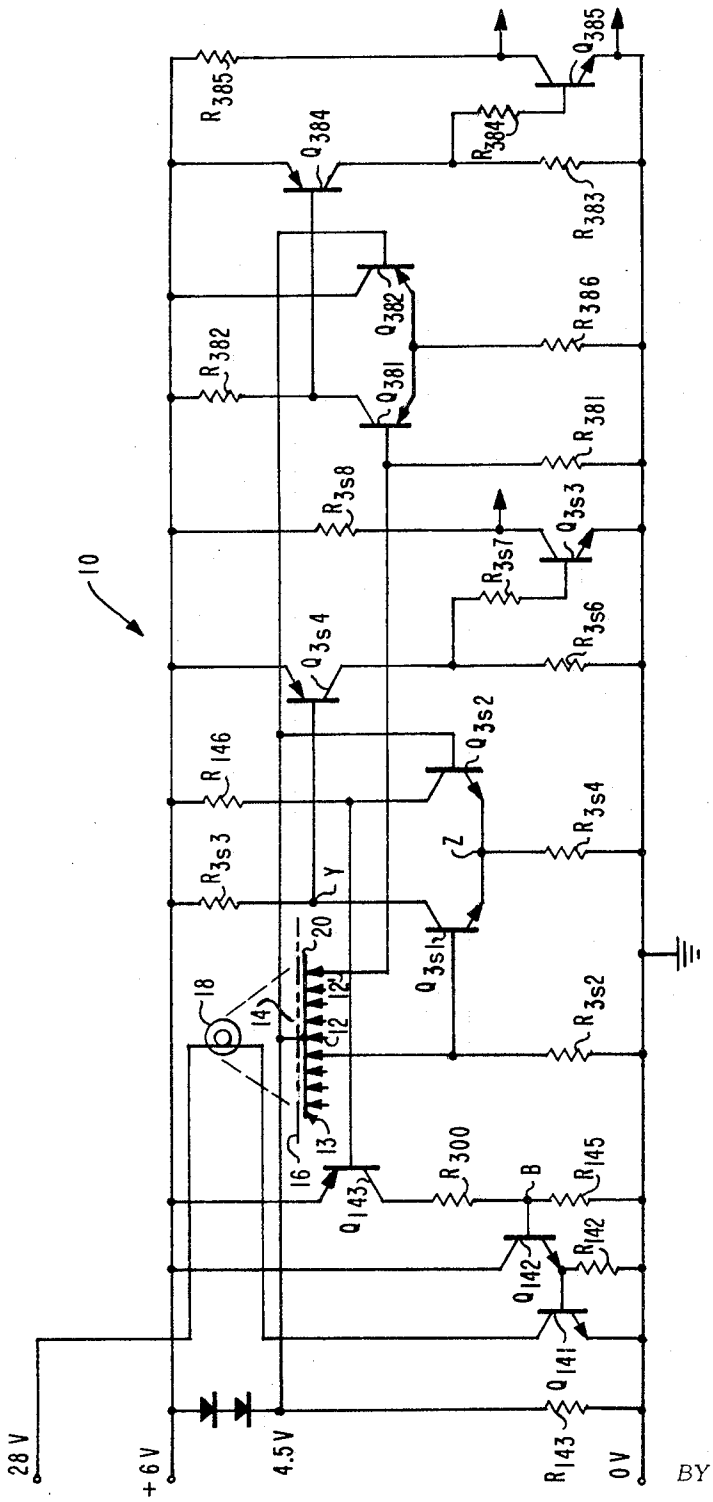
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RADIATION SENSITIVE LAMP REGULATOR FOR USE WITH A TAPE READER

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INVENTOR.
JEFFREY M. BEVIS

BY Julius L. Rubinstein

ATTORNEY

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RADIATION SENSITIVE LAMP REGULATOR FOR USE WITH A TAPE READER

Jeffrey M. Bevis, Long Beach, Calif., assignor to Chalco Engineering Corporation, Gardena, Calif.

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ABSTRACT OF THE DISCLOSURE

This invention relates generally to a tape readout apparatus and more particularly to a lamp regulator for use with a tape reader. The regulator functions to dim the lamp by an amount proportional to the excess illumination from the lamp over a predetermined minimum light intensity.

