

ELECTROMECHANICAL LOCK ASSEMBLY AND METHOD OF OPERATION THEREOF

FIELD OF THE INVENTION

The present invention relates to an electromechanical lock assembly with a bias clutch that enforces a rotational coupling between an interface and an inner cylinder.

BACKGROUND

Despite being used to secure property and assets for thousands of years, mechanical locks have numerous vulnerabilities, much of which are centred on the key. For example, a misplaced key creates a potential security vulnerability that can only be rectified by replacing the mechanical lock. Since a mechanical lock can be opened by anyone with a key, unauthorised duplication of the key by an authorised individual can lead to a security breach that is difficult to detect especially without external security devices such as close circuit televisions to monitor the access point in question. Lastly, the lack of a key may not necessarily serve as a barrier to entry since mechanical can be picked by a trained individual.

The shortcomings of mechanical locks are exacerbated in modern commercial and industrial settings where numerous keys may be in active circulation at any given time which makes inventory management of the keys challenging and increases the likelihood of keys going missing and undetected.

Electromechanical locks and associated smart keys combine the deliberateness of mechanical locks with the ability to electronically control any lock or key remotely along with on demand access to audit information. Keys can be configured to operate on a time, date and access level basis allowing high levels of granularity in access control granted. Electromechanical lock cylinders can seamlessly integrate into existing security infrastructure by the simple replacement of mechanical lock cylinders.

There still exists an unmet need to reduce the biggest barrier to mass market acceptance, namely costs by way of electromechanical lock cylinder design that is less reliant on complex control circuits and costly motor implementations for unlocking and returning the lock to a locked state.

SUMMARY OF THE INVENTION

A primary embodiment of the invention is an electromechanical lock assembly comprising an interface rotatable around a longitudinal axis, an inner cylinder disposed within the interface
5 and rotatable around the longitudinal axis, a clutch disposed within the inner cylinder and rotatable between a disengaged position and an engaged position that enforces a rotational coupling of the interface and the inner cylinder and a motor configured to rotate the clutch to the engaged position, wherein the clutch is bias towards the disengaged position.

Optionally, the motor is operable to hold the clutch at the engaged position. Optionally, the
10 clutch is held at the engaged position for a predetermined duration. Optionally, while the clutch is in the engaged position, the interface and the inner cylinder are rotatable to enforce a fall-back coupling between the interface and the inner cylinder. Optionally, the interface and the inner cylinder have a locked position wherein the fall-back coupling is disengaged when the interface and the inner cylinder are rotated to the locked position.

15 Optionally, the electromechanical lock assembly further comprises a first coupling member wherein, while the clutch is in the disengaged position, the first coupling member is freely disposed within a first cavity defined by the interface, the inner cylinder and the clutch, and while the clutch is in the engaged position, the first coupling member is disposed within a second cavity defined by the interface and the inner cylinder to enforce the rotational
20 coupling.

Optionally, the electromechanical lock assembly further comprises a second coupling member wherein, while the clutch is in the disengaged position, the second coupling member is freely disposed within a third cavity defined by the interface, the inner cylinder and the clutch, and while the clutch is in the engaged position, the second coupling member
25 is disposed within a fourth cavity defined by the interface and the inner cylinder to enforce the rotational coupling.

Optionally, the electromechanical lock assembly further comprises a fixed outer cylinder in which the interface is disposed, and a fall-back coupling member disposed within a fifth cavity defined by the interface and the inner cylinder to enforce the fall-back coupling while
30 the interface and the inner cylinder are being rotated.

Optionally, the fall-back coupling member is biased radially outwards from the longitudinal axis, and when the interface and the inner cylinder are in the locked position, the fall-back coupling member resides in a sixth cavity defined by the outer cylinder and the interface.

An alternate embodiment of the invention is a method of operating an electromechanical lock comprising the steps of biasing a clutch towards and at a disengaged position, receiving and authenticating security credentials, rotating a clutch at an engaged position, holding the clutch at the engaged position to enforce a rotational coupling between an interface and an inner cylinder, rotating the interface and the inner cylinder away from a locked position to enforce a fall-back coupling between the interface and the inner cylinder, releasing the clutch to disengage the rotational coupling, and rotating the interface and the inner cylinder to the locked position to disengage the fall-back coupling.

