Jan. 12, 1965 N. S. CLAY 3,165,599

KEY OPERATED COMBINATION SWITCH FOR ALARM SYSTEM

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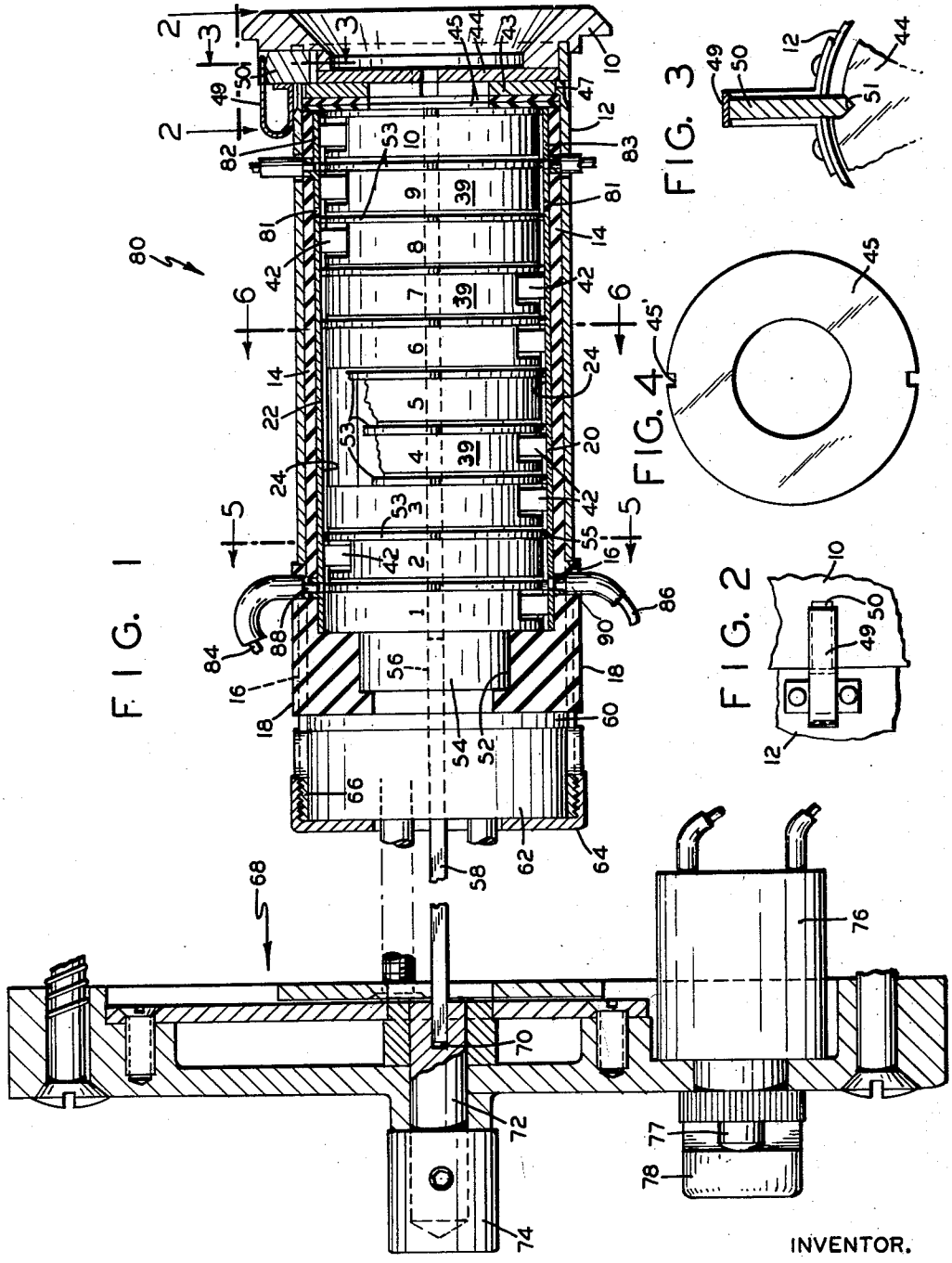


FIG. 1

FIG. 3

FIG. 4

FIG. 2

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FIG. 5

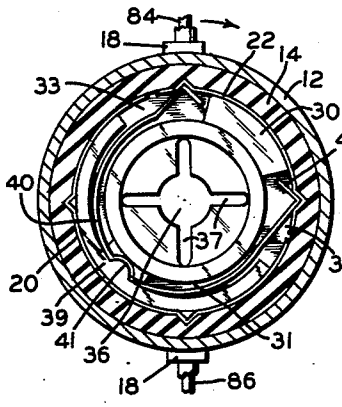


FIG. 6

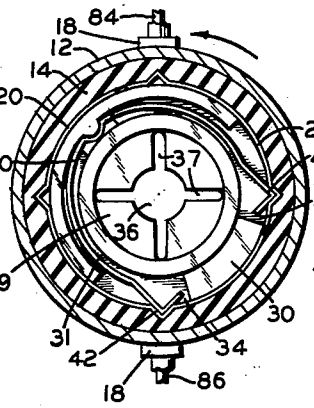


FIG. 7

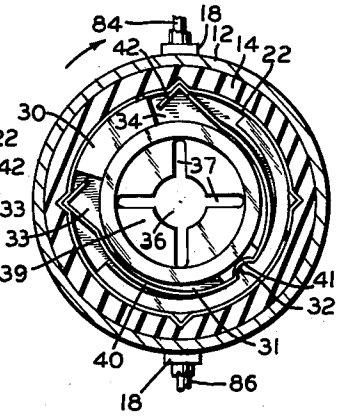


FIG. 8

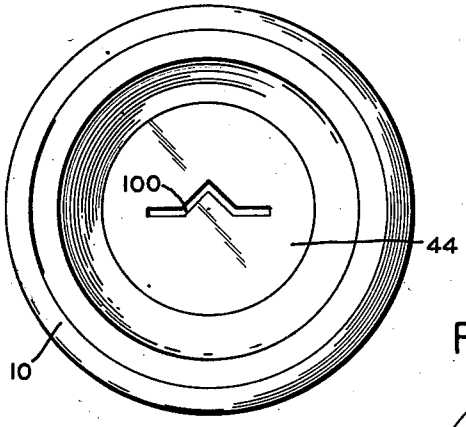


FIG. 9

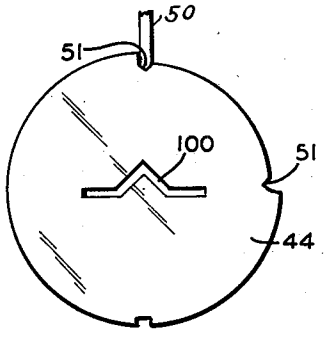


FIG. 10

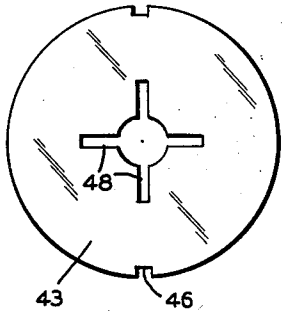
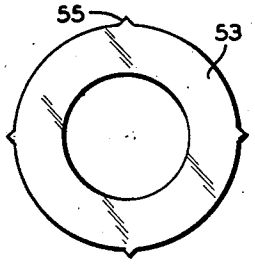


