

H. A. MARCHANT.
ELECTRIC COMBINATION LOCK.
APPLICATION FILED SEPT. 17, 1917.

1,283,845.

Patented Nov. 5, 1918.
3 SHEETS—SHEET 1.

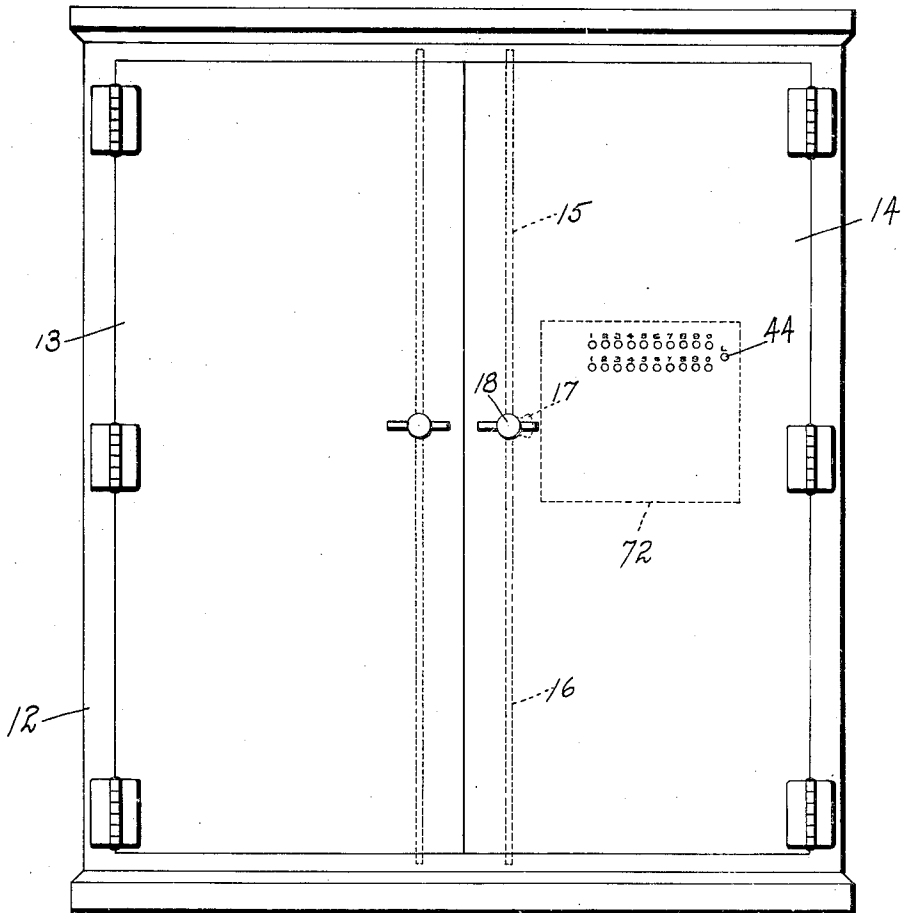


Fig 1

INVENTOR
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By his Attorneys,
W. Bennett & W. Cready.

