PAPER MONEY IDENTIFIER

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ABSTRACT
An improved currency identifier permits recognition of various denominations of paper currency by blind persons. The identifier includes a housing having a tray along which money to be identified is passed. In one embodiment, a source of light is stationed above the tray and positioned directly under the light source is a series of very small holes formed in the bottom of the tray. The holes are aligned across the tray so that light from the source shines through the center of paper currency passed along the tray, through the holes, and onto a photoelectric cell located beneath the tray. The photocell is connected to a relaxation oscillator circuit and controls the oscillator frequency in accordance with the amount of light passing through the money. The output from the oscillator is connected to a loudspeaker which produces a tone that varies in accordance with the output from the photocell. Since the various currency denomination have distinct printed patterns and thus have different light responsive characteristics, the audible sounds produced can be identified as being representative of a specific bill.

In a second embodiment, the photocell and light source are positioned on the same side of the bill to be identified. The light is transmitted onto the bill and a portion of the light is reflected onto the photocell. The reflected light is also distinctive of a particular bill and produces an identifiable tone pattern; however, this embodiment produces a simplified sound pattern since the characteristics identified by the light pattern are only taken from one side of the bill.

16 Claims, 4 Drawing Figures
PAPER MONEY IDENTIFIER

BACKGROUND OF THE INVENTION

The present invention relates, in general, to currency identification and, more particularly, to a method and apparatus for currency identification for the blind which converts light pattern characteristics of currency into distinctive audible tones, identifiable by the blind.

A number of devices have been constructed to aid in the identification of currency, and some of these devices utilize light and photocell combinations for this purpose. In addition, numerous devices have been constructed to aid the blind in reading printed material by utilizing a photocell to scan the printed material and produce an audible signal in response to the output from the photocell. However, most of these prior art devices require a specific orientation of the bill or printed matter within the device before an intelligible reading can be obtained, and this in itself produces serious problems for the blind.

Another difficulty with prior devices in that they have, in attempting to reach a high degree of accuracy, tended to become very complex, and thus have become expensive to purchase and difficult to maintain in working condition, and accordingly have not been satisfactory. Many of these devices have utilized various mechanical indicators which easily become misadjusted and which can thereby produce incorrect readings of currency denominations, while others use banks of photocells which not only are expensive, but which require complex circuitry to provide the desired indication.

Considerable effort and expense has been expended in the prior art to provide a highly reliable, maintenance-free, long-lasting, accurate, and easy to use device for producing an indication of the denomination of paper money. Such a device should provide maximum convenience for the user, be simple in operation, and should provide a reliable, easily identified, unique indication of the denomination of the currency being tested.

SUMMARY OF THE INVENTION

It is, therefore, as object of the present invention to provide an apparatus which enables the blind to identify paper currency by converting the dark and light characteristic patterns of the currency into distinctive, identifiable audible signals.

It is another object of the invention to provide an improved currency-identifying apparatus incorporating a circuit for converting light signals impinging on a photocell into audible signals representing the impinging light pattern.

Another object of the invention is to provide a money-identifying apparatus having a tray which receives the money, and which provides accurate identification of the currency whether it is placed within the receiving tray face up or face down.

Briefly, the present invention accomplishes the foregoing and other objectives by the provision of a currency identifier which incorporates means for distinguishing variations in the light reflectance of the printed patterns on paper currency. The identifier includes means for creating a predetermined light path between a source and a photocell. The currency to be identified is passed through this path, causing varying amounts of light to reach the photocell, in accordance with the configurations printed on the bill. This variation in light changes the output of the photocell, which causes the frequency of an oscillator circuit to change. The oscillator drives a loudspeaker, and the light variations thus cause corresponding changes in the sounds emitted as the bill is moved through the identifier. Each denomination of paper currency produces a characteristic sound pattern from the apparatus of the present invention, the sound variations corresponding to the changes in the shades of color and the presence or absence of printing on the portion of the bill passing through the light path as the bill is moved through the identifier, with light colors emitting a higher pitched sound than the darker colors.

