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Inventor(s)	McLoughlin; John et al.

Locking device

Abstract

The present invention relates to a locking device **1** having a deadbolt **104** within a casing **102,** which deadbolt **104** is movable between an advanced position wherein it protrudes from a front face of the casing **102** and a retreated position, wherein it is retracted into the casing **102.** The locking device **1** comprises: a link plate **130** which moves the deadbolt **104** to the advanced position; a deadbolt blocking member **110** which is moveable between a blocking position blocking the deadbolt **104** in the advanced position and an unblocking position to allow the deadbolt **104** to move to the retreated position; an electrically driven actuator unit **120** which moves the deadbolt blocking member **110** between the blocking position and the unblocking position; and a control circuit configured to control the electrically driven actuator unit **120** so that once the deadbolt **104** is moved to the advanced position, the deadbolt blocking member **110** is moved to the blocking position by actuation of the electrically driven actuator unit **120.**

Inventors: **McLoughlin; John (Manchester, GB), Jennings; David (Manchester, GB)**

Applicant: **UAP Limited** (Whitefield, GB)

Family ID: **1000008752141**

Assignee: **UAP Limited (Whitefield, GB)**

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Primary Examiner: Mills; Christine M

Assistant Examiner: Sidky; Yahya

Attorney, Agent or Firm: Woodard, Emhardt, Henry, Reeves & Wagner, LLP

Background/Summary

FIELD

(1) This invention relates to a locking device for door or window. More specifically, this invention is directed to a locking device activated by means of electric current.

BACKGROUND ART

(2) Electronic locks are becoming more common in door locks for homes or facilities because these locks offer a number of advantages over traditional mechanical door locks in both convenience and improved security. In particular, typical electronic locks use push-buttons or a keypad to enter a series of numbers or password for authentication. Users do not have to carry keys and worry about losing keys. Some electronic locks are even able to grant or deny access remotely via users' devices such as smart phones. These locks, in fact, allow exclusive access only to authorised people who have been given their own fob device, magnet card or the like, or who have been informed of the numeric code to be entered to the keypad. In addition, some electronic locks have an access record function to record when and who accesses and operates the lock. In some cases, such information is sent to an administrator or security services, with user consent, to track usage and also to monitor and adjust access rights.

(3) The electronic locks also have some drawbacks. The most striking problem for those powered with a battery, is linked to the possibility of not being able to open the door when the battery is low. Even in an electric lock that is directly powered by an external power source, an internal battery may be still necessary in case of a power failure at the home or facility.

(4) Particularly, in an electronic lock as disclosed in U.S. Pat. No. 6,035,676, wherein a deadbolt is directly moved by actuation of an electric actuator, such a problem would be critical because large torque is required to move the deadbolt forward and backward against relatively high frictional loads, and a larger amount of electric power is thus required to drive the actuator, which leads to a rapid decrease in the remaining battery level. This particularly holds true in a multipoint locking system.

(5) Moreover, conventional electric locks are expensive, not least due to the fact that they require large motors.

SUMMARY

(6) It is an object of the invention, therefore, to provide a locking device capable of locking and unlocking a door, or the like, in an electric manner with a low power consumption. Further objects and advantages of the present invention will be apparent from the detailed description as below.

(7) According to the present invention there is provided a locking device having a deadbolt within a casing, which deadbolt is movable between an advanced position wherein it protrudes from a front face of the casing and a retreated position wherein it is retracted into the casing, and comprising: a link plate which moves the deadbolt to the advanced position; a deadbolt blocking member which is movable between a blocking position blocking the deadbolt in the advanced position and an unblocking position to allow the deadbolt to move to the retreated position; an electrically driven actuator unit which moves the deadbolt blocking member between the blocking position and the unblocking position; and a control circuit configured to control the electrically driven actuator unit so that that once the deadbolt is moved to the advanced positon, the deadbolt blocking member is moved to the blocking position by actuation of the electrically driven actuator unit.

(8) The present invention is based on the idea that, instead of electrically moving a deadbolt against the relatively high frictional loads, a deadbolt blocking member, which may be less frictional than the deadbolt, is provided and electrically actuated to lock a door or the like.

(9) The initial locking action may be initiated either by lifting or lowering a door handle or the like, or by a mechanical power accumulating unit as described later, to move the link plate. This movement of the link plate advances the deadbolt into a corresponding cavity in a door frame to lock the door. The control circuit then controls the electrically driven actuator unit so that once the deadbolt is moved to the advanced position, the deadbolt blocking member is moved to the blocking position, whereby the retracting movement of the deadbolt is prevented. Unblocking of the deadbolt may be performed by a reverse operation of the blocking operation.

(10) In this way, the electrically driven actuator unit is not used to move the deadbolt that produces relatively higher frictional loads, but instead only activates the deadbolt blocking member which

may be less frictional than the deadbolt. Accordingly, the required output torque of the electrically driven actuator unit can be reduced. This allows the use of an electrically driven actuator unit with a low power consumption.

(11) The deadbolt blocking member may have any physical structure, as long as is is able to prevent the retracting movement of the deadbolt. For example, the deadbolt blocking member may be a pin that projects and retracts by a solenoid. However, as will be described later, in embodiments incorporating a manual override mechanism, it is preferable that the deadbolt blocking member has a structure suitable for the manual operation as well. Another consideration that may need to be considered is the strength of the deadbolt blocking member. It is preferable that the deadbolt blocking member has a strength and resilience to withstand a potential burglary by force. A pin may not be enough strong for this purpose.

