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MAGNETICALLY CONTROLLED CIRCUIT

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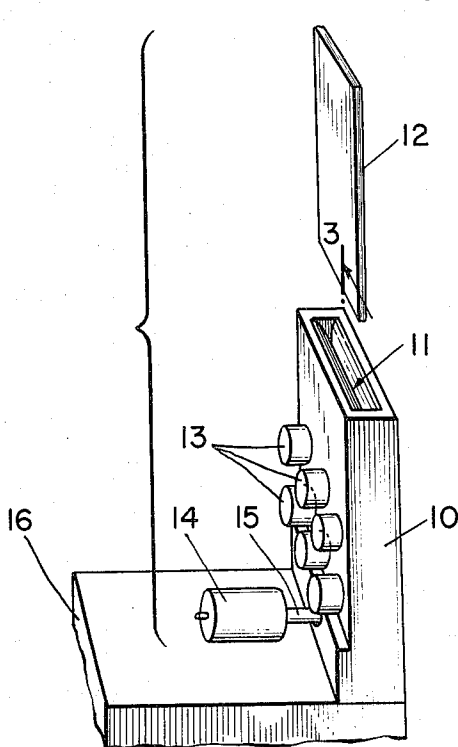


FIG. 1.

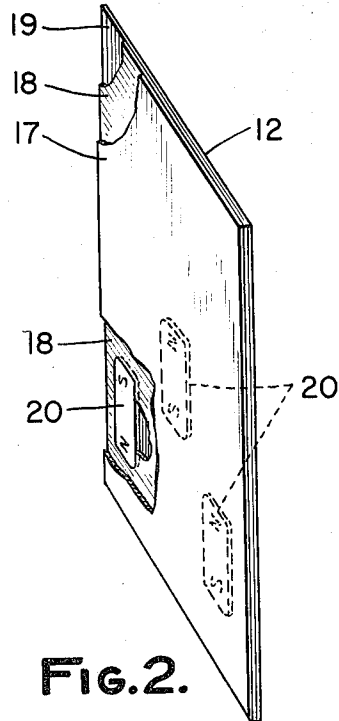


FIG. 2.

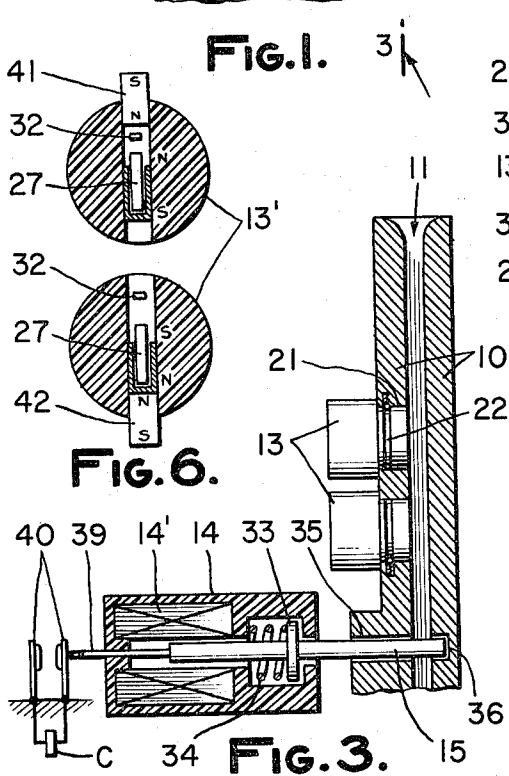


FIG. 3.

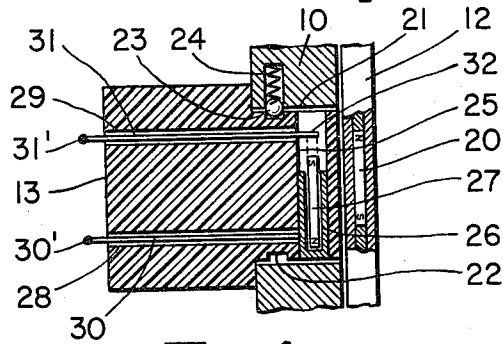


FIG. 4.

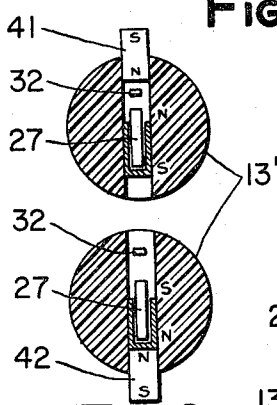


FIG. 6.

