Sept. 12, 1967 E. O'BRIEN 3,340,710

TIME OPERATED AND/OR REMOTE CONTROL-OPERATED ELECTRO-MECHANICAL LOCK

Filed Feb. 14, 1966 3 Sheets-Sheet 1

Fig. 1

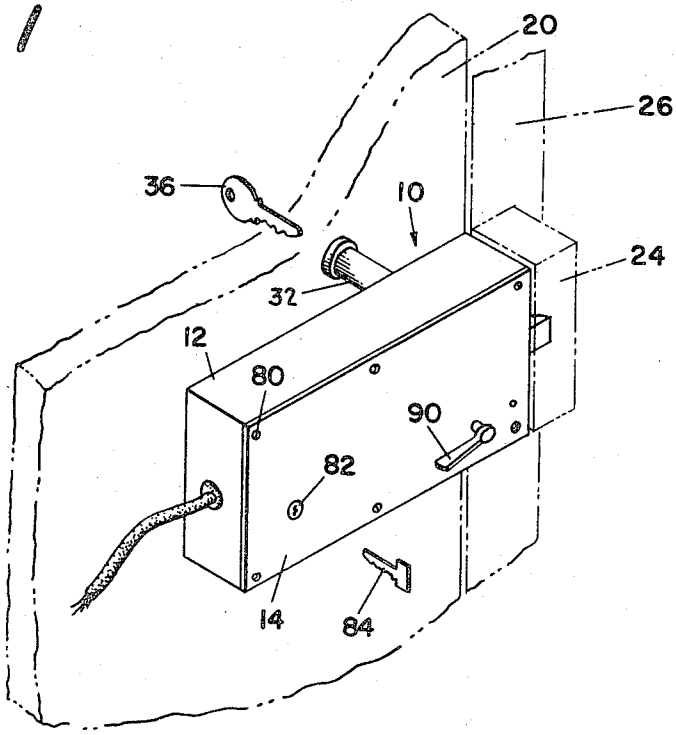
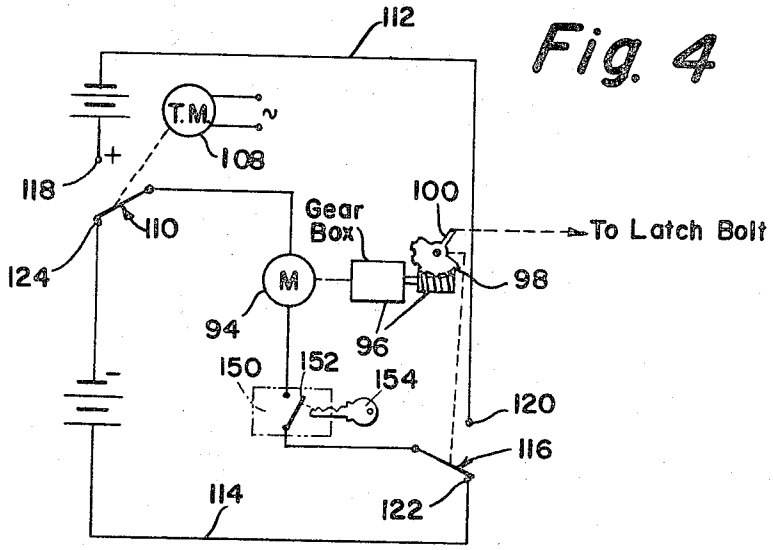


Fig. 4



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Filed Feb. 14, 1966 3 Sheets-Sheet 2

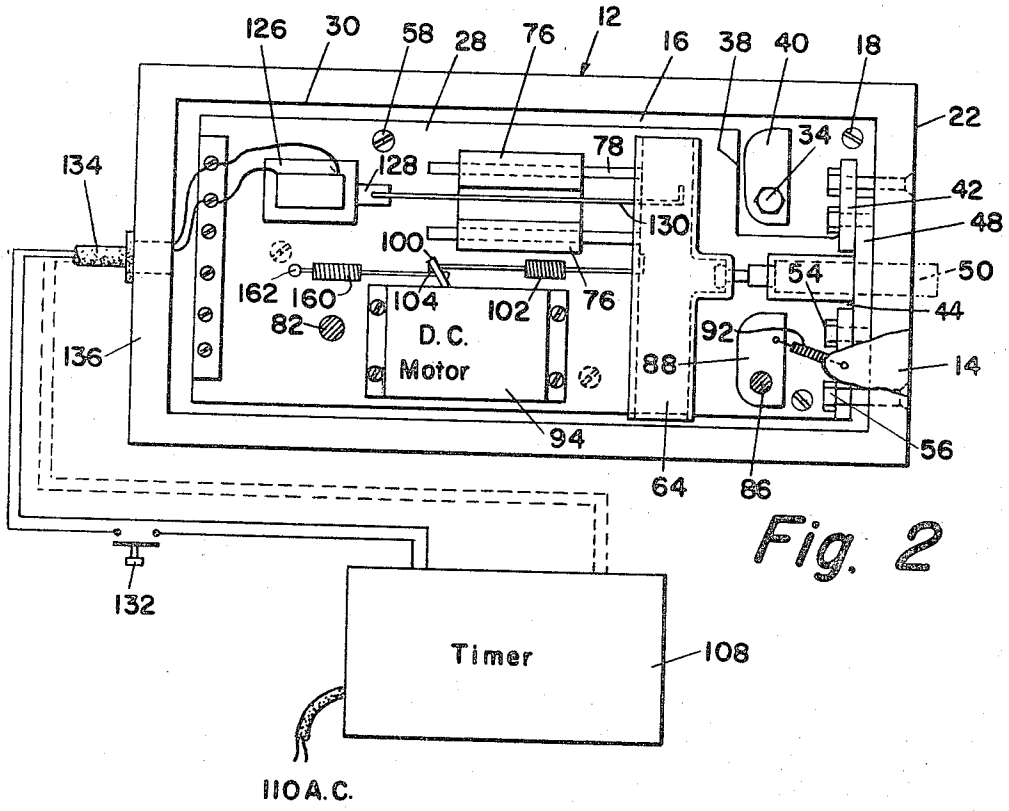
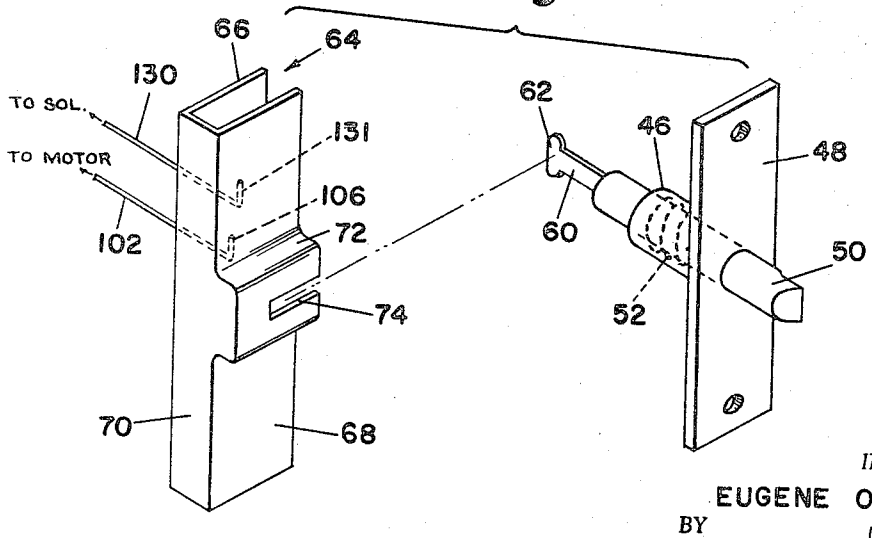


