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3,029,345

ELECTRONIC KEY-CARD SYSTEM

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Fig. 1

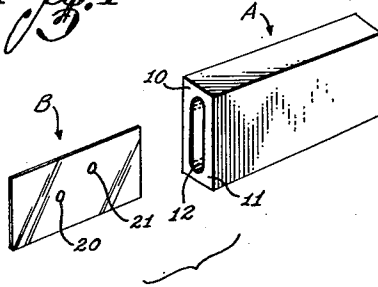


Fig. 2

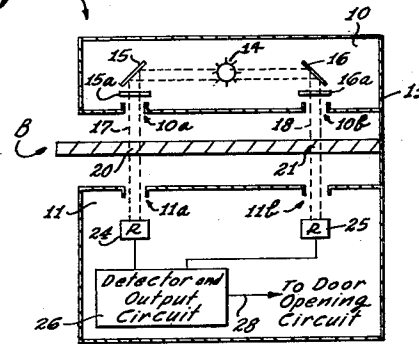


Fig. 3

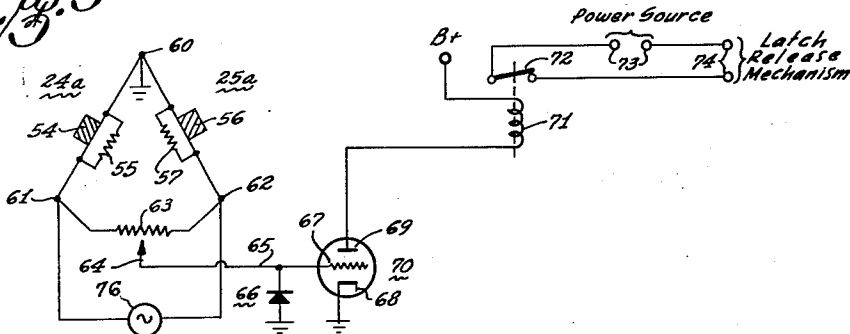


Fig. 4

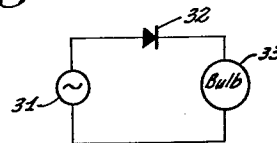
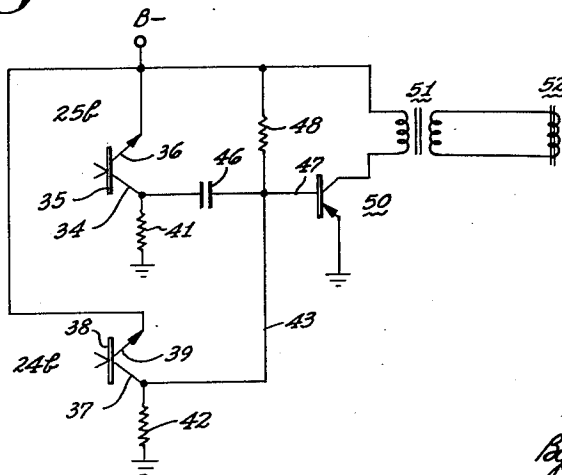


Fig. 5



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ELECTRONIC KEY-CARD SYSTEM
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The present invention relates to an electronic key-card system.

There are many situations where it is desirable to be able to open a lock by the use of a suitable identification card which may be conveniently carried in the wallet of its owner. For example, such usage of an identification card is particularly convenient for unlocking the entrance door of a private club or similar organization.

Electronic systems based upon the use of an identification card as the key to a lock are disclosed in Patent No. 2,497,405 to Glover and in Patent No. 2,779,874 to Sonbergh. The present invention, however, provides an improvement thereover and is based upon novel concepts.

It is therefore an object of the invention to provide an electronically controlled key-card system.

Another object of the invention is to provide a system such that the owner of an identification card cannot readily ascertain the features or characteristics of the card which permit its use as a key.

A further object of the invention is to provide electronic circuit means for operating a lock as determined by the light attenuation characteristics of a card which is used to open the lock.

Yet another object of the invention is to provide an electronic system for measuring and comparing the light-transmissive characteristics of two or more selected portions of an identification card, and for selectively opening a lock in accordance therewith.

The above and other objects of the invention will be more readily understood from the following description in conjunction with the accompanying drawing in which:

FIGURE 1 is a perspective view of an identification card in accordance with the invention, together with a slotted control housing in which it is adapted to be inserted;

FIGURE 2 is a cross-sectional view of the card and housing of FIGURE 1 illustrating in schematic form the various control elements contained in the housing;

FIGURE 3 is a schematic diagram of one type of detection circuit according to the invention;

FIGURE 4 is a schematic circuit diagram of a particular form of light source suitable for use in the system of FIGURE 2; and

FIGURE 5 is a schematic circuit diagram of a detection circuit suitable for use in conjunction with the light source of FIGURE 4.

