and mechanical lock system which includes a lock having a fixed lock cylinder and a rotatable key slug having a key aperture therethrough. A first solenoid is mounted in the lock cylinder and includes a lock pin which is normally extended to prevent rotation of the key slug. A pair of light sources and a pair of light detectors are mounted in the lock for generating electrical signals when a key having coded apertures therethrough is inserted into the key slug. Circuitry is responsive to predetermined characteristics of the electrical signals for operating the first solenoid to retract the lock pin to allow rotation of the key slug. A second solenoid is mounted in the lock cylinder and includes a latch pin operable to be extended in response to an electrical power failure in the system. When the latch pin is extended and a proper mechanical key is inserted and rotated, extension of the lock pin is prevented. A plurality of spring loaded pin tumblers are mounted in the lock cylinder and are operable to be moved away from the key slug upon insertion of a proper mechanical key to enable rotation of the key slug during an electrical power failure.

11 Claims, 15 Drawing Figures
FIG. 7

TRANSMITTED CLOCK SIGNAL

FIG. 8

FIG. 9

FIG. 10

FIG. 11
FIG. 14

FIG. 15
1
COMBINATION ELECTRICAL AND MECHANICAL LOCK SYSTEM

FIELD OF THE INVENTION

This invention relates to security systems, and more particularly relates to a lock system which is normally operated by an electrical circuit which senses a key having discrete coded portions therein, but which may be alternatively operated by a conventional mechanical key upon electrical failure.

THE PRIOR ART

A wide number of different types of security systems have been heretofore developed for use when security must be provided for a large number of doors and when large numbers of people are involved. For example, hotels and motels have a large number of different rooms, each of which is assigned to a different key to allow access to a particular room only by a designated guest. Substantial problems occur with the use of ordinary mechanical keys, not the least of which is the ease with which such mechanical keys may be duplicated or stolen. When such mechanical keys are lost, the entire lock must generally be replaced in order to maintain security. Due to the expense and complexity of changing locks, it is difficult to maintain security in such a system over a long period of time. A need has thus arisen for a security system in which security may be continuously provided to a large number of areas, such that access is available only when a person has a specific key, the system yet having the capability to enable selective changing of the key which opens a designated room in order to maintain the security of the entire system over a long period of time. Such a security system must be easy to operate and to change the keys which operate the system, and yet must be able to be operated continuously even during the event of electrical power failures.

SUMMARY OF THE INVENTION

In accordance with the present invention, a lock is provided which includes a key having coded areas therein. A lock receives the key and includes structure for sensing the positions of the coded areas and for generating electrical signals in response thereto. Circuitry is responsive to a predetermined electrical signal for enabling the lock to be opened by rotation of the key.

In accordance with another aspect of the invention, a lock system includes a key having first and second series of apertures formed therethrough. A lock has a device for transmitting light through the series of apertures and further includes devices for generating first and second electrical signals in response to light received through the series of apertures. Circuitry samples the first electrical signals in response to portions of the second electrical signals. Circuitry is responsive to a predetermined sampled sequence of the first electrical signals for enabling the lock to be opened by manual rotation of the key.

In accordance with another aspect of the invention, a lock system is provided which includes a lock cylinder and a key slug rotatable within the cylinder. A device is provided for normally preventing rotation of the key slug. A key is dimensioned to be received within the key slug and includes a first series of apertures along the length thereof and further includes a second series of apertures located below the first series. A light source is mounted in the lock for transmitting light through the apertures as the key is inserted into the key slug. A first light sensitive device generates electrical data signals representative of light transmitted through the series of apertures. A second light sensitive device generates an electrical clock signal representative of light transmitted through the other of the series of apertures. Circuitry samples the data signal in response to the clock signal and generates an enable signal upon detection of a predetermined sampled data signal sequence. Structure is provided to unlock the rotation preventing means in response to the enable signal to allow the key to rotate the key slug.

