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ELECTROMECHANICAL LOCK

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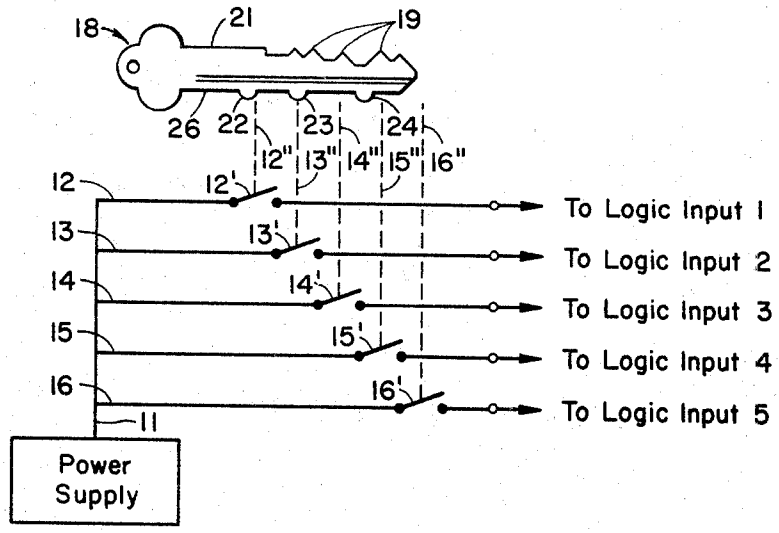

Fig. 1

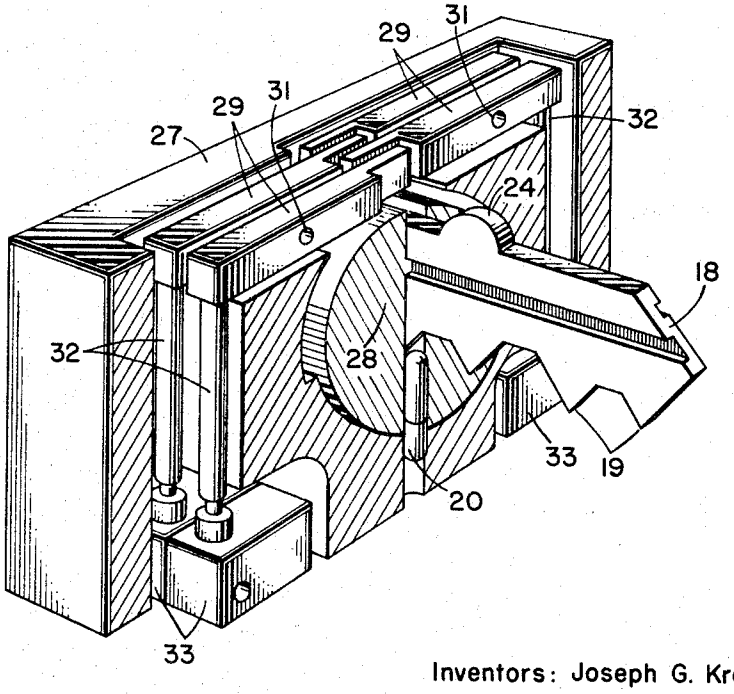

Fig. 2

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ELECTROMECHANICAL LOCK

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ABSTRACT OF THE DISCLOSURE

Electromechanical lock having security of mechanical lock and in which the key carries code means for operating selected switches of a plurality of switches.

This invention relates to locking devices and, in particular, to an electromechanical lock for providing authorized access to a secured area.

It is often necessary for a number of authorized persons to have access to a secured area. Such access may be provided by a simple lock and key. However, in many instances it is necessary not only to admit someone to a secured area, but to simultaneously activate accessory apparatus. For example, it may be required to keep a continuous record of the identity of persons entering an area, together with their times of entry and exit. In this case, the mechanism providing access to the area would also have to activate an identification device and a printing time clock. Another example is that of a tank truck driver requiring access to a central store of gasoliine. In this case, the device which unlocks the metering pump must also activate associated apparatus which records the identity of the driver and the number of gallons of gasoline he has withdrawn from the central store.

Most conventional access systems use a punched card reader as a source of coded signals to activate the associated recording apparatus. Each authorized person has a uniquely punched card which he presents to the card reader when he desires access to the secured area. The card reader provides a plurality of electrical currents corresponding to the presence or absence of holes on the card, and these currents are used to activate the associated recording apparatus in the system.

The chief disadvantage of the punched card access system is that it is relatively easy to fabricate a counterfeit punched card. For example, in the case of the tank truck driver mentioned above, a non-authorized driver could easily obtain several blank cards (these are standard commercial items) and randomly punch holes in them. Sooner or later he would hit upon a "winning combination" that would activate the metering pump. Not only would the non-authorized driver get free gasoline, but the system would charge the gasoline to the account of an unsuspecting authorized driver whose punched card happened to correspond to the hole pattern punched by the counterfeiter.

