ABSTRACT OF THE DISCLOSURE

An electronic control and supervisory system provides control and supervision of a normally locked access door. The door can only be opened by those having knowledge of a predetermined arbitrary "combination" or code. The system has a plurality of bistable flip-flop circuits which are either in a register or a reset condition, depending upon the selection of certain digit switches, however, prior to utilization of the switches, all circuits are simultaneously placed in the reset condition. The flip-flops, when all are in the register condition, enable a gate circuit which is used to assist in the activating of a lock releasing door relay circuit.

In business, industry, research and other fields of activity there are many plants and institutions which have rooms or sections of their premises that are reserved exclusively for the use of authorized personnel, it being important that all others be kept out. Frequently, those authorized to have access to a given department or area of the premises are among those denied access to one or more other restricted areas, and vice versa.

It is an object of the invention to provide an improved system for enabling authorized personnel, without the use of a key, easily to open a door giving access to the area they are authorized to enter, while preventing the door from being opened by anyone not familiar with an arbitrary code or combination known to said authorized personnel.

According to the invention, the code which must be known in order to open the door from the outside is a multi-digit code or the equivalent, and can have as many digits as desired. An object of the invention is to provide improved means for requiring the person seeking entry not only to register the correct digits of the code but also to register them seriatim in the correct order.

Another object is to require the person seeking entry to complete the correct code within a predetermined interval of time after code registration is initiated by him, this time interval being sufficiently short to prevent completion of the required code except by those familiar with it in advance.

A further object of the invention is to provide other effective safeguards against the possibility of unauthorized personnel gaining entry, or gaining knowledge of the code, through studied or random manipulation of the code registration facilities. In this connection, a salient feature resides in providing for automatic but undisclosed erasure of correct digital registration if accompanied by an incorrect digit or by an error in the digital sequence.

Another object is to provide means whereby a security officer or other supervisory personnel can very quickly and easily change the code or combination which must be known and used by those desiring to enter a restricted area via the combination-locked door. A related object is to provide a control circuit having a jack adapted to receive interchangeable plugs, the different plugs when inserted serving to establish different codes which will serve to unlock the door.

Still another object is to provide a door-control system of the character indicated having monitoring facilities whereby a security officer at a remote location is instantaneously apprised of every opening and every closing of the door so that he is fully informed as to its condition at all times; and whereby he also is automatically informed of every unsuccessful attempt to open the door so that such attempts can be investigated without delay, as and when they occur.

Other objects and features of the invention will appear in the course of the following description thereof.

For purposes of description, it will be convenient to refer to the accompanying drawings, wherein FIGURES 1 and 2, together, comprise a schematic circuit diagram of a control and supervisory system embodying the invention; these two figures should be positioned edge-to-edge with FIGURE 2 adjacent to the lower edge of FIGURE 1.

Referring more particularly to the drawings, M is a monitoring station which may be assumed to be situated at a location remote from the door whose operation is to be supervised. In a convenient place outside the door in question, for example on the wall adjacent thereto, there is a small panel or other suitable box A having a group of switches and lamps, the use of which will be explained presently. These lamps and the actuators for said switches are the only portions of the apparatus accessible to persons desiring to unlatch the door for the purpose of gaining entry to the restricted portion of the premises.

Save for the external station A and the monitoring station M, all of the apparatus shown in FIGURES 1 and 2 with the exception of solenoid S and switches E and D conveniently can be located in a junction box in the restricted area, preferably on a wall close to the latched door.

Solenoid S is part of the latching mechanism and is effective, when energized, to release the latch so that the door can be opened. The latching mechanism itself is conventional, being of the type having a spring-biased bolt or latching member which normally holds the door closed, but which can be released by actuation of solenoid S.

Switch E is a push-button type "exit" switch located close to the door in a position where it is readily accessible to those who are already inside the restricted room, but not, of course, to persons outside the room. Assume that a person inside the room desires to leave. Simply by pressing the exit switch E, he will complete an obvious circuit for energizing the latch solenoid S, thus releasing the latch so that he can open the door and depart. When the door swings closed behind him, it will automatically relatch under the influence of the spring-biased latch mechanism, and he then can reenter the room only by registering the proper code at the external station A, as described hereinafter.

