

[54] **POLARIZED LIGHT-CONTROLLED
COMBINATION DOOR LOCK**

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[58] Field of Search **317/134**

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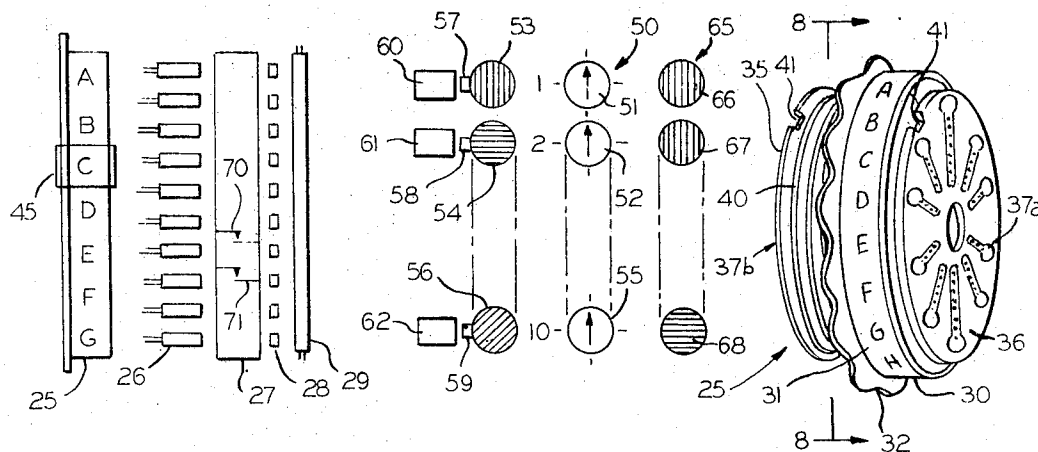
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[57] **ABSTRACT**

A plastic device somewhat similar to a credit card has a series of windows with polarized lens therein. Each lens is oriented in a unique manner according to a numerical code known to the card user. When the card is inserted into a door lock, the user sets one or more dials on a polarized reader. If the dial settings are in proper sequence and correspond to the polarized orientation of the credit card lens, a suitable signal enables a door to be opened for a predetermined time period. If the dials are set in a different sequence, a door is locked and an alarm is given.