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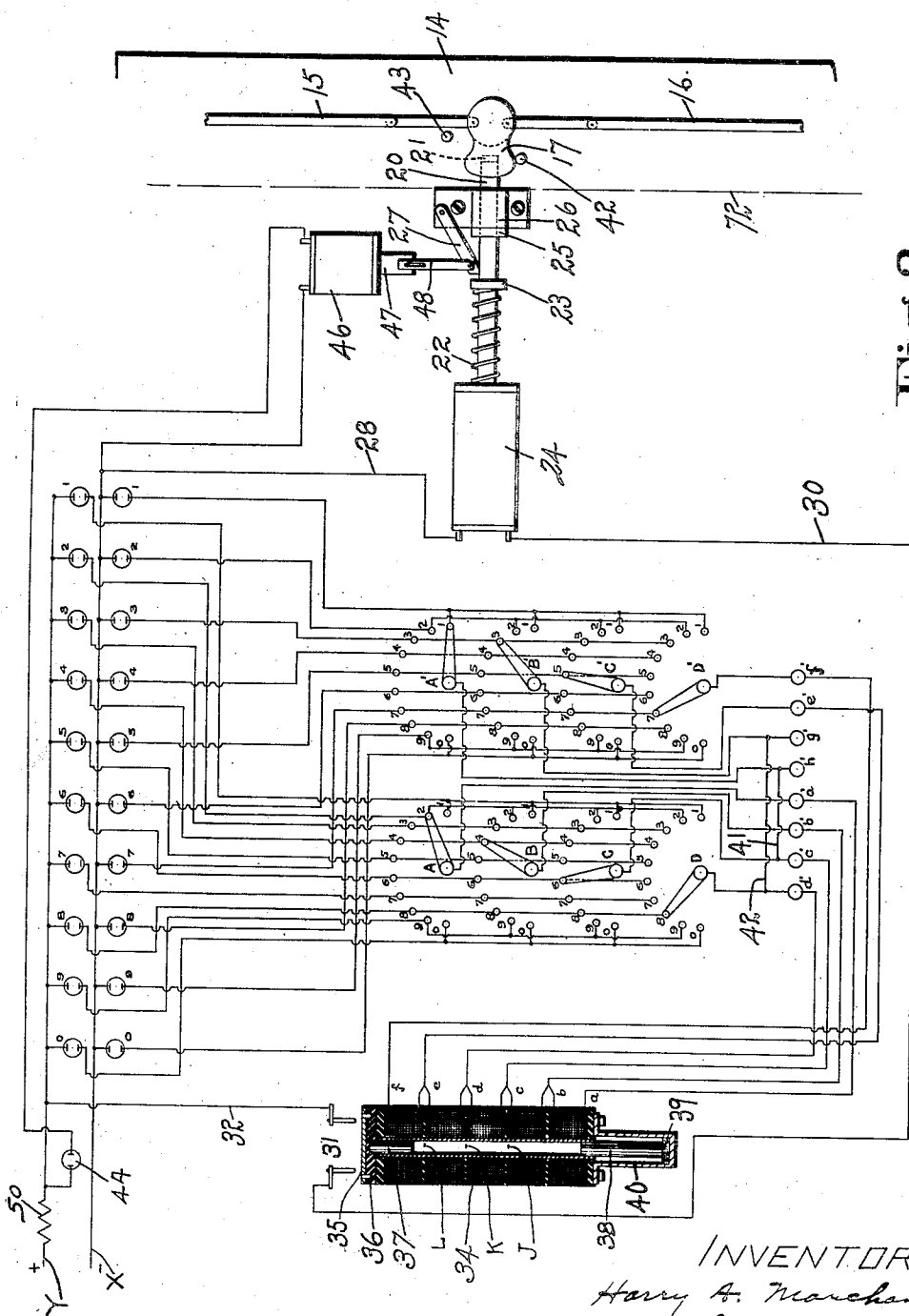


Fig 2

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3 SHEETS—SHEET 3.