In a first embodiment of the invention, the light path is constructed so that light passes through the bill to the photocell. With this arrangement, the device is sensitive to variations in the transmission of light through the bill, and these variations are the same whether the bill is face up or face down. The money identifier consists of a housing shaped to provide an elongated channel, or tray, which is adapted to receive paper currency to be identified and which defines a path along which the currency is drawn for identification. Mounted on the housing and extending over a portion of the tray is a light box which carries a convenient source of light and which includes a suitable opening for directing light onto a selected portion of the tray. Immediately below the light box and arranged at approximately the center of the path followed by the currency is a series of small holes in the tray. A photocell is located within the housing below the holes in the tray to receive light from the source. Preferably, the holes are located in a straight line transverse to the path followed by the currency, and extend about one-half inch across the center thereof, where variations in the printed pattern are at a maximum.

As a money bill is pulled along the housing tray, it travels through the light path defined between the light source and the photocell, causing variations in the amount of light passing through the bill and striking the photocell. These variations are unique for each denomination of currency, and correspond to the pattern printed on both sides of the bill.

Also mounted within the housing is an oscillator circuit having a frequency of operation which is responsive to the magnitude of the photocell resistance. The output from the oscillator is an audio frequency which is fed to a loudspeaker mounted in the housing. The speaker thus produces a sound which varies in frequency in accordance with the pattern of the bill passing through the light path of the identifier device. Since each denomination of currency has a unique printed pattern, each will produce a unique pattern of sound which can be identified by the user of the device to accurately identify each denomination bill.

In a modified form of the invention, the locations of the light source and photocell can be reversed, with the photocell being located above the path of the bill to be identified. However, this arrangement is less desirable than the previously described relationship, for it makes it more difficult to replace light bulbs when they burn out.

In another modification of the invention, both the light source and the photocell can be placed on the same side of the path followed by the bill to be identified, in which case the device responds to the light re-
flected from the bill, rather than that which passes through it. The light reflected to the photocell varies in accordance with the pattern on the side of the bill facing the photocell system, and produces a corresponding output sound. The photocell system may be either above or below the path followed by the currency. Although this arrangement requires that the operator be able to distinguish between the obverse and reverse faces of each denomination of bill, and thus may require that the operator place the bill with the proper face up, it has the advantage of producing a less complex sound pattern which is more easily recognized by an operator. However, the first-described embodiment is easier to operate, since it does not matter which face of the bill is up, and accordingly provides a faster identification of denomination.

BRIEF DESCRIPTION OF DRAWINGS

The foregoing and additional objects, features and advantages of the invention will be apparent to those skilled in the art from the following description, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view of the exterior housing of a currency identifier constructed in accordance with the present invention;

FIG. 2 is a cross-sectional view of the currency identifier of FIG. 1 taken along line 2-2, and illustrating a first embodiment of the photocell system;

FIG. 3 is a cross-sectional view of a light box used in another embodiment of the currency identifier constructed in accordance with the present invention; and

FIG. 4 is a schematic diagram of a preferred form of the electronic circuitry which can be used in the photocell systems of the embodiments of FIGS. 2 and 3.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to FIG. 1 there is illustrated in perspective view a currency identifier 10, the Figure showing the general appearance of the exterior housing of the currency identifier of the present invention. The identifier 10 consists of generally horizontal and upward standing portions, 12 and 14 respectively, forming an L-shaped housing. The housing itself may be formed of any rigid material suitable for the purpose, such as metal or plastic. Fixed to the top surface 15 of the horizontal portion 12 of the housing, as by bolting or otherwise, is a tray 18, which generally is formed of the same material as the housing, and along which money to be identified is passed. The tray 18 positions currency relative to a light box 20, which is fixed to the front wall of the upstanding portion 14 of the housing by any suitable means, the light box being cantilevered from portion 14 and extending transversely across, but spaced above, the tray.

As shown in FIG. 2, a plurality of small apertures 22 are formed through the center portion of the tray 18 and extend transversely thereacross, the apertures being aligned with the light box and being positioned across the center portion of the tray. The apertures 22 extend across approximately one-half inch of the tray, so that when tray 18 is used as a guide for the currency, the apertures will underlie the central longitudinal portion of each bill inserted into the tray and drawn under the light box 20. It will be understood that the apertures could be replaced by a corresponding narrow slot.

