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Hinman et al.

[11] **3,860,911**

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[54] **ELECTRONIC COMBINATION LOCK AND LOCK SYSTEM**

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[52] **U.S. Cl.** ..... **340/149 R**, 340/147 MD

[51] **Int. Cl.** **G06k 7/06**, H04q 9/00

[58] **Field of Search** ..... 340/147 MD, 149 A, 149 R

[56] **References Cited**

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Primary Examiner— Yusko

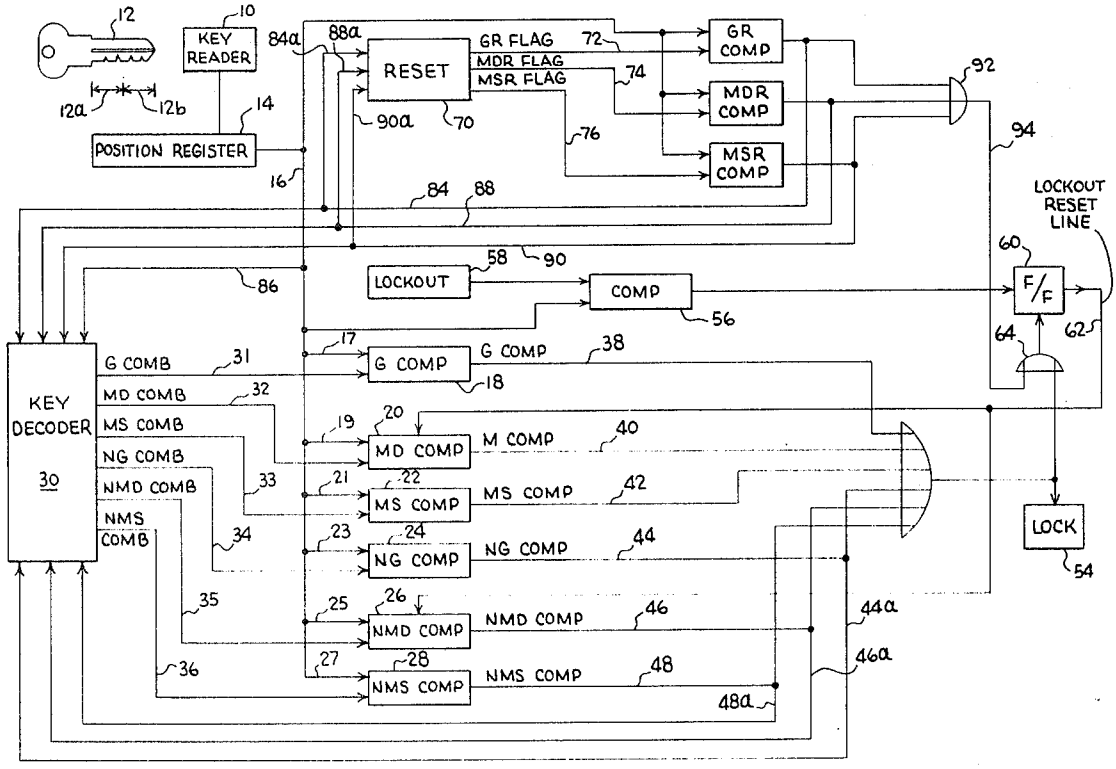
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[57] **ABSTRACT**

An electronic lock system utilizes a plurality of remote locking units, each lock unit including a key decoder with a functionally assigned pair of registers containing prestored code combinations. The first register of a pair is designed to store the current combination code. The other register of the pair stores the next or change combination code. When a key coded with said current and change combinations is inserted, the current combination carried by the key is compared with the data stored in each register. If a comparison is made with the first register or the second register, an appropriate access enable signal is provided. In addition, if a comparison is made with the second register, logic circuitry responds to provide a control sequence resulting in a transfer of the change combination code in the second register to the first register, thus becoming therein the current combination code. The key codes can be placed in set positions for current and next codes, or can be separately identified by means of tag codes or the like.

The control sequence further causes a new combination code, derived from the multi-coded key, to be placed in the second register as the new change combination code. Thus, the system provides for the use of a multi-coded key for establishing both unlocking and data source functions. A central station utilizes a code generator to appropriately encode the various keys which constitute the sole communication link between the central station and plural access points.