Fig. 2

Fig. 3



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TIME OPERATED AND/OR REMOTE CONTROL-OPERATED ELECTRO-MECHANICAL LOCK

Filed Feb. 14, 1966 3 Sheets-Sheet 3

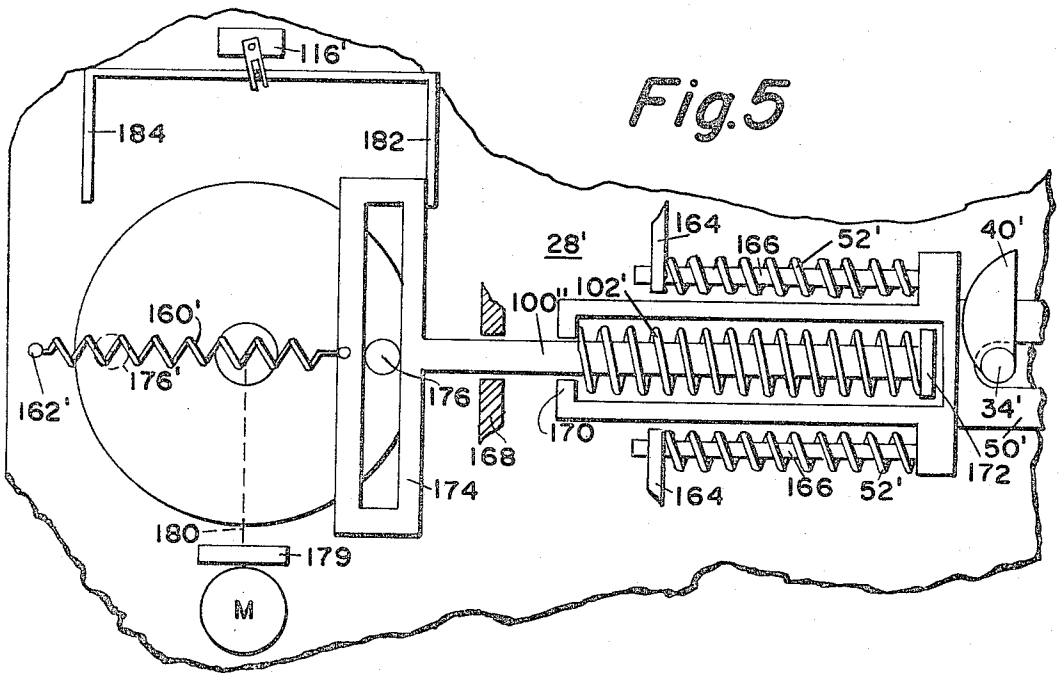


Fig. 5

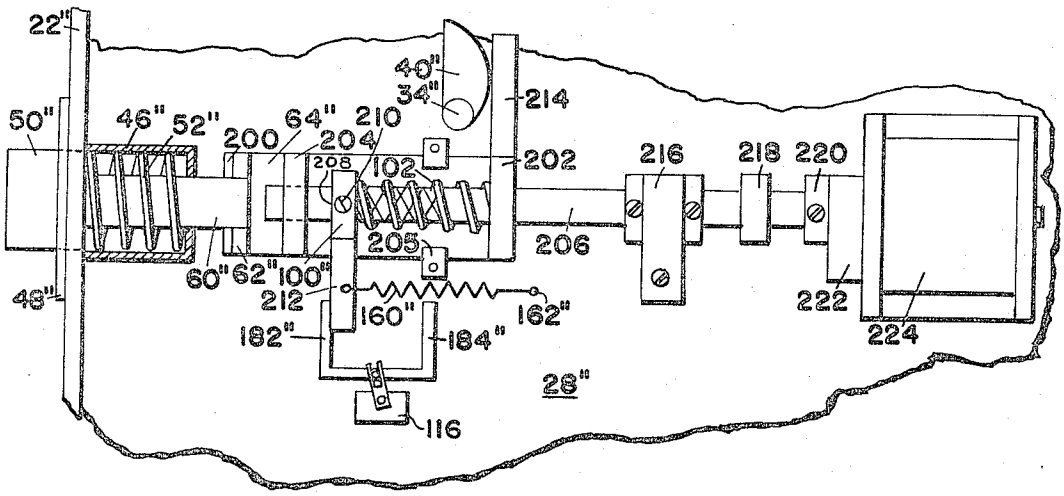


Fig. 6

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United States Patent Office 3,340,710 Patented Sept. 12, 1967

