United States Patent [19]

Arouete

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[54] **ELECTRIC LOCK FOR EMERGENCY EXIT DOOR**

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[21] Appl. No.: **316,440**

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Dec. 29, 1971 France.....71.47207

[52] **U.S. Cl.**..... **70/92,** 292/144, 70/441, 292/35

[51] **Int. Cl.**..... **E05b 65/10**

[58] **Field of Search**..... 70/92, 277, 441, 262, 263; 292/144, 75, 35; 340/274

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Assistant Examiner—Peter Nerbun
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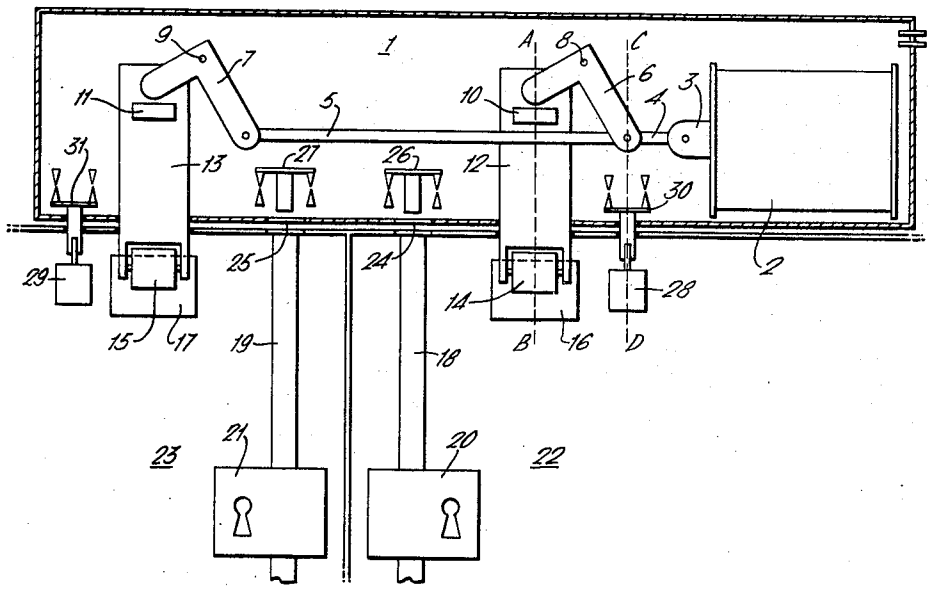
[57] **ABSTRACT**

A lock for an emergency exit door has an electromagnet with a movable core for actuating a bolt which cooperates with a striker box. When the electromagnet is energized the bolt is held in firm engagement with the striker box and the bolt remains in this position after an interruption of the current to keep the door closed, but the force urging the bolt against the striker box is cancelled so that the door may be opened by exerting a small pressure against the door.