20 Claims, 4 Drawing Figures



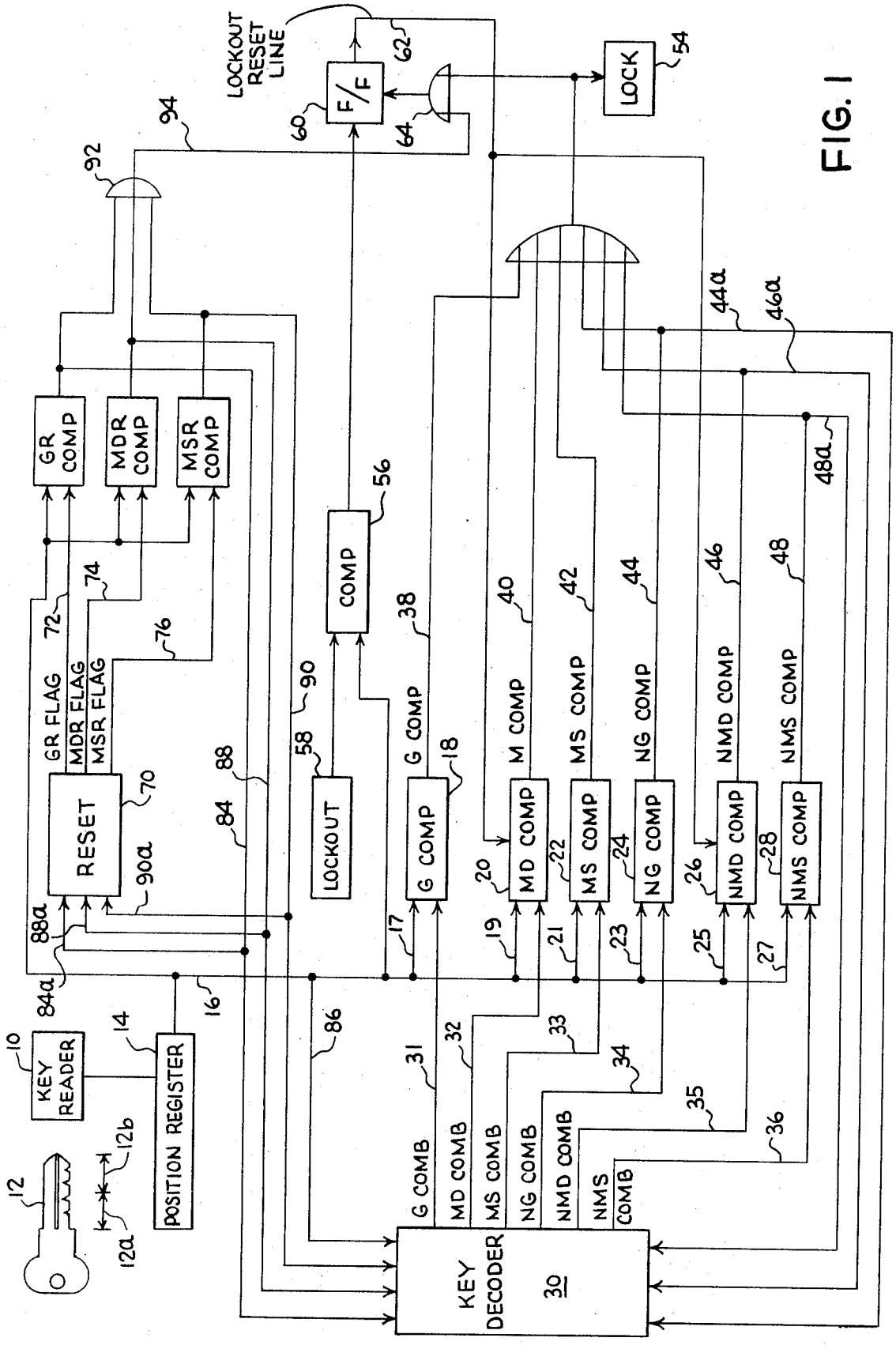

LOCKOUT RESET LINE
F/F
LOCK
GR COMP
MDR COMP
MSR COMP
COMP
GR FLAG
MDR FLAG
MSR FLAG
RESET
LOCKOUT
G COMP
M COMP
MS COMP
NG COMP
NMD COMP
NMS COMP
MD COMP
KEY READER
POSITION REGISTER
G COMB
MD COMB
MS COMB
NG COMB
NMD COMB
NMS COMB
KEY DECODER
30