Rails 24 and 26 are provided at the left and right ends of the tray, as viewed in FIG. 1, and serve to inform the operator of the identifier 10 of the location of the bill with respect to the light box 20, longitudinally along the tray. Similarly, the corner 28, formed by the intersection of the front surface of the upstanding portion 14 and the back edge of the tray, cooperates with a front rail 29 formed along the front edge of the tray to center the bill transversely on the tray and align its center with the apertures 22.

The light box 20 is offset to the left side of the housing, as viewed in FIG. 1, so that a currency bill can be placed flat in the tray to the right of the light box before it is drawn under box 20. This enables a blind operator to correctly position a bill in the tray for determining its denomination with little effort, and to insure consistently correct operation. To the left of the light box the tray need only be large enough to accommodate about one-half the length of a bill, since it is not generally necessary to pass a bill completely through the device to obtain an accurate identification; usually the identifying sound characteristics can be recognized from just a portion of the bill. The provision of the end rail 24 with respect to the photocell system within the light box permits the operator to position bills accurately under the light box to detect specific characteristics of various denominations.

To assist the operator in feeding the bill through the photocell light path, the bottom of the light box near the surface of tray 18 is tapered by means of two sloped wall portions 30 and 31 (FIG. 1), forming entry slots at the bottom edges of the light box to make it easier for a bill to slide into the opening 32 between the light box and the surface of tray 18, where the denomination of the bill is to be read.

Mounted at a convenient location, such as on the top of the upstanding housing portion 14, is a push-button switch 33 for switching the power to the identifier 10 on and off and a potentiometer control knob 34 for varying the tone-volume control. The potentiometer may be rotated to increase or decrease the pitch and volume of the audible signal produced by the present device to adjust it to the personal preference of the operator. The functions of switch 33 and tone-volume control 34 will be discussed again hereinbelow.

The interior of the light box 20 is shown in FIG. 2 as incorporating a light source 40, such as a standard pre-focused flashlight bulb, mounted in a socket 42 which is attached by a suitable bracket 44 to the upper surface of the light box 20. The lamp 40 directs its beam downwardly through an aperture 46 formed in the bottom of the light box, whereby light from the bulb is directed onto the apertures 22. The upper surface 15 of the horizontal housing portion 12 has a rectangular opening 48 which is directly below and in alignment with the apertures 22 in tray 18. A photocell 50 is mounted to the under side of surface 15, and covers the opening 48 so that any light passing therethrough illuminates the photocell. If desired, and in a preferred form of the invention, some means for directing the light from source 40 through the aperture 46 and onto the photocell 50 can be used, such as a cylindrical shroud 52 which confines the light to a downward direction. Source 40 is electrically connected by way of lines 53 and 54 to the remaining circuit elements, to be described, housed in an electronics package 56. Photocell 50 is also connected to this circuitry package.
through lines 58 and 60. The arrangement of the light source is such that light from source 40 shines through aperture 46 onto the currency positioned on tray 18. Light passes through the bill and falls on photocell 50 in accordance with the printed pattern on the two sides of the bill. The varying light striking the photocell causes a varying electrical resistance on lines 58 and 60 to the processing circuitry 56.

An alternate form of the apparatus of the present invention is shown in FIG. 3, which is a partial, front view of the housing 10, with only the light box 20' and the tray 18' shown in section to illustrate the relationship of the photocell system to the path followed by the bill to be identified. Elements in common with FIG. 2 are given the numerals used in FIG. 2, while equivalent, but different, elements are primed. Thus, the light source 40 in this embodiment is mounted in a modified form of the light box 20' by means of socket 42 and bracket 44, and is electrically connected to the electronic circuitry within housing 10' by way of lines 53 and 54 which pass into the housing through an opening 56 in the front wall of housing portion 14. Similarly, photocell 50 is connected to the circuitry (to be described) through lines 58 and 60. In this embodiment, the light box 20' takes a different form to accommodate both the light source and the photocell, and incorporates a support frame 61 connected to the upstanding portion 14 of housing 10 by brackets 62. The frame 61 carries the light box cover portion 20' which is removable to permit access to the photocell system mounted on the frame. Tray 18' is fixed to the upper surface of the horizontal housing portion 12, but does not require the small apertures needed in the embodiment of FIG. 2, although the end rails 24, 26 and 29 are still provided to guide the placement of the currency bill in the tray for exposure to the light source.