Reference is now made to FIGURE 1 which illustrates a control housing A including a first housing portion 10 and a second housing portion 11 which are disposed in parallel relation to each other to provide a slot 12 therebetween suitable for receiving an identification card B. On card B two predetermined portions thereof which are identified as 20 and 21, respectively, are provided with predetermined light-transmissive characteristics in accordance with the invention.

The operation of the invention is readily understood from FIGURE 2 which illustrates card B occupying its intended position in slot 12, with one of its ends resting against end wall 13 of the housing. Housing portion 10 has a pair of openings 10a, 10b which communicate with slot 12, while openings 11a, 11b are provided in aligned positions in housing portion 11 on the opposite side of slot 12. The relative positions are such that a beam of light generated within housing portion 10 which passes through opening 10a must necessarily pass through card

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portion 20 in order to reach opening 11a and thus to enter housing portion 11. In similar manner a light beam passing from housing portion 10 through opening 10b must also pass through card portion 21 before entering opening 11b.

A light source 14 is provided in housing portion 10 which illuminates a pair of mirrors or other suitable reflectors 15, 16, which in turn direct corresponding beams of light 17, 18 through openings 10a, 10b. Mirror or reflector 15 has a filter 15a associated therewith through which light beam 17 passes before entering slot 12 via opening 10a. Mirror or reflector 16 likewise has a filter 16a through which light beam 18 passes before entering slot 12. A pair of photo-receptors 24 and 25 disposed within housing portion 11 receive light beams 17 and 18, respectively. When card B occupies its intended position in slot 12 as illustrated, light beams 17 and 18 are intercepted and attenuated by corresponding card portions 20 and 21 before reaching their associated photo-receptors. A detector and output circuit 26 responds to the condition of photo-receptors 24 and 25 for selectively supplying an output signal as indicated by arrow 28 to a separate door opening circuit, not shown.

It will thus be seen that the basic concept of the invention is to provide a key-card system which operates selectively under the control of an identification card, and more particularly, as determined by the light-transmissive characteristics of two or more predetermined portions of the card. While visible light may be used I nevertheless prefer to filter out all or most of the visible light wave lengths by means of filters 15a and 16a. In fact, it is preferred that beams 17 and 18 consist predominately of wave lengths in the near-infra-red region. One advantage of the use of invisible light is that the operating principle of the control housing and the equipment contained therein is not easily ascertained merely from an inspection of the housing. More important is the fact that the significant characteristics of the identification card upon which its usefulness as a key depends cannot be ascertained by ordinary visual inspection of the card. More specifically, use of suitable material in the identification card, and treatment thereof with suitable chemicals, makes it possible to give the card a uniform degree of transparency or opacity throughout its entire area as far as visible light is concerned, while at the same time controllably varying the light-transmissive characteristics of selected portions of the card for the particular invisible light wave lengths which are being used.

While a single light source is illustrated in FIGURE 2 it will of course be understood that two separate sources may be used, one to provide light beam 17 and the other to provide light beam 18. In fact, I prefer to use two separate light sources in order to eliminate the need for reflectors 15, 16, and thus make it possible to economically obtain a high quality of invisible light. Even though separate sources for the two light beams are used there is no difficulty in regulating the relative intensity thereof, as will be explained.

Reference is now made to FIGURE 3 illustrating one form of electronic detection circuit suitable for carrying out my invention. It is preferred to utilize a light source which provides a constant level of illumination, although the energization thereof may be provided either from an alternating current or from a direct current source. The detection circuit of FIGURE 3 operates as a comparison circuit which provides an output signal when predetermined relative intensities of beams 17 and 18 are received by the corresponding photo-receptors.

In the circuit of FIGURE 3 the particular photo-receptors used are designated as 24a and 25a, respectively. Receptor 24a includes a cadmium selenide photo-cell 54 and a resistor 55 connected in parallel therewith. Receptor

25a includes a cadmium selenide photo-cell 56 and a resistor 57 connected in parallel therewith. The two photo-cells provide adjacent arms of a bridge circuit and are connected in common to a grounded terminal 60 while their opposite ends are connected to terminals 61 and 62, respectively. A potentiometer 63 connected between terminals 61 and 62 provides the two remaining arms of the bridge circuit. A movable contact 64 interconnects potentiometer 63 with a signal output line 65. Alternating voltage from a source 66 is supplied to terminals 61 and 62 of the bridge circuit. Whether or not a signal is generated upon output line 65 depends in part upon the position of movable tap 64, and also upon the light intensities received by photo-cells 54, 56. The purpose of resistors 55, 57 is merely to aid in matching the characteristics of the photo-cells for the operating range to be used.

