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(54) ELECTROMECHANICAL LOCK WITH AN ELECTRIC ACTUATOR

(57) Electromechanical lock with an electrical actuator (30) which actuator comprises; an electrical motor (32) having an output shaft (34) which is bi-directionally rotatable about a rotational axis, an external helical thread (36) comprising a crest (36b), a root (36a) and flanks (36c, 36d) connecting the crest (36b) and the root (36a), which thread (36) is connected to the output shaft (34), and a linearly displaceable sled (38) comprising an engagement portion (54) which is arranged to engage the external thread (36) for, in a first operation mode, driving the sled (38) longitudinally along the rotational axis upon rotation of the output shaft (34). The engagement portion (54) is arranged to, in a second operation mode, slide over the crest (36b) of the external thread (36) for allowing longitudinal displacement of the sled (38) irrespective of whether the external thread (36) is rotating or not.

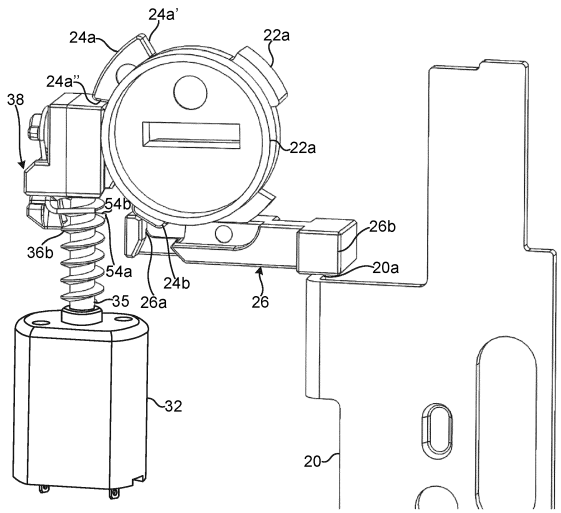

Fig. 5A

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of electromechanical locks and, in particular, to an electromechanical lock provided with an electric actuator arranged to accomplish certain actuation operations within the lock.

BACKGROUND

[0002] Electromechanical locks typically comprise a lock housing and a lock mechanism received in the housing for driving at least one lock bolt between a locking position, in which the bolt protrudes out from the housing and an opening position, in which the bolt is retracted into the housing. At some variants, the locks comprise manually operable means such as handles, thumb turns and key operated lock cylinders for driving the bolt between the locked and the opening positions. In cases where key operated lock cylinders are present, these lock cylinders provide one means of verifying the authority of the person operating the cylinder by means of the coded key. The electromechanical locks may additionally or alternatively be provided with electronic means for verifying the authority of person operating the lock. Such electronic authorisation verification means may comprise e.g. a keypad for entering an authorisation code, an RFID-tag reader, or readers for Bluetooth, Bluetooth Low Energy (BLE), Ultra Wideband Radio (UWB) or IEEE 802.15.x communication with a handheld device or the like. A further alternative for verifying the authority is so called galvanic readers which may be arranged in the keyway of a lock cylinder and which is arranged to communicate galvanically with a code carrying memory arranged e.g. on a key which is insertable in the keyway of the cylinder.

[0003] In addition to or as an alternative to means for manually driving the bolt(s) from the locking position to the opening position, electromechanical locks may also be provided with motors or other electrical means for driving the lock bolt(s).

[0004] Such electromechanical locks comprising electronic means for reading a verification code presented by the person intending to operate the lock often comprise an electric actuator which is controlled electrically in response to whether or not a correct authorisation code has been presented. Typically, the actuator is arranged to block the lock mechanism such that at least one lock bolt may not be retracted to the opening position unless a correct verification code has been received by the code reading means. Correspondingly, if a correct verification code has been presented, the actuator unblocks the lock mechanism such that the lock bolt(s) may be retracted to the opening position.

[0005] The actuator may be arranged in the lock housing for interacting with the lock mechanism. Alternatively, the actuator may be arranged in a lock cylinder of the electromechanical lock for selectively allowing and preventing the core of the lock cylinder to rotate relative to the cylinder housing. Often, the actuator is arranged to drive a blocking member rectilinearly between a blocking position and a releasing position. In some cases, a rectilinear output movement from the actuator may be translated into a rotational or pivotal movement by means of a follower or other linear-to-rotational movement conversion devices. The movement generating means of the actuator may comprise e.g. a solenoid, such as a linear solenoid or an electric motor.

[0006] EP2314809B1 discloses an electromechanical lock cylinder comprising an electrical motor, the output shaft of which is connected to a rotational threaded spindle. A carriage comprises a U-shaped spring element having an elastic longer arm and an elastic shorter arm which arms are mutually connected by means of an intermediate arm. The longer arm engages the valleys of the spindle such that the carriage is driven rectilinearly back and forth upon rotation of the spindle in a corresponding rotational direction.

SUMMARY

[0007] An object of the present invention is to provide an electromechanical lock comprising an enhanced actuator.

[0008] Another object is to provide such an electromechanical lock at which the actuator may be overridden.

[0009] A further object is to provide such an electromechanical lock providing increased safety by allowing manual opening of the lock from the inside of a door e.g. in the event of power loss or other failure of the electrical operation of the actuator.

[0010] Yet another object is to provide such an electromechanical lock wherein the actuator requires only a limited space.

[0011] Still another object is to provide such an electromechanical lock at which the actuator may be driven at low power consumption.

[0012] A further object is to provide such an electromechanical lock which may be both electrically operated for locking and manually operated for unlocking the electromechanical lock.

[0013] These and other objects are achieved by an electromechanical lock as set out in appended claim 1. The electromechanical lock has an electrical actuator. The actuator comprises; an electrical motor having an output shaft which is bi-directionally rotatable about a rotational axis, an external helical thread comprising a crest, a root and flanks connecting the crest and the root, which thread is connected to the output shaft, a linearly displaceable sled comprising an engagement portion which is arranged to engage the external thread for, in a first operation mode, driving the sled longitudinally along the rotational axis upon rotation of the output shaft. The engagement portion is further arranged to, in a second operation mode, slide over the crest of the external thread

for allowing longitudinal displacement of the sled irrespective of whether the output shaft is rotating or not.

[0014] In the first operation mode, the actuator may be used to electrically drive a blocking member of the lock mechanism to and from a blocking position, in which blocking position retraction of a lock bolt to an opening position is prevented. Hence, in the first operation mode, the actuator may be used to allow un-locking of the lock only after the presentation of a correct authorization code. After the presentation of a correct code, the actuator drives the blocking member from the blocking position such that the lock bolt may be retracted e.g. by means of depressing a door handle connected to the lock mechanism in the lock. In the first operation mode the actuator may also be used for electrically driving the blocking member to the blocking position to thereby lock the electromechanical lock. The actuator may be controlled to automatically initiate such driving of the blocking member to the blocking position when the door is closed. Alternatively, the actuator may be controlled to initiate such blocking after presentation of a correct verification code. It is also possible that e.g. a thumb turn on the inside of the door is electrically connected to the actuator such that turning the thumb turn in one direction initiates the actuator to electrically drive the blocking member to the blocking position and turning the thumb turn in the opposite direction initiates the actuator to electrically drive the blocking member to the non-blocking position.

[0015] In the second operation mode, where the engagement portion is allowed to slide over the crest of the thread, the operation of the actuator may be overridden. For example, the sled may be mechanically connected to a thumb turn or the like arranged on the inside of the door provided with the electromechanical lock. In such cases, the second operation mode allows for that the thumb turn may be used to manually override the actuator such that the blocking member may be driven from the blocking position by manually turning the thumb turn. Thus, the second operation mode allows for that the lock may be unlocked and the door opened from the inside also in cases where no correct authorization code has been presented and thereby where the motor of the actuator has not been rotated. The second operation mode also allows for that the lock may be manually un-locked from the inside in case of low battery or other failure of the actuator.

[0016] The electromechanical lock according to the invention thus provide an efficient means to combine electrical and manual manoeuvring of the lock. Especially, the lock allows to manually override the electric operation of the actuator.

[0017] According to embodiments of the invention, the engagement portion may comprise at least one resilient leg, which, in the first operation mode, is arranged to engage between flanks of the external thread.

[0018] The engagement portion may comprise two resilient legs which, in the first operation mode, are arranged to engage the flanks of the external thread at mutually opposite sides of the external thread.

[0019] The engagement portion may form part of an engagement member which further comprises a fixation portion which is fixed to the sled.

[0020] The fixation portion and the engagement portion of the engagement member may be formed as an integral part of a wire spring material.

[0021] The fixation portion may comprise a torsional spring.

[0022] The sled may exhibit a longitudinal channel which is arranged to receive the external thread.

[0023] The electromechanical lock may further comprise a lock housing which receives the actuator and a lock mechanism comprising at least one lock bolt which is movable between a retracted opening position and a locking position, in which the lock bolt protrudes out from the lock housing.