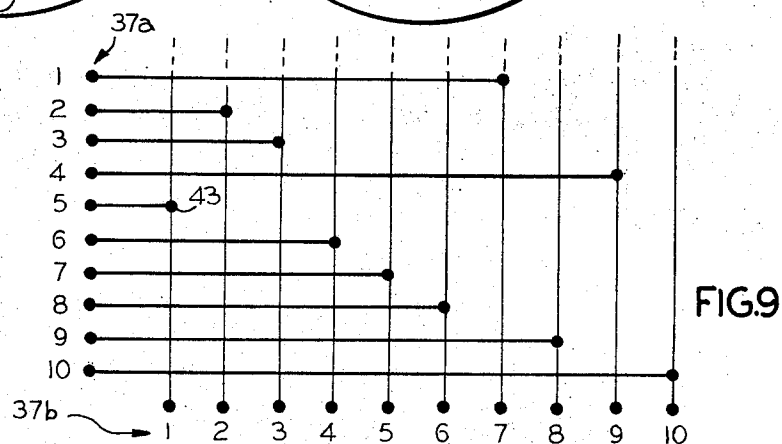
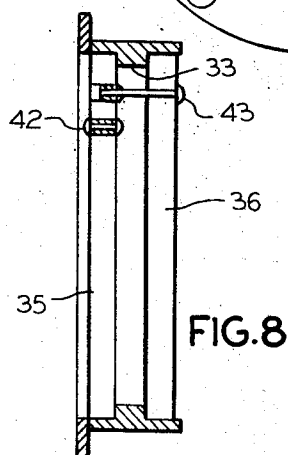
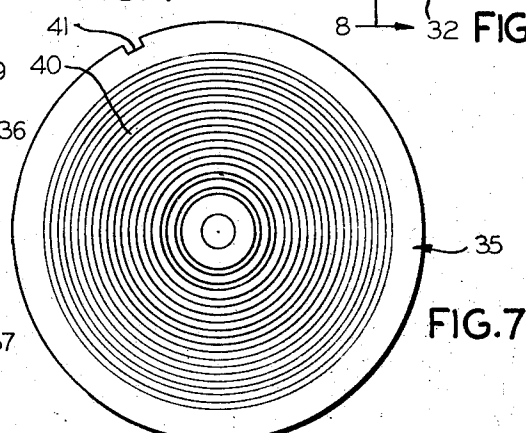
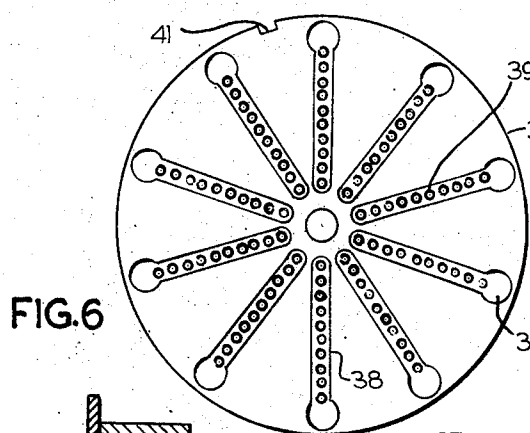
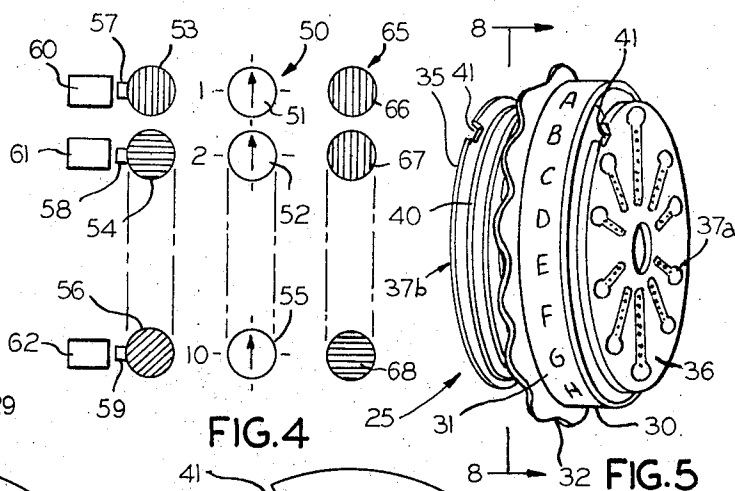
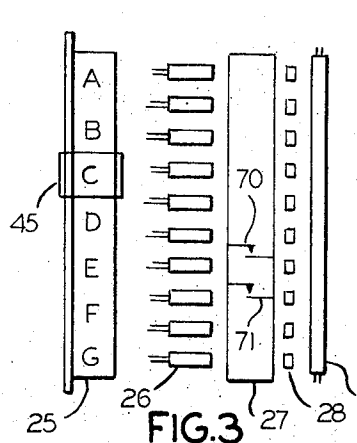
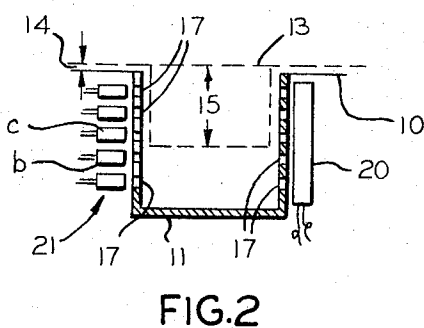
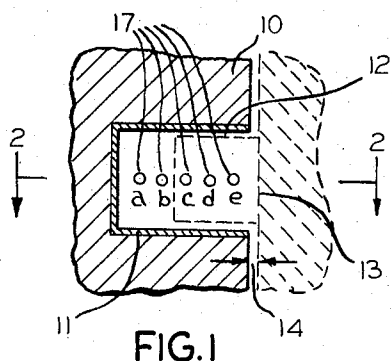
9 Claims, 10 Drawing Figures



