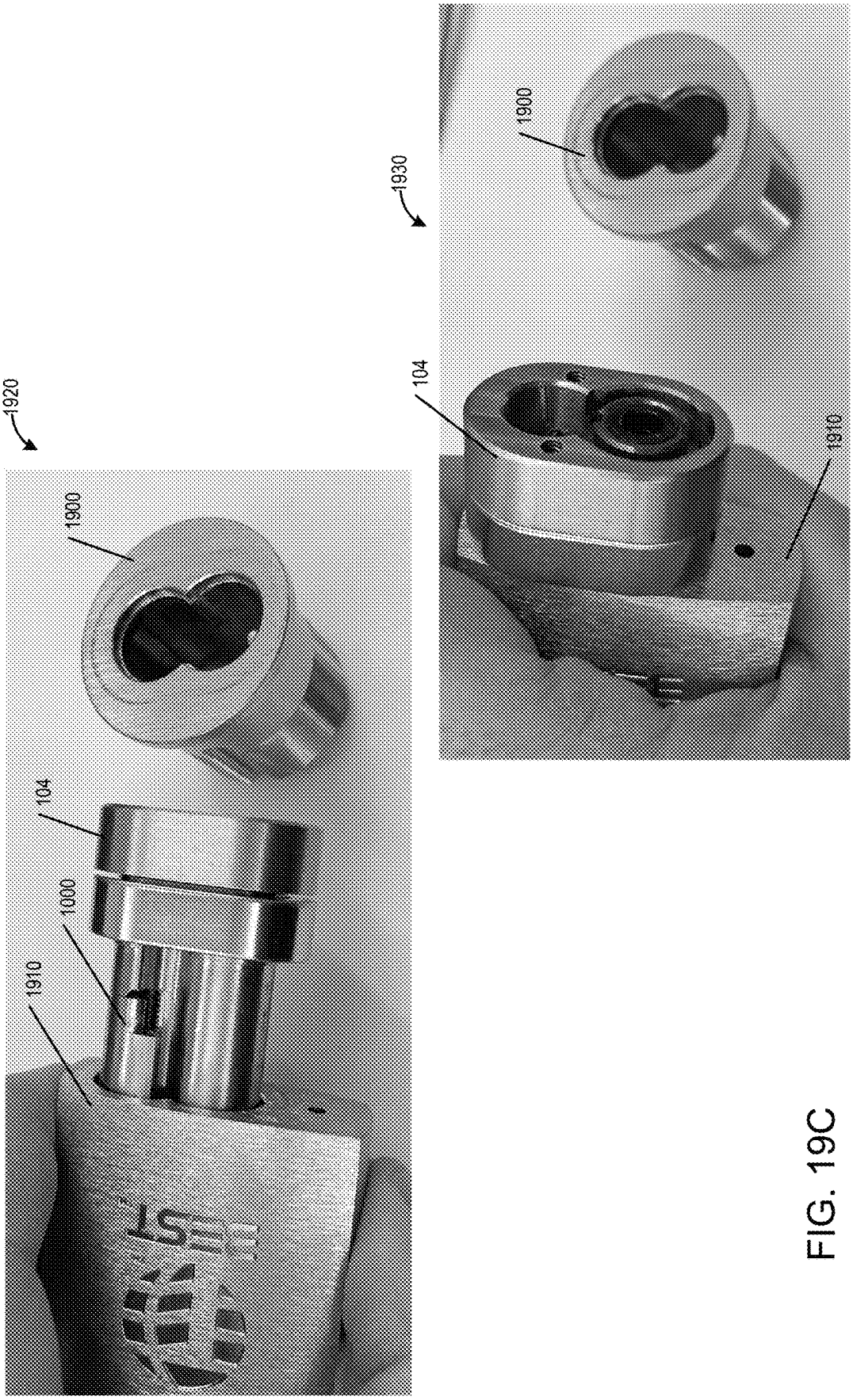

FIG. 19C

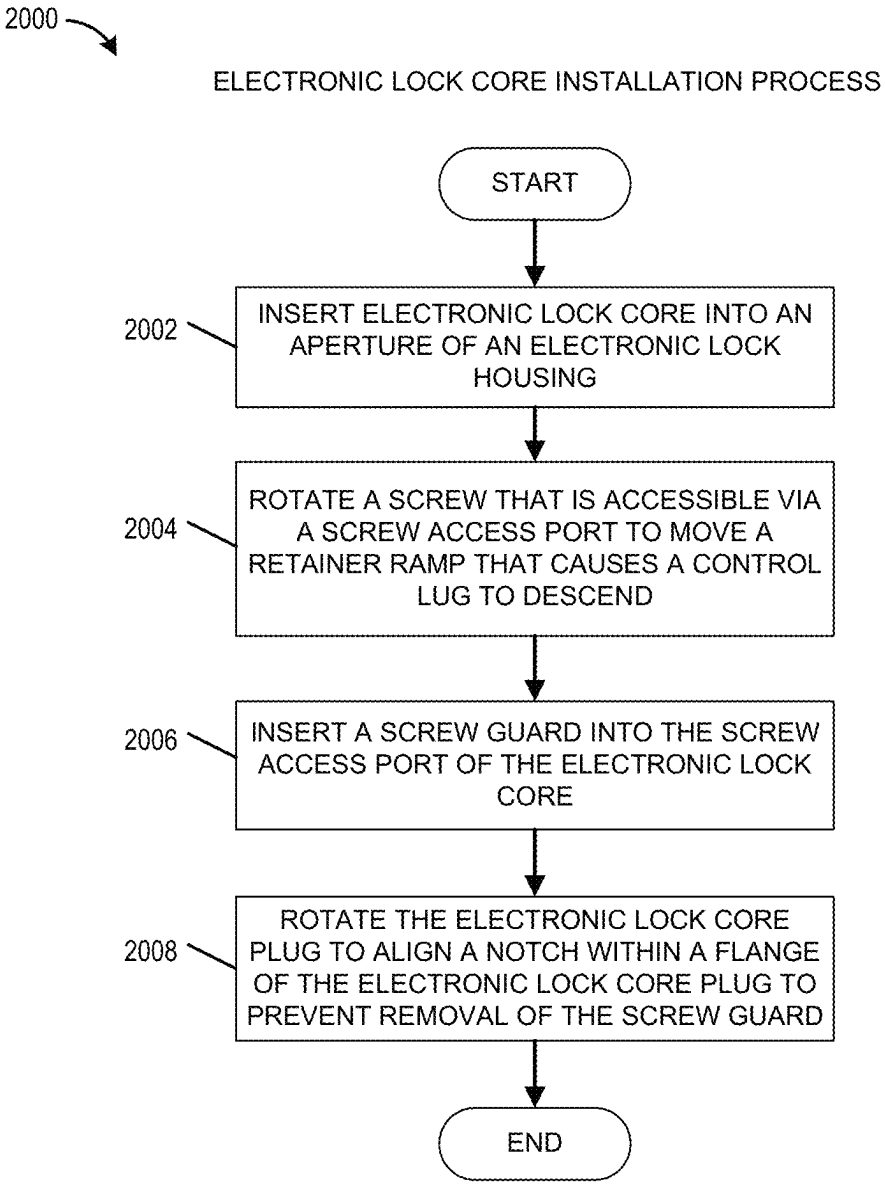
2000
ELECTRONIC LOCK CORE INSTALLATION PROCESS
START
2002
INSERT ELECTRONIC LOCK CORE INTO AN APERTURE OF AN ELECTRONIC LOCK HOUSING
2004
ROTATE A SCREW THAT IS ACCESSIBLE VIA A SCREW ACCESS PORT TO MOVE A RETAINER RAMP THAT CAUSES A CONTROL LUG TO DESCEND
2006
INSERT A SCREW GUARD INTO THE SCREW ACCESS PORT OF THE ELECTRONIC LOCK CORE
2008
ROTATE THE ELECTRONIC LOCK CORE PLUG TO ALIGN A NOTCH WITHIN A FLANGE OF THE ELECTRONIC LOCK CORE PLUG TO PREVENT REMOVAL OF THE SCREW GUARD
END

FIG. 20

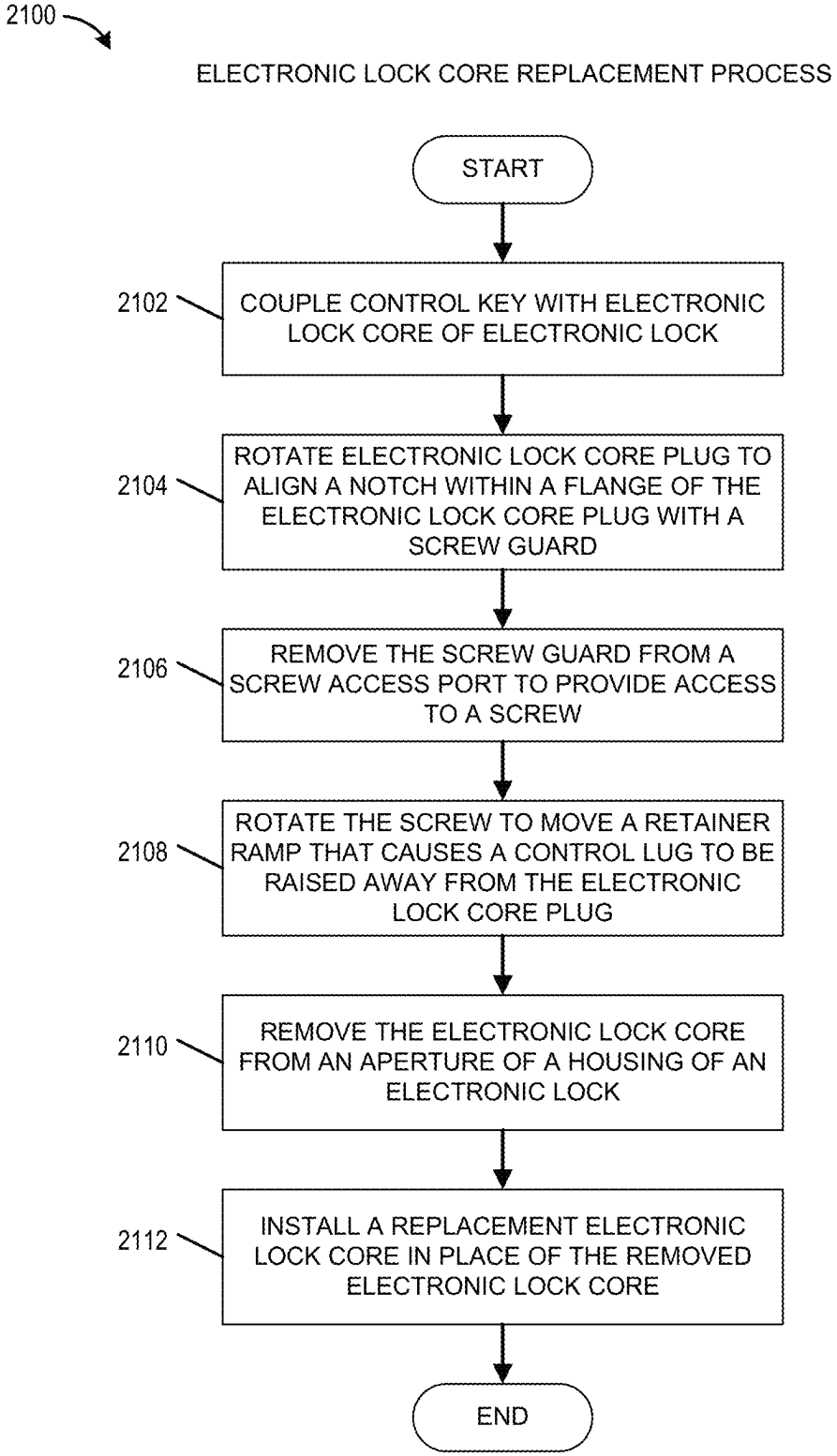
2100
ELECTRONIC LOCK CORE REPLACEMENT PROCESS
START
2102
COUPLE CONTROL KEY WITH ELECTRONIC LOCK CORE OF ELECTRONIC LOCK
2104
ROTATE ELECTRONIC LOCK CORE PLUG TO ALIGN A NOTCH WITHIN A FLANGE OF THE ELECTRONIC LOCK CORE PLUG WITH A SCREW GUARD
2106
REMOVE THE SCREW GUARD FROM A SCREW ACCESS PORT TO PROVIDE ACCESS TO A SCREW
2108
ROTATE THE SCREW TO MOVE A RETAINER RAMP THAT CAUSES A CONTROL LUG TO BE RAISED AWAY FROM THE ELECTRONIC LOCK CORE PLUG
2110
REMOVE THE ELECTRONIC LOCK CORE FROM AN APERTURE OF A HOUSING OF AN ELECTRONIC LOCK
2112
INSTALL A REPLACEMENT ELECTRONIC LOCK CORE IN PLACE OF THE REMOVED ELECTRONIC LOCK CORE
END