Tape readers are well-known devices for controlling operations in accordance with orders represented by combinations of perforations located in one or more rows of perforation sites across the width of a perforated tape. Heretofore the perforated tape was designed for use with mechanical readers in which the presence of holes or perforations was detected by purely mechanical means. In such an environment tape opacity was unimportant. Consequently, many kinds of tapes were used, some of which were translucent in varying degrees. When photo readers came into use, lines of photocells corresponding to lines of perforation sites across the width of the tape were used to detect the perforations. However, the translucent quality of some tapes in commercial use began to create difficulty because enough light penetrated the unperforated portions of the translucent tape to confuse the photocells.

Economic considerations require tape readers in commercial use to be able to use different kinds of tapes ranging in opacity to 50 percent (50%) translucent to 100 percent (100%) opaque. Consequently, an automatic reference is needed to tell whether or not a hole or perforation is present in a line of perforation sites across the width of a tape. Since a sprocket hole is present in each line of perforation sites across the width of a tape, the intensity of light transmitted through this sprocket hole provides an initial reference for distinguishing between the presence and absence of perforations. In the present invention electronic circuitry is associated with each photocell so that only the presence of a perforation transmits enough light to cause an electrical switch to close (or in this case a transistor to become conductive). At the same time the photocell associated with the sprocket hole is connected through appropriate circuitry to the light source and senses the light coming through the sprocket hole. This photocell causes the lamp to dim by a predetermined amount, proportional to the excess illumination from the lamp over the predetermined light intensity required to cause the circuitry associated with each photocell to provide an output signal. Variations in the intensity of the light from the lamp due to manufacturing tolerances or dimming due to the age of the lamp, changes the intensity of the lamp and consequently changes the amount of feedback control to the lamp. In this way the intensity of the light shining through the sprocket holes and the perforations is maintained just sufficient regardless of the age of the lamp or manufacturing tolerances in the construction of the lamp.

Brief summary

This invention relates to a lamp regulator for a tape reading head. The perforated tape used with photo tape readers is not standardized in that its light transmitting qualities vary in a range from completely opaque to around 50 percent (50%) translucent. When the tape reader used a mechanical pick-up for sensing perforations in the tape, this variation in opacity didn't matter; but when the perforations are sensed by photocells, the translucent quality of the tape is quite important because the photocells have difficulty in distinguishing between the presence and absence of perforations. This difficulty was compounded because the intensity of the lamps used with the reading head varied due to manufacturing tolerances and because of aging.

Heretofore attempts were made to compensate for these changes in light intensity by supplying the lamp with a regulated constant voltage power supply. However, this was not satisfactory because there was too much variation in the light intensity as the lamp aged. Consequently, adjustments had to be made periodically to maintain a constant light output. This was objectionable because it happened that the tape reader began to make errors before the dimming of the lamp was noticed.

Similarly, if the intensity of the lamp was increased to a point sufficient to compensate for variations in light intensity due to manufacturing tolerances or dimming due to age, the increased intensity of light shining through some of the more translucent tapes served to confuse the photocells. In addition, errors occurred because light shining through microscopic pinholes in the tape was sufficiently intense to affect the photocells and introduce error.

Furthermore, it was previously necessary for the photocell and amplifier associated with each line of perforation sites to operate in the same way. This required a separate adjustment for each photocell-amplifier combination. When a tape reader was a block reader involving, as a typical example, eight (8) perforation sites across the width of the tape for each line and perhaps up to eight (8) lines in a block, the cost of providing a separate adjustment (usually a potentiometer) for each photocell-amplifier became prohibitive. However, if the photocells used are manufactured in strips in a manner now well known in the art, their responses are so similar that individual adjustments are not required.

In the present invention, advantage is taken of the close response of the strips of photocells in a circuit which utilizes the sprocket hole in a tape which is always present in each line of perforation sites across the width of a tape to sense a hole. Appropriate circuitry is connected to the power supply of the lamp in a feedback arrangement which utilizes a photocell-amplifier combination associated with the sprocket hole to dim the lamp by an amount proportional to the excess illumination from the lamp over that predetermined light intensity required to cause the circuitry associated with the lamp to provide an output signal. This dimming effect decreases in accordance with the decreased light intensity from the lamp so that as the lamp ages less dimming is required and the light intensity is maintained somewhat constant. In addition, the photocell-amplifier combination, which in the present invention employs transistors, is biased so they only turn on (as an electric switch) when the light intensity shining through the sprocket hole is just bright enough. The photocell-amplifier combination assocated with other perforation sites for the tape are similarly biased so they only turn on (acting as an electric switch) to provide a signal indicating a perforation, when the light shining on them through a perforation has the above-described predetermined intensity.

