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SEARCH ROOM

United States Patent

Hudson, Jr.

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[45] Feb. 15, 1972

[54] CODE AUTHENTICATOR

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[73] Assignee: **Hudson Corporation**, Manchester, N.H.

[22] Filed: **Mar. 28, 1969**
[21] Appl. No.: **811,343**

[52] **U.S. Cl.** .....**235/61.7 B**, 340/149 A, 340/365
[51] **Int. Cl.** **G06f 3/02**, G06k 17/00, G08c 9/00
[58] **Field of Search** .....235/61.114, 61.11, 61.7, 61.7 B; 340/149 A, 164, 174 TF, 365; 222/2; 194/4; 179/100.2 CH, 100.2 A; 307/309

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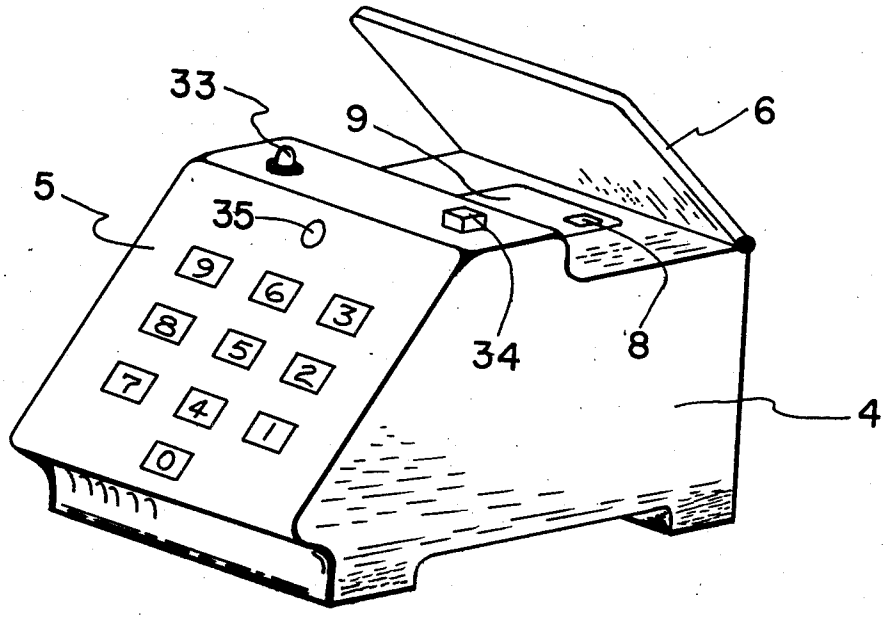
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[57] **ABSTRACT**

An authenticator device has an array of semiconductive magnetic transducers corresponding to an array of magnetically encoded areas on a card. The magnetic transducers statically sense the encoded areas on the card and provide electrical signals which are compared with information entered by a keyboard. Actuation of the keys causes a sequence of coded electrical signals to be generated corresponding to the order in which the keys are actuated. Each key code is compared in its turn with an appropriate part of the coded information read by the transducers from the card. Where a difference occurs between compared signals, the authenticator device provides an indication of noncorrespondence at the conclusion of a series of comparisons.