3,340,710

TIME OPERATED AND/OR REMOTE CONTROL-OPERATED ELECTRO-MECHANICAL LOCK

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Filed Feb. 14, 1966, Ser. No. 527,312
The portion of the term of the patent subsequent to Feb. 14, 1983, has been disclaimed
10 Claims. (Cl. 70—271)

This is a continuation-in-part of my copending patent application Ser. No. 324,012, filed Nov. 15, 1963, now U.S. Patent 3,234,766.

This invention relates to a time controlled lock, the primary object of which is to provide a construction in which the lock is automatically closed at a pre-set time and automatically re-opened after a pre-set interval thereafter, the lock being key or manually operable only by authorized personnel in said interim. It also relates to a remote control-operated lock in which the opening and closing thereof is automatically effected by a means other than a timer, such as by manual, pressure or temperature operation. A general object of this invention is to provide a new and improved electrically operated lock.

Another object of the invention is to provide a time controlled lock of the character described in which the latch bolt of the lock is extended into the closed or retracted into the open position by a timer actuated motor in such a manner that the motor shuts off at the end of a movement corresponding to the travel of the latch bolt thereby utilizing electrical energy only for the short time corresponding to that required to extend or retract the bolt.

Another object of the invention is to provide a time controlled lock of the character described in which the timer actuated motor is operatively connected to the latch bolt by a means which permits the retraction cycle to complete itself and which cuts off the motor even though the latch bolt may be temporarily restrained from movement, as by jamming in the keeper, said means storing the retraction energy and acting to move the bolt to the retracted position when the restraining force in the keeper is eventually released.

Another object of the invention is to provide a time controlled electromechanical lock which does not necessarily rely upon batteries as a source of current and which employs instead circuits of opposite polarity and switches therein in which are operatively connected an electrical source, a reversible motor and the lock bolt in such a manner that at the end of each stroke of the latch bolt a switch is actuated to break one of the circuits and cut off the motor but move to such a position that when the timer re-activates the motor at the pre-set time the opposite circuit is automatically closed.

Another object of the invention is to provide a timer actuated electromechanical lock which can be opened mechanically from the inside and by key operation from the outside only by authorized personnel during the interval when the lock has been pre-set to remain closed.

Another object of the invention is to provide an electromechanical lock which can be actuated by a remote control push button. Another object is to provide a timer actuated electromechanical lock which can be opened with a mechanical key only during the intervals when the lock has been pre-set to be so opened.

These and other objects of the invention will become more apparent as the following description proceeds in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of the lock shown installed;

FIG. 2 is a side elevational view of the instant lock, the cover having been removed to disclose the working parts;

FIG. 3 is an exploded perspective view of the latch bolt and slide actuating bar therefor;

FIG. 4 is a diagrammatic view of the timer, motor, latch bolt actuator and circuit therefor;

FIG. 5 is a schematic side elevational view of a modified form of this invention; and

FIG. 6 is a schematic side elevational view of another modified form of this invention.

Specific reference is now made to the drawings in which similar reference characters are used for corresponding elements throughout.

The lock is generally indicated at **10** and comprises a housing **12**, preferably rectangular, and a cover **14** therefor which encloses the lock mechanism. The rear plate **16** of the housing is itself secured as by screws **18** to a door **20** in any desired position so that one of its side walls **22** is adjacent the vertical edge of the door and proximate to a suitable keeper **24** which has been mounted on the door jamb **26**.

The lock mechanism is itself secured upon a substantially rectangular mounting plate **28** which is smaller than the opening **30** closed by the cover **14** so that the mounting plate can be readily slipped into the housing and there secured. Thus, where the door structure makes it difficult to install the entire lock as a unit, by the present arrangement, first the housing **12** can be readily secured and then the mounting plate. Mounted on and extending perpendicular to the rear housing plate **16** and through a hole in the door is a continuous wafer type lock **32** having a rotatable plug **34** which is operable by a key **36** that is removable in two positions 90° apart. The plug extends into the housing and through a cut-out **38** in the mounting plate **28** and secures a cam **40** on its inner end.

The mounting plate **28** has an upstanding wall **42** with a central opening **44** through which extends a conventional tubular-type spring latch. The latch includes a tube **46** secured to a plate **48**, the latch bolt **50** being slidable in the tube and normally urged by a spring **52** in the tube towards the extended or closed position through a hole provided in the plate **48** and an opening in the side wall **22** of the housing thence into the keeper. The wall **42** of the mounting plate **28** is secured by screws **54** to the latch plate **48** and then further recessed screws **56** are made to extend through the side wall **22** of the housing, the plate **48**, and the wall **42**. Additional screws **58** are used to fix the mounting plate **28** in its final position in the housing.

The inner end of the latch bolt **50** includes a flattened reduced shank **60** and a laterally enlarged head **62**. A latch bolt actuator **64** is provided which extends vertically across the mounting plate **28** and consists of a member which is substantially U-shaped in cross-section having a pair of spaced plates **66** and **68** connected by a web **70**, the plate **68** having a laterally extending enlarged portion **72** provided with an open-ended slot **74** for receiving the shank **60** and head **62** of the latch bolt **50** and effect coupling of the actuator **64** to the bolt. The plates **66** and **68** are spaced apart a distance greater than the total movement of the latch bolt **50**. The mounting plate **28** secures a pair of upstanding spaced bars **76** through which extend, slidably, rods **78** secured to the actuator **64** to guide the latter in its sliding movement longitudinally of the mounting plate.