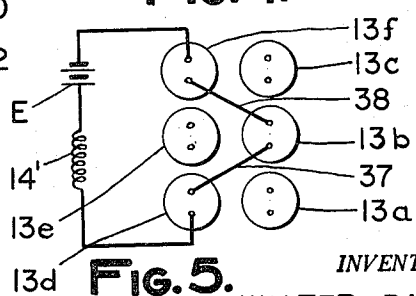


FIG. 5.

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3,215,903

MAGNETICALLY CONTROLLED CIRCUIT
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This invention relates to magnetically controlled circuits and more particularly to a locking and switching means for closing an electrical circuit that is operable by authorized keys in the form of cards having hidden or undiscernable operating means imbedded therein.

This application is a continuation in part of my co-pending application Ser. No. 438,587 filed June 22, 1954, now Patent No. 2,931,953, and entitled Magnetically Controlled Lock and Switch.

A primary object of this invention is to provide an improved magnetically controlled lock and circuit means in which many more combinations can be effected with a given number of components than has been possible in prior art devices.

More particularly, it is an object to provide a magnetically controlled lock and circuit in combination with a card key wherein various different combinations can be effected by both the positional location and polarity of certain magnetic members in both the lock and card.

Another object is to provide a magnetically controlled lock and circuit which will meet the various objects and perform most of the functions set forth in my above-mentioned patent application of which this is a continuation in part, with fewer components to the end that manufacturing expense is considerably decreased.

Various further objects and uses as well as advantages of magnetically controlled locks and circuits are fully set forth in the above mentioned co-pending application which application is incorporated herein by reference.

The particular objects of this continuation in part application are attained, briefly, by providing a housing structure having a key way therein for receiving a key means in the form of a card. The card contains concealed releasing magnets positioned in a given array in such a manner that when the card is received in the key way operation can only take place if corresponding responsive magnets within the housing structure are arranged in the same given array.

The housing itself includes a plurality of plugs preferably in the forms of cylinders received within suitable openings in one side of the housing for holding the responsive magnets. The ends of the plugs themselves terminate in substantially co-planar relationship with one wall of the key way. Each of the individual cylindrical plugs includes a transverse bore running parallel to the direction of the key way and incorporating a responsive magnetic bar which is moveable between first and second positions within the bore. Each of the plugs also includes terminal leads passing downwardly through the plugs into the transverse bore and arranged to be bridged by the corresponding magnetic bar when the same is actuated from a first position to a second position.

When the card is inserted in the key way, those magnetic bars in those particular plug members which correspond to the pattern of the releasing magnets in the card will be actuated, the rest of the movable bars in the remaining plugs remaining unactuated. By providing electrical conductors for connecting the various plugs in series into a circuit, the circuit can be closed only by that particular card having its releasing magnets arranged in the proper pattern.

The closing of the circuit in response to movement of the movable members or magnetic bars can be employed to operate a variety of different machines. As one example, the closing of the circuit could be arranged to re-

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move a pin extending transversely across the key way and blocking movement of the card beyond a given point. Moving of the pin in response to closing the circuit from the key way would then permit the card to drop entirely through the key way into a closed housing so that the card could not be reused once it was inserted. The same circuit operating the pin could also be employed to turn on another device such as a television set.

By the use of inter-changeable plugs in a plurality of openings in the side of the housing, different plugs having reversed polarity magnets could be substituted, thereby changing the combination of the device. Also, the terminal leads themselves extending from the plugs permits various different combinations to be set up by proper connections of the plugs from a remote location.

A better understanding of this invention as well as other features and advantages will be had by now referring to a preferred embodiment as illustrated in the accompanying drawings, in which:

FIGURE 1 is an exploded perspective view illustrating the basic components of the magnetically controlled lock and card key;

FIGURE 2 is an enlarged perspective view partly cut away of the card key illustrated in FIGURE 1;

FIGURE 3 is a cross-sectional view taken generally in the direction of the arrows 3-3 of FIGURE 1;

FIGURE 4 is an enlarged fragmentary cross section of one of the components illustrated in FIGURE 3;

FIGURE 5 is a schematic circuit diagram useful in explaining one example of operation of the system; and, FIGURE 6 is a cross section illustrating an optional feature of the invention.