1 Claims, 9 Drawing Figures



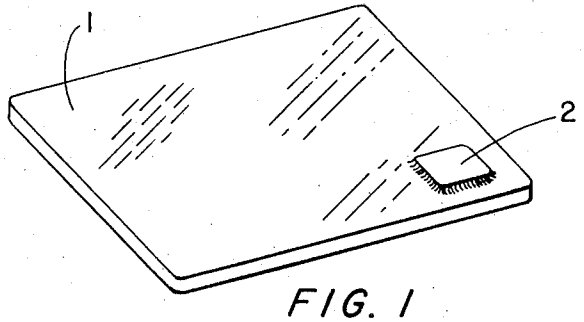


FIG. 1

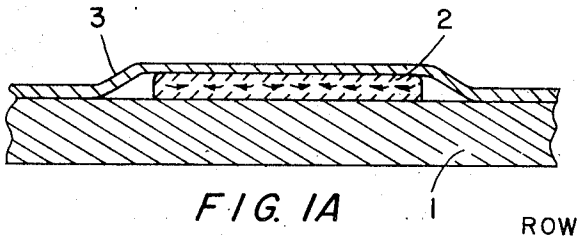


FIG. 1A

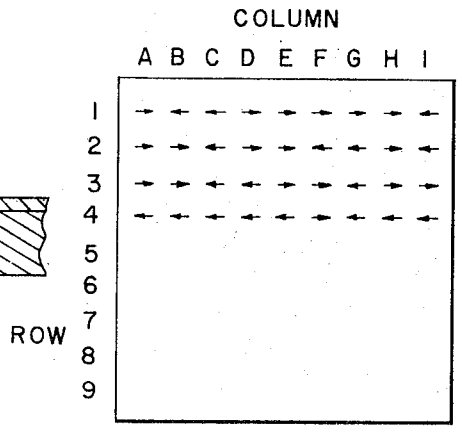


FIG. 1B

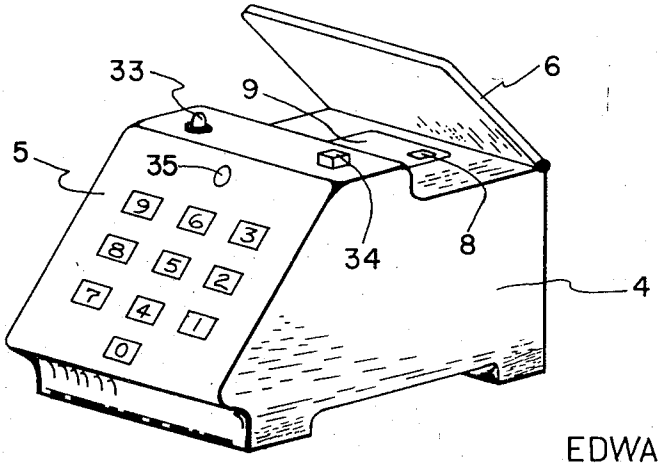


FIG. 2

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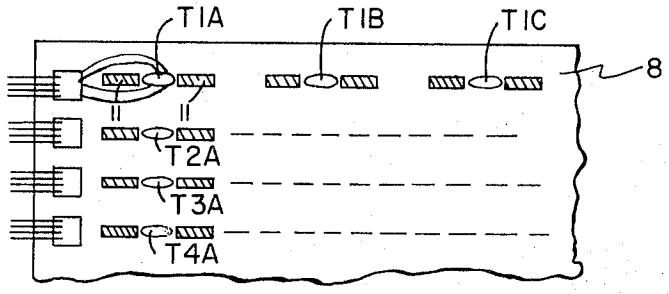


FIG. 3

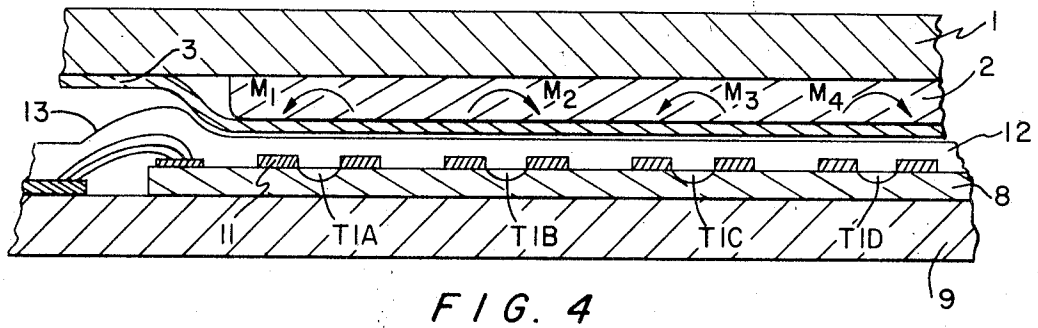
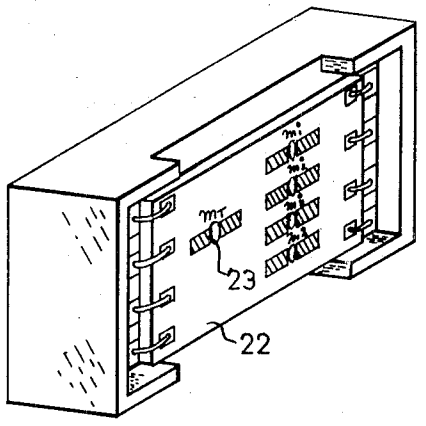


