United States Patent [15] 3,637,990

Bayha et al. [45] Jan. 25, 1972

[54] CREDIT CARD VALIDATOR WITH TRANSDUCER-READOUT

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[22] Filed: **Oct. 31, 1969**

[21] Appl. No.: **873,029**

[52] **U.S. Cl.** .... **235/61.7 B**, 340/149 A

[51] **Int. Cl.** **G06k 5/00**, H04q 3/00

[58] **Field of Search** .... 235/61.7, 61.7 B; 340/149 A, 340/156, 164; 221/2; 222/2; 194/4; 179/2 CA, 6.3 CC

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[57] **ABSTRACT**

An identification number is encoded on a card in the form of a number of areas of closely spaced variations in the planar configuration of the card, the spacing of the variations in a particular area being determined by the digit encoded on that region. The encoded number is read by a device which moves the card at a uniform speed with the variation bearing areas in contact with an electromechanical transducer. As each area passes the transducer a tone, whose frequency is determined by the spacing of the variations of the area and, therefore, identified with the digit encoded in that area, is produced, amplified, and then drives the coil of a resonant-reed relay. The contact of the relay which has a resonant period equal to the generated frequency and corresponding to the encoded digit closes. The reading device compares the number determined by the relay with one manually supplied to it and indicates the identity or nonidentity of the two numbers.

6 Claims, 5 Drawing Figures

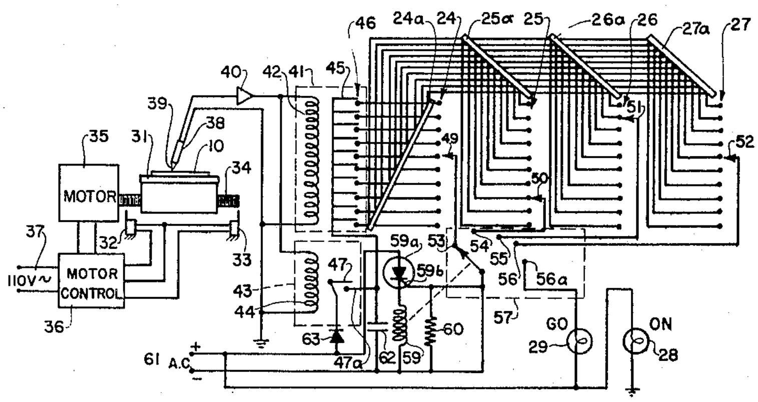


FIG.-1

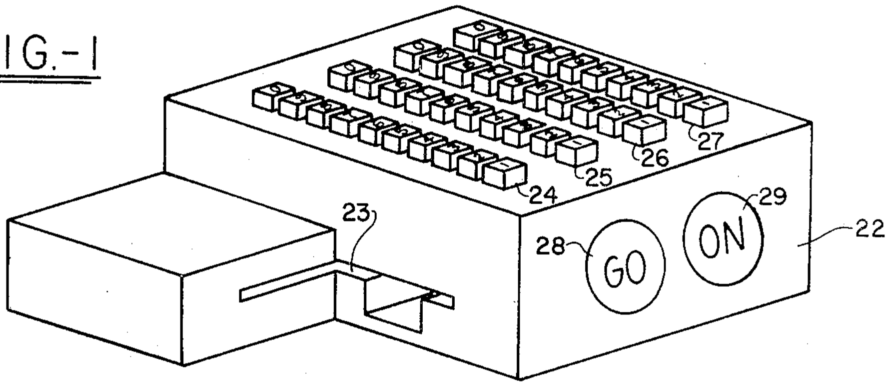
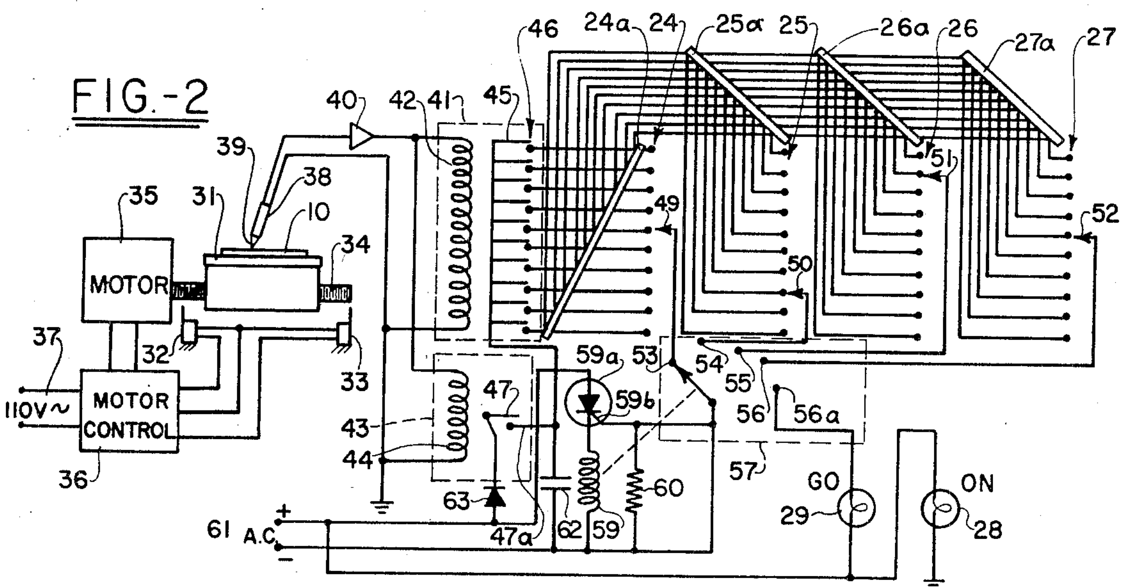


