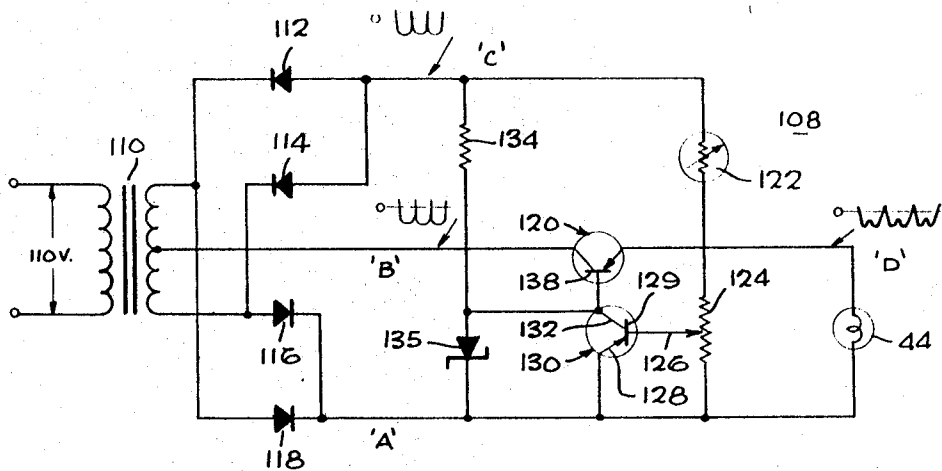


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PHOTOSENSITIVE CIRCUIT FOR CONTROLLING THE
INTENSITY OF A LAMP
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PHOTOSENSITIVE CIRCUIT FOR CONTROLLING THE INTENSITY OF A LAMP

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7 Claims

ABSTRACT OF THE DISCLOSURE

A bill detection circuit provides a light source whose intensity is controlled by the varied impedance of a first transistor. The impedance of the first transistor is controlled by a second transistor tied to a photocell. The photocell measures the light passing through a bill. As the light is obstructed by a bill, the photocell output drops which in turn decreases the impedance of the first transistor, increasing the intensity of the lamp. A Zener diode is employed in conjunction with the two transistors to limit the upper range of the intensity of the lamp. A maximum impedance of the first transistor establishes the minimum intensity of the lamp.

This invention relates generally to bill detection units for evaluating the authenticity of paper currency of a preselected denomination. More particularly, it relates to control circuits for controlling the intensity of illumination of selected areas of bills to be detected. Control circuits embodying the present invention are applicable to bill detection units such as those disclosed in copending United States patent application Ser. No. 115,947, filed Apr. 13, 1965, by George D. Haville and assigned to the assignee hereof. The disclosures of the aforementioned copending patent application are hereby incorporated by reference and made an integral part of this specification.

An object of this invention is to improve the reliability of bill detectors by increasing the probability that invalid currency will be recognized and rejected.

One type of bill detection unit includes photocells recessed in shaped area cavities in a detection head. The bill to be tested is placed in the detection area on a transparent carrier and light from a light source controlled by a compensating control device is transmitted through the transparent detection area, through the bill and into the shaped cavity. The illumination detected by the photocells in the shaped cavities is compared in a special detection circuit which produces an output signal indicative of whether or not the bill is acceptable.

It will be appreciated that some bills presented will be crisp and new while others will be old and dirty. Thus the light transmission through valid bills may vary over an appreciable range. It has been found desirable to compensate for age and dirt by adjusting the intensity of the light presented to the bill by the illuminating source in the detection head. Such compensation may be accomplished, for example, by a circuit which automatically adjusts the overall light intensity so that the photocells in the shaped cavities will receive the same illumination for any piece of paper currency exhibiting the pattern required for acceptance, regardless of its age or condition. In order to protect the system against cheaters who present bill-sized pieces of paper, such as xerographic or other types of copies of actual currency, having the proper type of light transmission pattern but differing substantially in overall transluence, it is beneficial to restrict the normal operating range of the compensating circuit. Preferably, the normal operating range should be kept within limits established by empirically testing valid but dirty currency.

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Certain types of prior art bill detector devices include alternating current feedback loops for controlling the intensity of the bill illuminating source. Intensity control is achieved in such circuits by altering phase relations of alternating current signals in the feedback loop.

The present invention is applicable to direct current feedback loops for controlling the output intensity of direct current light sources in bill detection apparatus.

In the preferred embodiment of the invention, the gain of the feedback loop is adjusted so as to be sufficient to compensate for the decreased transluence of old or dirty bills over a predetermined range but insufficient to compensate for the deficiency outside of the range. Thus bills or copies thereof which bear the characteristic light transmission patterns but which are so dark, either by reason of being extremely dirty or being carried on an improper paper or being formed by improper inks, will be rejected by the bill detection unit.

