May 19, 1970 M. H. DITTMORE 3,513,357

DOOR LOCK

Filed Sept. 13, 1967 2 Sheets-Sheet 1

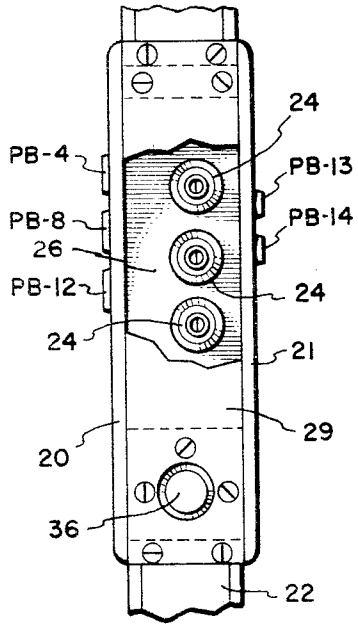


FIG. 2

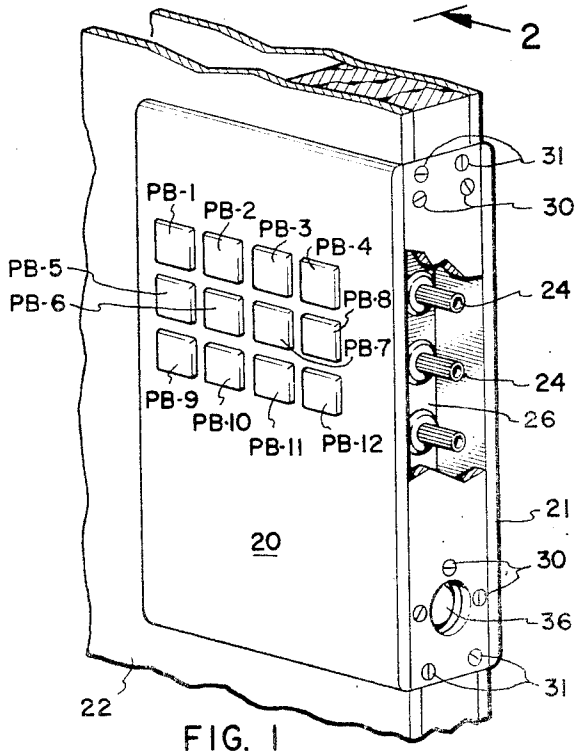


FIG. 1

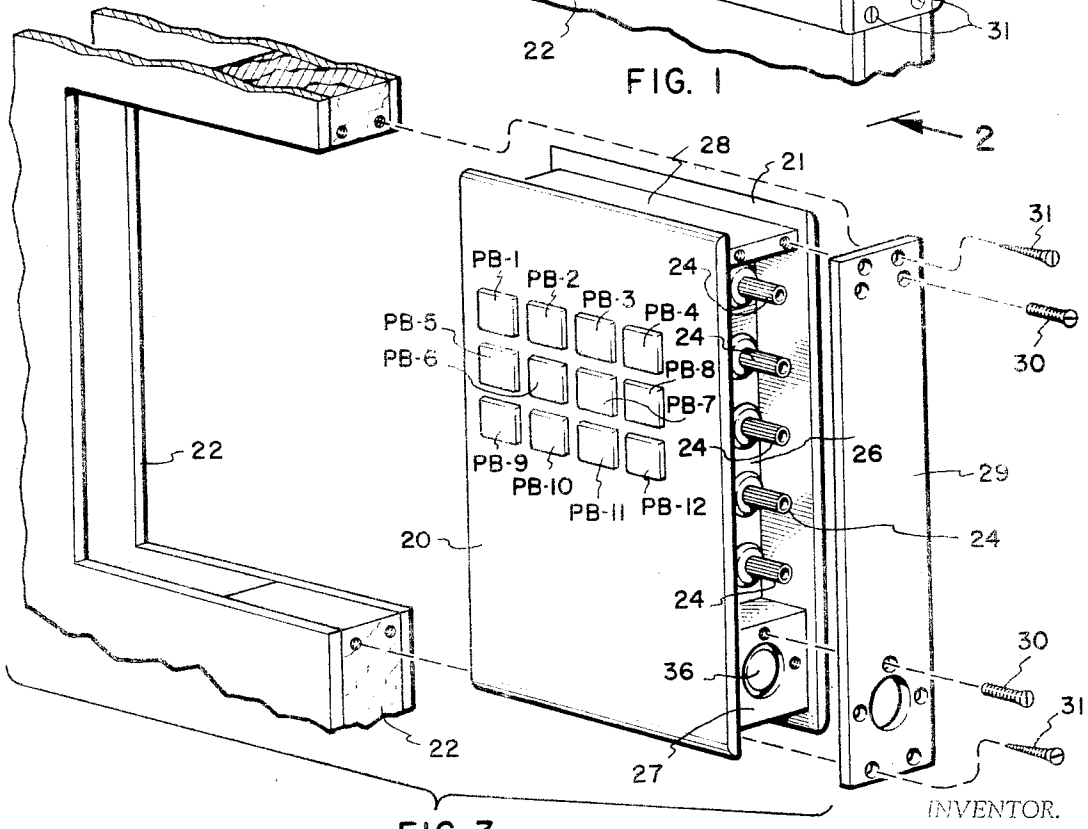


FIG. 3

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DOOR LOCK

Filed Sept. 13, 1967 2 Sheets-Sheet 2

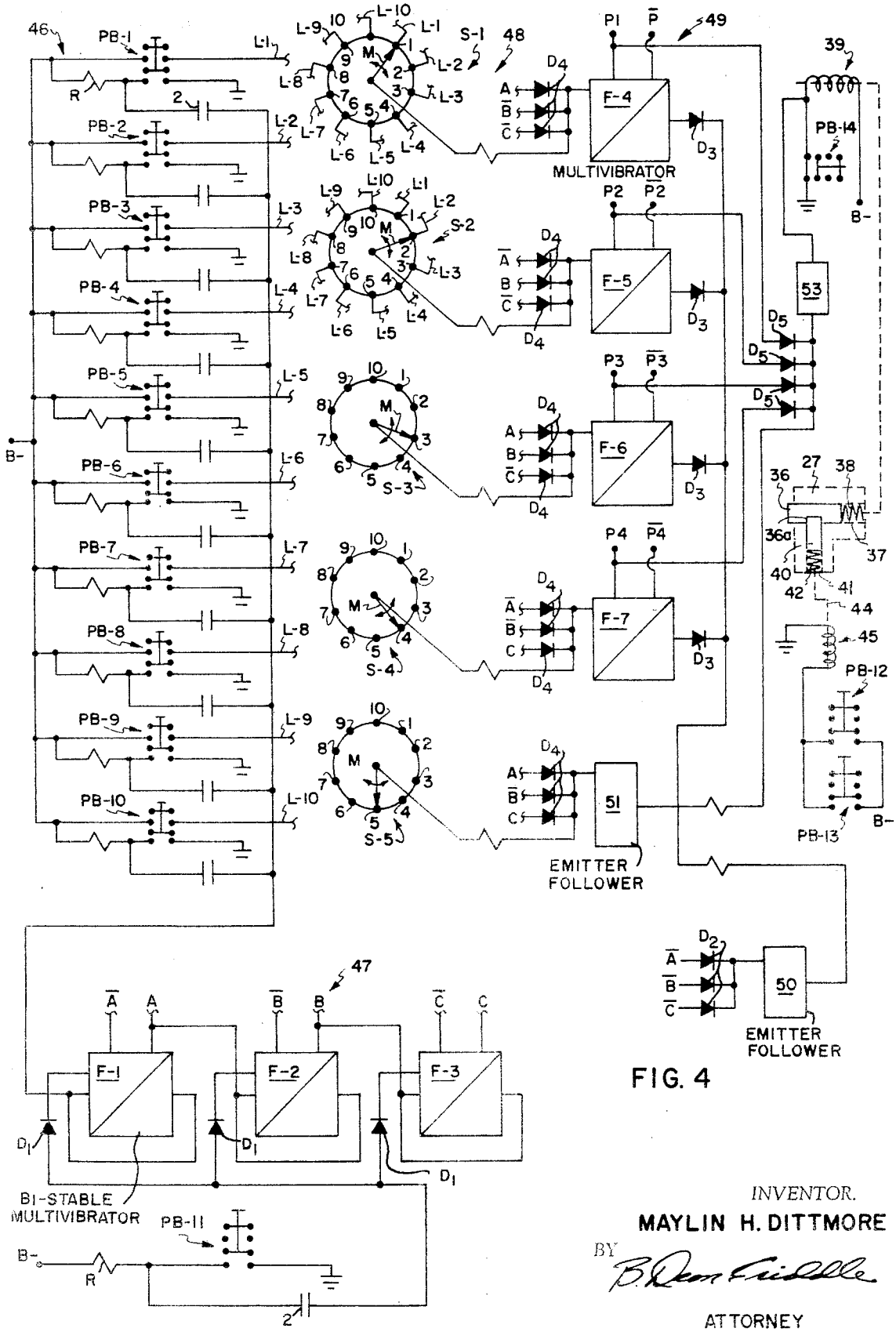


FIG. 4

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3,513,357

DOOR LOCK

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U.S. Cl. 317—134 8 Claims

ABSTRACT OF THE DISCLOSURE

A door lock comprising an electronic circuit that makes it possible to release a door latching bolt by entering a pre-set sequence into a series of pushbutton switches from outside the door. The latching bolt is also releasable by actuating a single pushbutton switch from inside the door. The bolt can be set by a single pushbutton switch from either outside or inside the door. The circuit includes an electronic counting mechanism that is activated by the pushbutton switches and provides sequential signals to a logic network that deciphers them and generates a signal to the latch releasing mechanism if, and only if, the proper code has been entered on the pushbutton switches.

Brief description

This invention relates to door locks and is particularly related to locks that are operated in accordance with the proper sequential actuation of a series of pushbuttons. Such pushbutton type, combination door locks are shown, for example, in