FIG.-2



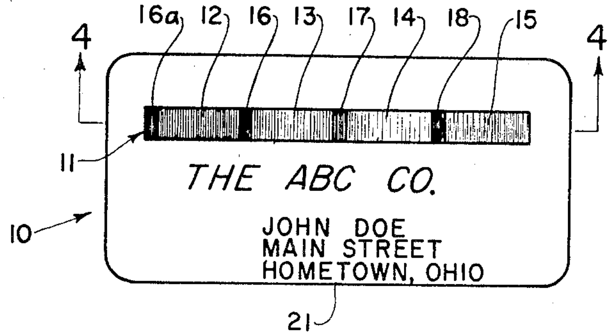


FIG.-3

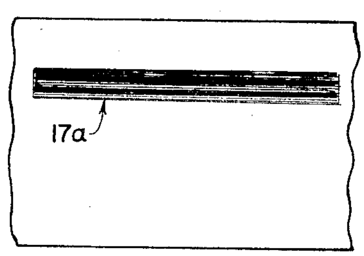


FIG.-5

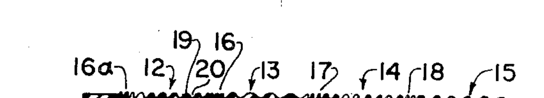


FIG.-4

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CREDIT CARD VALIDATOR WITH TRANSDUCER-READOUT

This invention relates to a credit card validation device and, more particularly, to a novel arrangement for encoding an identification number on a plastic card and to a device for reading the encoded identification number and for comparing the same with an identification number manually supplied to the device.

As one feature, this invention is concerned with the prevention of use of credit or identification cards by unauthorized persons. Such control of the use of the cards is desirable in many situations, for example, where the card is used to indicate that the holder is entitled to admission to a restricted area or where the card is used to advance credit to the holder at an unattended vending machine or where the card is used for automatic banking. In order to provide such an identification means on a plastic or laminated card, it is essential that the identifying indicia encoded on the card be in a form which can be read only by a properly designed reading device and which cannot be deciphered by visual inspection or other means so that unauthorized holders of the card cannot learn the identifying indicia encoded thereon. It is also necessary that the encoded indicia be read reliably and accurately by the reading device and that the method of encoding the identifying material on the card be such so to make the altering or counterfeiting of such cards extremely difficult or impossible. It is also important that the indicia be substantially permanent on the card.

It is an object of the invention to provide a device for reliably and accurately reading and determining the information encoded on such a plastic card. As described below, this is accomplished by moving the indicia-bearing portion of the card at a uniform rate past and in contact with an electromechanical transducer and by supplying the signal generated by said transducer to the coil of a resonant-reed relay which has a reed which resonates at each of the possible frequencies assigned to the encoded information.