The cover **14** is secured by screws **80** to the housing and by a threaded member **82** which engages the mounting plate **28** and rear housing plate **16**, the latter being locked in place by a key **84**. To one side thereof a shaft **86** is rotatably mounted on the cover and extends into the housing, the inner end thereof securing a cam **88** and the outer end an operating handle **90**.

A spring **92** connects the cam with the cover and urges it away from the actuator. Thus, it will be seen that rotation of the handle **90** in a counter-clockwise direction will cause the cam **38** to engage the actuator **64** and retract the latch bolt. Similarly, key operation of the barrel **34** will cause the cam **40** to engage the actuator **64** and retract the latch bolt.

Mounted on the plate **28** is a reversible DC motor **94** whose shaft drives gearing **96**, see FIG. 4, one of which is a sector gear **98** having an upstanding arm **100** which extends through the motor casing, as seen in FIG. 2. Such a motor and associated gearing is commercially available as a Duramite-Multi Servo unit supplied by Bonner Specialties of Los Angeles, Calif. A spring **102** is terminally hooked as at **104** to the arm **100** and behind the plate **66** as at **106** through which it is freely slidable. The spring rating of spring **102** is such that it is stronger than the latch spring **52** but weaker than the motor and gears for a purpose later to appear.

A conventional timer **108** is provided in the form of an electrically operated clock having trippers on its clock face which can be set at desired time intervals to open and close the instant lock, the trippers actuating a single pull, double throw toggle switch **110**. Such a timer is available from Tork Time Controls, Inc., of Mt. Vernon, N.Y., as Tork Time Switch, Model 7120. The switch **110** is interposed in two circuits of opposing polarity, **112** and **114**, each including the motor **94** and a shunt switch **116** energized at the end of each stroke of the sector gear **98** to break the circuit to the motor and prepare the opposing circuit for closure by mere actuation of the toggle switch **110** at the next time interval.

In use, suppose one wished to arrange for the lock to automatically close at 5 p.m. and automatically reopen at 9 a.m. the next morning. One of the trippers of the timer **108** is set at 5 p.m. and the other at 9 a.m. and the clock is set at the correct actual time. When the first tripper arrives at 5 p.m. it throws the pole of the toggle switch **110** to the position to engage the terminal **118** and close the circuit **112** driving the motor in one direction and through the gearing **96**, **98** the arm **100** from left to right on FIG. 2 or from a remote to a close position with reference to the keeper. In so doing, the tension on spring **102** is released allowing the compression latch bolt spring **52** to take over and urge the latch into the extended or closed position, the latch pulling the actuator **64** along. At the end of its travel, the sector arm **100** actuates the shunt switch **116** to break the circuit **112** by causing its pole to move away from terminal **120** which it had previously contacted, thus cutting off the current to the motor. At the same time, the pole of switch **116** moves to engage the terminal **122** of the shunt switch which would normally close the circuit of opposite polarity **114** but for the fact that the pole of the toggle switch **110** has not yet engaged the second terminal **124**. When the second tripper arrives at 9 a.m., it actuates the pole of the toggle switch **110** to engage the terminal **124** thereby automatically completing the circuit to the motor and reversing its rotation. In so doing, the sector arm **100** moves away from the keeper or from right to left of FIG. 2 extending the spring **102** somewhat which in turn pulls the actuator **64** to the left or away from the keeper and retracts the latch bolt **50** against action of its compression spring **52**. At the same time, the pole of shunt switch **116** moves off terminal **122** and engages terminal **120** to prepare the other circuit **112** to be closed only by the action of the timer tripper when it arrives at the next pre-set interval.

In the event that the latch bolt is jammed in the keeper for some reason, the arm **100** will complete its stroke to the left and shut off the motor while the spring **102** is fully extended. The spring therefore acts to store the retraction energy and when the jamming is mechanically released, the spring **102** will itself retract the actuator **64** and latch bolt **50**, thus preventing overload on the motor.

In the further event that an authorized person inside the enclosure wants to release the lock from the inside, a solenoid **126** may be provided in the housing whose core **128** is operatively connected by a wire **130** to the plate **66** behind which it is hooked as at **131** and through which it is freely slidable, there being a push-button switch **132** at any desired location to close the circuit to the solenoid and thereby retract the actuator **64** and latch bolt **50**. If desired, the solenoid can be located outside of the housing and operatively connected to the actuator **64** by other means.

When the bolt **50** is in its extended position and engages the keeper, the actuator **64** is at its furthest position towards the keeper or to the left of FIG. 2. If the timer has acted to cause the latch bolt to lock and has not yet arrived at the time to open it, those in the enclosure can let themselves out by rotating the handle **90** so that cam **38** abuts the plate **68** of actuator **64** to retract it and the latch bolt. From the outside this can be effected only by an authorized person having key **36** which when used to rotate barrel **34** in one direction will cause its cam **40** to abut the plate **68** of actuator **64** to retract it and the latch bolt **50**. The conduit **134** from the timer **108** enters the housing through a grommeted opening in the side wall **136** of the housing opposite wall **22**. Also, because the solenoid wire **130** and retractor spring **102** are freely slidable through plate **66**, the latch bolt can be manually retracted without any resistance from either the wire or spring and the latch bolt can be retracted by the solenoid without any resistance from the retractor spring **102**.