13 Claims, 13 Drawing Figures



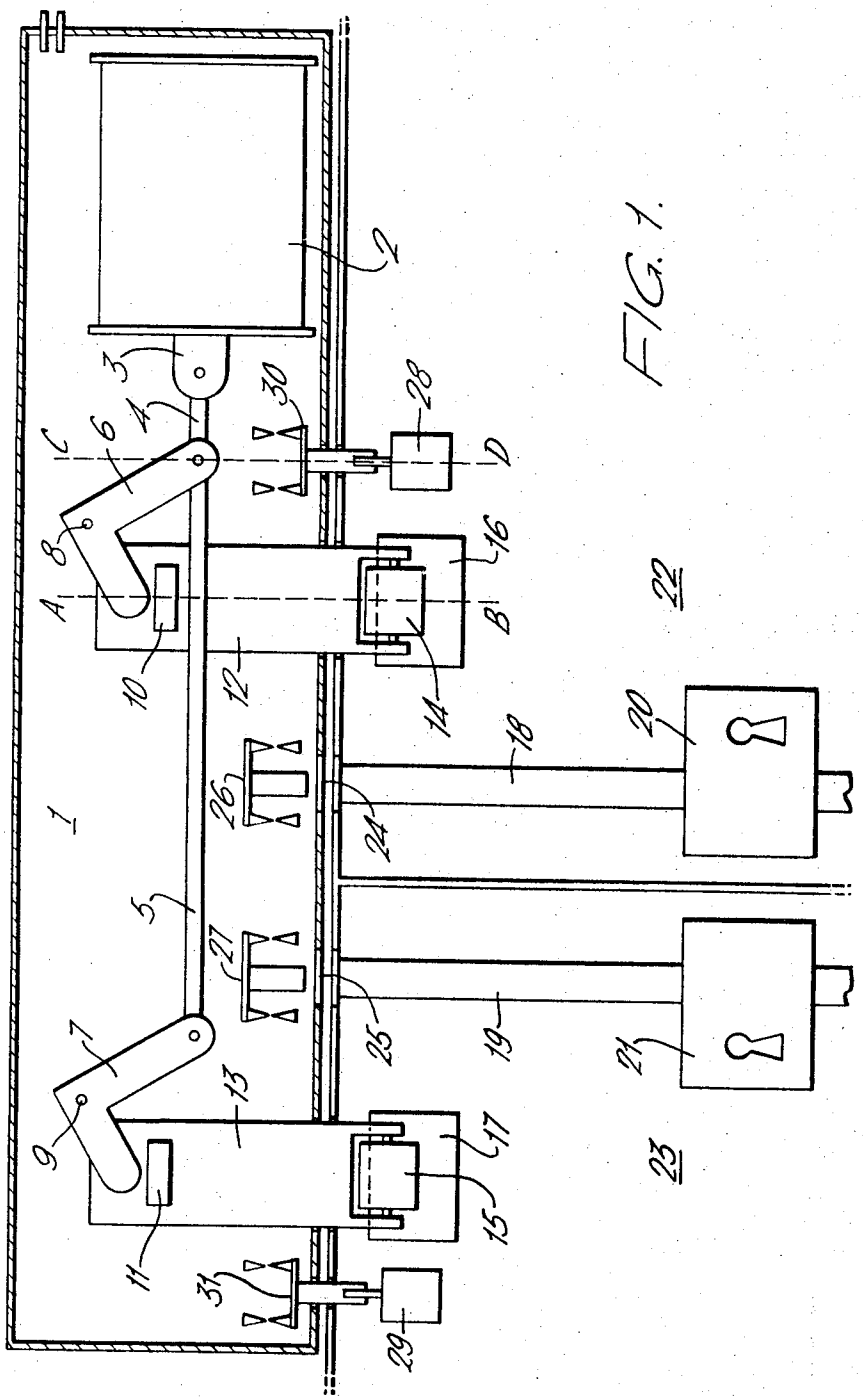

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FIG. 1.

FIG. 2.

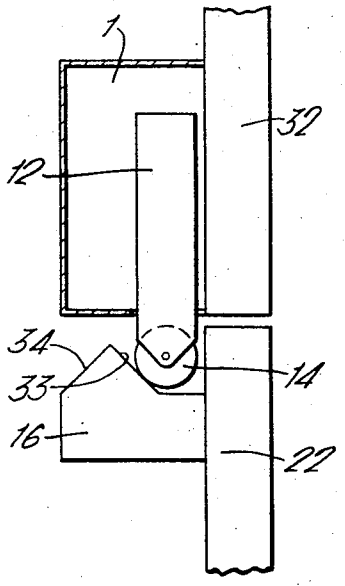

FIG. 3.

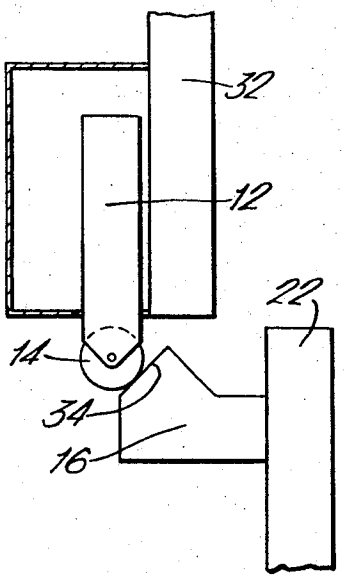

FIG. 4.

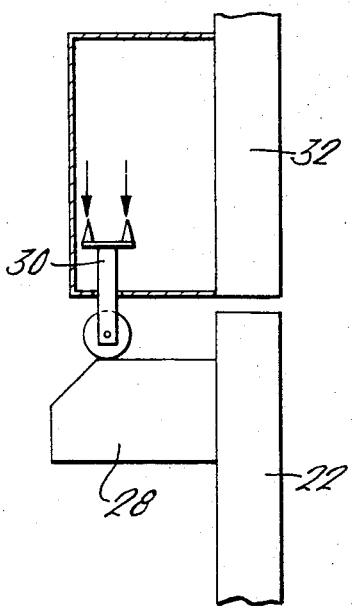

FIG. 5.

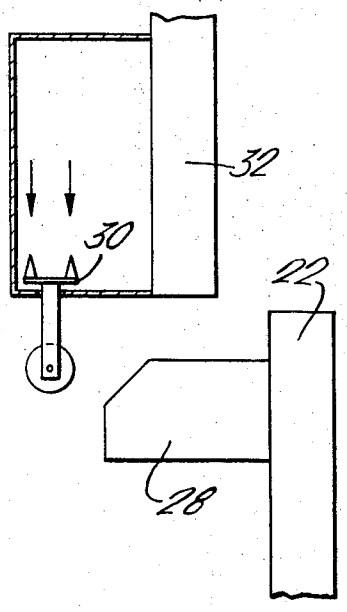

FIG. 6

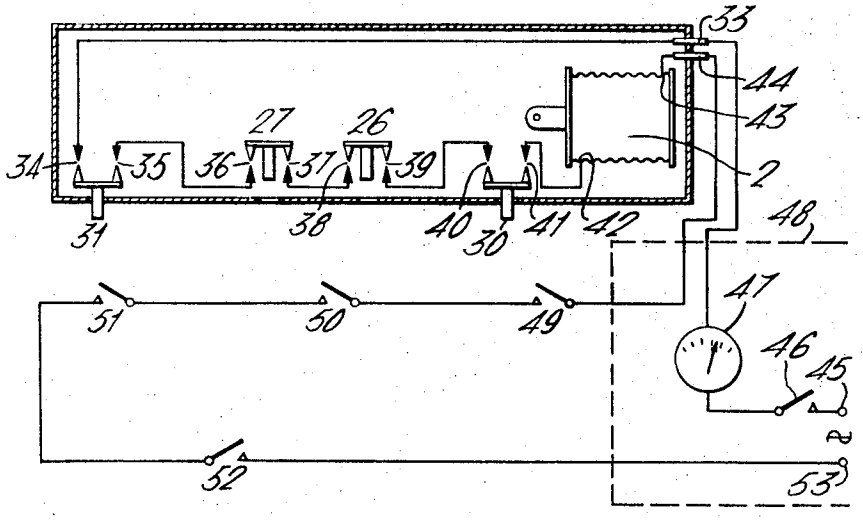
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FIG. 7