FIG. 11



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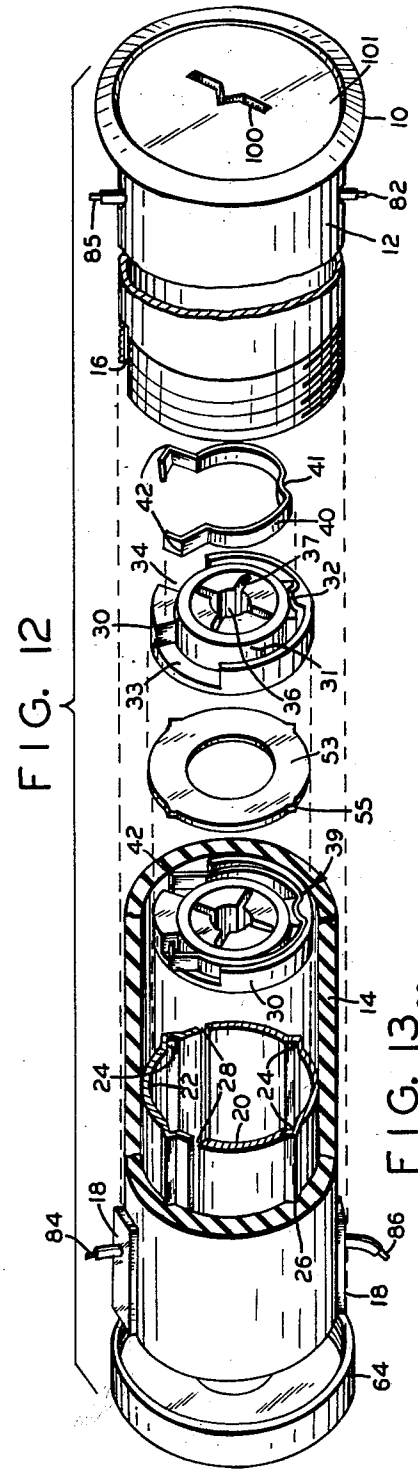


FIG. 12

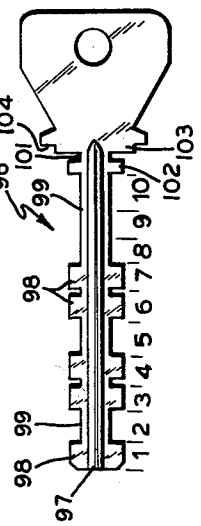


FIG. 13

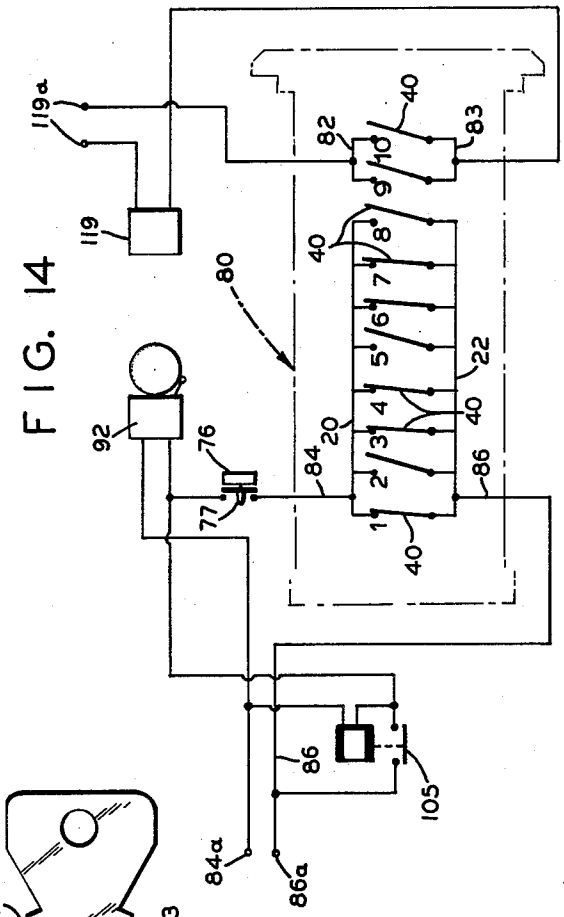


FIG. 14

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FIG. 15

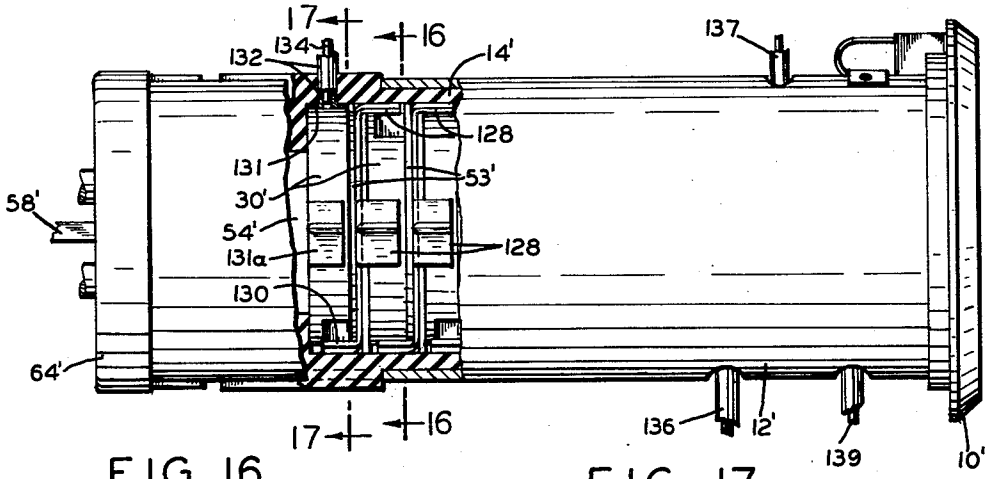


FIG. 16

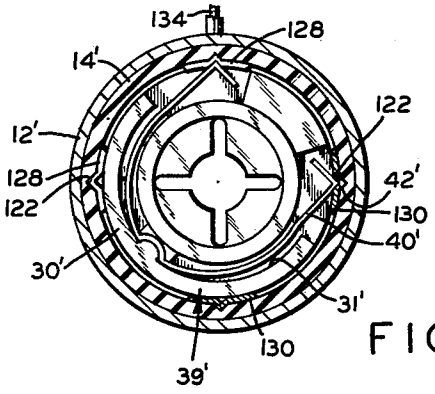


FIG. 17

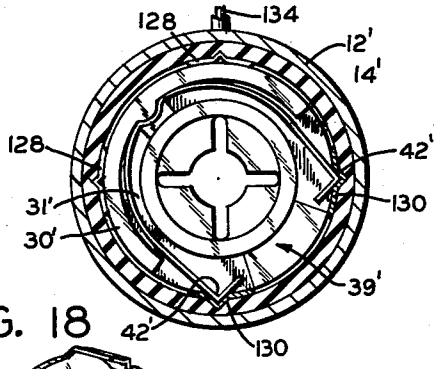


FIG. 18

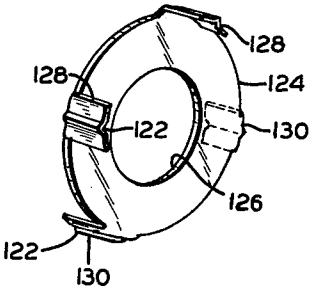
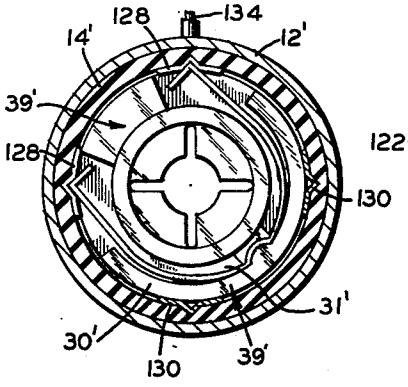