The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 depicts an exploded view of the lock assembly.

Fig. 2A, 2B, 2C and 2D depict sectional views of the assembled lock assembly in some embodiments in various states of operation.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. The illustrative embodiments described in the detailed description, drawings and claims are not meant to be limiting. Other embodiments can be utilized, and other changes can be made, without departing from the spirit or scope of the subject matter presented herein.

Referring to Fig. 1, an embodiment of the invention is an electromechanical lock assembly as part of an electromechanical lock comprising an interface **101** rotatable around a longitudinal axis **118**, an inner cylinder **102** disposed within the interface **101** and rotatable around the longitudinal axis **118**, a clutch **103** disposed within the inner cylinder **102** and rotatable between a disengaged position and an engaged position and a motor **104** configured to rotate the clutch **103** to the engaged position. While the clutch **103** is in the disengaged position, the interface **101** and inner cylinder **102** are capable of rotating independently from one another. It will be understood that any electric motor that produces sufficient torque to overcome the bias of the torsion spring **105** including but not limited to a DC motor, an AC motor, a stepper motor and a servo motor may be employed in this manner.

The clutch **103** is biased towards the disengaged position by a biasing means **105** such as a torsion spring. Any device that, while the clutch **103** is being rotated to the engaged position, exerts torque in an opposite direction from that of the torque from motor **104** and stores the accumulated mechanical energy therein may be used as the biasing means **105**.

- 5 The inner cylinder **102** may be associated on one end with a key connector **114** that permits the insertion of a corresponding key (not depicted) such that the inner cylinder **102** can be rotated by a corresponding rotation of the key. Once inserted into the key connector **114**, the key transmits security credentials to a control circuit (not depicted). The control circuit may include a microprocessor and associated memory for verifying the security credentials. Upon
- 10 successful authentication, the control circuit sends a signal to the motor **104** to rotate a shaft (not depicted) which in turn overcomes the clutch **103** bias and rotates the clutch **103** from the disengaged position to the engaged position. While in the engaged position, the clutch **103** places the lock assembly **100** in a mechanically ununlockable state by enforcing the rotational coupling of the inner cylinder **102** to the interface **101**. The interface **101** is
- 15 operably attached to a securing means **115**, for which non-limiting examples include a latch (as depicted in Fig. 1) or a deadbolt. Any means of securing the lock that is operable by the rotation of the interface **101** may be used as the securing means **115**. Therefore, by rotating the key, and in doing so, and, by way of inner cylinder **102** and interface **101**, the securing means **115**, the lock assembly **100** can be mechanically unlocked so long as the clutch **103**
- 20 remains in the engaged position. Alternatively, the inner cylinder **101** may be rotatable (not depicted) by a handle or knob in place of directly rotating the key. While in the disengaged position, rotating the inner cylinder **102** by way of the key is unproductive as the inner cylinder **102** remains uncoupled to the interface **101**. When torque from the motor **104** is no longer being transmitted to the clutch **103**, the clutch **103** is spontaneously returned to the
- 25 disengaged position by the release of stored mechanical energy from the biasing means **105**.

The biased clutch **103** is advantageous as it reduces/eliminates the need for more complex control circuits which require the motor **104** to have a degree of positional awareness in order to move the clutch from the disengaged position to the engaged position and back.

- 30 In some embodiments, the clutch **103** can be held at the engaged position by the constant application of torque supplied to the motor **104** and a physical barrier (not depicted) that prevents the clutch **103** from otherwise rotating past the engaged position. In some embodiments, the control circuit is configured to cut power to the motor **104** after a predetermined duration has passed, thus returning the clutch **103** to a disengaged position.
- 35 This is advantageous as it spares the motor **104** from running longer than necessary to

reduce wear and from a security standpoint, in that the assembly is not mechanically unlockable for longer than necessary thus ensuring that the assembly is not in an unlockable state for longer than necessary.