[0024] The lock housing may comprise guide means for rectilinear guiding of the sled.

[0025] The electromechanical lock may further comprise a manually rotatable follower which is received in the lock housing, wherein the actuator, in the first operation mode, is arranged to rotate the follower by transmitting the linear displacement of the sled into a rotational movement of the follower and wherein the follower, in the second operation mode, is arranged to linearly displace the sled relative to the external thread by forcing the engagement portion to slide over the crest of the external sled.

[0026] The rotatable follower may be arranged to drive a blocking member between a release position in which the lock bolt is allowed to be retracted to the opening position and a blocking position in which the lock bolt is prevented from being retracted to the opening position.

[0027] At embodiments the actuator may be arranged, in the first operation mode, to drive the lock bolt from the retracted opening position to the locking position and, in the second operation mode, to allow manual retraction of the bolt from the locking position to the opening position.

[0028] Further objects and advantages of the invention will appear from the following description and from the appended claims.

[0029] Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the element, apparatus, component, means, step, etc." are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] Aspects and embodiments are now described, by way of example, with reference to the accompanying

drawings, in which:

Fig 1. is an elevation view of an electromechanical lock with some parts removed according to an embodiment of the invention.

Figs. 2a-c are perspective views in enlarged scale showing some parts of the electromechanical lock shown in fig. 1 when assuming different locking states in a first operation mode.

Figs 3a and 3b are exploded views from different angles of an actuator comprised in the electromechanical lock shown in fig. 1.

Fig. 4a and 4b are elevation views of the actuator shown in figs. 2a-c showing the actuator in an assembled state and in two different operation modes.

Figs.5a-c are perspective views corresponding to figs. 2a-c, showing the different locking states in a second operation mode.

DETAILED DESCRIPTION

[0031] The aspects of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments of the invention are shown.

[0032] These aspects may, however, be embodied in many different forms and should not be construed as limiting; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and to fully convey the scope of all aspects of invention to those skilled in the art. Like numbers refer to like elements throughout the description.

[0033] Figs. 1 illustrate an electromechanical lock according to an exemplifying embodiment of the invention. The electromechanical lock comprises a housing or a lock case 10 which is fixed to a forend 12. In the drawings, a case cover has been removed for showing the inside of the electromechanical lock. A hook bolt 14 and a latch bolt 16 are arranged such that they may be driven between a respective protruding locking position (shown in fig. 1) and a respective retracted opening position. The lock further comprises a lock mechanism arranged in the housing 10. In the shown example the lock mechanism comprises, among other components, a first rotatable follower 18 which may be connected to e.g. a door handle (not shown) for manoeuvring the lock bolts 14, 16. The first follower 18 is mechanically connected to the lock bolts 14, 16 by means incorporating a rectilinearly displaceable plate member 20. The lock mechanism is arranged such that upward (as seen in the drawings) displacement of the plate member 20 retracts the bolts to their opening positions and downward displacement of the plate member 20 drives the bolts 14, 16 to their respective protruding locking position. In the shown example, the first follower 18 is connected to the lock bolts 14, 16, via the plate member 20 such that depression of a handle (not shown) connected to the first follower 18, retracts the lock bolts 14, 16. For ejecting the lock bolts 14, 15 to the protruding locking position, a spring 23 urges the plate member 20 downwardly (as seen in the drawings) for driving the lock bolts to the protruding locking position. The spring 23 is loaded when the plate member 20 is driven upwards by depressing the handle. A latch mechanism (not shown) retains the plate member 20 in the upper position and the spring in the loaded state after releasing the door handle. A door position sensing means (not shown) such as a latch or trigger bolt, a micro switch or a magnetic sensor is mechanically or electrically connected to the latch mechanism for releasing the latch mechanism to thereby eject the lock bolts 14, 16 when the door reaches its closed position. Thereby, the lock bolts are automatically driven to their protruding locking position when the door is closed.

[0034] With reference to figs. 1 and 2a-c, the lock mechanism further comprises a second rotatable follower 22 which is connectable to a thumb turn (not shown) arranged on the inside of the door carrying the electromechanical lock. The second follower 22 is arranged to cooperate with an auxiliary rotatable follower 24 which is arranged coaxially under the second follower as seen in the figures. The second follower 22 has a downwardly projecting tab 22a and the auxiliary follower has a first 24a, a second 24b and a third 24c radially protruding lug. Upon anti-clockwise rotation of the second follower 22, the downwardly projecting tab 22a engages a first drive surface 24a' of the first radially protruding lug 24a, thereby driving the auxiliary follower in the anti-clockwise direction as shown in the drawings. It may be noted that, during rotation of the second follower 22 in the clockwise direction, the downwardly projecting tab 22b will not make contact with any portion of the auxiliary follower such that clockwise rotation of the second follower will not influence the rotational position of the auxiliary follower 24.

[0035] The second radially protruding lug 24b is received in a recess 26a arranged in a rectilinearly displaceable blocking member 26. Upon rotation of the auxiliary follower 24 in the clockwise direction, the second lug 24b engages the recess 26a such that the blocking member 26 is driven rectilinearly to the left as seen in the drawings. The blocking member 26 then reaches its leftmost blocking position as shown in fig. 2c. In this blocking position an upwardly projecting cuboid stop 26b arranged at the right most end of the blocking member 26 is positioned aligned with a downwardly bent flap 20a of the plate member 20. In this blocking position (se fig. 2b) any attempt to displace the plate member 20 upwardly for retracting the bolts 14, 16 will result in that the flap 20a of the plate member 20 strikes the cuboid stop 26b to thereby preventing any further upwards displacement of the plate member 20. Hence, in this blocking position of the blocking member 26, the cuboid stop 26b prevents

upward displacement of the plate member 20 such that the bolts cannot be retracted to their opening positions and the door thus remain locked.

[0036] When starting out from the blocking position of the blocking member 26 shown in fig. 2c, anti-clockwise rotation of the auxiliary follower 24 causes the blocking member 26 to be displaced to its rightmost non-blocking, opening position shown in fig 2a. In this position the downwardly projecting flap 20a of the plate member goes free from the cuboid stop 26b, such that the plate member 20, in this position may be displaced upwardly for retracting the bolts 14, 16 to their respective opening positions. I.e. in this non-blocking position of the blocking member 26, the electromechanical lock is un-locked and the door may be opened by depressing a handle (not shown) connected to the first follower 18.

[0037] The electromechanical lock further comprises an actuator 30 arranged to drive the auxiliary follower to rotation in the clockwise and anti-clockwise directions. As best seen in figs 3a and 3b, the actuator 30 comprises an electrical motor 32 having a rotational output shaft 34. A shaft sleeve 36 is fixed to the output shaft 32 such that it rotates together with the output shaft 34. The shaft sleeve 36 is provided with an external thread 36 exhibiting a root 36a, a crest 36b and flanks 36c, 36d connecting the root 36a and crest 36b. In the shown example, the shaft sleeve 35 with external thread 36 is fixed onto the output shaft 34. However, the external thread may be connected to the output shaft also in other ways. For example, the external thread may be connected to the output shaft by means of a gear arrangement and/or another transmission arrangement such as a flexible coupling allowing the external thread to rotate about a rotational axis which is non-parallel with the rotational axis of the output shaft.

[0038] The actuator 30 also comprises an axially displaceable sled 38 which is arranged to be displaced rectilinearly in parallel with the rotational axis of the external thread 36. The rectilinear displacement direction of the sled 38 defines a longitudinal direction of the sled 38. As best seen in fig. 3b, the sled 38 exhibits a recess 40 having an open longitudinal end being proximal to the motor 32. The opposite longitudinal end of the recess 40 is closed by an end wall 40a. The recess 40 is arranged to receive at least a portion of the shaft sleeve 35 with external thread 36.

[0039] The sled 38 further comprises an engagement portion 54 arranged to engage the external thread 36. In the shown example, the engagement portion 54 forms part of an engagement member 50 which is fixed to the sled 38. In addition to the engagement portion 54, the engagement member 50 also comprises a fixation portion 53 which is fixed to the sled 38. The engagement portion 54 comprises two resilient legs 54a, 54b. The engagement member 50 is formed of a wire spring material. The fixation portion 52 comprises a circular loop of the wire spring which loop is press-fitted onto a protruding stud 42 of the sled 38, for fixation of the engagement member 50 to the sled 38. The circular loop forms a torsional spring which urges the legs 54a, 54b to a mutual normal distance, which normal distance is approximately equal to the diameter of the external thread 36 at its root 36a.

[0040] The two resilient legs 54a, 54b extend in parallel with the plane of the loop, from the loop towards the open end of the recess 40. Just outside of the open end, the two legs 54a, 54b are bent approx. 90° such that the free ends of the legs 54a, 54b are arranged just outside of the open end of the recess 40. When assembled, the two resilient legs 54a, 54b engage the external thread 36 at mutually diametrically opposite sides of the external thread 36.