In accordance with another aspect of the invention, a lock system includes a first key having coded apertures therethrough and a second key having a coded series of lands and grooves along one edge. A lock includes a rotatable key slug with a key aperture for receiving either of the first or second keys. Electrical circuitry is responsive to the coded apertures when the first key is inserted into the lock for enabling the key slug to be rotated to an unlocked position. A mechanical device is operable only when the electrical circuitry is deenergized for enabling the second key to be inserted in the end of the key slug and the key slug to be rotated to the unlocked position.

In accordance with yet another specific aspect of the invention, a combination electrical and mechanical lock system includes a lock having a fixed lock cylinder and a rotatable key slug having a key aperture therethrough. A first solenoid is mounted in the lock cylinder and includes a lock pin engaged to normally prevent rotation of the key slug. A light source and a light detector are mounted in the lock for generating electrical signals when a key having coded apertures is inserted into the key slug. Circuitry is responsive to predetermined characteristics of the electrical signals for operating the first solenoid to disengage the lock pin to allow rotation of the key slug. A second solenoid is mounted in the lock cylinder and has a latch pin operable to be extended in response to an electrical power failure. The latch pin, when extended, prevents engagement of the lock pin with the key slug. A plurality of spring-loaded pin tumblers are mounted in the lock cylinder and are operable to be moved away from the key slug upon insertion of a key having coded grooves and lands to enable rotation of the key slug during an electrical power failure.

DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and for other objects and advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a diagrammatic block diagram of a portion of the present lock system;
FIG. 2 is a front view of a lock used in the present system;
FIG. 3 is a perspective view of a key having coded apertures according to the invention;
FIG. 4 is a section view taken generally along the section lines 4—4 shown in FIG. 2;
FIG. 5 illustrates a side view, partially sectioned, of the key shown in FIG. 3 when inserted into the present lock;
FIG. 6 is a section view taken generally along the section lines 6—6 in FIG. 2.

FIGS. 7a—b illustrates the data and clock waveforms generated by the present lock.

FIG. 8 is a sectional view of the present lock when the lock pin prevents clockwise rotation of the key slug.

FIG. 9 is a sectional view corresponding with FIG. 9 illustrating how the lock pin is cammed upwardly by counter clockwise rotation of the key slug by the mechanical key.

FIG. 10 is a sectional view of the lock illustrating operation of the spring loaded pin tumblers when the lock is in the mechanical mode of operation.

FIG. 11 illustrates a side view of the mechanical key inserted into the lock sectioned generally along the section line 11—11 in FIG. 10.

FIG. 12 illustrates the line termination logic circuitry logic of the invention.

FIG. 13 illustrates the line termination unit selection logic.

FIG. 14 illustrates the memory accessing and test data compare logic; and

FIG. 15 illustrates the key assignment console interface circuitry.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates a block diagram of the present security system which includes a desk console 10 having a keyboard array 12 which may comprise for example a standard ASCII typewriter keyboard. The console 10 includes a key slot 14 for insertion of electronic keys according to the invention. The console further includes a display 16 whereby information input into the system by operation of the keyboard 12 may be displayed. The console 10 is connected through interface logic 18 to a central processor 20 which may include a memory 22. The interface logic 18 is connected through an electrical conductor 24 to the region of a door 26. The conductor 24 is connected to a circuit box 27 which is connected via an electrical lead 28 to a lock 30 constructed in accordance with the present invention. A plurality of similar locks installed in additional doors in the area are connected to the interface logic 18 in a similar manner.