FIG. 19



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FIG. 21

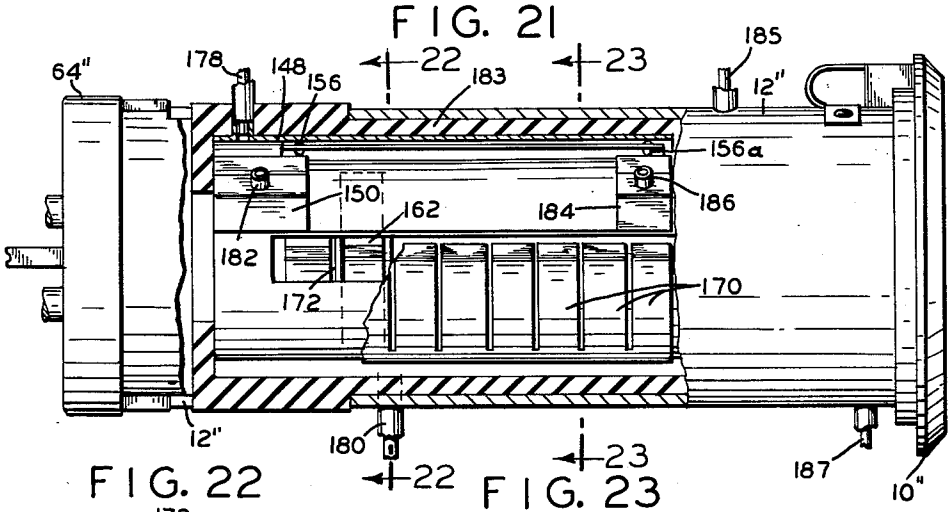


FIG. 22

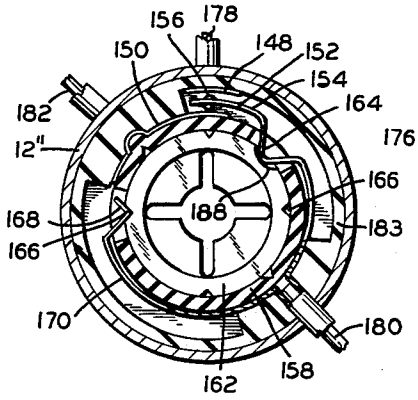


FIG. 23

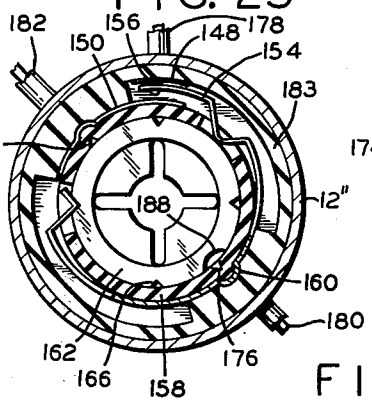


FIG. 26

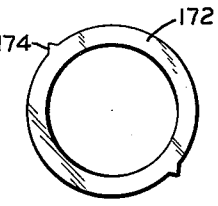


FIG. 20

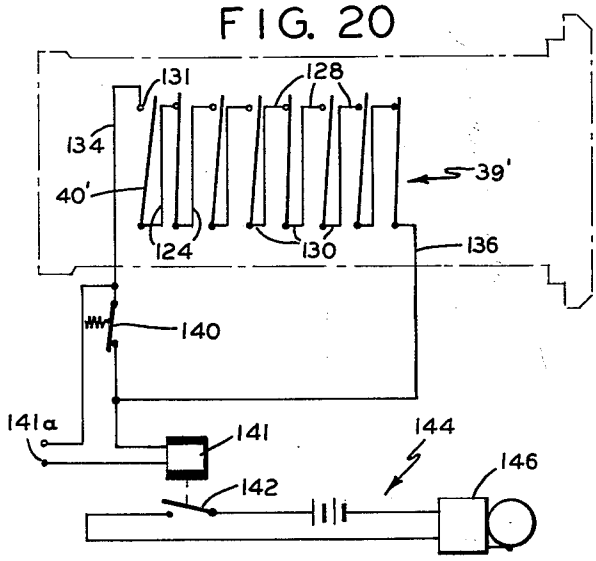
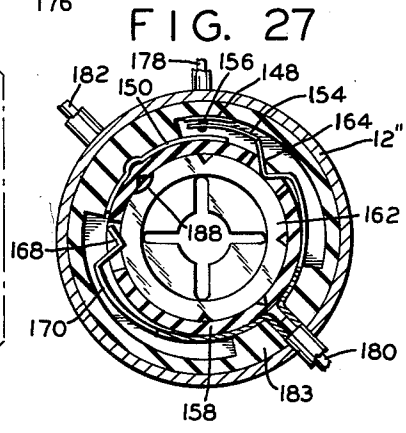


FIG. 27



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FIG. 24

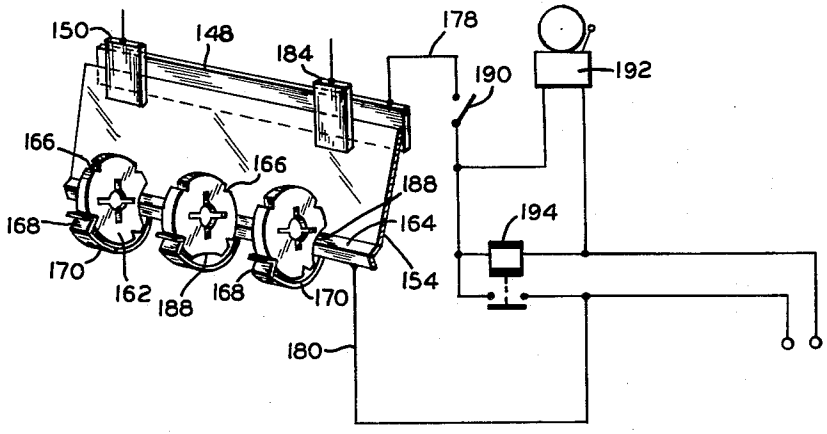


FIG. 25

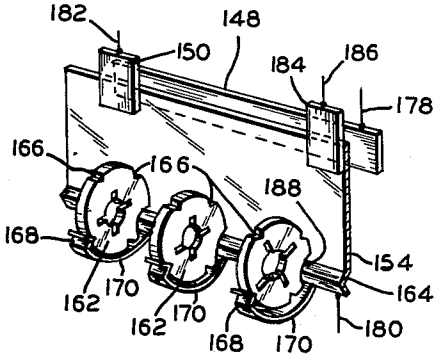
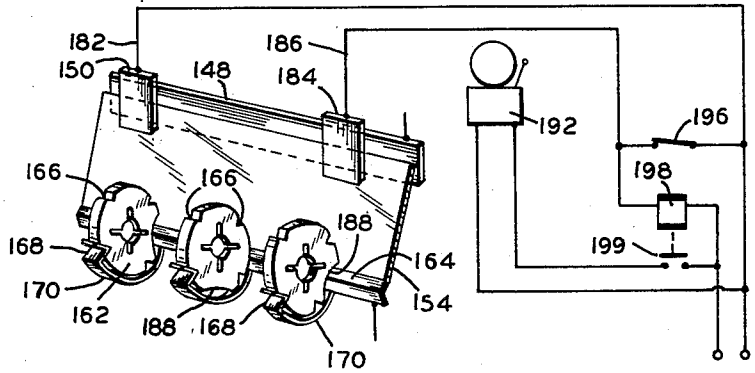


FIG. 28



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United States Patent Office 3,165,599 Patented Jan. 12, 1965

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KEY OPERATED COMBINATION SWITCH FOR ALARM SYSTEM

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Filed Nov. 2, 1959, Ser. No. 850,244
19 Claims. (Cl. 200—44)

This invention relates to alarm systems and relates more particularly to a reliable combination system which includes as an important component thereof a novel manually operated switch unit comprising a plurality of individual switch elements which are selectively moved to open or closed position by a key and wherein it is important to employ the same key for setting the alarm system and for releasing it when the premises are to be legally re-occupied.