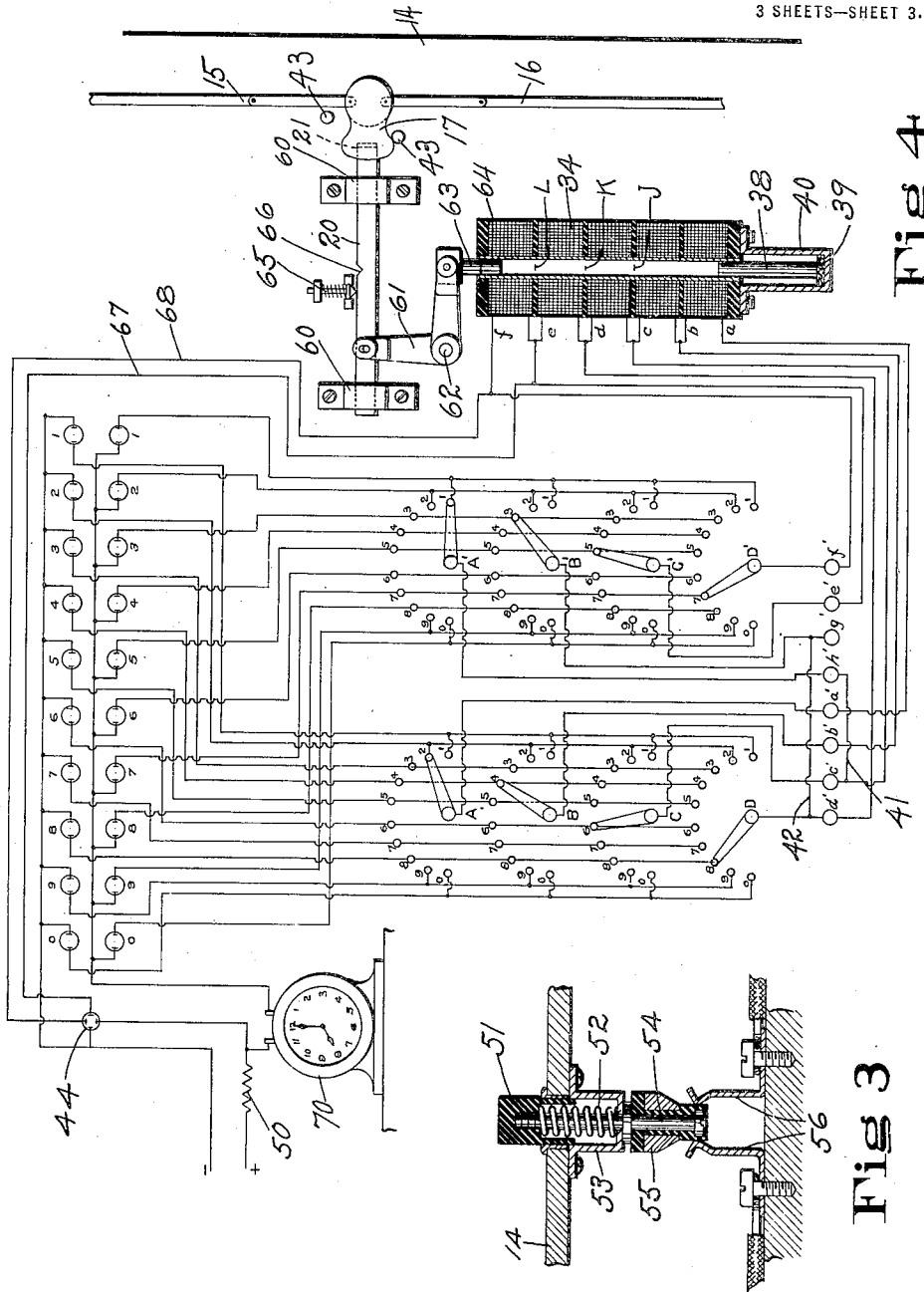


Fig 4

Fig 3

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UNITED STATES PATENT OFFICE.

HARRY A. MARCHANT, OF STONEHAM, MASSACHUSETTS.

ELECTRIC COMBINATION-LOCK.

1,283,845.

Specification of Letters Patent.

Patented Nov. 5, 1918.

Application filed September 17, 1917. Serial No. 191,711.

To all whom it may concern:

Be it known that I, HARRY A. MARCHANT, a citizen of the United States, residing at Stoneham, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Electric Combination-Locks, of which the following description, in connection with the accompanying drawings, is a specification, like reference characters on the drawings indicating like parts in the several figures.

This invention relates to electric combination locks; that is, locks which are controlled by electric circuits which must be opened, closed, or modified in a predetermined manner in order to operate or permit the operation of the lock.

The invention aims to devise a simple lock construction of this character which can be economically manufactured but in which a great number of combinations can be obtained, in which the combination of the lock can be easily changed, and which shall be secure from the tampering of persons who do not know the combination.