A further object of the invention is the provision of a card reading device which is capable of distinguishing a correctly identified card from one incorrectly identified. This function is accomplished in the reading device by comparing the encoded digit as determined by the resonant-reed relay with a digit manually entered into the reader by the card holder. Suitable circuitry detects the identity or nonidentity of the encoded digit and the manually entered digit.

Among other objects of the invention are the provision of a reader and validator for use with cards having information embossed thereon which is a simple and inexpensive construction utilizing commercially available components. A further object of the invention is the provision of means for encoding a number or other identifying indicia on a card or the like and for reading such information which is unaffected by ordinary wear or dirt on the card surface. Another object is the provision of such a card reader and validator system which may be readily and inexpensively altered so as to reject out-of-date cards.

Also, a purpose of the invention is to be able to put the information in code on existing "standard" credit cards, or a metal tag or card, or even paper.

The above and other objects and advantages of our invention will become apparent upon consideration of the following specification and the accompanying drawing wherein there is shown a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a isometric view of the credit card validator of our invention;

FIG. 2 is a schematic showing of the structural and circuit components necessary to achieve operation of the device of FIG. 1;

FIG. 3 is a plan view of a credit card with hill and dale recording used with the device of our invention;

FIG. 4 is a sectional view, on an enlarged scale, taken along the line 4—4 of FIG. 3; and

FIG. 5 is a plan view of a credit card with lateral recording that may also be used with the device of our invention.

Referring first to FIGS. 3 and 4, there is illustrated an information, credit, or identification card **10** normally made from plastic or other embossable material such as paper or metal, which is adapted to be used with the card validator described below. The card **10** is provided on one surface with a strip **11** extending linearly across the card face. This strip **11** may be formed in the card by any suitable means, for example by embossing. The strip **11** is divided into a number of regions **12–15** which are separated from one another by smaller regions **16–18**. Each of the regions **12–18** consists of a plurality of parallel ridges **19** and grooves **20** extending at right angles to the principal axis of the strip **11**. The ridges **19** and grooves **20** within each of the regions are uniformly spaced from one another. The spacing of the ridges and grooves **19** and **20** in each of the regions **12–15** is determined by the digit which the particular region represents and different spacings are employed for each digit represented. Thus, for example, if the digits **0–9** are employed, 10 different spacings are utilized to represent the different digits. The grooves **20** and ridges **19** of the dividing regions **16–18** are all provided with uniform spacings which are identical for each of these regions and which differ from any of the possible spacings of the regions **12–15**. The card **10** may also carry other indicia **21** on its face.

While the card of FIGS. 3 and 4 is preferably provided with vertically extending hill and dale recording grooves, the card of FIG. 5 is provided with one or more longitudinally extending lateral recording grooves **17*a***. Again, however, the longitudinal grooves will carry the same information as the strip **11** of FIGS. 3 and 4. In other words they will have uniformly spaced laterally directed surface variations.

While only surface embossing to achieve hill and dale or lateral variations to the planar surface of the card have been illustrated, it should be understood that the use of parallel aligned punched holes, laminated contoured strips, or the like will also meet the objects of the invention.

As shown in FIG. 1, the preferred embodiment of the card validating or verifying device consists of a housing **22** having a card-receiving slot **23**, a plurality of switches **24–27** for manually entering a multidigit number and a pair of signal lamps **28** and **29** which indicate the result of the card validity check. The housing **22** encloses a tray or platform **31** for receiving the card **10** which has been inserted through the slot **23**. The platform **31** is moved between stops or limit switches **32** and **33** by means of a screw **34** driven by a motor **35**. The motor **35** is preferably of the synchronous type and is connected by suitable controls **36** to an alternating current source **37**. An electromechanical transducer **38**, for example, a piezoelectric phonograph pickup, is mounted so as to track along the longitudinal axis of the strip **11** on the surface of the card **10**. Any suitable transducer capable of reproducing hill and dale recording or vertical recording may be used. It will be apparent that as the card is drawn across the transducer **38**, the stylus **39** of the transducer vibrates at a frequency determined by the spacing of the ridges **19** and grooves **20** of the regions **12–18** of the strip **11** and by the rate of travel of the carriage **31** and the card **10**. The signal generated by the transducer **38** is amplified by an amplifier **40** and the output of this amplifier drives the coil **42** of a resonant-reed relay **41**. The output signal of the amplifier **40** also drives the coil **44** of a second resonant-reed relay **43**.