What is needed therefore, and comprises an important object of this invention, is to provide a lamp regulator

for a tape reader employing a photocell pickup which causes a lamp to provide just enough light so that when the light shines through a perforation in the tape the circuitry associated with the photocells beneath the perforation provides a signal.

Another important object of this invention is to provide a tape reader using a photocell-amplifier combination for each perforation site across the width of the tape with appropriate circuitry for regulating the light from a lamp in order to produce an output signal for each perforation site only when the light shining on the photocell through a perforation in the tape has the necessary intensity.

Still another object of this invention is to provide a lamp regulator for a tape reader which uses a photocell-amplifier combination associated with the sprocket holes of the tape with a feedback connection to a lamp for dimming the lamp by a predetermined amount proportional to the excess light intensity shining through the sprocket holes so that the light intensity from the lamp is substantially constant and is independent of the age of the lamp.

Another object of this invention is to provide a circuitry in a photocell-amplifier combination for a tape reader wherein the circuitry associated with each photocell operates independently of the temperature.

This and other objects of this invention will become more apparent when better understood in the light of accompanying specifications and drawings wherein:

The drawing is a diagram showing the arrangement between the lamp, the perforated tape and the photocell-amplifier combination.

Referring now to the drawing, the circuit diagram **10** for the lamp regulator comprises a photocell **12** formed in a strip **13** of photocells and positioned in the path of sprocket hole **14** on the perforated tape **16**. Light from lamp **18** shining on the tape and through the sprocket hole causes current to flow. This current flow through the 4.7K resistance R_{3s2} causes the potential on the base of NPN transistor Q_{3s1} to rise. Transistor Q_{3s1} is biased so it is non-conducting until the potential on the base rises to a predetermined level. In the embodiment shown, the turn on level of transistor Q_{3s1} is selected so it starts to conduct when the base potential rises to an arbitrary reference voltage of 4.5 volts. This occurs only when the light intensity from lamp **18** has a predetermined minimum value. As seen from the circuit diagram, this voltage is the same as the voltage on the common cathode **20** of the strip **13** of the photocells. Since the cathode and anode of the photocell **12** are at the same potential, the performance of the photocell will then be independent of the temperature.

As transistor Q_{3s1} starts to conduct, the current flow through the 4.7K resistor R_{3s3} causes the potential at point Y to drop. This drop in potential, which is connected to the base of PNP transistor Q_{3s4} turns transistor Q_{3s4} completely on. When this happens, transistor Q_{3s4}, functioning as a switch, permits current to flow so that the potential on the base of NPN transistor Q_{3s3} rises turning the transistor completely on. The output of the transistor Q_{3s3} is taken at its collector and this signal voltage typically operates to stop the perforated tape when a line of perforations on a block of perforations are to be read.

The feedback portion of the circuit **10** comprises a differential amplifier including NPN transistors Q_{3s1} and Q_{3s2}. These transistors share a common emitter potential. As transistor Q_{3s1} becomes more conductive the potential at the emitter tries to rise. The base of transistor Q_{3s2} is biased to the 4.50 reference voltage and reacts to this attempt to rise in potential in the same way as if the base of the transistor Q_{3s2} went somewhat negative. Consequently, the transistor Q_{3s2} becomes less conductive and in the same proportion as transistor Q_{3s1} becomes more conductive so that the current flow through the 5.1K resistor R_{3s4} remains constant and the emitter of both transistors Q_{3s1} and Q_{3s2} are held at a constant potential.

Transistors Q_{3s1} and Q_{3s2} are selected so their characteristics are very similar and so they both have the same transistor offset voltage. This offset voltage varies with the temperature and consequently temperature changes in the equipment could cause the current flow through transistor Q_{3s1} to vary, which would introduce error into the feedback portion of the circuit. However, since Q_{3s1} and Q_{3s2} have a common emitter potential and since the base of transistor Q_{3s2} is directly connected to the 4.5 v. reference potential, changes in temperature cause a change in the potential of the emitters. This change is just enough, recalling that Q_{3s1} and Q_{3s2} have the same transistor offset voltage, so that the potential on the base of transistor Q_{3s1} is maintained at the 4.5 v. reference potential when Q_{3s1} starts to conduct. This effect will be independent of the temperature. With this arrangement, the above-described differential amplifier and, in fact, all the differential amplifiers in the circuit provide an output signal only when a perforation in the tape is opposite each photocell and the illumination through the perforation is sufficient to cause the potential across each photocell to be zero.