(12) In a preferred embodiment, the locking device further comprises a first detector which is configured to detect whether the deadbolt is in the advanced position. In such a case, the control circuit is configured to move the deadbolt blocking member by actuation of the electrically driven actuator unit when the first detector detects the deadbolt is in the advanced positon. The door handle operation, or the actuation of the mechanical power accumulating unit as described later, triggers the electrically driven actuator unit to move the deadbolt blocking member toward the blocking position. In this embodiment, the blocking of the deadbolt is automatically performed upon the detection by the first detector. In addition, an inappropriate blocking operation is prevented. More specifically, if the deadbolt blocking member is moved to the blocking position in spite of the deadbolt still being in the retracted position, the electrically driven actuator unit may be overloaded and generate heat. Such a scenario is prevented by the control circuit associated with the first detector.

(13) In a preferred embodiment, the locking device further comprises a second detector which is configured to detect whether the deadbolt blocking member is in the blocking position. In such a case, the control circuit is configured to stop actuation of the electrically driven actuator unit after moving the deadbolt blocking member from the unblocking position to the blocking position. In this embodiment, overload of the electrically driven actuator unit after moving the deadbolt blocking member from the unblocking position to the blocking position is prevented by the control circuit associated with the second detector.

(14) In a preferred embodiment, the locking device further comprises a third detector which is configured to detect whether the deadbolt blocking member is in the unblocking position. In such a case, the control circuit is configured to stop actuation of the electrically driven actuator unit after moving the deadbolt blocking member from the blocking position to the unblocking position. In this embodiment, overload of the electrically driven actuator unit after moving the deadbolt blocking member from the blocking position to the unblocking position is prevented by the control circuit associated with the third detector.

(15) In the embodiments having the first, second, and/or third detectors, it is preferable that at least one of these detector is a non-contact sensor. Examples of the non-contact sensor include a proximity sensor such as a Hall effect sensor or an electrostatic capacitance sensor or a photoelectric sensor. A Hall effect sensor is preferred as it does not deteriorate with dust, oil, lock shavings, etc. Also, Hall effect sensors are accurate, sensitive and function with accurate position measurement over a long period of time. Hence, a Hall effect sensor is the most suitable for use within the locking device, among other non-contact sensors. The detector is not however limited to a non-contact sensor. The detector may be a mechanical sensor such as a limit switch or a microswitch.

(16) In a preferred embodiment, the locking device further comprises a mechanical power accumulating unit which accumulates energy and releases a force to move the link plate so that the deadbolt is moved in association with the movement of the link plate. The mechanical power accumulating unit and the link plate may be directly connected. In such a case, the mechanical

power accumulating unit may be located near the deadbolt. Alternatively, the mechanical power accumulating unit and the link plate may be connected via a connecting rod in a torque-transmittable manner, in the direction of a longitudinal axis of a face plate of the locking device.
(17) According to this embodiment, the deadbolt is driven to the advanced position, similar to a conventional electric lock in which the deadbolt is moved by an electric actuator. It should be noted, however, that the locking device of the present invention does not consume any electric power to drive the deadbolt.
(18) To this end, the mechanical power accumulating unit may include a spring to releasably accumulate the energy. In general, metallic springs are more reliable than elastic materials such as rubber, especially in long-term use. The spring accumulates energy as it is compressed and dissipates it to move the deadbolt to the locking position. Additionally, or alternatively, the repulsive force of a pair of magnets may be used to move the deadbolt to the locking position.
(19) Preferably, the link plate is configured to convert the force released by the mechanical power accumulating unit into the advancing movement of the deadbolt to the advanced position. To this end, the link plate may include a cam groove, and the deadbolt may include a follower pin which moves along, and with respect to, the cam groove. Two or more sets of the cam groove and the follower pin may be provided.
(20) Preferably, the locking device comprises an operation part that moves the link plate against the mechanical power accumulating unit to accumulate energy. The operation part may be configured to be driven in association with the movement of the door handle or the like by a user. Preferably, the operation part may be fitted to a spindle of the door handle or the like. The operation part may include a radial groove, and the link plate may include a pin which is received in the radial groove. Accordingly, the operation part rotates by lifting or lowering the door handle, the rotation is converted into a linear movement of the link plate via the engagement of the radial groove and the pin.
(21) Preferably, the mechanical power accumulating unit includes a holding mechanism that releasably holds the spring in a compressed state after the spring has been compressed by operation of the operation part. This ensures that the compression force of the spring can be accumulated within the spring until the door is closed, for example.
(22) Specifically, the holding mechanism may include a connecting plate that directly, or indirectly, connects the spring to the link plate, and a strike pin that engages the connecting plate to hold the compressed state of the spring. The strike pin is configured to be moveable out of engagement with the connecting plate so that the mechanical power accumulating unit directly, or indirectly, moves the link plate. Preferably, the strike pin is spring-loaded toward a door frame side and projects over the face plate of the locking device. According to this configuration, when the door leaf with the locking device is closed, the door frame pushes the strike pin to disengage the connecting plate from the strike pin, allowing the connecting plate to move by means of the spring. This movement of the connecting plate is then transmitted to the link plate, and the deadbolt is advanced toward the corresponding cavity of the door frame, as described above. The ‘auto-lock’ function is thus provided by the cooperation of the mechanical power accumulating unit and the electrically driven actuator unit.
(23) In a preferred embodiment, in the blocking position the deadbolt blocking member is positioned immediately behind the deadbolt but with a gap there-between. The gap is provided between the rear surface of the deadbolt and the deadbolt blocking member in the blocking position. This ensures that the deadbolt blocking member does not come into contact with the deadbolt when it moves to block the deadbolt, allowing the deadbolt blocking member to move free from friction against the deadbolt during the movement of the deadbolt blocking member. The required power output of the electrically driven actuator unit is thus further reduced.
(24) Another aspect of the invention is directed to a manual override function. The manual override function may be necessary to ensure that the door may always be manually unlocked from the