Another object of the invention is to provide a combination alarm system employing the key-actuated switch just referred to and also a mechanical lock wherein the cooperation of the two components makes virtually impossible for an unauthorized person to gain admittance without setting off the alarm.

Yet another object of the invention is to provide a novel key-operated multiple switching unit for use in a combination alarm system wherein it is impossible to by-pass said switching unit and thus gain access to the interior of the premises.

A further object of the invention is to provide a novel key-actuated switch lock wherein any tampering with the switch lock, either by the use of a wrong key or any other tool or instrumentality, will actuate a circuit of either the normally open or normally closed type and set the alarm in action.

The "normally open circuit" system provides a control circuit which when set has no electrical current flowing therein, but the opening of the door or the use of an improper key or other tool will cause the circuit to be closed. In the "normally closed circuit" arrangement, the control system, when set, has electrical current continuously flowing therethrough and the consequent opening of the associated door or the use of an improper key will cause the circuit to be interrupted.

A further object of the invention is to provide a relatively flexible system of the character described wherein a main system and an auxiliary system may be provided wherein one may be a closed circuit system and the other open, or both may be open, or both may be the closed circuit variety.

One feature of the invention includes an electrical switch lock comprising several movable contacts electrically insulated from each other. These contacts are so arranged as to be individually capable of closing or opening an electrical circuit upon manipulation by a proper key or operating member.

An important feature of the invention is to provide a key-operated switch which may be operated from an initial control condition to a "set" condition by any one of a number of different keys, yet which thereafter can be restored to its original control condition by only that particular key which was used in the setting operation. The switch is identically the same regardless of which key is used, yet the switch when set is completely identified with the particular key used for "setting" it. In this way, a standardized switch can be operated by one key for a period of time in both setting and restoring operations and then, without any preparatory change in the switch, a different key can be substituted for subsequent setting and restoring operations.

In the drawings:

FIG. 1 is a side elevational view partly in section of a "normally open circuit" type of switch lock as used in conjunction with a door locking arrangement.

FIG. 2 is a plan view of the index means for limiting rotation of the key.

FIG. 3 is a broken section taken on line 3—3 of FIG. 1.

FIG. 4 is a plan view of an insulating disc.

FIG. 5 is a sectional view taken along line 5—5 of FIG. 1.

FIG. 6 is a sectional view taken along line 6—6 of FIG. 1.

FIG. 7 is a view similar to FIG. 6 except that the contact member has been turned in the opposite direction.

FIG. 8 is an end view of the switch lock showing the slot for inserting the key.

FIG. 9 is a view of the slotted plate with a cooperating detent 51.

FIG. 10 is a front elevation of a key restraining disc.

FIG. 11 is a plan view of a spacer.

FIG. 12 is an exploded view of the switch lock.

FIG. 13 is a plan view of a key to operate the lock.

FIG. 14 is a schematic of a "normally open circuit" system.

FIG. 15 is a side elevational view, partially broken away, showing the components of a "normally closed circuit" switch lock.

FIG. 16 is a sectional view taken along line 16—16 of FIG. 15.

FIG. 17 is a sectional view taken along line 17—17 of FIG. 15.

FIG. 18 is a perspective view of a conductor shown in FIGS. 16, 17, and 15.

FIG. 19 is a view similar to FIG. 17 except that the contact member has been turned to the opposite position.

FIG. 20 is a schematic of a "normally closed circuit" system.

FIG. 21 is a side elevational view, partially broken away, to show components of a combination "open-closed circuit" cam operated switch lock.

FIG. 22 is a sectional view taken along line 22—22 of FIG. 21.

FIG. 23 is a sectional view taken along line 23—23 of FIG. 21.

FIG. 24 is a schematic of a cam operated switch in a "normally open circuit" system, with one of the cams turned from "normal" position.

FIG. 25 is the schematic of a cam operated switch showing all cams in open position.

FIG. 26 is a plan view of an insulating partition.

FIG. 27 is a view similar to FIG. 23 but with the cam turned in the opposite direction.

FIG. 28 is a schematic of the same cam operated switch as in FIG. 24, in a "normally closed circuit" system, with one of the cams turned from "normal" position.

Referring to FIGS. 1 through 14, which illustrate the essential features of a normally open circuit alarm system, a circular end plate 10 is secured to a tubular housing 12 which receives an inner cylindrical housing member 14 therein. Two diametrically opposed slots 16 in the housing 12 receive mating ears 18 formed in the inner member 14 thereby securing it against rotation relative to the housing 12. Cylindrical housing member 14 is constructed from electrical insulating material suitable for proper functioning of the switch. There are two conductors 20 and 22 made from electrical conducting material which substantially line the inner wall of the cylindrical housing 14. These conductors are cemented in place and secured against rotation by longitudinal ribs 24 formed in the conductors 20 and 22 which are received in keyways 26 formed in the wall of cylindrical housing 14. The ribs 24 which project outwardly from the conductors 20 and 22 are cemented in place as shown but can be attached

in any convenient manner, such as moulding the housing 14 with inserts of conductive material. The conductors are furthermore spaced apart, as at 28, so that they will be electrically insulated from each other. A circular contact support 30 is constructed of electrical insulating material, the circumference being of proper dimension to be rotatably received within the lining conductors 20 and 22. A substantially circular channel section 31 is formed within the contact support 30. At one point the channel section takes an abrupt reverse curve 32, and the other side wall of the channel section has been removed at two other points 33 and 34 for reasons described hereafter. The central portion of the contact support 30 contains a hole 36 with radially projecting slots 37 to form a cross. A rotary contact assembly 39 comprises a contact support 30 and a contact 40 of electrical conducting material formed in a substantially U-shape, with a reverse curve 41 at the bottom portion of the U, as best shown by FIG. 12. The two top sides of the U are bent inwardly at right angles to form contact points 42.

Disc 43 is located between discs 44 45. Disc 43 has two notches 46 which receive inwardly extending radial projections 47 of outer housing 12. Disc 45 also has two notches 45' for the same purpose. This arrangement restrains rotation of disc 43. The cruciform slots 48 will prevent removal of the key until it has been turned a full 90° to open or closed position. Spring 49 presses against index plate 50 which in turn is pressed into V-shaped notches 51 in plate 44. This is to restrain rotation of disc 44 without use of the proper key.

It will now be observed that curved contact 40 can be assembled together with contact support 30 by inserting the contact within channel 31 in such manner that reverse curve 41 coincides circumferentially with reverse curve 32 of support 30 to hold the contact securely in position and to prevent relative rotational movement between the contact 40 and the support 30. The upper ends 42 protrude through openings 33 and 34 of the support 30. There are ten of these contact assemblies 39, as shown in FIG. 1, although in the exploded view of FIG. 12 only two are shown. It will be understood, however, that although the present illustration shows ten assemblies, the invention is not limited to that number but may have more or fewer of them, depending upon specific requirements. The rotary contact assemblies 39 are stacked within the lining conductors 20 and 22 and are separated by spacers 53 made from electrical insulating material. These spacers are provided with ears 55 for the purpose of mating with detents 24 to prevent rotation of the spacers. These spacers avoid frictional contact between supports 30, to avoid unintentional rotation of one support 30 when the next adjoining support 30 is being rotated. The inner cylindrical housing 14 at one end has a section 52 of reduced diameter (FIG. 1) to receive a driver drum 54 secured to first rotary contact assembly 1. An axial slot 56, which has a contour which is rectangular in cross section, is formed in the central portion of drum 54 to receive the end of a generally flat bar 58 which has a cross section shaped similar to slot 56. A disc 60 has a central elongated slot through which the bar 58 passes, the bar being staked to the disc at this point.