FIG. 21

ELECTRONIC LOCK CORE REPLACEMENT SYSTEMS

INCORPORATION BY REFERENCE

This application claims priority to U.S. Provisional Application No. 63/384,590, filed on Nov. 21, 2022, and titled "ELECTRONIC LOCK CORE REPLACEMENT," and which is hereby incorporated by reference in its entirety for all purposes and made a part of this specification. Further, this application is filed on the same date as U.S. application Ser. No. 18/514,134, which is titled "ELECTRONIC LOCK CORE REPLACEMENT METHODS," and which is hereby incorporated by reference in its entirety for all purposes and made a part of this specification. Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57. Further, non-limiting examples of electronic keys and electronic locks that may implement one or more embodiments disclosed herein or that may be used in conjunction with one or more embodiments disclosed herein are disclosed in U.S. Pat. Nos. 7,958,758; 8,276,415; 9,041,510; and 10,890,015, each of which is hereby incorporated by reference in its entirety for all purposes and made a part of this specification, which is hereby incorporated by reference in its entirety for all purposes and made a part of this specification.

TECHNICAL FIELD

The present disclosure generally relates to electronic locks, and more specifically, to retention and replacement of an electronic lock core of an electronic lock.

BACKGROUND

Electronic locks have several advantages over normal mechanical locks. For example, electronic locks may be encrypted so that only a key carrying the correct code will operate the lock. In addition, an electronic lock may contain a microprocessor so that, for example, a record can be kept of who has operated the lock during a certain time period or so that the lock is only operable at certain times. An electronic lock may also have the advantage that, if a key is lost, the lock may be reprogrammed to prevent the risk of a security breach and to avoid the expense associated with replacement of the entire lock.

SUMMARY

The systems, methods, and devices of this disclosure each have several innovative aspects, no single one of which is solely responsible for all of the desirable attributes disclosed herein. Details of one or more implementations of the subject matter described in this specification are set forth in the accompanying drawings and the description below.

In some aspects, the techniques described herein relate to an electronic lock core configured to permit replacement of the electronic lock core within an electronic lock, the electronic lock core including: an electronic lock core plug; an electronic lock core shell configured to house at least the electronic lock core plug and a retainment assembly; and the retainment assembly configured to retain the electronic lock core at least partially within an electronic lock housing of the electronic lock, wherein the retainment assembly includes: a screw; a retainer ramp configured to move axially along the screw from a first position to a second position when the screw is rotated; and a control lug configured to engage with the electronic lock housing when the retainer ramp is in the first position and to disengage from the electronic lock housing when the retainer ramp is in the second position, wherein the retainment assembly retains the electronic lock core within the electronic lock housing when the control lug engages the electronic lock housing.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the retainment assembly is further configured to enable the electronic lock core to be removed from the electronic lock when the control lug disengages from the electronic lock housing.

In some aspects, the techniques described herein relate to an electronic lock core, further including a screw guard configured to prevent access to the screw.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the screw guard magnetically engages with the screw to hold the screw guard in place.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the screw guard includes a magnet that magnetically engages with the screw to hold the screw guard in place.

In some aspects, the techniques described herein relate to an electronic lock core, further including a magnet that is positioned within a shaft of the screw guard, wherein the magnet engages with the screw to hold the screw guard in place.

In some aspects, the techniques described herein relate to an electronic lock core, wherein a magnetic strength of the screw guard is less than a magnetic strength of an electronic key configured to engage with the electronic lock core plug enabling removal of the screw guard using the electronic key.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the electronic lock core plug is rotatable between a first position and a second position, wherein the electronic lock core plug prevents removal of the screw guard when the electronic lock core plug is in the first position.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the electronic lock core plug permits removal of the screw guard when the electronic lock core plug is in the second position.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the electronic lock core plug permits removal of the screw guard when the electronic lock core plug is in the second position and an electronic key is not engaged with the electronic lock core plug.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the electronic lock core permits disengagement of the electronic key when the electronic lock core plug is in the second position and the electronic key includes a control key, and wherein the electronic lock core prevents disengagement of the electronic key when the electronic lock core plug is in the second position and the electronic key does not include the control key.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the control key omits a retention tab that is included in a non-control key, wherein the retention tab prevents removal of the non-control key when the electronic lock core is in an unlocked state.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the electronic lock core plug includes a flange with a notch, wherein the notch aligns with the screw guard when the electronic lock core plug is in the

second position, and wherein the notch is not aligned with the screw guard when the electronic lock core plug is in the first position.

In some aspects, the techniques described herein relate to an electronic lock core, further including a pin configured to prevent the screw from being removed from the retainer ramp.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the pin includes a dowel pin, a roll pin, a taper pin, or a cotter pin.

In some aspects, the techniques described herein relate to an electronic lock core, further including a screw guard configured to prevent access to the screw, wherein the screw guard includes a slot configured to at least partially surround the pin when the screw guard magnetically engages with the screw.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the control lug is further configured to prevent movement of the electronic lock core within the electronic lock housing when the retainer ramp is in the first position.

In some aspects, the techniques described herein relate to an electronic lock, wherein the control lug is further configured to prevent the movement of the electronic lock core within the electronic lock housing in one or more of an axial direction, a lateral direction, an angular direction, or a rotational direction.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the control lug is further configured to prevent movement of the electronic lock core within the electronic lock housing by more than a threshold degree when the retainer ramp is in the first position.

In some aspects, the techniques described herein relate to an electronic lock core, further including a cam lock that protrudes from the electronic lock core plug when the electronic lock core is in a locked state and that retracts into a cavity of the electronic lock core plug when the electronic lock core is in an unlocked state.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the cam lock prevents rotation of the electronic lock core plug within the electronic lock core when the electronic lock core is in the locked state.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the electronic lock core is a small format interchangeable core, and wherein an aperture of the electronic lock housing is configured to receive the small format interchangeable core.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the control lug is further configured to engage with a protrusion of an aperture of the electronic lock housing when the retainer ramp is in the first position preventing removal of the electronic lock core from the electronic lock.

In some aspects, the techniques described herein relate to an electronic lock core, wherein the control lug is further configured to disengage from a protrusion of an aperture of the electronic lock housing when the retainer ramp is in the second position enabling removal of the electronic lock core from the electronic lock.

In some aspects, the techniques described herein relate to an electronic lock including: the electronic lock core; and the electronic lock housing.

In some aspects, the techniques described herein relate to an electronic lock including: an electronic lock housing; and an electronic lock core configured to permit replacement of the electronic lock core within the electronic lock housing, the electronic lock core including: an electronic lock core plug; an electronic lock core shell configured to house at least the electronic lock core plug and a retainment assembly; and the retainment assembly configured to retain the electronic lock core at least partially within the electronic lock housing of the electronic lock, wherein the retainment assembly includes: a screw; a retainer ramp configured to move axially along the screw from a first position to a second position when the screw is rotated; and a control lug configured to engage with the electronic lock housing when the retainer ramp is in the first position and to disengage from the electronic lock housing when the retainer ramp is in the second position, wherein the retainment assembly retains the electronic lock core within the electronic lock housing when the control lug engages the electronic lock housing.

In some aspects, the techniques described herein relate to an electronic lock, further including a locking mechanism, wherein a state of the locking mechanism is controllable, at least in part, by the electronic lock core.

In some aspects, the techniques described herein relate to an electronic lock, wherein the locking mechanism includes at least one of: a padlock, a cabinet lock, a deadbolt, a mortise lock, a deadlatch, a latch, a cam lock, or a knob lock.

In some aspects, the techniques described herein relate to an electronic lock, wherein the electronic lock includes a small format interchangeable core form factor configured to receive a small format interchangeable core.

In some aspects, the techniques described herein relate to an electronic lock, wherein the electronic lock core includes a small format interchangeable core, and wherein the electronic lock includes an aperture configured to receive the small format interchangeable core.

In some aspects, the techniques described herein relate to a method of installing an electronic lock core of an electronic lock, the method including: inserting the electronic lock core into an aperture of an electronic lock housing of the electronic lock such that the electronic lock core is positioned so that a face of the electronic lock core is exposed to a user via the aperture of the electronic lock housing; rotating a screw that is accessible via a screw access port of the electronic lock core and that is inserted into a retainer ramp to cause the retainer ramp to move axially along the screw from a first position to a second position, and wherein moving the retainer ramp from the first position to the second position causes a control lug to engage with the electronic lock housing of the electronic lock; inserting a screw guard into the screw access port of the electronic lock core, wherein the screw access port provides access to a screw head of the screw, and wherein the screw guard prevents access to the screw head when the screw guard is inserted into the screw access port; and using an electronic key, rotating an electronic lock core plug of the electronic lock core to align a notch within a flange of the electronic lock core plug such that the screw guard cannot be removed from the screw access port.

In some aspects, the techniques described herein relate to a method, wherein the electronic key includes a control key, and wherein the control key omits a retention tab that is included in a non-control key, and wherein the retention tab prevents removal of the non-control key when the electronic lock core is in an unlocked state.

In some aspects, the techniques described herein relate to a method, wherein the electronic lock core is a small format interchangeable core, and wherein the aperture of the electronic lock housing is configured to receive the small format interchangeable core.

In some aspects, the techniques described herein relate to a method, wherein causing the control lug to engage with the electronic lock housing prevents the electronic lock core from moving within or being removed from the electronic lock housing.

In some aspects, the techniques described herein relate to a method, wherein the flange is a part of the electronic lock core plug.

In some aspects, the techniques described herein relate to a method, wherein the electronic lock core includes a replaceable electronic lock core.

In some aspects, the techniques described herein relate to a method, wherein rotating the screw includes rotating the screw in a direction that tightens the screw.

In some aspects, the techniques described herein relate to a method, wherein moving the retainer ramp from the first position to the second position further causes the control lug to engage with a protrusion of an aperture of the electronic lock housing preventing removal of the electronic lock core.