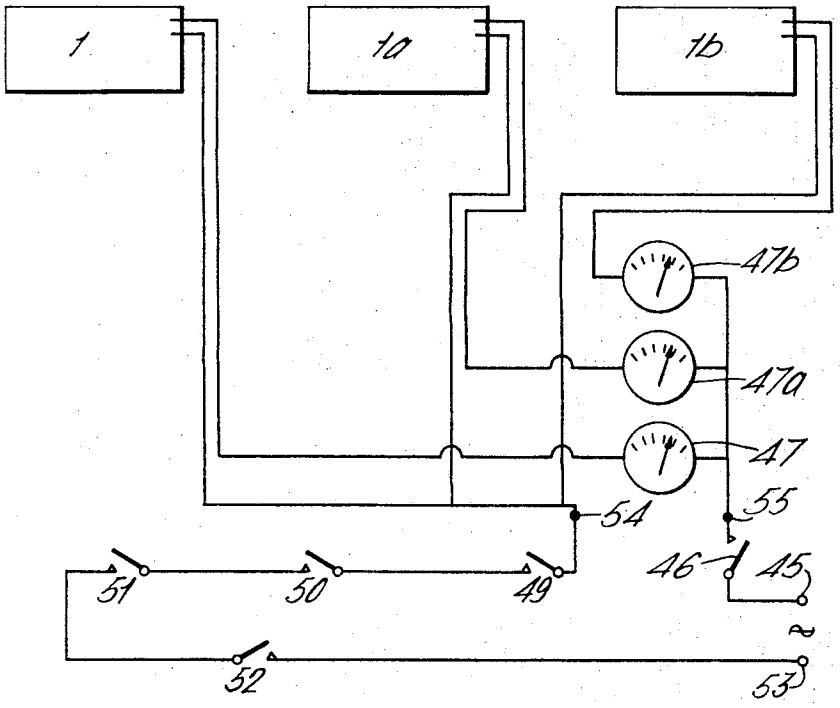
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FIG. 8.

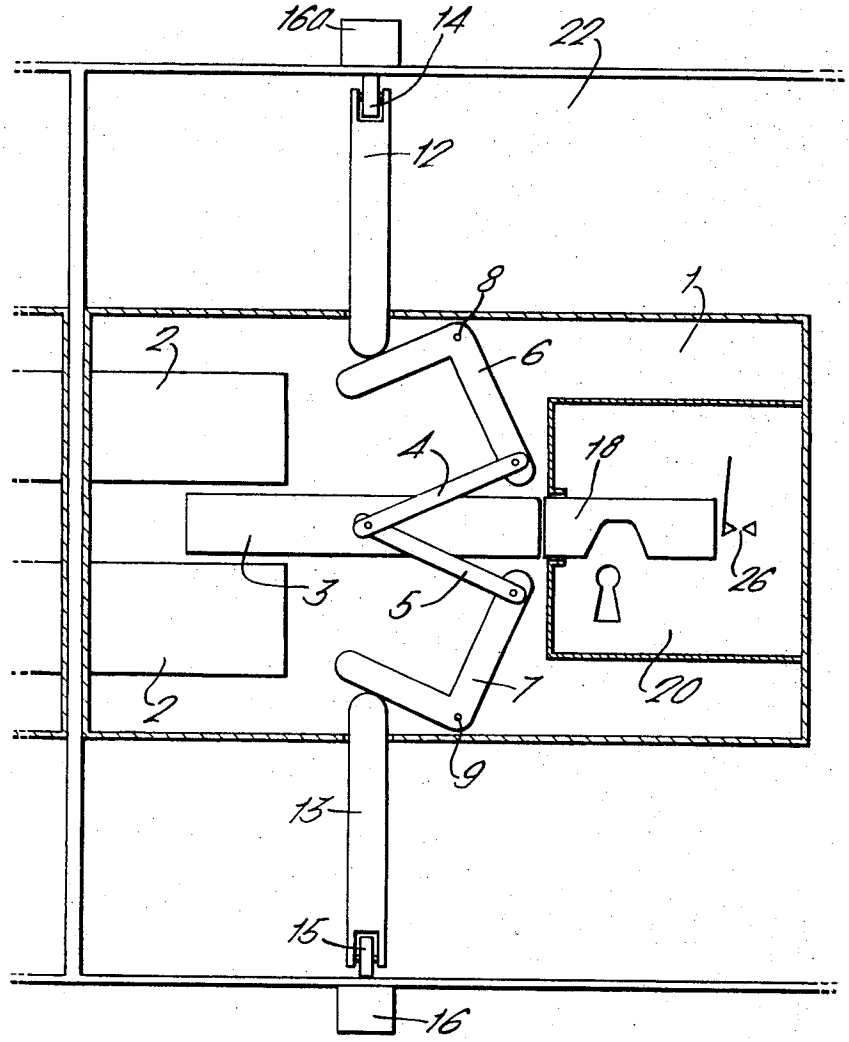


FIG. 9.