[0041] With reference to figs. 4a-b, the actuator may operate in two different modes. In a first operation mode shown in fig. 4a, the resiliency of the loop and the legs 54a, 54b urges the legs 54a, 54b to engage the external thread 36, between the flanks 36c, 36d. In the first operation mode, rotation of the output shaft 34 and the shaft sleeve 35 will cause the legs 54a, 54b to follow the flanks 36c, 36d axially along the external thread 36 in a corresponding direction. Hence, rotation of the external thread 36 in a first rotational direction will cause the engagement member 50 and thereby the sled 38 to be rectilinearly displaced in a first longitudinal direction. Rotation of the external thread 36 in the opposite rotational direction will cause the engagement member 50 and the sled 38 to be rectilinearly displaced in the opposite direction.

[0042] In a second operation mode of the actuator 30 shown in fig. 4b the sled may be forced to override the first operation mode. In the second mode, the sled 38 may be displaced rectilinearly along the thread 36 also when the thread is rotating. At stand still of the thread 36, an axial force in either direction applied to the sled 38 will cause the resilient legs 54a, 54b to slide over the crest 36b of the thread 36. Hence, the legs 54a, 54b may be said to jump over the crest 36b each time the legs 54a, 54b makes contact with the flanks 36c, 36d and crest 36b during their travel along the thread 36. The second operation mode may be applied to the actuator 30 when the thread 36 is not rotated, when the thread 36 is rotated for driving the sled in the opposite direction as compared to the direction of the axial force applied to the sled 38 and when the tread is rotated for driving the sled 38 in the same direction as the axial force applied to the sled 38.

[0043] With reference to figs. 2a-c, the first operation mode will now be described. At the non-blocking position of the blocking member 26 shown in fig. 2a, i.e. when the electromechanical lock is un-locked, the sled 38 of the actuator 30 is positioned proximal to the motor 32. For locking the lock, a control unit (not shown) initiate rotation of the electrical motor 32 in a first rotational direction. The engagement of the resilient legs 54a, 54b between the flanks 36c, 36d of the external thread 36 will cause the sled 38 to be longitudinally displaced away from the motor 32. During such displacement, the distal and

closed end of the sled 38 will make contact with a second surface 24a", being opposite to the first surface 24a' of the first radially protruding lug 24a of the auxiliary follower 24. As shown in fig 2b, continued longitudinal displacement the sled 38 will push the first lug 24a and thereby the auxiliary follower 24 to rotate in the clockwise direction. This rotation in turn causes the second radially protruding lug 24b, which engages the recess 26a, to drive the blocking member 26 from the non-blocking position shown in fig. 2a towards the blocking position. Further continued rotation of the thread 36 causes the sled 38, with the legs 54a, 54b engaging the flanks 36c-d to be displaced along the thread 36 to an end position being distal to the motor, as shown in fig. 2c. The blocking member 26 is thereby driven to its leftmost blocking position where the cuboid stop 26a blocks upward displacement of the plate member 20. During such clockwise rotation of the auxiliary follower 24, the third radially protruding lug 24c is rotated into the recess 40 of the sled 38 where it makes contact with the end wall 40a of the recess 40. In addition, during clockwise rotation of the auxiliary follower 24, the first surface 24a' of the first radially protruding lug 24a makes contact with the downwardly projecting tab 22a of the second follower, such that the second follower is rotated to the position shown in fig. 2c.

[0044] For unlocking the electromechanical lock by utilising the first operation mode of the actuator, the control unit (not shown) initiates rotation of the motor 32 in the opposite direction as compared to what is described above. Such initiation may be done e.g. after presentation of a RFID tag carrying an authorized access code to the outside of the door or by turning a thumb turn on the inside of the door. The opposite rotation of the motor 32 causes the sled 38, with the legs 54a, 54b engaging the flanks 36c-d of the thread 26 to be displaced from the distal position shown in fig. 2c towards the proximal position shown in fig. 2a. The end wall 40a of the sled's 38 recess 40 then makes contact with the third radially protruding lug 24c (which is received in the recess 40), whereby the auxiliary follower is driven to anti-clockwise rotation. Hereby, the second radially protruding lug 24b engaging the blocking member's 26 recess 26a drives the blocking member 26 towards the rightmost non-blocking position. Continued rotation of the motor 32 drives the sled 38 to the proximal position shown in fig. 2a, whereby the blocking member 26 is displaced to the non-blocking position shown in fig. 2a. Thereby the electromechanical lock has been un-locked and the door may be opened by rotating the first follower 18, e.g. by depressing a handle (not shown) on either side of the door and being connected to the first follower.

[0045] Now, the electromechanical lock allows for unlocking from the inside also at low battery situations or other failures when the motor is un-operable. This may be done by manually turning a thumb turn (not shown) arranged on the inside of the door and being connected to the second follower.

[0046] With reference to figs. 5a-c, such manual override of the actuator will now be described. When starting out from the blocking position shown in fig. 5a rotating the second follower 22 in the anti-clockwise direction will drive the blocking member 26 towards the non-blocking position shown in fig. 5c. While not rotating the motor 32, initial rotation of the second follower 22 in the anticlockwise direction brings the downwardly projecting tab 22a in contact with the first surface 24a' of the auxiliary follower's 24 first radially protruding lug 24a. At continued anticlockwise rotation of the second follower (still not rotating the motor) the second surface 24a" makes contact with the distal end of the sled 38 and pushes the sled downwards toward the motor 32. The actuator 30 the enters the second operation mode in which the resilient legs 54a, 54b resiliently slides over the crest of the thread 36. By this means the sled 38 may be forced to be displaced from the distal position shown in fig 5a, passed the intermediate position in fig. 5b to the proximal position in fig. 5c. During this axial displacement of the sled 38, the resilient legs 54a, 54b sequentially slides over the crest 36b each time they pass from the root 36a of one thread turn to the root 36a of the adjacent thread turn. By this means manual turning of the second follower 22, while not rotating the motor, brings the sled from the distal position shown in fig. 5a to the proximal position shown in fig. 5c. During such axial displacement of the sled 38, in the second operation mode, the blocking member 26 is displaced from the blocking position (fig. 5a) to the non-blocking position (fig. 5c) by engagement of the second radially protruding lug 24b in the recess 26a of the blocking member 26.

[0047] Hence, in the second operation mode, the electrical operation of the actuator 30 may be overridden for allowing manual unlocking of the electromechanical lock also when the motor is not functioning, e.g. in the case of power loss. Such an operation allows for fast and simple unlocking of the electromechanical lock from the inside of the door which may be advantageous and important for example at situations of emergency, when there is a need to quickly exit through the door provided with the electromechanical lock. Manual override of the electrical first mode operation of the actuator may also be used for exiting through the door from the inside in case of low battery or other failure of the electrical operation of the actuator.

[0048] In the above described embodiment, the actuator 30 is arranged for locking and unlocking the lock by driving the blocking member 26 between its blocking and non-blocking positions. In another, not shown embodiment, the actuator is arranged for, in the first operation mode, driving a pivotal hook bolt from its retracted to its protruding position. In one such example, the actuator is designed essentially as shown in figs. 3a-4b comprising a motor, a threaded shaft and a sled. The sled has an engagement portion which is arranged to engage the external thread for, in a first operation mode, displace the sled upon rotation of the thread and, in a second operation mode slide over the crest of the external thread. In

addition, a toothed rack is arranged to cooperate with the sled of the actuator such that the sled pushes the toothed rack to linear displacement from a first to a second position when the actuator's motor is rotated in a first rotational direction. The toothed rack meshes with peripheral teeth on a rotatable follower, which in turn is mechanically connected to the pivotal hook bolt via a link mechanism. Rotation of the follower in a first direction drives the hook bolt from its retracted to its protruding position. Vice versa, rotating the follower in a second, opposite direction retracts the hook bolt. A door position sensing means such as a latch bolt, a micro switch, a magnetic sensor or combinations thereof is connected to a control unit for controlling the operation of the actuator's motor in the first operation mode.

[0049] When the door reaches its closed position, the door position sensing means sends a signal to the control unit which in turn initiates the motor of the actuator to rotate in the first rotational direction. Thereby, the sled is linearly driven in a first rectilinear direction and pushes the toothed rack in the same direction from its first to its second position. The toothed rack, while meshing with the follower, causes the follower to rotate for ejecting the hook bolt via the link mechanism. A micro switch or other sensing means detects when the hook bolt has reached the fully protruding position and sends a signal to the control unit which in turn initiates the motor of the actuator to rotate in the opposite direction. Thereby, the sled is returned to its initial position, whereas the toothed rack, which meshes with the follower remains in its second position. By this means, the actuator, in its first operation mode, automatically ejects the hook bolt and returns the sled to its initial position when the door reaches its closed position.