For supervisory and other purposes which will be made clear presently, switch D is actuated by the door itself. Opening of the door serves to open the switch and cause it to remain open until the door is reclosed; stated differ-
ently, switch D is closed at all times except during such intervals as the door is open.

The external station A has a "start" switch 11a and 11b. This switch closes switches numbered consecutively 1, 2, 3 . . . 9 and 0. Conveniently, all of these can be push button switches of the spring-loaded self-restoring type, whereby each switch always remains open, except during the interval that pressure is manually applied to the associated push button. Code selection is effected by pressing certain ones of the numbered push buttons in a predetermined sequence.

The code which will serve to unlatch the door may have as many digits as desired, but for purposes of explanation it will be assumed that a four-digit code is used; according to the invention this requires three conventional bistable flip-flop circuits FF-1, FF-2 and FF-3 together with an associated three-stage series AND gate G.

Each of the flip-flops is reversible between two conditions under control of positive pulses applied to one or the other of two inputs. More particularly, assuming positive potential A which is connected to the first input 11a or 11b, a positive pulse applied to inputs 27, 28 and 29 establishes a stable condition in which transistors Q1, Q2 and Q3 are "off" or nonconducting, while transistors Q4, Q5 and Q6 are "on." In this condition (which conveniently can be referred to as the "register" condition only if the flip-flops) the base of each gate transistor (Q2, Q3 and Q4) is biased negatively so these transistors are disabled.

A positive pulse applied to input 31 of flip-flop FF-1 will reverse its condition, changing it to what may conveniently be referred to as "register" condition. In this condition transistor Q1 is "on" and Q2 is "off" and with Q1 conducting, the base of transistor Q1 is biased positively so this transistor is enabled, which is to say it is conditioned to become conductive if and when positive potential is applied to its collector.

Similarly, a positive pulse applied to input 32 of flip-flop FF-2 will place this flip-flop in "register" condition (wherein Q2 is "on" and Q4 is "off") and, as a consequence, will enable gate transistor Q4. In like fashion, a positive pulse applied to input 33 of flip-flop FF-3 will place it in "register" condition, which enables gate transistor Q6. As will be seen presently, flip-flop FF-1 will go into "register" condition only if the first digit of the required four-digit code is correctly selected at the external station A by the person seeking entry. Likewise, flip-flop FF-2 will go into "register" condition only if the second digit is correctly selected; and flip-flop FF-3 will do so only if the third digit is correctly selected and registered. Only when these prerequisites have been satisfied will correct selection of the fourth digit of the code cause the door to unlatch.

The particular digits in the required code are determined by a multi-pin plug P which is removabley received in a matching multi-terminal jack J. It is the function of the plug, among other things, to couple the "register" inputs 31, 32 and 33 of the three flip-flops to the code selector switch S so that the first three digits of the required code, and to couple all "noncode" switches to the flip-flop reset lead 35. In the case under consideration, the pins of plug P are jumpered so as to establish the digital sequence 2-5-7-8 as the code which will unlatch the door, but it will be understood that this is only exemplary and that other plugs (interchangeable with plug P) can be wired to set up any other four-digit code that may be desired.

With plug P in place in jack J, let it be assumed that a person familiar with the required code, 2-5-7-8, seeks to enter the restricted or "private" area via the latched door which is associated with external station A. To gain entry, he must first momentarily depress the "start" push button, closing switch contacts 11a and 11b. When this is done, a circuit is completed which extends from positive battery via conductor 12, switch contact 11a, conductor 14, winding of relay 15, conductor 16, switch D, conductor 18 and switch 19 to negative battery. Relay 15 thus operates, closing its contacts.