FIG. 1

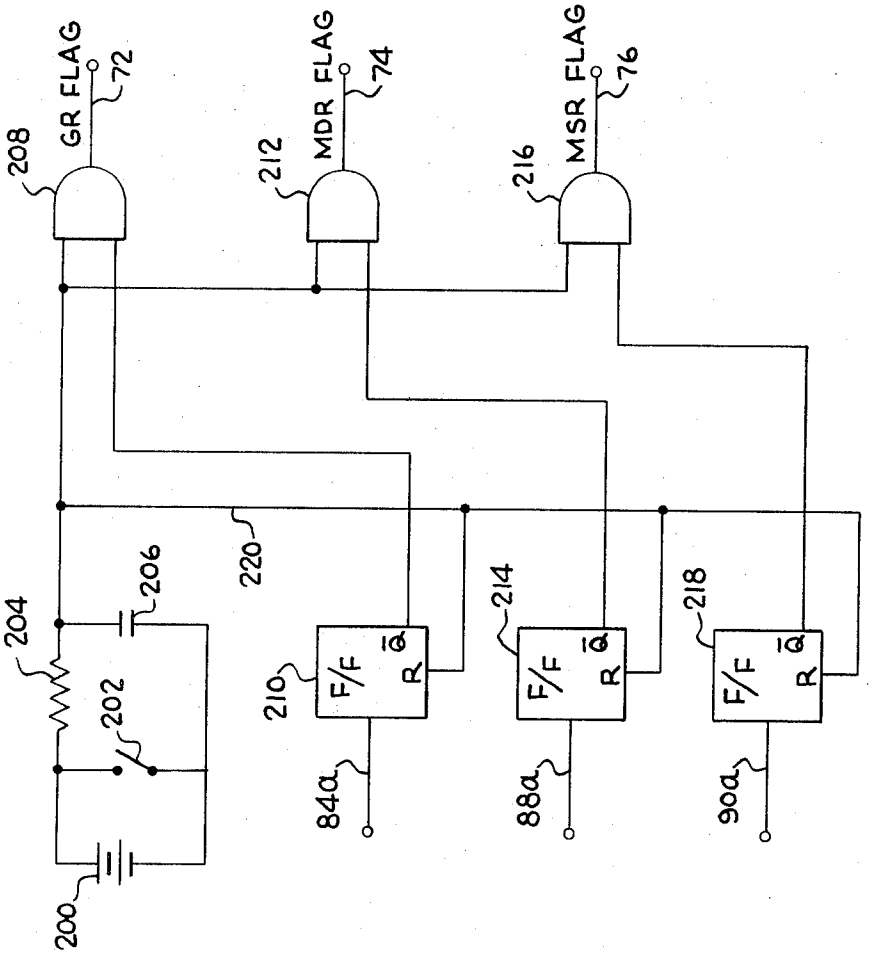

GR FLAG
72
MDR FLAG
74
MSR FLAG
76
208
212
216
220
204
206
202
200
210
214
218
F/F
R
Q
84a
88a
90a

FIG. 4

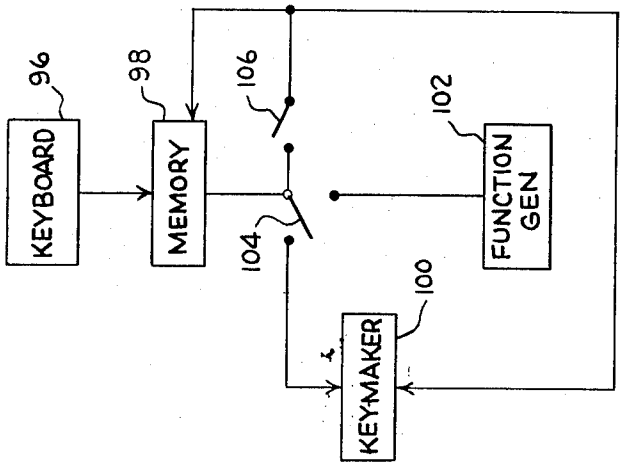

KEYBOARD
96
MEMORY
98
106
102
FUNCTION GEN
104
KEYMAKER
100

FIG. 2

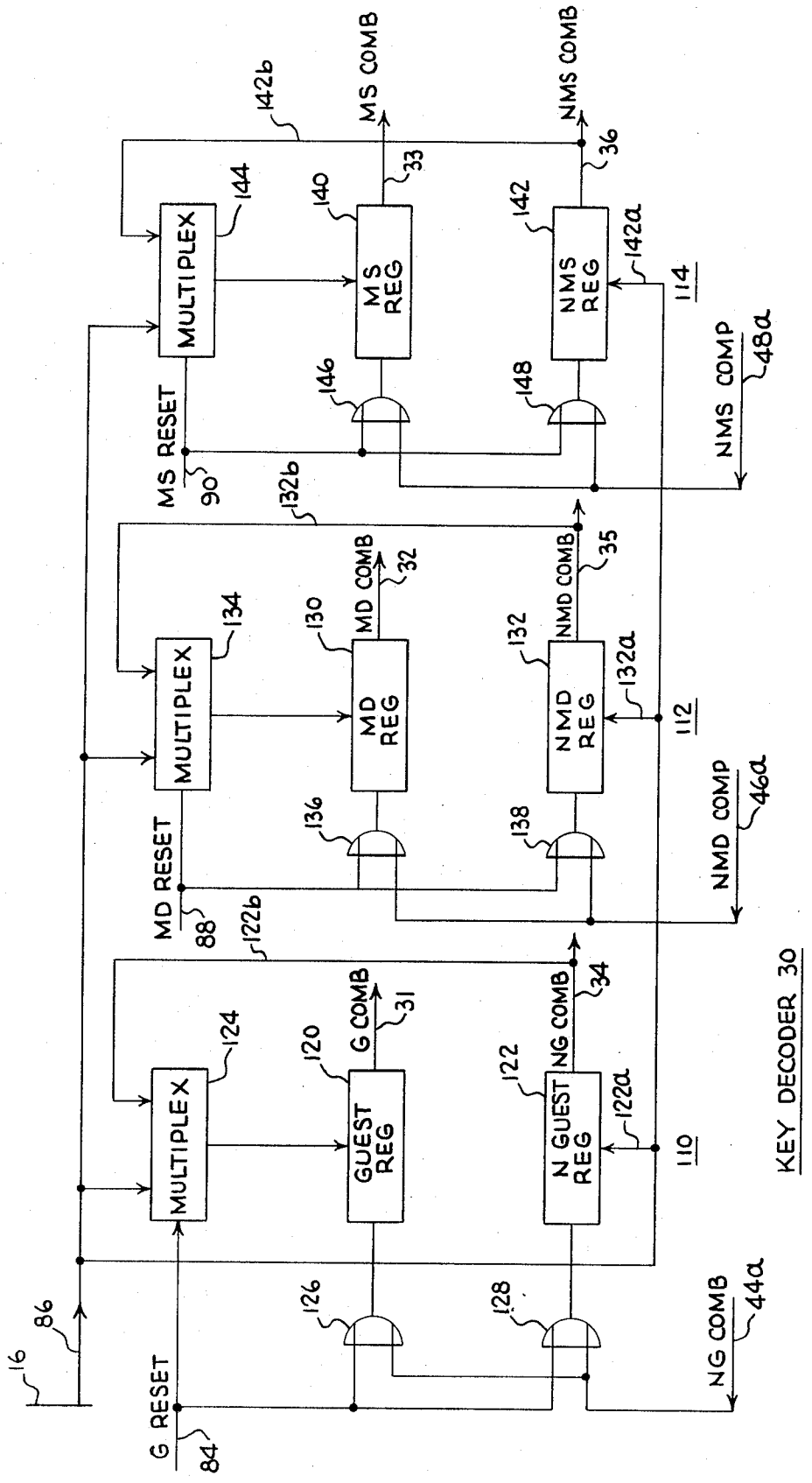

16
86
G RESET
84
MULTIPLEX
124
GUEST REG
120
G COMB
31
N GUEST REG
122
NG COMB
34
122a
110
KEY DECODER 30
122b
MD RESET
88
MULTIPLEX
134
MD REG
130
MD COMB
32
NMD REG
132
NMD COMB
35
132a
112
132b
MS RESET
90
MULTIPLEX
144
MS REG
140
MS COMB
33
NMS REG
142
NMS COMB
36
142a
114
142b
126
128
136
138
146
148
NG COMB
44a
NMD COMP
46a
NMS COMP
48a

FIG. 3

ELECTRONIC COMBINATION LOCK AND LOCK SYSTEM

Prior art electronic lock systems of the type contemplated herein, as exemplified by U.S. Pat. Nos. 3,694,810, 3,673,569, 3,662,342, 3,622,991 and 3,599,454, require special wiring to link a central station to each of the various access points in the system. This has the distinct disadvantage of rendering installation very expensive. On the other hand stand-alone electronic locks, such as exemplified in U.S. Pat. Nos. 3,700,859, 3,688,269, 3,587,051 and others, are not conducive to convenient changing of the access enabling code, since to do this requires adjustment of each lock at the various access points.

One proposed solution to this problem is discussed in copending application Ser. No. 323,098, filed Jan. 19, 1973 and assigned to the assignee of the present invention. As disclosed, in its application in a hotel or motel lock system, such a system is equally applicable to a wide variety of security systems where controlled access at a plurality of remote locations is desired. Thus, a standalone electric combination lock is provided at each controlled access point. A function generator included in each combination lock generates a "current" digitally encoded access enabling code or combination in conjunction with a digitally encoded access enabling "change" code or combination. Electronic logic, upon detection of a match between either one of the internally generated combinations and a combination entered by a person seeking access, generates an access enabling signal to, for example, release a lock mechanism. However, when the "change" combination is matched, the logic additionally triggers the function generator to generate a "new" combination in lieu of the previous "current" combination and further provides that the previous "change" combination becomes the "current" combination, while the "new" combination becomes the "change" combination. Thus, a person equipped with the previous "current" combination is denied access, while persons having the now "current" combination and/or the now "change" combination are afforded access.

The successions of different combination pairs generated by the function generators in the various combination locks follow a predetermined pseudo-random number sequence which is capable of duplication by a corresponding function generator located at a central station. A memory at the central station separately stores one or both of the combinations then prevailing at each access point. When the appropriate occasion arises, the change combination for the combination lock at a selected access point is retrieved from the memory or the change combination is derived by the function generator based on the current combination for the combination lock at the selected access point as retrieved from the memory and is given to the person or persons authorized for access.

In the illustrated embodiment of the aforementioned copending application, the change combination or, in some instances, the current combination is digitally encoded on a record element, which takes the form of a key, by an encoding mechanism, such as a keymaker. The key is then taken by the authorized person to the access point where the combination is entered into the combination lock by a key reader or the like. It is understood in the aforesaid copending application as well as in the present invention that the key may take a variety of physical forms and be fashioned from numerous materials. Also, the encoding thereof may utilize a variety of well known techniques. It will also be appreciated that the access enabling combination could be communicated to the authorized person in a readily intelligible form, such as orally or imprinted in numeric form, and the authorized person may then enter the combination via a keyboard or the like to gain access.