indoor side and/or outdoor side. The manual override function is for unlocking directly, perhaps even without requiring actuation of the electrically driven actuator unit in the locking device, but by actuation of a mechanical override mechanism alone. Installation of such a manual override function may be required by law or regulation, in some countries or regions.
(25) The deadbolt blocking member in a preferred embodiment therefore includes: a first slider movable by actuation of the electrically driven actuator unit; a second slider slidably attached to the first slider; a biasing member that applies a biasing force between the first slider and the second slider so that the second member moves to the blocking position together with the first slider during actuation of the electrically driven actuator unit; and a manual override mechanism for manually moving the second slider with respect to the first slider to the unblocking position against the biasing force of the biasing member. In the operation of the manual override mechanism, the second slider can move with respect to the first slider in an isolated manner, allowing a means of activating the manual override mechanism without transmitting torque to the electrically driven actuator unit. This ensures that the manual override mechanism is readily operated without undue manual force being required.
(26) In a preferred embodiment, the manual override mechanism includes a rack formed on the second slider, and a pinion which is driven by a manual operation key and engages with the rack to move the second slider with respect to the first slider. The manual operation key used to manually unlock the locking device from the outdoor side may be a high security key suitable for a high security lock cylinder or the like which is connected to the pinion, whereas the manual operation key used to manually unlock the locking device from the indoor side may be a simple pinon wheel key with any profile that can transmit the rotational torque from the pinon wheel key to the pinion, such as with star shape, square shape, or trapezoidal shape. Alternatively, the indoor side operation key may be a thumb-turn grip or the like which is connected to the pinion to drive.
(27) Another aspect of the invention is directed to a power feed structure that can also be incorporated into existing doors. It is not always easy to directly supply electric power from an external power source to the locking device via an electric wire. The locking device of a preferred embodiment therefore includes a rechargeable battery configured to provide electrical power to the control circuit; and an induction coil coupled to the rechargeable battery. The induction coil is configured to wirelessly receive power from an external device that is positioned proximate to the locking device. To this end, a transmitting induction coil may be arranged in or on the door frame, and the receiving induction coil connected to the rechargeable battery via the control circuit may be arranged in or on a face plate of the locking device, so as to face the transmitting induction coil, so that the rechargeable battery is charged while the door is closed. In this regard, the control circuit may be configured to monitor the residual capacity of the rechargeable battery and send the information thereof to a user's device such as a remote control and smart phone.
(28) The locking device of a preferred embodiment further comprises an operation pad connected to the control circuit by a wireless or wired channel including at least two separated buttons. The operation pad may be arranged on an indoor side and/or outdoor side of a door. The control circuit is configured to actuate the electrically driven actuator unit to move the deadbolt blocking member to the unblocking position when the at least two buttons are pressed simultaneously. This provides adequate security particularly against unwanted child operation for the internal opening operation more than just a single press of a single button.
(29) Finally, the locking device may be a multi-point locking device which comprises one or more auxiliary locks at multiple points. The present invention is not limited thereto, and the locking device may be a single-point lock having at least one of the aforementioned aspects.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The principle of the invention will now be more fully described by way of example with reference to the accompanying drawings, in which:
(2) FIG. **1** is a side view of a locking device, with side covers removed for making inside visible, according to an embodiment of the present invention;
(3) FIG. **2** is a front view showing a face plate of the looking device of FIG. **1**;
(4) FIG. **3** is an enlarged view of a main lock as encompassed by circle A in FIG. **1**;
(5) FIG. **4** is a schematic view highlighting a link plate in thick line and most of other parts removed for clarifying the principle of the link plate;
(6) FIG. **5** illustrates how the deadbolt is moved in association with the movement of the link plate of FIG. **4**;
(7) FIG. **6** is an enlarged view of a mechanical power accumulating unit as encompassed by circle B in FIG. **1**;
(8) FIG. **7** is a schematic view illustrating the operation of the mechanical power accumulating unit in FIG. **6**;
(9) FIG. **8** is an enlarged view of an auxiliary lock as encompassed by circle C in FIG. **1**;
(10) FIG. **9** is an enlarged view of another auxiliary lock as encompassed by circle D in FIG. **1**;
(11) FIG. **10** is a schematic view highlighting a deadbolt blocking member in the main lock and illustrating how it works in association with the deadbolt and a electrically driven actuator unit;
(12) FIGS. **11**A-**11**C show a series of movements of the deadbolt blocking member by actuation of the electrically driven actuator unit;
(13) FIGS. **12**A-**12**C show a series of movements of a second slider of the deadbolt blocking member with respect to a first slider of the deadbolt blocking member by operation of a manual override mechanism; and
(14) FIG. **13** is a schematic view illustrating the positional relationship of Hall effect sensors within a printed circuit board with respect to the deadbolt blocking member and the deadbolt.
DETAILED DESCRIPTION
(15) FIG. **1** is a side view showing an overview of an example of a locking device **1** according to an embodiment of the present invention. The locking device **1** is for locking a closure such as a door, a window, or the like. This exemplary device is a multi-point lock with not only a main lock **10** but also one or more auxiliary locks **20**, **30**. The present invention, however, is not limited thereto and may be a single-point lock with only the main lock **10** provided. FIG. **1** also shows a mechanical power accumulating unit **40** for automatically locking or at least assisting the locking.
(16) The mechanical power accumulating unit **40** and the main lock **10**, the main lock **10** and the auxiliary lock **20**, as well as the mechanical power accumulating unit **40** and the auxiliary lock **30** are respectively connected to each other via a connecting rod **50***a*, **50***b*, **50***c*. Each connecting rods **50***a*, **50***b*, **50***c* is movable along and with respect to a face plate **60** to which the locks **10**, **20**, **30** and mechanical power accumulating unit **40** are fixed by means of screws or the like. Such screws can be seen in FIG. **2**.
(17) These locks **10**, **20**, **30** and mechanical power accumulating unit **40** will be placed in pockets formed in the front face of a door leaf facing a door frame, and fixed thereto via the face plate **60**.
(18) Referring to FIG. **3**, the main lock **10** is shown with a side cover removed for making the inside of a casing **102** visible. The main lock **10** includes a deadbolt **104**, a deadbolt blocking member **110**, an electrically driven actuator unit **120**, a link plate **130**, and a printed circuit board (PCB) **140** on which a control circuit is mounted.
(19) The main lock **10** may further include an operation part **150**, a manual override mechanism **160** and a latch assembly **170**.
(20) The deadbolt **104** is arranged so as to be movable between an advanced position wherein it protrudes from the front face of the casing **102** and a retreated position wherein it is retracted into

