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(12) **United States Patent**
Sullivan

(10) **Patent No.: US 12,392,167 B2**
(45) **Date of Patent: *Aug. 19, 2025**

(54) **OVERHEAD LOCKING DEVICE**

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(73) Assignee: **Hanchett Entry Systems, Inc.**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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(22) Filed: **Jun. 18, 2024**

(65) **Prior Publication Data**

US 2024/0344362 A1 Oct. 17, 2024

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(63) Continuation of application No. 17/878,298, filed on Aug. 1, 2022, now Pat. No. 12,012,778, which is a (Continued)

(51) **Int. Cl.**
E05B 47/02 (2006.01)
E05B 9/02 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***E05B 47/023*** (2013.01); ***E05B 9/02*** (2013.01); ***E05B 9/08*** (2013.01); ***E05B 47/0047*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC E05B 47/0001; E05B 47/0002; E05B 47/0005; E05B 47/0046; E05B 47/0047;
(Continued)

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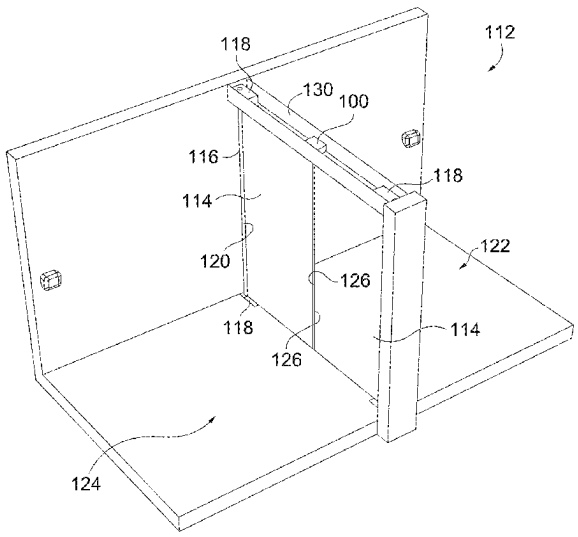
(57) **ABSTRACT**

A lock unit of an electric locking device comprises a lock housing, a keeper, an inhibitor and a latch bolt. A second end of the latch bolt is positioned outwardly and cooperates with the inhibitor when in a locked orientation. The keeper includes a keeper shaft having a shaft axis of rotation, wherein said keeper is rotatable about said keeper shaft between first and second rotational positions, wherein the keeper is movable between first and second directional positions relative to the lock housing, wherein the movement between the first and second directional positions is generally linear, wherein when the keeper is held in the first rotational position and the first directional position by the inhibitor, the door is secured to the door frame, and wherein when the keeper is in the second rotational position and the second directional position, the door is allowed to move away from said door frame.

18 Claims, 14 Drawing Sheets



Related U.S. Application Data

continuation of application No. 16/253,888, filed on Jan. 22, 2019, now Pat. No. 11,549,283.

(60) Provisional application No. 62/620,539, filed on Jan. 23, 2018.

(51) **Int. Cl.**

E05B 9/08	(2006.01)
E05B 47/00	(2006.01)
E05B 47/06	(2006.01)
E05B 63/00	(2006.01)
E05B 65/00	(2006.01)
E05B 65/06	(2006.01)
E05B 65/08	(2006.01)

(52) **U.S. Cl.**

CPC ***E05B 47/0603*** (2013.01); ***E05B 65/0025*** (2013.01); ***E05B 65/06*** (2013.01); ***E05B 65/0829*** (2013.01); *E05B 47/0012* (2013.01); *E05B 63/0052* (2013.01)

(58) **Field of Classification Search**

CPC E05B 47/0012; E05B 47/02; E05B 47/023; E05B 47/026; E05B 47/06; E05B 47/0603; E05B 2047/0017; E05B 2047/0023; E05B 2047/0036; E05B 63/0052; E05B 65/0025; E05B 65/06; E05B 65/0835; E05B 65/0811; E05B 65/0829; E05B 65/0847; E05B 65/0858; E05B 65/108; E05B 9/02; E05B 9/08; Y10T 292/081; Y10T 292/0818; Y10T 292/0829; Y10T 292/0854; Y10T 292/0883; Y10T 292/956; Y10T 292/225; Y10T 292/696; Y10T 292/699; Y10T 292/702; Y10S 292/29

See application file for complete search history.

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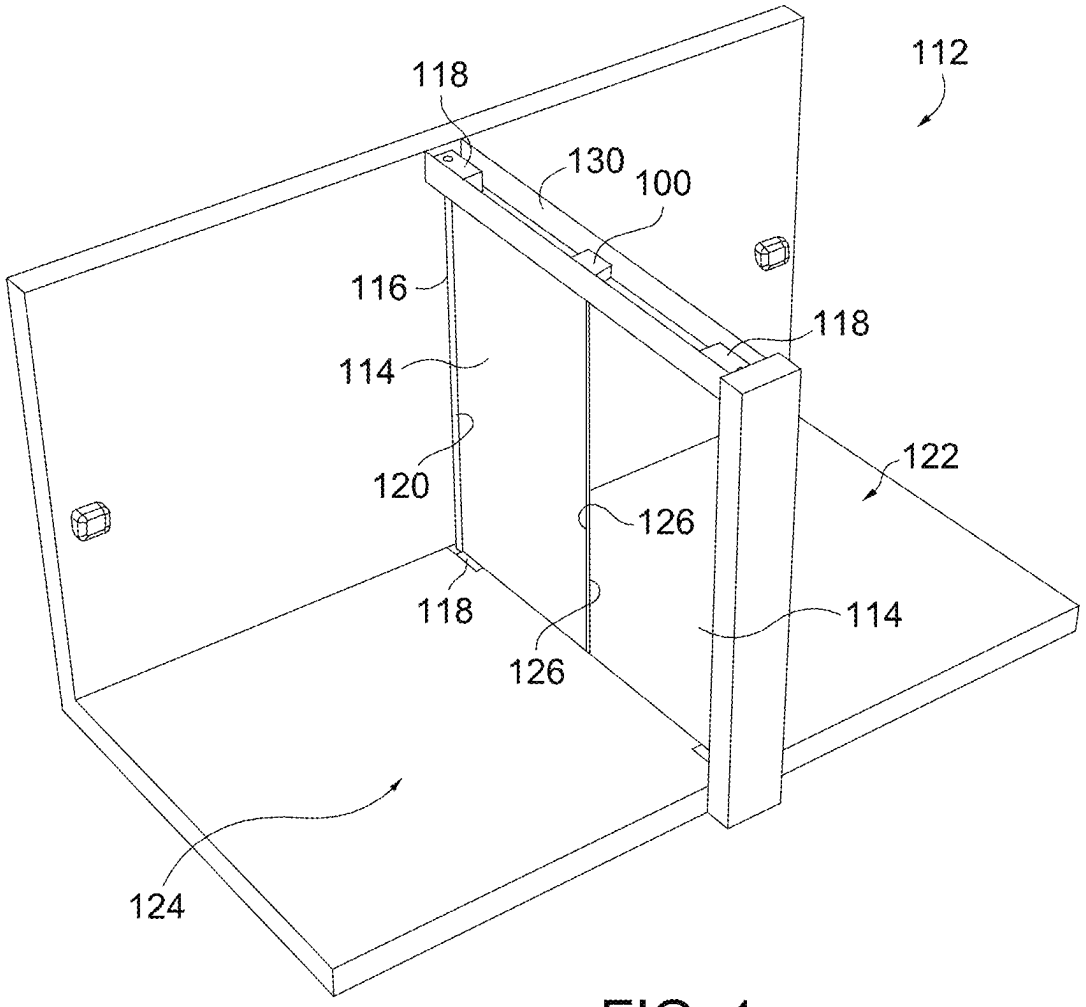

FIG. 1

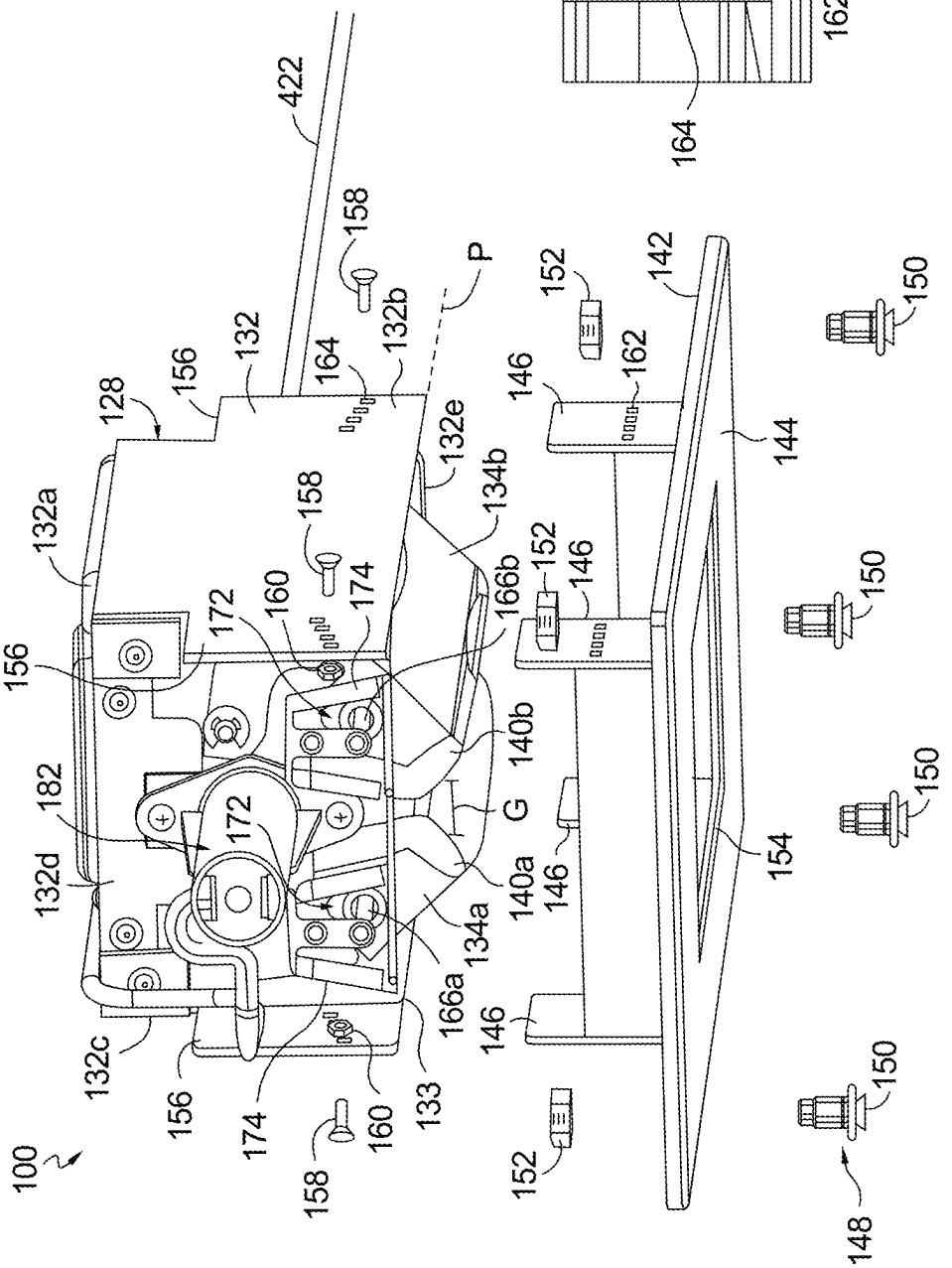
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FIG. 2