The invention will be readily understood from the following description of the embodiment thereof at present preferred, reference being made to the accompanying drawings, in which,

Figure 1 is a front elevation of a safe of a common form equipped with a locking apparatus embodying this invention;

Fig. 2 is a diagrammatic view of the locking apparatus;

Fig. 3 is a cross sectional view of a push-button switch; and

Fig. 4 is a diagrammatic view of a modification.

Referring now to the drawings, 12 indicates a safe of a construction much used in offices and 13 and 14 designate the doors of the safe. The door 14 is locked at its top and bottom by two rods designated at 15 and 16, respectively, both rods being connected to a member 17 which may be rotated by a handle 18 to withdraw the rods 15 and 16 from holes provided for them in the door casing and thus unlock the door. The door 13 is locked by the overlapping upon it of the door 14, but the door 13 may also be provided with a handle and locking rods similar to the handle 18 and rods 15 and 16 with which the door 14 is provided. This is a common arrangement for locking safes of this type and it is usual to lock the member

17 against rotative movement by means of a combination lock of some common type which, when set, has a bolt similar to the bolt 20, Fig. 2, that slides into a recess 21 in the member 17 and prevents any turning movement of this member until the combination has been operated to withdraw the bolt. Inasmuch as it is necessary to turn the member 17 in order to withdraw the rods 15 and 16, the locking of this member in its horizontal position, as shown in Fig. 2, effectually locks the safe.

The present invention provides an electromagnetic apparatus for controlling the bolt 20 which locks the member 17, although it is obvious that the part 20 might be used as the locking bolt for the door, if it were desired to dispense with the parts 15 and 16, 17 and 18. Referring to Fig. 2, it will be seen that the bolt 20 is normally held in its projected or locking position by means of a spring 22 which encircles the bolt and bears at one end against a collar 23 fast on the bolt, and at its opposite end against a solenoid 24 into which the bolt can be withdrawn. This bolt forms the core for the solenoid. A second collar 25 fast on the bolt 20 limits the forward movement of the bolt by its engagement with a guiding and supporting member 26 through which the bolt slides. When the solenoid 24 is energized, it withdraws the bolt 20 from the recess 21 in the member 17 and a latch 27, pivoted just above the bolt, drops in behind the collar 25 and holds the bolt in its retracted position.

For the purpose of energizing the solenoid 24, one of its terminals is connected by a conductor 28 to one main X from a source of electricity, and the other terminal is connected by a conductor 30, through a switch 31 and conductor 32, to the opposite main Y of the source of current. The switch 31 normally is open so that the solenoid 24 is normally deenergized and this switch can only be closed by energizing the solenoid 34. That is, the movable member 35 of the switch 31 is carried by a non-conducting disk 36 which is mounted on the upper end of a plunger 37, preferably made of non-magnetic material, and designed to slide freely in the upper end of the solenoid 34. Normally the disk 36 rests on the upper end of the solenoid so that the switch member 35 is out of engagement with the contacts of the switch 31. But when the solenoid 34 is energized in the proper manner the movable core 38 of the solenoid

is raised through practically the entire length of the solenoid and strikes the lower end of the plunger 37, raising the switch member 35 into engagement with the contact of the switch 31. Normally the core 38 is held at the lower end of the solenoid by gravity, resting on a cushion of felt or the like supported in a bracket 40 fastened to the solenoid.

As clearly shown in Fig. 2, the solenoid is made in five sections or consists of five coils. The leads from these coils are designated by the letters *a, b, c, d, e* and *f*, the terminals at the abutting ends of adjacent coils being joined or united to form the leads *b, c, d* and *e*. These leads are all secured to binding posts designated by the corresponding primed letters, namely, *a', b', c', d', e'* and *f'*. Two additional binding posts *h'* and *g'* are provided and the post *h'* is connected by a conductor 41 to the post *c'* while the post *g'* is connected by a conductor 42 to the post *d'*.