Referring first to FIGURE 1, there is shown a housing structure 10 provided with a key way 11 for receiving a key means in the form of a card 12. Projecting into one side of the housing 10 are a plurality of plugs 13 preferably cylindrically shaped. Also shown is a portion of an electrical circuit including a relay housing 14 and movable member actuated by the relay 14 in the form of a pin 15 projecting normally into the side of the housing 10. Below the housing 10 under the exit portion of the key way 11 is an enlarged enclosure 16 for receiving cards passed by the key way 11.

Referring to FIGURE 2, the preferred form of card key 12 constitutes a substantially flat, flexible base member comprising non-magnetic fibrous layers 17, 18, and 19 of a substantial area. The central layer 18 includes cut-out portions for receiving a plurality of releasing magnets 20, three of which are shown in FIGURE 2.

The thickness of each releasing magnet corresponds to the thickness of the central layer 18 so that with the cover layer 17 and bottom layer 19 all in position, the magnets are not discernable either visually or tactually. In FIGURE 2, the magnets are arranged in a given pattern.

Referring now to FIGURES 3 and 4, it will be noted that the cylindrically shaped plug members 13 extend through suitable openings 21 having axes generally normal to the plane of the key way 11. With particular reference to FIGURE 4, each of the plug members 13 may include a temporary holding means in the form of an angular groove 22 cooperating with a detent ball 23 biased by a spring 24 into the groove 22. By this arrangement, the plugs may be manually removed and other plugs readily substituted therefor. Equivalent holding means such as a bayonet pin and slot could be used.

As shown in FIGURE 4, each of the plugs includes a transverse bore 25 lined at its lower end with a cup structure 26 silverplated to provide a high degree of conductivity. The cup 26 holds a movable means in the form of a magnetic bar 27. The bar 27 is movable along the axis of the bore as indicated by the dotted lines, into and partially out of the cup 26.

The plug 13 also includes longitudinal bores 28 and 29 for passing terminal leads 30 and 31 from the top thereof down to the opposite ends of the bore 25. As shown, the terminal lead 30 makes direct electrical connection with the cup 26 so that in effect, this terminal lead is electrically connected to the magnetic bar 27 through the medium of the cup. To provide good electrical conductivity, the magnetic bar 27 may be silver-plated.

The other terminal lead 31, in turn, terminates in an end 32 positioned to be engaged by the end of the magnetic bar 27 when the same is moved from the first solid line position shown to a second dotted line position. It will be evident accordingly that when the magnetic bar 27 moves upwardly from the cup to engage the end 32 of the terminal lead 31, the two terminal leads 30 and 31 will be electrically bridged. The magnetic bar will normally be held within the cup in its first position by gravity.

Also shown in FIGURE 4 is the card 12 with one of the embedded releasing magnets 20 positioned in the key way. As the card 12 is moved downwardly, the releasing magnet 20 will pass substantially parallel to the magnetic bar 27. With the north and south poles arranged as shown, and with the card held in the position shown in FIGURE 4 so that the releasing magnet 20 is offset from the magnetic bar 27, the magnetic bar 27 will be attracted upwardly to the dotted line position to effect bridging of the terminals 30 and 31.

Referring once again to FIGURE 3, it will be noted that the pin 15 constitutes part of a solenoid plunger and includes an angular flange 33 cooperating with a spring 34 to bias the pin to its farthest extended position. In this position, the pin extends all the way through a bore 35 in the housing 10, normally across the key way 11, and into a receiving cavity 36 in the opposite wall of the key way. In this position, the inward movement of the card 12 within the key way is limited to substantially the corresponding position of the card shown in FIGURE 4. In actual operation, as the card is slid into the key way 11, as soon as the magnet 20 is sufficiently close to the magnet 27 it will be moved prior to engagement with the pin 15.

The remaining portion of the relay housing 14 includes relay coils 14'. From the position shown, it will be evident that upon energization of the relay coils 14', the plunger portion of the pin 15 will be drawn to the left against the spring 24 to retract the pin 15 from across the key way.