FIG. 4



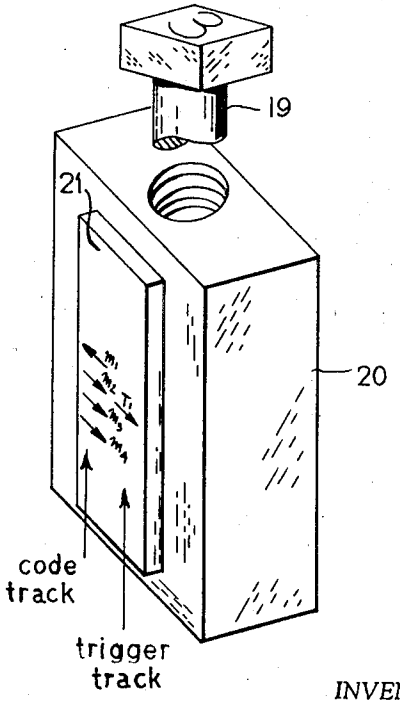


FIG. 5

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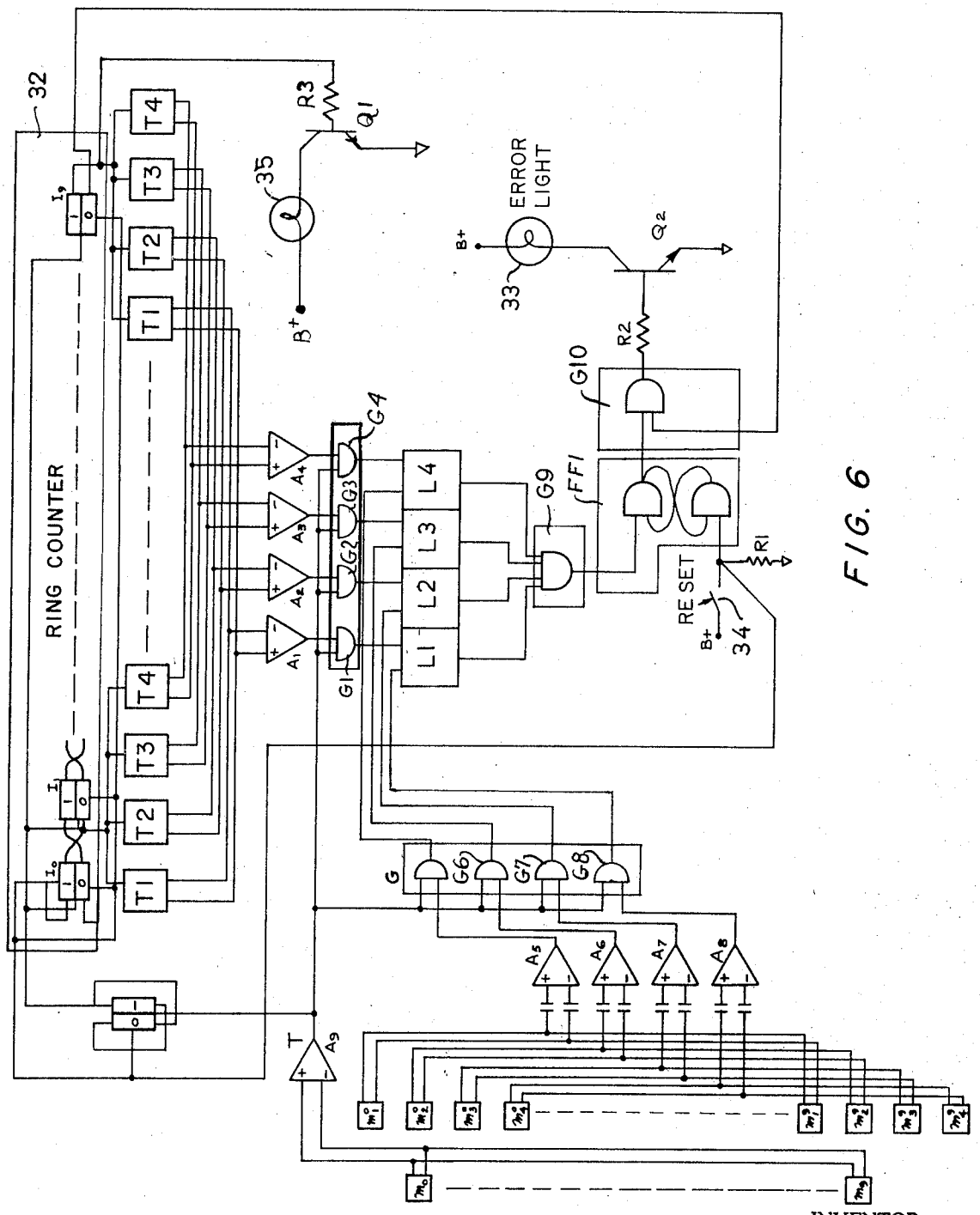