[0050] When the hook bolt is in the protruding position, where it normally engages a striking plate of a door frame, the hook bolt may be retracted by manually operating a door handle, a key cylinder or a thumb turn which is mechanically connected to the rotatable follower. Such manual operation is mechanically transformed into rotation of the rotatable follower in the second rotational direction, thereby to retract the hook bolt. Since the sled of the actuator, during the end phase of the electrical operation of the actuator, has been returned to its initial position, the sled will not impede linear displacement of the toothed rack meshing with said follower. Hence, manual operation of the rotatable follower for retracting the hook bolt results also in that the toothed rack is returned to its first position.

[0051] Thus, at the above described embodiment, the hook bolt is driven from the retracted position to the protruding position by means of electrically operating the actuator in its first operation mode. Retraction of the hook bolt on the other hand is achieved by manual operation of a door handle, a key operated lock cylinder, a thumb turn or the like, which is mechanically connected to the rotatable follower.

[0052] Now, the second operation mode of the actuator may be used e.g. in the case of power loss or other failure which has caused the sled not to return to its initial position after having pushed the toothed rod to its second position for ejecting the hook bolt. At such a situation, the hook bold may still be retracted by manual operation of the door handle, lock cylinder, thumb turn or the like. The second operation mode then allows the engagement portion of the sled to slide over the crest of the actuator's thread such that the toothed rack may push the sled along the still standing thread to its initial position.

[0053] By this means the second operation mode of the actuator allows for manual opening of the door also at low battery situations or other failures of the actuator. This in turn increases the reliability of the electromechanical lock. Additionally, it increases the safety of persons on the inside of the door since it allows for exiting through the door also at power loss and other failures.

[0054] The aspects of the present disclosure have mainly been described above with reference to a few embodiments and examples thereof. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the invention, as defined by the appended patent claims. For example, the engagement portion of the sled may be formed integral with the sled. In such case the sled with engagement portion may be formed in one piece of a resilient material such as a polymer material and the engagement portion may be formed as one or several protruding legs arranged to engage the external tread.

[0055] As readily understood, the actuator operating in a first electrical operation mode and a second mode for overriding the first mode may find several other applications in an electromechanical lock than the ones described above. E.g. the actuator may be arranged to linearly displace or rotate other components of the lock mechanism such as internal latching means, deadlocking means or the like, where it is desirable to allow overriding the electrical first operation mode for moving or altering the state of said components.

Claims

1. Electromechanical lock with an electrical actuator (30) which actuator comprises;

   - an electrical motor (32) having an output shaft (34) which is bi-directionally rotatable about a rotational axis,
   - an external helical thread (36) comprising a crest (36b), a root (36a) and flanks (36c, 36d) connecting the crest (36b) and the root (36a), which thread (36) is connected to the output shaft (34),
   - a linearly displaceable sled (38) comprising an engagement portion (54) which is arranged to engage the external thread (36) for, in a first op-

eration mode, driving the sled (38) longitudinally along the rotational axis upon rotation of the output shaft (34), **characterized in that**
- the engagement portion (54) is arranged to, in a second operation mode, slide over the crest (36b) of the external thread (36) for allowing longitudinal displacement of the sled (38) irrespective of whether the external thread (36) is rotating or not.

2. Electromechanical lock according to claim 1, wherein the engagement portion (54) comprises at least one resilient leg (54a, 54b), which, in the first operation mode, is arranged to engage between flanks (36c, 36d) of the external thread (36).

3. Electromechanical lock according to claim 2, wherein the engagement portion (54) comprises two resilient legs (54a, 54b) which, in the first operation mode, are arranged to engage the flanks (36c, 36d) of the external thread (36) at mutually opposite sides of the external thread (36).

4. Electromechanical lock according to any of claims 1-3, wherein the engagement portion (54) forms part of an engagement member (50) which further comprises a fixation portion (52) which is fixed to the sled (38).

5. Electromechanical lock according to claim 4, wherein the fixation portion (52) and the engagement portion (54) of the engagement member (50) are formed as an integral part of a wire spring material.

6. Electromechanical lock according to claim 4 or 5, wherein the fixation portion (52) comprises a torsional spring.

7. Electromechanical lock according to any of claims 1-6, wherein the sled (38) exhibits a longitudinal channel (40) which is arranged to receive the external thread (36).

8. Electromechanical lock according to any of claims 1-7, further comprising a lock housing (10) which receives the actuator (30) and a lock mechanism comprising at least one lock bolt (14, 16) which is movable between a retracted opening position and a locking position in which the lock bolt (14, 16) protrudes out from the lock housing (10).

9. Electromechanical lock according to claim 8, wherein the lock housing (10) comprises guide means for rectilinear guiding of the sled (38).

10. Electromechanical lock according to claim 8 or 9, further comprising a manually rotatable follower (24) which is received in the lock housing (10), wherein the actuator (30), in the first operation mode, is arranged to rotate the follower (24) by transmitting the linear displacement of the sled (38) into a rotational movement of the follower (24) and wherein the follower (24), in the second operation mode, is arranged to linearly displace the sled (38) relative to the external thread (36) by forcing the engagement portion (54) to slide over the crest (36b) of the external thread (36).

11. Electromechanical lock according to claim 10, wherein the rotatable follower (24) further is arranged to drive a blocking member (26) between a release position in which the lock bolt (14, 16) is allowed to be retracted to the opening position and a blocking position in which the lock bolt (14, 16) is prevented from being retracted to the opening position.

12. Electromechanical lock according to any of claims 8-10, wherein the actuator is arranged, in the first operation mode, to drive the lock bolt from the retracted opening position to the protruding locking position and, in the second operation mode, to allow retraction of the bolt from the locking position to the opening position.