Referring to the schematic drawing of FIGURE 5, various electrical connections for the terminal leads of the plugs 13, such as for the leads 30 and 31 of FIGURE 4, the relay coil 14', and any suitable electric circuit are shown connected together. Thus, in the particular example illustrated in the drawings, the total number of cylindrical plugs is six each being identified in FIGURE 5 by 13a, 13b, 13c, 13d, 13e, and 13f. These six plugs are arranged in a symmetrical pattern as shown. Referring again to FIGURE 2, it will be noted that the arrangement of the magnets 20 is such that when the card is inserted in the key way the movable magnetic bars, corresponding to the bar 27 in FIGURE 4, in only the plugs 13b, 13d, and 13f will be actuated. By connecting the end of the terminal leads such as the ends, 30' and 31' shown in FIGURE 4, in series as by leads 37 and 38 of these particular plugs and then connecting the series circuit into a given electrical circuit including a battery E and the relay coils 14', it will be evident that when the respective magnetic bars in the plugs 13b, 13d, and 13f are actuated, a closed circuit will result.

Upon energization of the relay coils 14' the resulting movement of the pin 16 will open the key way as described. In addition this movement can also be employed to close other switch means. For example, as shown in FIGURE 3, there may be provided a rear extension 39' of the pin 15 projecting from the rear of the housing 14 such that upon energization of the coils 14' to move the

pin 15 to the left, the extension 39 will close contacts 40 to close a circuit C.

In FIGURE 6, there is shown an added feature of this invention which may be employed when a large number of cylindrical plugs are used. In the interests of a compact structure, it is desirable to place the cylindrical plugs as close to each other as possible. However, to avoid any interference between the magnetic fields of the respective movable bars 27 in each of the plugs, neutralizing the magnets may be employed. Thus, as shown in FIGURE 6 for two plugs 13', there are provided neutralizing magnets 41 and 42 spaced on opposite sides of the two-plug array. These magnets may be imbedded in the plugs or in the housing adjacent the plug openings. The polarity of the neutralizing magnets 41 and 42 is such as to neutralize the fields developed by the movable bar magnets 27.

The operation of the magnetically controlled lock and switch will be evident from the foregoing description. A card key 12 is initially made up with magnets 20, as described, in a given pattern. In addition, various ones of the cylindrical plug members 13 are connected together to define a pattern of operable plugs corresponding to the pattern of the magnets 20 in the card 12.

When the card 12 is received within the key way 11, the respective magnets 20 will become juxtaposed to the magnetic bars 27 as described in connection with FIGURE 4 to move the bars 27 upwardly and thus bridge the terminal leads 30 and 31. This bridging of leads in turn will complete the series circuit between those plugs which correspond to the pattern in the card 12. Completion of the circuit as shown in FIGURE 5 will then energize the relay coil 14' from the voltage source E to retract the pin 15 shown in FIGURE 3 and permit the card to fall all the way through the key way 11 into the enclosure 16 where it is retained. Simultaneously, movement of the pin 15 to the left, as described, will close the contacts 40 which may operate the circuit C. The circuit C may be an automatic washing machine, television set, or other piece of equipment.

If it is desired to change the combination so that the circuit will no longer be closed when a card such as the card 12 is inserted, different ones of the plug members 13 may be connected to form a pattern different from that of the card. Insertion of the card will then not operate all of the plug members but only those corresponding to the original pattern so that at least one plug member and its associated magnetic bar therein will remain unoperated and thus the circuit will remain open. Further, the pin 15 will not be moved and thus the card will be prevented from passing entirely through the key way. Unauthorized cards will thus not operate in the device and by dimensioning the length of the key way from its opening to the pin 15 to be less than the overall length of the card, the user when employing an unauthorized card can simply remove it from the key way when it does not pass through.

In addition to the various combinations of connections of the plug members, the polarities of the specific magnetic bars may be changed. For example, if the plug 13 of FIGURE 4 is removed and another plug member inserted in its stead including a magnetic bar corresponding to the bar 27 with the poles reversed, then insertion of the card 12 will simply result in the magnet 20 repulsing the magnet 27 tending to urge it further into the cup 26. Thus the device will not operate because of the like polarities of the magnets. Accordingly, it will be evident that various different combinations can be effected by simply changing the polarity of the magnets in the plug members. In addition, however, this same variation and the various workable combinations can be effected by changing the polarity of the releasing magnets within the card 12. In actual practice, the polarity may be changed by the use of a strong electrical magnet so that the card itself need not be damaged nor need the magnetic material making up the magnets 20 actually be removed.