U.S. Pats. 3,242,388 and 2,855,588, but since these utilize relays and other mechanical components having sound-creating moving parts, it is possible for the movement of the parts to be detected, and it may be possible for a person detecting such movements to determine the correct operating sequence.

It is an object of the present invention to provide a pushbutton type, combination lock that has no sound-creating moving parts that can be detected by a person attempting to determine the correct sequence of actuation of the pushbuttons necessary to unlatch the door in which the lock is placed.

Another object is to provide such a door lock capable of being readily installed in a door in such a manner that the combination can be easily changed when the door is open, but such that the combination cannot be changed when the door is closed.

A principal feature of my invention is a control circuit having a series of pushbutton switches arranged to present an actuating surface at the outside of the door, some of these pushbuttons being "combination" switches, and others comprising a "reset" switch and a "lock" switch; two other pushbutton switches, each arranged to present an actuating surface at the inside of the door, serve as "lock" and "unlock" switches; a series of code-setting switches; and a digital electronic network for deciphering the signals from the combination switches so as to actuate a latch bolt releasing mechanism if, and only if, the correct sequence is entered on the combination switches.

The entire circuit is packaged so as to fit into and become an integral part of a door, with attractive decorator panels on both the outside and inside of the door. The actuating surfaces of the pushbutton switches will then be the only parts of the control circuit presented at the outside surfaces of the door, and the code-setting switches will then be arranged in the perimeter of the door, accessible only when the door is open.

Additional objects and features of the invention will become apparent from the following detailed description and drawings, disclosing what is presently contemplated as being the best mode of the invention.

The drawings

FIG. 1 is a partially broken away perspective view, showing how the door lock of the invention is arranged to be mounted in a door;

FIG. 2, an end elevation view, also partially broken away for clarity;

FIG. 3, a view like FIG. 1, but exploded, with the circuit package shown removed from the door; and

FIG. 4, a schematic circuit diagram showing the circuitry of the door lock and the latching bolt.

Detailed description

Referring now to the drawings:

In the illustrated preferred embodiment, the door lock of the invention is shown formed as an integral package, with ornamental plates **20** and **21** arranged to fit flush against the inside and outside faces of the door. These plates are larger than the interior body of the lock as shown in the drawings and effectively and attractively cover the opening in the door in which the package is inserted.