In the operation of the device of the aforementioned copending application, a current combination is given to each guest, thereby giving access to the room for which he is registered. When this guest checks out, the next guest to occupy that room is given the change combination applicable thereto. The first time the next guest uses his change combination to access his room, the electronic combination lock automatically, in effect, cancels the previous current combination to deny room access to the previous guest. The combination possessed by this next guest becomes the current combination, while the internally generated new combination becomes the change combination preparatory for the arrival of the next subsequent guest.

As an additional feature, the various combination lock function generators each generate current and change combination codes for hotel personnel for use as maid or master keys. The electronic combination lock and central station of the invention utilize the supplemental access combinations to afford room access in the same manner as in the case of the guest combination. The electronic combination lock logic is further equipped to respond to special and individually unique lock out codes given to the guest and which is effective to temporarily inhibit room access to the maid. In addition, the logic is equipped to respond to reset codes applicable to either guest or maid combinations to permit the entry of a predetermined access enabling combination to in effect reset the lock to a known point in a pseudo-random number generation sequence. This reset function is necessary in the event the function generator in a particular electronic combination lock unit loses synchronism with the central station or becomes inoperative due to improved matching of codes.

The requirement of synchronization with a central station is necessary in the description of the aforementioned copending application since each remote lock generates internally its own successive combination codes. While local internal code generation has been found effective to eliminate the difficulties in controlling remote lock units by a central station, nevertheless it remains desirable to reduce the synchronization problem and simplify the remote units. The provision of function generators within each lock combination unit also presents computational difficulties inasmuch as it is necessary to accurately reproduce a computational feature of a local function generator in order to provide proper central generation and encoding for each successively generated key.

It is accordingly the principle object of the present invention to provide an electronic access system which efficiently overcomes the drawbacks of the prior art in accordance with the system described in the aforementioned copending application.

A more specific object of the invention is to provide a system of the above character wherein each access point or location is non-dependent and functions in stand-alone fashion, without special wiring linking it to a central station.

Still another more specific object of the invention is to provide a non-dependent system of the above character wherein the access enabling code or lock combination is automatically changed in random, pseudo-random or any other fashion from a central location on appropriate, preselected occasions so as to provide a virtually secure system.

In accordance with the foregoing objects, it has been discovered that the use of a multiple-code key can provide not only the means for enabling access at a remote location, but also the source of combination code change control without the necessity of a local function generator.

Accordingly, the present invention provides for a multi-code key containing at least a current and next combination code to generate a pair of digitally encoded lock combinations. A local access unit is provided with a key decoder containing storage of current and next code combinations for one or more functions. In the embodiment disclosed in accordance with the present invention, a random function generator is not required at each remote access location. Instead, the multi-coded key provides the control sequences for enabling the remote access unit logic to effect its transfer of data from a current to a next combination code for response to the appropriate keyed input.

More specifically, each lock unit includes a key decoder with a functionally assigned pair of registers containing prestored code combinations. The first register of a pair is designed to store the current combination code. The other register of the pair stores the next or change combination code. When a key coded with said current and change combinations is inserted, the current combination carried by the key is compared with the data stored in each register. If a comparison is made with the first register, or the second register, an appropriate access enable signal is provided. In addition, if a comparison is made with the second register, logic circuitry responds to provide a control sequence resulting in a transfer of the change combination code in the second register to the first register, thus becoming therein the current combination code. The key codes can be placed in set positions for current and next codes, or can be separately identified by means of tag codes or the like.

The control sequence further causes a new combination code, derived from the multi-coded key, to be placed in the second register as the new change combination code. Thus, the system provides for the use of a multi-coded key for establishing both unlocking and data source functions.

The foregoing objects and brief description of the present invention will become more apparent from the following more detailed description and appended drawings wherein:

FIG. 1 is a logic block diagram of an electronic combination lock constructed in accordance with the invention for specific application in a hotel lock system;

FIG. 2 is a functional block diagram of the construction of a central station adapted for system operation with a plurality of the electronic combination locks exemplified in FIG. 1;

FIG. 3 is a logic block diagram of one form of a key decoder utilized in each electronic combination lock of FIG. 1; and

FIG. 4 is a detail of the reset function circuit.

The electronic combination lock, shown in FIG. 1 in a form applicable to a hotel lock system application, includes a key reader **10** for reading the digitally encoded access enabling combinations recorded on a key **12** inserted therein. The key will contain two codes, one a current code, the other a change code. The current code is in a first position, the change code in a second position. The particular recording and encoding techniques employed are not material to the present invention, but, by way of example, the access enabling combination may be recorded in the shank of key **12** in the form of digitally encoded perforations or holes, such as disclosed in U.S. Pat. No. 3,688,269. The position of the codes can be distinguished conveniently, either by virtue of location on the key shank, or by tag bits, or by any other distinguishing technique, and the codes temporarily stored in a position register **14.** For illustration, the key **12** is shown as including two code positions, **12***a* and **12***b* from which it is put out on a data bus **16.** The first position **12***a* code combination in register **14** is thus supplied over connection **17** to a guest comparator **18,** over connection **19** to a maid comparator **20,** over connection **21** to a master comparator **22,** over connection **23** to a next guest comparator **24,** over connection **25** to a next maid comparator **26** and over connection **27** to a next master comparator **28.** A key decoder **30,** included in each remote electronic combination lock of the invention, responds to data signals corresponding to the key codes derived from the register **14** along the data bus **16** for retaining therein the appropriate code designations. The key decoder **30** is also designed to respond to code changes on the multiple-coded key for altering the retained code designations as will be set forth in greater detail below.

The internal structure of the key decoder **30** includes storage to provide a current guest combination G COMB in digitally encoded signal form for application over connection **31** to the guest comparator **18,** a current maid combination MD COMB in digitally encoded signal form for application over connection **32** to maid comparator **20,** a current master combination MS COMB for application over connection **33** to next maid comparator **22,** a change or next guest combination NG COMB for application over connection **34** to next guest comparator **24,** a change or next maid combination NMD COMB over connection **35** to next maid comparator **26,** and a change or next master combination NMS COMB for application over connection **36** to next master comparator **28.** If the combination stored in register **14** and impressed on data bus **16** compares with any one of the six combinations stored in the key decoder **30,** one of the six comparators **18, 20, 22, 24, 26** or **28** will generate a true output, either G COMP on output lead **38** from guest comparator **18,** MD COMP on output lead **40** from maid comparator **20,** MS COMP on output lead **42** from master comparator **22,** NG COMP on output lead **44** from next guest comparator **24,** NMD COMP on output lead **46** from next maid comparator **26,** or NMS COMP on output lead **48** from next master comparator **28.** A true output from any one of these comparators is gated through an OR gate **50** as an access enabling signal on output lead **52** to a lock mechanism **54.** This access enabling signal may serve to initiate actuation of a solenoid, or the like, releasing the lock mechanism to thereby afford room access to the possessor of key **12.**