In operation of the present system, a plurality of coded keys are normally maintained under the control of the operator of the console 10. Assuming that the present security system is utilized in a hotel, when a guest checks in, one of the coded keys is inserted into the key slot 14 entering the key number into the console, and the guest's name and the assigned room number are entered into the keyboard 12 and all are displayed on the display 16. The information thus entered is also applied through the interface logic 18 to the central processor 20 for storage therein. This assigns the inserted key to the assigned room number. Thereafter, the lock 30 may be actuated only by the particular coded key assigned to the guest's room. A plurality of conventional mechanical keys are also provided for use in case of a power failure which renders the electronic system shown in FIG. 1 inoperative. Upon the occurrence of a power failure, one of the mechanical keys may be utilized to operate the lock 30. When the power to the system is restored, the lock 30 automatically reverts to the electronic mode and cannot be operated by the mechanical key. When the guest checks out, the assigned coded key is released from assignment by operation of the keyboard 12 and thereafter the coded key will not open the lock 30.

An important aspect of the present security system is that any one of the plurality of coded keys may be assigned to operate any of the locks in the system by proper insertion of the key in the key slot 14 and by operation of the keyboard 12. If one of the coded keys is thus stolen or duplicated, the single coded key could not be utilized to operate any of the door locks, as the coded key assigned to a particular lock will be periodically changed each time a guest departs from the room.

Maids and other members of the hotel staff whose duties require guestroom entry may be issued a coded key which is assigned to a group of rooms by proper operation of the keyboard 12. If desired, the system may be operated so that a maid's coded key may be used only once per door lock and may be used only during a specified period of the day. In order to increase the security provided by the present system, a much larger number of coded keys may be provided than the number of door locks in the hotel, thereby allowing assignment of a large number of different keys to the various door locks. If desired, the system may be operated to sound an alarm in case a particular coded key which has been stolen is inserted into any of the door locks in the system.

FIG. 2 illustrates a front view of the door lock 30 shown in FIG. 1. The lock includes a lock cylinder 32 which is rigidly mounted within the door 26 in the conventional manner. A rotatable key slug 34 is mounted within the lock cylinder 32 and includes a key aperture 36. Rotation of the key slug 34 in the clockwise direction causes operation of a door bolt in the well known manner. The key aperture 36 is dimensioned to receive either the coded key shown in FIG. 3 or the conventional mechanical key shown in FIG. 11. When the lock is in the electronic mode, only the coded key may be rotated to operate the lock, while when electrical power is disabled, only the mechanical key may be operated to operate the lock.

A first solenoid 38 is mounted within the lock cylinder and includes a movable lock pin 40. The second solenoid 42 is mounted within the lock cylinder at a right angle to the solenoid 38 and also includes a movable latch pin 44 which places the system in the mechanical mode upon a power failure, as will subsequently be described.

A pair of light emitting diodes 46 and 48 are laterally and vertically offset from one another on one side of the lock cylinder 32 and emit rays of light which pass through apertures in the coded key. The light transmitted through the key is detected by a pair of phototransistors 50 and 52 which are likewise laterally and vertically offset from one another. A first set of tumbler pins, not shown in FIG. 2, are mounted in front of and behind the locking pin 40 of the solenoid 38. A second set of spring biased tumbler pins 54 are mounted at a 45° angle from the first set and are utilized in the mechanical mode of operation of the system as will be subsequently described.

FIG. 3 illustrates a perspective view of the preferred coded key 60 of the invention. The key includes a conventional handle 62 and an elongated key portion 64. An upwardly extending projection 66 is formed on the forward end of the key to prevent the key from being withdrawn from the lock once inserted and rotated. A
first series of apertures 68 are spaced along the upper portion of the key according to a predetermined binary coded configuration. A second series of spaced apart apertures 70 are spaced apart below the first series of apertures. The series of apertures 68 is formed by rectangular vertical slots in one side of the key in order to define apertures 72 which extend completely through the width of the key. The second series of apertures 70 is formed by vertical slots made in the opposite side of the key in order to form the apertures 74 which extend completely through the side of the key.