The light box 20' is formed with a complex bottom surface shape to not only facilitate insertion of a bill between the box 20' and the tray 18', but to direct the light from source 40 onto the bill for reflection to the photocell. Thus, the bottom surface, as defined by frame 61, incorporates downwardly tapered portions 63 and 64 which facilitate insertion of paper currency from the tray 18' into space 32, and upwardly angled central portions 65 and 66 which accommodate a slot 67 and the photocell 50, respectively. The portions 63, 64, 65 and 66 form a generally W-shaped bottom for the light box, with the lowest portions of the bottom being closely spaced from the tray 18' to provide the narrow spaces 32 adapted to receive the currency to be identified.

Light source 40 is mounted by bracket 44 to the interior of wall 63, the mounting serving to direct light from the bulb through an aperture 67 formed in the wall 65. The aperture 67 extends transversely across the longitudinal center axis of the tray, and is so positioned and sized that light from the bulb will be reflected from the center portion of the surface of any currency positioned on tray 18' and drawn through slots 32 upwardly into the photocell 50. It will be understood that the amount of light reflected, and thus the output from the photocell on lines 58, 60, will depend upon the surface characteristics of the currency; i.e., upon the printed pattern thereon. Changes in reflected light from the bill cause the resistance of the photocell to change, creating a varying output on lines 58 and 60 to the electronic circuitry.

The electronic circuitry used in the embodiments of both FIGS. 2 and 3 is illustrated in FIG. 4, to which reference is now made. As indicated, the present money identifier operates from a conventional source of 115v. alternating current, as by way of a plug 70. The A.C. input is applied by way of lines 72 and 74 through the contacts 76 and 77 of pushbutton switch 32 to the primary winding 78 of an input transformer 80. When depressed, pushbutton switch 32, which may be of the push-to-close, push-to-open type, closes the circuit through the transformer 80 and turns the system on. Light source 40 is connected in parallel across a secondary winding 82 of transformer 80. A resistor 84 in series with the bulb limits the current passing through light source 40 and thus serves to regulate its brightness. A full wave rectifier consisting of diodes 88, 90, 92 and 94 is connected across secondary winding 82 via lines 96 and 98 to provide a source of direct current for the remainder of the circuit on lines 100 and 102. A capacitor 104 is connected across the output lines 100, 102 to provide a constant output voltage of approximately 9 volts d.c. If desired, a 9 volt battery could be placed across lines 100, 102 as a substitute for the a.c. rectifier network.

Connected across lines 100 and 102 is an R.C. series network consisting of a capacitor 106 which is charged through a resistor 108, photocell 50 and the adjustable resistance of a potentiometer 110 having a resistance 112 and a movable tap 114 adjustable by means of knob 34. Variation of resistor 112 provides the tone-volume control described above with respect to FIG. 1. A resistor 115 may be provided across potentiometer 110 to limit the resistance of the network. The capacity of capacitor 106 and the value of the total resistance in series with it determines the time required for it to charge to a preselected voltage level.

The R.C. network is connected to a unijunction transistor 116 to control its conduction, and to form a frequency-controlled relaxation oscillator. The junction between potentiometer 110 and capacitor 106 is connected by way of line 118 to the emitter 120 of transistor 116, while line 102 is connected through a bias resistor 122 to the base 2 of the transistor, indicated at 124. The base 1 connection 126 of the transistor is connected through the drive coil 128 of a loudspeaker 130 to line 100.

When the charge across capacitor 106 builds to the emitter-to-base breakdown voltage of transistor 116, the transistor becomes forward biased and conducts. Capacitor 106 then discharges through line 118, transistor 116 and speaker coil 128, causing a sonic pulse. Upon completion of the discharge, the transistor becomes reverse biased and nonconductive until the voltage on capacitor 106 again builds to the breakdown value. With a given value of capacitor 106, the frequency with which the capacitor 106 charges and discharges depends on the combined resistance values of resistor 108, potentiometer 110, shunt resistor 115, and the resistance exhibited by the light sensitive photocell 50.