FIG. 6

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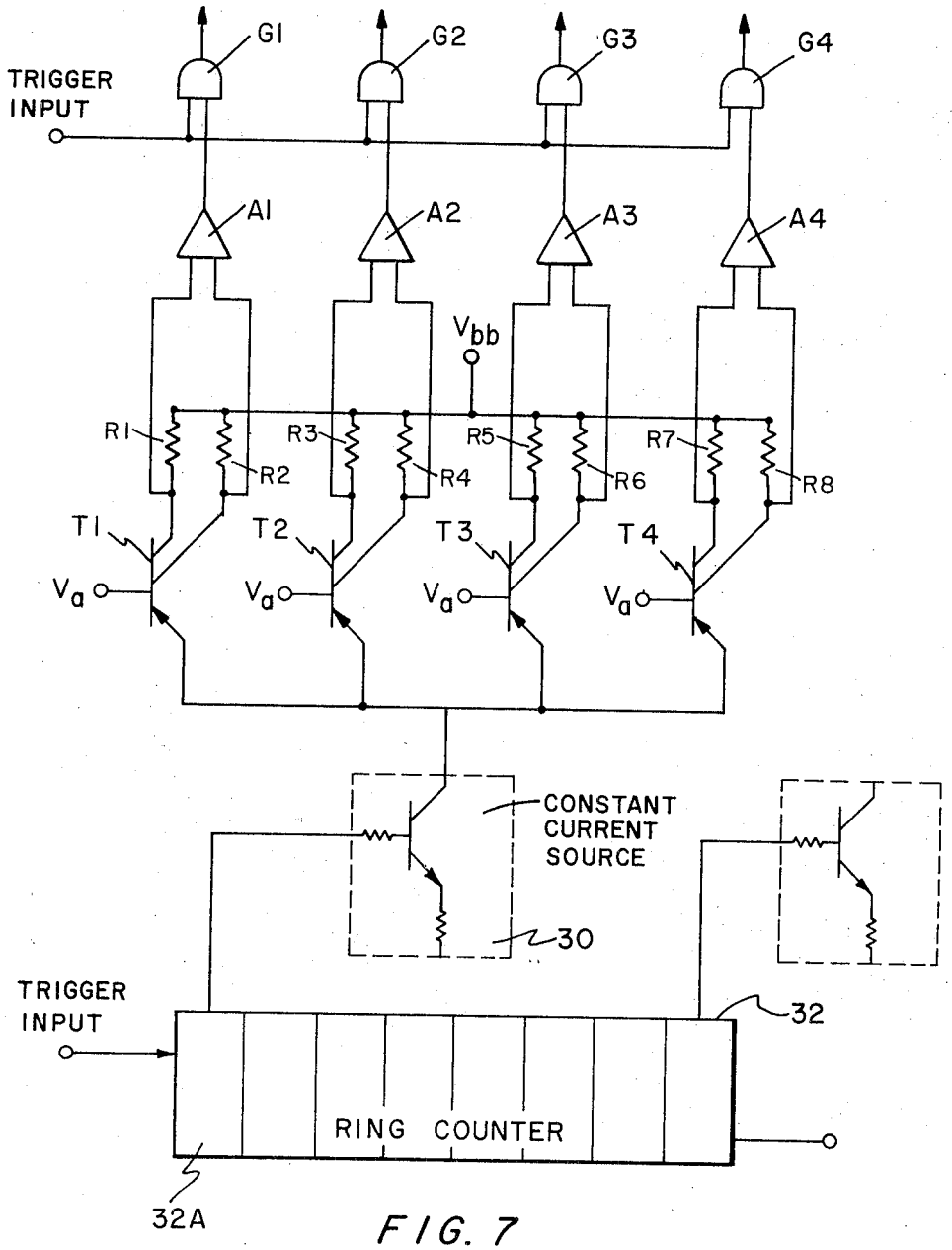


FIG. 7

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CODE AUTHENTICATOR

SUMMARY OF THE INVENTION

This invention relates to a system for determining the authenticity of a holder of a credit card. More particularly, the invention concerns a simple means for ascertaining whether a person presenting a credit card is using a stolen or unlawfully obtained card.