After assembling the rotary contact assemblies 39, spacers 53 and driver drum 54 within the inner cylindrical housing 14 in proper sequence, as shown in FIG. 1, this complete assembly is moved into outer cylindrical housing 12. The disc 60 with bar 58 attached is then inserted in place. A cylindrical filler plug 62 with a central opening large enough for free rotation of bar 58 is next placed over the bar to retain disc 60. A threaded cap 64 is screwed upon mating threads 66 of the tubular container 12 to clamp the assembly in place.

This compact cylindrical assembly generally indicated at 80, is installed in a door frame (not shown) by inserting it into a suitable hole from the outside in a manner well known and giving a resulting appearance from the outside of an ordinary lock, as shown by FIG. 8. The switch lock is arranged to cooperate with a conventional door latching mechanism, generally indicated 68, FIG. 1, by virtue of the cooperation of the free end of flat bar 58 within a slot 70 in a shaft 72 which carries a knob 74. A conventional door switch 76 is mounted in the door frame. Bracket 78 on the door is provided to press switch button 77 to hold the switch 76 in open position. While the assembly 80 has been described as being installed in the door frame, that assembly could also be arranged to be installed in the door. It will be noted from FIG. 1 that the conductors 20 and 22 do not run the full length of the tube but terminate at a point 81 leaving the balance of the distance occupied by conductors 82 and 83 which are constructed the same as conductors 20 and 22. There are lead wires 84 and 86 which form an electrical connection to conducturs 20 and 22 at points 88 and 90 respectively. These lead wires 84 and 86 extend to include the other components of the locking circuit such as an alarm bell 92, the door switch 76 and the extreme terminals 84*a* and 86*a* are connected to a suitable power supply (not shown). The circuit is best visualized by reference to the schematic FIG. 14.

It will immediately become apparent that when the contact assemblies 39 are assembled within the lining conductors 20 and 22 the protruding ends 42 of the contacts 40 cooperate in detents 24 of the conductors 20 and 22 to retain the assemblies 39 in position. The contacts 40 are formed from a spring type electrical conducting material such as Phosphor bronze so that as the assemblies 39 are rotated the ends 42 will drop into the detents 24 due to the inherent spring in the contacts 40.

To operate the switch lock system as represented by FIG. 14, it is necessary to use a key 96, such as shown by FIG. 13. The key is essentially a piece of flat strip stock having an arrangement of projections or teeth 98 and undercuts 99. The key 96 is inserted within the opening 100 in plate 44 adjacent the end plate 10 in the conventional manner, and turned in a rotating manner through a distance substantially 90° in the direction of the arrow, FIG. 5. It will be readily understood that the projections 98 cooperate in the slots 37 to rotate the assemblies 39, each projection operating its respective assembly. In order to relate the rotary assemblies 39 with the respective key projections 98, said key projections of FIG. 13 have been numbered 1 through 10, as have the assemblies shown in FIG. 1, and also indicated in the schematic FIG. 14. FIG. 5 represents the contact assemblies 39 in open circuit position. Inasmuch as the electrical current must pass from conductor 22 to conductor 20 to complete the circuit, as will become apparent with reference to the schematic FIG. 14, and since the contact points 42 are connected from detent 24 of the conductor 22 to a second detent 24 of conductor 22, the circuit is of course open. When all the assemblies 39 in the switch lock assume the position described by FIG. 5, the lock is in normally open position. Upon insertion of the key 96, as stated above, the projections 98 will rotate assemblies 39 at locations 1, 3, 4, 6 and 7 into closed circuit position, as best shown by FIG. 6, where one contact point 42 of the contact 40 is lodged within a detent 24 of the conductor 22, thus completing the circuit through the contact 40 to the other point 42 lodged in a detent 24 of the conductor 20. It is now obvious that there are five completed or closed circuits between the conductors 20 and 22. It is further apparent that one circuit is all that is necessary to operate the alarm 92. However, the several circuits are used in order to provide the burglar-proof feature of the invention. This is accomplished by the fact that it is not possible to ascertain either visibly or by the sense of touch which of the several circuits are closed and which are open. Consequently, anyone attempting to open the lock with anything other than the original key 96, or an exact duplicate, would be doomed to failure inasmuch as he would be required to guess which ones were closed. Furthermore,

in the process of attempting to open any of the closed circuits by rotating the assemblies 39 from closed position, shown by FIG. 6, back to open position, FIG. 5, the possibility exists that he may rotate some of them from open position of FIG. 5 to closed position of FIG. 7. Because ribs 24 are engaged by contact points 42 and give the same "feel" both in the open circuit condition and in the closed circuit condition, there will be no way of telling whether any single assembly 39 is in either condition. This makes tampering almost impossible. After the five circuits are closed, as described above, the total circuit is still incomplete or open due to the door switch 76 which is held in open position due to the pressure of the ear 78 upon the switch button 77 when the door is in closed position. If entrance is gained by opening the door, however, the ear 78 will be moved away from button 77 thus allowing a spring within the switch 76 to close the switch and complete the total circuit and setting off the alarm bell 92.

The opening 100 may be of any convenient or desired shape, such as the inverted V shown, and the key 96 contains a matching section 97. Opposed slots 101 adjacent the handle of the key leave projections 102 and 103, and to the front of projection 103 are edges 104 which contact the outer face of plate 44 to limit inward movement of the key. Projections 102 pass through plates 44 and 43 and when these projections pass beyond plate 43 the key can be turned. Thus the width of slots 101 is about the same as the thickness of plate 43, so the key can be rotated without interference from slots 48. Projection 103 now engages slot 100 in plate 44 and rotates the same within the limit of detent 51. The plate 44 is provided with detents 51 to preclude operation of the switch beyond the 90° required.

The switch 80 contains, in addition to the circuitry components above described, a second auxiliary circuit arrangement of components. These components include two contact assemblies 39 at locations 9 and 10 which cooperate with the conductors 82 and 83 to control the auxiliary circuit having power supply terminals 119*a* and any desired control device 119.

When the door is opened, thus closing switch 77, the alarm 92 will operate if any one of the switch elements 40 completes the circuit. It would then be possible to interrupt this alarm except for the provision of relay 105. This relay has its coil connected in parallel with alarm 92, and the relay contacts bridge and contacts 40 and switch 76. Consequently, if alarm 92 and holding relay 105 are once momentarily energized, it will not be possible to interrupt the alarm by pressing switch 76. Relay 105 will, of course, be placed in an inaccessible location remote from the door.

Referring now to FIGS. 15 through 20 which illustrate the basic features of a normally closed circuit alarm system, it will be noted that many of the components are the same as those used in the open circuit illustrations, such as the end plate 10', tubular housing 12' and inner cylindrical housing 14'. Also, the driver drum 54' and flat bar 58' are used together with filler plug 62' and cap 64'. While the open circuit switch described above is essentially a bank of switches connected in parallel, the closed circuit switch now to be described is a bank of switches connected in series, as will be apparent by reference to schematic FIG. 20.

The rotary contact asemblies 39' are the same as described above, including a contact 40' which is received within the channel 31' of the support 30'. This assembly is rotatable in the manner previously described, so that contact ends 42' cooperate in detents 122 of conductor 124. Conductor 124, as best shown by FIG. 18, is of course, constructed from electrical conducting material and is generally circular in shape having a central opening 126 and also four tabs 128, two of which project longitudinally in one direction at right angles from the circular section of conductor 124. The remaining two tabs 130 project at right angles but in reverse direction. Detents 122 of the tabs 128 and 130 also serve to secure the conductor 124 against rotation within the inner cylindrical housing 14'. These conductors 124 are stacked alternately with rotary contact assemblies 39' and partitions 53' within the inner cylindrical housing 14', as best shown in FIG. 15. Partition 53' provides insulation between spring contact 40' and the next opposite stationary conductor 124. For mechanical symmetry and to give the same "feel" in the event of tampering, there are provided a dummy metal part 131 and another similar part at the opposite end of the stack. A terminal 131 similar to end 122 of conductor 124 has an electrical connection at 132 with a lead wire 134, and in a similar manner the conductor at the opposite end of the stack is electrically connected to a second lead wire 136. It will now become apparent that when all the rotary contact assemblies 39' are rotated into position, best shown by FIG. 16, a circuit is completed between conductors 124 adjacent the rotary contact assembly 39' by virtue of the ends 42' of contact 40' cooperating within ribs 122. Thus it will be seen that a circuit is completed thereby from lead wire 134 alternately through conductors 124 and contacts 40' to lead wire 136. This is the position of the parts when the switch lock is in its normal position.