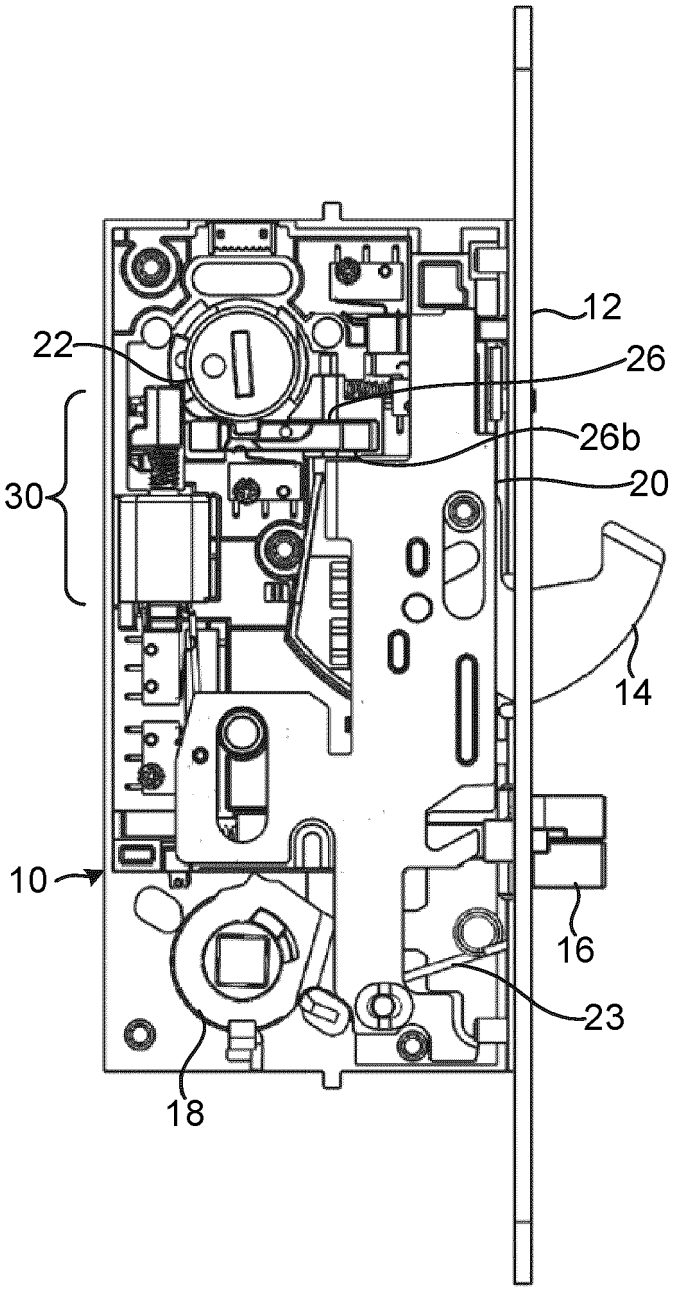
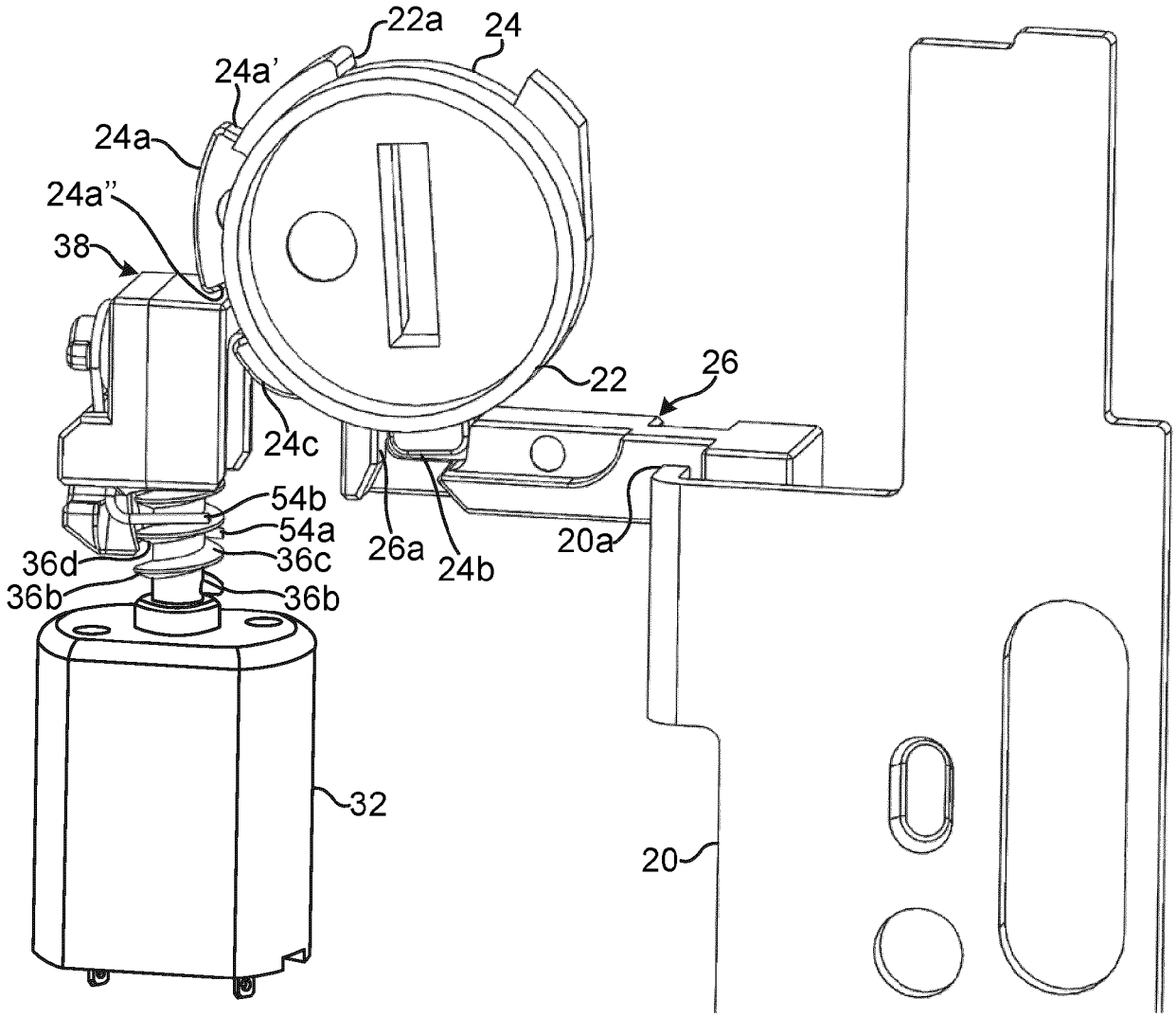


Fig. 1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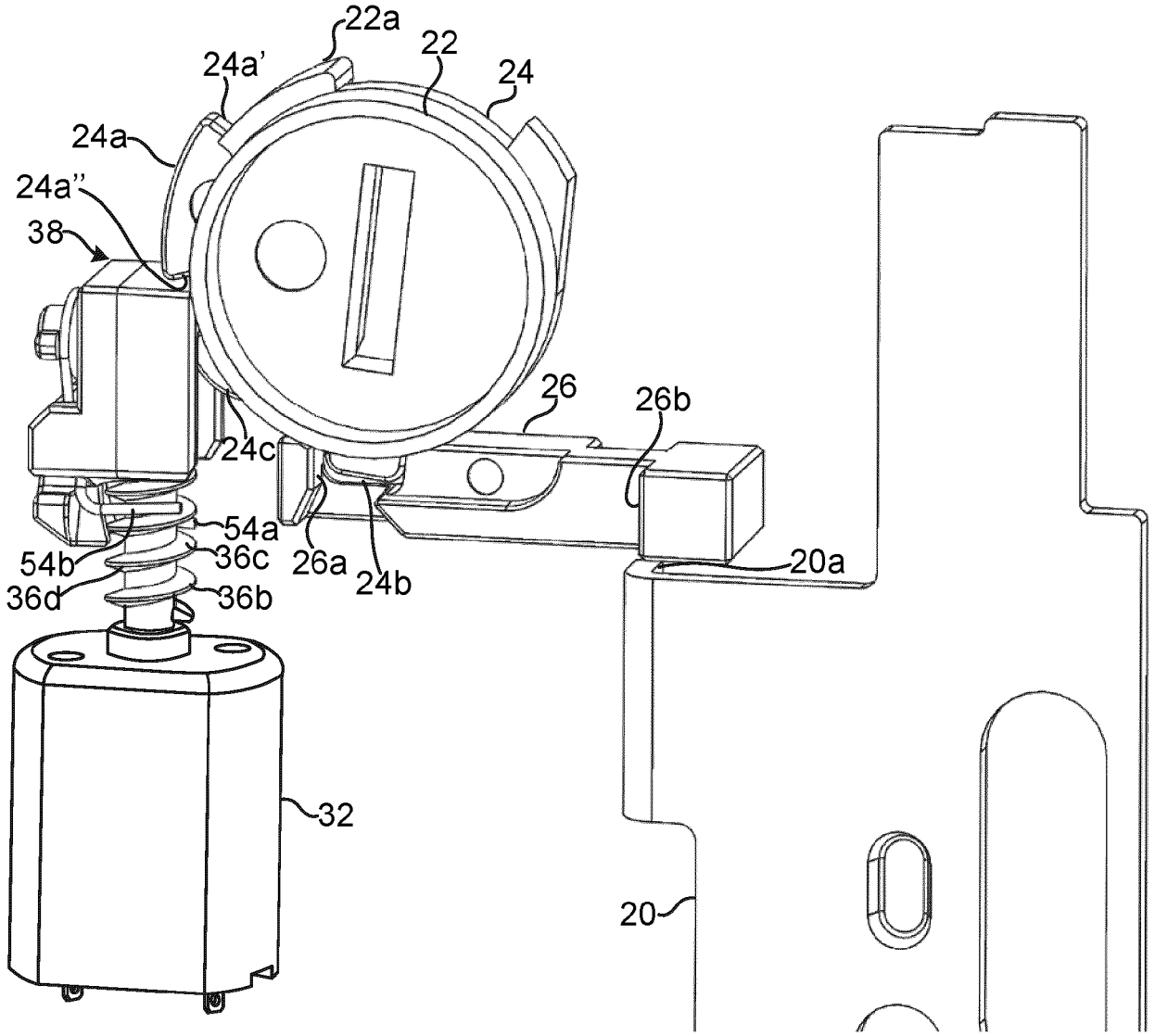
24
24a'
24a
24a''
38
22
26
24c
54b
54a
36d
36c
36b
36b
26a
24b
20a
32
20

Fig. 2A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24a'
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24a
24a''
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26b
24c
54a
54b
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24b
20a
36d
36b
32
20