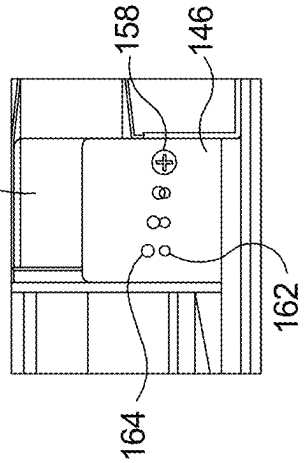
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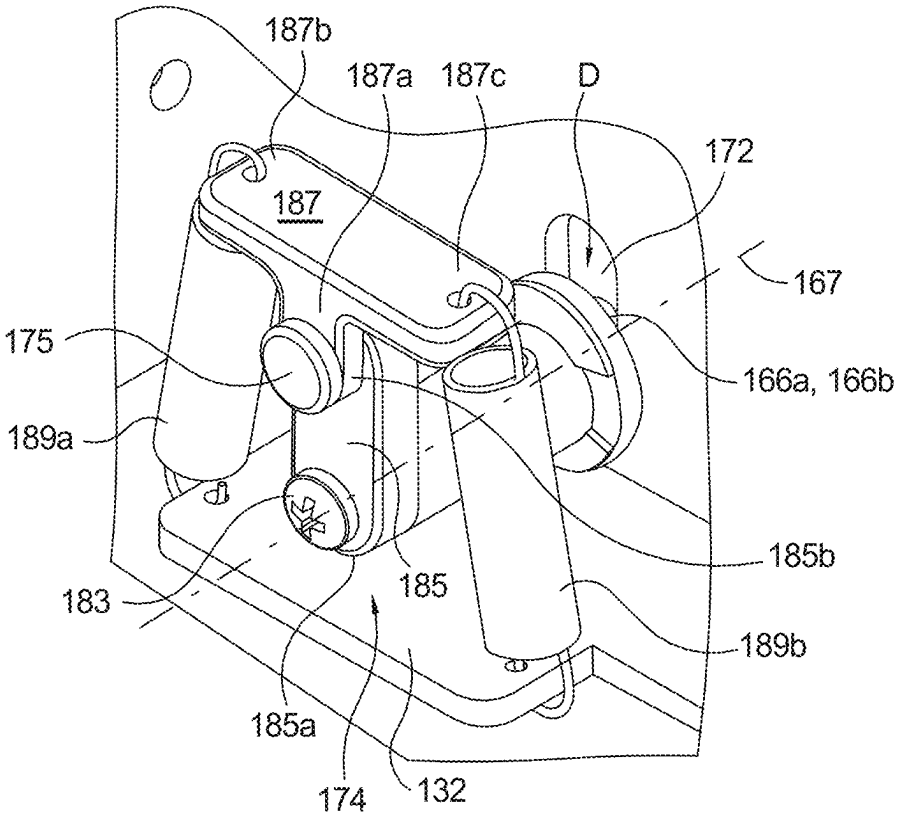
FIG. 3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189a
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185a
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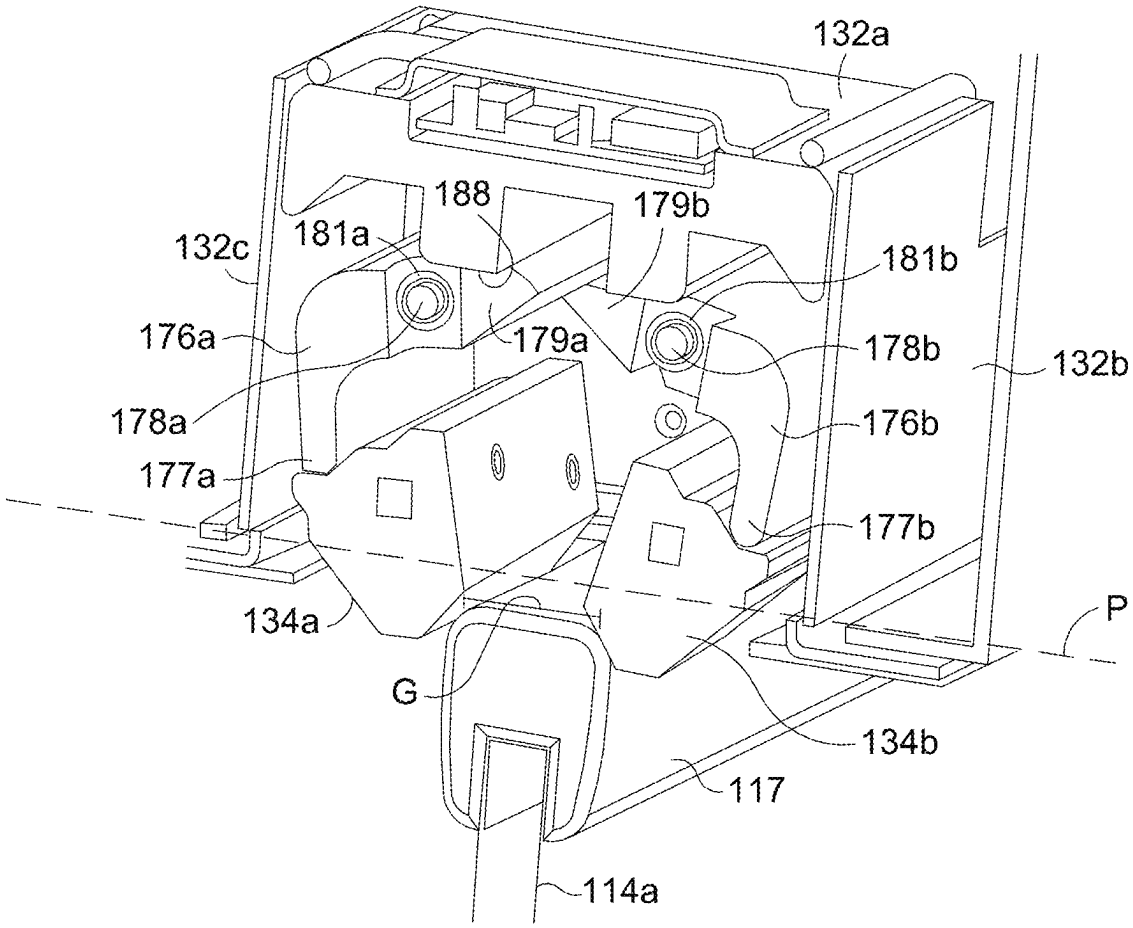
FIG. 2A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G
134b
117
114a

FIG. 4

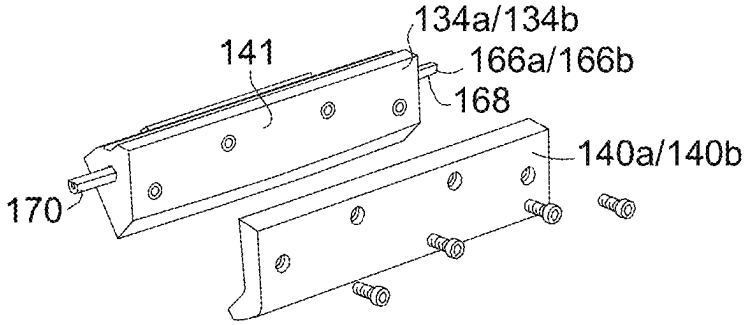
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FIG. 5