the casing **102**. The deadbolt **104** may engage with a cavity formed in the door frame in the advanced position to lock the door leaf with respect to the door frame. One or more guides **106** in the form of groove for guiding the deadbolt **104** may be provided in the casing **102**.

(21) The movement of the deadbolt **104** occurs in association with the movement of the link plate **130** in the direction of the long axis of the face plate **60**. FIG. **4** highlights the link plate **130** in thick line and most of other parts removed for clarifying the principle of the link plate **130**. The link plate **130** is slidable with respect to the casing **102** in the direction of the long axis of the face plate **60**. For this purpose, one or more pairs of guide grooves **108** and pins **132** are provided. These guide grooves **108** extend in the direction of the long axis of the face plate **60**. The upper end of the link plate **130** may be connected to the lower end of the first connecting rod **50***a*. The lower end of the link plate **130** may be connected to the upper end of the second connecting rod **50***b*.

(22) A cam groove **134** for receiving a follower pin **104***b* of the deadbolt **104** may be provided in the link plate **130**, so that the deadbolt **104** moves forward and backward in association with the movement of the link plate **130** in the direction of the long axis of the face plate **60**. The cam groove **134** extends obliquely with respect to the direction of the long axis of the face plate **60**. The follower pin **104***b* may also be received in one of the guide grooves **106** of the casing **102** that extends in the direction perpendicular to the long axis of the face plate **60**. The cam groove **134** and the follower pin **104***b* convert the movement of the link plate **130** in the first direction into the movement of the deadbolt **104** in the second direction perpendicular to the first direction. FIG. **5** shows how the deadbolt **104** moves forward and backward in the second direction (lateral direction in the figure) as the link plate **130** moves in the first direction (vertical direction in the figure).

(23) The link plate **130** may be driven by at least operation of the operation part **150**. The operation part **150** may be configured to move in association with the movement of the door handle or the like. Preferably, the operation part **150** may be fitted to a spindle (not shown) of the door handle or the like. The operation part **150** may include a radial groove **152**. The link plate **130** may include a pin **132** which is received in the radial groove **152**. Accordingly, when the operation part **150** rotates by lifting or lowering the door handle, the rotation is converted into a linear movement of the link plate **130** by engagement of the radial groove **152** and the pin **132**. The operation part **150** may move independently of a transmission plate **172** (FIG. **3**) that drives the latch assembly **170**.

(24) Referring to FIG. **6**, the detail of the mechanical power accumulating unit **40** can be seen. The mechanical power accumulating unit **40** is provided for moving, or at least assisting movement of, the link plate **130** so that the deadbolt **104** is automatically moved in association with the movement of the link plate **130**. The mechanical power accumulating unit **40** does not require electric power. Instead, the mechanical power accumulating unit **40** may temporarily accumulate energy from the force or torque generated by a user's operation of the door handle or the like and release it when activated. A spring **402** may be provided for that purpose. The spring **402** is preferably a compression coil spring. The axis of the coil spring **402** may be arranged in the direction of the long axis of the face plate **60**. The coil spring **402** may be guided by a guide shaft **404**. Alternatively, or additionally, a pair of repelling magnets may be used for accumulating the force.