As long as the access enabling combination entered into register **14** is either a current guest combination G COMB, a current maid combination MD COMB, or a current master combination MS COMB, the resulting comparator output, either G COMP, MD COMP or MS COMP is gated through OR gate **50** as an access enabling signal to the lock mechanism. If the person seeking room access possesses a change combination, i.e., either the next master combination NMS COMB, next maid combination NMD COMB or the next guest combination NG COMB provided by the key decoder **30,** the resulting comparator output, either NMS COMP, NMD COMP or NG COMP, in addition to releasing lock mechanism **54,** is fed back over leads **44***a*, **46***a*, **48***a* to the key decoder **30.** As will be seen more clearly from FIG. **3,** the key decoder **30** operates in response to the receipt of any of these signals to store a new current combination and a new change combination for either the master, guest or the maid, as the case may be. In practice, the logic of the key decoder **30** is designed such that the change combination, NMS COMB, NMD COMB or NG COMB, becomes the current combination, MS COMB, G COMB or MD COMB, and the key decoder is, in effect, reset so as to store a new, next or change combination. The new change combination is the second combination derived from register **14** and is the second position code from the dually encoded key position **12***b*. The logic of the key decoder thus, in effect, adopts this new combination as the appropriate next or change combination in response to sensing of the original change combination from the key **12.**

It is thus seen that the possessor of the key bearing the change combination is afforded room access while at the same time, triggering the electronic combination lock of the invention to change the internally stored access enabling combinations which must be matched to be afforded subsequent room access. However, since the change combination, which precipitated the changing of the lock combination, now becomes the current combination, the possessor of this key is assured subsequent room access since the combination encoded therein is thereafter treated as a current combination and not as a changed combination. It will be appreciated that possessors of the keys bearing the previous current combination are denied room access.

In the application of the electronic combination lock of FIG. **1** in a hotel lock system, a registered guest is provided with a key having the guest combination encoded therein for the electronic combination lock to the room for which he is assigned. Using this key this guest is afforded continuing room access. When this guest checks out and a next guest is assigned the same room, a new key encoded with the next guest combination (changed combination) is issued. The first time this new key is used in the electronic combination lock, which has stored therein the same change combination, the access enabling signal is generated to the lock mechanism, the next or change combination becomes the current combination, and the new combination contained on the key is now stored as the next or change combination. Maid keys encoded with the maid combination and the next maid combination are used in the same manner as the combination encoded guest keys to control room access. Typically, in the case of the maids, a plurality of electronic combination locks of the invention, e.g., those on the same floor, will contain the same maid combination and next maid combination.

Master keys encoded with the master combination and the next master combination are used in the same manner as the combinations encoded on guest keys and maid keys to control room access. Typically, in the case of master keys, a plurality of electronic combination locks of the invention, e.g., those for the complete hotel or very large sections of the hotel, contain the same master combinations and next master combinations.

Still referring to FIG. **1,** guests may be provided with a key having a special lockout combination encoded therein. This lockout combination imposed on data bus **16** is compared in a comparator **56** with a lockout combination held in a register **58** unique to each electronic combination lock. When the lockout combinations match, the output of comparator **56** sets a flip-flop **60,** causing its reset output on lead **62** to go false. This false reset output is supplied as an inhibiting input to the maid comparator **20** and the next maid comparator **26,** with the result that the comparator outputs MD COMP and NMD COMP otherwise issuing upon the entry into the electronic lock of the maid and next maid combinations are suppressed. It is thus seen that the guests can effectively lock out the maid. To remove this lockout function, the guest enters the appropriate access enabling combination, either the guest combination G COMB or the next guest combination NG COMB. The resulting comparator output signal, either G COMP or NG COMP, is gated through OR gate **56** as the access enabling signal to lock mechanism **54.** This access enabling signal is also gated through an OR gate **64** to force flip-flop **60** to its reset condition, thereby imposing a true condition on its reset output and thereby removing the inhibiting input from the maid and next maid comparators **20** and **26.**

On occasion, it may become necessary to reset the key decoder **30** of a particular electronic combination lock to its initial position. As seen in FIG. **1,** a reset circuit **70** is provided for generating a guest reset flag digit GR FLAG which is imposed on output connection **72,** a maid reset flag digit MDR FLAG which is imposed on an output connection **74,** and a master reset flag digit MSR FLAG which is imposed on output connection **76.** The guest reset flag digit is supplied as one input to a comparator **78,** the maid reset flag digit is supplied as one input to a separate comparator **80** and the master reset flag digit is supplied as one input to a separate comparator **82.** The other input to each of these comparators is derived from data bus **16.** If a guest reset flag digit GR FLAG is generated, comparator **78** supplies an output GR COMP on lead **84** to the key decoder **30,** conditioning it to accept the guest reset combination also present on data bus **16** and supplied thereto over connection **86.** As will be seen from FIG. **3,** the key decoder **30** derives the next guest combination NG COMB from the multi-coded key, and thus to reset the key decoder **30,** it is only necessary to enter the key **12** into the key reader **10** for placing the new code on the data line **16** for entry into the decoder **30.**

If it is desired to reset the maid combination by using a key **12** encoded with the appropriate maid reset flag digit, the maid reset combination is inserted in key reader **10.** Recognition of the maid reset flag MDR FLAG on data bus **16** causes comparator **80** to generate a maid reset signal MDR COMP on output lead **88**

which is returned to the key decoder **30**, conditioning it to accept the maid reset combination appearing on data bus **16** and supplied over connection **86**. The decoder **30** supplies this maid reset combination as the maid combination M COMB on output connection **32** and the next maid combination NMD COMB which is imposed on output connection **34**.

If it is desired to reset the master combination by using a key **12** encoded with the appropriate master reset flag digit, the master reset combination is inserted in key reader **10**. Recognition of the master reset flag MSR FLAG on data bus **16** causes comparator **82** to generate a maid reset signal MSR COMP On output lead **90** which is returned to the key decoder **30**, conditioning it to accept the master reset combination appearing on data bus **16** and supplied over connection **86**. The decoder **30** supplies this master reset combination as the master combination MS COMB on output connection **33** and the next master combination NMS COMB which is imposed on output connection **36**. The comparator output GR COMP, MDR COMP and MSR COMP are gated together in an OR gate **92** and supplied over lead **94** to OR gate **64**, thereby insuring that flip-flop **60** is reset to remove any pre-existing lockout function. Since the present system is designed to be reset only upon power activating of the remote units, the operation of the reset acts to lock out any further reset by means of the signals applied to the reset circuit **70** along lines **84***a*, **88***a* and **90***a*.