In some aspects, the techniques described herein relate to a method of replacing a first electronic lock core of an electronic lock with a second electronic lock core, the method including: coupling a control key with a first electronic lock core plug of the first electronic lock core to unlock the electronic lock; rotating the first electronic lock core plug to align a notch within a flange of the first electronic lock core plug with a first screw guard that is installed into a first screw access port of the first electronic lock core; removing the first screw guard from the first screw access port of the first electronic lock core, wherein the first screw access port provides access to a screw head of a first screw, wherein the first screw guard prevents access to the screw head when the first screw guard is inserted into the first screw access port, and wherein the first screw is inserted into a first retainer ramp; rotating the first screw in a first direction to cause the first retainer ramp to move axially along the first screw from a second position to a first position, wherein moving the first retainer ramp from the second position to the first position causes a first control lug to disengage from an electronic lock housing of the electronic lock; removing the first electronic lock core from an aperture of the electronic lock housing of the electronic lock; and installing the second electronic lock core into the electronic lock housing.

In some aspects, the techniques described herein relate to a method, wherein the control key prevents removal of the first screw guard when the control key is coupled to the first electronic lock core plug.

In some aspects, the techniques described herein relate to a method, wherein removing the first screw guard includes decoupling the control key from the first electronic lock core plug after the notch of the first electronic lock core plug is aligned with the first screw guard.

In some aspects, the techniques described herein relate to a method, wherein removing the first screw guard further includes using a first magnet to remove the first screw guard from the first screw access port.

In some aspects, the techniques described herein relate to a method, wherein the first magnet is part of the control key.

In some aspects, the techniques described herein relate to a method, wherein the first screw guard includes a second magnet that engages with the first screw of the first electronic lock core, and wherein a magnetic strength of the first magnet is greater than a magnetic strength of the second magnet.

In some aspects, the techniques described herein relate to a method, wherein removing the first electronic lock core includes using the control key to remove the first electronic lock core by at least: coupling the control key with the first electronic lock core plug; and pulling the first electronic lock core out of the electronic lock housing of the electronic lock.

In some aspects, the techniques described herein relate to a method, wherein the first electronic lock core is a small format interchangeable core, and wherein the aperture of the electronic lock housing is configured to receive the small format interchangeable core.

In some aspects, the techniques described herein relate to a method, wherein rotating the first screw in the first direction includes rotating the first screw in a direction that loosens the first screw.

In some aspects, the techniques described herein relate to a method, wherein the control key omits a retention tab that is included in a non-control key, and wherein the retention tab prevents removal of the non-control key when the first electronic lock core is in an unlocked state.

In some aspects, the techniques described herein relate to a method, wherein the flange is a part of the first electronic lock core plug.

In some aspects, the techniques described herein relate to a method, wherein installing the second electronic lock core includes: inserting the second electronic lock core into the aperture of the electronic lock housing such that the second electronic lock core is positioned so that a face of the second electronic lock core is exposed to a user via the aperture of the electronic lock housing; rotating a second screw of the second electronic lock core in a second direction to cause a second retainer ramp to move axially along the second screw from a first position to a second position, wherein moving the second retainer ramp from the first position to the second position causes a second control lug to engage with the electronic lock housing; inserting a second screw guard into a second screw access port of the second electronic lock core; and using the control key, rotating a second electronic lock core plug of the second electronic lock core to align a notch within a flange of the second electronic lock core plug such that the second screw guard cannot be removed from the second screw access port.

In some aspects, the techniques described herein relate to a method, wherein rotating the second screw in the second direction includes rotating the second screw in a direction that tightens the second screw.

In some aspects, the techniques described herein relate to a method, wherein causing the second control lug to engage with the electronic lock housing prevents the second electronic lock core from moving within or being removed from the electronic lock housing.

In some aspects, the techniques described herein relate to a method, wherein the second screw guard and the first screw guard are the same.

In some aspects, the techniques described herein relate to a method, wherein moving the second retainer ramp from the first position to the second position further causes the second control lug to engage with a protrusion of the aperture of the electronic lock housing preventing removal of the second electronic lock core.

In some aspects, the techniques described herein relate to a method, wherein moving the first retainer ramp from the second position to the first position further causes the first control lug to disengage from a protrusion of the aperture of the electronic lock housing.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects and advantages of the embodiments provided herein are described with reference to the following detailed

description in conjunction with the accompanying drawings. Throughout the drawings, reference numbers may be reused to indicate correspondence between referenced elements. The drawings are provided to illustrate example embodiments described herein and are not intended to limit the scope of the disclosure. In addition, various features of different disclosed embodiments can be combined to form additional embodiments, which are part of this disclosure. Further, one or more features or structures can be removed or omitted.

FIG. **1** illustrates a front face of an example of an electronic lock in accordance with certain embodiments disclosed herein.

FIG. **2** illustrates a perspective view of the example of the electronic lock of FIG. **1** in accordance with certain embodiments disclosed herein.

FIG. **3**A illustrates a cross section of a perspective view of the example of the electronic lock of FIG. **1** in accordance with certain embodiments disclosed herein.

FIG. **3**B illustrates an exploded view of the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **4** illustrates a sectioned perspective view of the example of the electronic lock of FIG. **1** with an electronic lock shell and screw sectioned to illustrate a state of a cam lock when an electronic lock core of the electronic lock is in a locked state in accordance with certain embodiments disclosed herein.

FIG. **5** illustrates a sectioned perspective view of the example of the electronic lock of FIG. **1** with the electronic lock shell and screw sectioned to illustrate the state of the cam lock when the electronic lock core of the electronic lock is in an unlocked state in accordance with certain embodiments disclosed herein.

FIG. **6** illustrates a cross section of the electronic lock of FIG. **1** in a locked state with the cam lock protruding from the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **7** illustrates a cross section of the electronic lock of FIG. **1** in an unlocked state with the cam lock retracted into the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **8** illustrates a pair of example electronic keys in accordance with certain embodiments disclosed herein.

FIG. **9** illustrates removal of a screw guard of the electronic lock of FIG. **1** in accordance with certain embodiments disclosed herein.

FIG. **10** illustrates a control lug of a retainment assembly of the electronic lock of FIG. **1** in accordance with certain embodiments disclosed herein.

FIG. **11** illustrates use of a screw to lower the control lug of FIG. **10** in accordance with certain embodiments disclosed herein.

FIG. **12** illustrates engagement of the control lug of FIG. **10** with the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **13** illustrates another view of the engagement of the control lug of FIG. **10** with the electronic lock core and a retainer ramp in accordance with certain embodiments disclosed herein.

FIG. **14** illustrates the electronic lock core and the retainment assembly of the electronic lock of FIG. **1** in accordance with certain embodiments disclosed herein.

FIG. **15** illustrates the electronic lock core with the retainment assembly fully engaged with the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **16** illustrates the electronic lock core with the retainment assembly partially engaged, or partially disengaged, with the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **17** illustrates the electronic lock core with the retainment assembly fully disengaged with the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **18** depicts a photograph of a prototype of the electronic lock with the retainment assembly fully disengaged with the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **19**A depicts a photograph of a prototype of the electronic lock with the retainment assembly fully disengaged with the electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **19**B depicts a photograph of a Small Format Interchangeable Core (SFIC) housing and an electronic lock core in accordance with certain embodiments disclosed herein.

FIG. **19**C depicts a pair of photographs of an electronic lock core that has been removed from a mortice lock housing and is being inserted into a padlock housing in accordance with certain embodiments disclosed herein.

FIG. **20** presents a flowchart of an example electronic lock core installation process in accordance with certain embodiments disclosed herein.

FIG. **21** presents a flowchart of an example electronic lock core replacement process in accordance with certain embodiments disclosed herein.

DETAILED DESCRIPTION

The headings provided herein, if any, are for convenience only and do not necessarily affect the scope or meaning of the claimed invention.

Introduction

An electronic lock may have several advantages over mechanical locks including programmability, increased security, logging and auditing features, and unique form factors, among others. Many of the features and advantages of the electronic lock are achieved or implemented, at least in part, by the electronic lock core. The electronic lock core may include some or all of the electrical and electronic features of the electronic lock including, but not limited to, the processor or processing capabilities, the data transfer elements (e.g., near field and short-range communication antennas and chipsets, capacitive and inductive elements, etc.), power circuitry (e.g., capacitors, inductors, batteries, etc.). It should be understood that an electronic lock core may include some or all of the aforementioned example elements, and in some cases, may include additional or alternative circuit elements. Some non-limiting examples of an electronic lock and/or electronic lock core that may be used with embodiments of the present disclose are described in the following patents, which are hereby incorporated by references in their entirety for all purposes and made part of the present specification: U.S. Pat. Nos. 7,958,758; 8,276,415; 9,041,510; and 10,890,015.

Although some electronic locks provide flexibility in that they can be programmed enabling changes in features and/or permissions, there may be cases where it is desirable to change the electronic lock itself. For example, it is possible that new features may be developed in the future that require a hardware modification. As another example, a different entity may assume control of the premises that includes the electronic lock and while in some cases it may be sufficient to reprogram the electronic lock, in other cases it may be

desirable to replace the electronic lock because, for example, logistics or a division in control of premises that include a set of electronic locks. As yet another example, it may be desirable to change electronic locks provided by one electronic lock provider because electronic locks of a different electronic lock provider are desired. Regardless of the reason for changing the electronic lock, in certain embodiments it is not desirable to change the entirety of the lock. For example, in some cases, the electronic lock may be physically secured at the location where it is installed. As another example, replacing the electronic lock may be expensive or logistically challenging.

In certain embodiments, the above issues can be addressed by replacing the electronic lock core, or at least a portion thereof, without replacing the entire electronic lock, which may include a housing or other mechanical or physical features. Embodiments of the present disclosure include a system that enables replacement of an electronic lock core. Further, embodiments of the present disclosure include a system that secures the electronic lock core to prevent undesired removal of the electronic lock core.

FIG. **1** illustrates a front face of an example of a portion of an electronic lock **100** in accordance with certain embodiments disclosed herein. The electronic lock **100** may represent a portion of an electronic lock **100** that may further include an electronic lock housing or a housing (not shown), and one or more locking mechanisms that secure a device. The housing may be part of a device (e.g., door, container, etc.) to be secured or may be attached to a device to be secured. Among other features, the electronic lock **100** includes an electronic lock core **104**. This electronic lock core **104** may be secured within the electronic lock housing of the electronic lock **100**. Further, the electronic lock core **104** may include at least an electronic lock core plug **102**. Further, in some cases, the electronic lock **100** may include an electronic lock core shell that housing the electronic lock core **104**, which may include the electronic lock core plug **102**. The electronic lock **100** may include additional housing, electronic components, or mechanical components that are part of the electronic lock **100**. For example, there may be additional physical structure that houses the electronic lock core **104** or that secures the electronic lock core **104** to a premises or other item (e.g., a safe, a medical container, etc.) that is being secured.

FIG. **2** illustrates a perspective view of the example of the portion of the electronic lock **100** of FIG. **1** in accordance with certain embodiments disclosed herein. In addition to the electronic lock core plug **102**, the electronic lock core **104** may include a spacer **202**. This spacer **202** may provide additional support structure for the electronic lock core **104** that facilitates inserting the electronic lock core **104** into a housing of the electronic lock **100**. Further, the electronic lock core plug **102** may include a cup **206** that is configured to receive a nose of an electronic key and one or more recesses **208** that can receive corresponding extensions included in the electronic key.