(25) The mechanical power accumulating unit **40** may further include a holding mechanism **406** that releasably holds the spring **402** in a compressed state after the spring **402** has been compressed to accumulate the energy generated by operation of the operation part **150**. The holding mechanism **406** may include a connecting plate **408** that directly, or indirectly, connects the spring **402** to the link plate **130**, and a strike pin **410** that engages the connecting plate **408** to hold the compressed state of the spring **402**. More specifically, the connecting plate **408** is arranged in the casing of the mechanical power accumulating unit **40** so as to be movable in the direction of the long axis of the face plate **60**. The connecting plate **408** has an opening **408***a* with a step **408***b* on its edge near the face plate **60**. The strike pin **410** includes a main body **410***a*, a protrusion **410***b* located in the opening **408***a*, and a spring **410***c* for pressing the protrusion **410***b* against the edge of the opening

408.
(26) Referring to FIG. **7**, operation of the mechanical power accumulating unit **40** is illustrated. The spring **402** and the guide shaft **404** are not shown for the reason of simplicity. In the left-hand figure, the connecting plate **408** is lifted by operation of the operation part **150** to open the door against the spring **402**. The spring **402** becomes compressed and accumulates the force. The protrusion **410***b* of the strike pin **410** then engages with the step **408***b* of the connecting plate **408** to hold the compressed state. The tip of the strike pin **410** projects from the face plate **60** by a large amount.
(27) The right-hand figure shows the state of the mechanical power accumulating unit **40** after the door is closed from the open state in the left figure. When the door leaf is closed, the strike pin **410** is pushed by the door frame against the spring **410***c* (see arrow in the left-hand figure). The engagement of the protrusion **410***b* with the step **408***b* is released. The connecting plate **408** is thus pushed down while releasing the force accumulated within the spring **402**. The force of the spring **402** is further transmitted to the link plate **130** via the connecting rod **50***a*, and the link plate **130** is moved. The movement of the link plate **130** advances the deadbolt **104** as described with reference to FIG. **5**.
(28) FIGS. **8** and **9** illustrate details of the auxiliary locks **20**, **30**. The auxiliary locks **20**, **30** include auxiliary deadlocks **204**, **304** and auxiliary link plates **206**, **306** to which the connecting rods **50***b*, **50***c* are connected. The auxiliary link plates **206**, **306** are provided with cam grooves **206***a*, **306***a* for advancing and retracting the auxiliary deadbolts **204**, **304** in association with the movement of the auxiliary link plates **204**, **304**. The auxiliary deadbolts **204**, **304** include follower pins **204***a*, **304***a* received in the cam grooves **206***a*, **306***a*. The follower pin **204***a*, **304***a* are also received in guide grooves **202***a*, **302***a* formed in the casings **202**, **302**. As such, when the link plate **130** of the main lock **10** is moved by actuation of the operation unit **150** and/or the mechanical power accumulating unit **40**, the auxiliary link plates **206**, **306** is also moved in a synchronised manner, and the auxiliary deadbolts **204**, **304** are thus advanced or retracted by the engagement of the cam grooves **206***a*, **306***a* and follower pins **204***a*, **304***a*.
(29) FIG. **10** shows details of the electrically driven actuator unit **120** and of the deadbolt blocking member **110**.
(30) The electrically driven actuator unit **120** is provided for displacing the deadbolt blocking member **110** in an electromotive manner to block and unblock the deadbolt **104**. The electrically driven actuator unit **120** has an actuator **121** such as an electric motor, a solenoid, or the like. The exemplary actuator uses a DC motor. The actuation of the actuator **121** is controlled by the control circuit as described later.
(31) The electrically driven actuator unit **120** further includes a pinion **122** rotationally driven by the actuator **121**. The pinion **122** interacts with a rack **111** formed on the deadbolt blocking member **110**. When the pinion **122** is rotated in one direction, the deadbolt blocking member **110** is moved toward a location immediately behind the deadbolt **104**. When the pinion **122** is rotated in the reverse direction, the deadbolt blocking member **110** is moved away from the deadbolt **104**.
(32) Preferably, the electrically driven actuator unit **120** further includes a reduction gearbox **123** between the output shaft of the motor **121** and the pinon **122**. The ratio of the reduction gearbox **123** is designed to be high enough so that, once the deadbolt blocking member **110** is displaced between the blocking position and the unblocking position by actuation of the motor **121** and then the motor **121** is switched off, the deadbolt blocking member **110** remains in the same place against gravity or other forces. The gearbox **123** can also amplify the motor torque by conversion of speed into torque.
(33) The deadbolt blocking member **110** in a preferred embodiment includes a first slider **112** movable by actuation of the electrically driven actuator unit **120** and a second slider **113** slidably attached to the first slider **112**. The deadbolt blocking member **110** may further include a biasing member **114**, such as a spring, that applies a biasing force between the first slider **112** and the