The negative potential on conductor 16 (from contact 19) therefore is now connected by relay contact 15a to conductors 21 and 22, thus supplying negative battery to the three flip-flop circuits. The negative potential on conductor 16 also is connected, by relay contact 15c, to the heater 24 of a thermal time delay relay TD, thereby to initiate measurement of a predetermined time interval for completing the code and opening the door. Relay contact 15b completes an obvious locking circuit for relay 15 to insure that it will remain operated when the start switch 11a, 11b is allowed to open; and contact 15a completes an obvious circuit for lighting the "start" lamp 25 at the external station A.

In addition to the foregoing, the momentary closing of the start switch completes a circuit which extends from positive battery via conductor 12, switch contact 11b and conductor 26 to "reset" conductor 25, so that a positive pulse is applied to the inputs 27, 28 and 29 of the three bistable flip-flop circuits. Consequently, as explained hereinafore, transistors Q1, Q2 and Q3 are turned "off" while transistors Q4, Q5 and Q6 are turned "on"; and with transistors Q1, Q2 and Q5 in off condition, the string of transistors Q7, Q8 and Q9 in the AND gate G is enabled.

Lighting of lamp 25 at the external station A upon momentary operation of the start switch, as described above, indicates to the person seeking entry that the apparatus has been conditioned to receive the code and that the correct code (which in the exemplary case under consideration is 2-5-7-8) must be registered within a predetermined brief interval of time. For a four digit code, the time delay relay TD may, for example, be set to allow an interval of approximately ten seconds for code registration.

The correct code is registered, of course, by momentarily operating switches 2, 5, 7 and 8 in that order. Operation of switch 2 momentarily connects the positive potential on line 12 to conductor 2a and thence through pin 2p, jumper conductor 31a, pin 31p, to the input 31 of the flip-flop circuit FF-1. This positive pulse converts the flip-flop to "register" condition, turning transistor Q2 off and transistor Q1 on, whereby gate transistor Q5 is enabled. As Q1 turns on, the rise in its collector current also delivers a positive spike through coupling capacitor 38 to the flip-flop circuit FF-2, but this is without effect as transistor Q4 is turned on by the "off" voltage.

When the person seeking entry now operates switch 5 at the external station A, this momentarily connects the positive potential on line 12 to conductor 5a and thence through pin 5p, jumper conductor 32a and pin 32p to input 32 of the flip-flop circuit FF-2. The effect of this is similar to that just described in connection with flip-flop FF-1, which is to say that transistor Q4 turns off while transistor Q5 turns on, delivering a positive spike to flip-flop circuit FF-3 through coupling capacitor 39 and biasing the base of gate transistor Q6 so that this transistor is enabled.

In similar fashion, when switch 7 at the external station A is operated, this momentarily connects positive potential from line 12 to conductor 7a and thence through pin 7p, jumper conductor 33a and pin 33p to the input 33 of the flip-flop circuit FF-3. Accordingly, this flip-flop also is changed to "register" condition, turning gate transistor Q9 on. The AND gate G now is fully conditioned as a result of correct registration of the first three digits of the code.

When the person seeking entry now closes switch 8 to register the last digit of the code, this completes a circuit which extends from positive battery through switch 8, conductor 8a, pin 8p, jumper conductor 34a, pin 34p, conductor 34, winding of relay 40, conductor 42, the series string of transistors comprising AND gate G, conductors 44, 22 and 21, relay contact 15d, conductor 16, switch.
D, conductor 18 and switch 19 to negative battery. Energized over this circuit, relay 40 operates, closing its contacts.

Relay contact 40a now completes an obvious locking circuit for the relay, to ensure that it will remain operated when switch 8 is allowed to open. Relay contact 40c completes a circuit for solenoid S, thus releasing the door latch so that the door may be opened; and contact 40b completes an obvious circuit for the "enter" lamp 45 at the external station A to indicate that the door may now be opened.