While only a mechanical readout using a stylus has been described, it will be apparent to one skilled in the art that the readout could be by other mechanical means, by optical scanning or by magnetic scanning if proper pickup indicia were formed on the surface of the card, such as magnetic for a magnetic readout.

Also, while a synchronous motor has been described above, it should be quite clearly understood that other equivalents or alternatives are possible. For example, to eliminate the necessity for a uniform speed of movement for the document, or card, a code wheel could be utilized, or a reference track or tracks, one on the card and one on the tray or platform, where both tracks are compared and if they are the same, no output would result. The tracks also could be partially overlapping so that zero output would only occur on the lapped portions. These systems would be nonfrequency responsive, and operate independently of frequency.

The invention regards as important that the information stored on the card as an embossed pattern or the like, actually be an averaging signal of the information. In other words, it is not a yes or no signal, or a 1 or 0 according to conventional computer techniques, but a long or average signal that will reproduce as the desired information only, or none at all, and even if part of the information is destroyed or damaged. This type of information storage excludes any counting or other false indication from being utilized and insures that only the information stored is read out.

It should further be understood that systems other than the electromechanical transducer might be utilized. As mentioned above, some of the other systems might be optical or magnetic. The information stored as an averaging signal can be applied at any position or location on the card. In fact, the position on the card could be a first authentication test, and provide the proper positioning of the card to the pickup or vice versa as directed by the card holder inserting it into the apparatus. Since the card may actually be embossed over its entire surface with only one or a plurality of selected areas having the desired information, the selection of the proper area can be the first validation step. This type of camouflaged technique with nonsignificant information clearly helps prevent compromise. Also, the camouflaged technique could apply to optically or magnetically responsive areas on the card. It also should be understood that multiple frequencies or information can be stored in the same area of the card so that simultaneous information readout could be accomplished. Information read out simultaneously could be validated sequentially by the use of appropriate memory devices.

The resonant-reed relay **41** consists of ten spring steel or other magnetically affected and electrically conductive reeds suspended near the coil **42** and each having a contact **46** adjacent its free end. The first reed has a resonant period equal to the frequency assigned to the digit 1, the second reed has a resonant period corresponding to that assigned to the digit 2, etc. Thus, if the first region **12** of the strip **11** represents the digit 1, the spacing of the ridges **19** and grooves **20** will be such as to produce a vibration of the stylus **39** of the transducer **38** at a frequency of 632 hertz. As a typical example, the first reed of the resonant-reed relay **41** might have a resonant period of 632 hertz and will be induced to vibrate when the transducer **38** moves across the region **12** and this reed will strike its contact, closing a circuit indicating that the digit one has been read by the transducer. The remaining reeds of the resonant-reed relay **41** have different resonant periods and will not close at this time. Relays of this type are highly discriminating and, typically, will not respond to frequencies displaced as little as 3 to 5 hertz from the assigned frequencies. Thus, the frequencies assigned to the various integers need be separated by only a short range. These relays are also characterized by an extremely high signal to noise ratio and are thus capable of responding to the identifying tones generated as the areas **12–18** are moved past the transducer stylus **39** even if a considerable amount of random static or noise is generated by dirt or scratches on the surface of the card. Reed relays of this type are available to the public, and a typical reed relay would be one made by the W. S. Deans Company of Gardena, Calif. The resonant-reed relay **43** is provided with a single resonant reed **47** and an associated contact **48**. The reed **47** has a resonant period different from that assigned for any of the integers, for example, 800 hertz. This frequency is delivered by amplifier **40** when the transducer tracks across the separating regions **16*a*–18** of the strip **11**.

According to the present state of the art, only so much information in the terms of embossed signals can be stored on the card. Normally, this means between about 50 to about 1,000 deviations or lines per inch. Practically, this limits the information read out to relatively low frequencies, probably not above 1,000 cycles per inch, and with a maximum relative movement between card and pickup of about 3 inches per second, a maximum signal would be about 3 kHz. This frequency signal performs well with a reed bank as described above, but if conventional techniques such as heterodyning or frequency multiplication are used, higher frequencies can be utilized with state of the art solid-state components to give greater resolution and more selective filtering capabilities. For example, ceramic filters could provide excellent frequency selection characteristics. The rise and decay times of ceramic filters would also be faster than on the reed bank to prevent excessive signal carry over.