second slider **113** so that the second slider **113** moves to the blocking position together with the first slider **112** when actuated by the electrically driven actuator unit **120**. This operation is shown in relation to FIGS. **11**A to **11**C. In FIG. **11**A, the deadbolt blocking member **110** is in the blocking position, blocking the retreat movement of the deadbolt **104**. In FIG. **11**B, the deadbolt blocking member **110** is moved toward the unblocking position by actuation of the electrically driven actuator unit **120**. During this operation, the first slider **112** and the second slider **113** move together via the biasing force of the biasing means **114**. In FIG. **11**C, the deadbolt blocking member **110** is in the unblocking position, allowing the deadbolt **104** to be retreated. The blocking operation of the deadbolt **104** can be made by the reverse operation.
(34) In connection with the deadbolt blocking member **110**, the locking device **1** may further include a manual override mechanism **160** for manually moving the second slider **113** with respect to, i.e., independently of, the first slider **112** to the unblocking position against the biasing force of the biasing member **114**. This is particularly in the event of an emergency, or when the electrically driven actuator unit **120** cannot be activated due to a power loss, failure, or the like.
(35) As shown in FIG. **10**, the manual override mechanism **160** may include a rack **161** formed on the second slider **113**, and a pinion **162** which is driven by a manual operation key (physical key) and which engages with the rack **161** to move the second slider **113** with respect to the first slider **112** against the biasing member **114**. The pinion **162** may be connected to a typical key cylinder such as Euro cylinder. Preferably, the pinion **162** is configured to be operated from the indoor side. In addition thereto, the pinion **162** may also be configured to be operated from the outdoor side. The operation of the manual override mechanism is shown in relation to FIGS. **12**A to **12**C. In FIG. **12**A, the deadbolt blocking member **110** is in the blocking position, blocking the retreat movement of the deadbolt **104**. In FIG. **12**B, only the second slider **113** is moved with respect to, i.e., independently of, the first slider **112** against the biasing means **114** toward the unblocking position, by actuation of the manual override mechanism **160**. The first slider **112** as well as the electrically driven actuator unit **120** are not activated. In FIG. **12**C, only the second slider **113** is in the unblocking position, thus allowing the deadbolt **104** to be retreated.
(36) In the operation of the manual override mechanism **160**, the second slider **113** therefore can move with respect to the first slider **112** in an isolated manner, allowing a means of activating the manual override mechanism **160** without transmitting torque to the electrically driven actuator unit **120**. This ensures that the manual override mechanism **160** can be easily operated with less human power.
(37) With reference to FIG. **13**, advantageous features are shown, that can be combined with any or all of the features described above. The locking device **1** may further include a first detector **141***c* which is configured to detect whether the deadbolt **104** is in the advanced position, thus allowing the deadbolt blocking member **110** to move to the blocking position. In such a case, the control circuit in the PCB **140** is configured to move the deadbolt blocking member **110** by actuation of the electrically driven actuator unit **120** when the first detector **141***c* detects the deadbolt **104** is in the advanced positon. The door handle operation, or the actuation of the mechanical power accumulating unit **160**, triggers the electrically driven actuator unit **120** to move the deadbolt blocking member **110** toward the blocking position. According to this configuration, the blocking of the deadbolt **104** is automatically performed upon the detection by the first detector **104***c*. In addition, wrong blocking operation is prevented. More specifically, if the deadbolt blocking member **110** is moved to the blocking position in spite of the deadbolt **104** being in the retracted position, the electrically driven actuator unit **120** may be overloaded and generate heat. Such a scenario is prevented by the control circuit associated with the first detector **141***c*.
(38) Preferably, the locking device **1** further includes a second detector **141***b* which is configured to detect whether the deadbolt blocking member **110** is in the blocking position. In such a case, the control circuit is configured to stop actuation of the electrically driven actuator unit **120** after moving the deadbolt blocking member **110** from the unblocking position to the blocking position.

According to this configuration, overload of the electrically driven actuator unit **120** after moving the deadbolt blocking member **110** from the unblocking position to the blocking position is prevented by the control circuit associated with the second detector **141***b*.

(39) Preferably, the locking device **1** further includes a third detector **141***a* which is configured to detect whether the deadbolt blocking member **110** is in the unblocking position. In such a case, the control circuit is configured to stop actuation of the electrically driven actuator unit **120** after moving the deadbolt blocking member **110** from the blocking position to the unblocking position. According to this configuration, overload of the electrically driven actuator unit **120** after moving the deadbolt blocking member **110** from the blocking position to the unblocking position is prevented by the control circuit associated with the third detector **141***a*.

(40) It is more preferable that at least one of these detectors **141***a* to **141***c* is a non-contact sensor. Examples of the non-contact sensor include a proximity sensor such as a Hall effect sensor or an electrostatic capacitance sensor, and a photoelectric sensor. A Hall effect sensor is preferred, as it does not deteriorate with dust, oil, lock shavings, etc. Also, Hall effect sensors are accurate, sensitive and function with accurate position measurement over a long period of time. A Hall effect sensor is therefore the most suitable for use within the locking device **1**, among other non-contact sensors. The detector is not however limited to the non-contact sensor. The detector may be a mechanical sensor such as a limit switch or a microswitch.

(41) In the case where each detector **141***a*, **141***b*, **141***c* is the Hall effect sensor, a respective magnet **116**, **104***c* to be detected by the Hall effect sensor is arranged in the deadbolt blocking member **110** and the deadbolt **104** so as to face the Hall effect sensor in the respected position to be detected.

(42) The control circuit in the PCB **140** may include a suitable controller or microprocessor to control the actuation of the electrically driven actuator unit **120** upon operation of an operation pad **142** which may be mounted on the door leaf to be operated by a user, and/or upon operation of one or more user's devices such as remote controllers and smart phones. The control circuit may further include a communication unit to communicate with the user's device or the like via a suitable communication interface.

(43) The control circuit may further include one or more memory units, such as RAM, for storing the controller's instructions or the like.