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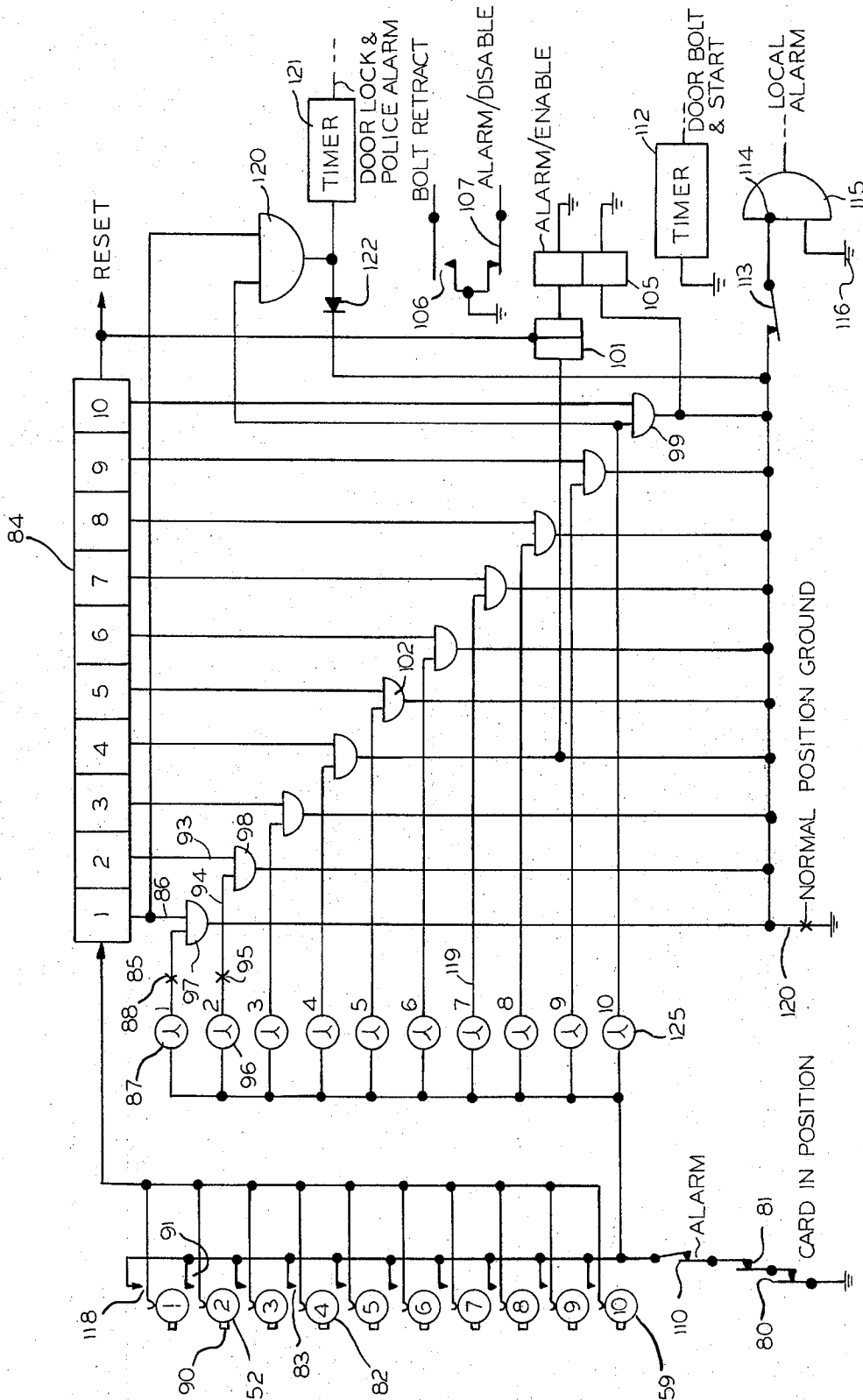


FIG. 10

POLARIZED LIGHT-CONTROLLED COMBINATION DOOR LOCK

My invention relates to a safety type door lock and, more particularly, to a lock controlled by a credit card type device that contains therein a concealed alpha-numerical identification, known only to the owner of the card.

Various forms of combination locks are known, wherein certain number dials or push buttons must be operated in a predetermined sequence in order to open a door or otherwise unlock something. The safety or security of the lock depends upon knowing the proper sequence. However, there usually is no way for a user to identify himself to the combination lock so that anyone can open the lock, if he learns the combination. An option would be to provide both a key and a combination lock. However, this does not add too much to the security of the lock since the person surreptitiously learning the combination could probably steal a key also. A better arrangement would be to provide a combination lock with a code which is never the same for any two persons and which also requires a unique identification of the user.

The invention described herein provides such an arrangement. In addition, a number of optional security devices are included to decrease the likelihood of a fraudulent defeat of the locking system. Any or all of these options may be provided or omitted, depending upon the cost versus security considerations.