When the bridge circuit of FIGURE 3 is unbalanced an alternating current flows on output line 65, and when the bridge circuit is balanced no alternating current flows on output line 65. A triode tube 70 has its control grid 67 connected to signal line 65 while its cathode 68 is grounded. A diode 66 has its anode grounded and its cathode connected to signal line 65. Plate 69 of triode 70 is connected through a relay coil 71 to a source of positive potential designated as B+. Relay coil 71 operates a switch 72 which is connected in a series loop circuit with a power source 73 and a latch release solenoid 74, neither of which is shown in detail.

The operation of the circuit of FIGURE 3 is as follows. For any condition of unbalance of the bridge an alternating voltage impressed on output line 65 produces a rectified current flowing through diode 66. The polarity of diode 66 is such as to negatively bias control grid 67 of triode 70, and this is true irrespective of the direction of unbalance of the bridge circuit. Triode 70 is therefore cut off when the bridge circuit is unbalanced, but when the bridge circuit is balanced the negative bias on grid 67 is removed and triode 70 becomes conductive. The flow of plate current through relay coil 71 then operates the latch release solenoid, thus opening the door.

Reference is now made to FIGURES 4 and 5 illustrating another form of electronic circuits which may be utilized to carry out my invention. In accordance with this second embodiment of the invention a light source of oscillating intensity is required, which may conveniently be provided by the circuit of FIGURE 4. In FIGURE 4 a source of alternating voltage 31 is connected in a series loop circuit with a rectifier 32 and a bulb 33.

In the circuit of FIGURE 5 a second form of photo-receptors identified as 24b, 25b consists of a pair of photo-transistors of the N-P-N type. Photo-transistor 25b has a collector 34, a base 35 and an emitter 36. Photo-transistor 24b has a collector 37, a base 38 and an emitter 39. Each emitter is directly connected to a source of negative potential identified as B-, with collectors 34 and 37 being connected to ground through load resistors 41 and 42, respectively. A signal output line 47 is connected directly to collector 37 by means of a lead 43 and is coupled to collector 34 through a series capacitor 46. An output transistor 50 of the P-N-P type has its emitter grounded while its collector is coupled through the primary winding of a transformer 51 to power supply terminal B-. A bias resistor 48 interconnects terminal B- with signal line 47 for normally biasing the base of transistor 50, which also receives a signal from signal line 47. The secondary winding of impedance-matching transformer 51 is coupled in a series loop circuit to a relay coil 52, whose operation is similar to that of relay coil 71 of FIGURE 3.

The electrical operation of the circuit of FIGURE 5 is as follows. Transistor 50 is normally biased to a conductive state by the operation of bias resistor 48, in conjunction with load resistor 42, and is normally in class A operation. Existence of a signal on signal line 47 cannot cut off transistor 50 but can throw it into a state of cur-

rent saturation. Signal line 47 may receive a direct voltage signal from photo-transistor 24b or an alternating voltage signal from photo-transistor 25b, or both at the same time.

Each of photo-transistors 24b, 25b is utilized as a three-state device. Each is characterized by current saturation for a received light intensity which exceeds a predetermined minimum value. The typical response characteristic of each photo-transistor is such that current at first increases slowly with the received light intensity, and then much more rapidly until the saturation current is reached. The energization of the light source (or sources) is so controlled that when card B does not occupy slot 12 the received light intensity is sufficient to maintain each photo-transistor in a continuous state of current saturation. That is, the minimum light intensity represented by the summation of the alternating and direct components of the light beam intensity is sufficient to produce current saturation of each photo-transistor.

If the light beam is completely blocked off by an opaque card portion, then no current flows in the photo-transistor. If the card is not occupying the slot, or if the particular card portion intercepting the beam presents negligible attenuation thereto, then the photo-transistor remains in saturation and exhibits a direct current flow only. If the intercepting card portion provides an intermediate degree of attenuation the oscillations in received light intensity will lie as a small band somewhere between the zero and saturation current values for the photo-transistor, which will then exhibit a current flow comprising both a direct component and an alternating component.