As previously explained, opening of the door causes switch D to open. This removes negative potential from conductors 16, 21 and 22 thus causing relays 15 and 40 to release. Accordingly, lamps 25 and 45 at the external station A are extinguished and all potential is removed from transistors Q1 to Q4, inclusive, and their associated circuit elements. Also, the circuit of heater 24 of the time delay relay TD is opened and this relay restores to normal, having been without effect since, in the case under consideration, the switch was opened within the prescribed interval of time after closing of the start switch 11a, 11b. Upon reclosing of the door, the system is restored to original condition, and the door then can be opened again only by repetition of the operation described hereinbefore.

It will be convenient at this point to refer to the door monitoring station M. This has a pair of transistors Q10 and Q11, with a "door condition" indicator lamp 46 in the collector circuit of one and a "lock out" lamp 48 in the collector circuit of the other. The emitters of both transistors are connected to negative battery through an audible signal device or alarm 50.

Under normal conditions, the negative bias applied to the base of both transistors maintains them in "off" condition so that lamps 46 and 48 are not lighted. Opening of the door switch D, however, removes the negative bias from transistor Q10, causing it to turn on. Accordingly, lamp 46 is lighted and the audible signal 50 is energized, a condition which continues until closing of the switch D restores the negative bias to the base of transistor Q10, turning it off.

The security officer or other attendant at station M thus is apprised exactly when the door is opened, exactly when it is closed and just how long it remains open in each instance. In the event the door stays open longer than is normal, appropriate investigation of the cause can be made at once.

Let it be assumed for a moment that the person seeking entry, after registering the correct code (whereby the door is unlatched by energization of solenoid S and the "enter" lamp 45 is lighted) is called aside, and, without opening the door, walks away leaving the door unlatched, or alternatively, that he leaves after registering only part of the code, in which case the door will not be unlatched but one or more of the flip-flops will be left in "register" condition.

The interval allowed by time delay relay TD for opening the door will run out almost immediately after complete registration is at the code hand, and, in the event of incomplete registration of the code, within only a few seconds; when the allowed interval runs out, contact 24a closes, connecting positive battery via conductor 20, resistor 23, conductors 26 and 35 to the inputs 27, 28 and 29 of the three flip-flop circuits. These therefore are "reset" to their original condition, that is to say transistors Q1, Q2 and Q4 are turned off while transistors Q2, Q4 and Q9 are turned on. As a result, transistors Q2, Q3 and Q9 of the AND gate G likewise are turned off, so that relay 40, if previously operated, releases and opens its contacts. The opening of relay contact 40c deenergizes solenoid S, restoring the door to latched condition; and the "enter" lamp 45 is extinguished due to opening of contact 40b.

The operation of time delay relay TD also connects positive battery via contact 24a and conductor 20 to the base of transistor Q11, turning this transistor on. Accordingly, the "lock out" lamp 48 at the monitor station M is lighted and the audible signal 50 is actuated, calling to the attention of the attendant the fact that a door control system has been locked out or inactivated for reasons that should be investigated. After appropriate investigation, he can restore the system to operation by momentarily opening the manual switch 19 at the monitor station M. By removing negative potential from conductor 19, this causes relay 16, thus causing D to normal, causes lamp 25 to be extinguished, and causes all potential to be removed from the flip-flop circuits FF–1, FF–2 and FF–3. When the manual switch 19 is reclosed by the security officer, the system is once more conditioned for operation.

Remembering that the correct code is 2–5–7–8–9, let it now be assumed that after momentarily pressing the start switch 11a, 11b, the person seeking entry registers the correct digits but in the wrong order, for example, 7–5–8–2. Upon closing switch 7, this will apply positive potential to input 30a of transistor Q10, thus turning transistor Q10 off and Q9 on, enabling transistor Q1 as previously described. When switch 8 next is closed this will apply positive potential via conductor 34 to relay 40, but the relay cannot operate inasmuch as transistors Q2 and Q3 have not been properly conditioned; accordingly, the second digit of the attempted code is "erased" in the event the positive code which now is delivered to flip-flop FF–3 through coupling capacitor 39 as transistor Q3 turns on resets FF–3 to its original condition, which is to say that transistor Q3 is turned off and Q4 on, so that gate transistor Q2 also is disabled.