All of these posts are connected through selecting switches to a series of circuit-controlling elements, shown as push button switches, arranged on the door 14. Fig. 1 shows the push buttons as they appear on the front of the door arranged in two series, one above the other, each series consisting of ten buttons. Fig. 2 shows the contacts for these buttons diagrammatically on the inside of the door and the connections to them. As clearly shown in the latter figure, one contact of each of the upper row of buttons is connected to the main Y, while one terminal of each of the lower row of buttons is connected to the main X. The other ten terminals of the upper row of buttons are all connected to the contacts of the four selecting switches, indicated at A, B, C and D. It will be noted that each of these selecting switches has ten contacts numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0, that the upper row of push buttons is correspondingly numbered, and that one terminal of each of these push buttons is connected to the correspondingly numbered contact of each of the four switches A, B, C and D. The lower contacts of each of the lower series of push buttons are similarly connected to the contacts of the four right hand selecting switches A', B', C' and D'. It will also be seen from an inspection of Fig. 2 that the pivoted switch arms A, B, C and D are connected, respectively, to the binding posts *a', b', c'* and *d'*, and that the switch arms A', B', C' and D' are connected to the binding posts *h', g', e'* and *f'*, respectively. Preferably all of these binding posts are fastened to the bottom of the solenoid 34 but they are shown separated from the solenoid in Fig. 2 for the purpose of illustrating the circuits more clearly.

The connections between the solenoid 34 and the selecting switches are so arranged that the upper pair of selecting switches, A and A', controls the circuit through the two

lowermost coils of the solenoid 34; that is, the circuit between the leads *a* and *c* of the solenoid. The second pair of selecting switches, B and B', controls the circuit between the leads *b* and *d*. The third pair of switches, C and C', controls the circuit between the leads *c* and *e*; while the lowermost pair of selecting switches D and D', controls the circuit between the leads *d* and *f*. It will be evident therefore that in order to complete a circuit through any pair of the selecting switches mentioned and thus to energize the coils of the solenoid with which they are connected, it is necessary to press both of the push buttons with which the switches are in connection. That is, in order to energize the section of the solenoid between the leads *a* and *c* it is necessary to press the upper 2 and lower 1 buttons, when a complete circuit is established between the positive main Y, through the upper push button switch 2, the selecting switch arm A, the binding post *a'*, the lead *a*, the two lower coils of the solenoid, the lead *c*, the binding post *c'*, the conductor 41, the switch arm A' and the lower button numbered 1, to the negative main X.

In other words, the setting or adjustment of the four pairs of selective switch arms A and A', B and B', C and C', and D and D', determines the combination for which the lock is set. With the switches in the positions shown in Fig. 2, the combination is: first, upper 2 and lower 1; next, upper 4 and lower 3; next, upper 6 and lower 5, and finally, upper 8 and lower 7. Upon pushing the two buttons, upper 2 and lower 1, the circuit is established in the manner just described through the two lower sections of the solenoid 34. The energizing of this part of the solenoid raises the core 38 until its upper end reaches the position indicated at J. While these two buttons are held depressed, the next pair, namely, upper 4 and lower 3 are depressed, thus completing the circuit through the switch arms B and B', and energizing the section of the solenoid between the leads *b* and *d*. The core 38 is partly within the magnetic field thus set up at the time that this circuit is established, and accordingly the new magnetic field set up will raise the core until its upper end reaches substantially the position K. The first pair of buttons is then released but the second pair, namely, upper 4 and lower 3, are held depressed while the third pair, that is, upper 6 and lower 5, are depressed. This establishes a circuit through the switch arms C and C' and through the section of the solenoid between the leads *c* and *e*. The release of the first pair of push buttons results in deenergizing the lowermost coil of the solenoid, but the circuit controlled by the second pair keeps the part of the solenoid between the leads *b* and *d* energized, while the third circuit just described is established.