The present invention provides a novel electromechanical lock which combines the security of a mechanical lock with the coding flexibility of a punched card access system. Briefly, the invention comprises a plurality of electrical switches disposed in spaced relation to the cylinder of a pin tumbler lock. A special key is provided for operating the lock. One edge of the key (hereinafter referred to as the "tumbler edge") has conventional serrations for operating the pin tumbler portion of the lock. The other edge (hereinafter referred to as the "switch edge") has a plurality of lobes or notches formed into it which cooperate with a link mechanism that activates one or more of the electrical switches. The position and number of the notches on the "switch edge" of the key may be varied so as to activate any desired number of switches, and hence the lock and key combination operate as a coding device, i.e., the conducting or non-conducting state of each switch is determined by the presence or absence of a corresponding notch or lobe on the "switch edge" of the key.

The unique advantage of the present invention over conventional card reader access devices is that it greatly reduces the possibility of unauthorized persons gaining access to the secured area. Various lock companies, e.g., the Best Lock Co. of Indianapolis, Ind. will, upon request, register a particular lock so that duplicate keys to that lock will only be issued on the authorization of the registrant. The keys to such registered locks are of a special type. They are exceedingly difficult for an ordinary locksmith to duplicate. Thus, unlike conventional card readers, an access system equipped with the present electromechanical lock is virtually immune to tampering and counterfeit inputs.

The invention will be described with reference to the accompanying drawing, in which:

FIG. 1 is a diagram showing the elements of the invention in schematic form, and

FIG. 2 is a cut-away cross-sectional view of a practical embodiment of the invention.

Referring now to FIG. 1, there is shown a common electrical lead **11** which is connected to a source of electrical power, and which branches out into five switched leads **12**, **13**, **14**, **15**, and **16**. The electrical switches associated with leads **12**, **13**, **14**, **15**, and **16** are designated **12'**, **13'**, **14'**, **15'**, and **16'**, respectively. These switches are opened and closed by respective mechanical links **12''**, **13''**, **14''**, **15''**, and **16''**. A key **18**, having conventional tumbler-engaging serrations **19** on its "tumbler edge" **21**, is provided with a number of projections **22**, **23**, and **24** along its other or "switch edge" **26**. The key is inserted into the cylinder of a conventional tumbler lock (omitted for sake of clarity) so that serrations **19** engage and operate the lock tumblers.

In the operation of the apparatus shown in FIG. 1, rotation of key **18** causes projections **22**, **23**, and **24** to bear against and depress links **12''**, **13''**, and **16''**, respectively. Accordingly, switches **12'**, **13'**, and **15'** are closed, and current will flow through leads **12**, **13**, and **15** via the power supply and common lead **11**. The various lead currents are connected into subsequent logic circuitry as indicated in the drawing. Such circuitry may comprise an AND gate having a number of inputs corresponding to the number of leads coming from the lock (five inputs in FIG. 1). The design of such logic circuit elements is well known in the computer art. It is to be understood that the three projections **22**, **23**, and **24** in the drawing are shown only for purposes of illustration, and the actual number of projections may range from one to five in the case of a five switch system as shown. Further, the switches shown in FIG. 1 are of the type which require a positive pressure to place them in their conducting state. The use of such switches dictates the use of projecting lobes on key **18**. However, the switches

may alternatively be the type which require the release of a pressure to place them in their conducting state. In such case, key **18** would be provided with a plurality of indented notches rather than projecting lobes.

The total number of combinations of open and closed switches may be determined by the relation:

$$C=\frac{N(N-1)(N-2)\ldots(N-P+1)}{P!}$$

where:

C=total number of switch combinations
N=total number of switches
P=number of lobes (or notches) on key

For example, five switches and three lobes (as shown in FIG. 1) gives a total number of switch combinations equal to ten

$$\left(\frac{5\times4\times3}{3\times2\times1}=10\right)$$

Thus, ten authorized persons could each have a unique key to the lock. If there were ten switches and four lobes, the total number of key combinations would be 210. It is therefore apparent that the number of switches, as well as the number of lobes or notches on the key, can be changed to accommodate the number of persons requiring access to the secured area.

FIG. 2 is a cut-away, cross-sectional view of a practical embodiment of the invention. Referring to FIG. 2, there is shown a housing **27** within which a lock cylinder **28** is rotatably mounted. A plurality of laterally opposed pivot members **29** are disposed within the housing and are pivotally mounted about pivot pins **31**. A plurality of laterally opposed push rods **32** are disposed within the housing so as to bear at one of their ends against pivot members **29**, and at their opposite ends against a plurality of laterally opposed electrical switches **33**.