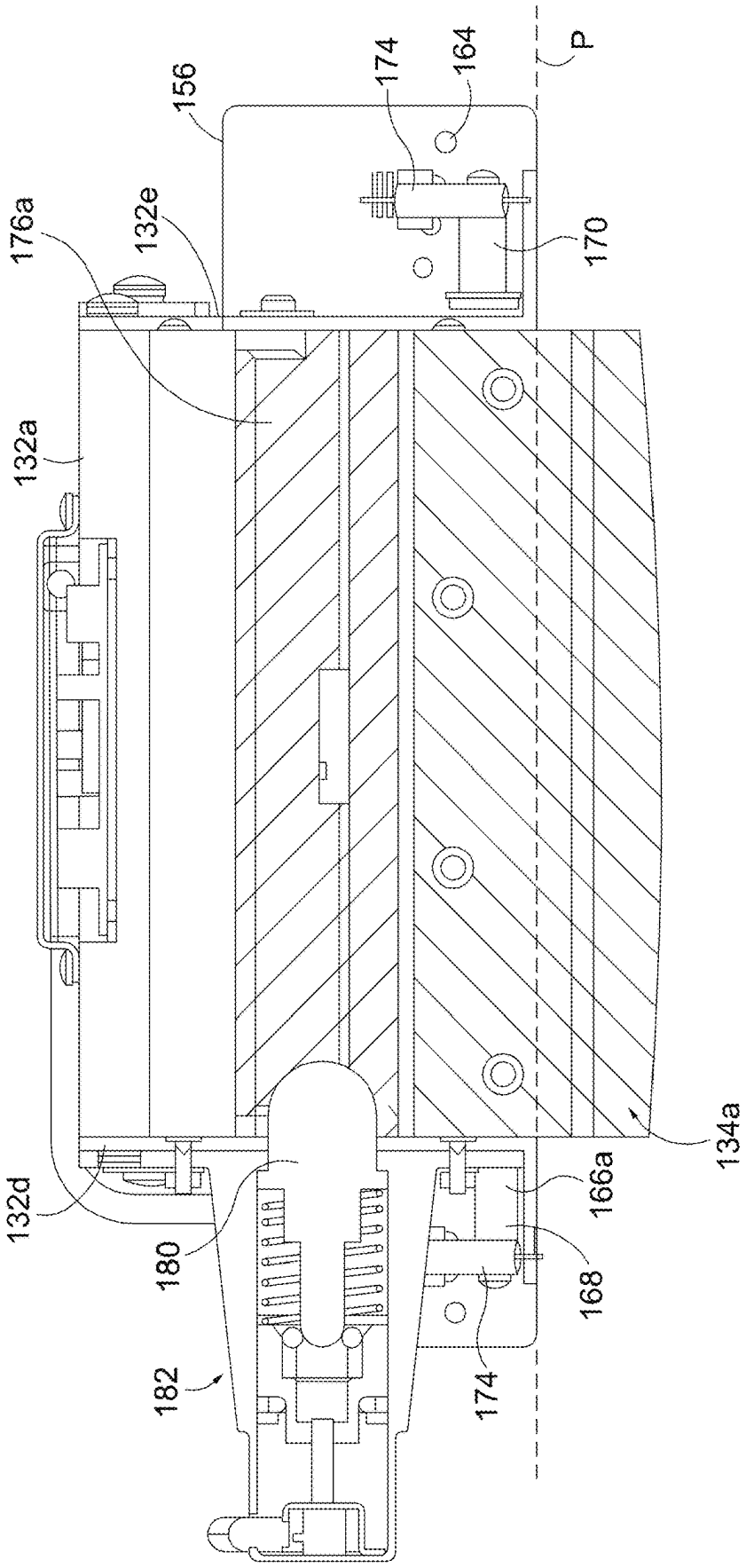


FIG. 6

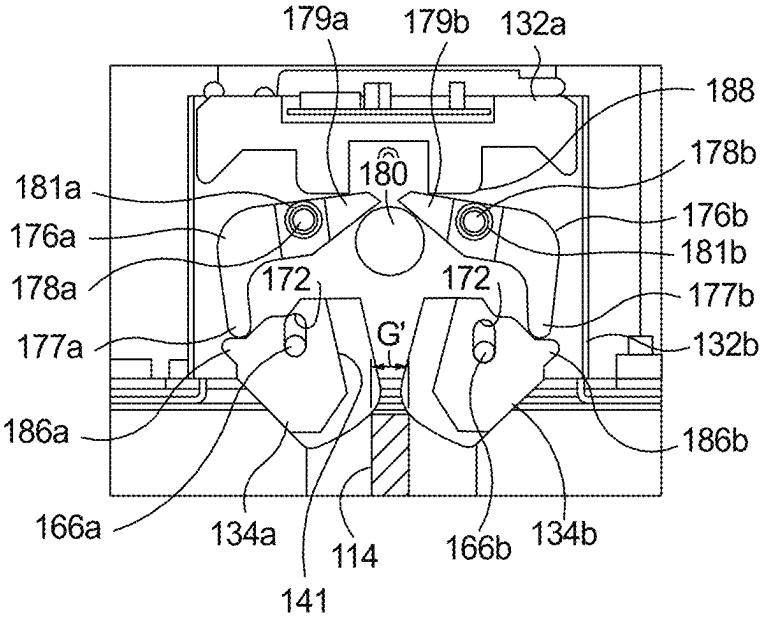


FIG. 7A

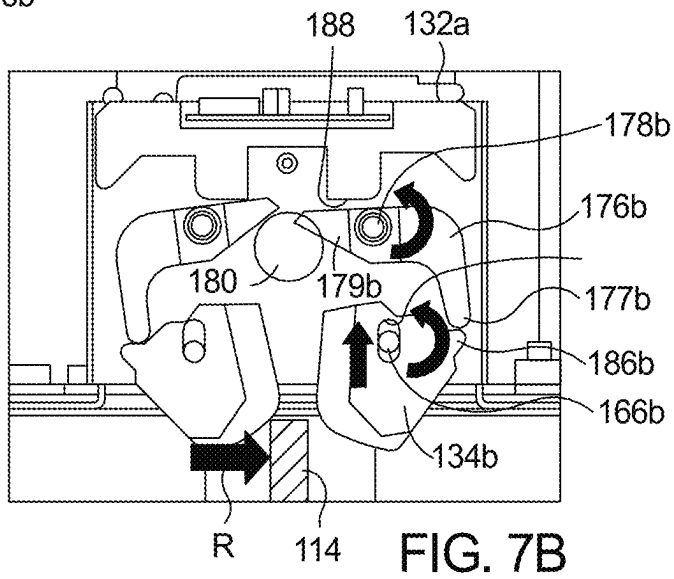


FIG. 7B

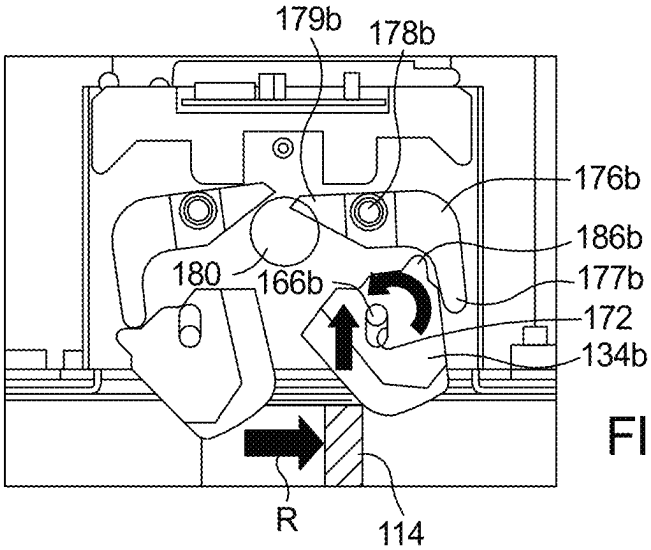


FIG. 7C

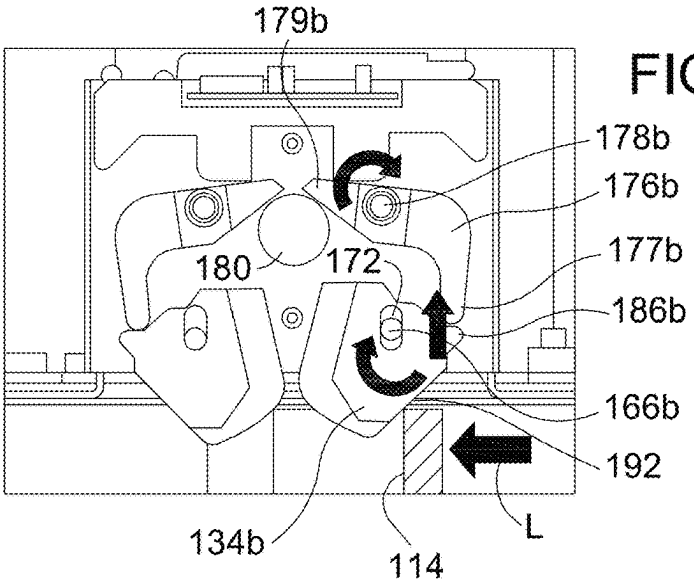
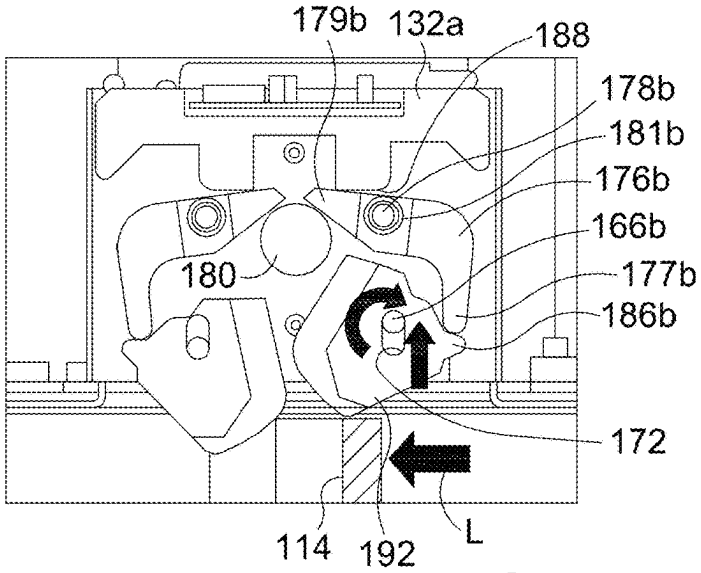


FIG. 8A



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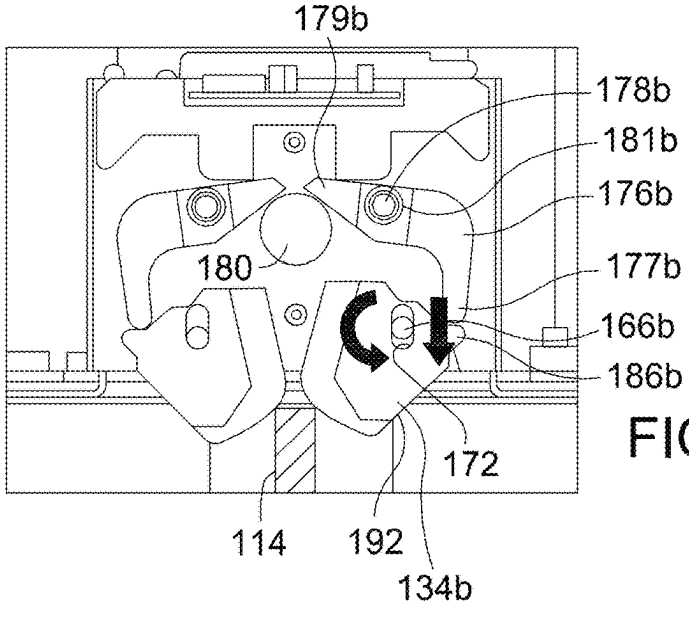

FIG. 8C

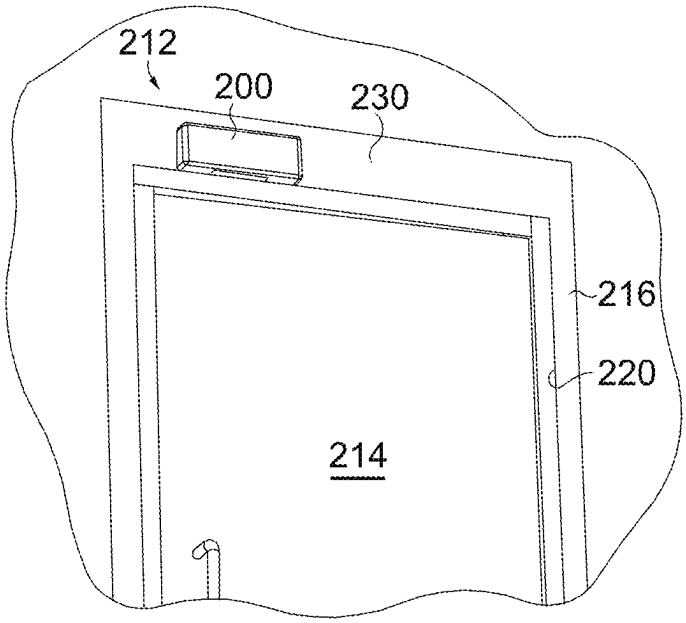

FIG. 9

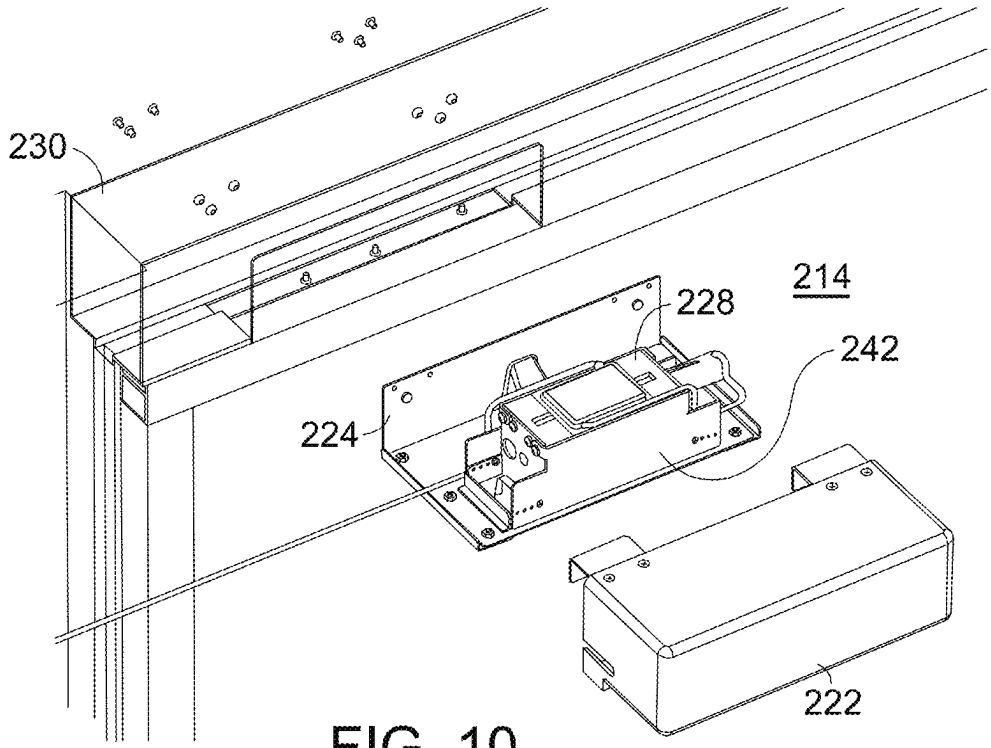
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FIG. 10