The apertures 72 are spaced apart according to a predetermined binary coded configuration. Each of the keys utilized with the system have a different binary coded configuration of apertures. The array of apertures 70 comprises a series of apertures 74 which are evenly apart in order to generate clock pulses to enable sampling of the signals generated by the coded series. As previously noted, light from diodes 46 and 48 is transmitted through the series of apertures 68 and 70 and is detected by phototransistors 50 and 52 to generate data and clock signals. While the preferred embodiment of the coded key uses coded apertures, it will be understood that other discrete coded areas could be formed on the key and detected. For example, magnetic particles could be spaced along the length of the key to form a coded data array and a clock array, and magnetic sensors could detect the passage of the magnetic particles to generate electrical data and clock signals. Similarly, the coded apertures in the key shown in Fig. 3 could alternatively be sensed by metal fingers which complete an electrical circuit upon the occurrence of an aperture. Other techniques for sensing coded apertures or other types of discrete coded areas on the key are intended to be encompassed by the present invention.

Fig. 4 is a section view taken along the section lines 4--4 in Fig. 2. The solenoid 38 includes a solenoid winding 80 which may be energized by electrical signals to move the solenoid pin 82 and lock pin 40 upwardly. A spring 84 normally biases the lock pin 40 in the illustrated downward position when solenoid 38 is deenergized in order to lock the key slug 34 to prevent clockwise rotation. The key slug is retained in its counterclockwise position by a lock 92e. The lock 92e is secured to the wall of the lock cylinder 32 and is adapted for holding the key slug 34 in its counterclockwise position.

A plurality of vertical pin apertures 90a-e are formed in the lock cylinder 32 and are adapted to mate with corresponding apertures formed in the key slug 34 as illustrated in Fig. 11. Tumbler pins 92a-e are adapted to slidably move vertically within the apertures in the key slug and in apertures 90a-e. If a mechanical key having a wrong shape is inserted into the key slot 36, the pins 92a-e will be raised into apertures 90a-e in order to prevent the rotation of the key slug 34.

Fig. 5 illustrates the insertion of the coded key 60 into the key slot 36. Upon insertion, the projection 66 causes each of the tumbler pins 92a-e to be initially moved upwardly into apertures 90a-e and then the tumbler pins 92a-e fall downwardly behind the projection 66. When the key slug 34 is rotated by the key 60, the tumbler pin 92e prevents withdrawal of the key 60, as pin 92e is no longer aligned under apertures 90e. When the key slug 34 is again vertically aligned with the openings 90e, key 60 may be removed from the lock.

Fig. 6 illustrates a sectional view taken generally along the section line 6--6 of Fig. 2 and illustrates the second set of tumbler pins 54a-e which are spring loaded within apertures set in the lock cylinder at 45° from the vertical. When the key slug 34 is in the vertical position, as shown in Fig. 6, the tumbler pins 54a-e bear against the outer edge of the key slug 34 and are maintained in the illustrated upward position. When the key slug 34 is rotated by the proper mechanical key, the pins 54a-e rest on top of the pins 92a-e to enable proper operation of the lock in the manner to be subsequently described. If an improper mechanical key is inserted into the key slug 34 and rotated, one or more of the pins 54a-e will move into the apertures in the key slug and will prevent further rotation of the key slug.

Operation of the lock when in the electronic mode will now be described with reference to Figs. 7 and 8. When the electrical power is on, the solenoid 38 is normally deenergized and the solenoid pin 82 is forced downwardly by spring 84 into a cammed recess formed within the lock slug 34 as illustrated in Fig. 8. The cam recess includes an abutment wall 96 and a cam surface 98.

As the coded key shown in Fig. 3 is inserted into the key slot 36, light rays are transmitted from the light emitting diodes 46 and 48 through the series of apertures 68 and 70 and are detected by the phototransistors 50 and 52. The outputs of the phototransistors comprise square wave signals representative of the light received due to the passage of the key into the key slot 36. Typical output signals from the phototransistors 50 and 52 are illustrated in Figs. 7a--b. The output of the phototransistor 52 comprises a periodic waveform shown in Fig. 7a which serves as the clock signal of the invention. The output of the phototransistor 50 comprises a plurality of square pulses such as shown in Fig. 7b which are spaced apart relative to Fig. 7a by varying amounts in accordance with the coded spacing of the apertures 72.