Accordingly, an object of the invention is to provide new and improved combination door locks. Here, an object of the invention is to provide a credit card-like device on which combination control means are not displayed in an easily read manner. Still another object of my invention is to provide a reading device which enables the user of the credit card-like device to signal the necessary combination to enable a lock to be operated.

A further object of my invention is to provide a device of the character described that employs polarized lenses and lights to complete an electrical circuit which enables the device to be put into operation.

According to the invention, the device illustrated, described, and claimed herein has an invisible number, known only to the owner of the card. He is required to set, in proper sequence, levers, dials, or buttons on a lock device in keeping with the invisible numbers of the card inserted therein. If this setting is now in proper sequence or in accordance with the invisible number of the card, the lock will not open and an alarm will be sounded.

The card device is simple and requires no special mechanical skill or training for its use, yet is positive in its operation and functions only if the owner of the card adjusts it in the correct sequence.

Since the "key" to the lock operation is, preferably, a plastic device similar to a credit card, it is herein called a "credit card key." However, this terminology should not be construed to limit the invention.

Other and further objects of my invention will become more apparent as the description proceeds, when taken in conjunction with the drawings in which,

FIG. 1 is a cross-sectional view of a door jamb with the bolt of a lock secured in a keeper;

FIG. 2 is a similar cross-section taken along line 2—2 of FIG. 1;

FIG. 3 is a schematic view of the lock as it appears to the user;

FIG. 4 schematically discloses the polarized light disks and controls operated by the user of the lock;

FIG. 5 is an exploded view in perspective of a cross-wired wheel used to adjust the code sequence;

FIG. 6 is a plan view of one side of a printed circuit card used to make the cross-wired wheel of FIG. 5;

FIG. 7 is a plan view of the other side of the printed circuit card of FIG. 6;

FIG. 8 is a cross-sectional view of the cross-wired wheel taken along line 8—8 of FIG. 5;

FIG. 9 is a schematic disclosure of the cross-wired wheel encoding technique; and

FIG. 10 is an electronic lock control system operated by the structure of FIGS. 1—9.

In FIG. 1, the door jamb has a keeper socket 11 for receiving a door bolt 12 on door 13. The door bolts may have variable lengths and the spacing 14 between the door and jamb has a random length. Hence, each bolt has a distinctive length 15 which projects a unique distance into the socket 11. The length can be measured, but allowance would have to be made for the random space 14, which may be mechanically shielded from view. Also, a dashpot on the bolt could prevent full extension of the bolt while the door is open.

The socket 11 has any suitable number of oppositely disposed pairs of holes therein, as at 17. Each hole is able to receive a snap-in photo electric cell or to transmit light, as the case may be. A light bulb 20 is placed on one side of the keeper socket 11 so that equal amounts of light shine through all of the holes 17. Thus, it is not possible to discover which of the holes is most important by the simple expedient of observing where the light is located.

When the lock is installed, the installer holds a photo cell at each of the holes *a*, *b*, *c*, *d*, and *e*, while the bolt 12 is in place and the light 20 is "on". It is easy to detect the fact that the bolt cuts the light at holes *c* and not at hole *b*. Hence, the installer snaps in a photo cell at each of the positions *b* and *c* (FIG. 2). Therefore, when the door is closed and the bolt is in proper position, there is no output from photo cell *c* and there is an output from photo cell *b*.

Anyone fraudulently trying to learn the positions of these two photo cells by inserting an object into the socket 11, would simultaneously reveal his fraudulent efforts by cutting the light beams in an unnatural manner. A detector could easily detect this fraud. A mechanical hooding of the holes could foil efforts to see into them in an effort to observe the photo cell locations.

FIG. 3 schematically shows the apparatus which the user manipulates to open the lock. This apparatus includes a cross-wired thumb wheel 25, a plurality of photo electric cells 26, a slot for receiving a credit card key 27, a series of polarized light filters 28, and a light bulb 29.

The cross-wired thumb wheel 25 comprises a plastic ring 30 including position indicators 31 and an indexing flange 32. The inside peripheral center 33 of the ring 30 has an annular boss forming a seat for each of two circular printed cards 35, 36. The outside surface of each of the cards 35, 36 has a plurality of circularly disposed conductive spots 37 which are engaged by adjacent brushes or contacts. Extending radially inwardly from each of the conductive spots are spoke-like con-

ductive strip lines 38 having therein a number of holes 39 piercing the printed circuit cards. On the inside of one of the printed circuit cards 35 are a plurality of concentric circular strip lines 40.