In mounting the lock, a section of the door **22** just as large as the interior body of the lock is cut out and the lock package will then be slipped into the cavity cut from the door with the ornamental plates **20** and **21** overlapping the opening cut into the door. Obviously, the distance between ornamental plates must be just slightly more than the thickness of the door, or must be made adjustable to fit assorted doors of various thicknesses.

The actuators of pushbutton switches PB–1 thru PB–12 extend through, and their actuator surfaces are preferably flush with, the surface of the outside ornamental plate **20**, and the pushbutton switches PB–13 and PB–14 extend through the inside ornamental plate **21** such that their actuator surfaces are flush with the surface of the inside ornamental plate.

Control knobs **24**, of code-selector switches S–1 through S–5, FIG. 4, protrude through an end plate **26**, that is positioned between a latch bolt housing **27** and a member **28** both of which are affixed to the ornamental plates **20** and **21**. The width of latch bolt housing **27** and member **28** define the interior body width of the lock and thickness of the door that the lock will fit.

A face plate **29** is adapted to be attached by bolts **30** to member **28** and to latch bolt housing **27** to thereby cover the control knobs and to reduce the possibility that they will be tampered with. Plate **29** also extends beyond member **28** and latch bolt housing **27** and screws **31**, passed through the plate to secure the lock package to the frame of the door, as shown.

The circuit components, shown schematically in FIG. 4, are all mounted within the interior body of the lock. The end plate **29** can be readily removed and the settings of the code-switches S–1 through S–5 can be easily changed by turning knobs **24** when the door is open to allow access to its periphery.

The latching mechanism of the door lock comprises a latch bolt **36**, FIG. 4, that is mounted to reciprocate in a bore **37**, formed in housing **27**. A spring **38**, biases the bolt to its expelled position, and a solenoid **39**, when energized, will act to retract the bolt into the housing. Bolt **36** has a recess **36***a*, formed in one side thereof, adapted to receive the end of a retaining pin **40**. The retaining pin reciprocates in a bore **41**, formed in housing **27** at right angles to bore **37**. A spring **42**, acting between the housing **27** and pin **40**, biases the pin into the recess **36***a* of bolt **36**. A locking solenoid **45**, retracts pin **40** from recess **36***a*, thereby allowing bolt **36** to be expelled by spring **38**. When solenoid **45** is de-energized and bolt **36** is expelled, pin **40** rides against the bolt, and when the

bolt is retracted, pin **40** is forced into recess **36***a* by action of the spring **42**.

When bolt **36** is expelled it will fit into a conventional recess (not shown) in the door frame to securely lock the door.

The circuit of the door lock utilizes electronic components and is entirely silent in its selection operation so that it is impossible to detect whether or not the proper combination of pushbuttons is being actuated by sounds created, even with the use of a stethoscope or other sound magnification aid.

The circuit includes a combination switch section **46**, including the pushbutton switches PB–**1** through PB–**10**; a counter section **47**, actuated in response to the pushing of any of the combination switches; a reset section **48**, providing means for resetting the counter and logic network to the initial conditions necessary to operate the lock; and a logic network **49**, for receiving signals from the counter and combination switches and for deciphering them to allow the latch bolt to be withdrawn if, and only if the signals are sequentially supplied in conformity to the setting of the code-selector switches S–**1** through S–**5**. As shown, each pushbutton includes a bypass circuit including a resistor R and a capacitor **2**, connecting the B— voltage to a multivibrator F–**1**.

Counter section **47** is made up of three bi-stable multivibrators F–**1**, F–**2** and F–**3** each including a diode D_1, connected in series as a conventional binary counter. The purpose of the counter is to count the number of pushbuttons that have been actuated. Momentary closing of any pushbutton switch connects the multivibrator F–**1** to ground to change its state. Each of the counter multivibrators is stable in one of two conditions. Looking at multivibrtaor F–**1**, for example: either a voltage of B— is at $\overline{A}$ with zero voltage at A or a voltage of zero is at $\overline{A}$ and B— voltage is at A. The state of the counter is designated by giving the three voltages that are B—. Thus, the voltage combination outputs of the counter, corresponding to the number of counts resulting from pushbutton actuations are as follows:

The reset or zero condition is $\overline{A}\ \overline{B}\ \overline{C}$;
one count is $A\ \overline{B}\ \overline{C}$;
two counts is $\overline{A}\ B\ \overline{C}$;
three counts is $A\ B\ \overline{C}$;
four counts is $\overline{A}\ \overline{B}\ C$;
five counts is $A\ \overline{B}\ C$;
six counts is $\overline{A}\ B\ C$;
seven counts is A B C; and
eight counts returns the counter to the reset condition $\overline{A}\ \overline{B}\ \overline{C}$.