Electronic circuitry, to be subsequently described, receives the waveforms shown in Figs. 7a--b and samples the waveform of the coded identification data signals shown in Fig. 7b upon each positive going transition of the clock pulse shown in Fig. 7a. Thus, the waveform of Fig. 7b is sampled at time $t_1$ as a logic "1", and is sampled at time $t_2$ as a logic "0". The resulting binary code output detected by the comparator circuitry of the invention is then compared against the stored binary code input into the central processor 20 as the correct code for that particular lock. If the detected code matches the stored code, an energizing signal is applied to the solenoid 38 and the solenoid pin 82 is moved upwardly in order to remove the lock pin 40 from contract with the abutment wall 96. The lock slug 34 may then be rotated clockwise by the key 60 in order to operate the door bolt in the conventional manner.

While the present invention could be operated using only a single set of key apertures in a spaced apart coded configuration and a plurality of light sources and light detectors each corresponding to a different key aperture, the use of the clock signal enables the code to be detected with only two light sources and two detectors irrespective of the speed in which the key is inserted into the key slot. In normal operation of the system in the electronic mode, the solenoid 42 is main-
tained in the energized position and thus the latch pin 44 is withdrawn from engagement with the lock pin 40. However, in case of a power failure, the electronic mode of operation of the system is not possible. Thus, when the electrical power fails, the solenoid 42 is de-energized and the latch pin 44 is moved outwardly from the solenoid 42 by operation of a spring 100. A mechanical key which includes coded lands and grooves may then be inserted into the key slot 36 and the key slug 34 rotated counterclockwise. The mechanical key must include coded lands and grooves which interfit with the tumbler pins 92a-e in such manner as shown in FIG. 11 in order to enable counterclockwise rotation of the key slug 34 and to establish the mechanical mode.

Rotation of the key slug 34 in the counterclockwise manner causes the lock pin 40 to be moved upwardly due to the cam surface 98. When the key slug 34 reaches the position shown in FIG. 9, the lock pin 40 reaches an upper position such as the the latch pin 44 abuts with the annular surface 104 of the lock pin 40 and prevents the lock pin 40 from being moved downwardly. The system is now in the mechanical mode and cannot be operated by any of the coded keys 60.

Once the lock pin 40 is latched as shown in FIG. 9, the key is then rotated clockwise in order to operate the door bolt. FIG. 10 illustrates the proper alignment of pin 92a with the pin tumbler 54a in order to allow rotation of the key slug. The lands and grooves of the mechanical key are such that the pins 92a-e mate with the tumbler pins 54a-e at the periphery of the key slug 34 to enable clockwise movement of the key slug 34 to enable operation of the door bolt in the conventional manner. If the proper mechanical key has not been inserted, the tumbler pins 54a-e will project downwardly into the key slug 34 and prevent further rotation.

FIG. 11 illustrates a sectional view taken generally along section lines 11-11 in FIG. 10 illustrating the proper operation of the mechanical key 110. As illustrated, the mechanical key 110 includes lands and grooves such that the tumbler pins 92a-e contact the tumbler pins 54a-e at the outer periphery of the key slug 34.

When the electrical power again comes on, the solenoid 42 is re-energized and the latch pin 44 is withdrawn, thereby allowing the lock pin 40 to be pushed downwardly by operation of the spring 84. The key slug 34 is then again locked against clockwise rotation by the lock pin 40 and the mechanical key 110 will not work to rotate the key slug 34 in the clockwise position beyond the vertical position. The coded key 60 must then be used to open the lock in the manner previously described.