The two cards 35, 36 are snapped into the ring 30 and pressed to rest against the seat formed by annular boss 33 (FIG. 8). Two notches 41, 41 in the peripheral edges of the cards 35, 36 mate with bosses (not shown) in ring 30 to insure proper alignment. Pins or solder 42 are passed through one of the printed circuit cards to electrically interconnect each of the conductive spoke strip lines 38 on one side of the printed circuit cards 35 to individually associated concentric strip lines 40 on the other side of the same card 35.

Pins 43 are passed through a selected hole in each of the spoke lines 38 on the outside of one of the boards 36 to individually connect those spoke lines to individually associated ones of the circular lines 40 on the inside of the other card 36. Thus, arbitrary connections may be made from any conductive spot 37a on one card to any conductive spot 37b on the other side. If the holes in card 35 are large enough to receive solder, all of the pins 42, 43 may be soldered in place from the outside of card 35. The solder for pin 43 runs down through the hole to engage the circular lines 40 on the inside of the wheel. The notches 41, 41 displace the positions of the two cards 35, 36, with respect to each other by a distance such that the conductive spoke lines 38 are not connected together from one printed circuit card to the other.

Since the numbers of spots 37, spokes 38, concentric lines 40, and holes 39 are all equal, it should now be apparent that any convenient and arbitrary code may be established. FIG. 9 has been drawn to show that the pins 43 complete the following code:

Conductive Spots 37a	Conductive Spots 37b
5	1
2	2
3	3
6	4
7	5
8	6
1	7
9	8
4	9
10	10

Thus, anyone using the dials when the cross-wired wheel 25 is in the position represented in FIG. 9 must operate the dials in the sequence 5, 2, 3, 6, 7, 8, 1, 9, 4, 10. It may be assumed that the code of FIG. 9 appears when the thumb wheel 25 is positioned so the C appears in a window 45 (FIG. 3). If the cross-wired thumb wheel 25 is moved to display D, for example, the cross-wiring moves so that 2 of spots 37a appears in the L position of spots 37b and spot 1 of spots 37a appears in the position 10. Thus, each cross-wired thumb wheel offers 10 different possible sequences. Additional sequences may be provided by substituting other cross-wired wheels having pins 43 in other optional interconnecting positions. To preclude a duplication of the code, either a new wheel may be substituted or several wheels may be placed in series.

A credit card key has a plurality of windows therein (in this example, 10 windows). Each window includes a polarized light filter 65 oriented in a predetermined direction. Thus, the code is stored by the positions of these light filters. Each credit card key is slipped into a notch 27 in the lock and the thumb wheel is turned to a display letter known to the card holder. Next, the

card holder rotates each of a series of operators in the form of dials 50 in the sequence known to him, i.e., 5, 2, 3, . . . 10 in the above-described example.

The rotation of each dial 50 places the polarized filters in predetermined positions which match the positions of the light filter 65 in the credit card key, individually held by the user. The nature of this structure is shown in my copending application Ser. No. 161,442, filed July 12, 1971 now abandoned. Preferably, each polarized filter disk is oriented in a distinctive manner so that merely knowing the code in the credit card key does not necessarily mean that the dials may be set. Thus, for example, a 90° rotation of dial 51 rotates filter 53 to a horizontal orientation, while a 90° rotation of dial 52 places filter 54 in a vertical position, and a 45° rotation of dial 55 moves filter 56 from a 45° to a 90° orientation.

Each dial has an associated cam 57-59 and microswitch 60-62. Whenever a dial is rotated, the cam operates the microswitch momentarily to send an electrical pulse. The object is to adjust each dial in the sequence selected by the cross-wired wheel 25 to a position wherein the positions of each of the filters 53, 54, 56 match the positions of the credit card key filters 65. As shown, filter 53 must be rotated 180° to match the credit card filter 66, and each of the filters 54 and 56 must rotate by 90°. Other filters, not shown, must be rotated in some other manner.

In the back of the slot 27 are contacts 70, 71 which are closed by notches in the edge of the credit card keys when in position in the slot. The notches, and these contacts 70, 71, may be combined with the dial positions to give a parity check to reject dial operations which are not proper. For example, the filter dial 54 could be rotated either 90° or 270° and produce the same result; or, credit cards could be read by holding them in front of a polarized lens, but then the parity would not check out because the user could not know whether to rotate the dial 56, for example, by 45° or 225°.