The three possible states of the two devices of FIGURE 5 give rise to nine possible circuit conditions which are dependent upon the light attenuation characteristics of a card inserted in slot 12. According to the invention, the lock will be opened only when a particular one of the nine conditions is fulfilled. For this particular condition card portion 20 is opaque, causing no current to flow in receptor 24b, while card portion 21 is translucent, causing an alternating current to flow in receptor 25b. Referring to the circuit of FIGURE 5, it will be seen that the flow of current in receptor 24b causes transistor 50 to become saturated, hence an alternating output current can be supplied to transformer 51 only if no direct current flows through receptor 24b. Also, such an alternating current can be derived only through capacitor 46 from receptor 25b when the latter is subjected to an attenuated alternating light intensity.

It will therefore be seen that transistor 50 and resistor 48 constitute gating circuit means for detecting the flow of direct current in photo-transistor 24b. Also, capacitor 46 and transformer 51 constitute additional gating circuit means for detecting the flow of alternating current in photo-transistor 25b.

Although my invention is fully capable of achieving the results and providing the advantages hereinbefore mentioned, it is to be understood that it is merely the presently preferred embodiment thereof, and that I do not mean to be limited to the details of construction above described other than as defined in the appended claims.

I claim:

1. A key-card system including a housing structure having a slot for receiving an identification card, an identification card adapted for insertion within said slot, light source means disposed within one side of said housing structure for generating a pair of invisible light beams directed toward corresponding predetermined portions of said card when inserted in said slot, a pair of photo-receptors disposed within the other side of said housing structure and adapted to receive corresponding ones of said light beams, electric circuit means associated with said photo-receptors, including a bridge circuit for comparing the light intensities received by said photo-receptors, and selectively operable for producing an output signal in response to a predetermined condition in which

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a particular one of said light beams is attenuated more than the other in passing through said slot, and lock-opening means operable in response to said output signal.

2. A key-card system as claimed in claim 1 in which means are provided for continuously varying the intensities of said light beams, said photo-receptors are continuously current-saturated when said beams are not attenuated, and said electric circuit means is responsive to the flow of alternating current in one of said photo-receptors coinciding with the absence of direct current flowing in the other of said photo-receptors for producing said output signal.

3. An electronic circuit comprising a pair of photo-transistors each having a collector, an emitter and a base, and characterized by a state of current saturation when the received light intensity incident upon its base exceeds a predetermined minimum value; power supply means for supplying a direct voltage to both of said photo-transistors; a pair of load devices, one associated with each of said photo-transistors; gating circuit means for detecting the flow of direct current in one of said photo-transistors; and additional gating circuit means including a coupling capacitor for detecting the flow of alternating current in the other of said photo-transistors.

4. An electronic circuit comprising a pair of photo-receptors each characterized by a state of current saturation when its received light intensity exceeds a predetermined minimum value, power supply means for supplying a direct voltage to both of said photo-receptors, a separate load device associated with each of said photo-receptors, and gating circuit means operable for producing an output signal only when the flow of direct current in a particular one of said photo-receptors coincides with the flow of alternating current in the other of said photo-receptors.

5. A key-card system comprising a housing structure having a slot for receiving an identification card; an identification card including two separate portions having predetermined light-transmissive characteristics relative to each other, said card being adapted for insertion within said slot; light source means disposed within one side of said housing structure for generating a pair of light beams

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directed toward corresponding ones of said card portions when said card is inserted within said slot; a pair of photo-receptors disposed within the other side of said housing structure and adapted to receive corresponding ones of said light beams; electric circuit means associated with said photo-receptors including means for comparing the light intensities received by said photo-receptors, said electric circuit means being selectively operable for producing an output signal in response to a predetermined ratio of the light intensity received by one of said photo-receptors to the light intensity received by the other of said photo-receptors; and lock-opening means operable in response to said output signal.

6. An electronic circuit adapted to respond to a predetermined condition of relative intensity values of a pair of light beams, said circuit comprising: a pair of photo-receptors for receiving corresponding ones of said light beams; impedance means coupled to said photo-receptors to provide an electrical bridge circuit which is normally unbalanced except upon the occurrence of said predetermined condition; means for supplying an alternating voltage across two terminals of said bridge circuit; a rectifier element coupled between the other two terminals of said bridge circuit, said rectifier element being responsive to any unbalance voltage produced by said bridge circuit for generating a bias voltage; an output device; and means for applying said bias voltage to said output device to maintain said output device in a non-operative condition except when said bridge circuit is balanced.

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