Referring to Figs. 2A and 2B, rotational coupling of the inner cylinder **102** to the interface **101** via the clutch **103** is achieved in some embodiments by a first coupling member **106** such as a ball bearing as depicted in the figures. It will be readily understood that first coupling member **106** may take any shape so long as it facilitates the coupling of the interface **101** and inner cylinder **102**.

Referring to Fig. 2A, when the clutch **103** is in the disengaged position, the first coupling member **106** is disposed freely within a first cavity **201**. The first cavity **201** is a continuous space formed by the alignment of, along a radial plane, a recess in the clutch **103**, an opening spanning the full thickness of the inner cylinder **102** and a recess in the interface **101**, the opening serving as channel that allows the first coupling member **106** to move between the recesses. Rotational coupling is not achieved via the first coupling member **106** while it is free to move within the first cavity **201**.

Referring to Fig. 2B, when the clutch **103** is in the engaged position, the recess in the clutch **103** is no longer continuous with the first cavity **201** thus giving rise to a second cavity **202** consisting of the opening in the inner cylinder **102** and the recess in the interface **101**. The recess in the clutch **103** is shallow relative to the diameter of the first coupling member **106** to ensure that when the clutch **103** is in the engaged position, the first coupling member **106** will reside within the second cavity **202** and not within the recess in the clutch **103**. The recess in the interface **101** is shaped to match the shape of the first coupling member **106** to allow the first coupling member **106** to transmit torque from the inner cylinder **102** to the interface **101**. While a single coupling member is sufficient, in some embodiments and as depicted in Figs. 2A-2F, a second coupling member **107** along with a corresponding third cavity **203** and fourth cavity **204** may be employed in a manner similar to that of the first cavity to provide additional reliability. Further coupling members employed in similar fashion are likewise within the scope of the invention. The clutch is mounted such that while the inner cylinder **102** is rotating around the longitudinal axis **118**, the position of the inner cylinder **102** relative to that of the clutch **103** remains unchanged. While in the position as depicted in Fig. 2A and 2B, the rotationally coupled inner cylinder **102** and interface **101** are said to be in a locked position.

In some embodiments, a fall-back coupling between the interface **101** and inner cylinder **102** is engaged to enforce rotational coupling between the interface **101** and inner cylinder **102** when, while the clutch **103** is engaged, the interface **101** and the inner cylinder **102** are

rotated away from the locked position. This rotational coupling is independent from that achieved by way of the clutch **103** and can in fact be concurrent till the clutch **103** returns to the disengaged position. In this manner, rotational coupling between the interface **101** and inner cylinder **102** can be maintained even when the clutch **103** is disengaged.

- 5 The fall-back coupling is thus advantageous as it allows the inner cylinder **101** and interface **102** at the unlocked position (as depicted in Fig. 2C and 2D) to be rotated back to the locked position regardless of whether the user still has permission to access the lock in question. For example, if a user who unlocks the electromechanical lock assembly forgets to lock it before his or her time-based access expires and after the clutch **103** has disengaged, the
10 user can nevertheless return the interface **101** and inner cylinder **102** to the locked position, thus avoiding a scenario that would leave the lock in an unlocked state without immediate means of returning it to a locked state, thus allowing the property or asset to be re-secured without external intervention.

Referring to Figs. 2A and 2B, in some embodiments, the fall-back coupling is achieved by
15 the inclusion of a fixed outer cylinder **116** in which the interface **101** is disposed and a fall-back coupling member **112**. The outer cylinder **116** is fixed in that it is incapable of independent rotation about the longitudinal axis **118**. While in the locked position, the fall-back coupling member **112** is disposed within a sixth cavity **205**. The sixth cavity **205** is a continuous space formed by the alignment of, along a radial plane, a recess in the outer
20 cylinder **116** and an opening spanning the full thickness of the interface **101**. The fall-back coupling member **112** is bias radially outwards towards the outer cylinder **116** by a resilient means **113** such as a compression spring as depicted in Figs. 2A-2D.