When the switch lock is in this position, relay 141 is energized by current from power supply terminals 141*a*. This condition exists whether the door is open or closed. However, when the door is closed, current can also flow through relay 141 via door switch 140, this switch being closed as by a bracket 78 (FIG. 1) when the door is closed. Switch 140 is spring-biased open, so when the door is open, it is necessary for the switch lock in FIG. 20 to be in its normal closed-circuit condition in order that relay 141 may be energized. Relay contacts 142 are open so long as relay 141 is energized. In the event that the door is opened after the switch lock is out of its normal condition, relay 141 is de-energized and the alarm circuit 144 with its alarm 146 will operate. Relay 141 is located in an inaccessible location and is of a type that will remain closed after it once closes, and will require resetting. Therefore, it will not be possible to shut off the alarm by pressing the door switch 140.

Lead wires 137 and 139 (FIG. 15) are for connecting an auxiliary system by means of suitable contacts within the lock switch. These contacts can be similar to the main system shown in FIG. 20, or similar to switch 82–40–83 in FIGS. 1 and 14, or any other design to suit the circumstance. Although only one auxiliary system is indicated, it may nevertheless be desirable to provide two or more of such auxiliary systems.

In order to operate the switch lock to its "set" condition, the key is inserted and is turned 90° in a clockwise direction. The teeth on the key, which may be the same type of key as shown in FIG. 13, will engage the corresponding rotary contact assemblies 39'. As a result, the circuit will be interrupted at each contact assembly which has been rotated. The current will still flow through the door switch 140, as shown in FIG. 20, so long as the door is closed. If the door is now opened, switch 140 will open and the circuit is interrupted, immediately actuating the alarm system 144 through the closing of contacts 142.

The using of an improper key in an effort to restore the switch lock will result in the possible returning of only some of the rotary contact assemblies to normal position, leaving the circuit still interrupted. There is also a great probability that the improper key will break the circuit in more places by turning rotary contact assemblies that were not turned by the proper key in the original "setting" operation. This is shown in FIG. 19.

It will be readily understood that rotation of any of the rotary contact assemblies 39', by use of an improper key, would interrupt the circuit, thus setting off the alarm. This is due to the fact that contact points 42', as best shown in FIG. 17, have come to rest in detents 130 of

the same conductor, whereas, to complete the circuit, points 42' must rest in such manner that one will contact one of the tabs 128 of a conductor 124 at one side of the assembly, and the other point 42' of the contact should contact tab 130 of the conductor on the other side of the rotary contact assembly 39'.

Another modification of the switch lock is shown in FIGS. 21–28. This modification is characterized by the fact that it can be used for "normally open" or for "normally closed" circuits by wiring either to the normally open lead wires 178–180, or to the normally closed lead wires 182–186. This modification is further characterized by the fact that it is a cam operated arrangement. The cams may be of proper electrical insulating material or of a combination of metal and insulation material. This modification is positioned within a similar tubular housing 12", having the same end piece 10" and end cap 64". It also includes a front plate like plate 44 (FIG. 8) and discs 43 and 45 as described earlier.

An inner cylindrical housing 183 is received in housing 12". A conductor 148 is secured to the inner cylindrical housing 183 and radially separated from this is another conductor 150. Between conductors 148 and 150 there is a space in which is received terminal points 156 of a spring type contact 154. The contact 154 is secured between the inner cylindrical member 183 and a tubular insulating member 158 by the arrangement of a reverse curve 160, in the manner described above. Any one of a number of rotatable cams 162, supported within member 158, serves to actuate contact 154 by virtue of a V-shaped section 164 formed in the contact member 154, as described below. Each cam 162 is formed with four detents 166 which cooperate with the V-shaped free end 168 of a spring part 170 to prevent the cam from rotating freely. The spring parts 170 are integral extensions of the contact 154 and are created by virtue of slots so that each spring part may cooperate individually with its corresponding cam 162. Several cams 162 are assembled within the switch in a manner similar to that described above with alternate spacers 172 placed therebetween which are secured against rotation with the cam by virtue of ears 174 cooperating within longitudinal groove 176. The conductor 148 is electrically connected to a lead wire 178 and contact 154 is connected to lead wire 180. Lead wires 178 and 180 encompass the normally open circuit section of the switch which includes conductor 148 and contact 154. The normally closed circuit section of the switch includes a lead wire 182 secured to conductor 150 at one end and including contact 154 and conductor 184 terminating with lead wire 186. It will now be understood that cams 162 are normally in the position shown in FIG. 22. In this position detent 188 in the cam allows projection 164 of the contact 154 to drop therein causing point 156 to rest upon conductor 150 at one end of contact 154, and contact point 156*a* to rest on conductor 184 at the opposite end of same contact 154, as best shown by FIG. 21. This is a normal operating position for both the "normally open" and the "normally closed" circuit section of the switch. The normally open circuit section of the switch is closed by rotating cam 162 clockwise with the key to position shown in FIG. 23 wherein contact 154 had been raised and contact points 156 complete a circuit between the conductor 148 and the contact 154.

It will be further understood that by rotating a cam to the position shown in FIG. 23 the "normally closed" section of the switch is open, the contact is raised, consequently contact points 156 and 156*a* are separated from conductors 150 and 184. Any one or more cams will do this.

The operation of the cam operated switch will more readily be understood by reference to schematic representation of FIGS. 24, 25 and 28. The schematic showing of FIG. 25 is comparable to the section shown in FIG. 22 in that it presents schematically the normal position of both the "normally open" and the "normally closed" sections of the switch lock.

The schematic showing of FIG. 24 is comparable to the section shown in FIG. 23 in that it presents a schematic with one of the cams rotated from its normal position with the result that the "normally open" section of the switch lock has been closed and the "normally closed" section of the switch lock has been opened.

It will be seen that the rotated cam holds the contact 154 against the conductor 148 to close the normally open section of the switch lock between the lead wires 178 and 180. There is furthermore included in the circuit a door switch 190, like switch 76, alarm 192 and relay 194, like relay 105. When the door is opened the switch 190 is closed, the circuit is completed and the alarm is set. The relay 194 will continue the alarm even after the door has been closed and the door switch "opened."

The normally closed section of the switch lock includes contact 154, conductors 150 and 184 and lead wires 182 and 186. Rotation of any cam 162 (FIG. 23) breaks this circuit, whose operation is to be described.

The lead wires 182 and 186 in the system of FIG. 28 are connected to the door switch 196 (like switch 140). When the door is closed the door switch 196 is held in closed position furnishing current to relay 198, thereby holding the switch 199 in open position in the alarm circuit. Assuming one or more cams 162 is out of normal position, switch 196 opens when the door is opened, breaking the circuit through relay 198, allowing switch 199 to close, due to the urging of a spring contained therein, thereby operating the alarm. The switch 199 will be located in distant premises. It will be of a type which will stay closed even after the door has been closed, and will require resetting in order to open it again.

As generally indicated by lead wires 185 and 187, the cam operated switch lock may have arrangement for more than one circuit "normally open" or "normally closed," or any combination of both.