Another advantage in the use of various plug members having terminal leads extending therefrom resides in the fact that a change in the combination of the lock can be effected from a remote location. For example, all of the twin leads passing from the plugs could be bound in a single-sheathed cable extending to a remote location. The ends of the leads could then terminate on a patchboard and various different series or parallel connections of the plug members could be effected at the remote location. Thus it would be a simple matter to change the entire combination of the magnetically controlled lock without having to physically tamper with the structure itself.

Various other features and advantages will occur to those skilled in the art. Further, minor changes that fall within the scope and spirit of this invention will also occur to workers in this field. The magnetically controlled lock and switch is therefore not to be thought of as limited to the particular embodiment set forth merely for illustrative purposes.

What is claimed is:

1. A key for operating an electric switch comprising a substantially flat and flexible base member comprising non-magnetic fibrous layers of substantial area, and a discrete integral magnet of considerably smaller area than said base member concealed therein without being discernable visually or tactually, said magnet having north and south poles arranged in a characteristic pattern in said base member at a given location relative to the remaining area of said base member for cooperation with the north and south poles of a responsive magnet in the switch and adapted to move the same when it is placed adjacent thereto, and thereby permit operating the switch by said base member.

2. A magnetically controlled apparatus for closing an electrical circuit comprising, in combination: a housing having a key way therein; a key means receivable in said key way, said key means including a releasing magnet having north and south poles; and a movable magnet having north and south poles in said housing responsive to the position of said releasing magnet when said key means is received in said key way to move from a first position to a second position, said electrical circuit being normally open, movement of said movable magnet to said second position closing said electrical circuit, said housing including at least one opening intersecting said key way; a removable plug means extending into said opening and terminating at the adjacent wall of said key way, said plug having a bore, said movable magnet being disposed in said bore and constituting a magnetic bar, said electrical circuit including two terminal leads passing into said plug to intersect said bore adjacent its opposite ends, one of said terminal leads connecting to said bar and the other terminating in an end spaced from said bar when said bar is in said first position and in contact with said bar when said bar is in said second position so that said bar bridges said terminal leads to close said circuit when moved to said second position.

3. An apparatus according to claim 2, including additional openings in said housing provided respectively with additional plug means incorporating movable magnets at least some of which have north and south poles oriented in opposite directions, said additional plug means being constructed substantially identical to said first mentioned plug means; and electrical conductors connecting together various ones of the terminals of said plug means in such a manner that only movement of certain ones of said mov-

able magnets will effect closing of said electrical circuit.

4. An apparatus according to claim 3, in which said plug means are interchangeable in said openings, each opening and plug means including temporary holding means cooperating to hold said plugs when inserted in said openings.

5. An apparatus according to claim 4, in which said key means comprises a card in the form of a base member of a substantially flat non-magnetic material within which is imbedded said releasing magnet, said card including additional releasing magnets having north and south poles oriented and positioned to effect movement of said certain ones of said movable magnets.

6. An apparatus according to claim 3, including neutralizing magnets disposed on opposite sides and adjacent to said additional movable magnets to minimize magnetic field interference between adjacent ones of said movable magnets.

7. A magnetically controlled apparatus for closing a circuit comprising, in combination: a housing having a key way therein; a key means incorporating a plurality of releasing magnets having their north and south poles in a given pattern receivable in said key way; a plurality of plugs passing into a side of said housing to terminate in ends that are in substantially co-planar relationship with one wall of said key way, each of said plugs including a bore incorporating a magnet bar movable back and forth in said bore with its north and south poles in a given orientation for cooperation with said releasing magnets and electrical terminal leads positional to be bridged by said bar when moved from a first to a second position; and electrical conductors connecting the terminals of certain ones of said plugs in series into said circuit, said certain ones of said plugs being juxtaposed said releasing magnets when said key means is inserted in said key way, whereby only those movable bars associated with said certain ones of said plugs are activated to said second position to close said circuit.

8. A magnetically controlled apparatus for closing an electrical circuit comprising, in combination: a housing having a key way therein; a key means receivable in said key way, said key means including a releasing magnet having north and south poles; a movable magnet having north and south poles in said housing responsive to the position of said releasing magnet when said key means is received in said key way to move from a first position to a second position, said electrical circuit being normally open, movement of said movable magnet to said second position closing said electrical circuit; a pin passing through a portion of said housing across said key way in a position to block movement of said key means within said key way when said pin is in a first position and to unblock movement of said key means when said pin is in said second position; and means responsive to closing of said electrical circuit to move said pin to said second position.

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