DISCUSSION OF THE PRIOR ART

The widespread use of credit cards has resulted in an increasing trend toward the theft and unauthorized use of such cards. Where the card is lost or stolen, the person obtaining possession of the card is usually able to make unauthorized use of the card without difficulty because the mere possession of the card is accepted in most instances as sufficient to establish the authority to use it. Many of the card holders are obligated, in the event the card is lost or stolen, to indemnify the issuing agency for purchases made on the card for a reasonable period after notification is given of the theft or loss. There is, therefore, a strong motive for card holders to guard against the theft or loss of their credit cards.

OBJECTIVES OF THE INVENTION

The primary objective of the invention is to provide a simple and inexpensive system for assuring that the person presenting the credit card has authority to use it. The invention contemplates assigning a number or other identifying symbols to a credit card holder and encoding the card with the assigned identification in a manner readable only by a special machine. The card is used by having the card holder enter into the machine the number or identifying symbols corresponding to the encoding on the card. The machine does not indicate the identification encoded on the card but rather only indicates the correspondence or noncorrespondence between information entered into the machine by the card holder and the encoding on the card. The card holders's protection resides in memorizing the identifying number or in keeping that number, if written, in a secure place apart from the card. To facilitate memorizing the assigned identification, a number familiar to the card holder, such as his Social Security number, can be encoded on the card.

THE DRAWINGS

The invention, both as to its construction and mode of operation, can be better understood from the exposition which follows when it is considered in conjunction with the accompanying drawings in which:

FIG. 1 is a view of a preferred form of a magnetically encoded card,

FIG. 1A depicts a cross section of the encoded portion of the card,

FIG. 1B schematically depicts the preferred coding arrangement in which the coded areas form an orthogonal array of columns and rows,

FIG. 2 depicts a preferred form of the "authenticator" machine which compares keyboard entered information with the encoded card information,

FIG. 3 depicts apparatus for sensing the information encoded on the card,

FIG. 4 is a cross-sectional view depicting the alignment of the sensors with the encoded areas on the card,

FIG. 5 depicts a key and the key code generator,

FIG. 6 schematically depicts the logic arrangement in the "authenticator"c machine, and

FIG. 7 shows, in schematic form, the manner in which the magnetic transducers are arranged in sets.

THE EXPOSITION

FIG. 1 depicts a preferred form of the card-carrying encoded identification. The card 1 is a rectangular sheet which may have the holder's name and address printed on it in the usual manner. Secured upon the card adjacent one of its corners is a square of material 2 that can be permanently magnetized. The square, for example, may be 0.2 inch on a side and 0.010 inch thick. Over the square, as indicated in FIG. 1A, is a protective film 3 of nonmagnetic material. The protective film, preferably, is as thin as possible consistent with the protection afforded to the square of magnetic material. The square of magnetic material is encoded by magnetizing selected areas. Assuming the information to be encoded is a sequence of decimal numbers, as in a Social Security account, the code employed is preferably a four bit binary decimal code. That is, each decimal numeral is preferably encoded in the form of a binary number having four bits. As the usual Social Security account number has nine decimal numerals, an encoded square would represent that number as a matrix of magnetized areas arranged in four rows and nine columns, as depicted in FIG. 1B. The remainder of the square is, of course, available to represent other encoded information. In FIG. 1B, the arrows schematically represent the polarized directions of the magnetized areas. That is, the two binary values employed in the code are represented by oppositely magnetized areas. If desired, one binary value may be represented by a magnetized area and the other binary value may be represented by an unmagnetized area. In the preferred embodiment, oppositely magnetized areas are used to represent the two binary values because that manner of encoding increases the difficulty of altering the code except with special apparatus.

