United States Patent

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[54] **NONCODED DIGIT DETECTION CIRCUIT FOR ELECTRICAL COMBINATION LOCK**
4 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **317/134,** 317/148.5; 340/164
[51] **Int. Cl.** **H01h 47/00**
[50] **Field of Search** 317/134; 340/164

[56] **References Cited**

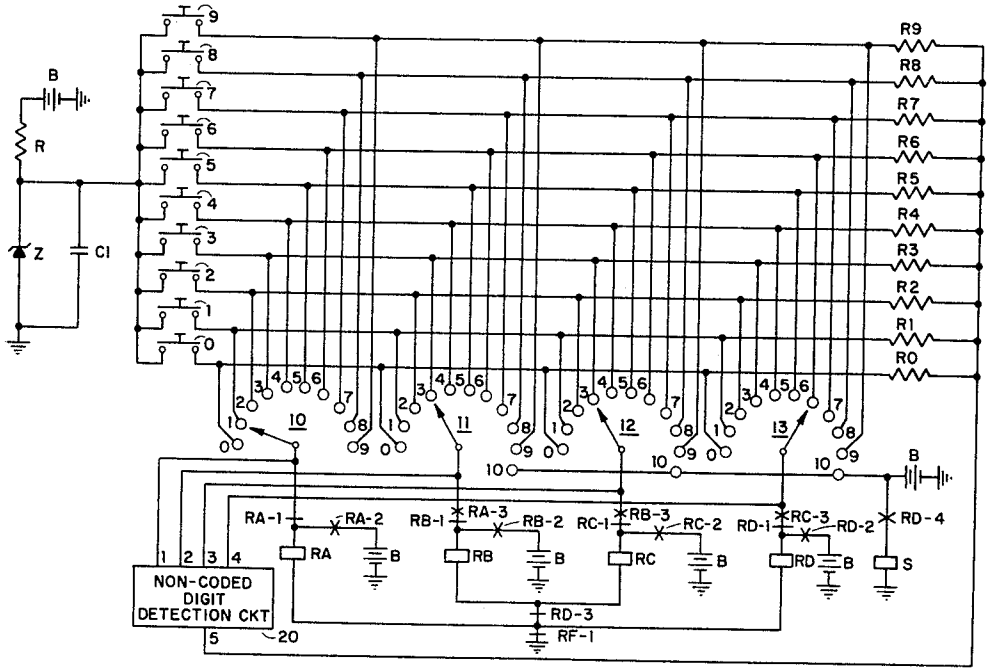
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ABSTRACT: This disclosure relates to an electrical combination lock of the type comprising *n* key circuits each having a digit key, *m* digit selecting switches each having *n* inputs connected to an associated digit key and one wiper output which is positioned to contact one of the inputs in accordance with a preselected code, and a chain of *m* relays connected to an associated selecting switch, each relay having a contact in the operating path of the following relay and such relays being sequentially operated one by one to open the electrical lock.

In accordance with the invention, the above electrical lock is provided with a gate circuit having a first input connected to the wipers of the selecting switches, a second input connected to the key circuits and an output circuit adapted to open the operating path of the chain of relays when a noncoded digit is keyed thus restoring the electrical combination lock to normal.