As previously described, it is desirable in some cases to be able to replace the electronic lock core **104**. It is also desirable for the electronic lock core **104** to be secured so that it is not removed by malicious users or accidentally removed. The electronic lock core **104** includes a retainment assembly that can secure or retain the electronic lock core **104** at least partially within an electronic lock housing (not shown) of the electronic lock **100**. Further, the retainment assembly may prevent undesirable removal of the electronic lock core **104** and enable ejection of the electronic lock core **104** by an authorized user. The retainment assembly may further prevent or reduce movement of the electronic lock core **104** within the electronic lock **100** or within an electronic lock housing of the electronic lock **100**. In some cases, the retainment assembly may reduce movement of the electronic lock core **104** within the electronic lock **100** to less than a threshold degree of movement. Access to the retainment assembly may be permitted or restricted by a screw guard **204**. As will be described in more detail below, the screw guard **204** permits or prevents access to a screw that is included as part of the retainment assembly. The retainment assembly is described in more detail below.

Example Retainment Assembly Access

FIG. **3**A illustrates a cross section of a perspective view of the example of the electronic lock core **104** of FIG. **1** in accordance with certain embodiments disclosed herein. As stated above, access to a retainment assembly may be permitted or restricted by a screw guard **204**. The screw guard **204** permits or restricts access to a screw **310** that forms a portion of the retainment assembly. The screw **310** may be referred to as a control screw as it may be configured to control a state of the retainment assembly as described in more detail below.

The screw guard **204** may itself be secured by the electronic lock core **104**. More specifically, the electronic lock core **104** may include an electronic lock core plug **102** that may serve as a shell for components of the electronic lock core plug **102**. Further, the electronic lock core plug **102** may include a flange **304** that overlaps with a protrusion **306** of the screw guard **204** preventing removal of the screw guard **204**. As illustrated in FIG. **1**, and described in more detail below, the electronic lock core plug **102** may, in certain circumstances, be rotated such that a notch within the flange **304** aligns with the protrusion **306** of the screw guard **204** enabling removal of the screw guard **204**.

Returning to FIG. **3**A, the electronic lock core plug **102** includes a cam lock **308**. The cam lock **308** prevents the electronic lock core plug **102** from being rotated. The cam lock **308** may be a spring-loaded cam lock or any other type of cam lock that prevents rotation of the electronic lock core plug **102**.

Further, the screw guard **204** may include a magnet **312** that attracts the screw guard **204** to the screw **310**. The attraction of the screw guard **204** to the screw **310** using the magnet **312** helps prevent the screw guard **204** from falling out of a screw access port of the electronic lock core **104** upon unlocking of the electronic lock **100**. It should be understood that illustration of the magnet **312** as a separate element from the screw guard **204** is for illustrative purposes only and that the magnet **312** may be integrally formed with the screw guard **204**. In some cases, the screw guard **204** may be formed from a magnet in its entirety obviating the need for a separate magnet. In cases where the magnet **312** is a separate element, the magnet **312** may be inserted within a shaft, hole, or indent within the screw guard **204** that is configured to receive and house the magnet **312**.

The electronic lock core **104** may further include a pin **314**. This pin **314** may prevent removal of the screw **310** from the electronic lock core **104**. As is described in more detail herein, a user may tighten or loosen the screw **310** to install or remove the electronic lock core **104** from a housing (not shown) of the electronic lock **100**. In some cases, it is desirable to prevent the screw **310** from being removed or from being loosened too much. For example, it may be desirable to prevent removal of the screw **310** to prevent undesired movement of elements of the electronic lock core **104**. As another example, it may be desirable to prevent removal of the screw **310** to prevent the screw **310** from

being lost or to prevent insertion of undesired elements within the electronic lock core **104** or the electronic lock **100**.

The pin **314** may include any type of pin or post that can be used to prevent removal of the screw **310**. For example, the pin **314** may be a dowel pin, a roll pin, a taper pin, or a cotter pin. Further, the screw guard **204** may include a slot or other opening that is configured to accommodate the pin **314**. For example, as can be seen in FIG. **3**A, the screw guard **204** may include a slot that at least partially surrounds the pin **314** enabling the screw guard **204** to be inserted into a screw access port of the electronic lock core **104** without being inhibited by the pin **314**.

FIG. **3**B illustrates an exploded view of the electronic lock core **104**. The electronic lock core **104** may include an electronic lock core shell, an electronic lock core plug **102** with a cam lock **308**, and a retainment assembly for retaining the electronic lock core **104** within an electronic lock housing of an electronic lock.

FIG. **4** illustrates a sectioned perspective view of the example of the electronic lock core **104** of FIG. **1** with the electronic lock core shell **404** and screw **310** sectioned to illustrate a state of a cam lock **308** when an electronic lock core plug **102** of the electronic lock **100** is in a locked state in accordance with certain embodiments disclosed herein. As illustrated, the cam lock **308** prevents the electronic lock core plug **102** from being rotated when the electronic lock **100** is in a locked state and the cam lock **308** protrudes from the electronic lock core plug **102**.

In certain embodiments, to rotate the electronic lock core plug **102**, the cam lock **308** is moved from a first position associated with a lock state, to a second position associated with an unlock state. In the unlock state, the cam lock **308** descends into the electronic lock core plug **102** enabling rotation of the electronic lock core plug **102** and consequently, alignment of the notch of the flange **304** with the protrusion **306** of the screw guard **204**. When the notch of the flange **304** is aligned with the protrusion **306** of the screw guard **204**, the screw guard **204** can be removed.

FIG. **5** illustrates a sectioned perspective view of the example of the electronic lock core **104** of FIG. **1** with the electronic lock core shell **404** and screw **310** sectioned to illustrate the state of the cam lock **308** when the electronic lock core plug **102** of the electronic lock **100** is in an unlocked state in accordance with certain embodiments disclosed herein. As illustrated, the cam lock **308** may retract into a cavity in the electronic lock core plug **102** enabling the electronic lock core plug **102** to be rotated to an unlocked position, and to align the notch **502** in the flange **304** with the protrusion **306** of the screw guard **204**.

FIG. **6** illustrates a cross section of the electronic lock core **104** of FIG. **1** in a locked state with the cam lock **308** protruding from the electronic lock core plug **102** in accordance with certain embodiments disclosed herein. The electronic lock core plug **102** includes a pair of magnets **602** (within the illustrated springs) that are repelled from the center of the electronic lock core plug **102** causing the cam lock **308** to protrude from the electronic lock core plug **102** when the electronic lock **100** is in a locked state. As illustrated with respect to FIG. **4**, the protrusion of the cam lock **308** prevents the electronic lock core plug **102** from being rotated and accordingly, prevents alignment of the notch **502** of the flange **304** with the protrusion **306** of the screw guard **204**. When the screw guard **204** cannot be removed, access to the screw **310** cannot be obtained and this the retainment assembly cannot be accessed to release or eject the electronic lock core **104**. Thus, when the electronic lock **100** is in a locked state, the electronic lock core **104** cannot be removed and security of the electronic lock core **104** is maintained.

FIG. **7** illustrates a cross section of the electronic lock core **104** of FIG. **1** in an unlocked state with the cam lock **308** retracted into the electronic lock core plug **102** in accordance with certain embodiments disclosed herein. When the electronic lock **100** is unlocked, the magnets **602** are attracted to the center of the electronic lock core plug **102**, and the cam lock **308** is retracted within the electronic lock core plug **102**. As illustrated with respect to FIG. **5**, upon the cam lock **308** retracting inside the electronic lock core plug **102**, the electronic lock core plug **102** is capable of being rotated and accordingly, alignment of the notch **502** of the flange **304** with the protrusion **306** of the screw guard **204** can be achieved. Thus, when the electronic lock **100** is in an unlocked state, the screw guard **204** can be removed and access to the screw **310** of the retainment assembly can be achieved enabling removal of the electronic lock core **104** as will be described further herein.

Example Electronic Keys

As has been described herein, the ability to access the retainment assembly that retains the electronic lock core **104** within an electronic lock housing of the electronic lock **100** may depend on the lock state of the electronic lock core **104** and/or the electronic lock **100**. To transition the electronic lock core **104** and/or the electronic lock **100** between a locked state and an unlocked state, an electronic key may be used. FIG. **8** illustrates a pair of example electronic keys (the electronic key **800** and the electronic key **850**) in accordance with certain embodiments. Unlocking the electronic lock core **104** and/or the electronic lock **100** may include accessing data and/or access control information from an electronic key.

In some embodiments, it is desirable for the electronic key to be unremovable from the electronic lock **100** when the electronic lock core **104** and/or the electronic lock **100** is in an unlocked state. For example, to prevent the electronic key from being misplaced, or to reduce the possibility that a location or device that is secured by the electronic lock **100** is left unsecured, it may be desirable that the electronic key is secured to the electronic lock **100** when the electronic lock **100** is in an unlocked state.

The electronic key **800** may include one or more retention tabs **802** that secure the electronic key **800** to the electronic lock **100** when the electronic lock **100** is in an unlocked state. For example, when using the electronic key **800**, a user may insert a nose **804** of the electronic key **800** into a cup of the electronic lock core plug **102** that is configured to receive the nose **804**. To insert the nose **804** into the cup of the electronic lock core plug **102**, extensions **806** of the electronic key **800** are aligned with recesses **208** within the electronic lock core plug **102**. To unlock the electronic lock **100** the electronic key **800** is rotated. And when the electronic key **800** is rotated, the one or more retention tabs **802** may engage with corresponding tabs in the electronic lock core plug **102** preventing the electronic key **800** from being removed from the electronic lock **100** and/or the electronic lock core **104**. In some cases, the electronic key **800** can only be rotated within the electronic lock core plug **102** when it is determined that the electronic key **800** is authorized to unlock the electronic lock **100**. In other cases, the electronic key **800** can be rotated within the electronic lock core plug **102** prior to the electronic lock **100** determining whether the electronic key **800** is authorized to unlock the electronic lock **100**, but the electronic lock **100** will not unlock until it is

determined that the electronic key **800** is authorized to unlock the electronic lock **100**.

Advantageously, in some embodiments, when the electronic key **800** is inserted into the electronic lock core plug **102** and rotated such that the one or more retention tabs **802** are secured, the shoulder **810** of the electronic key **800** may provide an additional barrier to removal of the screw guard **204**. For example, in some cases, the shoulder **810** may be aligned with the screw guard **204** when the electronic key **800** is inserted into the electronic lock core plug **102** and rotated to an unlock position, thereby preventing removal of the screw guard **204**. Accordingly, in some cases, even when the electronic lock **100** is unlocked, the screw guard **204** may still be unremovable as the shoulder **810** of the electronic key **800** may prevent removal of the screw guard **204**, and the one or more retention tabs **802** may prevent removal of the electronic key **800** from the electronic lock core plug **102** while the electronic lock **100** is unlocked. Further, as the one or more retention tabs **802** prevent removal of the electronic key **800** from the electronic lock **100** when the electronic lock **100** is unlocked, in some cases the electronic lock core **104** may be secured within the electronic lock **100** both when the electronic lock **100** is locked and when the electronic lock **100** is unlocked.

In some such embodiments, the electronic lock core **104** may not be removed or ejected while the electronic key is in use. Further, the electronic lock core **104** may not be removed or ejected unless the electronic lock **100** is unlocked. And the electronic key **800** cannot be removed unless the electronic lock **100** is locked. Accordingly, in certain embodiments, a particular electronic key designed for removal of the electronic lock core **104** is used to enable removal or replacement of the electronic lock core **104**. This particular electronic key, of which the electronic key **850** is one non-limiting example, and which may be referred to as a "control key" herein, can be used to facilitate replacement of the electronic lock core **104**.