FIGS. 12-15 illustrate the circuitry for determining the validity of a particular coded key and for assigning coded keys to various rooms as desired. The transmitted clock (TC) signal shown in FIG. 7a and the transmitted key ID signal shown in FIG. 7b are transmitted to the console by the switch in FIG. 12. The ID line terminates in a line receiver 101 which outputs to the data input of serial in/parallel out shift register 104. The TC line terminates in line receiver 102 which outputs to the clock input of shift register 104 and to the reset input of flipflop 106. As the coded key is inserted into the key slot of FIG. 4, the light beam through aperture 88 is interrupted by slots 74 of FIG. 3, producing the TC signal. The light beam through aperture 86 is interrupted by slots 72 of FIG. 3, producing the signal pattern of FIG. 7b. The slots 72 of FIG. 3 represent a binary code and are unique to each key of the system.

At the time t₁ of FIG. 7, the clock signal causes the binary data then present on the ID signal, a logical "1," to be shifted into the shift register 104 of FIG. 12. At time t₂, a logical "0" is shifted into the shift register 104. The clocking continues as the key progresses into the key slot, until 16 data bits have been loaded into the shift register 104. This condition is signaled by the DATA READY output of shift register 104 going to a logical "1," causing a service request to be made to selection logic 201 shown in FIG. 13. Logic 201 comprises logic to generate a memory address corresponding to the particular data ready signal line or lines requesting service and logic to queue and select one of a plurality of lines requesting service for servicing. The memory address lines are gated by gates 205 in response to the address enable strobe from the memory timing and control logic. The address of the selected line termination unit is also routed to the data enable selector 202, the unlock strobe selector 203, and to the reset strobe selector 204.

Following receipt of the memory service request signal from 201, memory timing and control 301 (MTC), shown in FIG. 14, activates ADDRESS ENABLE which causes gates 205 to apply the state of the memory address lines from logic 201 to the address bus and to generate the read request signal received by control 301. Control 301 then causes the memory 302 to begin a read access of the location specified by the address appearing on the address bus. Concurrent with the address enable strobe, control 301 activates the data enable strobe to data enable selector 202 (FIG. 13). If line termination logic LTL No. 1, corresponding to a particular lock, is selected for service, for example, selector 202 issues a data enable to gates 105, thereby applying the contents of shift register 104 to the memory test data compare bus received by comparator 303.

Following receipt of cycle complete from the memory 302, control 301 issues a start compare strobe to comparator 303. If the data on the memory read data bus is logically equal to the data on the test data compare bus, the comparator 303 activates the equal compare strobe received by unlock strobe selector 203 and the OR gate 304. Since the address input to selector 203 corresponds to LTL No. 1, an unlock strobe is issued to flipflop 106, clocking it to the set condition. The output Q of flipflop 106 received by line driver 103 causes an unlock pulse to be transmitted to the unlock solenoid 80 of FIG. 4, causing the lock pin 82 to be withdrawn. The key slug 36 is thus enabled to be rotated clockwise by the key operator, unlatching the lock mechanism.

If the data on the memory read data bus received by comparator 303 is logically unequal to the data on the test data compare bus, comparator 303 activates the unequal compare strobe received by reset strobe selector 204, through OR gate 304. Since LTL No. 1 is selected by the memory address received by 204, the reset line to shift register 104 is activated, clearing the register 104. Clearing register 104 removes its DATA READY signal from logic 201. Logic 201 then services the next queued LTL requesting service and repeats the key validation cycle.

The assignment of persons to keys and keys to rooms is accomplished using console 10 of FIG. 1. Referring
to FIG. 15, the console consists of an alpha/numeric keyboard 401 for entering information manually into refresh memory 403 and a key reader similar to FIG. 2 for entering the key ID into memory 403. The contents of memory 403 are stored in memory 302 of FIG. 14 by operation of an ENTER BUTTON on keyboard 401. Terminal interface logic 406 operates to transfer the contents of memory 403 to memory 302, beginning at a location corresponding to the room ID. The key ID is stored in this first location, the keyholder’s name and other information in following location. Writing to memory is accomplished in a manner similar to reading, but in a different mode.