It should be noted that the cam switch may have any number of cams and the chances of returning all of the rotated discs back to their normal position by using an improper key are very small. There are also great probabilities that the improper key will rotate other cams from their normal position to the position shown in FIG. 27 and reduce any chances to disengage the alarm system to practically zero.

It has been mentioned above that the door latch is operated by an inserted key both for latching and releasing the door, at the same time either "setting" the switch members or returning the switch members to their "normal" position, however, in another operation the door latch can be manipulated by engaging the knob 74 from inside the door in latching or releasing the door. When this is done the innermost switch member 39, which is mechanically united to the latch actuator, is necessarily operated to its "set" position or to its "normal" position. In this way an occupant can protect himself when within the premises guarded by the alarm system.

While there have been described herein what are at present considered preferred embodiments of the invention, it will be obvious to those skilled in the art that many modifications and changes may be made therein without departing from the essence of the invention. It is therefore to be understood that the exemplary embodiments are illustrative and not restrictive of the invention, the scope of which is defined in the appended claims, and that all modifications that come within the meaning and range of equivalency of the claims are intended to be included therein.

What I claim is:

1. A combination switch for operation by a key having coded teeth along an edge thereof, comprising a pair of electrical terminals, switch means including contacts operable to complete or break a circuit between said terminals, a plurality of axially aligned control elements

mounted for independent selective rotation, said control elements and said switch means being coupled to establish a normal circuit condition between said terminals only in a particular unique relationship of all said control elements, said control elements having formations cooperable with and selected by corresponding teeth, if present, on an insertable key, said formations providing axially aligned spaces for admitting a key into its fully inserted position and allowing withdrawal thereof at both ends of an arcuate operating stroke of the key, irrespective of which control elements may be selectively rotated during such toothed-key operation, and said combination switch having guide means axially aligned with said control elements and formed to provide an opening for admission and withdrawal of such key in said two arcuately spaced positions, said guide means being formed to restrict said key against removal in positions between said arcuately spaced positions.

2. An electrical switch comprising a housing and a plurality of rotary switch elements mounted therein for independent relative rotation as selected by a key passing therethrough and provided with a tooth for each element rotated and which are arranged to be connected in series so that when all the switch elements are in closed position a closed circuit through the switch will be formed, each rotary switch element comprising a circular contact support and a contact carried thereby, and a conductor interposed between each pair of switch elements and formed with oppositely extending axial tabs to be contacted by a contact from an element on each side of the conductor.

3. A key-controlled switch having a front portion providing for admission and removal of a key in either of two fixed key-receiving positions that are spaced apart by a certain angle, a plurality of switching members each having a control element, said switch having circuit means placed in a normal condition by and only when the control elements of said switching members are all in predetermined relative positions, means supporting said switching members behind said front portion for rotation individually, each of said switching members having plural key-receiving slots spaced apart by said angle and there being one of said slots in each of said switching members aligned with one of said fixed positions when another of the slots in each said switching member is aligned with the other of said key-receiving positions in plural rotation positions of each said switching member.

4. In combination, a key-controlled switch and an elongated key having relatively raised and recessed portions, said key also having a manual portion and a relieved portion between said manual portion and said raised and recessed portions, said key-controlled switch having a front portion providing two fixed key-receiving passages spaced apart by a certain angle, said relieved portion of said key providing clearance allowing rotation of a key from alignment with one of said passages to alignment with the other of said passages, said key-controlled switch including a series of switching members at successive locations behind said front portion, said switching members having respective control elements collectively effective to establish a normal switch condition only when in predetermined relative angular positions and any one of said elements being effective when shifted out of said relationship to change the switch to a "set" condition, each of said switching members having plural slots respectively aligned with both said passages in plural rotational positions of such switching member, whereby said key may be inserted in one of said passages when said switching members are in said normal predetermined relative positions and said key may be rotated and then removed from the other of said passages so that those raised portions of said key which are received in the respective slots of certain of said switching members are effective to "set" said certain switching members, and whereby said switch may be readily restored to said normal condition only by restoring operation of said key or a duplicate thereof.

5. A key-controlled switch having a front portion defining a key-receiving opening for admission and removal of a key in each of two discretely spaced-apart key-receiving positions, a plurality of switching members disposed at successive locations behind said front portion, means supporting said switching members for rotation individually, individual circuit control means associated with each of said switching members, said individual circuit control means including serially arranged contacts effective to complete a circuit through the switch only when the switching members are in predetermined relative positions, each of said switching members having plural slots spaced apart by said certain angle and there being a slot in each switching member in alignment with each of said key-receiving positions in plural rotational positions of each such switching member.

6. A key-controlled switch having a front opening for a key, a plurality of switching members each having a control element, said switch having circuit means placed in a normal condition by and only when said elements are all in predetermined relative positions, means supporting said switching members for rotation of said members individually, each of said switching members having plural slots regularly spaced from each other by a certain angle and the slots of all said switching members being in alignment with each other behind said front opening for receiving a key both when said members are in said predetermined relative positions and when one or more of said members is displaced therefrom by said certain angle or an integral multiple thereof.

7. In a combination, a switch having a plurality of switching members and a key having a series of raised and recessed portions in code form, said switching members each having a circuit controlling element and said switch having circuit means placed in a normal condition by disposing said switching members and the circuit controlling elements thereof in predetermined relative positions, means supporting said switching members for rotation of said members individually, each of said switching members having plural slots regularly spaced from each other by a certain angle, the slots in all such switching members being aligned with each other both when said members are in said predetermined relative positions and when one or more members are displaced therefrom by said angle or an integral multiple thereof, the raised portions of said key being disposed to enter the slots of corresponding switching members and the recessed portions of said key being disposed to clear the other switching members, whereby said key may be inserted and rotated through said angle to "set" the switch to a configuration corresponding to said code and said key is uniquely adapted to restore said switch to its normal condition, said switch in its coded condition being in a configuration independent of special manufactured coded structure and independent of memorization of the setting code by the user of the switch.

8. A method of controlling an alarm system having a combination switch that includes several switching members having respective "normal" positions wherein said alarm system is passive, said method including the steps of "setting" only certain of said switching members away from their normal positions by inserting any key of a plurality of keys having respectively different code notches along an edge thereof and rotating the inserted code-notched key through a "setting" angle and thereby to "set" only selected ones of the switching members in dependence on the code notches of the inserted and rotated key, and removing the key without disturbing the switching members in their "set" and "normal" positions, respectively, then inserting a code-notched key and rotating the latter through a restoring angle, said passive condition of the alarm system being restored only if the latter

key had the same code notches as the key used in the setting operation.

9. In combination, a door latching mechanism having a rotatable actuator operable between two arcuately spaced positions for latching and releasing a door, a key controlled combination switch including plural switching members selectively operable by key rotation between a "normal" configuration and a "set" configuration, circuit-completing means forming part of said combination switch, and a control part on each of said switching elements cooperating with said circuit-completing means to establish a unique control condition only when all said switching members are in their normal configuration, said switching members and said rotatable actuator respectively having aligned key-receiving openings in said "set" configuration and being arranged in relation to each other for coordinate return of the switching members from their "set" configuration to their normal configuration and for operation of the latching mechanism from its latched to its released condition and said switching members and said rotatable actuator having aligned key-receiving openings in said normal configuration.