Pushbutton switch PB–**11** is the reset switch and will set the counter to the zero condition, $\overline{A}\ \overline{B}\ \overline{C}$. The reset circuit also includes emitter follower **50**. Whenever the reset condition, $\overline{A}\ \overline{B}\ \overline{C}$, is passed through leads containing diodes D_2 present on the counter, a voltage will be produced out of emitter-follower **50** which will reset the logic multivibrators F–**4** thru F–**7**. In this reset condition a voltage of zero is present on leads P**1**, P**2**, P**3**, and P**4** of the multivibrators F–**4** through F–**7**, respectively, and all of the logic multivibrators are thus reset through diodes D_3 each time the counter reads $\overline{A}\ \overline{B}\ \overline{C}$. Thus a person attempting to open the lock must provide the correct sequential combination in the first five combination buttons that are actuated after reset, or the process must be started over again.

The logic network, **49**, includes four multivibrators, F–**4** thru F–**7** and the emitter-follower, EF–**51**. Each of the multivibrators and the emitter-follower has four inputs, three coming from the counter each containing a diode D_4 and one coming from a code-selector switch. Only when all four of these input voltages are B— will the multivibrators F–**4** thru F–**7** change states, thereby presenting a voltage of B— at each of the leads P–**1** thru P–**4**, respectively. It is noted that the three voltages coming from the counter to multivibrator F–**4** correspond to one count, to multivibrator F–**5** to two counts, to multivibrator F–**6** to three counts, to multivibrator F–**7** four counts and to emitter-follower **51** five counts. If the combination pushbutton that is activated first after reset and which changes the counter to state $A\ \overline{B}\ \overline{C}$ is the correct first number of the code, i.e. the number set on the code-selector switch S–**1**, a voltage of B— is applied through code-selector switch S–**1** to the input of multivibrator F–**4**. Since now all the inputs to multivibrator F–**4** are at B— its state will change and a voltage of B— will be presented at lead P**1**. If a pushbutton switch other than the correct one is activated first only three of the four inputs to F–**4** will be at B— and it will not change its state. The other multivibrators F–**5** through F–**7** are similar to multivibrator F–**4** and similarly will not change their states to have a voltage of B— at their leads P**2** through P**4** unless the proper pushbutton has been actuated in the proper sequence.

If however, the first four numbers of the combination have been entered correctly, a voltage of B— is present at leads P**1**, P**2**, P**3** and P**4**. It is necessary that all five inputs, each containing a diode D_4 to an unlatching emitter-follower, **53**, which serves as an AND gate and amplified, be at B—, before a current will flow through the unlatching solenoid **39**, which will be energized to retract the latching bolt, **36**, in the manner previously described. Thus, if after the first four numbers have been entered correctly, the fifth number is also entered correctly, the four inputs to emitter-follower **51** will be at B— and its output will also be B—. All inputs to emitter-follower **53** will then be at B— and the lock will open.

The latching bolt **36** is retracted against the biasing effect of spring **38**. When the bolt is completely withdrawn, retaining pin **40** will be biased into recess **36***a* by spring **42**. Bolt **36** is thus held in its retracted position after the fifth pushbutton has been released, with a resultant deactivation of solenoid **39**. The lock is thereby set in a passive open condition.

Pushbutton switch PB–**12**, which has an actuating surface exposed at the outside of the door **22**, and pushbutton switch PB–**13**, which has an actuating surface exposed at the inside of the door, are the lock switches. The activation of either of these switches will energize solenoid **45** to retract the retaining pin **40**. This will allow the latching bolt **36** to be expelled by spring **38** to its door locking condition.