It should be understood that the switch **110** can be operated by manual, pressure or temperature means, instead of a timer, in which case the mechanism becomes a remote-control-operated electro-mechanical lock. For the purposes of manual remote operation, it has been found desirable to provide a set of indicator lamps for the operator and associated switches at the lock. For example, a switch has been provided in keeper **24**, which is effective to energize a lamp when the bolt **50** is retracted; another switch has been provided within housing **12** to be operated by actuator **64** in its different positions so that a lamp is lit or not depending on the operated condition of the actuator. Thereby, the operator is able to monitor the condition of the lock at all times.

As shown in FIG. 4, a key-operated switch unit **150** in lock housing **12** provides a secondary control of the motor **94**. The unit **150** includes a single-pole, normally-open switch **152** that is connected in series in the lock-opening circuit **114**; for example, it may be connected as shown between the motor **94** and switch **116**. The unit **150** also includes a suitable operator for the switch **152**, one form of which is a mechanical lock and key **154**, which serves to mechanically actuate switch **152** when inserted therein. The unit **150** may take the form of any suitable key-operated switch; for example, the cam **40** actuated by key **36** may be used to operate a simple single pole switch when it is rotated a quarter-turn. Such a key operator unit may be installed at any desired location within the housing **12** where it does not interfere with the mechanism, or such a key operated unit may be installed at a separate location on the door or door jamb and appropriate wiring connections made to form an appropriate control circuit such as the circuit illustrated in FIG. 4.

With the switch unit **150**, the operation of the lock under the control of the timer **108** is similar to that described above during the closing operation via circuit **112**, which is effective to extend the bolt **50** into keeper **24**. However, when the timer operates the switch **110** to the position illustrated in FIG. 4 to initiate retraction of the bolt **50**, the circuit **114** is not completed to energize the motor **94** until a key **154** is inserted in unit **150** to close the switch **152**. When the switch **152** is closed, the motor

is energized and the bolt **50** is retracted in the manner described above. Thereby, a double security control of the lock is provided, and personnel may be supplied with copies of the key **154** that are only effective to open the lock during the time intervals for opening established by the timer **108**. The switch **152** does not prevent proper closing operation by the timer **108** to extend the bolt **50**; and once so extended, the key **154** is ineffective to energize the motor **94** and open the lock until timer **108** throws switch **110** to the bolt retraction position shown in FIG. 4.

In FIG. 2, spring **160** is connected between a pin **162** fixed to mounting plate **28** and the arm **100** of motor **94**, and acts in a direction to assist the motor **94**, acting via arm **100**, in extending spring **102** or compressing bolt spring **52**. The balance spring **160** is extended by the arm **100** when motor **94** is operated for actuation of the bolt **50** to its extended position. The extension of spring **160** stores much of the energy of the motor during that portion of the operation. Upon operation of motor **94** to retract the bolt **50**, spring **160** assists arm **100** in the retraction operation, and the energy stored in the spring **160** is transferred to coupling spring **102** or to the bolt spring **52**, one of which is extended during this bolt retraction operation depending on whether the bolt **50** is struck in the keeper **24**, or whether it is readily retracted. The balance spring **160** has less spring force than the coupling spring **102** and serves to balance the load on the motor **94** to require approximately equal drive of the motor in both the bolt-extension and bolt retraction operations.

Without the balance spring **160**, the bolt spring **52**, compressed by the retracted bolt **50**, stores the motor energy and assists the motor in the bolt-extension operation; while the spring is a load during bolt retraction. Since the motor operation, without the balance spring **160**, is not the same for bolt retraction as bolt extension, one can provide a smaller energizing current during the bolt-extension operation to compensate for the unbalance and provide smoother operation. However, it has been found that the balance spring **160** serves not only to balance the load on the motor for the most part, but also during normal operation, the spring **160** tends to reduce substantially the load on motor **94**. The reduction in load results from the transfer of energy from the balance spring to the bolt spring **52** during bolt retraction, and back from the bolt spring to the balance spring during bolt extension. When the bolt **50** sticks in the keeper **24**, energy is transferred from the balance spring **160** to the coupling spring **102**, and after the bolt is released from the keeper **24**, from the coupling spring **102** to the bolt spring **52** to retract the bolt. When motor **94** is operated for bolt extension and the bolt **50** is blocked from entering the keeper **24**, the motor **94** has the additional load of extending balancing spring **160** since it is not assisted by bolt spring **52** at that time. However, this is an infrequent occurrence, relatively speaking, so that the overall loading of the motor **94** is substantially reduced by use of the balance spring **160**.

A modified form of the invention is illustrated in FIG. 5, in which parts corresponding to those described above are referenced by similar numerals with the addition of a prime (′). A bolt **50′** is biased outwardly in the extension direction for engagement in a keeper (not shown) by a pair of compression springs **52′**. Each of these springs **52′** lies between and bear against a shoulder on the bolt **50′** and a guide post **164**, which post is fixed to the lock mounting plate **28′** and slidably receives a guide rod **166** that is secured to the bolt **50′** and passes through spring **52′**. A pull rod or arm **100″** is slidable between guides **168** and within a chamber formed within a yoke extension **170** of the bolt **50′**. A compression coupling spring **102′** bears between an inner shoulder of the yoke **170** and a shoulder **172** at the end of pull rod **100″** and tends to bias the bolt **50′** in the retraction direction. At the end of pull rod **100″**, a slotted crosshead **174** receives a pin **176** eccentrically located on a rotatable disk **178**, the center of which is rotatable by way of a shaft coupling to a motor **94′**, which includes an appropriate gear box **179**. The motor **94′** may be reversible motor or it may be a unidirectional motor that can be alternating current or direct current energized. A balance spring **160′**, shown as an extension spring, is connected between a fixed post **162** and the crosshead **174** and biases the pull rod **100″** in the bolt-retraction direction. The crosshead **174** operates a toggle-switch **116** when it is moved to either of its extreme positions by way of two operator arms **182** and **184** connected to the pole of switch **116**, which are respectively engaged by the crosshead **174** at opposite ends of its path.