Corresponding contacts of each of the 10-position switches **24–27** may normally be connected to the contacts of the corresponding reed of the resonant-reed relay **41**. However, in order to provide a selective scrambling ability each of the sets of switches **24–27** has a scrambling bar **24*a*–27*a*** associated therewith, as best seen in FIG. **2**. These bars **24*a*–27*a*** provide the ability to scramble one device from another and give a much greater number of potential numerical combinations to the four groups of 10 digits. In effect the bars **24*a*–27*a*** simply allow a selective connection of the input to another output, and can be made in any convenient way by one skilled in the art, or are commercially available for smaller numbers of input-output.

Thus, the contacts of each of the switches **24–27** representing the integer one may be connected to the contact of the reed having a resonant period equal to the frequency assigned to the integer one or it may be selectively scrambled with the other contacts. The movable contacts **49–52** of the switches **24–27**, respectively, are connected to terminals **53–56** of a stepping relay **57**. The relay **57** is driven by coil **59** that is connected in series through a silicon-controlled rectifier **59*a***. The control gate **59*b*** for controlled rectifier **59*a*** is connected directly to switch **57** and through a resistor **60** to the low side of an AC power source **61**. The bottom side of the reed bank **45** is connected through a capacitor **62** to the low side of source **61** in parallel relation to the controlled rectifier **59*a*** and resistor **60**. The high side of source **61** is connected through a diode **63** to the reed **47** of switch **43**. Reed **47** when it closes switch **43** effectively charges capacitor **62** by virtue of its connection **47*a*** thereto.

The remainder of the circuit comprises an ON-lamp **28** and a GO-lamp **29** with the ON lamp connected directly to the high side of the AC source **61** through the lamp to ground, and the GO lamp likewise connected to the high side of source **61** to contact **56*a*** of the stepping switch **57**. Hence, the GO-lamp **29** is only actuated when stepping switch **57** has moved completely to contact **56*a***, and this only will occur upon proper check of all information on the card, as will be now more fully defined.

OPERATION

In operation, the credit card is inserted into the slot **23** of the housing **22** and actually manually positioned onto the tray or platform **31**. The platform **31** drives from the extreme left-hand position shown in FIG. **2** to the extreme right-hand position or from switch **32** to switch **33** while reading is thus effected from right to left across the card **10** by stylus **39**. To this end, the credit card shown in FIG. **3** is inserted so that the left end as viewed in the figure is inserted first into the slot **23**.

The relative movement of the stylus **39** across the first transfer tone area **16*a*** of the card **10** energizes coil **44** of switch **43** and thereby vibrates reed **47** and closes the contact with line **47*a*** and thus energizes capacitor **62**. As soon as the stylus engages area **12**, a frequency is set up that might for example vibrate the sixth reed from the bottom of the reed bank **45** to thus complete a circuit through switch **49**, contact **53**, stepper switch **57**, and energize rectifier **59*a***. The energization of rectifier **59*a*** causes discharge of capacitor **62** through the rectifier and effects immediate energization of coil 59 thus transferring stepper switch 57 to contact 54. Any excess current through rectifier 59a is immediately grounded and dissipated through resistor 60. The engagement of the stylus with area 16 on the card again energizes reed 47 and recharges capacitor 62. The engagement of stylus 39 with area 13 then may vibrate the third reed from the bottom of bank 45 thus completing the circuit through switch 50, contact 54, switch 57 that is now made with contact 54 and again energize the rectifier 59a. The same sequence thus causes stepper switch 57 to shift to contact 55. Assuming the proper positioning of the switch 51 to correspond with the information carried in area 14 of card 10, the same sequence will occur to shift stepper switch 57 to contact 56. Again, if validation is proper and switch 52 is in the proper position, the stepper switch 57 will shift to contact 56a thereby energizing the GO-light 29. This of course indicates that complete validation of all four areas 12–15 on the card has occurred. This could be visually observed by a guard to allow an individual to enter a secured area, or it might actuate a vend function. or it might indicate that a particular program should be performed on a general purpose computer, for example, or any other purpose to which the validation of the information on the card might necessarily be applied.