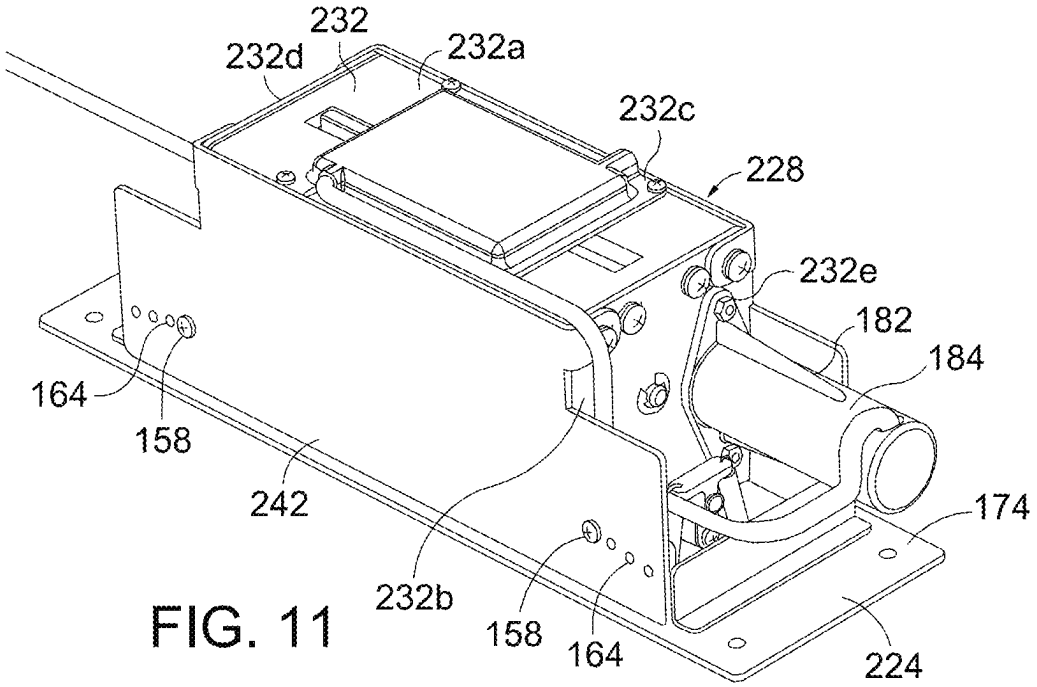
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FIG. 11

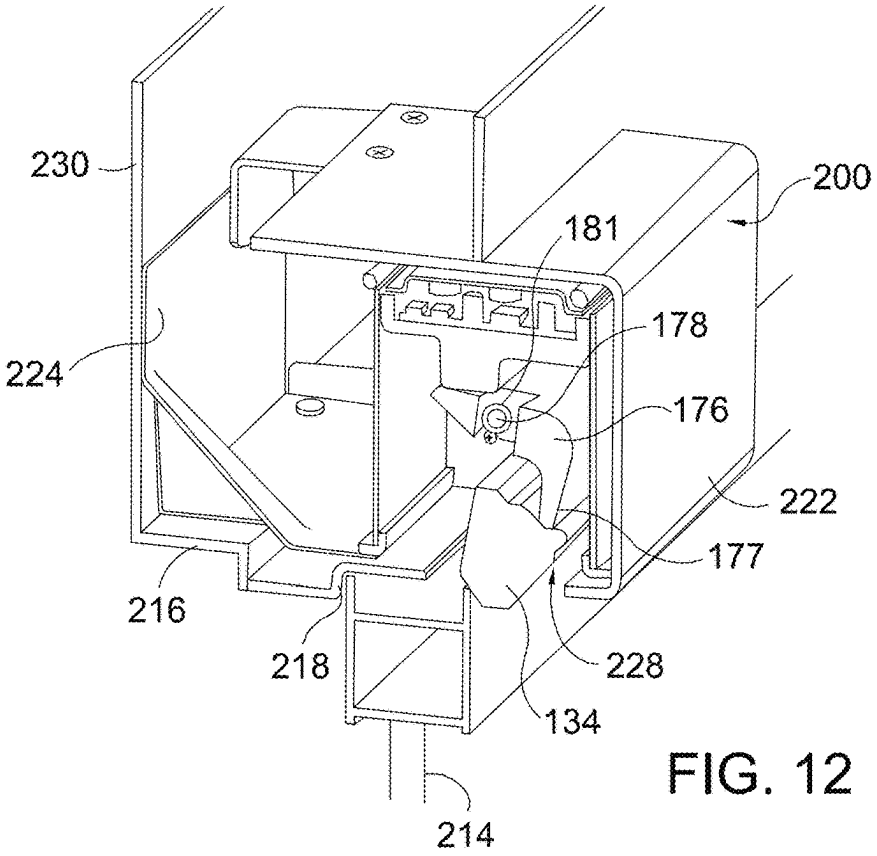
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FIG. 12

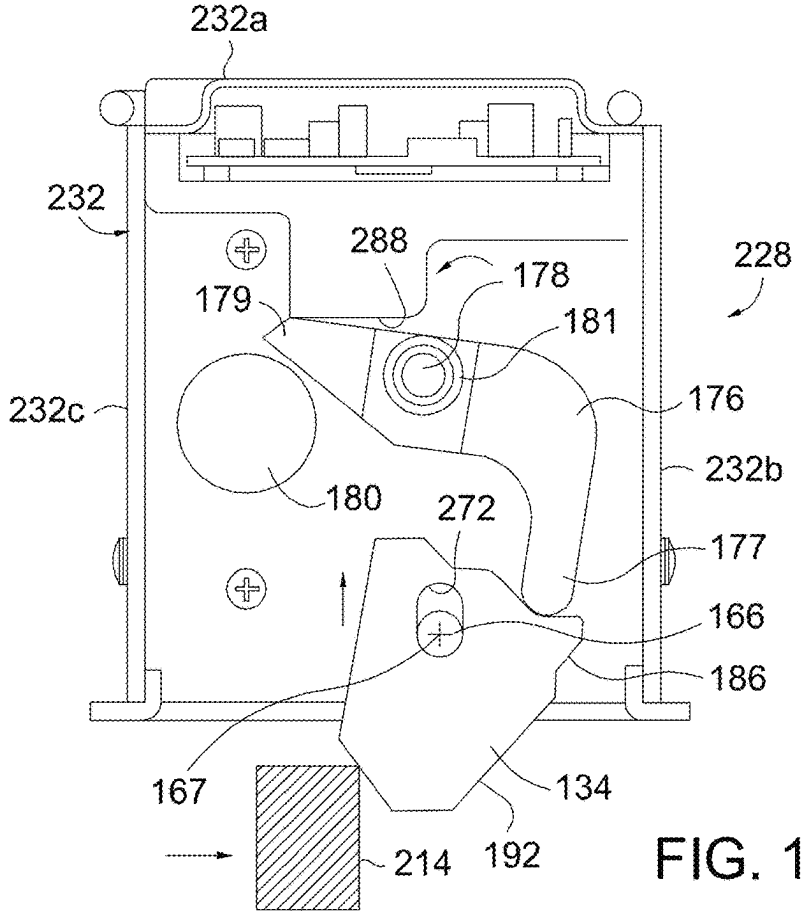
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FIG. 13

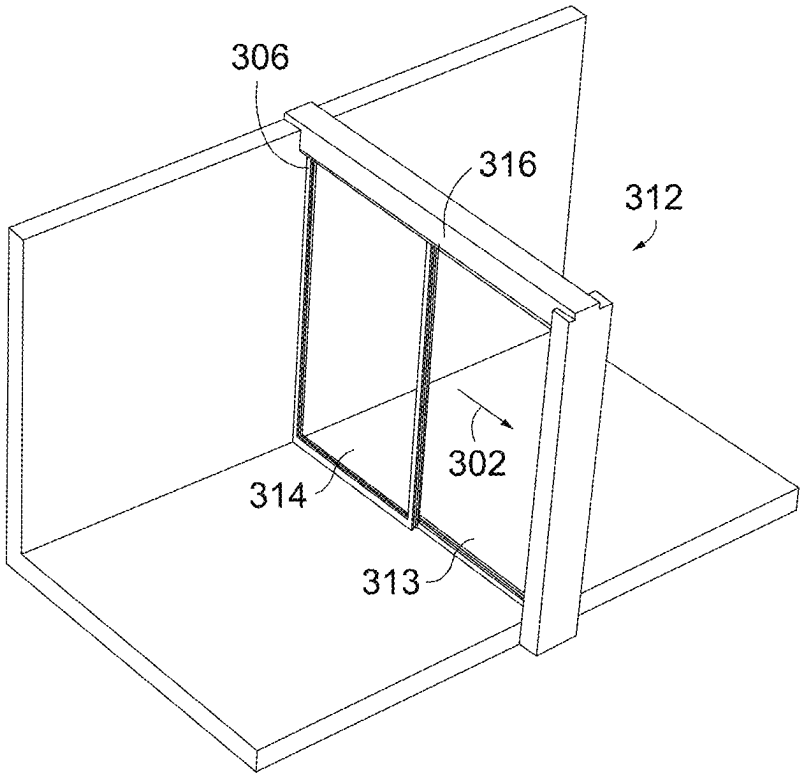

FIG. 14

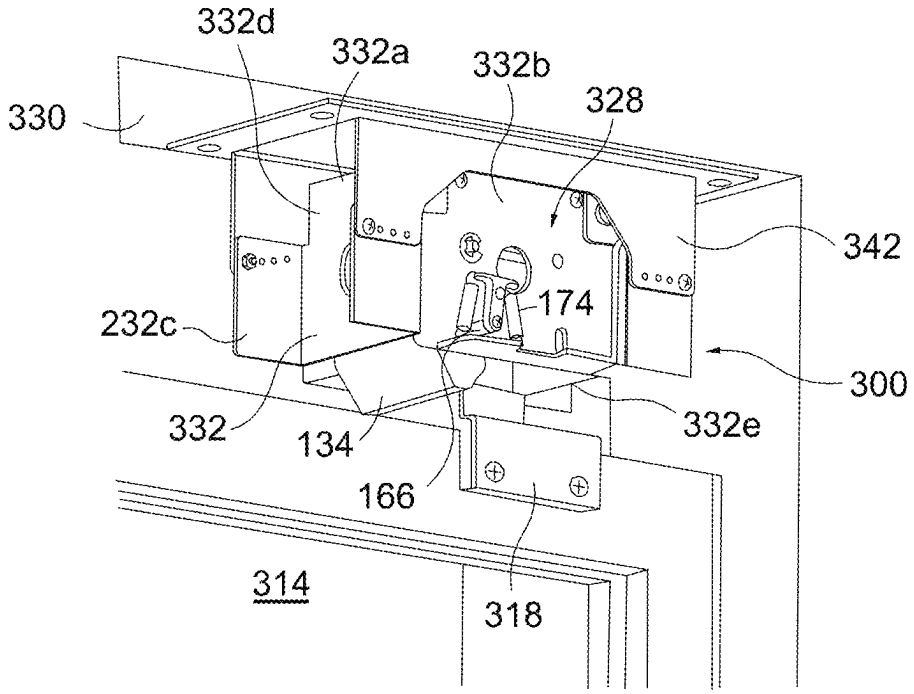
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FIG. 15

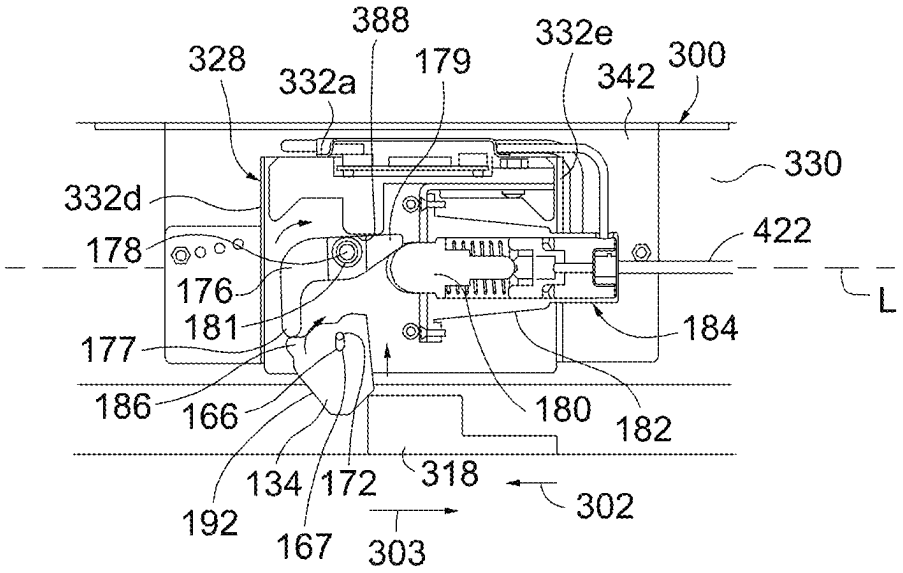
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FIG. 16