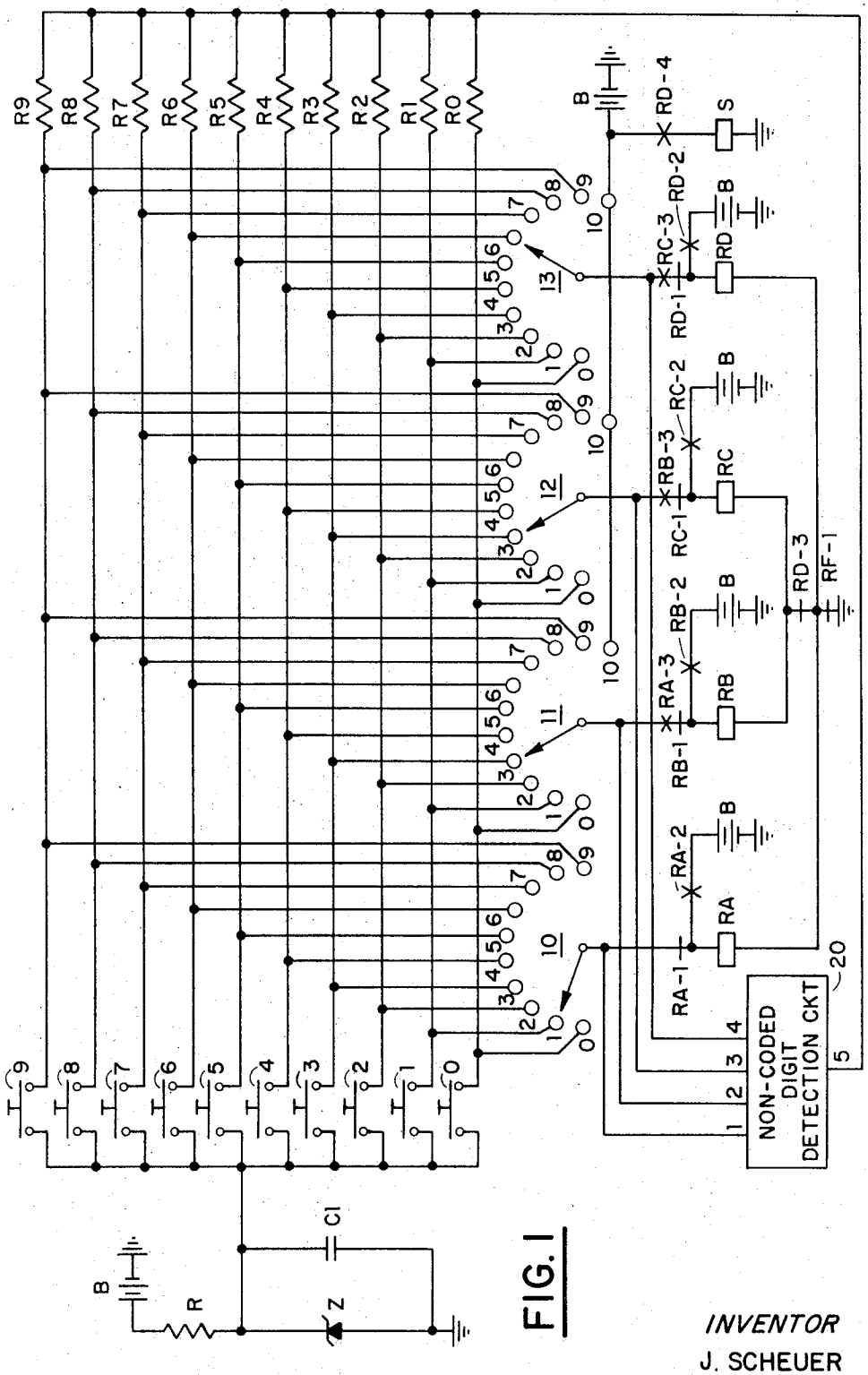


FIG. 1

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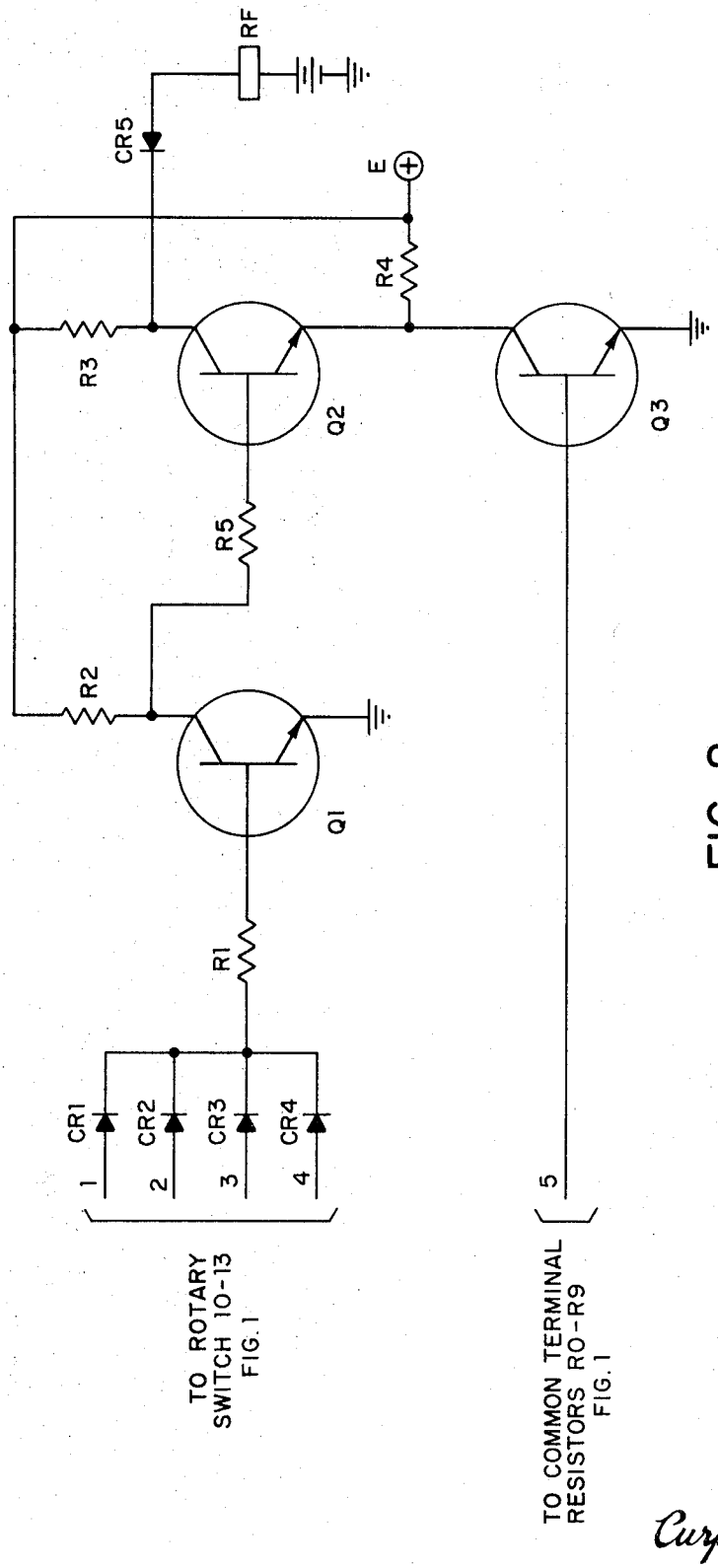


FIG. 2

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NONCODED DIGIT DETECTION CIRCUIT FOR ELECTRICAL COMBINATION LOCK

This invention relates to an electrical combination lock circuit and more particularly to a circuit for releasing an electrical combination lock circuit when a noncoded digit has been keyed.

The prior art contains various ways of nullifying attempts at hunting for any one of the assigned combinations by activating two or more keys together or in succession. For example, Canadian Pat. No. 749,513 issued to Brian G. Watkinson on 27th Dec. 1966 discloses a system having a number of relays which are sequentially operated by a source of discrete energy having just enough energy to operate one relay thus preventing actuation of more than one relay at a time. The patent further discloses a timeout circuit to prevent unlimited hunting for the correct combination by trial and error solutions over an extended time period. However the patent does not have provisions for erasing a partially completed operating path if during a keying process a wrong key is depressed. If after releasing the noncoded key, the remaining digits are keyed within the timeout period the lock will open. This leaves room for a trial and error solution. If during the timeout period a number of cycles of sequential keying of all digit keys equal to the number of digits in the code (for example **4**) are performed, all possible keys will have been operated the required number of times (4) and the lock will function as if the correct code sequence had been operated. The lock will then open.

It is the main feature of the invention to increase the security of combination locks by providing a circuit which erases the previously partially closed circuit in the operating path of the lock if during the keying process a noncoded digit is keyed. It therefore eliminates the possibility of opening the lock by continued sequential keying.

The conventional electrical combination lock upon which the invention is based comprises *n* key circuits each having a digit key, *m* digit-selecting switches each having *n* inputs connected to an associated digit key and one wiper output which is positioned to contact one of the inputs in accordance with a preselected code, and a chain of *m* relays connected to an associated selecting switch each relay having a contact in the operating path of the following relay and such relays being sequentially operated one by one to open the electrical lock. In accordance with the invention, the above electrical lock is provided with a circuit for detecting noncoded digits and for opening the operating path of the chain of relays to restore the electrical lock to normal when any noncoded digits are keyed. The detection circuit is a gate circuit having a first input connected to the wipers of the selecting switches, a second input connected to the key circuits and an output circuit adapted to open the operating path of the lock.