The electronic key **850** may include some or all of the features described with respect to the electronic key **800** but may exclude the one or more retention tabs **802**. Thus, the electronic key **850** may be removed from the electronic lock **100** when the electronic lock **100** is unlocked enabling removal of the screw guard **204** and access to the screw **310** that may be used to remove the electronic lock core **104** as described further herein.

Both the electronic key **800** and the electronic key **850** may be capable of unlocking the electronic lock **100**. When either electronic key is inserted (e.g., a nose **804** of the electronic key mates with a cup **206** of the electronic lock core plug **102**) into the electronic lock, it may be determined whether the electronic key is authorized to unlock the electronic lock. The determination of whether the electronic key is authorized to unlock the electronic lock may be based at least in part on data transferred between the electronic key and the electronic lock when the electronic key mates with the electronic lock.

In some embodiments, the electronic key **850** may differ in functionality from the electronic key **800**. For example, in some embodiments, the electronic key **850** may be configured to permit replacement of the electronic lock core **104** without unlocking a device or location secured by the electronic lock **100**. In some such embodiments, upon determining that the electronic key **850** is mated with the electronic lock core plug **102** of the electronic lock core **104**, the electronic lock **100** may permit rotation of the electronic lock core plug **102** as part of the electronic lock core replacement process described herein while preventing unlocking of the electronic lock **100**. Rotation of the electronic lock core plug **102** without unlocking of the electronic lock **100** may occur, for example, by retracting a portion of the electronic lock core **104** that interacts with a mechanical locking mechanism of the electronic lock **100**, such as a lock tab, such that the mechanical locking mechanism is not modified by the rotation of the electronic lock core plug **102**. The locking mechanism of the electronic lock **100** may include any type of locking mechanism including, for example, a padlock, a cabinet lock, a deadbolt, a mortise lock, a deadlatch, a latch, a cam lock, a knob lock, or any other type of mechanical mechanism that can secure a device or door.

Example Retainment Assembly

As described above, the retainment assembly of the electronic lock core **104** is secured by a combination of features of the electronic lock core **104** including the screw guard **204**, which is secured by the electronic lock core plug **102** and the electronic key **800**. The retainment assembly may secure or retain the electronic lock core **104** within an electronic lock housing of the electronic lock **100**. Further, as described above, use of a control key, such as the electronic key **850** enables the screw guard **204** to be removed from the electronic lock core **104**. FIG. **9** illustrates removal of a screw guard **204** of the electronic lock core **104** of FIG. **1** in accordance with certain embodiments disclosed herein. FIG. **9** further illustrates the electronic lock core **104** inserted into or in combination with the spacer **202**, which may facilitate attaching the electronic lock core **104** to a housing (e.g., the electronic lock housing) to house the electronic lock core **104** and enable attachment of the electronic lock core **104** to a device (e.g., a safe, a door, a lockbox, a medical cabinet, a shipping container, etc.) to be secured. In some cases, the housing may be integral to the device to be secured. In other cases, the housing, with the electronic lock core **104**, may be affixed or attached to a device to be secured.

As previously described, and as illustrated in FIG. **9**, upon alignment of the notch **502** of the flange **304** of the electronic lock core plug **102** with the protrusion **306** of the screw guard **204**, the screw guard **204** can be removed from the electronic lock core **104**. In some embodiments, the electronic key **850** may include a magnet that can be used to remove the screw guard **204** from the screw access port (e.g., a cup or space of the electronic lock core **104** that houses or holds the screw guard **204**). The magnet of the electronic key **850** can attach to metal of the screw guard **204** enabling a user to pull the screw guard **204** from the electronic lock core **104** (or the electronic lock core shell **404**) of the electronic lock core **104**. Generally, the magnetic strength of the magnet of the electronic key **850** is greater than the magnetic strength of the magnet **312** of the screw guard **204** that keeps the screw guard **204** affixed to the screw **310** enabling a user to overcome the magnetic attraction between the screw guard **204** and the screw **310** when attempting to remove the screw guard **204** from the electronic lock core shell **404** of the electronic lock core **104**. It should be understood that, in some cases, any magnet with a greater magnetic strength than the magnet **312** included in the screw guard **204** can be used to remove the screw guard **204** from the electronic lock core **104** and that, in some such cases, use of the electronic key **850** to remove the screw guard **204** from the electronic lock core **104** may be optional.

In some cases, the magnet of the electronic key **850** may be of opposite polarity than the magnet **312**. In some such cases, attraction between the magnet of the electronic key

850 and the magnet 312 may be used to help remove the screw guard 204 from the electronic lock core 104.

Once the screw guard 204 is removed, access to the screw 310 is obtained. The screw 310 may serve as the interface element of the retainment assembly that enables a user to interact with the retainment assembly. As is described further herein, the retainment assembly may be used to retain the electronic lock core 104 within the electronic lock 100. In some cases, the retainment assembly may be used to retain the electronic lock core plug 102 of the electronic lock core 104 within the electronic lock core 104 or the electronic lock 100. The retainment assembly may also be used to eject the electronic lock core 104 enabling the electronic lock core 104 to be replaced by another electronic lock core. In some cases, the retainment assembly may be used to eject the electronic lock core plug 102 of the electronic lock core 104 from the electronic lock core 104 or the electronic lock 100. In some cases, the screw 310 may be part of the retainment assembly. As can be seen in FIG. 9, the pin 314 may also be visible upon removal of the screw guard 204. As previously described, the pin 314 may prevent the screw 310 from being removed or over loosened. It should also be understood, as can be seen by comparing FIG. 3A and FIG. 9, that the location of the pin 314 is not limited to a particular location within the electronic lock core 104 but may be positioned at any location that can prevent removal of the screw 310 from the electronic lock core 104.

FIG. 10 illustrates a control lug 1000 of a retainment assembly of the electronic lock core 104 of FIG. 1 in accordance with certain embodiments disclosed herein. The control lug 1000 secures the electronic lock core 104 to the electronic lock 100, or to an electronic lock housing (not shown) of the electronic lock 100. More specifically, the control lug 1000 secures the electronic lock core 104 to a housing (not shown) of the electronic lock 100. The control lug 1000 secures the electronic lock core 104 to the housing of the electronic lock 100 when the control lug 1000 engages or is in contact with a portion of the electronic lock core shell 404 that houses the electronic lock core plug 102 and enables removal of the electronic lock core 104 when the control lug 1000 disengages from the portion of the electronic lock core shell 404 that houses the electronic lock core plug 102 or is moved to the top of the electronic lock core shell 404 and away from the electronic lock core plug 102. In some cases, when the control lug 1000 disengages from the portion of the electronic lock core shell 404 that houses the electronic lock core plug 102 or is moved to the top of the electronic lock core shell 404 and away from the electronic lock core plug 102, the electronic lock core plug 102 can be removed from the electronic lock core 104 or the electronic lock 100. In other cases, the electronic lock core plug 102 cannot be separately removed from the electronic lock 100 and is removed in combination with the electronic lock core 104.

A position of the control lug 1000 may be controlled by the screw 310. Tightening (or turning clockwise) the screw 310 may cause the control lug 1000 to engage with a portion of the electronic lock core shell 404 that houses the electronic lock core plug 102 and retain the electronic lock core 104 within a housing (not shown) of the electronic lock 100. The electronic lock core 104 is a Small Format Interchangeable Core (SFIC). As is explained in more detail herein, when the control lug 1000 engages with a portion of the electronic lock core shell 404 that houses the electronic lock core plug 102 (or descends to a bottom of a retainer ramp that moves the control lug 1000), a shape of the electronic lock core 104 no longer conforms to a shape of the SFIC. The control lug 1000 becomes an obstruction that prevents removal of the electronic lock core 104 from an aperture of an electronic lock 100 shaped to house an SFIC. Accordingly, the electronic lock core 104 is secured and cannot be removed when the control lug 1000 descends to a portion of the electronic lock core shell 404 that houses the electronic lock core plug 102. Although primarily described with respect to an SFIC, embodiments disclosed herein can be used with other types of lock cores that can be replaced within a lock.

Loosening (or turning counterclockwise) the screw 310 may disengage the control lug 1000 from a portion of the electronic lock core shell 404 that houses the electronic lock core plug 102 (or ascends to a top of a retainer ramp that moves the control lug 1000) enabling the electronic lock core 104 to be removed or ejected from a housing of the electronic lock 100. When the control lug 1000 is disengaged from the portion of the electronic lock core shell 404 that houses the electronic lock core plug 102 and raised towards the top of the electronic lock core 104, the shape of the electronic lock core 104 once again conforms with the shape of an SFIC and can be removed from a housing of the electronic lock 100. Once the electronic lock core 104 is removed, it may be serviced and/or replaced by another electronic lock core, which may be of the same type or of a different type (e.g., upgraded with different/newer features, or produced by a different manufacturer, etc.). It should be understood that tightening or loosening of the screw 310 is selected by convention. It is possible for the electronic lock core 104 to be configured such that turning the screw 310 clockwise disengages the control lug 1000 and that turning the screw 310 counterclockwise engages the control lug 1000 with the electronic lock core plug 102.

FIG. 11 illustrates use of the screw 310 to lower the control lug 1000 of FIG. 10 in accordance with certain embodiments disclosed herein. As can be seen by comparing FIG. 10 and FIG. 11, as the screw 310 is turned clockwise, or tightened, the control lug 1000 may be lowered towards the portion of the electronic lock core shell 404 that houses the electronic lock core plug 102 enabling the control lug 1000 to modify the shape of the electronic lock core 104 and to retain the electronic lock core 104 within the electronic lock housing of the electronic lock 100. When lowered, the control lug 1000 may descend linearly towards the electronic lock core plug 102 of the electronic lock core 104. In some cases, the control lug 1000 may move in a different manner. For example, in some cases, the control lug 1000 may move linearly or down towards the electronic lock core plug 102 for a portion of its travels and then may move forwards towards a face of the electronic lock core 104 for a portion of its travels. In other words, in some cases, the control lug 1000 may move in an "L" type pattern, first descending towards the electronic lock core plug 102 and then moving forwards towards a face (e.g., towards the cup 206) of the electronic lock core plug 102. Advantageously, the movement in an "L" type pattern enables the control lug 1000 to engage not only a portion of the electronic lock core shell 404 that houses the electronic lock core plug 102, but also to engage with a portion of the electronic lock housing (as described more herein) of a lock configured to accept or house an SFIC (e.g., the electronic lock core 104). Advantageously, in certain embodiments, by engaging the housing of the electronic lock 100, the control lug 1000 is able to reduce or eliminate rattling or movement of the electronic lock core 104 within the housing of the electronic lock 100.

FIG. 12 illustrates the engagement of the control lug 1000 with the portion of the electronic lock core shell 404 that

houses the electronic lock core plug **102**. Once the control lug **1000** has descended towards the portion of the electronic lock core shell **404** that houses the electronic lock core plug **102**, the electronic lock core **104** may no longer satisfy the SFIC form factor and is held within a housing of the electronic lock **100** and is unremovable. Further, the engagement of the control lug **1000** with the electronic lock housing reduces or eliminates movement of the electronic lock core **104** within the electronic lock **100** as may occur due to manufacturing tolerances or wear and tear of materials over time. In some embodiments, the control lug **1000** may prevent or reduce movement of the electronic lock core **104** in one or more of an axial direction, a lateral direction, an angular direction, or a rotational direction. Although the present disclosure describes an electronic lock core **104** that has an SFIC form factor and that may be inserted into a lock configured to support an SFIC form factor, it should be understood that embodiments of the present disclosure may be used with other form factors. For example, the electronic lock core **104** may have any type of form factor and may be inserted into a corresponding lock configured to house the form factor of the electronic lock core **104**. Further, the form factor of the electronic lock core **104** may be modified using, for example, the control lug **1000** such that the electronic lock core **104** is retained within the housing of the lock when the form factor of the electronic lock core **104** is modified.