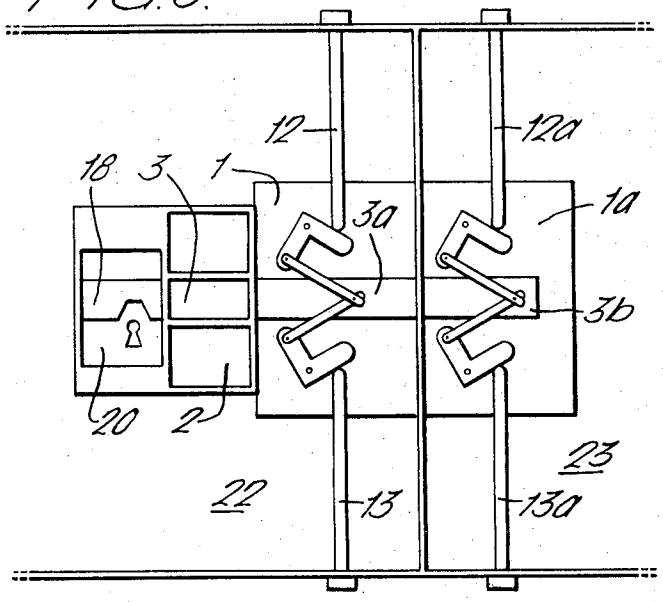


FIG. 10.

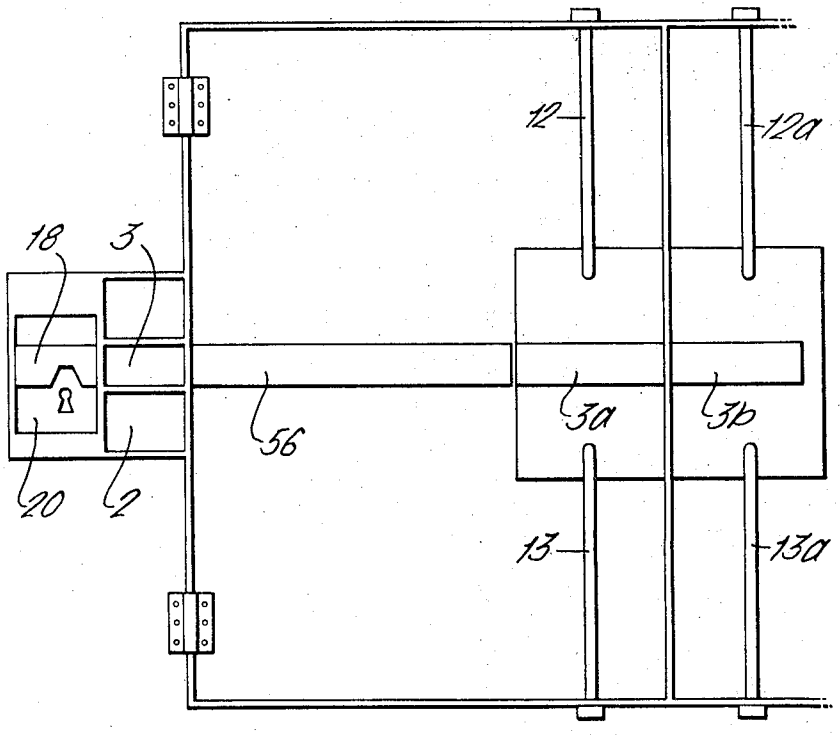


FIG. 11.

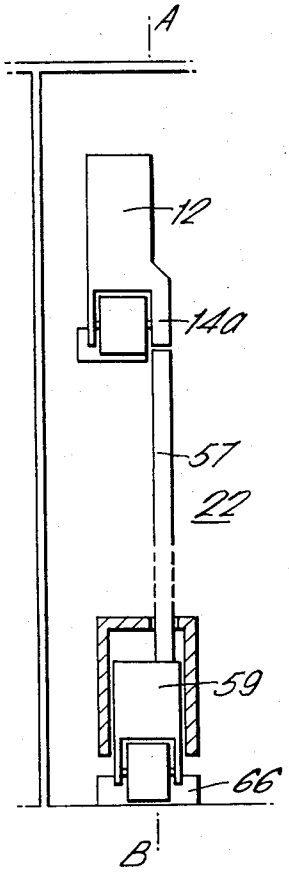


FIG. 12.