The objects, features and advantages of the invention will be clearly understood from the following detailed description taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a circuit schematic diagram of a preferred embodiment of the invention.

The circuit 108 disclosed in FIGURE 1 automatically adjusts the output intensity of an illuminating source 44 to correctly detect all valid bills having a transluence within a predetermined range regardless of the age of the bills or their condition or cleanliness. If a bill is old and dirty, the light transmission therethrough is less than that through a crisp new bill. The light control circuit 108 compensates for age and dirt by adjusting the intensity of the light from the source 44 which passes through the bill and is detected by photocell 122. It is preferred for optimum operation of the bill detection unit that the intensity of the transmitted light reaching the photocell 122 be the same for all bills having a transluence within a predetermined range. With the intensity of the light from source 44 set at the proper level with respect to photocell 122, the remainder of the circuitry disclosed in the copending application of George D. Haville carries out a comparison of the light transmitted through selected areas of the bill to complete the determination of its validity or invalidity.

Power for the circuit 108 is provided through a transformer 110 which isolates the circuit from the AC power source and steps the line voltage down to a value suitable for transistor operation. Three output levels of direct current voltage are provided by two full wave diode rectifiers using diodes 112, 114, 116 and 118. Point A will be considered the reference voltage level with point B being at a level more negative than A and point C being more negative than B. A transistor 120 acts as a series regulator and is inserted in series with light source 44 which is connected to the DC output of the power source between voltage levels A and B. As the impedance of transistor 120 is increased, the light intensity of light source 44 decreases and vice versa. Thus transistor 120 and light source 44 form a voltage divider across voltage levels A and B.

The sensing photocell 122 is connected in series with a variable resistor 124 to form a voltage divider across the full wave power supply output between reference levels A and C. Resistor 124 has a sliding tap 126 which is connected to the base of a transistor 130. The output of the tap 126 serves as a feedback signal indicative of the intensity of the illumination received by photocell 122 from the illuminating source 44. Sliding tap 126 is adjusted to establish the reference level or input signal which sets the light source 44 at the proper intensity for a bill of average age and condition. The photocell 122 is advantageously located so as to measure the light transmission

characteristics of a portion of the bill selected to give a good indication of the age and condition of the bill.

In operation if the bill is old and dirty less light will be transmitted to photocell 122, causing the voltage thereacross to increase because of an increase in the photocell impedance due to its inherent characteristics. This will cause the voltage at the variable tap 126 of series resistor 124 to go more positive towards reference level A. This causes the base 129 of control transistor 130 to go more positive and tends to move the transistor toward cutoff and increases its impedance. Since the emitter 128 of transistor 130 is at voltage level A and the collector 132 is connected to one end of resistor 134 which is connected at its other end to voltage level C, the voltage level at the collector 132 will vary as the impedance of transistor 130.

As photocell 122 receives decreased illumination through a dirty bill, control transistor 130 goes toward cutoff and its impedance increases as described above. This causes the voltage at its collector to become more negative. The base 138 of transistor 120 is connected to the collector 132 of transistor 130 and the action of collector 132 causes the base of transistor 120 to go more negative thereby lessening the impedance of transistor 120. A lessened impedance in the series regulator transistor 120 causes the current in the light source 44 to increase, thereby increasing the intensity of the light output. The increased light intensity causes the illumination of photocell 122 to increase because of increased light transmission through the dirty bill. When the photocell 122 receives the proper illumination its impedance ceases to change and no further change occurs in the intensity of the light output of source 44. Conversely, a new or exceptionally clean bill will cause the impedance of photocell 122 to decrease thereby increasing the impedance of series regulator 120 and decreasing the light intensity.

In accordance with the principles of the invention, the collector 132 of transistor 130 is connected to voltage level A through Zener diode 135. It will be appreciated that, in the absence of such a connection, if a very dirty bill or a dark copy of a bill is presented to the detector the control circuit 108 would cause the intensity of the light output from illuminating source 44 to continue to increase until the proper amount of light was transmitted through the unacceptable currency, or until the lamp 44 burned out. Zener diode 135 is included in order to limit the range over which the compensation is carried out. The Zener diode 135 is used to limit the maximum voltage that can be placed across the lamp. This aids detection of invalid currency in the bill detection system and insures that the lamp will not be subjected to overvoltages. The breakdown voltage of Zener diode 135 is higher than that present across transistor 130 during normal operation. Should an abnormality occur, due to the presentation of false currency or otherwise, the base of transistor 120 will rise in voltage until Zener diode 135 becomes conducting, thereby clamping the base to a fixed maximum voltage regardless of the signal applied to the base of transistor 130.