Transfer to the next area might be made dependent on validation of the previous area dependent on the position thereof and the information content of the area itself. While transfer herein is indicated as being accomplished by a transfer tone, this could easily be accomplished in other manners, such as by any convenient mechanical or optical means. Also, it should be understood that transfer is necessary only when sequential validation is utilized.

Naturally, while the invention has been described as utilizing a reed bank 46, any equivalent electrical circuitry such as quartz crystals, for example that are frequency responsive to close a switch could be utilized to achieve the objects of the invention. The rotary switch 57 is a conventional component well known to those skilled in the art, and for example a Rotomite as made by Guardian Electric Company of Chicago, Illinois, will very adequately perform the desired function. Further, it should be recognized that if a validation feature is not desired, but simply a readout of the information, the switches 49 through 52 could be all contact switches with the particular reed 45 that is energized by the signal from transducer 38 lighting a light or energizing a numerical control equivalent to the numerical data carried in each respective area on the card 10.

The critical aspect of the invention is believed to reside in the high discrimination with excellent signal to noise ratio achieved by utilizing a transducer 38 with some type of pickup to read out the variations from the planar surface of card 10. The amplified signal thus drives any suitable response mechanism to provide a precise and highly reliable indication of the information stored on the surface of the card. While we have found that the extremely good tolerance achieved by the sensitivity of the audio reed bank 46 seems to provide the preferred embodiment of the invention, similar tolerances could be obtained with other electrical components such as quartz crystals, for example. However, because of the close tolerance in the reed bank 46, we achieve the highly desirable feature of having readout of the proper data unit because only the proper reed 47 will vibrate to close its contact upon driving energization by the signal from transducer 38.

The above-described circuitry for utilizing the coincidence/noncoincidence signals produced by the resonant-reed switch 41 in conjunction with the manual switches 24–27 is illustrative only and it should be understood that other systems may be used. For example, suitable circuitry may be provided to actuate an incorrect identification lamp as soon as any one digit read from the card 10 by the transducer 38 does not coincide with the digit entered by means of the manual switches. This type of circuitry is especially desirable where a two-digit number is used rather than a four-digit number as this circuitry can be adapted to cause the card to be retained in the validator thus preventing an unauthorized user from determining the encoded number by running through the possible combinations of digits until the correct combination is reached. This adaptation is well within the capabilities of one skilled in the art.

It should be apparent that while the embodiment has been described with a particular reference to a four-digit number, a greater or lesser number of digits may be used by providing fewer or more switches and additional contacts on the stepping relay. Likewise, our invention is not limited to the use of a 10-digit code but may be used with any length of code by assigning an appropriate number of frequencies and providing an appropriate number of resonant reeds in the reed relay or other equivalent discriminating filter. The range of possible encoded information may be further extended by providing additional bands 11 on the card surface and providing means for reading the additional bands, for example, by moving the transducer 38 laterally at the completion of reading of the first band to engage and read the succeeding band in the next part of the card. Also, it should be understood that various combinations of information storage on the surface of the card may be used, such as shown in U.S. Pat. No. 3,440,606. It should also be apparent that the indicating lamps described above are not necessary. For example, where the verification device is used in a security system, a correct identification signal may be used to permit access to a restricted building or area while an incorrect identification signal may be employed to prohibit access to or to sound an alarm, as desired. The correct identification signal may also be used to activate a vending machine.

While relative movement between the card and the pickup device has been defined above, it should also be clear to those skilled in the art that multiple passes could be undertaken to read two or more channels or tracks on the card sequentially or simultaneously. In fact oscillation could be utilized in each area or over multiple areas. In other words the idea of providing for more than one pass to achieve reading is contemplated by the invention.

In summary, the apparatus is so designed that it can compare the stored information, or certain parts of it, with easily remembered data inserted in the machine by the card holder (and selected initially by him), in order to identify the holder. The apparatus may also be designed to be capable of actuating a printout device to record all or any part of the stored information, or may be associated by telephone line or the like to a central computer system or the like.

The system is usable with existing cards without interfering with their readability by eye, or by other information storage methods (magnetic, Hollerith punching, etc.).