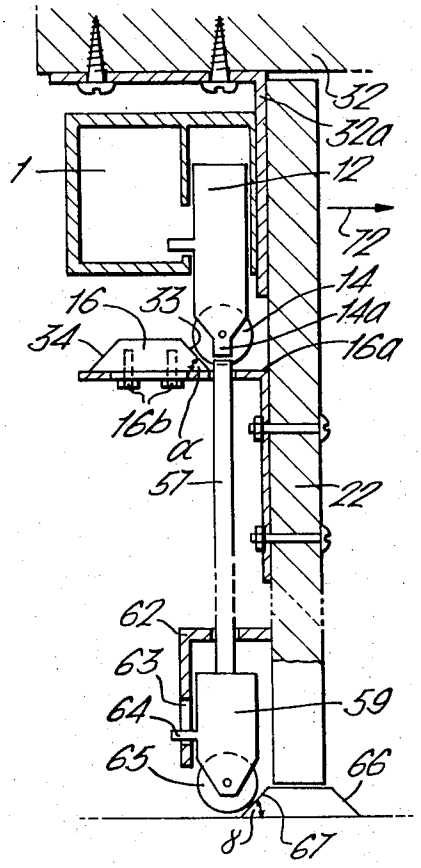
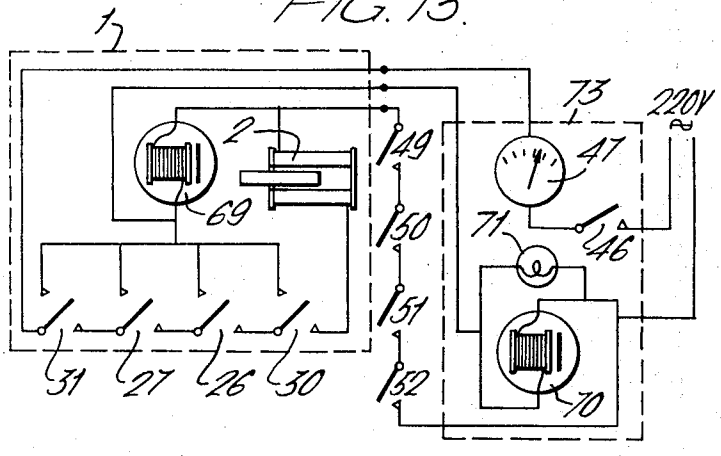


FIG. 13.



ELECTRIC LOCK FOR EMERGENCY EXIT DOOR

The present invention relates to an electric lock for an emergency exit door capable of being opened by one or more remote control switches, wherein the opening of the door is facilitated by a current failure or by the accidental destruction of the circuit.

Electric locks have been used for a long time providing a closure of the lock by an electromagnet which causes the bolt to project; an opening of the lock by cutting off the current and by returning the bolt into the lock, either by the action of a spring or by the action of a chamfered edge at the end of the bolt. As far as I am aware, such locks have never been used for emergency exit doors by reason of a number of disadvantages; risk of breakage of the return spring of the bolt, risk of forgetting to unlock the conventional locks of the emergency door, absence of control elements, and other disadvantages which create the inherent danger of being ineffective or non-functioning if an immediate opening of the emergency door is needed during a disaster.

A preferred embodiment of the invention enables these disadvantages to be avoided by a series of security and control devices which assure the lock of a real effectiveness in its use for emergency doors.

One embodiment of the invention is an electromagnetic lock which is mounted at the top of the door frame, and comprising two bolts, one for each door, both actuated by an electromagnet. The bolts may have a movement in the vertical direction. They are preferably not returned by a spring. When the electromagnet is cut off from the circuit the bolts may remain in the lowered position in which they project from the lock. Each bolt may carry at its front end a cylindrical roller. The latter preferably enters into contact with a surface of the striker box which may comprise two opposed slopes to permit the movement of the door in the opening direction as well as in the closing direction, when the electromagnet is cut out of the circuit, and the projecting bolt does not prevent this movement. This device operates as follows: In the opening or closing direction, the surface of the striker box with its two slopes drives back the bolt, the cylinder of the latter rolling on the rail of the striker box. When the electromagnet is energized in the circuit, with the door in the closed position, the cylinder of each bolt is locked against the corresponding slope of the striker box, which then acts as a stop and prevents opening of the door. When the current is interrupted, the bolt is freed and if the door is pushed, the first slope of the rail of the striker box pushes back the bolt, permitting the opening of the door. When the door is required to be closed, the opposing slope pushes back the bolt whose roller will roll on the rail and the door can be re-closed in spite of the projecting position of the bolt.

When this type of lock is provided on the emergency doors of a public hall, the electromagnetic lock must be placed at rest, out of circuit, when the hall is not used and a conventional lock with a key must be used to lock up the premises. The provision of this conventional lock can create a risk in that it is possible to forget to unlock this conventional lock for the period of public use thereby negating or cancelling the safety feature provided by the electromagnetic lock. To avoid this disadvantage, the following device may be added to that which has just been described. A small electric

pressure switch is placed opposite the bolt of the conventional lock, either on the inside of the electromagnetic lock (one part of which then serves as a striker box for the conventional lock) or on the outside of the electric lock, in a separate striker box. This switch is preferably actuated by the bolt of the conventional lock in the following manner: in the projecting position of the bolt, the bolt rests on the button of the switch and cuts out the latter; in the retracted position of the bolt, that is to say when the conventional lock is open, the released switch is closed. This switch can be placed in an electrical circuit (the description of an example of which will follow) so as to provide an indication of the state of the conventional lock, either open or closed. This switch may be connected in series with the electromagnet of the electric lock. The circuit may further comprise cut-out switches situated at different points of the room (e.g., in positions where an employee is stationed) and also comprise an ammeter situated at a permanent surveillance point, the deviation of which will indicate that all the security requirements are in effect, viz. voltage applied to the electric lock, conventional lock open.

Preferably a remote control element is provided since, in the embodiment which has just been described, a voltage can be applied to the electric lock while the door is open. The remote control element for making this impossible and to assure the possibility of remote control of the security elements of the emergency door, is preferably a switch disposed in the lock and operable by a stop mounted on the door so that the door comes into the closed position resting on the switch. This switch may also be connected in series in the circuit. Thus if the door has remained open, no voltage can be applied to the electric lock and this condition will be visible on the ammeter indicator.