The invention will now be disclosed with reference to the drawings which illustrate a preferred embodiment of the invention with no intention however to limit the scope of the invention to the embodiment disclosed. In the drawings:

FIG. **1** illustrates the electrical combination lock disclosed in the above mentioned Watkinson patent modified in accordance with the invention; and

FIG. **2** illustrates a noncoded digit detection circuit in accordance with the invention.

The electrical combination lock which is shown in FIG. **1** for the purpose of illustrating the invention is based on the above-mentioned Watkinson patent. The portion thereof which does not form part of the present invention will only be described in broad terms and a reference is made to the patent for a more complete description thereof.

A source of DC voltage B charges capacitor **C1** through a resistor R. The potential value of capacitor **C1** is determined by zener diode Z which breaks down when such potential is reached. The capacitor **C1** is connected to the common side of a set of digit keys **0—9**. The keys are connected in input terminal **5** of a noncoded digit detection circuit **20** through resistors **R0—R9**. Each key is also connected to associated contacts **0—9** of four rotary switches **10—13**. The wipers of rotary switches **10—13** which are used to assign the code combinations to the electrical lock are connected to relays RA, RB, RC and RD respectively. The wipers of rotary switches **10—13** are also connected to input terminals **1—4** of the noncoded digit detection circuit **20**.

LOCK OPERATION BY CODED KEYING

The digit code is selected by positioning the wipers of rotary switches **10—13** to anyone of positions **0—9** (e.g. code 1336). Operation of the key corresponding to the first digit (**1**) of the code discharges capacitor **C1** through rotary switch **10**, normally closed contacts **RA–1**, relay RA and normally contacts **RF–1** of a relay RF to be disclosed later thus operating relay RA. Relay RA locks operated through its own contacts **RA–2** and closes normally open contacts **RA–3** to prepare the operating path of relay RB.

Release of the first digit key recharges capacitor **C1**. Operation of the second digit key (**3**) discharges the capacitor **C1** through rotary switch **11**, now closed contacts **RA–3**, normally closed contacts **RB–1**, relay RB, normally closed contacts **RD–3** and **RF–1**, thus operating relay RB. Once operated, relay RB locks operated through its own contacts **RB–2** and prepares the operate path of relay RC at contacts **RB–3**.

Release of the second digit key recharges capacitor **C1**. Operation of the third digit key (**3**) discharges capacitor **C1** through rotary switch **12**, now closed contacts **RB–3**, normally closed contacts **RC–1**, relay RC and normally closed contacts **RD–3** and **RF–1**. Relay RC locks operated through its own contacts **RC–2** and prepares the operate path of relay RD at contacts **RC–3**.

Release of the third digit key recharges capacitor **C1**. Operation of the fourth digit key (**6**) discharges capacitor **C1** through rotary switch **13**, now closed contacts **RC–3**, normally closed contacts **RD–1**, relay RD, and normally closed contacts **RF–1**. Once operated relay RD locks operated through its own contacts **RD–2** and supplies battery to solenoid S of the door lock magnet at contacts **RD–4** thereby opening the door.

Capacitor **C1** is chosen at such a value that it contains just enough energy to operate only one relay at a time. Consequently the actuation of digit key **3** for operating relay RB does not operate relay RC. Digit key **3** must be released and reoperated to energize relay RC. The use of capacitor **C1** permits combinations having two identical consecutive digits. Furthermore the use of capacitor **C1** prevents operation of the lock by actuating two or more digit keys together. Each key must be released before a second key can be actuated.

Each code combination requires sequential operation of the right keys to unlock the door. If during the keying sequence a wrong key is depressed, the partially completed operating path of the lock circuit is released. This function is performed by the noncoded digit detection circuit illustrated in block diagram in FIG. **1** and in detail in FIG. **2**.

NONCODED DIGIT DETECTION CIRCUIT

In FIG. **2**, inputs **1—4** are connected to rotary switches **10—13** as illustrated in FIG. **1**. Similarly input **5** is connected to the common terminal of resistors **R0—R9** of FIG. **1**. The detection circuit comprises transistors **Q1—Q3** which are properly biased by resistors **R1—R5** and potential source E. Diodes **CR1—CR4** are used for isolation purposes as is well known in the art. Relay RF is the release relay whose contacts **RF–1** are illustrated in FIG. **1**. Relay RF is energized through diode **CR5** and the collector-emitter junctions of transistors **Q2** and **Q3**.

KEYING OF NONCODED DIGITS

The keying of a noncoded digit applies a source of positive potential to input **5** only. Inputs **1—4** receive no input since the wipers of rotary switches **10—13** are not positioned at the contacts corresponding to the depressed key. The appearance of a positive pulse at input **5** causes transistor **Q3** to be for-

ward biased and to conduct heavily. The heavy conduction of transistor Q3 places the emitter of transistor Q2 near ground potential and transistor Q2 becomes conductive due to the positive voltage provided at its base by potential source E through resistors R2 and R5. When transistors Q2 and Q3 are conductive, the resistance of the circuit including relay RF becomes low enough to operate relay RF thus opening contacts RF–1 in the electrical combination lock circuit of FIG. 1. This opens the operating circuit of relays RA, RB, RC and RD causing them to open any partially completed operating circuit paths. The electrical combination lock circuit is thus returned to the same electrical state it was at previous to commencing of the keying operation. The keying process must again be started from the beginning if the door is to be opened.

KEYING OF A CODED DIGIT

A coded digit being keyed results in a positive pulse appearing simultaneously at one of inputs 1 to 4 and at input 5. The pulse at input 5 places a forward bias on the base of transistor Q3 and is conducts as in the case of a noncoded digit. However, transistor Q1 is also caused to conduct by the forward bias placed on its base by the pulse appearing at one of inputs 1 to 4. The conduction of transistor Q1 places the base of transistor Q2 near ground (provided R5 is low) and transistor Q2 is rendered nonconductive. Transistor Q2 being nonconductive the resistance of the operating path of relay RF remains high and relay RF is not affected. Correct keying may thus be continued in the regular manner.

When the noncoded detection circuit is used with the combination lock circuit disclosed in the above-mentioned Watkinson patent relay RF may be the same relay RF illustrated in the timeout circuit of FIG. 2 of the patent.

I claim:

1. A circuit for an electrical combination lock responsive to a preselected *m* digit code selected from a choice of *n* digits comprising:

a. *n* key circuits each including a normally open digit key;

b. *m* digit-selecting switches each having *n* input contacts connected to an associated digit key and a wiper for connection to a predetermined contact of each selecting switch in accordance with the preselected code;

c. a chain of *m* relays, each relay being connected to the wiper of an associated selecting switch, each relay when energized conditioning an operating path for the following relay in the chain, the last relay in the chain, when energized, completing an operating path for the clock;

d. a source of discrete energy connected to said key circuit to operate said relays one by one upon operation of the digit keys in accordance with the preselected code to establish said operating path for the lock; and

e. means connected to all of the input contacts and wipers of said digit-selecting switches for detecting potentials at any of said contacts and wires, said means being responsive to a potential appearing only at the input contact of a selector switch as indicating the keying of a noncoded digit for deenergizing any energized ones of said relays of said chain to return said lock to an unkeyed condition.

2. A circuit as defined in claim 1 wherein said potential detecting means comprises a gate circuit having a first input connected to each of said wipers, a second input connected to said key circuit, and an output circuit adapted when energized to remove the source of discrete energy from the relays of said chain of *m* relays, the gate circuit being responsive to a potential appearing only at the second input to energize the output circuit.

3. A circuit as defined in claim 2 wherein said output circuit includes a release relay having normally closed contacts in the operating path of each of the relays in said chain of *m* relays, said release relay being energized to open said normally closed contacts when said output circuit is energized.

4. A circuit as defined in claim 2 wherein said gate circuit includes a first transistor responsive to said first input, a second transistor responsive to said second input, and a third transistor responsive to said first and second transistors, said second and third transistors being connected in the output circuit of said gate circuit, the simultaneous appearance of a potential at said first and second inputs in response to keying of a coded digit rendering said second transistor nonconductive to prevent energization of the output circuit, the appearance of a potential at said second input alone in response to keying of a noncoded digit rendering said second and third transistor conductive to energize the output circuit, and thereby deenergize any energized ones of the relays of said chain of *m* relays to return said lock to an unkeyed condition.