The magnetic fields of the encoded areas extend above the protective film 3. Those fields and their directions can be sensed by employing semiconductive magnetic transducers of the kind disclosed in my U.S. Pat No. 3,389,230. The magnetic transducer there disclosed responds to the intensity of magnetic field by altering the ratio in which current from a common emitter divides between a pair of collectors. In contrast to conventional magnetic transducers which respond to the rate of change of magnetic flux, my semiconductive magnetic transducer is influenced by the intensity of the magnetic field and can, even in a nonvarying magnetic field, provide electrical signals indicating the direction and intensity of the field. Insofar as the binarily encoded areas on the card are concerned, the information is carried by the direction of the field. So long as the field is above a minimum intensity, the field intensity is unimportant as the transducer merely has to sense the field direction to determine the binary value of the coded area.

FIG. 2 depicts a preferred embodiment of the "authenticator" device for comparing information entered by the card holder with the encoded information on the card. The "authenticator" employs a housing 4 having a keyboard 5 and a hinged lid 6. Situated in the bed 7 of the housing is a square silicon chip 8 which is slightly larger than the encoded square 2 on the card. On the silicon chip, depicted in FIG. 3, are a matrix of my magnetic transducers arranged to register with the matrix of encoded areas on the card. The bed 7 preferably has an indentation 9 corresponding to the outline of the card to aid in positioning the encoding on the card in proper relation to the matrix of magnetic transducers on the chip. In FIG. 3, each magnetic transducer is represented by an oval. Electrical connections from the magnetic transducers are made to connectors at the edges of the chip. For clarity, the electrical connections from the magnetic transducers have, except for one transducer TIA, been omitted from the drawing. Adjacent to each magnetic transducer are deposited strips 11 of magnetic material. The magnetic strips 11 provides a low reluctance path for magnetic flux and when in a magnetic field direct the magnetic flux through the transducer for detection. The thickness of magnetic material deposited adjacent the transducer is typically about 5,000 A. To protect the magnetic transducers, the silicon chip is mounted on a back plate and the exposed surface of the silicon chip is preferably coated with a thin film of quartz or epoxy.

FIG. 4 depicts, in cross section, the silicon chip 8 mounted on the back plate 9 and protected by coating 12. Magnetic

transducers, diffused into the silicon chip, are indicated at TIA, TIB, etc., between the deposited magnetic strips 11. The border 13 around the silicon chip is raised to form a square indentation which aids in positioning the magnetic square on the card so that the encoded areas register with the magnetic transducers on the chip. With the card properly positioned, the matrix of transducers is aligned with the matrix of encoded areas whereby each transducer is adjacent to a coded magnetized area, as depicted in FIG. 4. The coded magnetized areas, represented by the vectors M_1, M_2, M_3–, are sensed by the adjacent magnetic transducers which provide signals indicating the direction of the vector. Thus the signal from a transducer is a binary One if the vector is in one direction or is a binary Zero if the vector is in the opposite direction. The "reading" of the encoded card is static in the sense that motion between the transducer and the magnetized areas is not required. The code "reading" is compared with information entered into the "authenticator" through the keyboard 6.

The keyboard has an array of keys, depicted in FIG. 2, which can be manually actuated to enter information for comparison with the encoded information on the card. Assuming the encoded information on the card represents a sequence of decimal numbers, such as a Social Security account number, the keys are marked with the decimal numbers o, 1, 2,–8, 9. Upon actuation of a key, electrical signals are generated corresponding to the four bit binary code of the key's number. A key and its "reader" are shown in FIG. 5. The key 19 is attached to a carrier 20 upon which is secured a sheet 21 of permanent magnet material having four magnetized areas arranged in a code track and having another magnetized area in a trigger track. The four magnetized areas in the code track represent the binary code of the key's number. Fixed in the housing 5 is a "reader" having a silicon chip 22 on which are diffused five magnetic transducers in an arrangement corresponding to the magnetized areas of the key. Each transducer, represented by an oval in FIG. 5, is situated between a pair of deposited strips of magnetic material. The magnetic strips act to concentrate magnetic flux in the same manner as the previously described strips 11. On depressing the key, the carrier is moved to place the coded magnetized areas adjacent to the transducers on the reader. The key is arranged to move the carrier downwardly relative to the reader and the carrier is guided to insure that the magnetized areas move into alignment with the array of transducers on the reader. The trigger transducer 23 emits a "trigger" signal when it is in register with the magnetized area in the trigger track. Simultaneously, the four other transducers in the reader are in position to sense the magnetized areas in the code track. For convenience, the trigger transducer is designated $m_T{}^3$, and the other four transducers in the reader are designated $m_1{}^3 m_2{}^3, m_3{}^3$, and $m_4{}^3$, the superscript indicating that those transducers are related to the key bearing the decimal 3.