Consequently, the magnetic field set up upon the pushing of the second pair of buttons maintains the core 38 within the influence of the magnetic field set up by energizing the section of the solenoid between the leads *c* and *e*. The second pair of buttons is next released but the field established by the third pair of buttons moves the core 38 up until its upper end reaches substantially the position indicated at L. While the upper 6 and lower 5 buttons are still held depressed, thus maintaining the core in the elevated position to which it has been moved, the final pair, namely, upper 8 and lower 7, are depressed thus establishing a circuit through the switch arms D and D' and through the section of the solenoid between the leads *d* and *f*, the third pair of buttons then being released. This new magnetic field raises the core 38 into engagement with the plunger 37 and lifts the plunger thus carrying the switch member 35 into engagement with the contacts 31, which preferably are made of carbon. The closing of this switch establishes a circuit through the solenoid 24, which immediately withdraws the bolt 20 from engagement with the member 17, the latch 27 dropping in behind the collar 25 as soon as the bolt has been retracted. As soon as the push buttons are released, the core 38 drops back under the influence of gravity into its initial or zero position, thus opening the switch 31 and deenergizing the solenoid 24. The latch 27, however, holds the bolt 20 in its retracted position. The operator may now turn the handle 18, thus withdrawing the rods 15 and 16 and unlocking the safe door 14. Preferably a pin 42 (Fig. 2) is positioned for engagement with the member 17 to prevent the turning of this member in more than one direction and another stop 43 may be provided to limit the extent of the turning movement.

When the operator wishes to lock the safe again, he turns the handle 18 back to its initial position, in which it is shown in Fig. 2, the stop 42 acting to arrest this movement when the member 17 has been returned to the proper position to be locked by the bolt 20. He then depresses a push button 44 which closes the circuit through a solenoid 46 having a core 47 connected by a link 48 to the latch 27. The energization of this solenoid results in lifting the latch 27 out of engagement with the collar 25, thus permitting the spring 22 to push the locking bolt 20 forward into the recess 21 in the member 17, locking the latter member against the turning movement necessary to permit the safe to be unlocked.

It will be evident from the foregoing description that in order to move the bolt 20 into its unlocked position it is necessary to operate the push buttons in a predetermined

manner, and that even if an unauthorized person should accidentally discover the first steps necessary to unlock the apparatus, the failure either to select the proper pair of buttons to be operated at any subsequent point in the process or to maintain each pair of buttons depressed until the next succeeding pair in the process were depressed, would result in the return of the apparatus to its zero position since the core 38 would drop into engagement with the bracket 40 that sustains it and the operator would have to begin the cycle over again. The piece of felt 39 or other suitable material positioned on the bracket 40 deadens the sound of the core 38 when it drops. It is obvious that instead of relying upon gravity to return the core to its initial position, a spring or a cord and weight could be used for this purpose. It will also be understood that any change in the setting or adjustment of the selecting switches will change the combination. Since each of these switches may be moved to any one of ten different positions and since there are eight of them, it is obvious that a tremendous number of different combinations may be obtained. It is thus practically impossible to discover the combination by the "cut and try" method. Furthermore, a change in the combination may be very easily effected. The difficulty of "picking" the lock is further increased by the fact that the push buttons must be operated in pairs and that each pair must be maintained in its depressed condition until the next succeeding pair in the combination is depressed, any failure in observing this requirement resulting in releasing the core 38 and allowing it to drop back to its initial position. The selecting switches should not all be set on the same number and care should also be taken to avoid setting the four right hand switches or the four left hand switches on the same number, even though the two sets of switches be set on different numbers. In fact, the switches of each set should be placed on different numbers. If all the push buttons should be depressed simultaneously, it would result in short-circuiting the mains X and Y, and accordingly a resistance 50 is connected into one main to avoid such a short circuit.