The stored information is not affected by ordinary wear or dirt, and can within limits be changed without making a new card. A simple field adjustment to the apparatus can be made at any time, to outdate all outstanding cards and require a new coding, by changing the reed banks, discrete filters or the scrambler bars.

The method employed is to emboss, on the surface of the card, a horizontal strip made up of small areas normally aligned to facilitate reading, each of which is made up of fine vertical or lateral lines very exactly spaced, which may be at any of a predetermined number of one-frequencies. The apparatus transports the card at an exact predetermined speed through an area where a piezoelectric pickup reads the succession of frequencies embossed on the card. By a suitable filter the resulting tones are decoded into decade information, which is then used in the appropriate manner. Scrambling of the order of the areas on the strip and of the digital significance of a given line-frequency in different positions of the sequence (with plug-in scrambler bars in the reader and embosser) preserves security of the information and its relationship to the particular reader. Security and nonduplication of the code is maintained by the manufacturer. By present techniques, about 10 areas can be read in one strip, and a card of the usual credit-card size (about 2⅛×3⅜ inches) can accommodate as many as five strips if desired. Normally one strip would be sufficient.

The holder identification number, of two to four digits, is inserted by the holder in a manual keyboard. If this information matches correctly, the card is accepted and the transaction goes forward. If it is incorrect, the card will be returned, or if desired can be made to remain in the machine after the first, second or third incorrect matching, without interfering with subsequent transactions.

If the holder identification code is less than four digits, unmatched cards should be held in the machine after a few tries, in order to prevent an unauthorized holder from running through all the possible numbers.

The possibility is very remote that the reader will record a wrong digit in any given area. However, the condition of the card could result in no reading at all in an area. Therefore, if important information is being printed out, other than the holder identification code, the machine should reject the card if any single required digit is missing.

While in accordance with the patent statures only the best known embodiment of the invention has been shown, it is to be understood that the invention is not limited thereto or thereby, but that the inventive concept is covered by the appended claims.

What is claimed is:

1. A validating device for a card having information coded on its surface in the form of a plurality of regions having uniformly spaced surface configurations embossed therein, the spacing between the configurations of each region being determined by the identifying data unit encoded thereon, comprising:

transducer means;

means for moving the card and the transducer means relative to each other at a uniform rate of speed so that the transducer engages the embossed regions and produces a signal, the frequency of which is indicative of the identifying data unit encoded thereon;

a plurality of discrete frequency-sensing means, one said frequency-sensing means being provided for each of the possible identifying data units encoded on said card;

switch means associated with the frequency-sensing means and selectively cooperating with at least one individual frequency-sensing means, said switch means including a plurality of switches for entering identifying data manually to said validating device;

a means for sequentially connecting each of said plurality of switches to said frequency-sensing means; and

circuit means for determining when contact of said switch indicating the identifying data unit manually supplied to said device is sensed by the frequency-sensing means to indicate correspondence with the signal produced by said transducer.

2. A device according to claim 1 where the frequency-sensing means comprise a resonant-reed bank and the signal is generated as an audio tone.

3. Apparatus according to claim 2 further including additional regions on the surface of said card separating each of said plurality of regions, said additional areas having uniformly spaced surface configuration embossed therein, the spacing of said configurations being identical for each of said additional regions and different from the spacing of any of said first-mentioned regions; and a second resonant-reed relay responsive to said transducer and having a reed with a resonant period equal to the frequency produced by said transducer when in moving contact with one of said additional regions said stepping relay being responsive to said second reed relay.

4. Apparatus according to claim 3 where said means for sequentially connecting is a stepping relay further including means for energizing said stepping relay, said means being operative only upon the closing of a reed contact of said first reed relay corresponding to the closed contact of one of said plurality of switches and the closing of the reed contact of said second reed relay.

5. Apparatus according to claim 4 further characterized in that said means for energizing includes a silicon-controlled rectifier responsive to said second reed relay, and a memory capacitor to maintain the energization of the rectifier as long as the proper setting of the manually controlled switches is achieved.

6. Apparatus according to claim 4 further characterized by a scrambling bar between each resonant reed relay and its respective switch means.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,637,990 Dated January 25, 1972

Inventor(s) Jack E. Bayha et al.

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

Following the title insert:

-- Assigned to Transmarine Corporation, Chesterland, Ohio, an Ohio corporation.--

Signed and sealed this 23rd day of January 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334