In operation, the bolt **50′** is biased by springs **52′** to its extended position for engagement in the keeper in the position illustrated in FIG. 5. Where motor **94′** is a reversible direct current motor, the circuit FIG. 4 may be used in the manner described above, in which batteries (or any other equivalent power supply) of opposite polarity (as shown in FIG. 4) may be used to energize the opening and closing circuits **114** and **112**, respectively, and switch **116′** is used in place of switch **116** in FIG. 4. Where an A-C motor is used, it is operated in a single direction, and the direct-current power supply, shown as batteries in FIG. 4, may be replaced by an A-C line with the pair of A-C power terminals being connected in reverse fashion to the two circuit sections **112** and **114**, or coupled thereto by a transformer with separate secondary windings for the two sections **112** and **114**. In that arrangement, the motor **94′** is energized via circuit **114** to retract the bolt **50′**, and via circuit **112** to extend the bolt **50′**. That is, when energized by a circuit **114**, motor **94′** rotates disk **178** a half-cycle, at which pin **176** is in the phantom position **176′**, to move crosshead **174** and pull rod **100″** to the left, compress coupling spring **102′**, and pull bolt **50′** to the retracted position against the bias action of springs **52′**. The chamber of yoke **170** is somewhat longer than the required bolt retraction to permit adequate compression of spring **102′** and relative movement if bolt **52′** is stuck in its keeper. When the crosshead **174** reaches its extreme bolt-retraction position, switch arm **184** is operated to actuate switch **116′** to the opposite position. Thereafter, when switch **110** is moved to complete the bolt-extension circuit **112**, the motor **94′** is again energized to continue the rotation of disk **178** another half-cycle, moving pull rod **100″**, which relieves the compression of spring **102′** and permits bolt **50′** to be extended by bias springs **52′**. When crosshead **174** completes its movement to a position illustrated in full lines in FIG. 5, switch arm **182** is actuated to operate switch **116′** to the opposite position, and the circuit is in condition to start the next cycle of bolt-retraction and extension.

The balance spring **160′** operates in a fashion similar to the balance spring **160** described above; it tends to balance the load on motor **94′** during the two half-cycles of operation for bolt retraction and extension, respectively, and it reduces the load on the motor during normal operation.

In FIG. 6 another modified form of the invention is illustrated; parts corresponding to those previously described are referenced by similar numerals with the addition of a double-prime (″). Mounted on a side wall **22″** of the lock housing is a conventional tubular type spring latch (similar to that shown in FIG. 1); the latch includes a tube **46″** secured to the mounting plate **48′**, a latch bolt **50″** that is slidable through the plate **48″** and within the tube **46″** and that is normally biased by a spring **52″** towards the extended or locked position into the keeper commonly associated with such a bolt. The spring **52″** bears between a shoulder on the bolt and the opposite inner wall of the tube **46″**. At its inner end, latch bolt **50″** includes a rectangular shank **60″** and head **62″**. A latch bolt actuator **64″** is formed as a flat member fixed to mounting plate **28″** and having upstanding walls **200** and **202** at each end thereof as well as an upstanding

guide member or intermediate wall 204. The bolt shank 60" is slidably received within a rectangular slot in the wall 200, and its head 62" is retained thereby. The walls 202 and 204 have bearing openings that slidably and rotatably support the shaft ends of an endless-worm adjustment screw 206. The endless-worm 206 has an intermediate portion that is formed with transverse left-hand and right-hand helical grooves that operate a follower arm 100" in the form of a rectangular member bearing against the flat plate of actuator 64" so as to be non-rotatable. Arm 100" has therein a rotatable member 210 with a groove-following blade 212 formed at the bottom thereof which engages in the helical grooves of endless worm 206. This mechanism is a well known device for providing reciprocating movement of the follower arm 100" back and forth along the worm as the worm shaft 206 rotates in but a single direction. In a commonly formed construction of this mechanism, the grooves at their ends are arranged to rotate the follower blade 210 a partial turn; thus, as it reaches the end of the helical groove in one direction it engages the helical groove in the other direction and thereby reverses the direction of translation of the entire follower member 208.

Bearing between follower arm 100" and wall 202 is a compression spring 102', which serves as a coupling between the arm 100" and bolt actuator 64". That is, as follower arm 100" is moved to the right (as viewed in FIG. 6), coupling spring 102' tends to be compressed and to move bolt actuator 64" to the right to retract the bolt 50"; as follower arm 100" is moved to the left, coupling spring 102" tends to be relieved to permit bolt actuator 64" and bolt 50" to be moved to the left under the action of bolt spring 52".

An extension arm 212 secured to follower arm 100", reciprocates therewith, and is biased to the right by extension spring 160" connected between arm 212 and a fixed post 162". Spring 160" serves to oppose somewhat the bias of bolt spring 52' and to balance the load on motor 224. Extension arm 212 is also used to actuate a toggle switch 116", as the follower 100" is moved to its extreme positions, by engagement with arms 182" and 184" attached to the switch 116" in a manner similar to that described above. An extension 214 of a rear wall 202 is engaged by a cam 40", which is secured to the rotatable plug 34" of a continuous wafer lock in a manner similar to that described above with respect to FIG. 1; thereby, a mechanical key can be used to operate the lock and rotate the cam 40" against the extension wall 214 and move the bolt actuator 64" to the right for bolt retraction.

The endless worm shaft 206 is guided in the walls 204 and 202 and is mounted in a fixed thrust bearing 216 and secured from reciprocation by appropirate shaft collars on either side of the thrust bearing. The shaft is connected via a universal coupling 218 to the output shaft 220 of a gear train 222 and motor 224. The motor 224 may be any suitable form of single-direction motor, such as an A-C motor. The universal 218 assures appropriate parallel alignment of the worm shaft 206 and drive shaft 220.