Referring to Figs. 2C and 2D, when rotated away from the locked position, the recess of the outer cylinder **116** ceases to be aligned and accordingly is no longer continuous with the
25 opening on the interface **101**, thus giving rise to a sixth cavity **205** formed by the opening of the interface **101** and an opening spanning the full thickness of the inner cylinder **102**. The fall-back coupling member **112** having been displaced from its position within the recess of the outer cylinder **118**, migrates radially inwards towards the longitudinal axis **118** into the sixth cavity **205**. Now spanning both the interface **101** and inner cylinder **102**, the fall-back
30 coupling member **112** effectively enforces coupling between the aforementioned even when the clutch **103** has returned to the disengage position as depicted in Fig. 2D. It should be noted that for the purposes of enforcing coupling, a recess in place of the opening on the inner cylinder **102** is sufficient to enforce the coupling so long as it is sufficient depth to adequately accommodate a sufficient length of the fall-back coupling member **112**.

The fall-back coupling is maintained till the inner cylinder **102** and interface **101** are rotated back to the locked position where the recess of the outer cylinder **116** is aligned with the opening on the interface **101**, giving rise once again to the fifth cavity **206** which results in the bias fall-back coupling member migrating into fifth cavity **205** by way of the resilient means **113** thus disengaging the fall-back coupling.

This allows the fall-back coupling to disengage after performing its intended function, that is to allow the inner cylinder **102** and interface to be rotated back to the locked position thus resetting the lock assembly to a locked and ready-to-accept-key state.

CLAIMS

1. An electromechanical lock assembly comprising:
an interface rotatable around a longitudinal axis;
an inner cylinder disposed within the interface and rotatable around the longitudinal axis;
5 a clutch disposed within the inner cylinder, rotatable between:
a disengaged position, and
an engaged position, that enforces a rotational coupling of the interface and the inner cylinder; and
a motor configured to rotate the clutch to the engaged position;
10 wherein the clutch is bias towards the disengaged position.
2. The electromechanical lock assembly according to claim 1, wherein the motor is operable to hold the clutch at the engaged position.
3. The electromechanical lock assembly according to claim 2, wherein the clutch is held at the engaged position for a predetermined duration.
- 15 4. The electromechanical lock assembly according to any of claims 1-3, wherein while the clutch is in the engaged position, the interface and the inner cylinder are rotatable to enforce a fall-back coupling between the interface and the inner cylinder.
5. The electromechanical lock assembly according to claim 4, wherein the interface and the inner cylinder have a locked position; and wherein the fall-back coupling is disengaged
20 when the interface and the inner cylinder are rotated to the locked position.
6. The electromechanical lock assembly according to any of claims 1-5, further comprising a first coupling member;
wherein,
while the clutch is in the disengaged position, the first coupling member is freely disposed
25 within a first cavity defined by the interface, the inner cylinder and the clutch; and
while the clutch is in the engaged position, the first coupling member is disposed within a second cavity defined by the interface and the inner cylinder to enforce the rotational coupling.

7. The electromechanical lock assembly according to any of claims 1-6, further comprising:

a second coupling member;

wherein while the clutch is in the disengaged position, the second coupling member is freely
5 disposed within a third cavity defined by the interface, the inner cylinder and the clutch; and

while the clutch is in the engaged position, the second coupling member is disposed within a fourth cavity defined by the interface and the inner cylinder to enforce the rotational coupling.

8. The electromechanical lock assembly according to claim 7, further comprising:

a fixed outer cylinder in which the interface is disposed; and

10 a fall-back coupling member disposed within a fifth cavity defined by the interface and the inner cylinder to enforce the fall-back coupling while the interface and the inner cylinder are being rotated.

9. The electromechanical lock assembly according to claim 8, wherein the fall-back coupling member is biased radially outwards from the longitudinal axis; and

15 when the interface and the inner cylinder are in the locked position, the fall-back coupling member resides in a sixth cavity defined by the outer cylinder and the interface.

10. A method of operating an electromechanical lock comprising the steps of:

biasing a clutch towards and at a disengaged position;

receiving and authenticating security credentials;

20 rotating a clutch at an engaged position;

holding the clutch at the engaged position to enforce a rotational coupling between an interface and an inner cylinder;

rotating the interface and the inner cylinder away from a locked position to enforce a fall-back coupling between the interface and the inner cylinder;

25 releasing the clutch to disengage the rotational coupling; and

rotating the interface and the inner cylinder to the locked position to disengage the fall-back coupling.