When key **18** is inserted into lock cylinder **28**, serrations **19** engage the lock tumblers **20**, thereby allowing cylinder **28** to rotate within housing **27**. Rotation of the key causes projections **22**, **23**, and **24** to bear against respective pivot members **29**, causing them to pivot about pins **31**. The pivotal motion of pivot members **29** is transmitted to push rods **32**, thereby causing the push rods to activate switches **33**. As mentioned previously in connection with FIG. 1, the depiction of projections or lobes on key **18** is merely for convenience in illustration. The apparatus can just as easily be constructed using indented notches on the key rather than projections. If notches were used, switches **33** would have to be selected such that a pressure release would activate the switch.

The basic concept of the invention is the combination of a mechanical locking device and corresponding key together with a plurality of electrical switches which are activated in a coded sequence in response to information coded on the key. It will be appreciated that there are many ways to embody this basic concept. For example, although the invention has been described and shown with particular reference to a mechanical lock of the pin tumbler type, there are types of mechanical lock that are suitable for use with the invention, and it is not intended to limit the invention to pin tumbler locks. In another modification, instead of activating the electrical switches simultaneously (as shown in FIGS. 1 and 2), the notches on the key could be staggered rather than aligned so that as the key was turned the switches would be activated at different times. The result would be an electrical output coded in time, and such an output might be more suitable for certain applications. A further embodiment providing such a sequential coded output would be to provide the key in the form of a cylinder having contact studs at spaced intervals on its surface. The mechanical unlocking function of the key in this case could be embodied as a projection on the

cylindrical surface that would displace (and hence unlock) a corresponding projection in the body of the lock. Yet a further modification applying to the embodiment of FIGS. 1 and 2 would be to substitute plural contact switches for the single throw switches shown in the drawing. Thus, as push rods **32** were activated, they would cause to close (or open) a predetermined number of contacts in each switch. The number of contacts to be closed could easily be preset by limiting the linear travel of the push rods, and this, in turn, would be set by the depth of the key notch or the height of the key projection.

It will be apparent that there are various ways to embody the basic concept the invention, and it is intended to limit the scope of the invention solely by the scope of the following claims.

We claim:

1. An electromechanical lock, comprising in combination,

(a) lock means capable of existing in locked and unlocked mechanical states,

(b) key means having serrations along one edge and cooperating with said lock means to transfer said lock means between its locked and unlocked states, said key means including coded means carried by the key means, said coded means comprising a plurality of notches and lands disposed on an edge of said key which is opposite to said first named edge, and

(c) a plurality of electrical switches operated by the coded means of said key means when said lock means is in its unlocked state and adapted to provide a plurality of electrical signals.

2. An electromechanical lock, comprising in combination,

(a) a housing,

(b) a pin tumbler lock cylinder rotatably mounted within said housing,

(c) a key having on one of its edges serrations which engage the pin tumblers of said lock, and having on its opposite edge a coded sequence of notches and lands,

(d) a plurality of electrical switches disposed within said housing, and

(e) a plurality of link members adapted to be operated by said key as said cylinder is rotated, and means connecting said link members to said switches so that the switches are actuated in accordance with the code of the notches and lands (as to convert the coded sequence of notches and lands into corresponding activation of said switches).

3. In an electromechanical lock, a body, a barrel rotatably mounted in the body for movement between locked and unlocked positions, a plurality of tumblers slidably mounted in said barrel and said body for movement radially of the barrel, said barrel having a keyway extending axially of the keyway, a key adapted to be inserted into the keyway and having a plurality of serrations for engaging the tumblers to correctly position the tumblers so that the barrel can be rotated in the body from the locked to the unlocked positions when the key is disposed in the keyway, a plurality of switches mounted on the body, coded means carried by the key and lever means pivotally mounted on the body for each of the switches and adapted to be engaged by the coded means carried by the key whereby selected switch or switches of said plurality of switches are operated upon rotation of the barrel from the locked position.

4. An electromechanical lock as in claim **3** wherein each of said switches is a self-contained switch having an operating member yieldably urged in one direction, and wherein said lever means includes an operating rod engaging the operating member of the associated switch.

5. An electromechanical lock as in claim **4** wherein said barrel is provided with a slot in alignment with

said keyway and wherein said coded means carried by the key is disposed on the side of said key opposite the side on which the serrations are provided and is accessible through the slot provided in the barrel and wherein each of said lever means includes means for engaging the coded means carried by the key.

6. An electromechanical lock as in claim 3 wherein said switches are disposed on opposite sides of said body.

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