By way of example several embodiments of the invention will now be described with reference to the accompanying drawings, in which:

FIG. **1** shows a front view of a first electromagnetic lock according to the invention;

FIGS. **2** and **3** are vertical cross-sections taken along the line A–B of FIG. **1**, when the door is respectively closed and open;

FIGS. **4** and **5** are vertical cross-sections taken along the line C–D of FIG. **1** when the door is respectively closed and open;

FIG. **6** is a diagram of an electric circuit for the lock;

FIG. **7** illustrates a circuit diagram for a plurality of doors;

FIG. **8** illustrates a second embodiment;

FIG. **9** illustrates a third embodiment;

FIG. **10** a modification of said third embodiment;

FIG. **11** shows a front view of an alternative bolt and striker box arrangement for the electromagnetic lock of FIG. **1**;

FIG. **12** is a cross-section along line A–B of FIG. **11** and

FIG. **13** is a diagram similar to that of FIG. **6** but additionally including an alarm means.

The electromagnetic lock **1** is mounted in the lintel region of a door-frame for the two doors **22,23** of a double door. The electromagnetic lock **1** has an electromagnet **2** whose core **3** acts on rods **4** and **5**. The rods **4** and **5** act on angle pieces or bell cranks **6** and **7** which are rotatable about pivot points **8** and **9**, and

which rest on stops **10** and **11** of bolts **12** and **13** and lock the latter in their lowered position projecting out of the lock. The extremity of each of the bolts comprises a cylinder **14, 15** fixed at rotatable about its axis on the bolt. When the bolts project downwardly the cylinders **14** and **15** bear against striker boxes **16** and **17,** thus lock the two door **22** and **23** of the double door. The bolts **18** and **19** of the conventional locks **20** and **21** used on the two emergency exit doors are introduced in the closed postion into two apertures **24** and **25** of the electromagnetic lock, which apertures serve in that case as a striker box for each conventional lock. Two switches **26** and **27** disposed opposite the apertures **24, 25** are in the open position when the bolts **18** and **19** are introduced into the holes **24** and **25.** When the conventional locks of the door are opened, the bolts **18** and **19** are withdrawn, releasing the buttons of the switches **26** and **27** which are thus closed. The two doors of the double door have two stops **28** and **29** which, when the doors **22** and **23** are closed, come to bear against switches **30** and **31** thereby closing them. When the doors are open, the switches **30** and **31** are released and thus opened.

FIG. **2** shows the door **22** in the closed position, in line with the frame on which the lock **1** is fixed with its bolt **12** in the lowered position. The cylinder **14** at the end of the rod comes to bear against the stop **16** which serves as striker box, and which comprises a double-sloped rail **33** and **34.** When the door is closed and the bolt is held by the electromagnet in the lowered position, the slope **33** of the striker box rests against the cylinder **14** and the door is thus held in the locked position. When the electromagnet is released, the bolt is freed and if the door is pushed, the stop **16** pushes back the bolt **12,** the cylinder **14** rolling on the slope **33.** Conversely, when the door **22** is opened as in FIG. **3,** to close it again, the stop **16** will push back the bolt **12,** the cylinder **14** rolling on the slope **34** and the door may be closed. Thus co-operation of the two slopes **33** and **34** with the cylinder **14** of the bolt **12** allows the elimination of a return spring for the bolt.

As shown in FIG. **4,** when the door **22** is closed, the small stop **28** may rest on the switch **30** and keep it closed. FIG. **5** shows the same section when the door **32** is opened and illustrates that the released switch **30** is opened. This switch provides an indication of the open or closed status of the door **22.**

FIG. **6** shows the electrical circuit inside and outside the lock. Inside the lock electrical current enters by the terminal **33** and then passes through the switches **31, 27, 26, 30,** into the electromagnet **2,** all these elements being connected in series, and then leaves the lock by the terminal **44.** The series circuit therefore passes successively through connection or contact points **33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43** and leaves at **44.** On the outside of the lock the electrical circuit is as follows: the source of supply which is the electricity mains, leaves from the point **45,** passes through a switch **46** and the ammeter indicator **47** situated in the room (shown by the dotted line **48**) of the person responsible for monitoring the apparatus, then enters in the lock at **33,** leaves again at **44,** then passes through the switches **49, 50, 51, 52** etc. . . . situated at different points of the room within quick reach of the employees, and finally is closed at the other terminal **53** of the mains. If the conventional lock has been left closed, the switches **26** and **27** remain open or if the emergency door is left open, the switches **30** and **31** remain open, and the ammeter **45** does not deviate, illustrating that one of the security conditions is not fulfilled. Reciprocally, the ammeter deviates only if the switches **26, 27, 30** and **31** are closed, that is to say, conventional lock opened and emergency door closed, all other switches closed.

In large rooms where there can be a large number of emergency doors, it is possible to place several circuits, each one of them having a control ammeter, and the ammeters are grouped in the area or in a room of the person in charge. If an ammeter does not deviate it will indicate the particular door to be checked is not in "secure" condition. FIG. **7** shows the electric circuit for the connection of several doors, with ammeter indicators for each door. The source of current is at **45** and **53.** The switches **49, 50, 51 52** etc. . . . are in series in a first part of the circuit connecting the two poles of the mains to points **54** and **55.** On these two points as many secondary circuits as there are emergency doors are connected in parallel with one another, each secondary cirucit having its ammeter indicator **47, 47***a*, and **47***b*, etc. . . . in series with each electromagnetic lock **1, 1***a*, **1***b*, etc. . . . . The cutting out of a single one of the switches **46, 49, 50, 51, 52,** etc. . . . interrupts the current in all of the locks and therefore opens all the doors at one time. The ammeter indicators grouped in the chamber **48** permit the individual surveillance of each emergency door.