FIG. **13** illustrates another view of the engagement of the control lug **1000** of FIG. **10** with the portion of the electronic lock core shell **404** that houses the electronic lock core plug **102** and a retainer ramp **1302** in accordance with certain embodiments disclosed herein. The retainer ramp **1302** forms a portion of the retainment assembly. More specifically, the combination of the screw **310**, the control lug **1000** and the retainer ramp **1302** may form the retainment assembly. In some embodiments, one or more of the screw guard **204**, the pin **314**, and/or the magnet **312** may be considered part of the retainment assembly. In other embodiments, the retainment assembly may be separate from the screw guard **204**, the pin **314**, and/or the magnet **312**.

The screw **310** is threaded through the retainer ramp **1302**. Accordingly, the retainer ramp **1302** may guide the control lug **1000** by rotating the screw **310**. When the screw **310** is tightened or turned clockwise, the screw **310** may cause the retainer ramp **1302** to lower the control lug **1000** towards the electronic lock core plug **102**. In some cases, the retainer ramp **1302** may also push the control lug **1000** towards the front of electronic lock core plug **102** (e.g., in the direction of the cup **206**). In contrast, when the screw **310** is loosened or turned counterclockwise, the retainer ramp **1302** may guide the control lug **1000** away from the cup **206** and raise the control lug **1000** above or away the electronic lock core plug **102** and towards a top portion of the electronic lock core shell **404**.

FIG. **14** illustrates the electronic lock core plug **102** and the retainment assembly of the electronic lock core **104** of FIG. **1** in accordance with certain embodiments disclosed herein. As described herein, the screw **310** can be used to move the retainer ramp **1302** axially along the screw **310**. As the retainer ramp **1302** moves away from the head of the screw **310**, the control lug **1000** is moved or raised away from the electronic lock core plug **102** thereby, disengaging from the portion of the electronic lock core shell **404** that houses the electronic lock core plug **102** and restoring a shape of the electronic lock core **104** to that of the SFIC form factor, which thereby enables the electronic lock core **104** to be removed from the electronic lock **100**. Further, when the control lug **1000** is disengaged, an electronic lock core may be inserted into the electronic lock **100** either during manufacture or during an electronic lock core replacement process.

FIG. **14** also illustrates the magnet **312** that may be used to hold the screw guard **204** in place when installed. Additionally, the pin **314** that prevents the screw **310** from being removed from the electronic lock core **104** and from being removed from the retainer ramp **1302** is also illustrated.

FIG. **15** illustrates the electronic lock core plug **102** of the electronic lock core **104** with the retainment assembly in a retainment configuration that retains the electronic lock core **104** within an electronic lock in accordance with certain embodiments disclosed herein. In FIG. **15**, the control lug **1000** is in its lowest point and in some cases, may contact a portion of the electronic lock core shell **404** (not shown) that houses the electronic lock core plug **102**. Further, the control lug **1000** at the illustrated height may make contact with a portion of the electronic lock housing of the electronic lock **100** preventing movement of the electronic lock core **104** within the electronic lock housing of the electronic lock **100**. The control lug **1000** may abut against a protrusion or portion of the housing of the electronic lock **100** preventing movement of the electronic lock core **104** within the electronic lock **100**. Advantageously, in certain embodiments, engagement of the control lug **1000** with the electronic lock housing can prevent loosening of the electronic lock core **104** within the electronic lock **100** due to vibrations that may occur when the electronic lock electronic lock **100** is installed in a mobile device (e.g., a medical cabinet in an emergency vehicle). Further, the engagement of the control lug **1000** with the electronic lock housing can prevent movement due to manufacturing tolerances or wear and tear of the electronic lock **100** due to use or weather conditions at a location where the electronic lock **100** is installed.

FIG. **16** illustrates the electronic lock core plug **102** of the electronic lock core **104** with the retainment assembly with the control lug **1000** partially raised in accordance with certain embodiments disclosed herein. Comparing the position of the screw **310** with respect to the retainer ramp **1302** in FIG. **16** and FIG. **15**, it can be seen that as the screw **310** is rotated counterclockwise, the head of the screw **310** axially moves further from the retainer ramp **1302** (e.g., as if attempting to remove the screw **310** from the retainer ramp **1302**). Consequently, the control lug **1000** is lifted away from the electronic lock core plug **102** disengaging from the electronic lock housing (not shown) of the electronic lock **100**. In contrast, as the screw **310** is rotated clockwise, the head of the screw **310** moves towards the retainer ramp **1302** (e.g., as if attempting to insert or screw the screw **310** into the retainer ramp **1302**) causing the control lug **1000** to move down towards the portion of the electronic lock core shell **404** (not shown) that houses the electronic lock core plug **102** and to eventually engage with the electronic lock housing, thereby holding the electronic lock core **104** in position within the electronic lock **100**. In some implementations, the retainer ramp **1302** may further cause the control lug **1000** to move towards the face (e.g., towards the cup **206**) of the electronic lock core plug **102**. Thus, the control lug **1000** may move diagonally as it descends. Alternatively, the control lug **1000** may first move down (e.g., linearly) towards the central axis of the electronic lock core plug **102** and then forwards (e.g., linearly) towards the face (e.g., towards the cup **206**) of the electronic lock core plug **102**. This movement pattern may be similar to a shape of an "L" or the movement of a knight piece in chess.

FIG. **17** illustrates the electronic lock core plug **102** of the electronic lock core **104** with the control lug **1000** of the

retainment assembly fully raised away from the electronic lock core plug **102** in accordance with certain embodiments disclosed herein. At this point illustrated in FIG. **17**, the control lug **1000** is fully disengaged from the electronic lock housing and the electronic lock core **104** satisfies the SFIC form factor such that the electronic lock core **104** can be removed from the electronic lock **100** enabling replacement of the electronic lock core **104** as desired. The electronic lock core **104** may be removable from the housing of the electronic lock **100** because, for example, the full retraction or disengagement of the control lug **1000** causes the electronic lock core **104** to comply in shape with the SFIC form, thereby matching the aperture of the housing of the electronic lock **100** as is described further herein. As described above, the form factor may be any type of form factor that matches the form factor of the electronic lock **100** and the present disclosure is not limited to SFIC form factors.

As described herein, the electronic lock core plug **102** may be housed within an electronic lock core shell **404**, or a portion of the electronic lock core shell **404**. However, in some embodiments, the electronic lock core plug **102** may not include a separate housing. In such cases, the retainment assembly may cause the control lug **1000** to directly engage the electronic lock core plug **102**.

FIG. **18** depicts a photograph of a prototype of the electronic lock core **104** with the retainment assembly fully disengaged and the control lug **1000** raised away from the electronic lock core plug **102** in accordance with certain embodiments disclosed herein. As can be seen in the photograph, a screwdriver can be used to raise the control lug **1000** away from the electronic lock core plug **102** by turning the screw **310**.

FIG. **19**A depicts a photograph of a prototype of the electronic lock core **104** with the retainment assembly fully disengaged such that the electronic lock core **104** satisfies the SFIC form factor in accordance with certain embodiments disclosed herein. Further, FIG. **19**A depicts an electronic lock housing, or housing **1900**, of an electronic lock **100** that can receive the electronic lock core **104**, which may include the electronic lock core plug **102**. The housing **1900** may be configured to house or otherwise receive the electronic lock core **104** and may be part of an electronic lock **100**. The housing **1900** may include an aperture **1904** that is configured to receive the electronic lock core **104**. When the electronic lock core **104** is inserted into an aperture **1904** of the housing **1900**, the control lug **1000** may be in a raised state (e.g., as illustrated in FIG. **19**A) enabling the electronic lock core **104** to be inserted into and or removed from the housing **1900**. When the control lug **1000** is lowered, the control lug **1000** restricts movement of the electronic lock core **104** because, for example, the control lug **1000** may abut against one or more protrusions **1902** that extend from a side wall of the housing **1900** into the aperture **1904** of the housing **1900** that is configured to receive the electronic lock core **104**. In some cases, the one or more protrusions **1902** may be latches or any other type of obstruction that extends into the aperture **1904** of the housing **1900**. The protrusions **1902** may be part of the shape of the aperture **1904** that gives the housing **1900** the form factor or shape of a housing that supports a SFIC. It should be understood that other form factors for the housing **1900** are possible and that other form factors for the electronic lock core **104** are possible without deviating from embodiments of the present disclosure.

In some embodiments the electronic lock core **104** is a small format interchangeable core (SFIC). Further, the housing **1900** may be any type of housing that supports or is capable of housing a small format interchangeable core. In the illustrated example, the housing **1900** may be part of a mortice lock. In some cases, the movement of the control lug **1000** can change the shape of the SFIC to a non-SFIC shape, which may prevent removal of the SFIC.

FIG. **19**B depicts a photograph of a second example of an electronic lock housing, or housing **1910**, and an electronic lock core **104** in accordance with certain embodiments disclosed herein. The present disclosure is not limited by the type of housing that may be used to house the electronic lock core **104**. In the example of FIG. **19**B, the housing **1910** may be a padlock. However, it is also possible for the housing to be a mortise lock (e.g., the housing **1900**), a cabinet lock, a cam lock, a deadbolt lock, or any other type of lock or housing that can house the electronic lock core **104**. The electronic lock core **104** may be inserted into the housing **1910** and may be secured using one or more of the embodiments disclosed herein.

FIG. **19**C depicts a photograph **1920** of an electronic lock core **104** that has been removed from a mortice lock housing (e.g., the housing **1900**) and is being inserted into a padlock housing (e.g., the housing **1910**). As illustrated in the photograph **1920**, the control lug **1000** is fully raised enabling the removal of the electronic lock core **104** from the housing **1900** and the insertion of the electronic lock core **104** into the housing **1910**. The photograph **1930** depicts the electronic lock core **104** fully inserted into the housing **1910**. Once inserted, the control lug **1000** may be lowered to modify the form factor of the electronic lock core **104** and to engage with a protrusion, latch, or extension within the housing **1910**, which prevents removal of the electronic lock core plug **102** from the housing **1910**. In some implementations, the control lug **1000** prevents removal of the electronic lock core **104** because the control lug **1000** is obstructed by the one or more protrusions **1902** of the aperture **1904**, which may exist within both the housing **1900** as well as the housing **1910**. These one or more protrusions **1902** may prevent the control lug **1000**, and consequently the electronic lock core **104** from being moved or pulled through an aperture (e.g., the aperture **1904**) of a housing configured to support a SFIC.

Example Electronic Lock Core Installation Process

FIG. **20** presents a flowchart of an example electronic lock core installation process **2000** in accordance with certain embodiments disclosed herein. The electronic lock core installation process **2000** can include any process for installing an electronic lock core **104** in an electronic lock **100**, or into a housing (e.g., the housing **1900** or the housing **1910**) of the electronic lock **100**. In some embodiments, the electronic lock core **104** is an SIFC designed to fit into a housing configured to accept an SFIC. In some embodiments, certain operations may be performed in a different order or in parallel. Further, the electronic lock core installation process **2000** may be performed as part of a manufacturing process for an electronic lock **100**, during installation of the electronic lock **100** at a site location or on a device to be secured, as part of an electronic lock core replacement process, or as part of any other process that may involve the installation of an electronic lock core.