Once the value of potentiometer 110 is set by adjusting arm 114, the frequency of the relaxation oscillator will depend solely on the value of the resistance of photocell 50, which is sensitive to the amount of light striking the surface of the photocell device, and in particular with the amount of light from light source 40 which is transmitted through or is reflected from a cur-
The limiting resistors 108 and 115 establish the minimum and maximum resistances, respectively, of the R.C. network and thus limit the maximum and minimum rates at which the capacitor 106 will charge to the breakdown voltage of transistor 116. In this manner, the maximum frequency of the oscillator, and thus the maximum tone pitch produced by the loudspeaker, is established at a level below the supersonic sounds which might hurt the ears of sensitive dogs which often accompany blind persons. The maximum resistance of the R.C. circuit establishes the lowest tone frequencies produced by the circuit. It will be understood that resistor 108 and 115 may be made adjustable, if desired, to permit compensation for variations in other components in the circuit, and that a variable gain amplifier may be provided between the oscillator and the loudspeaker with a volume control knob mounted on the housing for convenient control of the sound produced by the speaker.

In operating the money identifier of this invention, a currency bill to be identified is placed flat in tray 18 or 18' and is located to the right of the light box, as viewed in FIG. 1, with the back edge of the bill against the upper right portion 14 of the cabinet and the left end of the bill against the light box. The tray, housing, and light box are so arranged as to facilitate convenient and consistent correct placement of the bill in the identifier by a blind operator. Using his fingers, the operator then feeds the bill into the space below the light box, and thus into the path of the light beam from source 40. The bill is then drawn steadily through the identifier so that variations in the optical properties of the printing on the bill will cause variations in the light path between source 40 and photocell 50. In the first embodiment described above, the light path is through the bill, and the variations in the pattern printed on both sides of the bill cause corresponding variations in the resistance of the photocell, and thus in the frequency of the sound produced by the relaxation oscillator. In the second embodiment described above, the light path is reflected from the surface of the bill, so that variations in the printed pattern on only one side of the bill cause corresponding variations in the sound produced by the identifier. Both embodiments produce unique and identifiable sounds, although the sound produced by the first embodiment is more complex and thus more difficult to learn, since it is a composite of the patterns of both sides of the bill. Although producing a simpler sound pattern, the second embodiment may require two passes of the bill through the device since the faces of all denominations of bills have very similar light and dark patterns and may present difficulties in identification. In this event, it may be necessary to turn the bill face down and feed it through the light path again for identification. With both embodiments there may be slight differences in sound, depending on which end of the bill is introduced into the path first; however, the difference is slight and not significant for purposes of bill identification since the readings are taken along the longitudinal center of the bill.

To illustrate the manner in which the present money identifier operates, consider a five dollar bill inserted into the FIG. 2 embodiment, where light passes through the bill. The $5.00 bill is very symmetrical except that the word "FIVE" appears in big light print on the face to the right of the picture of Lincoln. The back side is perfectly symmetrical except that the illumination of the Lincoln Memorial is from the left side and produces a light spot between the second and third columns of the picture of the Lincoln Memorial. The columns are light and the shadows behind them are dark. When the picture of these columns passes thru the light beam, alternate high and low tones are produced by the oscillator. They are very distinct and of the same pitch and same distance apart, especially in the center of the bill. When the bill is moved back and forth from a point where the left edge of the bill is ¼ inch from the left edge of the tray to the left edge of the tray, it sounds like someone pulling a stick along a picket fence.

When moving a $20.00 bill thru the instrument, all of the tones are deep with very few high pitched tones. The most distinguishing features of the $20.00 bill are the overall deep tones, the short high tone an inch in from either end, and the alternate high and low tones in the center of the bill near the end of the movement.

The face of the $20.00 bill is symmetrical except for the word "TWENTY" to the right of Jackson's picture. These letters are very faint and do not show up clearly as the bill passes through the instrument. The back side is symmetrical except for trees covering the left side of the picture of the White House, but not the right hand side. The trees are very dark and produce the low tones, lower than any other bill. About an inch from either end, a light area (high pitch) exists for about ¼ inch. This occurs when the left end of the bill is about 2¼ inches from the left end of the tray. This makes identification between a $5.00 and $20.00 simple because the light area on the five is about ¾ inch long.