The administration of a hotel lock system comprising a plurality of units each corresponding to the electronic combination lock of FIG. **1** is carried out at a central station, such as a hotel desk, whose principle system components are shown in FIG. **2**. As seen therein, these components include a keyboard **96**, a random access memory **98**, a key maker **100**, and combination generator **102**. Keyboard **96** accesses the memory **98** by room number under which is stored the guest, maid and master combinations then being

To issue a new guest, maid or master key, memory **98** is accessed by keyboard **96** under the room number of the room being assigned and the next combination of that room lock which is stored in the key decoder **30** is retrieved. This combination is routed by a switch **104** to the key maker. At the same time, a signal is sent to the combination function generator **102** to generate a new random combination with a parity comparison with the combination just previously taken out of the memory **98** and sent to the key maker **100**. When this has been accomplished, both combinations that are in the key maker are encoded on a key accordingly. If it is desired to issue a duplicate key the appropriate combination is retrieved from memory **98** and routed by switch **104** directly to the key maker. Since the combination function generator **102** is not operative in this instance, the combination stored in its assigned memory location is unaltered. Similarly, should a guest desire a maid lockout key, memory **98** is accessed by keyboard **96** to retrieve the lockout combination for the electronic combination lock to the guest room, and this combination is routed by switch **104** directly to the key maker **100**.

To issue a guest or maid reset combination for a particular room, memory **98** is accessed and the reset flag digit and reset combinations are routed by switch **104** directly to the key maker. In this instance, a second switch **106** is closed such that the reset combination retrieved from the memory is stored as the guest combination G COMB, maid combination MD COMB, or master combination MS COMB, as the case may be, in place of the combination previously stored there. This reset combination then becomes the current combination affording room access. With the arrival of the next guest, the reset combination is retrieved from memory and supplied to the function generator through routing switch **104** with switch **106** open. The function generator **102** then generates the next guest combination which is returned to memory **98** and also used by the key maker **100** to encode this next guest's key.

The function generator **102** (FIG. **2**) at the desk may comprise an adder and a fixed increment register in order to derive the next combinations for the various electronic combination locks based on their current combinations as retrieved from memory **108**.

It will be appreciated that the function generator **102** may in practice be considerably more complex and sophisticated to enhance the security of the lock system. For example, the function generator **108** may be a trigonometric function generator or a logarithmic function generator. Alternatively, a random number generator may be employed which uses the prior next guest, maid or master combinations as seed numbers for generating the next combinations in accordance with a pseudo-random number algorithm, or with any random sequence or selection scheme. Since synchronism is not required between the central station and each lock unit, the successive combinations can be generated in any desired manner.

Other alternative forms of central stations may be employed. The central station memory can be limited merely to some form of simple storage for only one prior code combination, that found in the second position on the key. Since the system allows the key itself to control the lock settings, it is only necessary that the central station issue a new key having the prior key second combination in the new key first combination position, and a new second combination recorded in the new key second combination position. It is thus within the scope of the invention to employ a storage device responsive to the codes on a prior key to randomly generate a new code combination, re-code the original second code on the new key units first code position, and place the newly generated code on the new key in its second position. In this latter case, a memory need be only a temporary storage register and accessing stored locations need not be necessary. However, it is preferable to have some means of retaining the next combination code, either by making a duplicate key to be kept at the central station, or electronically, as in a central memory such as is shown in FIG. **2**.

Referring now to FIG. **3**, the key decoder **30** is illustrated in greater detail.

The decoder **30** included three sections establishing the code combination sequences for each respective lock function input. Thus, section **110** is applicable to guest combination codes, section **112** is applicable to maid combination codes and section **114** is applicable to master combination codes. It will be appreciated that greater or lesser numbers of sections may be employed in accordance with the desired functions to be utilized at the remote unit in response to the data inputs applied thereto.

Each section includes a first register for storing current combinations, a second register for storing next or

change combinations, and logic circuitry for affecting the manipulation of the data upon application thereto by the coded input device. Thus, with applicability to the hotel locking system described hereinabove, section **110** includes a guest register **120** for storing the current guest combination, a register **122** for storing the next or change guest combination, a multiplexing device **124** for controlling the data manipulation and a first OR gate **126** and a second OR gate **128** for channeling NG compare and G reset signals to the registers **120** and **122.**

Section **112** includes a maid register **130** for storing the current maid combination, a register **132** for storing the next or change maid combination, a multiplexing device **134** for controlling the data manipulation, and a first OR gate **136** and a second OR gate **138** for channeling NMD compare and MD reset signals to the registers **130** and **132.** Section **114** includes a master register **140** for storing the current master combination, a register **142** for storing next or change master combination, a multiplexing device **144** for controlling the data manipulation, and a first OR gate **146** and a second OR gate **148** for channeling NMS compare and MS reset signals to the registers **140** and **142.**

The initial condition for a remote unit lock is established by resetting each of the registers to an initial or zero information state. Resetting can be accomplished at the lock during power installation, particularly in a remote locking unit environment wherein batteries may be employed to power the units. Upon establishment of power, the circuitry of the lock sets each of the bits in all of the registers to zero. At this point, each of the registers is set to receive information placed therein by means of a data input mechanism, in this case the key **12,** through the key reader **10** and the register **14.** The multicoded key contains two combinations for filling the two appropriate registers. For example, a guest key contains a guest and next guest combination. The code data from the guest key is applied along data bus **16** from the register **14** and applied in section **110** to the guest register **120** through the multiplexer **124** and to the next guest register **122** directly along the line **122***a*. The maid and master registers are similarly filled by the insertion of an appropriate key. Distinction between the various registers may be established by means of a code bit for gating the proper information into the appropriate registers in accordance with conventional logic techniques. Once stored, the use of subsequent code combinations impressed upon the data bus **16** as a result of repeated use of the key device **12** into the key reader **10** will set forth the chain of sequential events noted in connection with FIG. **1** for opening the lock **64.** Thus, a comparison between the key entry data and the data stored in any of the six registers, **120, 122, 130, 132, 140** or **142** will provide an appropriate true output on the output of the appropriate respective register in accordance with the data input applied. If, for example, a guest combination code is applied along the data bus **16,** a true output will be generated by the guest comparator **18** in accordance with the similarity of inputs along the input line **17** and the line **31** from the guest register **120.** The true output from the guest comparator **18** along the line **38** to the OR gate **50** will apply an appropriate access enabling unlocking pulse along the line **52** to the lock **54.** This access enabling signal will thus activate the lock and release the lock mechanism. Thus, as long as the access enabling combination entered into the register **14** and applied along data bus **16** is either a current guest combination, a current maid combination or a current master combination, the resulting register output will be gated through the OR gate **50** as an access enabling signal for the lock mechanism.