The process **2000** begins, for example, at the block **2002** where an electronic lock core **104** is inserted into an aperture of an electronic lock **100**, or an aperture of a housing (e.g., the housing **1900** or the housing **1910**) of the electronic lock **100**. The aperture may include any opening within the electronic lock **100** that is configured to receive the electronic lock core **104**. Further, the electronic lock core **104** is inserted in such a manner that the face of the electronic lock core plug **102** (e.g., a portion with the cup **206**) is exposed

so that an electronic key **800** can mate with the cup **206** of the electronic lock core plug **102**. The aperture of the electronic lock **100** may be shaped or configured to receive an electronic lock core **104** with an SFIC form factor.

At block **2004**, the process **2000** involves rotating a screw **310** that is accessible via a screw access port of the electronic lock core **104**. Rotating the screw may move a retainer ramp **1302** in a direction that causes a control lug **1000** to descend towards the electronic lock core plug **102**. The screw **310** may be rotated clockwise to cause the retainer ramp **1302** to move towards a head (e.g., a portion of the screw configured to receive a screwdriver) of the screw **310** and, in turn, to cause the control lug **1000** to be lowered toward the electronic lock core plug **102**. In some cases, the movement of the retainer ramp **1302** may further cause the control lug **1000** to move towards the face of the electronic lock core plug **102**. The screw **310** may continue to be rotated until the control lug **1000** descends to a point where the control lug **1000** is in contact with a portion of the electronic lock core shell **404** that houses the electronic lock core plug **102** or to a point where the control lug **1000** can no longer descend further due to contact with the electronic lock core plug **102** or contact with a portion of the electronic lock core shell **404** surrounding the electronic lock core plug **102**. In some cases, the screw **310** may continue to be rotated until the control lug **1000** engages with or abuts against one or more protrusions **1902** included in the housing of the electronic lock **100**. Thus, in some cases, the control lug **1000** may be in contact with both the portion of the electronic lock core shell **404** housing the electronic lock core plug **102** (or a housing of the electronic lock core plug **102**) and one or more protrusions **1902** that forms part of the shape of the aperture **1904**. Moving the control lug **1000** may cause the electronic lock core **104** with an SFIC form factor to no longer satisfy the SFIC form factor, thereby preventing removal of the electronic lock core **104** from the housing of the electronic lock **100**.

At block **2006**, the process **2000** involves inserting a screw guard **204** into the screw access port of the electronic lock core **104**. The screw guard **204** may include a magnet **312** that facilitates keeping the screw guard **204** in place. The magnet **312** may removably affix (or non-permanently affix) the screw guard **204** to a head of the screw **310** within the screw access port. Affixing the screw guard **204** to the head of the screw **310** may help maintain a position of the screw guard **204** and prevent the screw guard **204** from falling out or otherwise being removed at an undesired time. The screw guard **204** may be positioned such that a protrusion **306** of the screw guard **204** can be aligned with a flange **304** of the electronic lock core plug **102** to prevent removal of the screw guard **204** until such time that the flange **304** is rotated.

At block **2008**, the process **2000** involves rotating the electronic lock core plug **102** to align a notch **502** within a flange **304** of the electronic lock core plug **102** to prevent removal of the screw guard **204**. Aligning the notch **502** may include positioning the notch **502** such that it does not overlap with the protrusion **306** of the screw guard **204**. In other words, the electronic lock core plug **102** may be rotated such that a portion of the flange **304** that does not include the notch **502** is aligned with the protrusion **306** of the screw guard **204** preventing removal of the screw guard **204** from the electronic lock **100**. Further, the electronic lock core plug **102** may be rotated such that the cam lock **308** can extend out of a trench of the electronic lock core plug **102**. In other words, the electronic lock core plug **102** can be rotated such that the electronic lock core **104** does not prevent the cam lock **308** from being extended beyond an outer circumference of the electronic lock core plug **102**.

Example Electronic Lock Core Replacement Process

FIG. **21** presents a flowchart of an example electronic lock core replacement process **2100** in accordance with certain embodiments disclosed herein. The electronic lock core replacement process **2100** can include any process for replacing an electronic lock core **104** in an electronic lock **100** with another electronic lock core. The replacement electronic lock core may be of the same type as the electronic lock core **104**, or may be an improved or different version of the electronic lock core **104** that is designed to fit within the same size space or housing as the electronic lock core **104**. In some embodiments, the electronic lock core **104** is an SIFC designed to fit into a housing configured to accept an SFIC. In some embodiments, certain operations may be performed in a different order or in parallel. Further, the electronic lock core replacement process **2100** may be performed as part of a manufacturing process for an electronic lock **100**, as part of a testing process, during installation of the electronic lock **100** at a site location or on a device to be secured, or as part of any other process that may involve the replacement of an electronic lock core in an electronic lock.

The process **2100** begins, for example, at the block **2102** where a control key (e.g., the electronic key **850**) is coupled with the electronic lock core **104**, or an electronic lock core plug **102**, of the electronic lock **100**. As described herein, using a standard electronic key or an electronic key that is not configured as a control key (e.g., an electronic key **800**) may, in some cases, not be compatible with performing the process **2100** because, for example, the non-control key may include one or more retention tabs **802** that prevent removal of the non-control key when the electronic lock **100** is unlocked and therefore, the use of the non-control key may prevent removal of the electronic lock core **104**. In contrast, the control key may omit the one or more retention tabs **802** enabling removal of the control key from the electronic lock core plug **102** even when the electronic lock **100** is in an unlocked state.

Coupling the electronic key **850** with the electronic lock core **104** may include inserting a nose **804** of the electronic key **850** into a cup **206** of the electronic lock core plug **102**. Further, coupling the electronic key **850** with the electronic lock core **104** may include aligning one or more extensions **806** with one or more corresponding recesses **208** of the electronic lock core plug **102**. The extensions **806** and corresponding recesses **208** may help align the electronic key **850** with the electronic lock core plug **102** even when the one or more retention tabs **802** are omitted.

In some embodiments, the block **2102** may include performing an unlocking process to unlock the electronic lock **100**. The electronic lock **100** may determine whether the electronic key **850** is authorized to unlock the electronic lock **100** by, for example, authenticating the electronic key **850** and/or a user using the electronic key **850**. If it is determined that the electronic key **850** or the user is authorized to unlock the electronic lock **100**, the electronic lock **100** may be unlocked. Unlocking the electronic lock **100** may include, among other operations, retracting the cam lock **308** enabling rotation of the electronic lock core plug **102** as part of the block **2104**.

At block **2104**, the process **2100** includes rotating the electronic lock core plug **102** to align a notch **502** of a flange **304** of the electronic lock core plug **102** with a screw guard **204**. Aligning the notch **502** with the screw guard **204** may include aligning the notch **502** with a protrusion **306** of the

screw guard **204**. By aligning the notch **502** with the protrusion **306**, the screw guard **204** is no longer held in place by the flange **304** of the electronic lock core plug **102** and it is possible to remove the screw guard **204** from the screw access port of the electronic lock core **104**. The screw access port may be a separate access port or aperture that includes a shaft or space for inserting the screw guard **204** and that is separate from an aperture that is configured to receive an electronic lock core. Alternatively, the screw access port may be a portion of a single aperture that includes multiple portions with one portion being configured to receive the screw guard **204** and one portion being configured to receive the electronic lock core plug **102** within an electronic lock core shell **404** of the electronic lock core **104**.

At block **2106**, the process **2100** includes removing the screw guard **204** from a screw access port of the electronic lock core **104** to provide access to a screw **310**. The screw **310** may be part of a retainment assembly that retains or ejects the electronic lock core **104** from the electronic lock **100**. The screw guard **204** may be removed by using a magnetic force from a magnet to pull the screw guard **204** from the screw access port. The magnet may be a magnet that is included in the electronic key **850** or may be any other magnet with a greater magnetic strength than the magnet **312** of the screw guard **204**. The magnet **312** may be selected to have a lower magnetic strength than a magnet of the electronic key **850** to enable the electronic key **850** to be used to help remove the screw guard **204** and obtain access to the screw **310**.

In some embodiments, removing the screw guard **204** may include removing or decoupling the electronic key **850** from the electronic lock core plug **102** after the notch **502** of the electronic lock core plug **102** is aligned with the screw guard **204**. Removing the electronic key **850** is possible because the electronic key **850** omits the one or more retention tabs **802** of the electronic key **800**. Further, removing the electronic key **850** may, in some cases, stop the shoulder **810** of the electronic key **850** from inhibiting removal of the screw guard **204**. In some cases, the electronic key **850** may be shaped differently such that removal of the screw guard **204** is not inhibited when the electronic key **850** is coupled to the electronic lock core plug **102**. In some such cases where the key is shaped differently (e.g., differently than illustrated in FIG. **8**), either the electronic key **800** or the electronic key **850** may be used to replace the electronic lock core **104**.

At block **2108**, the process **2100** includes rotating the screw **310** to move a retainer ramp **1302** that causes a control lug **1000** to be raised away from the electronic lock core plug **102**. Further, moving the retainer ramp **1302** may cause the control lug **1000** to disengage from one or more protrusions **1902** of an electronic lock housing (e.g., the housing **1900** or the housing **1910**). Typically, although not necessarily, the screw **310** is rotated in a counterclockwise direction to cause the screw **310** to move the head of the screw **310** away from the retainer ramp **1302**, which in turn may cause the control lug **1000** to be raised or disengaged from a portion of the electronic lock core shell **404** that houses the electronic lock core plug **102**. In some cases, rotating the screw **310** may also cause the control lug **1000** to be moved away from the front of the electronic lock core plug **102** (e.g., away from the cup **206**). Moving the control lug **1000** away from the front of the electronic lock core plug **102** may cause the control lug **1000** to disengage from one or more protrusions **1902** of the housing of the electronic lock **100**. In some embodiments, the electronic lock core **104** does not satisfy the SFIC form factor prior to performing operations associated with the block **2108**. Upon performing the operations associated with the block **2108** (e.g., adjusting the position of the control lug **1000**), the electronic lock core **104** may be modified to confirm with the SFIC form factor, which enables removal of the electronic lock core **104** from the electronic lock **100** as described herein.

Rotating the screw **310** may be achieved by using a screwdriver, a star key, a hex key (sometimes referred to as an Allen wrench/key), or any other device that may be used to rotate a screw, which may include a standard head, or a specialized head. In some cases, the screwdriver may be included as part of the electronic key **850**. For example, the electronic key **850** may include a screwdriver that is folded into or inserted into the electronic key **850**. The screwdriver can be accessed or used upon removal of the screw guard **204** to rotate or adjust the screw **310**.