Another distinguishing feature of the $20.00 bill is the columns in the picture of the White House. There are six columns and five dark areas between them. The columns are located in the center of the bill. An alternate high and low pitch tone can be heard when the left edge of the bill is moved from a point ½ inch away from the left edge of the tray to the edge of the tray.

The $10.00 bill creates sound patterns very similar to the $5.00 bill but does not have the alternate high and low patterns caused by the columns on the $20.00 bill and does not have the alternate high and low patterns in the center which are characteristic of the $20.00 bill. The major identifying point is a dark area (low tone) created by shadows about ¾ inch long between two columns of the picture of the Treasury Building. When the bill is fed into the identifier with the back up and right side up, this low tone occurs when the left edge of the bill is about 1 inch from the left edge of the tray. It also occurs when the bill is inserted face up, but with Hamilton's picture upside down. If the bill is inserted in the other two directions, it will not appear unless the left edge of the bill is lifted so it can pass over the left edge of the tray about ¼ inch.

The sounds emitted when a $1.00 bill is passed through the instrument do not have a pattern that is as easily identified as the other bills. The sounds are a series of high and low tones, none of very long duration.

One distinctive feature is a light spot (high pitch) that occurs when the left end of the bill is about 1¾ inches from the left edge of the tray. This light area is only about ¼ inch long and exists on either side of the word "ONE". The areas on either end of the bill are mostly dark (low pitched) before this area. This high pitch is produced when either end of the bill is fed into the instrument. Another distinctive feature is a very low tone at a position where the left edge of the bill is about ¾
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5. The currency identification apparatus of claim 1 further including a second resistor means in series with said photosensitive means and said capacitor means, for limiting the maximum resistance in series with said capacitor means, thereby limiting the lowest pitched audible tone produced by said loudspeaker.

6. The currency identification apparatus of claim 1, further including a third adjustable resistor means in series with said photosensitive means and said capacitor means for setting the audible tones produced by said loudspeaker to a desired frequency range.

7. The currency identification apparatus of claim 4 further including a second resistor means in series with said photosensitive means and said capacitor means for limiting the maximum resistance in series with said capacitor means, thereby limiting the lowest pitched audible tone produced.

8. The currency identification system of claim 7 wherein said apparatus further includes a third adjustable resistor means in series with said photosensitive means and said capacitor means for selecting a desired frequency range for the audible tones produced.

9. The currency identification apparatus of claim 2, wherein said housing includes a tray means for positioning said currency in said path of said light beam, and wherein said light means and said photosensitive means are on the same side of said tray so that said light beam is reflected from the surface of said currency into said photosensitive means.

10. The currency identification apparatus of claim 9, further including a first resistor means in series with said photosensitive means and capacitor means for limiting the minimum resistance in series with said capacitor means and thereby limiting the highest pitched audible tone produced.

11. The currency identification system of claim 10 wherein said apparatus further includes a second resistor means in series with said photosensitive means and said capacitor means for limiting the maximum resistance in series with said capacitor means and thereby limiting the lowest pitched audible tone produced.

12. The currency identification apparatus of claim 1, further including a third adjustable resistor means in series with said photosensitive means and said capacitor means for setting the audible tones produced to a desired frequency range.

13. The currency identification apparatus of claim 1, wherein said means for directing said light beam includes light box means supporting said light beam generating means, and aperture means in said box means for directing said light beam onto said currency.

14. The currency identification apparatus of claim 13, wherein said light box means further includes means for supporting said photosensitive means adjacent said light beam generating means, and in the path of light reflected from the surface of said currency.

15. The currency identification apparatus of claim 13, including means for mounting said photosensitive means adjacent said light beam generating means and in the path of light transmitted through said currency.

16. The currency identification apparatus of claim 13, further including tray means for receiving said currency, said tray means locating said currency for movement through said path, whereby upon motion of the currency the amount of light from said light generating means striking said photosensitive means will vary in accordance with variations in the printed pattern on said currency to produce a varying output tone characteristic of said currency.

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