Whereas the present invention has been described with respect to specific embodiments thereof, it will be understood that various changes and modifications will be suggested to one skilled in the art, and it is intended to encompass such changes and modifications as fall within the scope of the appended claims.

What is claimed is:

1. A lock system comprising:
   a lock having a lock cylinder and a key slug rotatable within said cylinder,
   a pin contacting a surface on said key slug for normally preventing said lock from being opened, electrical means adapted for movement of said pin, a key having first and second series of discrete coded portions formed therein, said first series being laterally offset relative to said second series, means in said lock, for detecting the passage of said coded portions upon insertion of said key and for generating first and second electrical signals in response thereto, said first electrical signals comprising a series of data pulses spaced apart according to a predetermined configuration and said second electrical signals comprising a series of clock pulses spaced apart by a common interval, one edge of said clock pulses occurring concurrently with ones of said data pulses, means for sampling said data pulses in response to said one edge of said clock pulses, and means responsive to a predetermined sampled sequence of said data pulses for activating said electrical means for movement of said pin to permit opening said lock.

2. The lock system of claim 1 wherein said coded portions comprise series of apertures formed through said key, said apertures in said first series being spaced apart in a predetermined coded configuration relative to said apertures in said second series, means for transmitting light through said apertures, and means for detecting light passed through said apertures.

3. The lock system of claim 1 and further comprising:
   a second key having coded lands and grooves operable to open said lock only when the electrical power supply for said lock is inoperative.

4. The lock system of claim 1 and further comprising:
   means within said lock for permitting insertion of said key when said lock is in the locking position, and means for preventing removal of said key from said lock when said lock is not in the locking position.

5. A lock system comprising:
   a lock having a lock cylinder and a key slug rotatable within said cylinder either in a first or second direction wherein the lock system may be opened by rotation said key slug in said first direction, a pin contacting a surface on said key slug for normally preventing rotation of said key slug in said first direction, a key for being received by said key slug and having first series of apertures along the length thereof and further including a second series of apertures located below said first series, light source means mounted in said lock for transmitting light through said apertures as said key is inserted into said key slug, first light sensitive means for generating an electrical data signal representative of light transmitted through one of said series of apertures, second light sensitive means for generating an electrical clock signal representative of light transmitted through the other of said series of apertures, circuitry for sampling said data signal in response to said clock signal and for generating an enable signal upon detection of a predetermined sampled signal sequence, and means for moving said pin in response to said enable signal to allow said key to rotate said key slug in said first direction to open the lock system.

6. The lock system of claim 5 and further comprising:
   a first set of tumbler pins in said lock cylinder, a second set of tumbler pins in said key slug alignable with said first set of tumbler pins upon rotation of said key slug in said lock cylinder, a second key having coded lands and grooves thereon for positioning said second set of tumbler pins in said key slug at the interface between said key slug and said lock cylinder thereby maintaining said second set of tumbler pins at said interface during rotation of said key slug within said lock cylinder so that said key slug may be rotated in said second direction, a cam surface on said key slug for camming said pin away from said surface on said key slug when said key slug is rotated in said second direction, and means for maintaining said pin away from said surface on said key slug to allow rotation of said key slug in said first direction thereby opening the locking system.

7. The lock system of claim 5 wherein said moving means comprises a solenoid for moving said pin in response to said enable signal.