To unlock a door equipped with the lock of the invention from outside the door, it is therefore necessary to first operate pushbutton PB–**11** to be sure that the counter is set to zero condition. It is then necessary to operate five of the pushbutton switches P–**1** through P–**10**, in proper sequence. If any but the proper five of the pushbuttons PB–**1** through PB–**10** are operated, in the sequence determined by the setting of code-selector switches S–**1** through S–**5**, the latch bolt will not be retracted.

As an example, if it is desired to use the combination **1–2–3–4–5**, it must be set into the lock by positioning the movable contacts M of the code-selector switches as follows: S–**1** to position **1**, S–**2** to **2**, S–**3** to **3**, S–**4** to **4**, S–**5** to **5**. Thus, contact M of code-selector switch S–**1** is then positioned to engage contact **1** to which a line, L–**1**, that is also connected to one terminal of pushbutton switch PB–**1**, is attached. The contacts M of code-selector switches S–**2** through S–**5** are then positioned to respectively engage contacts **2**–**5** of the respective code-selector switch and lines L–**2** through L–**5** each respectively interconnect the contacts **2** through **5** and one of the terminals of the pushbutton switches PB–**2** through PB–**5**. The contacts **1**–**10** of each of the code-selector switches are each respectively connected to a contact of each of the pushbutton switches via lines L–**1** through L–**10**.

The pushbutton switches PB–**6** through PB–**10** have no function when the above described combination is used. However, if one of them is actuated the counter will step

one count, but since there can be no simultaneous B— voltage input from the combination switches to any of the logic elements, since PB–6 through PB–10 are not connected through any of the code selector switches S–1 through S–5, multivibrators F–4 through F–7 will not change states when pushbuttons PB–6 through PB–10 are actuated. If a mistake in the combination is made at any point, the reset switch PB–11 must be actuated and the combination started over again. An error will cause the counter to step one count but since one of the sequential voltage combinations from the counter has been generated without a simultaneous B— voltage application through a code selector switch, the logic element at which the error was made will not change state. The necessary voltage combination from the counter will not be available again until the counter has gone past the $\overline{A}\ \overline{B}\ \overline{C}$ condition which will automatically reset any of the logic elements set before the error was made.

In practice, with the combination described above set into the lock, it is first necessary to actuate pushbutton PB–11 to insure that the counter is reset to its zero condition. Pushbutton PB–1 is then actuated to change the counter to $A\ \overline{B}\ \overline{C}$ and to simultaneously provide a voltage through S–1 so that all inputs to multivibrator F–4 will be at a B— voltage and it will change its state.

The sequential operation of the pushbuttons PB–2 through PB–4 will similarly sequentially establish the correct combination of voltages $\overline{A}\ B\ \overline{C}$, $A\ B\ \overline{C}$ and $\overline{A}\ \overline{B}\ C$ from the counter and each of these, when simultaneously coupled with inputs from the respective pushbutton switches will make each of multivibrators F–5 through F–7 change states. To complete the process, PB–5 must be actuated. This will change the counter to $A\ \overline{B}\ C$ while simultaneously providing a B— voltage through S–5. Thus all the inputs to emitter-follower **51** are a B— voltage, and, therefore, its output is a B— voltage. This, in turn, makes all the inputs to emitter-follower **53** a B— voltage, current will now flow, energizing solenoid **39** and withdrawing the latch bolt so that the door can be pushed or pulled open.

It should be obvious that any of the pushbuttons PB–1 through PB–10 can be used in the combination, in any desired sequence.

If, for example, the pushbutton switch PB–10 was to be the first to be actuated in the combination, it would only be necessary to set the movable contact M of code-selector switch S–1 to engage fixed contact **10** of the code-selector switch. The contact **10** is at all times connected to line L–10 that is also connected to one terminal of the pushbutton switch PB–10 and the positioning of movable contact M to engage it and closure of the switch would complete a circuit to supply an input voltage to the multivibrator F–4, through the pushbutton switch PB–10.

Pushbutton switch PB–14, which has an actuating surface exposed at the inside of the door **22**, is connected in a circuit that bypasses emitter-follower **53**. When pushbutton switch PB–14 is energized the unlatching solenoid **39** is activated to retract the bolt. Retaining pin **40**, which is riding against bolt **36** as it is retracted, is biased by spring **42** into recess **36***a* and the bolt is held open.