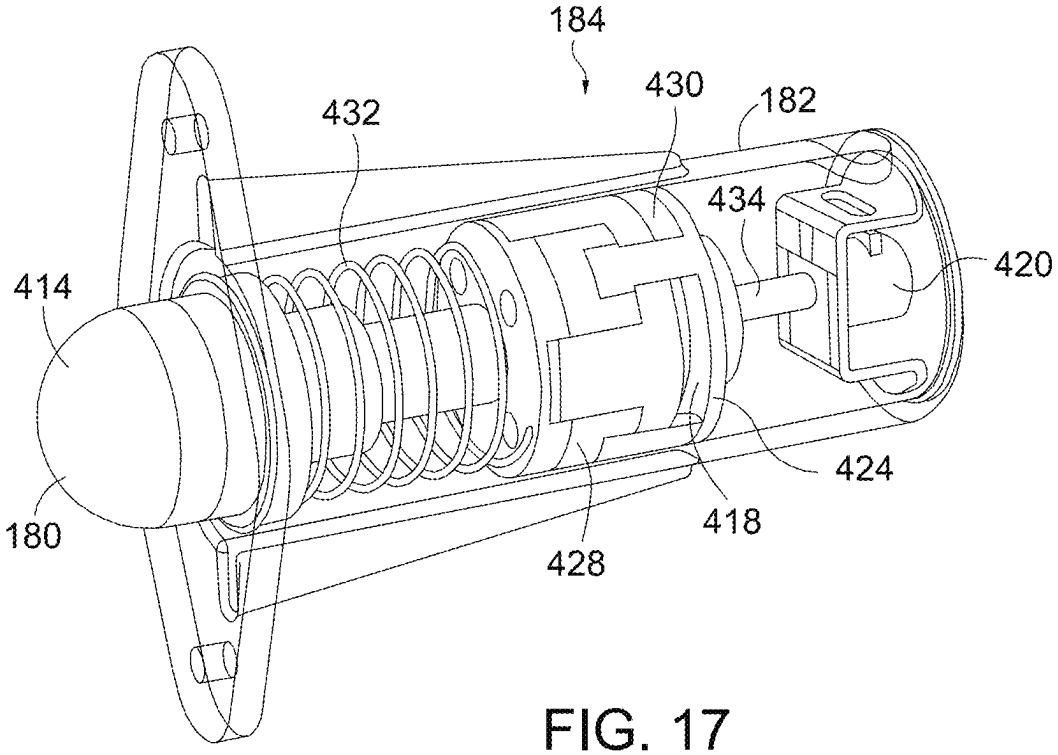
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FIG. 17

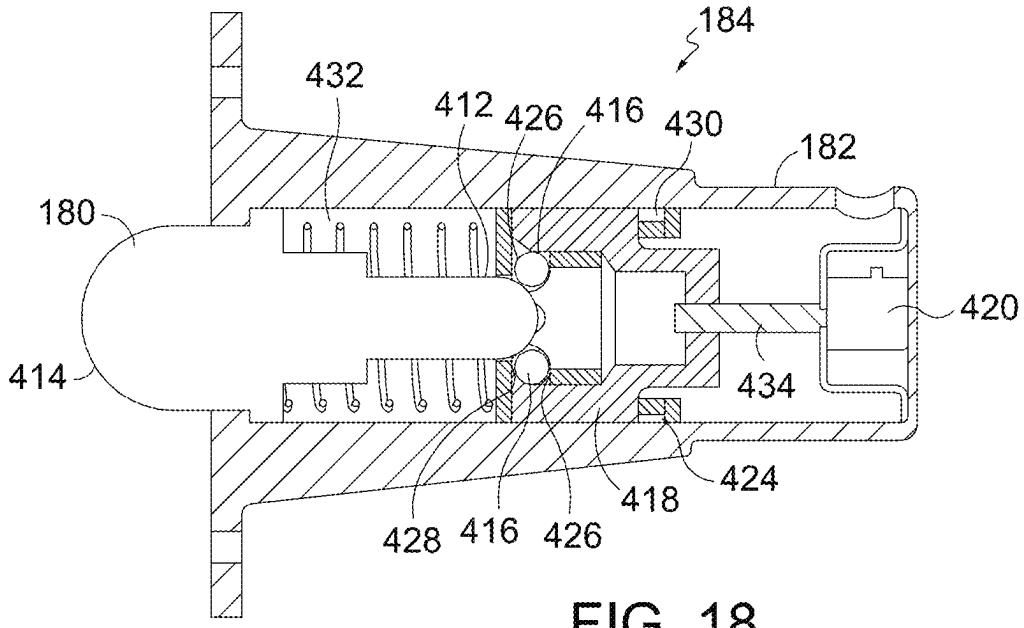
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FIG. 18

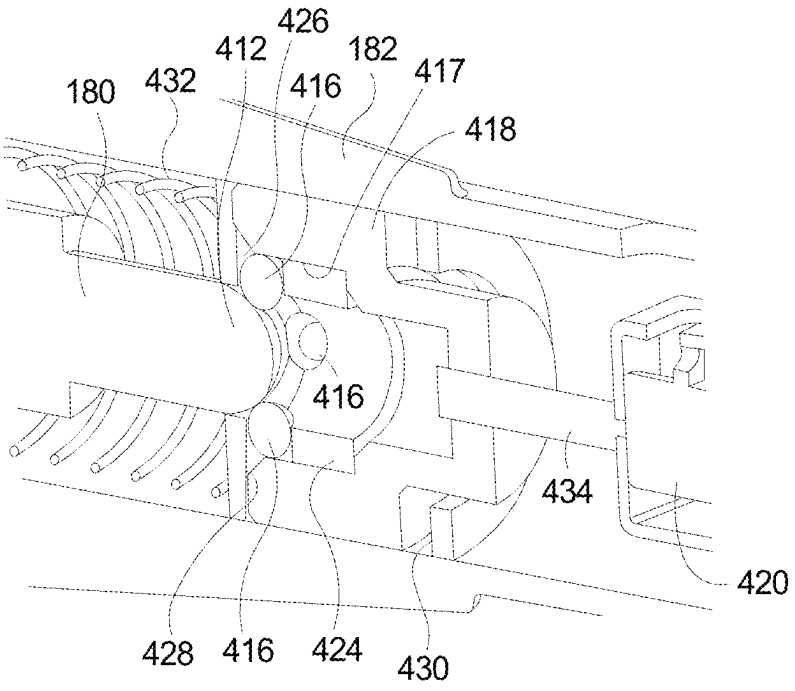
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FIG. 19

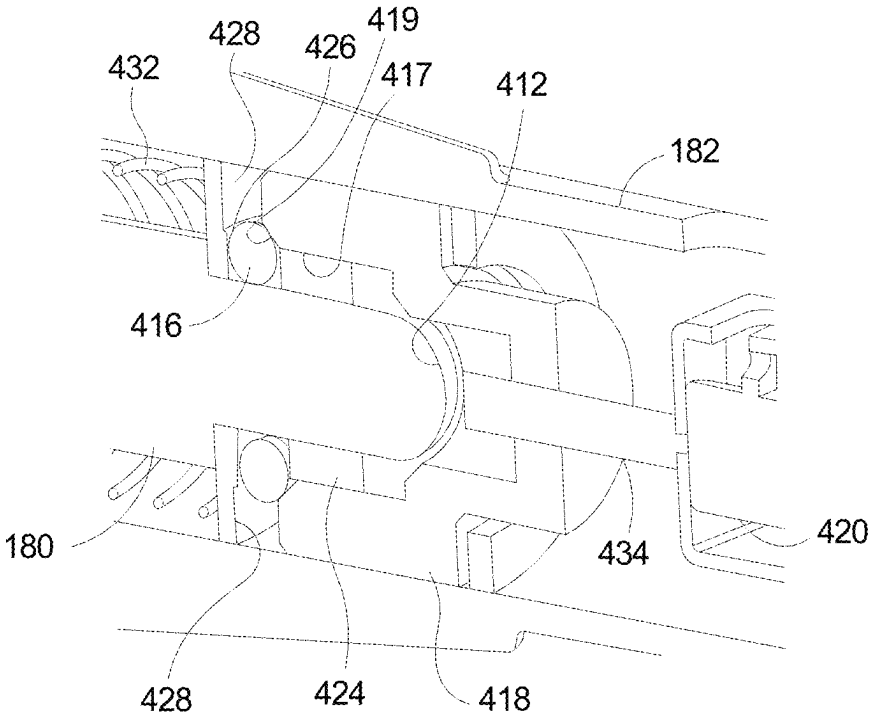
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FIG. 20

OVERHEAD LOCKING DEVICE

RELATIONSHIP TO OTHER APPLICATIONS AND PATENTS

The present application is a continuation of U.S. patent application Ser. No. 17/878,298 filed on Aug. 1, 2022, now U.S. Pat. No. 12,012,778, which is a continuation of U.S. patent application Ser. No. 16/253,888 filed on Jan. 22, 2019, now U.S. Pat. No. 11,549,283, which claims the benefit of U.S. Provisional Patent Application No. 62/620,539, filed Jan. 23, 2018, the contents of which are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

The present invention relates to electric locking devices for securing a door to a door frame in a closed position; particularly to an overhead electric locking device that may be used in conjunction with glass doors; and more particularly, to an overhead electric locking device for framed or frameless uni-directional or bi-directional glass doors and for use with sliding glass doors.

BACKGROUND OF THE INVENTION

Electromagnetic door locking devices are widely used in diverse electronic door applications. These locks typically use electromagnets attached to the door frame in conjunction with a ferromagnetic strike plate attached to the door, to hold the door firmly closed. When the electromagnet is energized and is in contact with the strike plate, the strike plate becomes an armature for the electromagnet, thus providing a mechanism for locking the door to the frame.

However, there may be some circumstances where a strike plate cannot be mounted onto a door, or such a fixture would be unseemly. One such circumstance would be glass panel doors. Typically, when mounting a strike plate to a door, one or more fasteners are passed through holes within the door. However, if the door is a glass panel, any holes drilled therethrough for fasteners would weaken the integrity of the glass making it susceptible to breakage should sufficient force be applied to the panel. Moreover, a mounted strike plate may disrupt the decorative aesthetic in which the glass door is situated.

Thus, what is needed in the art is an electric locking device, which may be used with glass panel doors that provides desired locking properties without comprising panel integrity or requiring mounting of a strike plate to the door panel.

What is also needed in the art is a latch assembly for an electric locking device that may be interchangeably used within locking systems designed for bi-directional swing doors, inswing doors and sliding doors.

It is the principal object of the present invention to provide these and other needs.

SUMMARY OF THE INVENTION

Briefly described, the present invention is directed toward an electric locking device for selectively locking and unlocking a door to a door frame, wherein the door is pivotally coupled to the door frame. The electric locking device comprises a lock housing configured to be mounted to the door frame, wherein the lock housing includes a top wall and an open bottom opposite the top wall. The electric locking device further comprises a keeper movably connected to the housing, wherein the keeper includes a keeper shaft having a shaft axis of rotation. The keeper is rotatable about the shaft axis of rotation between a first rotational position and a second rotational position. The keeper is also movable between a first directional position and a second directional position relative to the lock housing. The movement between the first directional position and the second directional position is generally linear, wherein the shaft axis of rotation is configured to move relative to the lock housing as the keeper moves between the first directional position and the second directional position. When the keeper is in the first rotational position and the first directional position, the door is secured to the door frame by the keeper. When the keeper is in the second rotational position and the second directional position, the door is allowed to move away from the door frame.