8. A lock system comprising:
   a first key having coded discrete portions therein and a second key having a coded series of lands and grooves along one edge, a lock having a rotatable key slug with a key aperture for receiving either of said first or second keys, electrical circuitry responsive to said coded discrete portions when said first key is inserted into said lock for enabling said key slug to be rotated to an unlocked position, mechanical means operable only when said electrical circuitry is deenergized for enabling said second key to be inserted into said key slug and said key slug to be rotated to an unlocked position, and means for preventing said key slug from being rotated to an unlocked position by said second key.
A lock system comprising:

a lock having a lock cylinder and a key slug rotatable within said cylinder in either a first or second direction wherein the lock system may be opened by rotating said key slug in said first direction, a first set of tumbler pin holes in said lock cylinder at an angle to vertical, first tumbler pins carried in said first set of pin holes, a second set of vertical tumbler pin holes in said key slug, said second pin holes being alignable with said first pin holes, second tumbler pins carried in said second set of pin holes, means for normally preventing rotation of said key slug in said first direction, a first key for being received by said key slug and having a series of apertures disposed along the length thereof, a light source mounted in said lock for transmitting light through said apertures as said key is inserted into said key slug, light sensitive means for generating electrical data signals representative of the light transmitted through said series of apertures, circuitry for detecting said data signals and for generating an enable signal upon detection of a predetermined sample signal sequence, means for withdrawing said rotation preventing means in response to said enable signal to allow said key to rotate said key slug in said first direction to open said lock system, a second key having coded lands and grooves thereon for positioning said second set of tumbler pins in said key slug at the interface between said key slug and said lock cylinder thereby maintaining said second set of tumbler pins at said interface during rotation of said key slug within said lock cylinder so that said key slug may be rotated in said second direction, means associated with said key slug for withdrawing said rotation preventing means as said key slug is rotated in said second direction, means actuated by an electrical power failure to the system for securing said rotation prevention means in the withdrawn position to allow rotation of said key slug in the first direction to unlock the locking system.

* * * * *

A lock system comprising:

a lock having a lock cylinder and a key slug rotatable when electrical power is available to said lock system.

9. The lock system of claim 8 wherein said discrete portions comprise apertures formed through said key and further comprising:

means for transmitting light through said coded apertures, means for generating electrical signals in response to light transmitted through said apertures, said electrical circuitry responsive to said electrical signals for enabling said key slug.

10. A combination electrical and mechanical lock system comprising:

a lock having a fixed lock cylinder and a rotatable key slug having a key aperture therethrough, a first solenoid mounted in said lock cylinder and having a lock pin engaged to normally prevent rotation of said key slug to an unlocked position, a first key having coded apertures therethrough, a light source and a light detector mounted in said lock for generating electrical signals when said first key having coded apertures is inserted into said key slug, circuitry responsive to predetermined characteristics of said electrical signals for operating said first solenoid to disengage said lock pin to allow rotation of said key slug to an unlocked position, means actuated by rotation of said key slug to withdraw said lock pin from its normally locking position, a plurality of spring loaded pin tumbler mounted in said lock cylinder at an angle to vertical, a second key for insertion into said key aperture and having coded lands and grooves adapted to position said pin tumbler to allow rotation of said key slug to actuate said means of withdrawing said lock pin, and a second solenoid mounted in said lock cylinder and having a latch pin operable to be extended in response to an electrical power failure to prevent the return of said lock pin to its normally locking position thereby allowing rotation of said key slug to an unlocked position during an electrical power failure.

11. A lock system comprising:

a lock having a lock cylinder and a key slug rotatable
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,889,501 Dated June 17, 1975

Inventor(s) Charles P. Fort

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 5, "invenetion" should be --invention--.
Col. 5, line 17, immediately following "evenly" insert --spaced--.
Col. 6, line 57, "clockwsie" should be --clockwise--.
Col. 8, line 51, "solenod 80" should be --solenoid 80--;
   line 61, "toshift register 104" should be --to
   shift register 104--;
   line 63, "READY singnal" should be --READY signal--.
Col. 9, line 17, "and it is intened" should be --and it
   is intended--.
Col. 10, line 9, "s first series" should be --a first series--.

Signed and Sealed this

[SEAL]

seventh Day of October 1975

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks