

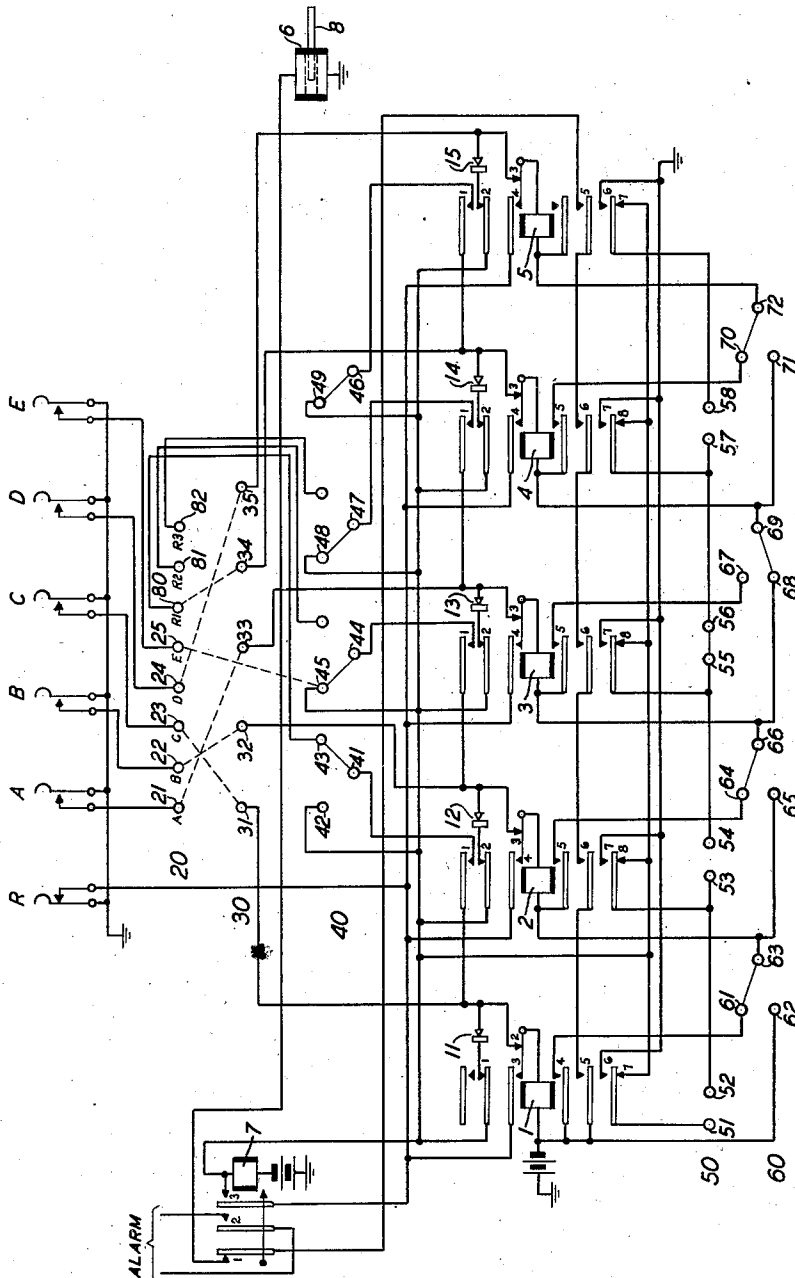
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ELECTRIC COMBINATION LOCK

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ELECTRIC COMBINATION LOCK

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This invention relates to locks and more especially to electrically controlled combination locks.

Previously electric combination locks have been suggested employing a series of relays operated by push-buttons or keys all of which are operated singly in a predetermined order.

In accordance with the present invention, means is provided for operating the series of relays which control the lock mechanism by means of keys which may be operated singly, repeatedly or in combination.

To this end cross-connections are provided to make the keys effective to operate the series of relays only when operated in the proper order or combination.

In addition the operation of any key outside of its code order or combination causes an alarm to be sounded.

The features of the invention will become more apparent from a consideration of the following description read in connection with the drawing which shows the wiring of a typical lock control circuit.

The lock control circuit as shown in the drawing discloses a five stage combination although it will be understood that any number of stages may be used. It employs five non-locking keys, A, B, C, D and E and a release key R, five stage relays 1, 2, 3, 4 and 5, a bolt operating solenoid 6 and an alarm relay 7. Included in the circuits are five rectifiers 11 to 15, the purpose of which will appear hereinafter. For the purpose of setting the code, five sets of cross-connecting terminals 20, 30, 40, 50 and 60 are employed, together with a group of auxiliary terminals 80, 81 and 82, which have been shown wired for a code C, B, AC, D.

The correct operation of the circuit as wired will first be described and the possible variations pointed out thereafter. When key C is operated, a circuit is closed from ground over the contacts of key C, terminal 23, cross-connected to terminal 31, normally closed contact 2 and winding of relay 1, to battery. Relay 1 operates, locking over its contact 3 to ground over the normally closed contacts of key R, independent of its operating circuit which it opens at contact 2 and setting the first stage of operation of the combination. At contact 4, relay 1 prepares the second stage of the combination by connecting battery over its contact 4, and terminal 61, connected to terminal 63, to the winding of relay 2.

When key B is operated in accordance with the second item of the code, ground is connected

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over the contacts of key B, terminal 22, cross-connected to terminal 32, contact 3 and the winding of relay 2, to which battery was supplied as above-described. Relay 2 operates and locks over its contact 4 to ground at key R to set the second stage of the combination. At its contact 5, relay 2 extends the battery supplied to its winding over terminals 64 and 66 to the winding of relay 3. This battery is also extended in parallel with the winding of relay 3, over terminals 68 and 69 to the winding of relay 4.

Keys A and C are now operated simultaneously, closing one circuit from ground over the contacts of key A, terminals 21 and 33, contact 3 and winding of relay 3 to battery as above traced. The second circuit extends from ground over the contacts of key C, and terminals 23 and 31, contact 1 of relay 2, terminal 41, cross-connected to terminal 43, terminal 80 cross-connected to terminal 34 and thence to contact 3 and the winding of relay 4 which is connected to battery as above-described. Relays 3 and 4 both operate and lock over their contacts 4 under the control of key R. Relays 3 and 4 set the third and fourth stages of the combination.

Since terminal 67 is disconnected, relay 3 is ineffective to extend the battery supply, but relay 4 extends battery as supplied to its winding over its contact 5 and terminals 70 and 72 to the winding of relay 5.

When key D is operated, ground is connected over the contacts of key D, terminals 24 and 35 to the contact 3 and winding of relay 5 which is connected to battery as previously traced. Relay 5 locks over its contact 4 to ground at the contacts of key R, completing the setting of the combination.

With the five stages completed by the operation of relays 1 to 5, a circuit is closed from battery over contact 5 of relay 1, contacts 6 of relays 2, 3 and 4, contact 5 of relay 5, normally closed contact 1 of alarm relay 7 to the winding of solenoid 6 and ground. Solenoid 6 attracts bolt 8 to open the lock. The solenoid remains operated until key R is operated to open the locking circuits of the series of relays 1 to 5 and thereby the circuit of solenoid 6 to permit the bolt 8 to return to its normal locking position.

To illustrate the safeguards provided, assume that one of the keys is operated out of the code order, for example that key A were operated first. Relay 3, to which key A is cross-connected, cannot operate since no battery is supplied to the winding of relay 3 until after the first two stages have been completed by the operation of relays

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1 and 2. However, a circuit is closed from ground over the contacts of key A, terminals 21 and 33, rectifier 13, contact 2 of relay 3, to the winding of alarm relay 7 and battery. Relay 7 is slightly slow to operate to prevent it from operating during the operating time of a correctly energized series relay, but operates much more quickly than the solenoid 6. When relay 7 operates it closes an alarm circuit and opens the circuit of the solenoid 6. Similar circuits are closed for relay 7 by other keys when operated out of order. The rectifiers 11 to 15 are included in these operating circuits for relay 7 in order to prevent current flowing back to the windings of other ones of the relays 1 to 5 which are connected over their back contacts in multiple to the winding of relay 7.

In the case where the two keys A and C are to be operated simultaneously, provision is made by means of the set of terminals 50 to operate the alarm relay 7 if only one key is operated. If, for example, keys A and C are operated in succession, since battery has been supplied by relay 2 to the windings of both relays 3 and 4, these relays can operate. However, with relay 3 operated and relay 4 non-operated in the interval between the operation of the two keys, ground is connected over the front contact 7 of relay 3, terminals 55 and 56 which are connected together, back contact 8 of relay 4 to the winding of alarm relay 7 and battery. Similarly, if key C is operated first, relay 4 can operate, but ground is connected over contact 7 of relay 4, terminals 55 and 56, and contact 8 of relay 3 to the winding of the alarm relay.

It may be noted that key E is not employed for the code selected. Therefore, the terminal 25 connected with that key is cross-connected to one of the terminals, 42, 45, 48, for example, to terminal 45 which is connected directly to alarm relay 7. Similarly relay 7 is operated over terminals 45, 48 or 49 and the front contact of the subsequent stage relay if a key is falsely reoperated.

From the foregoing description it should be apparent that each key and each stage relay has an individual terminal whereby the keys may be used in any order for the five stages of the code. Furthermore, the set of terminals 40 in combination with the auxiliary terminals 80, 81 and 82 permits any key to be reused for a later, non-consecutive stage by extending the circuit completed by a key to the proper stage relay, after one intermediate stage relay has been operated. At those stages for which no repetition is expected, the extended key circuits are connected to the alarm relay, as are the circuits of any unused keys.

As pointed out above, the set of terminals 50 are connected to detect the false operation of one relay where two should be operated. If stage relays 1 and 2 were to be operated simultaneously, instead of relays 3 and 4 as described above, terminals 51 and 52 would be connected and terminals 55 and 56 disconnected. Similarly terminals 53 and 54 would be connected if stages 2 and 3 were to be simultaneous, or terminals 57 and 58 would be connected if stages 4 and 5 were to be simultaneous.

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Terminals 60 are also involved in the simultaneous operation of two stages and control the battery supply for the stage relays. Where stages are to be consecutive, the upper left terminals 61, 64, 67 and 70, which are connected to front contacts of the stage relays 1 to 4 respectively are cross-connected to the associated right-hand terminals 63, 66, 69 and 72 and thence to the winding of the next stage relay. Where two stages are to be set simultaneously the lower left terminal 62, 65, 68 or 71, which is connected in parallel with the winding of the associated stage relay, is cross-connected to the right terminal of the group, permitting the two stage relays to operate at the same time.

What is claimed is:

1. An electric combination lock comprising a plurality of keys, a series of relays, lock control means responsive to the simultaneous operation of said series of relays, means for cross-connecting said keys and said relays to render said relays operable in response to the operation of said keys, means responsive to the operation of each relay to prepare an operating circuit for a succeeding relay, and means to cause certain of said relays to prepare the circuits of a plurality of succeeding relays.

2. An electric combination lock comprising a plurality of keys, a series of relays, lock control means responsive to the simultaneous operation of said series of relays, means for cross-connecting said keys and said relays to render said relays operable in response to the operation of said keys, means responsive to the operation of each relay to prepare an operating circuit for a succeeding relay, means to cause certain of said relays to prepare the circuits of a plurality of succeeding relays, means responsive to the simultaneous operation of a plurality of keys for operating said plurality of relays, and means to sound an alarm if only one of said keys is operated.

3. An electric combination lock comprising a plurality of keys, a plurality of relays arranged to complete a plurality of stages, lock control means, cross-connecting means for associating said keys with said relays in accordance with a predetermined combination including means to associate the same key with a second one of said relays, said last means being effective only after the operation of an intermediate relay, means responsive to the operation of said keys in accordance with said combination to operate said relays at the arranged stages, and means responsive to the operation of all of said relays to operate said lock control means.

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