If a person seeking room access possesses a key with a change combination, i.e. the combination either residing in any of the second registers in each of the sections **110, 112** and **114,** the resulting register output in addition to releasing the lock mechanism is fed back to the appropriate multiplexer unit. Thus, referring to section **110** specifically, receipt of the next guest compare signal along the data bus **16** will result in a similarity of outputs along lines **23** and **34** to the next guest comparator **24** resulting in a true output along the line **44.** As noted, the true output is applied through the OR gate **50** along the line **52** for unlocking the lock mechanism **54.** In addition, this signal is fed back along the line **44***a* to the key decoder **30** where it is applied to the OR gates **126** and **128.** Application of pulses through the OR gates **126** and **128** result in the code combination of the next guest register **122** being shifted along the output line **122***b* to the multiplexer **124** for entry into the guest register **120** as the new current combination. As a result, the new next guest combination derived from the multi-coded key as applied along the data bus **16** will be entered directly into register **122** along the appropriate input connections **122***a*. The original current guest combination stored in register **120** is effectively destroyed by the replacement thereof by the new guest or next guest combination received from the next guest register **122** along the line **122***b*, through the multiplexer **124** and into the guest register **120.** It is thus seen that the possessor of the key bearing the change combination is afforded room access while at the same time triggering the electronic lock of the invention to change the internally stored access enabling combinations which must be matched to be afforded subsequent room access. However, since the change combination which precipitated the changing of the lock combination now becomes the current combination, the possessor of this key is assured subsequent room access since the combination encoded therein is thereafter treated as the current combination and not as a change combination. It will be appreciated that the possessors of the keys bearing the previous current combination are now denied room access. The same operative principle is applied to sections **112** and **114.**

When the situation arises to reset the guest, maid or master combination, the appropriate reset flag digit and reset combination, code are entered into the electornic combination lock of FIG. **1** via the key reader **10** as previously described. For example, if the guest combination is to be reset, and the GR FLAG **72** is set, the entry of the guest reset flag digit causes the comparator **78** to generate the output GR COMP on lead **84** to the OR gates **126** and **128** and the multiplexer **124.** The GR COMP signal conditions multiplexer **124** to connect the data bus **16** via the connection **86** to the input of the guest combination register **120.** The GR COMP signal also supplied to the OR gates **126** and **128** conditions both registers **120** and **122** to accept the new data being applied along the data bus **16.** Thus both the guest register **100** and the next guest register **122** will be loaded with their respective data from the key **12** present on bus **16.** Reset of the maid and master section

112 and 114 is accomplished in precisely the same manner.

Referring now to FIG. 4, there is illustrated a circuit showing that generation of reset flags occurs only upon initializing the lock electronics and allowing the lock to accept a reset key for executing the functions for guest, maid or master reset. As shown in FIG. 4, a power on reset circuit includes a potential source 200 connected across a switch 202. A resistance 204 and a capacitor 206 are coupled across the switch 202. For the guest reset flag GR FLAG, a logical AND gate 208 is provided with a first input coupled to the junction of the resistance 204 and the capacitor 206 and a second input coupled to the complimented output of the flip-flop 210. For the maid reset flag MDR FLAG, a logical AND gate 212 is provided with a first input coupled to the junction of the resistance 204 and the capacitance 206 and a second input coupled to the complimented output of the flip-flop 214. For the master reset flag MSR FLAG, a logical AND gate 216 is provided with the first input coupled to the junction of the resistance 204 and the capacitor 206 and a second input coupled to the complimented output of the flip-flop 218. The flip-flop 210 received the guest reset compare input along line 84*a*, the flip-flop 214 receives a maid reset compare input along the line 88*a*, and the flip-flop 218 receives its master reset compare input along the line 90*a*. A power on reset signal indicating reapplication of the power from the source 200 is applied along the line 220 commonly to the reset inputs of each of the flip-flops 210, 214 and 218.

In operation, the power on reset condition is provided by virtue of the switch 202 which is in a normally open position when the circuit is in operation. If the voltage source 200 is removed for replacement, the switch 202 is mechanically closed for discharging the capacitor 206. Upon reinstallation of the power source 200, the switch 202 70 potential charge any is designed to be sufficient to allow all circuitry to become energized, and the flip-flops 210, 214 and 218 to assume their normal condition with a complimented output $\overline{Q}$ at a logical one. When the capacitor 205 is fully charged, the output of the respective AND gates 208, 212 and 216 each indicate a logical one, thereby signifying enabled reset flags. The significance of enabled reset flags is that a new power source has been positioned and the circuitry thus prepared for receipt of new combinational codes. As each new key and its combination codes are reinserted, an appropriate pulse appears along the appropriate compare line 84*a*, 88*a* and 90*a*. The presence of each of these respective signals will be to set each of the respective flip-flops, 210, 214 and 218 receiving the inputs thereon, causing the complimented output $\overline{Q}$ to go to zero and thereby disabling each of the respective AND gates 208, 212 and 216 in accordance with the input condition applied thereto. The reset flag thus is disabled and remains disabled until power is again removed and reapplied, as described above. For security, the system is thus designed to be reset only by removal and replacement of the power unit, thereby preventing users of a resetting key from gaining access by resetting the lock and inserting an unauthorized combination code.

Since, in this system, it is the key that carries the combinations to the locks for entry into the storage of the key decoder 30 of each electronic lock, additional security must be added in order to prevent the bearer of a present key from gaining knowledge of the information contained on that key for the next combination. To enchance the security of the next combination, which may be typically perforated, punched or encoded in some way on the key, the arrangement of the next combination on the key is mixed with the present combination. In addition, the bit pattern arrangement of the next combination found on the present key combination is rearranged completely when that next combination appears as the present combination on a subsequently issued key. This transferring or scrambling of the present and next combination on a key may be handled conveniently within the lock unit by any conventional form of scrambler or descrambler. For example, if the present and next combination codes are each represented by a four bit binary code, the present code may be formed by bits number one, three, five and six, while the next combination by bits number two, four, seven and eight. The key reader and key maker merely provide the appropriate data transducing for each code to the assigned bit positions, thus making the key itself unintelligible to an observer or key reader not equipped with the appropriate bit designations.

From the foregoing description, it is seen that the present invention includes all the advantages of an electronic combination lock system including a plurality of electronic combination locks which are conducive to being administered from a central location without requiring electrical connections therebetween. The only link between the central station and the various electronic combination locks of the invention are the combination encoded keys possessed by those persons authorized for access. Consequently, no special wiring is required to implement the lock system of the invention. Since the combinations of the various electronic combination locks of the invention can be changed simply by using a new key encoded with the appropriate change combination there is no necessity for security personnel to visit each access point to adjust the lock thereat. Moreover, upon use of the change combination, possessors of the previous access enabling combinations who are no longer authorized access are automatically denied future access.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings should be interpretated as illustrative and not in a limiting sense.