At block **2110**, the process **2100** includes removing the electronic lock core **104** from an aperture of a housing (e.g., the housing **1900** or the housing **1910**) of the electronic lock **100**. The aperture may include any space within the electronic lock **100** configured to hold or house the electronic lock core **104**. In some embodiments, the aperture may be configured to receive or house an SFIC. In such cases, the electronic lock core **104** may have the form factor of an SFIC. In some embodiments, the form factor of the electronic lock core **104** may differ from an SFIC. In such cases, the form factor of the aperture of the electronic lock **100** may also differ from that of an SFIC and may be configured to accept the form factor of the electronic lock core **104**. The electronic lock core **104**, similar to the screw guard **204**, may be removed using a magnet of the electronic key **850**. Alternatively, or in addition, the electronic lock core **104** may be pulled out by hand, using a flat edge (e.g., screwdriver) that can be wedged behind a portion of the electronic lock core **104** (e.g., behind the flange **304**), or using any other type of tool that can be used to remove the electronic lock core **104** from the electronic lock **100** upon disengagement of the control lug **1000**. In some cases, the electronic lock core **104** may be pulled out by hand, or by positioning the electronic lock **100** such that gravity removes or helps to remove the electronic lock core **104**.

At block **2112**, the process **2100** includes installing a replacement electronic lock core in place of the removed electronic lock core **104**. The operations associated with the block **2112** may include performing the process **2000** or one or more operations associated with the process **2000**.

Terminology

Conditional language used herein, such as, among others, "can," "could," "might," "may," "e.g.," and the like, unless specifically stated otherwise, or otherwise understood within the context as used, may be generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or states. Thus, such conditional language may be not generally intended to imply that features, elements and/or states may be in any way required for one or more embodiments or that one or more embodiments necessarily include these features, elements and/or states.

Conjunctive language such as the phrase "at least one of X, Y, and Z," unless specifically stated otherwise, may be otherwise understood with the context as used in general to convey that an item, term, etc. may be either X, Y, or Z. Thus, such conjunctive language may be not generally intended to imply that certain embodiments require the presence of at least one of X, at least one of Y, and at least one of Z.

While the above detailed description may have shown, described, and pointed out novel features as applied to various embodiments, it may be understood that various omissions, substitutions, and/or changes in the form and details of any particular embodiment may be made without departing from the spirit of the disclosure. As may be recognized, certain embodiments may be embodied within a form that does not provide all of the features and benefits set forth herein, as some features may be used or practiced separately from others.

Additionally, features described in connection with one embodiment can be incorporated into another of the disclosed embodiments, even if not expressly discussed herein, and embodiments may have the combination of features still fall within the scope of the disclosure. For example, features described above in connection with one embodiment can be used with a different embodiment described herein and the combination still fall within the scope of the disclosure.

It should be understood that various features and aspects of the disclosed embodiments can be combined with, or substituted for, one another in order to form varying modes of the embodiments of the disclosure. Thus, it may be intended that the scope of the disclosure herein should not be limited by the particular embodiments described above. Accordingly, unless otherwise stated, or unless clearly incompatible, each embodiment of this disclosure may comprise, additional to its essential features described herein, one or more features as described herein from each other embodiment disclosed herein.

Features, materials, characteristics, or groups described in conjunction with a particular aspect, embodiment, or example may be to be understood to be applicable to any other aspect, embodiment or example described in this section or elsewhere in this specification unless incompatible therewith. All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps may be mutually exclusive. The protection may be not restricted to the details of any foregoing embodiments. The protection extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Furthermore, the features and attributes of the specific embodiments disclosed above may be combined in different ways to form additional embodiments, all of which fall within the scope of the present disclosure. Also, the separation of various system components in the implementations described above should not be understood as requiring such separation in all implementations, and it should be understood that the described components and systems can generally be integrated together in a single product or packaged into multiple products.

Moreover, while operations may be depicted in the drawings or described in the specification in a particular order, such operations need not be performed in the particular order shown or in sequential order, or that all operations be performed, to achieve desirable results. Other operations that may be not depicted or described can be incorporated in the example methods and processes. For example, one or more additional operations can be performed before, after, simultaneously, or between any of the described operations. Further, the operations may be rearranged or reordered in other implementations. Those skilled in the art will appreciate that in some embodiments, the actual steps taken in the processes illustrated and/or disclosed may differ from those shown in the figures. Depending on the embodiment, certain of the steps described above may be removed, others may be added.

For purposes of this disclosure, certain aspects, advantages, and novel features may be described herein. Not necessarily all such advantages may be achieved in accordance with any particular embodiment. Thus, for example, those skilled in the art will recognize that the disclosure may be embodied or carried out in a manner that achieves one advantage or a group of advantages as taught herein without necessarily achieving other advantages as may be taught or suggested herein.

Language of degree used herein, such as the terms "approximately," "about," "generally," and "substantially" as used herein represent a value, amount, or characteristic close to the stated value, amount, or characteristic that still performs a desired function or achieves a desired result. For example, the terms "approximately", "about", "generally," and "substantially" may refer to an amount that may be within less than 10% of, within less than 5% of, within less than 1% of, within less than 0.1% of, and within less than 0.01% of the stated amount. As another example, in certain embodiments, the terms "generally parallel" and "substantially parallel" refer to a value, amount, or characteristic that departs from exactly parallel by less than or equal to 15 degrees, 10 degrees, 5 degrees, 3 degrees, 1 degree, 0.1 degree, or otherwise.

The scope of the present disclosure may be not intended to be limited by the specific disclosures of preferred embodiments in this section or elsewhere in this specification and may be defined by claims as presented in this section or elsewhere in this specification or as presented in the future. The language of the claims may be to be interpreted broadly based on the language employed in the claims and not limited to the examples described in the present specification or during the prosecution of the application, which examples may be to be construed as non-exclusive.

Unless the context clearly may require otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, may be to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense, that may be to say, in the sense of "including, but not limited to".

It should be noted that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications may be made without departing from the spirit and scope of the invention and without diminishing its attendant advantages. For instance, various components may be repositioned as desired. It may be therefore intended that such changes and modifications be included within the scope of the invention. Moreover, not all of the features, aspects and advantages may be necessarily required to practice the present invention. Accordingly, the scope of the present invention may be intended to be defined only by the claims.

What is claimed is:

1. An electronic lock core configured to permit replacement of the electronic lock core within an electronic lock, the electronic lock core comprising:

an electronic lock core plug;

an electronic lock core shell configured to house at least the electronic lock core plug and a retainment assembly; and

the retainment assembly configured to retain the electronic lock core at least partially within an electronic lock housing of the electronic lock, wherein the retainment assembly comprises:

a screw;

a retainer ramp configured to move axially along the screw from a first position to a second position when the screw is rotated; and

a control lug configured to engage with the electronic lock housing when the retainer ramp is in the first position and to disengage from the electronic lock housing when the retainer ramp is in the second position, wherein the retainment assembly retains the electronic lock core within the electronic lock housing when the control lug engages the electronic lock housing.

2. The electronic lock core of claim **1**, wherein the retainment assembly is further configured to enable the electronic lock core to be removed from the electronic lock when the control lug disengages from the electronic lock housing.

3. The electronic lock core of claim **1**, further comprising a screw guard configured to prevent access to the screw.

4. The electronic lock core of claim **3**, wherein the screw guard comprises a magnet that magnetically engages with the screw to hold the screw guard in place.

5. The electronic lock core of claim **4**, wherein a magnetic strength of the screw guard is less than a magnetic strength of an electronic key configured to engage with the electronic lock core plug enabling removal of the screw guard using the electronic key.

6. The electronic lock core of claim **3**, wherein the electronic lock core plug is rotatable between a first position and a second position, and wherein the electronic lock core plug prevents removal of the screw guard when the electronic lock core plug is in the first position.

7. The electronic lock core of claim **6**, wherein the electronic lock core plug permits removal of the screw guard when the electronic lock core plug is in the second position.

8. The electronic lock core of claim **6**, wherein the electronic lock core plug permits removal of the screw guard when the electronic lock core plug is in the second position and an electronic key is not engaged with the electronic lock core plug.

9. The electronic lock core of claim **8**, wherein the electronic lock core permits disengagement of the electronic key when the electronic lock core plug is in the second position and the electronic key comprises a control key, and wherein the electronic lock core prevents disengagement of the electronic key when the electronic lock core plug is in the second position and the electronic key does not comprise the control key.

10. The electronic lock core of claim **9**, wherein the control key omits a retention tab that is included in a non-control key, and wherein the retention tab prevents removal of the non-control key when the electronic lock core is in an unlocked state.

11. The electronic lock core of claim **6**, wherein the electronic lock core plug comprises a flange with a notch, wherein the notch aligns with the screw guard when the electronic lock core plug is in the second position, and wherein the notch is not aligned with the screw guard when the electronic lock core plug is in the first position.

12. The electronic lock core of claim **1**, further comprising a pin configured to prevent the screw from being removed from the retainer ramp.

13. The electronic lock core of claim **12**, further comprising a screw guard configured to prevent access to the screw, wherein the screw guard includes a slot configured to at least partially surround the pin when the screw guard magnetically engages with the screw.

14. The electronic lock core of claim **1**, wherein the control lug is further configured to prevent movement of the electronic lock core within the electronic lock housing when the retainer ramp is in the first position.

15. The electronic lock of claim **14**, wherein the control lug is further configured to prevent the movement of the electronic lock core within the electronic lock housing in one or more of an axial direction, a lateral direction, an angular direction, or a rotational direction.

16. The electronic lock core of claim **1**, wherein the control lug is further configured to prevent movement of the electronic lock core within the electronic lock housing by more than a threshold degree when the retainer ramp is in the first position.

17. The electronic lock core of claim **1**, further comprising a cam lock that protrudes from the electronic lock core plug when the electronic lock core is in a locked state and that retracts into a cavity of the electronic lock core plug when the electronic lock core is in an unlocked state.

18. The electronic lock core of claim **17**, wherein the cam lock prevents rotation of the electronic lock core plug within the electronic lock core when the electronic lock core is in the locked state.

19. The electronic lock core of claim **1**, wherein the electronic lock core is a small format interchangeable core, and wherein an aperture of the electronic lock housing is configured to receive the small format interchangeable core.

20. The electronic lock core of claim **1**, wherein the control lug is further configured to engage with a protrusion of an aperture of the electronic lock housing when the retainer ramp is in the first position preventing removal of the electronic lock core from the electronic lock.

21. The electronic lock core of claim **1**, wherein the control lug is further configured to disengage from a protrusion of an aperture of the electronic lock housing when the retainer ramp is in the second position enabling removal of the electronic lock core from the electronic lock.

22. An electronic lock comprising:

an electronic lock housing; and

an electronic lock core configured to permit replacement of the electronic lock core within the electronic lock housing, the electronic lock core comprising:

an electronic lock core plug;

an electronic lock core shell configured to house at least the electronic lock core plug and a retainment assembly; and

the retainment assembly configured to retain the electronic lock core at least partially within the electronic lock housing of the electronic lock, wherein the retainment assembly comprises:

a screw;

a retainer ramp configured to move axially along the screw from a first position to a second position when the screw is rotated; and

a control lug configured to engage with the electronic lock housing when the retainer ramp is in the first position and to disengage from the electronic lock housing when the retainer ramp is in the second position, wherein the retainment assembly retains the electronic lock core within the electronic lock housing when the control lug engages the electronic lock housing.

23. The electronic lock of claim 22, further comprising a locking mechanism, wherein a state of the locking mechanism is controllable, at least in part, by the electronic lock core.

24. The electronic lock of claim 23, wherein the locking mechanism comprises at least one of: a padlock, a cabinet lock, a deadbolt, a mortise lock, a deadlatch, a latch, a cam lock, or a knob lock.

25. The electronic lock of claim 22, wherein the electronic lock comprises a small format interchangeable core form factor configured to receive a small format interchangeable lock core.

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