In a door lock, such as the one described herein, with S number of multivibrator and emitter follower units in the logic network and P number of combination switches to choose from, the possible number of combinations is given by the formula $N=P^S$. If, as in the above described lock, S is five and P is ten, there are one-hundred thousand possible combinations for the door lock. The number of possible combinations can be changed by increasing or decreasing either P or S.

Multivibrators are completely silent as they change states. They may generate a small, transient electromagnetic pulse as they change states, but, this can be effectively shielded by a steel casing for the lock. Also, the counter multivibrators of the counter **47** change states with each pushbutton actuation, producing identical pulses that would tend to mask any produced in the logic network. Thus, the possibility of learning the combination from the outside by successive attempts is greatly reduced over mechanical type combination locks.

Although a preferred form of my invention has been herein disclosed, it is to be understood that the present disclosure is made by way of example and that variations are possible.

I claim:

1. A door lock comprising

a plurality of combination switches arranged to have their actuator surfaces presented at the outside face of the door;

a reset switch arranged to have its actuator surface presented at the said outside face of the door;

a lock switch arranged to have its actuator surface presented at the said outside face of the door;

a plurality of rotary code-selector switches, each having as many contacts as there are combination switches;

a binary counter consisting of a plurality of bi-stable counter multivibrators connected in series, with the first one in said series being connected in parallel to each of the said combination switches, and each of the counter multivibrators connected to the reset switch;

means providing power through each of the combination switches to the first of the counter multivibrators;

a logic multivibrator corresponding to each code-selector switch, said logic multivibrators connected so as to have their states changed sequentially by the correct combinations of voltages from the counter and simultaneous voltage from the combination switches through the corresponding code-selector switches;

an automatic reset circuit that will reset all the logic and counter multivibrators to the initial reset conditions after a predetermined number of combination switches have been actuated;

an AND gate and amplifier for receiving voltages from the logic multivibrators and for producing a voltage to the unlatching mechanism if, and only if, all the logic multivibrators have had their states changed from their initial reset conditions; and

a solenoid controlled door latch, having its solenoid energized by the said voltage from the said AND gate and amplifier.

2. A door lock according to claim **1**, wherein the door latch comprises a latching bolt;

a spring biasing said latching bolt to its door locking position; and

a latch-bolt solenoid energized by voltage from the AND gate and amplifier and retracting said bolt in opposition to said spring when energized.

3. A door lock according to claim **2**, further including another circuit to the latch-bolt solenoid;

an unlocking switch in the said other circuit, having an actuator surface arranged to be presented at the inside of the door, whereby actuation of said unlocking switch will energize the latch bolt solenoid and move the latch bolt to its door unlocking position.

4. A door lock according to claim **1**, wherein the code-selector switches are arranged to be mounted within the door with their adjusting knobs recessed into the perimeter of the door and accessible only when the door is open.

5. A door lock according to claim **1**, wherein the latch mechanism also includes

a solenoid controlled retaining pin that must be retracted prior to locking of the door latch;

an electric circuit to the solenoid of the retaining pin;

a locking switch in the said circuit having its actuator arranged to extend through the outside face of the door; and

another locking switch in the said circuit having its actuator arranged to extend through the inside face of the door, whereby actuation of either locking

switch will retract the locking pin to allow the door latch to move to its door locking position.

6. A door lock according to claim **5**, wherein the door latch comprises

a latching bolt;

a spring biasing said latching bolt to its door locking position; and

a latch-bolt solenoid energized by voltage from the AND gate and amplifier and retracting said bolt in opposition to said spring when energized.

7. A door lock according to claim **6**, further including another circuit to the latch-bolt solenoid;

an unlocking switch in the said other circuit, having an actuator surface arranged to be presented at the inside of the door, whereby actuation of said unlocking switch will energize the latch bolt solenoid and move the latch bolt to its door unlocking position.

8. A door lock according to claim **7**, wherein

the code-selector switches are arranged to be mounted within the door with their adjusting knobs recessed into the perimeter of the door and accessible only when the door is open.

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U.S. Cl. X.R.

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