Fig. 2B

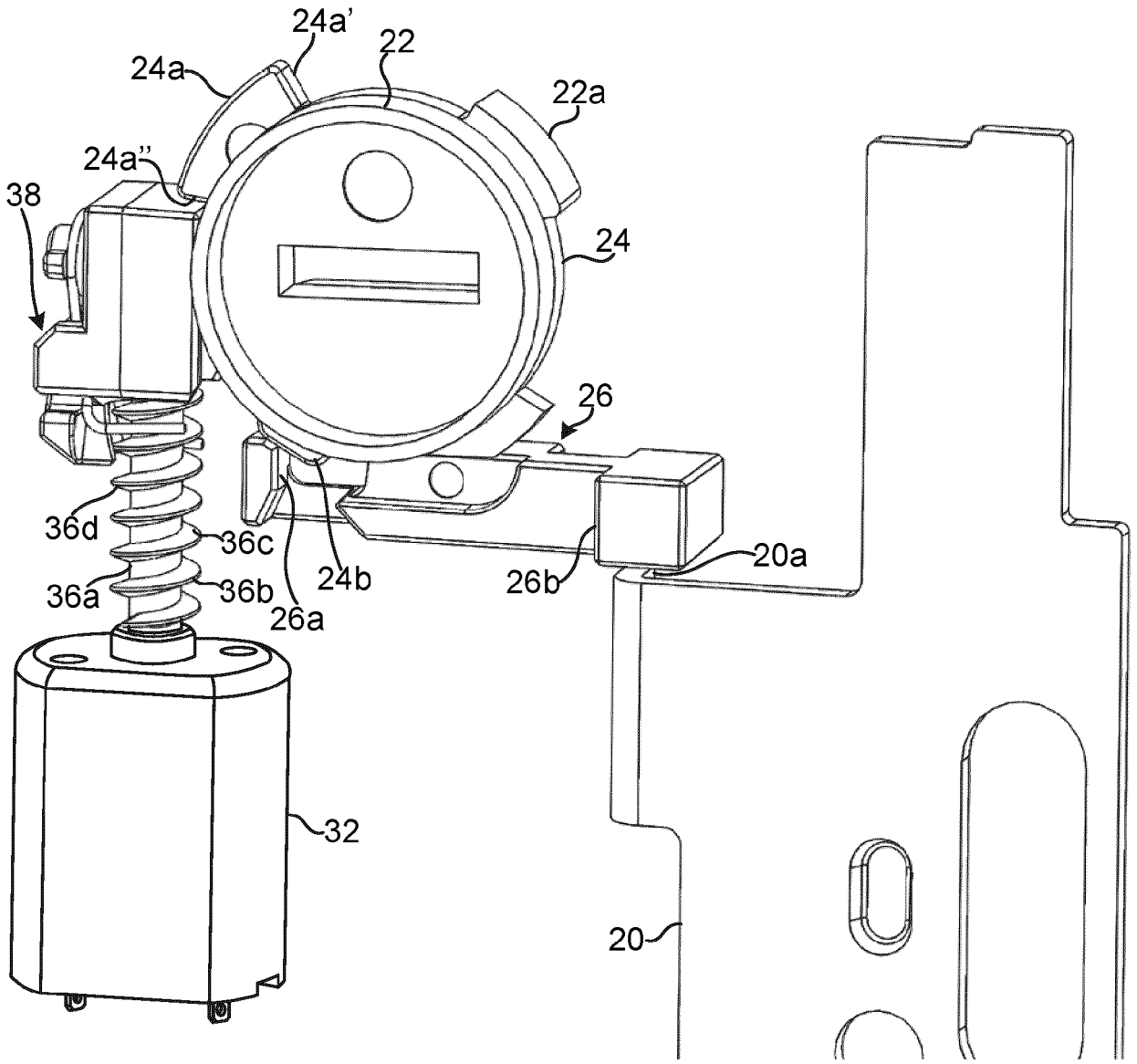
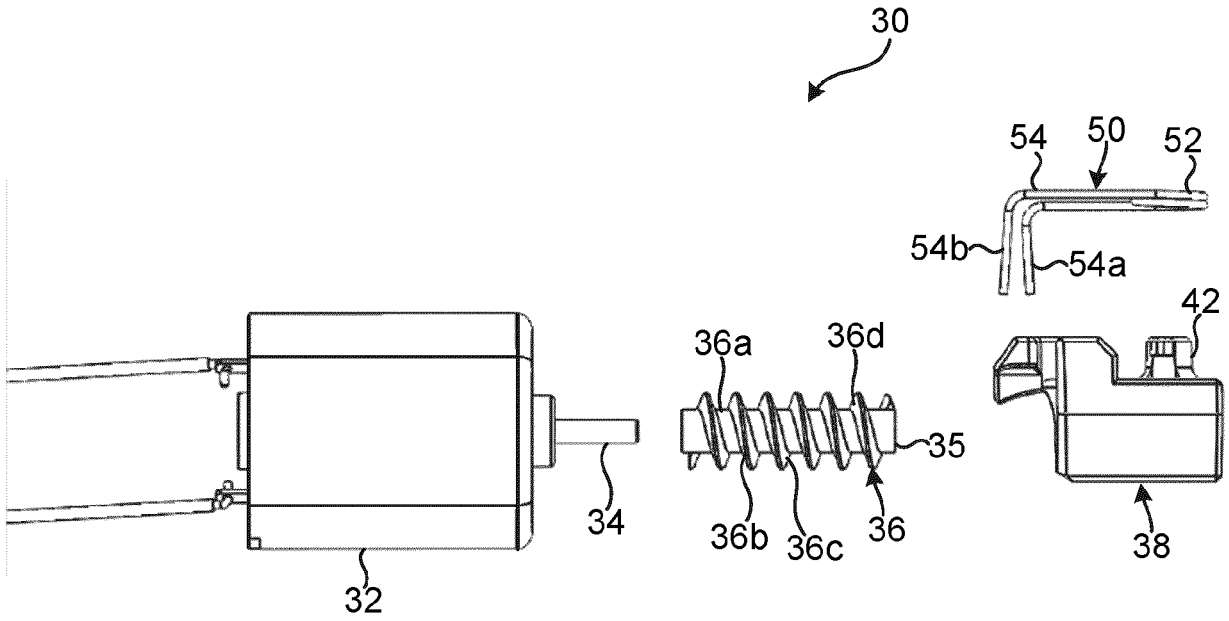


Fig. 2C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54b
54a
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36d
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36b
36c
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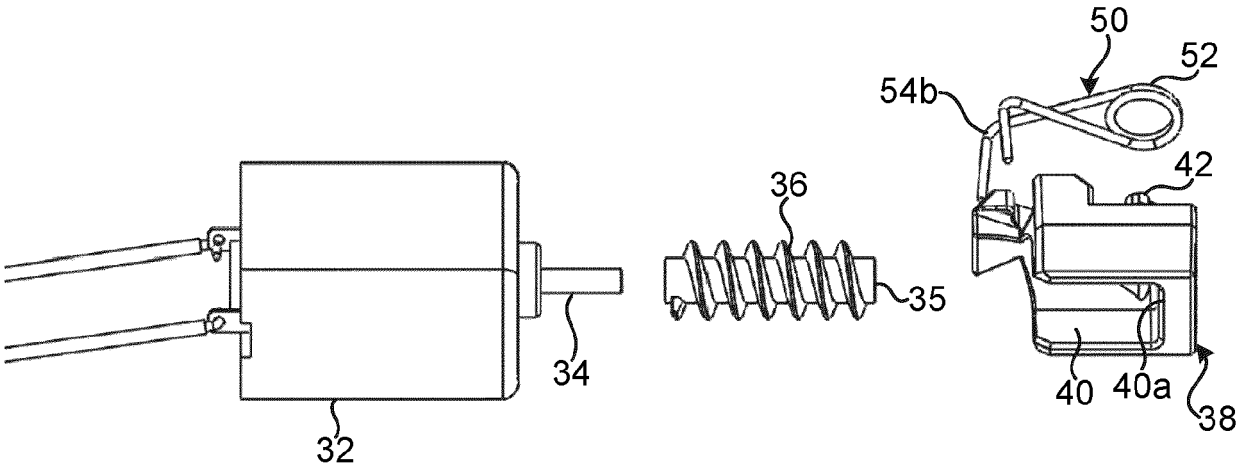
38
34
32

Fig. 3A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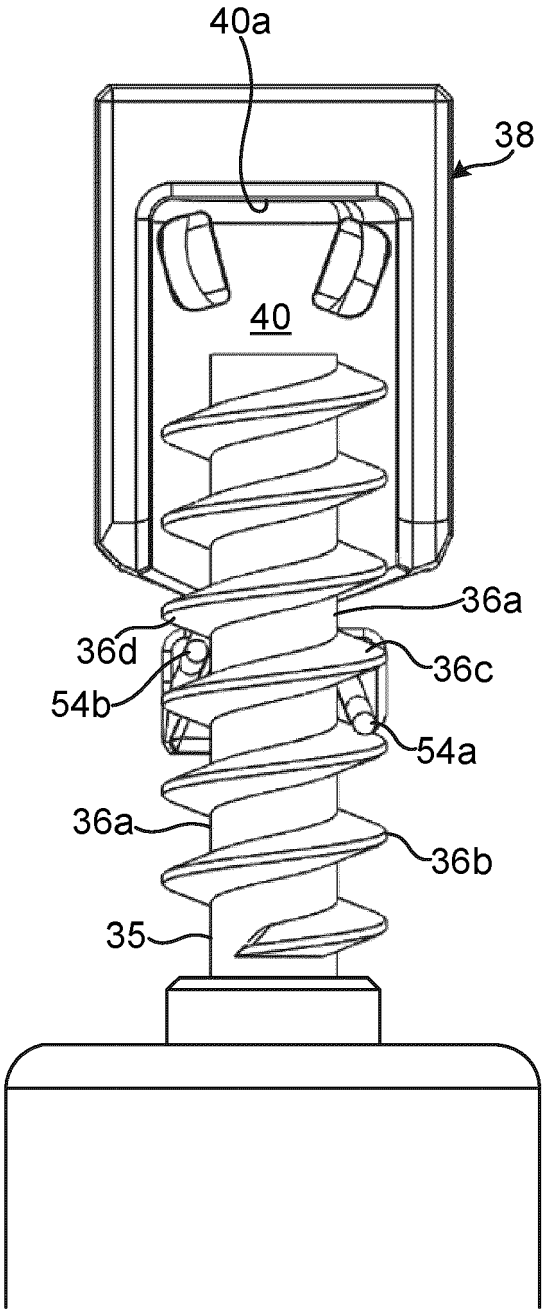
40a
38
32