(44) The “user's device” means a device owned by any person who is authorised to access a room or place secured by a locking device according to the invention. Therefore, not only a user or a resident of the secured place, but also one or more persons, e.g., laundry and cleaning services, authorised by the user or the residence of the secured place or by administrative authority, or the like, may have one or more user's device.

(45) Examples of such a user's device are a mobile phone, smart phone, tablet, fob or remote control, or other smart home devices such as Amazon Alexa® or Google Assistant®. Any secured wireless communication technology, such as Bluetooth®, Wi-Fi, Z-wave, Radio Frequency Identification (RFID), or cellular broadband service may be used to communicate between the communication interface and the one or more user's devices.

(46) The control circuit may be fed with power from a battery. The battery may be a rechargeable battery and arranged inside the casing **102** of the main lock **10**. The battery may be charged in a contactless manner by means of electromagnetic induction. To this end, a primary or transmitting induction coil may be arranged in or on the door frame, and a secondary or receiving induction coil connected to the rechargeable battery via the control circuit may be arranged in or on the front plate **60** of the locking device **1**, so as to face the primary coil, so that the battery is charged while the door is closed. The control circuit may be configured to detect the residual capacity of the battery and send the information thereof to one or more user's device or the like if needed.

(47) Hereinafter, a particular example of the locking and unlocking operations of the locking device **1** will be described. In FIG. **1**, the door is closed, and the dead bolts **104**, **204**, **304** are in the advanced position, each engaging a corresponding cavity formed in the door frame. The locking

device **1**, and consequently the door, is thus in a so-called “locked” state. The deadbolt blocking member **110** is in the location immediately behind the deadbolt **104**, blocking the retreat movement of the deadbolt **104** (FIG. **11**A). The door is thus locked and secured.

(48) A user now operates a user device or the operation pad on the door leaf or the lock housing to unlock the door. To this end, the user may push the two separated buttons **143** on the operation pad, to have the control circuit actuate the electrically driven actuator unit **120** to move the deadbolt blocking member **110** to the unlocking position (FIG. **11**B). This is by way of example only, any form of signalling to the locking device **1** can be conceived to cause the control circuit to actuate the electrically driven actuator unit **120**. Examples include the use of a Bluetooth® connected device, a WiFi connected device, physical buttons located on the door, the door frame or the locking device **1** itself. The actuation of the electrically driven actuator unit **120** is stopped when the third detector **141***a* detects that the deadbolt blocking member **110** is in the unblocking positon. The user then can lift or lower the door handle to rotate the operation part **150** and thus to generate the upward movement of the link plate **130**. The upward movement of the link plate **130** not only leads to the retreat movement of the deadbolt **104** (FIG. **11***c*), but also generates the upward movement of the connecting plate **408** of the accumulating unit **40** via the first connecting rod **50***a* against the spring **402** to accumulate the mechanical energy within the spring **402** with the aid of the holding mechanism **406** (left image in FIG. **7**). The locking device **1**, and consequently the door, is now in an “unlocked” state, meaning that the user can open the door as desired.

(49) Once the door has been unlocked and opened as above, the locking device **1** will be in the unlocked state, such that the dead bolts **104**, **204**, **304** are each held within the door body. From this configuration, when the user closes the door, the strike pin **410** of the mechanical power accumulating unit **40** is pushed by the door frame against the spring **410***c*, releasing the accumulated energy to power a downward movement of the link plate **30**. The downward movement of the link plate **30** generates forward movement of the deadbolt **104** via the engagement of the cam groove **134** in the link plate **30** and the follower pin **104***b* of the deadbolt **104** (FIG. **5**). When the first detector **141***c* detects that the deadbolt **104** is successfully moved to the advanced position, the control circuit controls the electrically driven actuator unit **120** to move the deadbolt blocking member **110** to the blocking positon (FIG. **11**). The door is thus automatically locked and movement of the mechanism controlling the dead bolts **104**, **204**, **304** is blocked. The arrival of the deadbolt blocking member **110** at the blocking position is detected by the second detector **141***b*, causing the control circuit to stop the actuation of the electrically driven actuator unit **120**.

(50) In the event of an emergency, or when the electrically driven actuator unit **120** cannot be activated due to a power loss, failure, or the like, the user can manually unlock the door by operation of the manual override mechanism **160**. When the locking device **1** is in the locked state above and as shown in FIG. **1**, the user can move the second slider **113** of the deadbolt blocking member **110** with respect to the first slider **112**, against the biasing means **114**, to the unblocking position; this is achieved by rotating the pinion **162** of the manual override mechanism **160** with the manual operation key or physical key (FIGS. **12**A and **12**B) from indoor side and/or outdoor side. While holding the manual operation key in place, the user can lift or lower the door handle to retract the deadbolt **104** and to accumulate the mechanical power within in the mechanical power accumulating unit **40**. It is also conceivable that there is enough friction in the manual override mechanism **160** to hold the manual operation key in a location which counters the biasing means **114**, thus meaning that the second slider **113** of the deadbolt blocking member **110** remains in the unblocked orientation. The user now can open the door. When the door is closed again, the mechanical power accumulating unit **40** is activated in the manner described above to automatically lock the door again.

(51) Whilst the present invention has been illustrated by the description of example locking device, the Applicant does not intend to restrict or in any way limit the scope of the appended claims to

such detail. Additional modification will also readily appear to those skilled in the art. The Applicant does not intend to restrict or in any way limit the scope of the appended claims to that the locking device is supplied with a door and thus all electronics are well hidden. The locking device of the present invention may be an after-sales lock—and the electronics are prepared for the user/door or lock fitter to integrate.