10. A combinational switch for operation by an elongated edge-coded key having relatively projecting and relieved code portions, said switch having a front part and an opening therein for insertion and removal of such key, a plurality of switching elements rotationally supported in successive positions behind said front part, said switching elements having key-receiving formations which, when aligned, define a key-receiving passage extending rearward from said opening across all said switching elements, said formations being aligned both when all of said switching elements are in their normal positions and when any one or more of said switching elements is rotationally displaced from said normal positions through a predetermined "setting" angle into "set" positions, the edges of said formations being disposed in the rotational path of any projecting code portions of an inserted key but being clear of relieved code portions so that only certain of said elements are "set" by rotation of an inserted key through a setting angle while the other switching elements remain in their normal positions and the switching elements thereupon providing a passage for key-removal, said switch having a pair of terminals, circuit-completing means connected thereto, and a control part of each of said switching elements cooperating with said circuit-completing means to establish a unique control condition when and only when all said switching elements are in their aforesaid normal positions, whereby insertion of a key with any given code and rotation thereof through a predetermined angle will "set" the switch, the key being thereupon removable, and restoration of the switch to said unique control condition may be effected by insertion and restoring rotation of a key having the same code, the same switch being operable in successive setting-and-restoring sequences by keys having different codes.

11. A key-operated switch in accordance with claim 10, wherein said circuit completing means includes a main pair of contacts, and wherein said control parts of said switching elements are cams, said switch also including cam-follower means cooperating with said cams and in control relation to said contacts for establishing said unique circuit condition only when said elements are in their respective normal positions.

12. A combination switch operable by a key having coded control teeth and notches, including a series of rotatable control members having a common axis, means supporting said control members for rotation individually, each of said members having plural regularly angularly spaced formations engageable by a tooth of an axially inserted key upon rotation thereof, means providing a key-receiving opening formed for preventing insertion and removal of the key in any position other than those particular angularly related key positions wherein said key is aligned with one of the formations of each of said control members, each of said control members having a respective circuit control element, and means cooperable with said circuit control elements only when said members are all in their normal positions for establishing a normal circuit condition through the switch, whereby said key may be inserted in one position when said control members are in their normal positions and the key may then be rotated through an angle to advance one or more key-selected control members into "set" position and the key then withdrawn, and the same or a similar key may be inserted and operated through a restoring angle and withdrawn, said normal circuit condition being thereupon restored if and only if the latter key and the first-mentioned key have the same coded control teeth and notches.

13. In combination, a key having a coded combination of formations, including one or more teeth, and a combination switch operable thereby in an initial setting operation and in a subsequent restoring operation, said switch embodying passage-defining means for admitting said key and allowing removal thereof in at least two discrete mutually spaced positions and said passage-defining means constraining said key against removal at intermediate positions, a plurality of key-operable switching elements supported for individually independent movement relative to each other and each of said elements having plural formations cooperable individually with a tooth of a key when inserted into the combination switch in any of said discrete positions, and each of said elements being operable by movement of the key from one of said positions to another, said elements each having a control portion, and circuit control means cooperable with the control portions of all said switching elements collectively and effective to establish a normal switching condition through the switch only when said control portions are in a particular relationship and to establish a different switching condition when said elements are in any different relationship, whereby said key may be inserted in one position and moved to another position and then withdrawn, one or more teeth of the key thus being effective to engage one or more of said elements as selected by corresponding teeth of the coded key and to move said selected elements out of said particular relationship prevailing initially to a "set" relationship, and whereby said key may be subsequently inserted and operated to restore said elements to said particular relationship and said switch being free of obstruction against completion of a restoring stroke of operation of a key having a complement of teeth that is different from that of the aforementioned key used in the setting operation, whereby the user is unable to distinguish such different key during a restoring operation from a key used initially.

14. A switch comprising a housing and a plurality of coaxial rotary switch elements mounted therein for independent relative rotation by means of a key having teeth at fixed positions along an edge of the key, the key having coded teeth for selectively rotating corresponding switch elements, and fixed conductors in the housing adapted to connect one switch element with the next adjoining one only in certain selected rotary positions of said adjoining switch elements, whereby a series circuit will be established through said rotary switch elements and said fixed conductors only when all said switch elements are in said certain selected positions thereof, each switch element having plural slots extending generally radially to receive an endwise-inserted key, and the lateral edges of the slots cooperating with corresponding teeth that the key may have for rotary drive of the switch element by rotation of the key, the arcuate spacing between the slots of each said element being the same as that of the slots of the other switch elements so that the slots in any switch elements not rotated by the key due to lack of corresponding teeth will be aligned with slots provided in the switch elements rotated through said arcuate spacing, and thereby providing for subsequent insertion of a key

after the key has been first inserted, rotated and removed.

15. A key-controlled switch having a pair of terminals, a front portion providing at least one key-receiving opening formed to limit key insertion and removal to a plurality of discrete positions that are spaced apart, a plurality of switching members each having a control element and said switch having means cooperating with said switching members for providing a normal circuit condition between said terminals only when all said control elements are in predetermined relative positions, means supporting said switching members for movement into and out of such relative positions, each of said switching members having plural formations spaced apart in accordance with the spacing of said discrete positions, and said formations being disposed for cooperation with and being actuatable by a key when the latter is inserted in one of said discrete positions, there being a sufficient number of such plural formations for cooperation with a key when inserted in any of said discrete positions and whether or not the respective switching members are in said predetermined positions.

16. A key-controlled switch operable by a key having an arbitrary combination of teeth, said device switch having a pair of terminals, a plurality of control elements arranged to be operable selectively in dependence upon the tooth combination of an inserted key, means supporting said elements for independent rotation in relation to each other, each of said elements having a series of formations and the formations of each of said elements being regularly spaced arcuately from each other and the formations in each of said control elements being aligned with corresponding formations in the others of said control elements, whereby operation of one formation in one such element out of alignment with a first formation of a companion element and into alignment with a second formation of the companion element concurs with movement of another formation of the operated element into alignment with said first formation of said companion element, means defining a key-receiving opening for both admission and withdrawal of a key in each of two discretely spaced-apart positions of the key in which the key is effective to index selected ones of said elements from a "normal" condition of alignment of said formations to a "set" condition of alignment thereof and reversely, and said opening-defining means constraining an inserted key against removal after only partial operation of one or more of said control elements from one said condition to the other, each of said control elements having a control portion that has a particular unique relationship to the control portions of the other control elements in a "normal" condition of the switch, and output control means cooperable with the control portions of said control elements, said control means including means providing a normal circuit condition between said terminals when said control portions are in their unique relationship and providing a different circuit condition between said terminals in all other relationships of said control portions.

17. A method of controlling a combination switch having a series of switching members selectively operable individually between "normal" and "set" positions, wherein the switch provides a predetermined circuit condition only when said switching members are in their "normal" positions, including the steps of inserting any code-notched key of a plurality of keys having respectively different code notches into operative cooperation with said members when in their normal positions, operating said inserted key through a setting stroke to effect setting of only certain of said switching members out of their normal positions into "set" positions in dependence upon the code of the thus operated key, removing the key so as to leave the initially standardized series of switching members in a special configuration that is uniquely identified with the code of the key, then again inserting a code-notched key and operating the latter key through a restoring stroke, whereby said predetermined circuit condition of the switch is restored if the code notches used in both the setting and restoring operations correspond but is not restored upon completion of the restoring motion of the latter key in case of non-correspondence of the code notches of the keys used in said two strokes.

18. In combination, a key-controlled switch in accordance with claim 16 and a door-latching mechanism secured thereto, said mechanism including an alternately projectable and retractable latch and actuating means therefor, the latter including an operable element having a key-receiving formation aligned with a respective formation of each of said switching members for receiving an inserted key when said control elements are in said predetermined relative positions and said actuating means then disposing the latch in its retracted position, said operable element being moved by an inserted key to move the latch into its projected position when the inserted key is moved from its initially inserted position to another of said discrete positions for moving said control elements selectively out of their said predetermined relative positions.

19. A key-controlled switch in accordance with claim 16, wherein each said control element has a connector that individually completes a circuit from one of said pair of terminals to the other in all positions except when in its said predetermined position, the connectors of said control elements providing parallel circuits between the pair of terminals when displaced from their said predetermined positions but said terminals being disconnected from each other when each of said control elements is in its said predetermined position.

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