Having described the invention, what is claimed as new and desired to secure by Letters Patent is:

1. A combination lock comprising, in combination:
   A. entry means for accepting first and second lock combination entries;
   B. first logic means for establishing first and second stored lock combinations;
   C. comparing means responsive to a match between a first lock combination entry and either one of said first and second stored lock combinations for developing an access enabling signal; and
   D. second logic means responsive to a match between a first lock combination entry and said second stored combination for controlling said first logic means to replace said first stored combination with said second stored combination, and said sec-

ond stored combination with the second lock combination entry associated with said first lock combination entry.

2. An electronic combination lock comprising, in combination:

A. a lock mechanism;

B. means for generating a digital readout of an encoded lock combination borne by a key;

C. a key decoder for storing first and second digitally encoded lock combinations;

D. a first comparator for comparing said first lock combination with said key readout and, upon comparison, generating a first compare signal effective to initiate actuation of said lock mechanism;

E. a second comparator for comparing said second lock combination with said key readout, and, upon comparison, generating a second compare signal also effective to intiate actuation of said lock mechanism; and

F. logic means responsive to said second compare signal for cancelling said first stored lock combination and to store a third digitally encoded lock combination derived from said key.

3. An electronic combination lock system comprising in combination:

A. an electronic combination lock located at each of a plurality of access points, each of said locks including

1. a lock mechanism,

2. means for reading and generating a plurality of digital combination key-readout codes from an encoded lock combination borne by a key,

3. means for storing first and second digitally encoded lock combination codes,

4. a first comparator responsive to a comparison between said first stored lock combination code and a key readout code for generating a first compare signal effective to initiate actuation of said lock mechanism,

5. a second comparator responsive to a comparison between said second stored lock combination code and a key readout code for generating a second compare signal effective to initiate actuation of said lock mechanism, and

6. logic means responsive to said second compare signal for respectively replacing said first stored lock combination code with said second stored lock combination code and said second stored lock combination code with a key readout code, and

B. a central station including

1. first means for providing at least said second lock combination code for a selected one of said electronic combination locks,

2. second means for generating a next successive lock combination code, and

3. recording means for entering said second lock combination code and said next successive lock combination code on said key.

4. The combination of claim 3 wherein said first means includes a memory for storing digitally encoded lock combination codes.

5. The combination of claim 4 wherein said first means includes means for accessing said memory to retrive the second stored lock combination code for a selected one of said electronic combination locks.

6. The combination of claim 3 wherein said second means includes a random number generator.

7. The combination of claim 5 wherein said second means includes a random number generator for deriving the said next successive lock combination code in respect to said retrieved lock combination code in a random sequence for said selected one of said electronic combination locks, and means for entering said next successive lock combination code in said memory.

8. A lock system comprising a multiple coded key having at least first and second combination code positions, a lock including storage means having a first storage location for storing a first code and a second storage location for storing a second code, the lock including means responsive to a match between a key combination code in said first combination code position and said first stored code for providing an access enabling signal, and the lock including means responsive to said control signal for transferring said second stored code from said second storage location to said first storage location and for placing the key combination code in said second combination code position into said second storage location.

9. The lock system of claim 8 wherein said storage means includes first and second registers respectively having said first and second storage locations, and wherein said lock system includes means for resetting said first and second registers to a predetermined condition.

10. The lock system of claim 8 wherein said first and second storage locations include a plurality of sections, each of said sections having first and second storage locations, and said lock includes means responsive to a predetermined combination code for rendering selective ones of said sections inoperative.

11. The lock system of claim 8 wherein said lock includes a reset circuit, said reset circuit including means for providing a reset signal, and said lock includes compare means responsive to said reset signal and a further combination code on said key for resetting said first and second codes to codes derived from codes at said first and second combination positions of said key, and said reset circuit being further responsive to said compare means for disabling said reset signal.

12. An electronic combination lock system comprising in combination a multiple coded key having at least first and second combination code positions, a lock including storage means having a first storage location for storing a first code and a second storage location for storing a second code, the lock including means responsive to a match between the combination code in said first combination code position and said first stored code for providing an access enabling signal, the lock including means responsive to a match between the combination code in said first combination code position and said second stored code for providing an access enable signal and a control signal, the lock including means responsive to said control signal for respectively transferring said second stored code from said second storage location to said frist storage location and placing the combination code in said second combination code position into said second storage location, a central station including first means for providing at least said second combination code for a selected one of said electronic combination locks, and said central station including second means for generating a next successive combination code and recording means for entering said second combination code and said next successive combination code on said key.

13. The combination of claim 12 wherein said storage means includes a first register having said first storage location and a second register having said second storage location, and wherein said lock system includes reset means for resetting said first and second storage registers to a predetermined condition.

14. The combination of claim 12 wherein said first and second storage locations include a plurality of sections, each of said sections having first and second storage locations, and said lock including means responsive to a predetermined combination code for rendering selective ones of said sections inoperative.

15. The combination of claim 12 wherein the lock includes a reset circuit, said reset circuit including means for providing a reset signal, compare means responsive to said reset signal and a further code combination on said key for resetting the codes in said first and second storage locations in accordance with codes derived from the codes at said first and second combination code positions of said key, and said reset circuit being further responsive to said compare means for disabling said reset signal.

16. The combination of claim 12 wherein said first means includes a memory for storing digitally encoded lock combination codes.

17. The combination of claim 16 wherein said first means includes means for accessing said memory to retrieve the stored lock combination code for a selected one of said electronic combination locks.

18. The combination of claim 12 wherein said second means includes a random number generator. sequence and means

19. The combination of claim 17 wherein said second means includes a random number generator for deriving the next successive lock combination code in respect to said retrieved lock combination code in a random sequence for said selected one of said electronic combination locks, and means for entering said next successive lock combination code in said memory.

20. A combination lock programmable by means of a code bearing key, said lock comprising, in combination:

A. means for accepting first and second lock combination entry codes borne by the key;

B. lock programming means programmed to store first and second lock combination access codes;

C. comparing means responsive to a match between a first lock combination entry code and either one of said first and second lock combination access codes for developing an access enabling signal, and

D. logic means responsive to a match between a first lock combination entry code and said second lock combination access code for controlling said lock programming means to respectively replace the first and second stored access codes with the second stored access code and second entry code, whereby the second stored access code becomes a new first stored access code and the second entry code becomes a new second stored access code.

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