(52) Further although the above-description describes the locking device being used in a door, it is conceivable that the locking device may be used in other types of closures, such as windows, gates, shutters, or the like.

LIST OF REFERENCE NUMERALS

(53) **1** Locking device **10** Main lock **20**, **30** Auxiliary lock **40** Mechanical power accumulating unit **50***a*-**50***c* Connecting rod **60** Face plate **104** Deadbolt **104***b* Follower pin **104***c* Magnet **110** Deadbolt blocking member **111** Rack **112** First slider **113** Second slider **120** Electrically driven actuator unit **121** Actuator (electric motor) **122** Pinion **123** Gearbox **130** Link plate **132** Pin **134** Cam groove **140** Printed circuit board **141***a*-**141***c* Hall effect sensor **150** Operation part **152** Radial groove **160** Manual override mechanism **161** Rack **162** Pinion **170** Latch assembly

Claims

1. A locking device having a deadbolt within a casing which deadbolt is movable between an advanced position wherein it protrudes from a front face of the casing and a retreated position wherein it is retracted into the casing, comprising: a link plate which moves the deadbolt to the advanced position; a deadbolt blocking member which is moveable between a blocking position blocking the deadbolt in the advanced position and an unblocking position to allow the deadbolt to move to the retreated position; an electrically driven actuator unit which moves the deadbolt blocking member between the blocking position and the unblocking position; and a control circuit configured to control the electrically driven actuator unit so that once the deadbolt is moved to the advanced position, the deadbolt blocking member is moved to the blocking position by actuation of the electrically driven actuator unit; the locking device further comprising a first detector which is configured to detect whether the deadbolt is in the advanced position, wherein the control circuit is configured to move the deadbolt blocking member by actuation of the electrically driven actuator unit when the first detector detects the deadbolt is in the advanced position, wherein the deadbolt blocking member does not contact the deadbolt when it moves to block the deadbolt.
2. The locking device according to claim 1, further comprising a second detector which is configured to detect whether the deadbolt blocking member is in the blocking position, wherein the control circuit is configured to stop actuation of the electrically driven actuator unit after moving the deadbolt blocking member from the unblocking position to the blocking position.
3. The locking device according to claim 1, further comprising a third detector which is configured to detect whether the deadbolt blocking member is in the unblocking position, wherein the control circuit is configured to stop actuation of the electrically driven actuator unit after moving the deadbolt blocking member from the blocking position to the unblocking position.
4. The locking device according to claim 1, wherein the first detector is a non-contact sensor.
5. The locking device according to claim 4, wherein the non-contact sensor is a Hall effect sensor.
6. The locking device according to claim 1, further comprising a mechanical power accumulating unit which accumulates energy and releases a force to move the link plate so that the deadbolt is moved in association with the movement of the link plate.
7. The locking device according to claim 6, wherein the mechanical power accumulating unit includes a spring which directly, or indirectly, provides the force for moving the deadbolt to the advanced position.
8. The locking device according to claim 7, wherein the mechanical power accumulating unit includes a holding mechanism that releasably holds the spring in a compressed state after the spring

has been compressed.
9. The locking device according to claim 8, wherein the holding mechanism includes a connecting plate that directly or indirectly connects the spring to the link plate, and a strike pin that engages the connecting plate to hold the spring in its compressed state, wherein the strike pin is movable out of engagement with the connecting plate so that the mechanical power accumulating unit directly or indirectly moves the link plate.
10. The locking device according to claim 6, wherein the link plate is configured to convert the force released from the mechanical power accumulating unit into the advancing movement of the deadbolt to the advanced position.
11. The locking device according to claim 6, further comprising an operation part that moves the link plate against the mechanical power accumulating unit to accumulate the force.
12. The locking device according to claim 1, wherein in the blocking position the deadbolt blocking member is positioned immediately behind the deadbolt but with a gap therebetween.
13. The locking device according to claim 1, wherein the deadbolt blocking member includes: a first slider moveable by actuation of the electrically driven actuator unit; a second slider slidably mounted on the first slider; a biasing member that applies a biasing force between the first slider and the second slider to move the second slider to the blocking position together with the first slider during actuation of the electrically driven actuator unit; and a manual override mechanism to move the second slider with respect to the first slider to the unblocking position against the biasing force of the biasing member.
14. The locking device according to claim 13, wherein the manual override mechanism includes a rack, which is formed on the second slider and a pinion, which is driven with a manual operation key by a user and engages with the rack to move the second slider with respect to the first slider.
15. The locking device according to claim 1, further comprising: a rechargeable battery configured to provide electrical power to the control circuit; and an inductive coil coupled to the rechargeable battery, the inductive coil being configured to wirelessly receive power from an external device that is positioned proximate to the locking device.
16. The locking device according to claim 15, wherein the inductive coil is positioned on or in a face plate of the locking device.
17. The locking device according to claim 1, further comprising an operation pad connected to the control circuit by a wireless or wired channel and including at least two separated buttons, wherein the control circuit is configured to actuate the electrically driven actuator unit to move the deadbolt blocking member to the unlocking position when the at least two buttons are pressed simultaneously.
18. The locking device according to claim 1, which is a multi-point locking device comprising one or more auxiliary locks at multiple points.