In the position illustrated in FIG. 6, the bolt 50" is in the extended position for interlocking with a keeper. It is biased to this position by bolt spring 52", the balance spring 160" is extended, being weaker than the bolt spring 52", and the coupling spring 102" is in its normal, substantially uncompressed condition. When motor 224 is energized by operation of switch 110 (using the circuit of FIG. 4 with a suitable A-C or power supply), shaft 206 is rotated in the direction of the arrow to drive the endless worm portion thereof as a right-hand screw, which moves the follower arm 100" to the right (assisted by balance spring 160") to compress coupling spring 102" so as to overcome the bias of spring 52" and retract the bolt 50". When the bolt 50" is fully retracted, the follower arm 100" reaches the end of the right-hand helical groove of the worm 206, and the extension arm 212 operates the toggle switch to de-energize the motor 224, which stops substantially instantaneously due to the load thereon; the groove follower blade 210 is rotated and aligned with the left-hand groove to be ready to start on the return path upon re-energization of the motor 224. Upon operation of switch 110 in the opposite direction, motor 224 is energized again and rotates endles worm shaft 206 in the same direction to drive the follower arm 100" along the left-hand groove back to the position illustrated in FIG. 6 to operate the switch 116" and stop the motor 224. The movement of follower arm 100" to the left, is transmitted by coupling spring 102" and bolt actuator 64" to permit bolt extension under the action of bias spring 52"; at the same time balance spring 160" is extended to the condition illustrated.

In the embodiment of FIG. 6, a D-C motor with the opposite polarities of power supply shown in FIG. 4 may be utilized; in which case, the endless worm 206 may be replaced by a conventional worm gear or adjustment screw engaging in a threaded follower arm of conventional form, and opposite rotations of such a worm gear produces the desired reciprocation of the follower arm in forward and reverse directions. Thus, in each of the above-described embodiments of the invention, a reversible electromechanical motor device is provided in which a motor arm is coupled by means of a spring to an actuator for a spring-biased bolt, and reversible operation of the motor arm in opposite directions produces the desired retraction and extension of the bolt. This invention is not limited to any particular type reversible or reciprocating motor device; for example, a solenoid or an electrical linear actuator with an appropriate mechanical drive may be used as the electric motor which provides reversible, reciprocating movement of a motor arm (such as the arm 100, 100' or 100") for bolt retraction and extension, the motor and mechanical drive being such as to maintain the motor arm in its extreme positions when the motor is not energized. With an appropriate mechanical drive, motor and size and weight of the various parts, it is not necessary to provide for braking of the motor or indexing of the motor arm in its extreme positions of travel. However, if necessary due to particular requirements (such as for large or extra heavy construction), dynamic braking of the motor or a similar expedient may be employed.

For greater security, a tubular dead latch mechanism may be used in place of that of spring bolt 50"; such a dead latch mechanism operates as a spring bolt in the manner described, but, once engaged in its keeper, the dead latch cannot be retracted by forces applied to the outer end of the bolt. The free movement needed for the bolt of such a dead latch is provided by the relative sliding movement permitted between the bolt shank 60 (60") and bolt actuator 64 (64"). Moreover, this invention may be used for electrical control of the operation of a releasable keeper instead of the bolt of a lock, and such a keeper may be extended into engagement with the bolt and retracted out of engagement in a manner similar to that described above.

Thus, in each form of this invention, no standby power is required to maintain the lock in either a locked or an unlocked condition; that is, with the bolt extended or retracted. The mechanism (e.g., worm and pinion or scotch yoke) coupling the electric motor to the motor arm 100, 100' or 100" has a mechanical advantage going from the motor to the motor arm and, therefore, is of such a nature as to be moved only by motor power and to remain unaffected by forces applied from the bolt end of the mechanism (e.g., by the energized coupling spring when the bolt is not free for retraction). Where binding of the bolt in the keeper occurs (due to common faults such as sagging of the door hinges or warping or bad fit of the door), the electric motor is not overloaded in attempting to retract the bolt; instead, the motor operates only for the time necessary to store in the coupling spring the energy required for bolt retraction. This energy continues to be stored until the bolt is freed, since the motor arm is retained

in position by its drive mechanism. When the door is subsequently manipulated, the bolt is ultimately freed, and the coupling spring retracts it to complete unlocking of the door. Similarly, the motor action in the reverse direction (where the bolt is blocked from extension into the keeper) is for the short time needed to transfer the energy for bolt extension and to make it available in the bolt spring, where it is stored until the door is manipulated to permit extension of the bolt. Thus, in neither case is there any danger of overloading the motor such as may damage it.

The energization of the motor is for but a short period of time corresponding to that required to actuate the coupling spring **102**, **102'** or **102''** and to store the energy therein for bolt retraction, or corresponding to that required to actuate the balance spring for bolt extension. In the above described embodiments, the switch **116**, **116'** or **116''** detects the appropriate movements of the motor arms **102**, **102'** or **102''** and cuts off the motor when the required motor arm movement is completed. Thereby, an accurate determination is made of when to cut off the motor. The switch **116** may take the various forms noted above and equivalent forms such as commutator brushes and the like. Alternatively, the switch **116** may be operated indirectly; for example, the switch **110** may also be connected to known timing circuits or other known timing devices; and the operation of switch **110** to energize the motor via circuit **112** or **114** may also be effective to operate an associated timing circuit or device that actuates switch **116** to the opposite position after a certain time period that is sufficient for the motor to move the motor arm to the proper extreme positions.