Likewise, when the person seeking entry closes switch 2, this applies positive potential to the input 31 of flip-flop circuit FF–4 which reverses the condition thereof, turning transistor Q2 off and Q3 on, with the result that the positive spike delivered to flip-flop FF–2 through capacitor 38 "erases" the digit previously registered thereon.

If the person seeking entry closes any of the switches 3, 4, 5, 6, 9 or 0 (that is to say, any switch corresponding to a digit which is not in the code) positive potential will be applied via the corresponding numbered pin of plug P, conductor 35a, pin 35p and conductor 35 to the inputs 27, 28 and 29 of the three flip-flop circuits. This has the effect of resetting to their original starting condition any of the flip-flop circuits which previously have been reset as a result of prior operation of one or more of the switches 2, 5 or 7. In other words, if any one or more correct digits of the code are registered, the registration is automatically "erased" in the event it is followed by closing of a code selection switch corresponding to a non-code digit. Likewise, as we have seen, even if the correct digits are registered, but out of order, the later registration will erase the effect of the earlier one.

Since the erasures or cancellations resulting from errors in code selection occur without knowledge of the person seeking entry, the ease of guessing the correct code within the allotted time interval through random choice of the code-selection switches. Attempts to do so are cut short by the time delay relay TD which, as previously explained, signals the attendant at the door monitoring station M by lighting lamp 48 and locks out the system against further registration of digits until such time, following investigation, as it is deemed appropriate to clear the condition by momentarily opening switch 19.

It is contemplated that other plugs, interchangeable with plug P, will be pre-wired to establish other codes for unlatching the three flip-flops in connection. It will be noted that pins 1p, 2p, 3p ... 10p of the plug correspond respectively to the digits 1, 2, 3, . . . 0. To set up a different code, say 3–0–7–4, pin 3p would be jumped to pin 31p; pin 10p jumped to pin 32p; pin 7p jumped to pin 33p; pin 4p jumped to pin 34p; and pins 1p, 2p, 5p, 6p, 8p
and 39p, jumpered to pin 35p. Stated differently, pins 31p, 32p, 33p and 34p are always connected, respectively, to the pins corresponding to the four digits of the desired code, while all pins are jumpered to all other (i.e., non-code) digits are connected to pin 35p.

Also, it should be noted that the same digit may be used more than once in the code. For a code such as 1-5-5-2, for example, pins 32p and 33p would both be jumpered to pin 5p; and for the code 5-5-5, pins 34p, 33p and 32p would be jumpered to pin 5p of the plug.

By having a number of interchangeable plugs prewired for different codes it is only necessary for a security officer to remove one plug and substitute another in jack J in order to change the code which will be effective to unlatch the door. Thus the code can be changed very easily when desired, and as frequently as the circumstances warrant, which in some installations may be daily or oftener.

From the foregoing it will be seen that the invention is one well adapted to attain all of the ends and objects hereinbefore set forth, together with other advantages which are obvious from the description. It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the appended claims.

Inasmuch as various possible embodiments of the invention may be made without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim:

1. A system for releasing a door latch, a group of digit selection switches, a plurality of bistable flip-flop circuits each having a register input for setting the circuit in the first stable state and a reset input for setting the circuit in the second stable state, a gate circuit controlled by said flip-flop circuits and enabled only when all of the flip-flop circuits are in said first stable state, a relay, means connecting said relay and gate circuit in series to a particular one of said digit switches, means connecting said register inputs to said digit switch, means connecting said reset inputs to still other ones of said switches, and latch releasing means capable of energizing said relay.

2. A system as in claim 1, wherein said register means comprises a multi-terminal jack and code-assigning plug, said register input being in said jack.

3. A system as in claim 1, having a door operated switch, and means controlled by said switch for deenergizing said relay responsive to opening of said door.

4. A system as in claim 1, having a door operated switch, and means controlled by said switch for disablind said gate circuit responsive to opening of the door.