Any suitable type of push button may be used and it is obvious that the particular type selected will depend upon the voltage used and other conditions which will vary with the installation made. Fig. 3 shows a type of push button which is satisfactory for many conditions. In this construction a button, indicated at 51, is mounted to project through the door 14 and is normally held in its projected position by a spring 52 located between the button 51 and a thimble 53 secured to the inside of the door. The button

carries a plunger 54 on which the movable contact 55 of the switch or circuit-controlling element is mounted, this contact being insulated from the plunger 54. The stationary contacts for the device are indicated at 56. When the circuit is open these contacts rest on an insulating member carried by the plunger 54, but located below the contact 55.

In Fig. 4 another embodiment of the invention is shown which differs from that shown in Fig. 2 chiefly in that the solenoids 24 and 46 have been eliminated and connections are provided which enable the solenoid 34 to move the bolt 20 in both directions. The connections between the various sections of this solenoid and the push buttons are exactly the same as that shown in Fig. 2. In this arrangement, however, the bolt 20 is mounted to slide through suitable guides 60 and has a pivotal connection with the upper arm of a bell crank lever 61 which is fulcrumed at 62. This lever has a horizontal arm pivoted to the upper end of a plunger 63 made of some non-magnetic material and carrying a plunger element 64 made of magnetic material and positioned in the upper end of the bore of the solenoid.

With this construction the operation of the push buttons in the prescribed order will result in raising the core 38 step by step as above described in connection with Fig. 2. The final movement of this core operates through its engagement with the plunger 64 to swing the bell crank lever 61 about its fulcrum in a counter-clockwise direction and thereby withdraw the bolt 20 from engagement with the member 17 or, in other words, to move the bolt to its unlocked position. The bolt may be yieldingly held in this position by a spring-pressed plunger 65 arranged to engage and enter a notch 66 formed in the bolt 20. In this arrangement the locking push button 44 is made of the double pole type and is connected by conductors 67 and 68 to the leads *e* and *f*, respectively, of the uppermost section of the solenoid 34. Consequently, when the push button 44 is depressed, the uppermost section of the solenoid 34 will be energized and, through its action on the magnetic member 64 of the plunger 63, will swing the bell crank lever 61 about its fulcrum in a clockwise direction, thus projecting the bolt 20 forward into the recess in the member 17.

If desired, a time-controlled switch may be used with this apparatus either to control entirely the time during which current is turned on to the apparatus, or to turn the current on or off at a certain time. Inasmuch as time switches of this type are well known and since any form suitable to the requirement of the particular installation may be used, no detailed showing of this apparatus is made herein, but it is indicated

diagrammatically at 70 (Fig. 4). It is obvious that such a switch might also be applied to the arrangement shown in Fig. 2, if desired.

Preferably the operating parts of the apparatus are inclosed in a casing 72 (see Fig. 1) mounted on the inside of the door 14 and secured by a suitable lock. Obviously the safe ordinarily would not be left open except when persons authorized to use it were in constant attendance and it would be necessary even then for a person to have a key to unlock the casing 72 in order to obtain access to the operating parts of the combination lock to change its combination or modify its action in any manner.

While I have herein shown and described the best embodiment of the invention of which I am at present aware, it is obvious that the invention may be embodied in many other forms differing in arrangement of parts and details of construction from the form shown. The invention, therefore, is not limited to embodiment in the specific forms shown.

What is claimed as new, is:

1. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including means depending for its operation upon the establishment of a plurality of electric circuits in a predetermined order, a plurality of circuit-controlling elements, and adjustable means for rendering certain only of said elements operative to control said circuits.

2. An electric combination lock, having, in combination, a locking member mounted for movement into either a locking or unlocking position, and controlling apparatus for said member including means for establishing a series of electric circuits and means operative to effect the movement of said member from one of said positions to another and dependent for its operation upon the establishment of said circuits in predetermined order.

3. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including means depending for its operation upon the establishment of a plurality of electric circuits in a predetermined order, a plurality of circuit-controlling elements, and adjustable means constructed and arranged to render certain only of said elements operative to control said circuits and requiring the actuation of said elements in pairs.

4. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including a series of manually operable circuit controlling elements, and means constructed and arranged to cause the operation of said elements in a predetermined order to unlock

said member but operative to cause the re-setting of the apparatus in its zero position upon a failure to follow the prescribed order.

5. An electric combination lock having, in combination, a locking member, electro-magnetic apparatus controlling said member, and circuit connections for said apparatus including a series of manually operable circuit controlling elements and adjustable selecting means for rendering certain only of said elements operative to control the lock, said apparatus comprising a device operative to unlock said member and depending for its operation upon the actuation of said elements in a predetermined order.

6. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including means for establishing a series of magnetic fields, a device arranged to be moved by the setting up of said fields in a predetermined order and operating means for said member arranged to be actuated by said device.

7. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including means for establishing a series of magnetic fields, adjacent to each other, and a device arranged to be moved by said fields through a predetermined path to modify the locking action of said member, the movement of said device through said path being dependent upon the setting up of said magnetic fields in a predetermined manner.

8. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including means for establishing a series of magnetic fields adjacent to each other, and a device arranged to be moved by said fields through a predetermined path to modify the locking action of said member, the movement of said device produced by one of said fields serving to carry it into the range of influence of another of said fields, whereby the failure to establish said fields in a predetermined manner will result in a failure to give said device the required movement to enable it to perform said function.

9. An electric combination lock, having, in combination, a locking member movable into either a locking or unlocking position, and controlling apparatus therefor including means for establishing a series of magnetic fields and means dependent for its operation upon the establishment of said fields in a predetermined order and operative to effect the movement of said member from its locking to its unlocking position when said fields are set up in the prescribed order.

10. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including means for establishing a series of magnetic fields

and a device arranged to be moved step by step by said fields and operative upon its movement through a predetermined path to unlock said member, the movement of said device through said path being dependent upon the setting up of said magnetic fields in a predetermined order.

11. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including means for establishing a series of magnetic fields, and a device arranged to be moved step by step by said fields and operative by its movement through a predetermined path to unlock said member, the movement of said device from one step to another being dependent upon the maintenance of one field until the next succeeding field is set up.

12. An electric combination lock, having, in combination, a locking member, and electro-magnetic controlling apparatus therefor including a solenoid having a plurality of sections, a series of circuit-controlling elements arranged to be connected with the sections of said solenoid, adjustable means for rendering certain only of said elements operative at a given time to control the circuits through said sections, and a core for said solenoid arranged to be moved through the solenoid by the energizing of its sections in a predetermined order.

13. An electric combination lock, having, in combination, a locking member, and electro-magnetic controlling apparatus therefor including a solenoid having a plurality of sections, a series of circuit-controlling elements arranged to be connected with the sections of said solenoid, adjustable means for rendering certain only of said elements operative at a given time to control the circuits through said sections, a core for said solenoid arranged to be moved through the solenoid by the energizing of its sections in a predetermined order, said core being arranged to return to its initial position upon the failure to energize said sections in the prescribed order, and connections between said member and said solenoid whereby the core is enabled to operate said member when moved by the energizing of said sections in the prescribed manner.

14. An electric combination lock, having, in combination, a locking member, and controlling apparatus therefor including means for establishing a series of magnetic fields and means dependent for its operation upon the establishment of said fields in a predetermined order and arranged to unlock said member when said fields are set up in the prescribed order, said apparatus including electrical circuits comprising a series of circuit-controlling elements and adjustable means for rendering certain only of said elements operative at a given time to control the circuits that establish said fields.

15. An electric combination lock, having, in combination, a locking member movable into either a locking or unlocking position, electro-magnetic means controlling said member, and circuit connections controlling said means and including a series of manually operable circuit-controlling elements, and a plurality of selecting switches between said elements and said means operative to render certain only of said elements effective to control the lock, said means including a device operative to move said member from one of said positions to the other and dependent for its operation upon the actuation of said elements in a predetermined order.

In testimony whereof I have signed my name to this specification.

HARRY A. MARCHANT.