In another aspect, an electric locking device for selectively locking and unlocking a door to a door frame is provided, wherein the door is pivotally coupled to the door frame. The electric locking device comprises a lock housing configured to be mounted to the door frame, and a keeper movably connected to the housing. The keeper includes a keeper shaft having a shaft axis of rotation. The keeper is rotatable about the shaft axis of rotation between a first rotational position and a second rotational position. The keeper is also movable between a first directional position and a second directional position relative to the lock housing. The shaft axis of rotation is configured to move relative to the lock housing as the keeper moves between the first directional position and the second directional position. When the keeper is in the first rotational position and the first directional position, the door is secured to the door frame by the keeper. When the keeper is in the second rotational position and the second directional position, the door is allowed to move away from the door frame.

In yet another aspect, a latch assembly for use within an electric locking device is provided. The assembly comprises a latch housing, a latch bolt, a blocking member, and a blocking element. The latch bolt is disposed within the latch housing and has a first end and an opposing second end. The second end is configured to be positioned in a first orientation outwardly from the latch housing and to be positioned in a second orientation inwardly of the first orientation. The blocking member has an engaged position when the latch bolt is in the first orientation and an unengaged position when the latch bolt is in the second orientation. The blocking element is coupled to the blocking member and moveable along a linear path between a blocking position and an unblocking position. The blocking member is in the engaged position when the blocking element is in the blocking position to prevent the latch bolt from moving between the first orientation and the second orientation. The blocking member is in the unengaged position when the blocking element is in the unblocking position to allow the latch bolt to move between the first orientation and the second orientation.

Numerous applications, some of which are exemplarily described below, may be implemented using the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of a bi-directional door installation including an electric locking device in accordance with an aspect of the present invention;

FIG. **2** is a partially exploded view of the electric locking device shown in FIG. **1**;

FIG. **2**A is a close-up view of a keeper shaft biasing assembly shown in FIG. **2**, in accordance with the invention;

FIG. **3** is a partial exploded view of the mounting holes within the electric locking device shown in FIG. **2**;

FIG. **4** is a partial cross-section view of the bi-directional door installation shown in FIG. **1**;

FIG. **5** is an exploded perspective view of a keeper and optional shim in accordance with an aspect of the present invention;

FIG. **6** is a cross-section side view a lock unit used within the electric locking device shown in FIG. **1**;

FIGS. **7**A, **7**B and **7**C are cross-section end views of the electric locking device shown in FIG. **1** generally illustrating an unlocking sequence;

FIGS. **8**A, **8**B, **8**C are cross-section end views of the electric locking device shown in FIG. **1** generally illustrating a locking sequence;

FIG. **9** is a plan view of a uni-directional door installation including an electric locking device in accordance with a further aspect of the present invention;

FIG. **10** is a partially exploded view of the electric locking device used within the uni-directional door installation shown in FIG. **9**;

FIG. **11** is perspective view of a lock unit used within electric locking device shown in FIG. **10**;

FIG. **12** is a partial cross-section view of the uni-directional door installation shown in FIG. **9**;

FIG. **13** cross-section end view of the electric locking device shown in FIG. **11**;

FIG. **14** is a plan view of a sliding door installation including an electric locking device in accordance with a further aspect of the present invention;

FIG. **15** a perspective view of the electric locking device shown in FIG. **14**;

FIG. **16** is a cross-section side view of the electric locking device shown in FIG. **15**;

FIG. **17** is a phantom perspective view of a latch assembly suitable for use within the electric locking devices shown within FIGS. **1**-**16**;

FIG. **18** is a cross-section side view of the latch assembly shown in FIG. **17**;

FIG. **19** is an exploded cross-section view of the locking mechanism of the latch assembly shown in FIG. **18** with the latch in a locked orientation; and

FIG. **20** is an exploded cross-section view of the locking mechanism of the latch assembly shown in FIG. **18** with the latch in an unlocked orientation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Relative positional or directional terms used herein, such as for example, top, bottom, front, back, left side, right side, upward, downward, rightward, leftward, inward, outward, vertical, horizontal, clockwise, counterclockwise, etc., may be used to describe a positional or directional relationship among elements as the elements are presented in the drawings. However, these terms should not limit in any way a specific orientation of the referenced feature, in practice. For example, a top wall as depicted in a drawing may be thought of as a side or bottom wall if the element is oriented differently in practice.

With reference to FIGS. **1**-**7**C, an overhead electric locking device **100** configured for use within a bi-directional door installation **112** is shown. As shown in FIG. **1**, a typical bi-directional door installation may include one or more doors **114** pivotally mounted within a frame **116**, such as via hinges **118** at hinge edge **120** of doors **114**. Hinges **118** may permit doors **114** to be opened either inwardly (such as into open space **122**) or outwardly (such as into open space **124**).

Electric locking device **100** may include a lock unit **128** (FIG. **2**) that may be configured to be mounted above doors **114**, such as within transverse upper frame member **130**, proximate door latch edges **126**. Lock unit **128** may generally include a lock housing **132** having a top wall **132***a* and a front wall **132***b*, back wall **132***c*, left side wall **132***d* and right side wall **132***e* defining an open bottom **133**. Lock housing **132** is configured to pivotally receive a pair of keepers **134***a*, **134***b* arranged in spaced parallel relation to one another. Keepers **134***a*, **134***b* may define a gap G therebetween (see FIG. **4**) which is selected to capture door **114** therein. As shown in FIG. **4**, gap G has been selected to engage an optional upper rail **117** of a framed door **114***a*. However, should a frameless glass door be installed, keepers **134***a*, **134***b* may be outfitted with removable shims **140***a*, **140***b* wherein shims **140***a*, **140***b* (FIG. **5**), attachable to keeper contact faces **141**, operate to create reduced gap distance G' (see FIG. **7**A) and are configured to engage the glass panel of the frameless glass door (such as that shown in FIG. **1**). In this manner, keepers **134***a*, **134***b* (and optional shims **140***a*, **140***b* if required) may secure door **114** (or glass door **114'** fitted with upper rail **117**) in a locked position as will be discussed in greater detail below.

In a further aspect, and in reference to FIG. **2**, lock unit **128** may be secured to upper frame member **130** via mounting plate **142** which may include a generally horizontal mounting surface **144** with vertically extending tabs **146**. Mounting plate **142** may be securely fixed to the upper frame member **130** using appropriate fasteners **148**, such as screw **150**/nut **152** pairs as is known in the art. Mounting plate **142** may further include an opening **154** through which is disposed at least a portion of keepers **134***a*, **134***b*.

As shown most clearly in FIGS. **2** and **3**, each respective vertically extending tab **146** may be configured to adjustably engage a flange **156** on front wall **132***b* and back wall **132***c* of lock housing **132**. A fastener, such as screw **158**/nut **160** pair may affix lock housing **132** to extending tabs **146**. To that end, and to provide for vertical adjustability of the housing relative to mounting surface **144**, each vertically extending tab **146** may include a plurality of holes **162** while each flange **156** may include a plurality of holes **164** wherein the patterns of the plurality of holes differ and a respective pair of holes may align with one another to allow passage of screw **158** therethrough (see FIG. **3**).

As for example as shown in FIG. **3**, one pattern of holes **164** may be disposed in one of the housing or mounting plate at an angle relative to the pattern of holes **162** disposed in the other of the housing or mounting plate. As a result, only one respective pair of holes **162**/**164** will properly align depending upon the relative vertical position of lock housing **132** within opening **154** while the remainder of the holes will remain unaligned. In this manner, lock housing may be vertically positioned and affixed so that keepers **134***a*, **134***b* are disposed within opening **154** to extend below a plane P defined by the bottom edges of walls **132***b*-**132***e* so that keeper **134***a*, **134***b* engage door **114** when electric locking device **100** is in a locked state.

With reference to FIGS. **2**, **2**A, **5** and **6**, keepers **134***a*, **134***b* are rotatably mounted within lock housing **132** via respective keeper shafts **166***a*, **166***b* having opposing first and second ends **168**, **170** which pass through vertically elongated slots **172** defined within left side wall **132***d* and right side wall **132***e*. In this manner, each keeper **134***a*, **134***b* may rotate upon its respective keeper shaft **166***a*, **166***b*,

about the shaft's axis of rotation **167**, between a first rotational position and a second rotational position, while also translating generally linearly between a first directional position and a second directional position, to the extent each keeper shaft **166***a*, **166***b* may travel within its respective slot **172**. Each first and second end **168**, **170** may be further coupled to a biasing assembly **174** configured to bias the shaft and therefore keeper **134***a*, **134***b* in a direction D to its extended position, in a direction away from top wall **132***a* of the housing such as that shown in FIG. **2**A.

Referring specifically to FIG. **2**A, biasing assembly **174** includes link **185**, yoke **187** and biasing members **189***a* and **189***b*. Biasing members **189***a* and **189***b* may be tension springs as shown. A first end **185***a* of link **185** may be fixedly attached to each opposing ends **168**, **170** of shafts **166***a*, **166***b* by a suitable fastener such as screw **183** as shown. Yoke **187** may be attached at a center point **187***a* to a second end **185***b* of link **185** by pin **175** as shown. In one aspect of the invention, yoke **187** may be rotatably attached to link **185** by a pivot pin. A first end of each biasing member **189***a* and **189***b* may be attached to respective ends **187***b* and **187***c* of yoke **187**. A second end of each biasing member **189***a* and **189***b* may be attached to lock housing **132**. As can be seen, by way of biasing assembly **174**, each keeper shaft **166***a*, **166***b* may be biased in direction D, within their respective slots **172** and may also be permitted to rotate within their respective slots. Further, the biasing forces, when balanced between biasing members **189***a* and **189***b*, serve to return the respective keepers to their default positions as shown in FIG. **7**A.

As further shown in FIG. **4**, inhibitors **176***a*, **176***b* may be pivotally mounted within lock housing **132** via respective inhibitor shafts **178***a*, **178***b* passing through left and right side walls **132***d*, **132***e*. Each inhibitor **176***a*, **176***b* may be coupled to its respective keeper **134***a*, **134***b* via a respective leg portion **177***a*, **177***b*. In this manner, each inhibitor may pivot between a coupled position wherein the keeper is maintained in a locked orientation and an uncoupled position wherein the keeper is free to rotate and thereby allow door **114** to open, as will be discussed in greater detail below.

Each inhibitor **176***a*, **176***b* may also include an inhibitor spring **181***a*, **181***b* disposed about a respective inhibitor shaft **178***a*, **178***b* wherein each inhibitor spring biases the inhibitor to the coupled position (FIG. **4**). Rotation of inhibitors **176***a*, **176***b* is dependent upon the orientation of latch bolt **180** with respect to latch housing **182** of latch assembly **184** (FIG. **17**). As will be described in greater detail below, latch housing **182** is mounted to either left side wall **132***d* or right side wall **132***e* such that latch bolt **180**, when in a locked orientation, extends into lock housing **132** to engage inhibitors **176***a*, **176***b* thereby preventing rotation of inhibitors **176***a*, **176***b* from the coupled position. Selective retraction of latch bolt **180** to an unlocked orientation disengages latch bolt **180** from inhibitors **176***a*, **176***b* thereby permitting rotation of the inhibitors and unlocking of door **114** as will be described.

Operation of electric locking device **100** when permitting a locked door to be opened is shown generally in FIGS. **7**A-**7**C. FIG. **7**A shows electric locking device **100** in its default locked state, used in conjunction with an optional frameless door, wherein latch bolt **180** engages head portion **179***a*, **179***b* of inhibitors **176***a*, **176***b* to prevent rotation of the inhibitors about inhibitor shafts **178***a*, **178***b* in a first direction (i.e. inhibitor **176***a* is prevented from rotating clockwise and inhibitor **176***b* is prevented from rotating counterclockwise). In this state, the door is secured to the door frame by keeper **134***a*, **134***b*. Head portion **179***a*, **179***b* may also contact an inner surface **188** of top wall **132***a* to prevent rotation of the inhibitors in the opposite direction (i.e. inhibitor **176***a* is prevented from rotating counterclockwise and inhibitor **176***b* is prohibited from rotating clockwise). Inhibitor leg portions **177***a*, **177***b* engage a shoulder **186***a*, **186***b* on respective keepers **134***a*, **134***b* so as to prevent vertical translation and rotation of the keepers should an attempt be made to open door **114** either inwardly or outwardly.