A different assembly may be required because in two circumstances the above-described realizeation may be insufficient. These two circumstances are the following: firstly, when the emergency door is flush with the ceiling and when there is no room on the frame to accommodate the lock, and secondly when the elements of the conventional lock and of the emergency lock would obstruct one another. The descriptions which will follow concern an improvement of the preceding embodiment, and one in which the conventional lock is incorporated in the electrical emergency locking system. This is achieved in that the cylindrical bolt serves at the same time for locking during emergency use and for locking during conventional use, and in that striker boxes are located on the high and low horizontal portions of the frame, the lock itself being mounted on the door. According to FIG. **8,** the lock **1** is fixed to the door **22;** it comprises the electromagnet **2** whose core **3** acts on the arms **4** and **5** which act on the angle pieces or bell cranks **6** and **7.** These angle pieces are rotatable about points **8** and **9** and push against bolts **12** and **13** each of which has a cylinder **14** and **15** at its extremity. The stop of the striker box is identical to that of FIGS. **2** and **3** but the situations are reversed: the striker boxes **16** and **16***a* in FIG. **8** are fixed to the frames above and below, the operating mechanism of the electromagnetic lock is the same as before. In FIG. **8** the extremity of the core **3** moves opposite the bolt **18** of a conventional lock **20** incorporated in the electric lock **1.** When this lock **20** is closed, the bolt **18** pushes the core **3** back (i.e., to the left in FIG. **8**) and by means of the angle pieces or bell cranks **6** and **7** the bolts **12** and **13** are moved to their locking positions. Thus after the current supply to the electromagnet is stopped, the bolts **12, 13** continue to prevent entry to the premises and thereby lock them when not used for public meetings. The switch **26** is the indicator of the locking by key, the electrical connections being the same as for

FIG. 6. The switches 30 and 31 in the security system of FIG. 1, are located in FIG. 8 between the door and the frame, on the edge at which the hinges are provided. The embodiment of FIG. 8 necessitates a lock for each door of a double door.

Another embodiment comprises only a single combined electric-and-conventional lock for both doors of a double door. This embodiment is illustrated in FIG. 9, where each door 22 and 23 comprises adjacent locking parts 1 and 1a oppositely mounted on each door. One of the doors comprises the driving electromagnet 2 and the conventional lock 20. When the electromagnet is energized, the core 3 of the electromagnet 2 pushes the piece 3*a* to the right (FIG. 9) which pushes the piece 3*b* to the right (FIG. 9). These two pieces 3*a* and 3*b*, in the same manner as in the preceding embodiment, hold the bolts 12, 13 and 12, 13*a* in the locking position. The bolt 18 of the conventional lock 20 actuating the core 2 of the electromagnet permits all elements to be maintained in the locking position when the electromagnet is at rest. The electromagnet-conventional lock assembly of FIG. 9 can be fixed to one of the doors in contact with part 1, or (as shown in FIG. 10) can be fixed to the door frame, the movement being transmitted by a long rod.

It should be mentioned that if one exerts a force greater than the force of the electromagnet against the door when the electromagnet is energized the core of the electromagnet will be moved against the force of the magnet and the door will be opened without damage to the door. One of the two arms of the angle pieces or bell cranks 6, 7 is preferably longer than the other so that force transmitted to the electromagnet or to the bolt may be increased depending on the arrangement of the angle piece or bell cranks 6, 7.

Referring to FIGS. 11, 12 and 13 wherein like parts are indicated by the same reference numerals as in FIGS. 1 to 10, FIGS. 11 and 12 show the electromagnetic lock 1 with the bolt 12 having a cylinder 14 fixed rotatably to the bolt. As shown in FIG. 11 the bolt 12 has on one side a projection 14*a* forming an abutment for engaging a long rod 57. The rod 57 locking a similar bolt 59 fixed to the lower end of the door 22 against a striker box 66 attached in turn to the floor so that when the electromagnet is energized, the door will be locked at an upper point and a lower point. The lock is fixed to the upper edge of the door frame. While in FIG. 11 the striker boxes and bolts interconnected by the rod 57 are shown for one door only of a double door it is evident that a similar arrangement is provided for the other door.