Fig. 3B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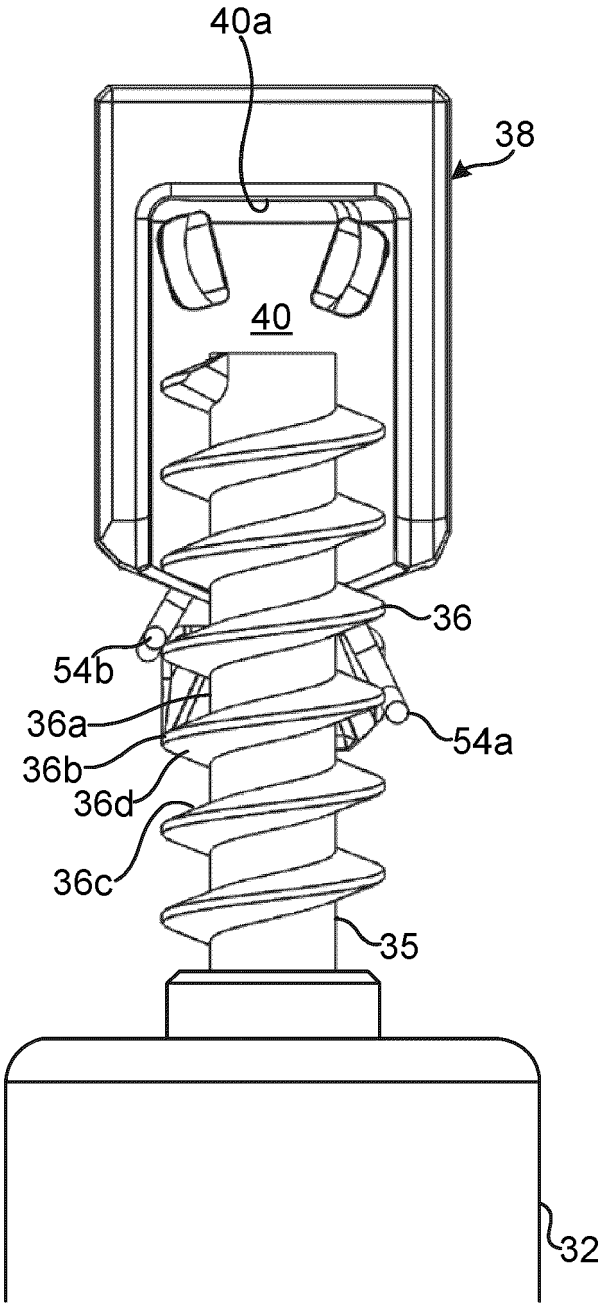
36c
54b
54a
36a
36b
35

Fig. 4A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54b
36a
54a
36b
36d
36c
35
32