5. In a system for releasing a door latch, a group of digit selection switches, a plurality of bistable flip-flop circuits each having a first stable state and a second stable state, means for initially conditioning said circuits to said first stable state for operation under control of said switches, other means for setting said circuits in said first stable state responsive to operation of certain of said switches, said circuits corresponding respectively to certain other ones of said switches, means for setting each circuit in said second stable state responsive to operation of its corresponding switch, means for releasing said latch when all of said second stable circuits are in said second stable state, and means controlled by said circuits for disabling said latch releasing means whenever any one or more of said circuits is in said first stable state.

6. A system as in claim 5, wherein at least one of said flip-flop circuits has means for setting that circuit in said first stable state responsive to a change of another one of said circuits from said first state to said second state.

7. A system as in claim 5, having a signal, and door controlled means for operating said signal and disabling said flip-flop circuits whenever the door is open.

8. A system as in claim 5, wherein said flip-flop circuits are normally disabled, and are enable and become effective for a predetermined interval of time after the conditioning of said circuits for setting and holding all of said circuits in said first stable state.

9. A system as in claim 8, having door controlled means for disabling said time controlled means responsive to opening of the door.

10. In a system for releasing a door latch, a group of digit selection switches, a plurality of bistable flip-flop circuits each having a first stable state and a second stable state, said circuits corresponding respectively to certain of said switches, means operable at will to condition said circuits for operation and simultaneously to set them in said first state, means for thereafter shifting each circuit to said second state responsive to operation of its corresponding switch, means for releasing said latch when all of said circuits are in said second stable state, and means controlled by said circuits for disabling said latch releasing means whenever any one or more of said circuits is in said first stable state.

11. In a system for releasing a door latch, a group of digit selection switches, a plurality of bistable flip-flop circuits each having a first stable state and a second stable state, said circuits corresponding respectively to certain of said switches, means operable at will to condition said circuits for operation and simultaneously to set them in said first state, means for thereafter shifting each circuit to said second state responsive to operation of its corresponding switch, a relay, means under control of said circuits for energizing said relay only when all of said circuits are in said second stable state, and latch releasing means operatively energizing said relay.

12. In a system for releasing a door latch, a group of digit selection switches, a plurality of bistable flip-flop circuits each having a first stable state and a second stable state, means operable at will to condition said circuits for operation and simultaneously to set them in said first state, means for setting all circuits in said second stable state and latch releasing means operatively energizing said relay.

13. A system as in claim 12, wherein said flip-flop circuits are concatenated, each having means for setting that circuit in said first state responsive to a change of the next-preceding circuit from said first to said second state.

14. In a system for releasing a door latch, a group of digit selection switches, a plurality of bistable flip-flop circuits each having a first stable state and a second stable state, means operable at will to condition said circuits for operation and simultaneously to set them in said first state, means for setting all circuits in said second stable state responsive to operation of certain of said switches, means for setting said circuits in said second state responsive to operation of certain other ones of said switches in predetermined sequence, a relay, means under control of said circuits for energizing said relay only when all of said circuits are in said second state, and latch releasing means operatively energizing said relay.

15. A system as in claim 14, wherein said flip-flop circuits are concatenated, each having means for setting that circuit in said first state responsive to a change of the next-preceding circuit from said first to said second state.

16. A system for releasing a door latch, said system comprising, a group of digit selection switches, a plurality...
of concatenated bistable flip-flop circuits each having a first stable state and a second stable state, means for initially conditioning each of said circuits to said first stable state for operation under control of said switches, means for setting said circuits in said first state responsive to operation of certain of said switches, means for setting said circuits in said second state responsive to operation of certain other ones of said switches in predetermined sequence, a relay, gate means controlled by said flip-flop circuits for enabling said relay only when all of said circuits are in said second state, means for resetting said circuits responsive to said operation of said switches out of said sequence to preclude operation of said enabling gate means and latch releasing means operated responsive to energization of said relay.