Turning now to FIG. **7**B, latch bolt **180** has been retracted into latch housing and electric locking device is in an unlocked state. Because each inhibitor **176***a*, **176***b* is biased to the coupled position shown in FIG. **7**A by respective inhibitor springs **181***a*, **181***b* and each keeper **134***a*, **134***b* is biased to the extended orientation shown in FIG. **7**A by biasing assemblies **174**, the inhibitors and keepers will remain in the positions shown in FIG. **7**A without any external force directed upon them, such as by movement of door **114**. However, as shown in FIG. **7**B, directing door **114** rightward in direction R causes door **114** to engage keeper **134***b*. As a result, keeper shaft **166***b* is directed upwardly within slot **172** as keeper **134***b* rotates counterclockwise upon keeper shaft **166***b*. Upward travel of keeper **134***b* causes counterclockwise rotation of inhibitor **176***b* whereby inhibitor leg portion **177***b* may disengage shoulder **186***b*. As shown in FIG. **7**C, continued rightward movement in direction R of door **114** further drives keeper **134***b* and keeper shaft **166***b* upward with continued rotation of keeper **134***b* until inhibitor leg portion **177***b* clears shoulder **186***b* so that door **114** has cleared keeper **134***b* whereby door **114** is unimpeded and free to be opened and move away from the door frame. Once door **114** clears keeper **134***b*, inhibitor spring **181***b* and keeper biasing assembly **174** bias inhibitor **181***b* and keeper **134***b* to their respective default positions shown in FIG. **7**A. Latch bolt **180** may then be selectively returned to the extended position as shown in FIG. **6**.

Return closure of door **114** is shown in FIGS. **8**A-**8**C. Note that the latch bolt **180** is extended and engageable with inhibitor **176***a*, **176***b* during the entire sequence, **8**A-**8**C. As shown in FIG. **8**A, door **114** moves leftward in direction L and contacts external face **192** of keeper **134***b* causing keeper shaft **166***b* to travel upwardly in slot **172** while keeper **134***b* rotates clockwise about keeper shaft **166***b*. As shown in FIG. **8**B, continued leftward travel of door **114** in direction L continues to drive keeper **134***b* and keeper shaft **166***b* upwardly while keeper **134***b* continues to rotate in a clockwise direction until door **114** clears keeper **134***b* and engages keeper **134***a*. As shown in FIG. **8**C, keeper biasing assembly **174** then biases keeper **134***b* and keeper shaft **166***b* toward their default positions such that door **114** will become lockingly received within gap G as shown in FIG. **7**A.

With reference to FIGS. **9** through **13**, an overhead electric locking device **200** configured for use with a unidirectional door installation **212** is shown. Door installation **212** may include a door **214** pivotally mounted within a frame **216** at a hinge edge **220**. Door **214** is prevented from swinging outwardly (FIG. **9**, into the page) through abutting engagement with jamb **218** of frame **216** (see FIG. **12**). Electric locking device **200** may include a lock unit **228** that may be configured to be secured within transverse upper frame member **230** above door **214**, as shown in FIG. **10**, and configured to selectively unlock door **214** for permitting inswing of door **214**.

Lock unit **228** is similar to lock unit **128** described above, also including a lock housing **232** having a top wall **232***a* and a front wall **232***b*, back wall **232***c*, left side wall **232***d*

and right side wall **232***e* proportioned to receive a single keeper **134** and inhibitor **176**. Lock unit **228** may be secured to upper frame member **230** via L-shaped mounting plate **224** having wall surface **242**. The position of lock housing **232** with respect to mounting plate **224** may be vertically adjusted through a similar set of holes formed in front wall **232***b* of housing **232** (not shown) and mating holes **164** in wall surface **242** of mounting plate **224** as described in reference to device **100**. To adjust the relative positions of keeper **134** to door **214**, first, lock housing **232** is secured to wall surface **242** of mounting plate **224** using fasteners **158**, after aligning one pair of holes **164** with a selected pair of holes in housing **232** to obtain the desired keeper to door relationship. Then, the housing/mounting plate is secured to the door frame as shown in FIGS. **10** and **12**. Cover **222** may then be secured over that portion of mounting bracket **224**/lock unit **228** which extends outwardly from upper frame member **230** following installation (see FIG. **10**).

With continued reference to FIGS. **12** and **13**, a single keeper **134** rotationally mounted within lock housing **232** via keeper shaft **166** having opposing first and second ends which pass through vertically elongated slots **272** defined within left side wall **232***d* and right side wall **232***e* of lock housing **232**. In this manner, keeper **134** may rotate upon keeper shaft **166**, about the shaft's axis of rotation **167**, between a first rotational position and a second rotational position, while also translating generally linearly between a first directional position and a second directional position, to the extent keeper shaft **166** may travel within slot **272**. The first and second ends may be further coupled to a biasing assembly **174** as described above, and configured to bias the shaft and therefore keeper **134** to its extended position, in a direction away from the top wall of the housing such as that shown in FIGS. **12** and **13**.

As further shown in FIGS. **12** and **13**, a single inhibitor **176** may be pivotally mounted within lock housing **232** via inhibitor shaft **178** passing through left and right side walls **232***d*, **232***e*. Inhibitor **176** may be coupled to keeper **134** via leg portion **177**. In this manner, inhibitor **176** may pivot between a coupled position shown in FIG. **13** wherein keeper **134** is maintained in a locked orientation and an uncoupled position wherein keeper **134** is free to rotate and thereby allow door **214** to open. Inhibitor **176** may also include an inhibitor spring **181** disposed about inhibitor shaft **178** wherein inhibitor spring **181** biases inhibitor **176** toward the coupled position shown.

Rotation of inhibitor **176** is dependent upon the orientation of latch bolt **180** with respect to latch housing **182** of latch assembly **184**. Latch housing **182** may be mounted to either left side wall **232***d* or right side wall **232***e* such that latch bolt **180**, when in a locked orientation, extends into lock housing **232** to engage inhibitor **176** thereby preventing rotation of inhibitor **176** from the coupled position. Selective retraction of latch bolt **180** to an unlocked orientation disengages latch bolt **180** from inhibitor **176** thereby permitting rotation of inhibitor **176** and unlocking of door **214** as will be described.

Operation of electric locking device **200** when permitting locked uni-directional door **214** to be opened is similar to that operation of electric locking device **100** shown and described above and generally in view of FIGS. **7**A-**7**C. However, as door **214** is a uni-directional door, door jamb **218** prevents outswing of the door so that only one keeper/inhibitor assembly is required to selectively lock uni-directional door **214**. Similar to that operation described above, and with reference to FIG. **13**, when electric locking device **200** is in its default locked state latch bolt **180** engages head portion **179** of inhibitor **176** to prevent rotation of the inhibitor **176** about inhibitor shaft **178** in a first direction (i.e. inhibitor **176** is prevented from rotating counterclockwise). Head portion **179** may also contact an inner surface **288** of top wall **232***a* to prevent rotation of inhibitor **176** in the opposite direction (i.e. inhibitor **176** is prevented from rotating clockwise). Inhibitor leg portion **177** engages a shoulder **186** on keeper **134** so as to prevent vertical translation and rotation of keeper **134** should an attempt be made to open door **214** inwardly (FIG. **9**, out of the page).

To selectively unlock and permit opening of inswing door **214**, latch bolt **180** is selectively retracted into latch housing **182** to place electric locking device **200** in an unlocked state. Because inhibitor **176** is biased to the coupled position by inhibitor spring **181** and keeper **134** is biased to the extended orientation by biasing assembly **174** as described in reference to locking device **100**, inhibitor **176** and keeper **134** will remain in the default positions shown in FIG. **13** without any external force directed upon them, such as by inward movement of door **214**. However, inswinging of door **214** (FIG. **9**, out of the page) causes door **214** to engage keeper **134**. As a result, keeper **134** and keeper shaft **166** are directed upwardly within slot **272** as keeper **134** rotates counterclockwise upon keeper shaft **166**. Upward travel of keeper **134** causes counterclockwise rotation of inhibitor **176** whereby inhibitor leg portion **177** disengages shoulder **186**. Continued inswing force of door **214** further drives keeper **134** and keeper shaft **166** upward with continued rotation of keeper **134** until door **214** has cleared keeper **134** whereby door **214** is unimpeded and free to be opened inwardly (FIG. **9**, out of page). Once door **214** clears keeper **134**, inhibitor spring **181** and keeper biasing assembly **174** bias inhibitor **181** and keeper **134** to their respective default positions shown in FIG. **13**. Latch bolt **180** may then be selectively returned to the extended position, such as that shown in FIG. **6**.

Return closure of door **214** is similar to that shown and described above in relation to FIGS. **8**A-**8**C. Door **214** moves toward door jamb **218** (FIG. **9**, into the page) and contacts external face **192** of keeper **134** causing keeper **134** and keeper shaft **166** to travel upwardly in slot **272** while keeper **134** rotates clockwise about keeper shaft **166**. Upward travel of keeper **134** causes shoulder **186** to engage inhibitor leg portion **177** to rotate inhibitor **176** clockwise until inhibitor head portion **179** contacts latch bolt **180** whereby further clockwise rotation of inhibitor **176** is prevented. Continued travel of door **214** toward door jamb **218** continues to drive keeper **134** and keeper shaft **166** upwardly while keeper **134** continues to rotate in a clockwise direction until door **214** clears keeper **134** and engages door jamb **218**. Keeper biasing assembly **174** then biases keeper **134** and keeper shaft **166** to their default positions such that door **214** is now lockingly received within electric locking device **200**.

Turning now to FIGS. **14**-**16**, an overhead electric locking device **300** configured for use with a sliding door installation **312** is shown. Sliding door installation **312** may include a fixed panel **313** and sliding door **314** slidably mounted within a track **316** as is known in the art. Electric locking device **300** may include a lock unit **328** that may be configured to be mounted to transverse upper frame member **330** above door **314** proximate door latch edge **326** at any desired location along the top of sliding door **314**. Lock unit **328** is similar to lock units **128** and **228** described above, also including a lock housing **332** having a top wall **332***a* and a front wall **332***b*, back wall **332***c*, left side wall **332***d* and right side wall **332***e* proportioned to receive a single

keeper **134** and single inhibitor **176**. Lock unit **328** may also be similarly secured to upper frame member **330** via mounting plate **342** which is similarly proportioned to lock housing **332**. The position of lock housing **332** with respect to mounting plate **342** may be vertically adjusted through a similar arrangement described above with regard to mating sets of holes **162**/**164** of electric locking devices **100** and **200**.

With continued reference to FIG. **16**, keeper **134** is rotatably mounted within lock housing **332** via keeper shaft **166** having opposing first and second ends which pass through vertically elongated slots **172** defined within front wall **332***b* and back wall **332***c* of lock housing **332**. In this manner, keeper **134** may rotate upon keeper shaft **166**, about the shaft's axis of rotation **167**, between a first rotational position and a second rotational position, while also translating generally linearly between a first directional position and a second directional position, to the extent keeper shaft **166** may travel within slot **172**. Each of the first and second ends of keeper shaft **166** may be further coupled to a biasing assembly **174** as described with respect to FIG. **2**A, and configured to bias the shaft and therefore keeper **134** to its extended position, in a direction away from the top wall of the housing such as that shown in FIGS. **15** and **16**.

As further shown in FIG. **16**, inhibitor **176** may be pivotally mounted within lock housing **332** via inhibitor shaft **178** passing through front wall **332***b* and back wall **332***c*. Inhibitor **176** may be coupled to keeper **134** via leg portion **177**. In this manner, inhibitor **176** may pivot between a coupled position wherein keeper **134** is maintained in a locked orientation and an uncoupled position wherein keeper **134** is free to rotate and thereby allow door **314** to slide open in the direction shown by arrow **302**.