After placing the card in position in the "authenticator", the card user, to establish his authority to use the card, is requested to actuate the keys to enter, in proper sequence, the numbers corresponding to the numbers encoded on the card. Each time a key is depressed, the binary code generated by the key's reader is compared with information read from the encoded card.

FIG. 6 schematically depicts apparatus for comparing the keyboard entered information with the information obtained from the encoded card. The magnetic transducers on the card reader 8 are arranged in nine sets, each set having four magnetic transducers. Referring to FIG. 7, a typical set of magnetic transducers is shown. The emitters of the transducers T1, T2, T3, T4 are connected to a constant current source 30 and the collectors of the transducers are connected through resistors R1, R2, etc., to a source of electrical potential V_{bb}.

The constant current source is controlled by a stage of a ring counter 32. For illustrative purposes the constant current source is here shown to be controlled by the first stage 32A of the ring counter. In actual practice, the stages of the ring counter may themselves provide the constant current for the associated set. In the initial condition of the ring counter, all the stages are set so that the constant current sources are off. The application of a signal to the input of the ring counter causes the first stage to turn on the constant current source. A signal V_a is applied to the base of each semiconductive magnetic transducer in the set to bias each of those transducers into conduction whereby the current form the source 30 flows through all four transducers. Each of the transducers is adjacent to a magnetized area on the coded card and, depending upon the direction of the areas' magnetic field, the current flow through the transducer is more heavily influence toward one or the other of its two collectors. Therefore as the potential at one collector drops due to the increased current flow through its resistor, the potential at the other collector rises due to the decreased current flow through its resistor. The two collectors of each transducer provide the inputs to a differential amplifier A1, A2, A3, or A4. The output of the differential amplifier indicates, therefore, the direction of the magnetic field senses by the transducer. The four transducers in the set remain activated while the constant current source remains on. Upon the application of a second trigger signal to the input of the ring counter, the first stage current source is turned off and the second stage current source is turned on to activate the next set of four transducers. Thus each set of four transducers is activated in turn as trigger signals are applied to the ring counter.

The trigger signal is generated each time a key is fully depressed and occurs when the magnetized area in the key's trigger track is sensed by the trigger transducer. As the numbered keys are depressed, the trigger pulses cause the ring counter to turn on, in succession, a set of four transducers. The trigger signal, in addition to advancing the ring counter, is applied to gates G1, G2, G3, G4 (FIGS. 6 and 7) to enable those gates to pass the signal emitted at the outputs of differential amplifiers A1, A2, A3, A4. Concurrently, the trigger signal enables gates G5, G6, G7, G8 (FIG. 7) to pass the signals emitted from the key reader which are amplified by amplifiers A5, A6, A7, A8. The outputs of the card reader and the key reader are compared by half adders L1, L2, L3, L4 which receive their inputs from the signals passing through the gates G1 to G8. Where the two input signals applied to a half adder are both One or both Zero the half adder does not emit an energizing signal to gate G9. Where the two inputs applied to the half adder are different, the half adder emits an energizing signal to gate G9. Thus, if one or more of the half adders emits an energizing signal, the gate G9 emits a signal to the set input of flip-flop FF1. Upon being "set", the flip-flop emits a signal to AND gate G10. The AND gate, however, remains blocked until the last stage in the ring counter is turned on. Upon the last stage in the ring counter being turned on, the counter emits an enabling signal to gate G10. If the flip-flop has been "set", gate G10 then emits a signal to turn on transistor Q2 and cause the error lamp 33 to be lighted. Flip-flop FF1, once it has been "set", remains in that state and is unaffected by subsequent "set" signals. To restore the flip-flop to its initial state, a key 34 must be manually actuated to apply a "reset" signal to the flip-flop FF1 to its initial state, actuation of the key causes the ring counter to be restored to its initial state where its first stage will be turned on by the next trigger signal.