Each form of the invention provides a slip-joint or movable connection between the motor arm and the bolt actuator, by way of, for example, the connection of the coupling spring; thereby, together with an appropriate mechanical lock and operator for the bolt actuator, mechanical override of the electrical control is provided for bolt retraction. Moreover, a double-security control of the bolt is made available by means of a manually-operated switch **152** that must be closed in addition to operation of switch **110** to energize the motor and retract the bolt. Thus, this switch **152** is effective only during conditions or time periods established by the operation of switch **110**. This switch **152** may be any desirable form of key-operated device or it may be actuated by a combination push-button switching device. The security requirements for the operation of switch **152** may be of a lesser character since it is only effective during limited times.

The invention is not limited to any particular form of electric motor; rotary or linear motors may be used, either A.-C. or D.-C. In the case of rotary motors, the reversing action of the motor arm or bolt actuator can be supplied by reverse rotation of the motor itself or its associated mechanical drive.

By means of a balance spring **160**, **160'** or **160''**, the motor loading is substantially the same when operating in either the bolt-retraction or extension portion of the cycle. In addition, this spring serves to reduce the peak loading on the motor during normal operation; this reduction of loading comes about as a consequence of storing energy in the balance spring during the bolt-extension half-cycle (when both the coupling spring and bolt spring are aiding the motor drive), and using the stored energy for bolt retraction (when both the coupling and bolt springs are opposing the motor drive). The energy stored in the balance spring may come entirely from the motor during the bolt-extension half-cycle, or it may come at least in part from the bolt and coupling springs as they return excess energy to the system. It is preferred that the balance spring serve to balance approximately the load on the motor for each of the different half-cycles during normal operation; however, this relationship may vary with the lock design, and the balance spring may be chosen to provide a somewhat greater (or lesser) load on the motor during the bolt-extension half-cycle compared to the bolt-retraction half-cycle, under normal conditions, of the bolt being free to retract from and extended into the keeper.

In addition to the various embodiments and modifications of the invention described and shown, it will be apparent to skilled artisans that variations in the construction and arrangement of parts may be made without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. An electromechanical lock mechanism for interlocking a bolt element and keeper element of a closure, said mechanism comprising:

a movable one of said interlocking elements, including resilient means for biasing said movable element in a direction to interlock with the other of said elements;

means for guiding the extending and retracting movements of said movable interlocking element into and out of interlocking relation with said other element;

an electric motor device, including means for controlling the supply of electric power to said device;

and means for coupling said motor device to said movable interlocking element for initiating said out-of-locking movements, said coupling means including resilient means for storing energy supplied by said motor device and in an amount sufficient to effectuate said out-of-locking movement and for transmitting said energy to said movable element in a direction to effectuate said out-of-locking movement, and means between said motor device and said resilient coupling means for maintaining said resilient coupling means in an energy-storing condition when said motor device is de-energized and after having been placed in an energy-storing condition by said motor device, so that upon operation of said motor device for said out-of-locking movement said resilient means receives and retains the energy therefor when said movable interlocking element is restrained from out-of-locking movement;

said power controlling means including switch means for energizing said electric motor device to supply sufficient energy to said resilient means to move said movable element out of said interlocking relation and for thereafter terminating the energization of said device.

2. An electromechanical lock mechanism as set forth in claim **1** wherein said switch means includes means for energizing said motor device to initiate movement of said movable element into said interlocking relation and thereafter terminating the energization of said device.

3. An electromechanical lock mechanism as set forth in claim **2** wherein said coupling means includes additional resilient means energized at the time of initiation of the movement of said movable element into said interlocking relation and adapted for storing energy and for thereafter supplying said stored energy to said movable element to assist in said out-of-locking movement of said movable element.

4. An electromechanical lock mechanism as recited in claim **1** wherein said means for controlling the supply of power to said motor device includes a timing device having first electrical switch means and means for operating said switch means during certain time periods, and additional manually operable switch means effective to initiate the supply of power to said motor device for out-of-locking movement of said movable element only during time periods of operation of said first switch means.

5. An electromechanical lock mechanism as recited in claim **4** wherein said manually operated switch means includes a switch, and a mechanical key-operated device for said switch.

6. An electromechanical lock mechanism as recited in claim **1**, and further comprising a mechanical key-operated device including means for moving said movable

element out of locking relation; said coupling means including means for accommodating said out-of-locking movement initiated by said key-operated device without interference from said resilient means and for transmitting the stored energy from said resilient means to said movable element to effectuate an out-of-locking movement thereof.

7. An electromechanical lock mechanism as set forth in claim 1 wherein said means for maintaining the energy storing condition of said resilient coupling means includes a mechanism having a mechanical advantage connected from said motor device to said resilient means whereby said de-energized motor device is substantially unaffected by forces from said resilient means.

8. An electromechanical lock mechanism as set forth in claim 1 wherein said resilient means includes spring means having a displacement corresponding to the displacement of said movable element from interlocking to out-of-locking relation, said motor device being coupled to said spring means to produce said displacement thereof when supplying said energy for storage thereby, said spring means being coupled to said movable element to produce said displacement thereof when supplying said stored energy thereto.

9. An electromechanical lock mechanism for interlocking a bolt element and keeper element of a closure, said mechanism comprising:

a movable one of said interlocking elements;

means for guiding the extending and retracting movements of said movable element into and out of interlocking relation with said other element;

an electric motor device coupled to said movable element;

and means for controlling the supply of electric power to said device to effectuate interlocking and out-of-locking movements of said movable element; said controlling means including a control device having first electrical switch means and means for operating said first switch means in one way at certain times to initiate the supply of power to said motor device for interlocking movement of said movable element and in another way at certain other times, and additional manually operable switch means for initiating the supply of power to said motor device for out-of-locking movement of said movable element only during time periods of operation of said first switch means in said other way.

10. An electromechanical lock mechanism as recited in claim 9 wherein said manually operated switch means includes a switch, and a key-operated device for said switch; and further comprising a mechanical key-operated device for moving said movable element out of locking relation during time periods of operation of said first switch means in said one way.

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