Fig. 4B

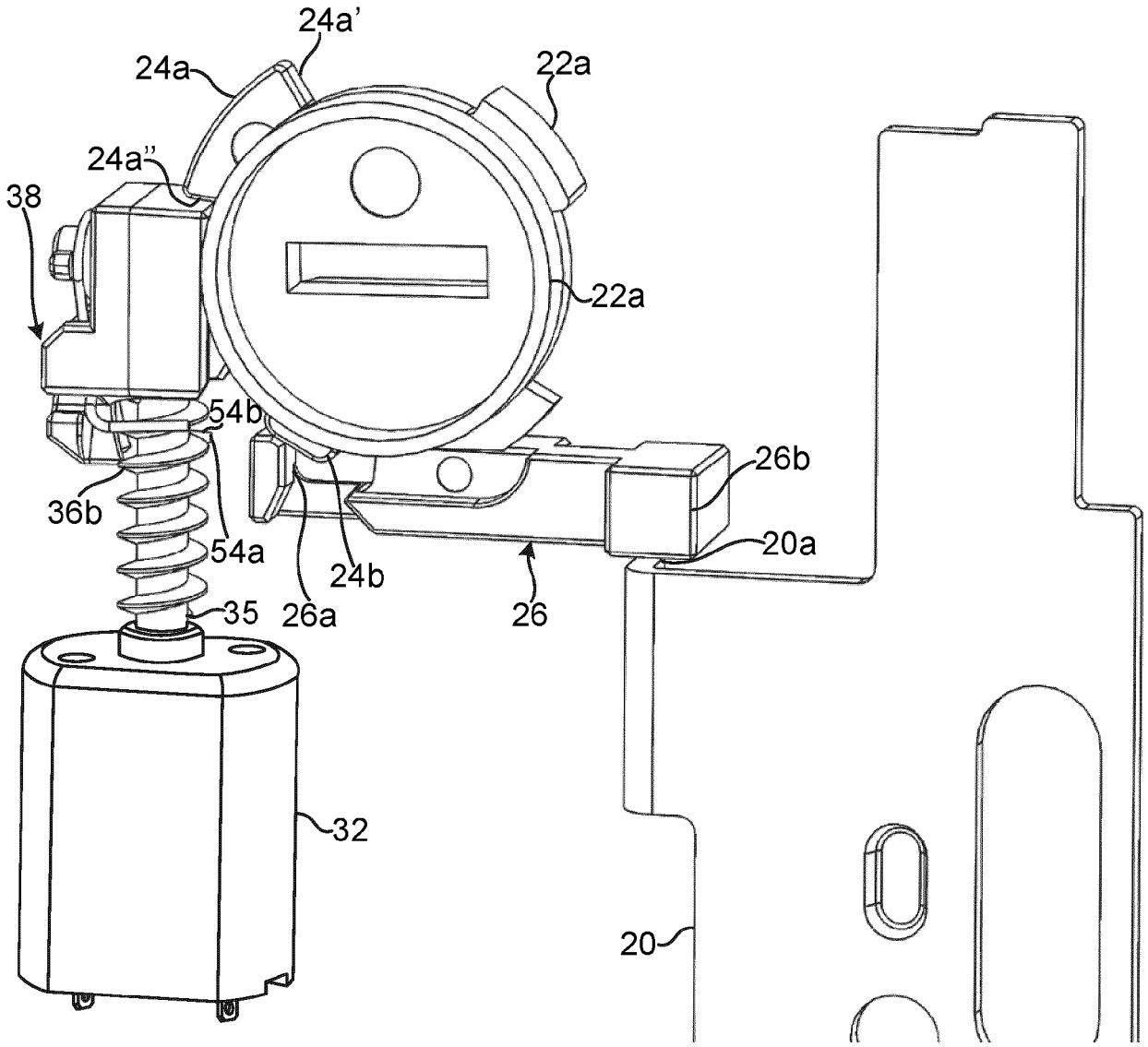

Fig. 5A

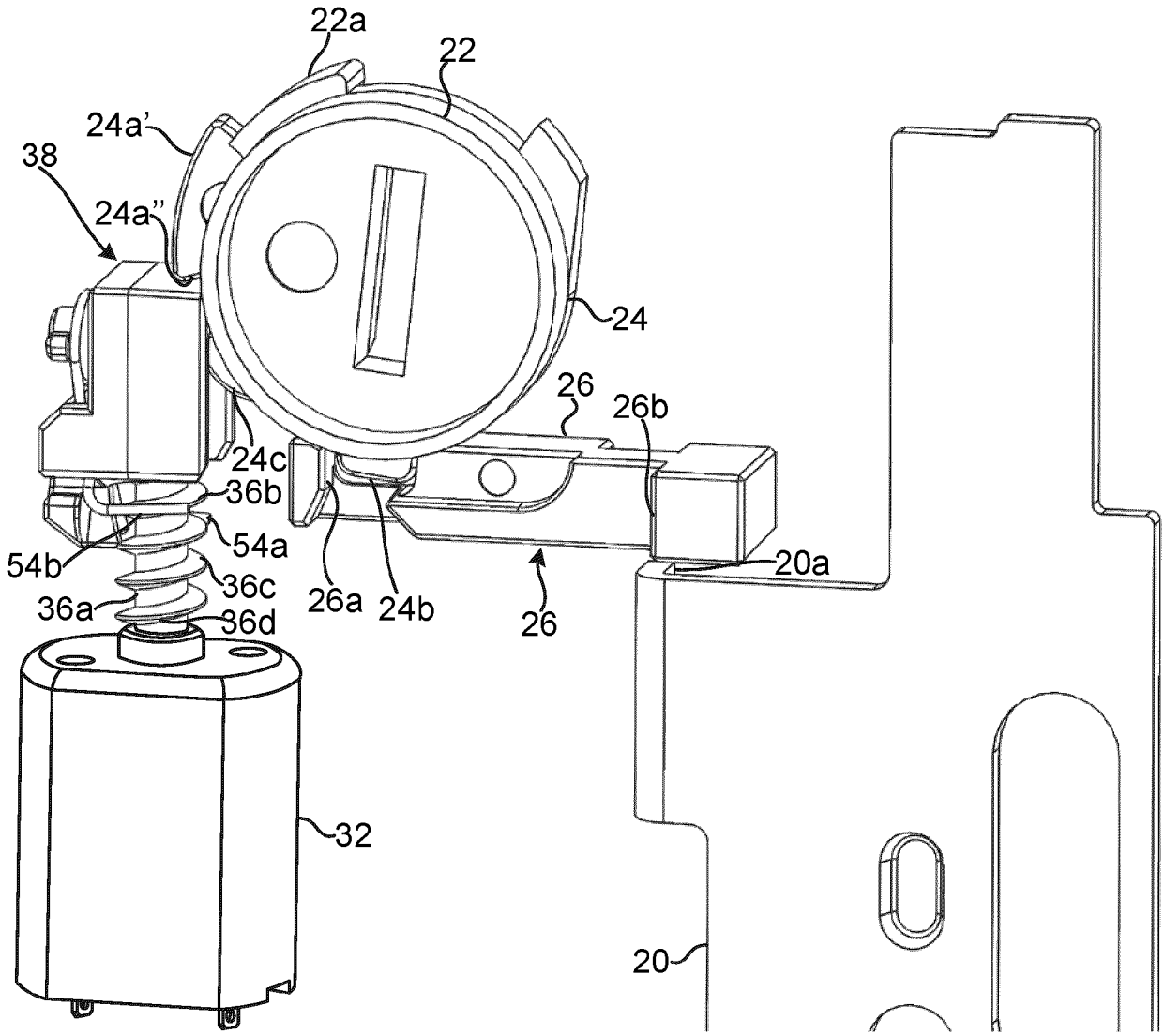
22a
22
24a'
38
24a''
24
26
26b
24c
36b
54a
54b
36c
36a
36d
26a
24b
26
20a
32
20

Fig. 5B

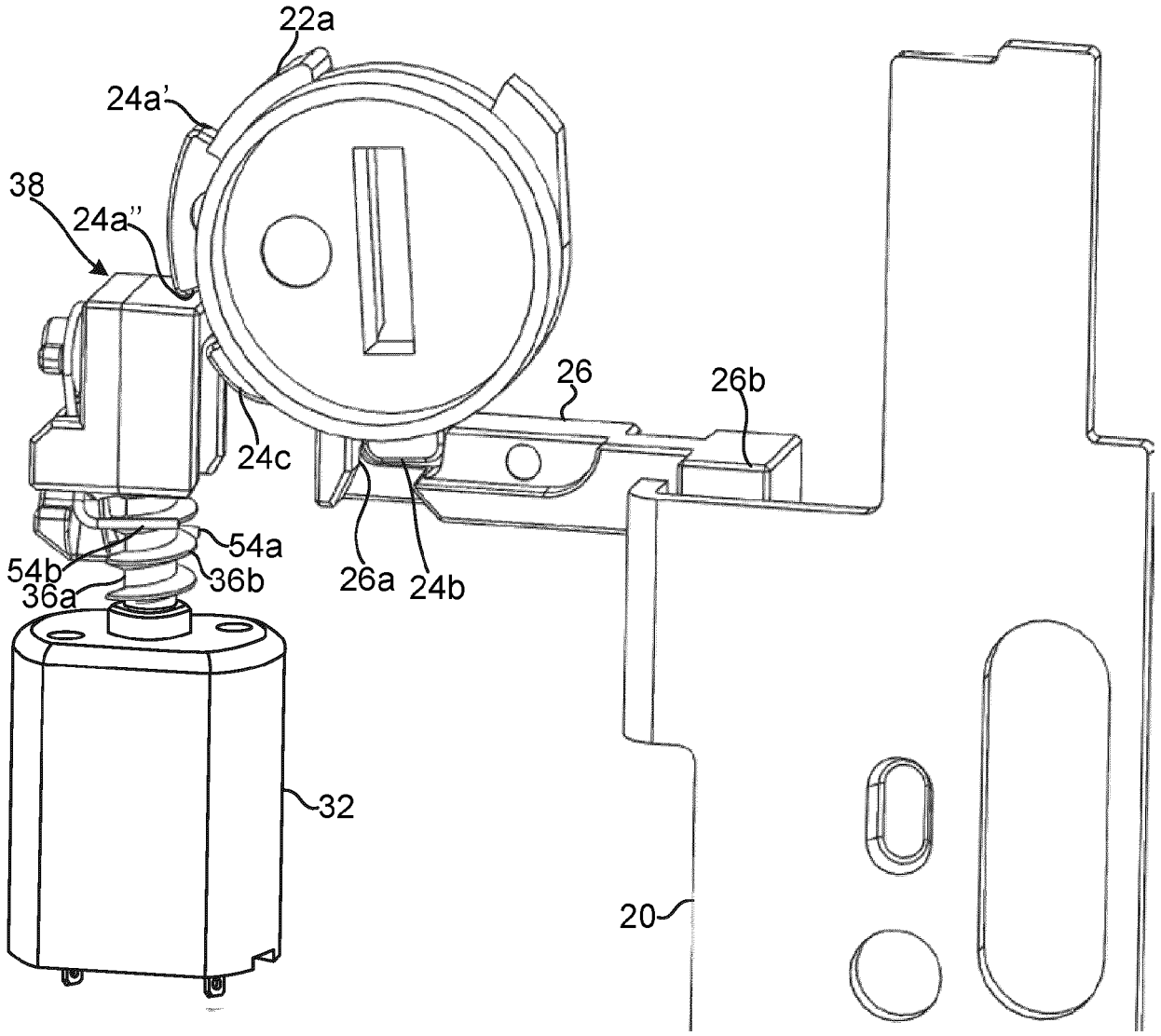

Fig. 5C

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EUROPEAN SEARCH REPORT

Application Number
EP 20 16 0226

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	TW M 297 993 U (HUANG R-HUEI [TW]) 21 September 2006 (2006-09-21) * page 7 - page 10 * * figures 1-10 *	1-9 10-12	INV. E05B47/00 E05B47/06
A	US 2012/260704 A1 (FERREIRA SANCHEZ CARLOS [ES]) 18 October 2012 (2012-10-18) * paragraph [0069] - paragraph [0088] * * figures 1-6c *	1-12	
A	US 9 834 959 B2 (SCHLAGE LOCK CO LLC [US]) 5 December 2017 (2017-12-05) * column 2, line 3 - column 5, line 43 * * figures 1-7 *	1-12	
A	US 9 316 025 B2 (WFE TECHNOLOGY CORP [TW]) 19 April 2016 (2016-04-19) * column 4, line 28 - column 9, line 61 * * figures 2-13 *	1-12	
			TECHNICAL FIELDS SEARCHED (IPC) E05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 July 2020	Antonov, Ventseslav

CATEGORY OF CITED DOCUMENTS

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21-07-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
TW M297993 U	21-09-2006	NONE	
US 2012260704 A1	18-10-2012	DK 2698489 T3	13-11-2017
		EP 2698489 A1	19-02-2014
		ES 2393482 A1	21-12-2012
		ES 2637768 T3	17-10-2017
		US 2012260704 A1	18-10-2012
		WO 2012140297 A1	18-10-2012
US 9834959 B2	05-12-2017	CA 2946335 A1	03-09-2015
		EP 3111026 A2	04-01-2017
		US 2015240528 A1	27-08-2015
		US 2016369529 A1	22-12-2016
		US 2018238080 A1	23-08-2018
		WO 2015130774 A2	03-09-2015
US 9316025 B2	19-04-2016	EP 2664736 A2	20-11-2013
		ES 2639308 T3	26-10-2017
		TW 201346118 A	16-11-2013
		US 2013305792 A1	21-11-2013

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Patent documents cited in the description

- EP 2314809 B1 **[0006]**