Because each set of four magnetic transducers in the card reader is turned on in succession by the ring counter, the nine sets of transducers in the card reader can employ the same differential amplifiers A1, A2, A3, A4. Schematically, in FIG. 6, the sets of transducers T1, T2, T3, T4 are arranged with all T1 transducers connected to amplifier A1, all T2 transducers connected to amplifier A2, and so forth. Only the transducers in the set that is turned on affect the amplifiers to which they are connected. The other transducers, due to their high-output impedance, do not materially load the signal-producing transducer.

In the logic arrangement of FIG. 6, it is convenient to have the ring counter actuated by the trailing edge of the trigger

pulse. In this manner, the ring counter is preset by the last-occuring trigger pulse to energize the appropriate set of four magnetic transducers in preparation for the actuation of the next key on the keyboard. By employing the trailing edge of the trigger pulse, switching problems are avoided as the energized set of transducers have time to "settle" before the set is required to detect the magnetized areas on the card.

The keys of the keyboard are arranged to permit only one key at a time to be actuated and means are provided to return the key when it is released. As only one key is actuated at a time, the four code transducers in the key readers are arranged to use amplifiers **A5**, **A6**, **A7**, **A8**. Further, the trigger signal provided by the trigger transducers in the key readers are amplified by a common amplifier **A9**.

The scheme shown in FIG. **6** for comparing the keyboard entered information with the code read from the card is but one form of "logic". In that scheme, as each key is actuated, a four bit code is generated and is compared with a four bit code read from the card. Each time a key is actuated, the ring counter is advanced to cause the comparison to be made with the appropriate card-encoded information. The comparison proceeds serially with the sequential actuation of the keys. The logic arrangement can be modified to store the keyboard entered information in a manner permitting all or part of the stored information to be simultaneously compared with the encoded card information. The serial comparisons, however, permit a reduction to be achieved in the amount of apparatus.

To insure that the keys have been actuated to permit a full comparison to be made with the encoded card, the authenticator (FIG. **2**) is provided with a lamp **35** which remains lit until the last stage in the ring counter is turned on. Where lamp **35** is lit, it indicates that the full nine numerals in the Social Security account number have not all been entered in the keyboard. Where the keys are actuated nine times, the last stage of the ring counter emits a signal which turns transistor **Q1** off and causes lamp **35** to be extinguished. If either lamp **33** or lamp **35** is lit, the authority of the card holder to employ the credit card is not established.

It is obvious to those familiar with electronic data processing technology that the signals generated by the keyboard and the signals furnished by the card reader can be transmitted to a computer programmed to compare the signals and transmit back to the authenticator a signal indicative of the result of the comparison. In effect, the signal comparison operations are then performed by apparatus in the computer rather than by apparatus in the "authenticator".

I claim:

1. Authenticating apparatus for comparing keyboard entered information with binary information encoded on a card as an array of magnetized areas, the binary values of the code being represented by the orientations of the magnetic field emanating from the magnetized areas, the apparatus comprising

a keyboard having a plurality of keys corresponding to different symbols, each key having a carrier magnetically coded to correspond with its symbol;

key-code-generating means, operable upon actuation of a key to read the magnetically coded information on the carrier and generate correspondingly coded electrical signals;

a card reader for reading information encoded upon the card, the card reader having an array of semiconductive transducers arranged in sets, the array of transducers being arranged to register with the array of magnetized areas on the card when the card is properly aligned on the card reader, the transducers, when energized, sensing the magnetic fields emanating from the coded card and providing electrical signals indicative of the directions of those fields, the card reader having means providing low reluctance paths which concentrate flux from a card's magnetized area upon the transducer in register with that magnetized area;

alignment means for properly positioning the card on the card reader to cause the arrays to be in register;

a counter coupled to the array of card reader transducers, the counter being arranged to cause the transducers to be energized in sets whereby each set is energized according to its order in a sequence of sets as the counter is advanced;

means for providing a signal to advance the counter upon the actuation of a key;

a comparator for comparing in sequence the electrical signals from the key-code-generating means with the electrical signals from the sets of card reader transducers; and

means connected to the comparator for indicating the result of the comparisons upon advance of the counter to the end of the sequence.

* * * * *