A code reader comprises the electrical controls for the circuit, as seen in FIG. 10. If the credit card key is in position and contacts 70, 71 are closed, an enabling signal is sent to FIG. 10, here shown as closed contacts 80. If the door bolt is in position, photocell *b* (in the example of FIG. 1) does not cut the beam of light and photo-cell *c* does cut it. Then contacts 81 are closed.

The first dial is rotated in the desired sequence. For example, with cross-wired wheel connections, as in FIG. 9, dial 5 is rotated first, and a signal appears on wire 1 at 37b. The cam 82 on dial 5 momentarily closes contacts 83 to drive a shift register 84 one step. There is a coincidence of signals. Wire 86 is energized from shift register 84, and wire 85 is energized from a photocell connected to wire 1 via cross-wired wheel contacts 88.

According to the cross-wired wheel connections of FIG. 9, dial 52 is adjusted second to energize wire 2 at 37b. The cam 90 closes contacts 91 to step the shift register 84 to the second position. There is now a coincidence on wire 93, 94. The photocell 96 energizes wire 94 via contacts 95 in the cross-wired wheel if the polarized light filters are properly oriented by the dial 54 operation. In a similar manner each of the other dials is set in proper sequence to cause a coincidence between signals dependent upon the shift register position and the light filter positions. If the signals properly

coincide, each of the AND gates 97-99 conduct, in order. In the fifth position, a flip-flop circuit 101 operates responsive to the output of AND gate 102.

An alarm/enable relay 105 has two windings which are sufficient to operate the relay if energized simultaneously, but not if energized alone. Thus, the code sequence must be properly dialed in both the first five and the last five dial operations in order to operate flip-flop 101 to energize the first winding and AND gate 99 to energize the second winding. This coincidence is a redundant parity check.

Operation of the relay closes contacts 106 to retract the bolt 13 from the door socket or keeper 11. Contacts 107 open to disable any alarms which otherwise would sound when the door opens.

A number of safety interlocks cause an alarm to be sounded, or any other desired action to occur. For example, the alarm could lock another door to trap the fraudulent user of the credit card key. These interlocks include contact 80 which is closed when a proper credit card key is in position in slot 27. Contacts 81 are closed when the bolt is extended a predetermined distance into the keeper socket. Contacts 110 open during alarm conditions. To unlock the lock, all the contacts 80, 81, 110 must be closed to supply the ground to the various AND gates 97-99.

Timer 112 is started whenever the door bolt is retracted. This timer allows one or perhaps two people to enter the door. If the bolt does not thereafter return to position within the measured time period, contacts 113 open to remove an inhibit at 114, and an alarm is sounded when the gate 115 conducts responsive to the ground at 116. Contacts 110 open to disable the electrical locking circuit.

If the proper sequence of dial operations are not followed, the dial operation does not coincide with the shift register operation, the AND gates 97-99 do not conduct. Their output fails to energize the inhibit 114. Gate 115 conducts, and an alarm is sounded. For example, suppose that the cross-wired wheel makes the interconnections of FIG. 9. Dials 82 and 52 must be the first and second operated, respectively, in order to energize terminates 1 and 2 in sequence at 37b. If dial 51 is operated second (instead of dial 52), a signal appears on terminal 7 (instead of terminal 2) at 37b while the shift register 84 steps to the second step responsive to the pulse from contacts 118. The resulting signals on wires 119 and 93 do not coincide at any AND gate 97-99.

In this error condition, an alarm is given. During the first and correct dial operation at the fifth dial, contacts 83 and photo-cell 87 give proper signals to cause AND gate 97 to conduct and energize the inhibit 114 to prevent the alarm. When shift register 84 steps to its second position responsive to the pulse at contacts 91, the signal disappears from wire 86 and the AND gate 97 turns off. Since it is assumed that the wrong dial was operated second, there is no coincidence at wires 93, 94 and AND gate 98 does not conduct. There is no signal to energize the inhibit 114. Gate 115 conducts, and an alarm is given.

When the lock is in a normal position and no one is attempting to open it, a signal at 120 energizes the inhibit 114 to prevent the alarm.