As shown in FIG. 12 the door 22 when closed is at the middle of the door frame 32 to which the lock 1 is fixed by means of an angle piece 32a against which the door abuts in the closed position. The arrow 72 indicates the direction in which the door may be opened. The striker box consists of two parts, an angle piece 16*a* fixed to the door at one side and the rail of the striker box 16 mounted at the other side. This rail is a profiled piece to triangular or trapezoidal shape. This latter part is fixed to the angle piece by two metallic screws 16*b* which may slide in a slot of the angle piece so that the position of part 16 may be adjusted with respect to the cylinder of the bolt when the lock 1 is mounted on the door. The part 16 having a triangular or trapezoidal cross-section is mounted by its base on the angle piece. The two sides adjacent the base are the two slopes 33 and 34 which have already been described hereinbefore. The slope 33 on which the cylinder of the bolt rolls during the opening movement defines an angle α of 55° with the base. If this angle is greater the horizontal component of the force of the bolt against the striker box, component which conditions the friction of the bolt against the lock, is too high with respect to the vertical, upwardly directed component, and the force applied against the door will lock the bolt with respect to the lock. Contrariwise, if this angle is smaller the vertical upwardly directed component will be important for a relatively small force exerted against the door, thus making the provision of an electromagnet with a high force necessary so that it will not yield to a small force exerted against the door. Referring further to FIG. 12, the bolt has at one side near the cylinder 14 a projection 14*a*, which bears against the upper end of a long rod 57 which in turn bears with its lower end against the bolt 59 fixed to the door by a metallic frame 62. The vertical movement of the bolt 59 is limited by a slot 63 in which a projection 64 of the bolt 59 slides. The cylinder 65 of the bolt 59 bears against the striker box 66 fixed to the floor and is similar to part 16. The angle γ of the slope 67 is smaller than the angle α of the slope 33 so that during the opening movement of the door the bolt 12 will move more rapidly upward than the bolt 59 and its rod 57 so that there will be no friction between the upper end of the rod 57 and the projection 14*a* of the bolt. The contact between rod 57 and projection 14*a* will be established only at the moment when the door is in the closed position. When the door is closed, the bolts 12 and 59 are locked by the electromagnet in their lower position, the slopes 33 and 67 of the striker boxes bear against the cylinders 14 and 65, and the door is therefore locked in the closed position at its upper side and at its lower side.

As shown in FIG. 13 an acoustic alarm is incorporated in the lock and in the control panel so that if one of the above mentioned unusual situations occurs, the ammeter will no longer deviate and in addition an alarm will be started in the lock and on the control panel and a light will be illuminated on the control panel. The switches 31, 27, 26 and 30 of FIG. 6 are replaced by change-over switches 31, 27, 26 and 30 in FIG. 13. These change-over switches, in their first, normal position, close the circuit to energize the electromagnet to permit the current to pass through the electromagnet. It is sufficient if one of these change-over switches is in its second position, i.e., reversed so that not only the current will be interrupted in the electromagnet, with the ammeter returning to zero, but also an alarm 69 will be energized which is located on the inside of the lock 1 (indicated by the broken lines) and at the same time an alarm 70 and a check light 71 provided on the control panel (indicated by broken lines 73) will be energized.

What we claim is:

1. A lock in combination with an emergency exit door, and a door frame said lock comprising:
   a. an electromagnet having a core movable between an extended and a retracted position and an energizing circuit,
   b. a bolt carrying a roller rotatably mounted at the free end of said bolt,
   c. a striker box against which the bolt is positively pressed by said extended movable core when said electromagnet is energized, said striker box having

two oppositely inclined surfaces along which said roller rolls when said door is opened or closed and

d. an intermediate member operatively connecting said movable core to said bolt, said intermediate member being adapted to move said core from said extended position to said retracted position when said door is opened with said electromagnet energized.

2. A lock according to claim **1**, wherein said intermediate member is a pivotably mounted bell crank pivotably connected at one end to said core and cooperating at its other end with said bolt and wherein the longitudinal axis of said bolt is offset from the pivotal mounting of said bell crank.

3. A lock according to claim **1**, including a conventional mechanical lock and a switch, wherein said conventional mechanical lock comprises a bolt cooperating with said switch and wherein said switch is arranged in the circuit of said electromagnet and in series therewith.

4. A lock according to claim **1**, including a stop and a change over switch which are provided on said door, said stop being adapted to actuate said change-over switch when said door is closed, said switch being located in the circuit of said electromagnet in series therewith.

5. A lock according to claim **1**, wherein an ammeter is located in the circuit of said electromagnet in a control room remote from said lock.

6. A lock according to claim **2** wherein the bell crank has two arms of different lengths, the longer arm being pivotably connected to said movable core and the short arm cooperating with said bolt.

7. A lock according to claim **1**, wherein the electromagnet with said movable core, said intermediate member and said bolt with said roller are mounted in a housing fixed to said door frame and wherein said striker box is fixed to said door.

8. A lock according to claim **7**, including link means, two bell cranks, two bolts, a second striker box and wherein said door is a double door having two leaves wherein said movable core is connected to said link means which is pivoted to said two bell cranks, each of said bell cranks cooperating with said bolts, each bolt cooperating in turn with said striker box fixed to said one leaf of a double door.

9. A lock according to claim **1**, including two intermediate members, upper and lower bolts, upper and lower striker boxes and a conventional mechanical lock having a bolt wherein the core of said electromagnet is connected to said two intermediate members adapted to actuate said upper and lower bolts which are to be pressed against said upper and lower striker boxes, respectively, and said bolt is adapted to actuate the core of said electromagnet.

10. A lock according to claim **6**, wherein the striker box fixed to the door comprises an angle piece being mounted with one arm on the door, and a part having upwardly converging side surfaces fixed by means of two screws extending through an elongated slot in the said other arm of said angle piece, the slot having a length greater than the distance between the screws.

11. A lock according to claim **10**, including a vertical rod, a lower bolt and a striker box having two slopes and fixed to the floor wherein the bolt has a downwardly extending projection for engagement with said vertical rod extending along the door and bearing against said lower bolt which cooperates with said striker box.

12. A lock according to claim **1**, characterized in that an acoustic alarm is provided in the circuit and that the alarm is adapted to be energized when the current supply to the electromagnet is interrupted.

13. A lock according to claim **11**, characterized in that a second acoustic alarm and a control light are located in the circuit remote from the door in a control room.

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