The output wave form across the source 44 is shown at D. As can be noted, the tips of the waves are distorted due to the large amount of feedback signal into the base of transistor 130. If the line voltage increases the output voltage would normally increase. However, the voltage at C also increases feeding back through the base of transistor 130 and maintaining the output essentially constant. Thus the control cell also notes changes in transmitted light which are due to variations in the line voltage and aids in the maintenance of a constant illumination intensity of the currency presented to the detection unit.

It is to be understood that the above described arrangement is illustrative of the application of the principles of the invention. Numerous other arrangements are possible and may be devised by those skilled in the art to which the invention pertains without departing from its scope and spirit.

What is claimed is:

1. A bill detector including a light control circuit comprising:

- a power source;
- an output lamp connected to said power source;
- a control element controlling the power supplied to said output lamp;
- means for generating an error signal in response to variations in the output intensity of said output lamp with respect to a predetermined standard;
- means connecting said error signal generator to said control element;
- means for limiting to a predetermined range the response of said control element to said error signal; and
- means for limiting the output intensity of said output lamp within a predetermined range.

2. Apparatus for controlling a bill detector light source comprising:

- means for detecting the amount of light transmitted through a selected portion of a bill presented to said detector;
- means for generating an error signal indicative of the deviation of the light intensity incident on said detection means from a predetermined intensity;
- means for limiting the magnitude of said error signal to a predetermined range;
- means responsive to said error signal for controlling the intensity of the light incident on said selected portion of said bill; and
- means for limiting the output intensity of said output lamp within a predetermined range.

3. A bill detector including apparatus for controlling the intensity of illumination incident on a bill presented thereto, comprising:

- means for illuminating said bill;
- means for detecting the amount of light transmitted through a selected portion of said bill;
- means for generating an error signal representative of the difference between the light intensity detected by said detection means and a predetermined intensity;
- means responsive to said error signal for controlling the intensity of the light incident on said selected portion of said bill; and
- means for limiting the intensity of illumination of said bill to a predetermined range.

4. A bill detector including apparatus for controlling the intensity of illumination incident on a bill presented thereto, comprising:

- a first power source;
- a first voltage divider, including a variable impedance element and a lamp connected in series, connected across the terminals of said first power source;
- a second power source having a terminal in common with said first power source;
- a second voltage divider including a light sensitive variable impedance element and a resistor connected in series, connected across the terminals of said second power source, said light sensitive element being placed so as to be illuminated by light from said lamp passing through a selected portion of said bill;
- an output terminal on said resistor in said second voltage divider;
- control means for controlling said variable impedance element to vary the voltage across said lamp in response to changes in the voltage at said output terminal; and
- means for limiting to a predetermined range the response of said control means to changes of said output terminal voltage.

5. Apparatus for controlling a bill detector light source comprising:

- first and second power sources having one terminal in common;

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- a first voltage divider including a variable impedance element and a light source in series, connected across the terminals of said first power source; said light source being placed so as to illuminate a bill presented to said detector;
- a second voltage divider including a light sensitive variable impedance element and a resistor in series, connected across the terminals of said second power source, said light sensitive element being coupled to light passing from said light source through a selected portion of said bill;
- an output terminal on said resistor in said second voltage divider;
- control means for controlling said variable impedance element to vary the voltage across said light source in response to changes in the voltage at said output terminal; and
- means for limiting the impedance of said variable impedance element to a range predetermined by reference to acceptable bills.
6. Apparatus for controlling a bill detector light source comprising:
- first and second power sources each having one terminal at a common potential;
- a first voltage divider including a variable impedance element and a light source in series, connected across the terminals of said first power source, said light source being placed so as to illuminate a bill presented to said detector;
- a second voltage divider including a light sensitive variable impedance element and a resistor in series, connected across the terminals of said second power source, said light sensitive element being coupled to light passing from said light source through a selected portion of said bill;
- an output terminal on said resistor in said second voltage divider;
- control means for controlling said variable impedance element to vary the voltage across said light source in response to changes in the voltage at said output terminal; and
- means for limiting the voltage across said light source to a range predetermined by reference to acceptable bills.

7. Apparatus for controlling a bill detector light source comprising:
- first and second power sources each having one terminal at a common potential;
- a first voltage divider including a first transistor and a lamp in series, connected across the terminals of said first power source, said light source being placed so as to illuminate a bill presented to said detector;
- a second voltage divider including a photocell and a first resistor in series, connected across the terminals of said second power source, said photocell being placed so as to couple to light passing from said lamp through a selected portion of said bill;
- an output terminal on said first resistor in said second voltage divider;
- a second transistor connected in series with said lamp between the base and the emitter of said first transistor, the base and the collector of said second transistor being connected respectively to said output terminal and the base of said first transistor; and
- a second resistor and a Zener diode in series, connected in parallel with said photocell and said first resistor, one electrode of said Zener diode being connected at a point between the base and the emitter of said first and second transistors, respectively, and the other electrode of said diode being connected to the emitter of said second transistor.

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