If the dials are operated in a predetermined different than normal sequence, known to the user, the door may be locked for a brief time period, and an alarm may be

simultaneously sent to the local police station. The user may be protected from the wrath of a frustrated, would be burglar or robber by a sign near the lock stating that the lock will not open until 15 minutes, for example, after the code is dialed. That 15 minutes, or a similar period, should allow the police to arrive on the scene before the door opens.

In greater detail, one predetermined dial is assigned as the burglar alarm, if it is dialed first. It is never assigned as the first digit of any code. When a robbery is in progress, the user merely dials the predetermined dial first. He may also dial it in the normal code position assigned to his credit card key. If it is desirable to avoid operating the same dial twice, which the burglar or robber might see, than only nine out of 10 digits are dialed in any code to unlock the door. The burglar alarm signal then amounts to a substitution of the normally unused tenth digit for the normally used first of nine digits in any given code. Since each person has a different cross-wired wheel setting, the burglar would have no way of knowing which dial is first used in normal coding or that a new first digit had been substituted for the normal one.

More particularly, FIG. 10 shows an extra first digit AND gate 120 which is energized by a coincidence of the output from the first step in shift register 84 and of the light cast on the tenth photo-cell 125 when the polarized filters are properly set. Normal encoding would require a coincidence from photo-cell 87 and not from photo-cell 125, responsive to the first digit. The AND gate 120 could not conduct responsive to any but the first digit since shift register 84 would then have stepped beyond its first output 86.

When the AND gate 120 conducts, a signal is fed to timer 121 to immediately give a police station alarm and to lock the door for 15 minutes. After 15 minutes, timer 121 releases a signal to retract the bolt, thereby conforming to an announcement on the sign over the lock. This will make the delay appear to be beyond the control of the user and thereby protect him from the wrath of the burglar or robber. In some locks, the 15 minute delay may be used on all codes whether or not a police alarm is sent.

Diode 122 feeds an inhibiting signal to gate 115 to prevent the local alarm from sounding and thus revealing the police alarm sent by the user. The diode 122 prevents the local alarm inhibit signals of the other gates 97-99 from starting timer 121 and sending the police alarm.

The lock may be made as complicated as necessary for the user's needs. At one extreme, a privacy lock is provided by elimination of the bolt position sensor of FIGS. 1 and 2 and the cross-wired wheels of FIGS. 5-9. The wires, such as 85, 94, 119, are permanently connected to selected photo-cells 87, etc. The sequence of dial operations is fixed by the configuration of wires.

At the other extreme, the bolt sensor may be made more difficult to fail by dashpot control of the bolt and by mechanical shielding of the random spacing 14. Many cross-wired wheels may be used in series, and they may be changed daily, if necessary. Moreover, memory means may be provided to store the dial encoding address and prevent the same code from unlocking the door more than, say, twice in sequence. This way, each person might allow, for example, one guest to enter, but no more. The timer 112 may be adjusted to force the user to run through the door, in

which case the credit card key is ejected on the opposite side of the door; or, the timer 112 may be adjusted to allow almost any number of guests to enter after the door is opened.

Other modifications will occur to those skilled in the art. Therefore, the appended claims are to be construed to cover all equivalent structures.

I claim:

1. A lock comprising non-contacting key means uniquely coded to identify a user, key means comprising card means having a plurality of windows therein, each window having a polarized light filter therein, said polarized filters being oriented to form said code, a plurality of discrete operator means each comprising a polarized filter individually associated with said windows which operators must be individually operated according to said unique user code, and means for establishing a sequence in which said operator means must be operated in order to open said lock.

2. The lock of claim 1 and means for changing the sequence for different users.

3. The lock of claim 2 wherein said sequence changing means comprises means for changing a configura-

tion of wiring between means associated with said filters and a reader of said code.

4. The lock of claim 3 wherein said configuration changing means comprises at least one changeable cross-wired wheel means.

5. The lock of claim 1 and means for detecting when a bolt in said lock is in a locking position, and for giving an alarm if said bolt is out of said locked position for more than a predetermined period of time.

6. The lock of claim 1 and means for giving a burglar alarm if a predetermined operator sequence is followed.

7. The lock of claim 6 and means for maintaining a locked condition for a predetermined period of time following said burglar alarm and thereafter unlocking said lock.

8. The lock of claim 1 and means for giving a local alarm if said operators are operated in an improper sequence.

9. The lock of claim 1 and means for selecting a sequence of operator operations and means for parity checking the key and sequence selecting means.

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