Inhibitor **176** may also include an inhibitor spring **181** disposed about inhibitor shaft **178** to bias inhibitor **176** to the coupled position (FIG. **16**). Rotation of inhibitor **176** is dependent upon the orientation of latch bolt **180** with respect to latch housing **182** of latch assembly **184**. Latch housing **182** may be mounted to right side wall **332***e* such that latch bolt **180**, when in a locked orientation, engages inhibitor **176** thereby preventing rotation of inhibitor **176** from the coupled position. Selective retraction of latch bolt **180** to an unlocked orientation disengages latch bolt **180** from inhibitor **176** thereby permitting rotation of the inhibitor and unlocking of door **314** as will be described.

Operation of electric locking device **300** when permitting locked sliding door **314** to be opened is similar to that operation of electric locking devices **100** and **200** shown and described with the exception that keeper **134** and inhibitor **176** are oriented normal to the longitudinal axis L of lock housing **332** and latch bolt **180**. As shown in FIGS. **15** and **16**, electric locking device **300** in its default locked state wherein latch bolt **180** engages head portion **179** of inhibitor **176** to prevent rotation of inhibitor **176** about inhibitor shaft **178** in a first direction (i.e. inhibitor **176** is prevented from rotating clockwise). Head portion **179** may also contact an inner surface **388** of top wall **332***a* to prevent rotation of inhibitor **176** in the opposite direction (i.e. inhibitor **176** is prevented from rotating counterclockwise). Inhibitor leg portion **177** engages shoulder **186** on keeper **134** so as to prevent vertical translation and rotation of the keeper should an attempt be made to slide door **314** in opening direction **302**.

Retraction of latch bolt **180**, such as in direction **303**, retracts latch bolt **180** into latch housing **182** thereby placing electric locking device **300** in an unlocked state. Because inhibitor **176** is biased to the coupled position by inhibitor spring **181** and keeper **134** is biased to the extended orientation by biasing assembly **174**, inhibitor **176** and keeper **134** will remain in their default positions shown in FIGS. **15** and **16** absent any external force directed upon them, such as by sliding movement of door **314** in direction **302**. However, with latch bolt **180** retracted, sliding door **314** in direction **302** causes a door stop **318** mounted on door **314** to engage keeper **134**. As a result, keeper **134** and keeper shaft **166** are directed upwardly within the slot in lock housing **332** as keeper **134** rotates clockwise upon keeper shaft **166**. Upward travel of keeper **134** causes clockwise rotation of inhibitor **176** whereby inhibitor leg portion **177** disengages shoulder **186** as described above. Continued door opening force in direction **302** further drives door stop **318** into keeper **134**. As a result, keeper **134** and keeper shaft **166** continue to travel upward with continued clockwise rotation of keeper **134** until door stop **318** has cleared keeper **134** whereby door **314** is unimpeded and free to slide open. Once door stop **318** clears keeper **134**, inhibitor spring **181** and keeper biasing assembly **174** bias inhibitor **181** and keeper **134** to their respective default positions shown in FIGS. **15** and **16**. Latch bolt **180** may then be selectively returned to its extended position, such as that shown in FIG. **6**.

Return closure of door **314** is similar to that shown and described above in relation to FIGS. **8**A-**8**C. As door **314** moves in a closing direction opposite opening direction **302** (such as direction **303**), door stop **318** contacts external face **192** of keeper **134** causing keeper **134** and keeper shaft **166** to travel upwardly in the slot within housing **332** while keeper **134** rotates counterclockwise on keeper shaft **166**. Upward travel of keeper **134** causes shoulder **186** to engage inhibitor leg portion **177** to rotate inhibitor **176** clockwise until inhibitor head portion **179** contacts latch bolt **180** whereby further clockwise rotation of inhibitor **176** is prevented. Continued travel of door **314** in the closing direction continues to drive door stop **318** against keeper **134** causing keeper **134** and keeper shaft **166** to continue moving upwardly while keeper **134** continues to rotate in a counterclockwise direction until door stop **314** clears keeper **134**. Keeper biasing assembly **174** then biases keeper **134** and keeper shaft **166** to their default positions such that door **314** is now locked as shown in FIGS. **15** and **16**.

In each of the above examples of an electric locking device (electric locking devices **100**, **200**, **300**), each electric locking device utilized a universal latch assembly **184** shown in FIGS. **17**-**20**. To that end, latch assembly **184** may generally comprise a latch housing **182** and a latch bolt **180** disposed within the latch housing **182**. Latch bolt **180** has a first end **412** and an opposing second end **414**. Second end **414** is configured to extend outwardly from latch housing **182** to engage inhibitor **176** when in a locked orientation (FIGS. **17**-**19**), and to be slidably received within latch housing **182** when in an unlocked orientation (FIG. **20**). Blocking member **416** is moveable between an engaged position (FIGS. **18** and **19**), wherein latch bolt **180** is maintained in the locked orientation and an unengaged position (FIG. **20**), wherein latch bolt **180** may move to the unlocked orientation. Blocking element **418** may be coupled to blocking member **416** and be moveable along a linear path between a blocking position wherein blocking member **416** is in the engaged position (FIGS. **18** and **19**), and an unblocking position wherein blocking member **416** may move to the unengaged position (FIG. **20**). An actuator **420** may be coupled to blocking element **418** and is configured to receive power from a power source (not shown) such as through wires **422** (see FIGS. **2**, **11** and **16**) so as to

selectively move blocking element **418** between the blocking position (FIGS. **18** and **19**) and the unblocking position (FIG. **20**).

In a further aspect of the present invention, blocking member **416** is a ball and latch assembly **184** and may further include a ball race **424** fixedly secured to the latch housing **182**. Ball race **424** may include one or more notches **426** configured to receive ball **416**. In an aspect of the present invention, ball race **424** may include a plurality of notches **426** spaced apart an equal distance about the circumference of ball race **424**.

By way of example, ball race **424** may include four (4) notches, each configured to receive a respective ball **416**, spaced apart 90° from one another. When blocking element **418** is in the blocking position (FIG. **19**), an inner diameter **417** of blocking element **418** overrides each ball **416** to position each ball **416** within a respective notch **426** so that ball **416** engages first end **412** of latch bolt **180** to secure latch bolt **180** in the locked orientation by preventing first end **412** from retracting within race **424**. When blocking element **418** is in the unblocking position (FIG. **20**), inner diameter **417** of blocking element **418** no longer overrides balls **416** so that balls **416** are engaged with an end portion **419** of blocking element **418**. Latch bolt **180** may then position each ball **416** within its respective notch **426** so as to permit latch bolt **180** to move to the unlocked orientation. Blocking element **418** may be configured to capture ball **416** within ball race **424** when in the unblocking position so as to prevent ball **416** from escaping notch **426**. Ball race **424** may further include a forward stop **428** and a rearward stop **430** configured to limit reciprocal travel of blocking element **418**. A biasing member **432** may be coaxially aligned with latch bolt **180** and be configured to bias latch bolt **180** toward the locked orientation as shown in FIGS. **17** and **18**.

In a further aspect of the invention, actuator **420** may be, for example, a solenoid. Actuator **420** may also be a stepper motor coupled to blocking element **418** via a drive screw **434**, as shown. Powering of stepper motor **420** with a voltage having a first polarity may turn drive screw **434** in a first direction thereby retracting blocking element **418** and allowing latch bolt **180** to move to the unlocked orientation while powering stepper motor **420** with a voltage having the opposite polarity may turn drive screw **434** in an opposing second direction thereby extending blocking element **418** to the blocking position and maintaining latch bolt **180** in the locked orientation.

While the above aspects of the present invention describe electric locking devices for use with glass doors, it should be understood by those skilled in the art that such electric locking devices may be used with any suitable door system, including wood and metal doors.

Although the present invention has thus been described in detail with regard to the preferred embodiments and drawings thereof, it should be apparent to those skilled in the art that various adaptations and modifications of the present invention may be accomplished without departing from the spirit and the scope of the invention. Accordingly, it is to be understood that the detailed description and the accompanying drawings as set forth hereinabove are not intended to limit the breadth of the present invention, which should be inferred only from the following claims and their appropriately construed legal equivalents.

I claim:

1. A latch assembly, comprising:

a housing configured for mounting to a door;

a latch bolt mounted in the housing for axial movement along a longitudinal axis between a projected position and a depressed position relative to the housing;

a roller engaged with the latch bolt such that the axial movement of the latch bolt from the projected position to the depressed position engages a drive surface of the latch bolt against the roller to urge the roller from a first position toward a second position; and

a locking sleeve movably mounted to the housing for movement relative to an axis via an actuator, the locking sleeve having a recess operable to partially receive the roller, and the locking sleeve having a blocking surface operable to engage the roller to prevent movement of the roller from the first position to the second position;

wherein the locking sleeve is displaced relative to the axis between a locking position in which the blocking surface is aligned with the roller and engages the roller to prevent movement of the roller from the first position to the second position and thereby retain the latch bolt in the projected position, and an unlocking position in which the recess is aligned with the roller to permit movement of the roller from the first position to the second position and into the recess to thereby enable depression of the latch bolt; and

wherein the locking sleeve is slidably mounted to the housing for axial movement along the axis via the actuator, and wherein the locking sleeve is axially displaced along the axis between the locking position and the unlocking position.

2. The latch assembly in accordance with claim **1** wherein the roller is a ball.

3. The latch assembly in accordance with claim **1** wherein the drive surface is a first end of the latch bolt.

4. The latch assembly in accordance with claim **1** wherein the blocking surface is an inner diameter of the locking sleeve.

5. The latch assembly in accordance with claim **1** wherein the recess of the locking sleeve is an end portion of the locking sleeve.

6. The latch assembly in accordance with claim **5** wherein the end portion of the locking sleeve is chamfered.

7. The latch assembly in accordance with claim **1** wherein the actuator is a motor.

8. The latch assembly in accordance with claim **1**. wherein the actuator is a solenoid.

9. A latch assembly, comprising:

a housing assembly comprising an aperture;

a roller seated in the aperture for movement between a first position and a second position;

a latch bolt mounted to the housing assembly for axial movement along a longitudinal axis between a projected position and a depressed position relative to the housing assembly, wherein the latch bolt includes a ramped surface that engages the roller to urge the roller from the first position toward the second position as the latch bolt moves from the projected position toward the depressed position, and wherein engagement between the ramped surface and the roller prevents movement of the latch bolt from the projected position to the depressed position when the roller is in the first position, and wherein the roller permits movement of the latch bolt from the projected position to the depressed position when the roller is in the second position; and

a locking sleeve movably mounted between an inner housing and an outer housing of the housing assembly;

wherein the locking sleeve is configured to be driven between a locking position and an unlocking position via an actuator, wherein a blocking surface of the locking sleeve is aligned with the roller and engages the roller when the locking sleeve is in the locking position to prevent movement of the roller from the first position to the second position and thereby retain the latch bolt in the projected position, and wherein a recess of the locking sleeve is aligned with the roller when the locking sleeve is in the unlocking position to receive the roller and permit

movement of the roller from the first position to the second position to thereby enable depression of the latch bolt; and

wherein the locking sleeve is configured to be linearly driven between the locking position and the unlocking position via the actuator.

10. The latch assembly in accordance with claim **9** wherein the roller is a ball.

11. The latch assembly in accordance with claim **9** wherein the ramped surface is a first end of the latch bolt.

12. The latch assembly in accordance with claim **9** wherein the blocking surface is an inner diameter of the locking sleeve.

13. The latch assembly in accordance with claim **9** wherein the recess of the locking sleeve is an end portion of the locking sleeve.

14. The latch assembly in accordance with claim **13** wherein the end portion of the locking sleeve is chamfered.

15. The latch assembly in accordance with claim **9** wherein the actuator is a motor.

16. The latch assembly in accordance with claim **9** wherein the actuator is a solenoid.

17. The latch assembly in accordance with claim **9** wherein the inner housing is a ball race.

18. The latch assembly in accordance with claim **9** wherein the outer housing is a latch housing.

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