In addition, it can be seen that the differential amplifier comprising transistors Q_{3s1} and Q_{3s2} provides an output signal proportional to the excess illumination from the lamp **18** over the predetermined minimum light intensity required to just start Q_{3s1} conducting. As the current flow through the transistor Q_{3s2} decreases, the potential at the collector of transistor Q_{3s2} increases causing the potential on the base of the PNP transistor Q_{143} to rise. This, however, causes transistor Q_{143} to become less conductive in a manner well-known in the art.

As the transistor Q_{143} becomes less conductive, the current flow and IR drop across the 4.7K resistor R_{300} decreases so that the potential at the base of the NPN transistor Q_{142} decreases. Consequently, the NPN transistor Q_{142} becomes less conductive. This, in turn, reduces the voltage on the base of the current limiting NPN power transistor Q_{141} so the current flow in that transistor decreases. Since lamp **18** is in series with transistor Q_{141} the decreased current flow through that transistor causes lamp **18** to dim.

The feedback circuit is arranged so that the dimming of the lamp **18** is in proportion to the excess illumination from lamp **18** over the predetermined amounts required to turn transistors Q_{3s3} completely on. With this arrangement, if lamp **18** dims with age or if the lamp intensity because of manufacturing tolerances is lower than it should be, the dimming effect on the lamp to the feedback portion of the circuit will be lessened. Conversely, if the output from lamp **18** is larger than normal, the dimming effect on the lamp will be increased. It will be noted that this circuit functions, not so much to maintain a constant lamp voltage or even a constant illumination, but instead, it is designed to function to provide just enough illumination to produce an output signal when a hole is opposite a photocell during the reading operation. Variations in lamp intensity, supply voltage, and the physical characteristics of the photocells are all compensated for by this circuit.

It is further seen that the differential amplifier which includes transistors Q_{3s1} and Q_{3s2} serve three (3) functions. They keep the operation of transistor Q_{3s1} independent of temperature, which in turn keeps the anode and cathode of photocell **12** at the same potential and hence independent of temperature. In addition, they provide the phase inversion necessary for transistor Q_{3s2}. Finally, they provide an output potential at the collector of transistor Q_{3s2} which is sufficient to dim lamp **18** by the required amount.

The other photocells of strip **13** have generally the same characteristics as photocell **12** because they are all in the

form of strips. These other photocells are all connected to associated circuitry including differential amplifiers which are identical in operation to the differential amplifier described above. For example, photocell **12'** is connected to a differential amplefier comprising transistors Q_{381} and Q_{382} which serve to keep the operation of transistor Q_{381} independent of temperature so that photocell **12'** will also not be affected by temperature changes.

Because of geometrical factors (see FIG. 1), all holes or perforations in a line or block of perforation sites do not receive the same illumination. For this reason, in order for these circuits associated with the other photocells in the strip to turn on at the same reference voltage as photocell **12**, the biasing resistors associating with the various photocells must have different values corresponding to the different geometrical positions of the photocells.

In summary, lamp **18** and its voltage supply is selected so the light intensity from lamp **18** is low enough to prevent the translucence of the perforated tape or tiny pinholes accidentally formed in the body of the tape during manufacture from introducing error during reading. The photocell **12** and the feedback portion of the circuit connected to lamp 18 operate to automatically regulate the light intensity from lamp **18** to compensate the lamp for variations in its light output which occur due to age or for manufacturing tolerances and to operate automatically to cause the lamp to provide just enough illumination to produce an output signal from the photocells only when light shining through a perforation on the tape falls on the photocells during the reading operation. Any lesser light intensity would be insufficient to produce an output signal. The feedback circuit would dim the lamp if the initial light intensity was too high. In this way the operation of the tape reader will not be affected by the translucence of the tape.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention can be practiced otherwise than as specifically described.

I claim:

1. In a tape reader of the class described, a plurality of photocells selected to have generally similar physical and electrical characteristics, said photocells mounted so when perforated tape is being read each photocell is opposite a perforation site or a sprocket hole in the tape, a lamp, one photocell associated with a sprocket hole in the tape, an output signal circuit and a lamp regulating feedback circuit connected to said one photocell, said output signal circuit connected to said one photocell in such a way that there is no output signal until at least a predetermined minimum light intensity falls on said one photocell, said lamp regulating feedback circuit connected to said lamp and functioning to dim the lamp by an amount proportoinal to the excess illumination from the lamp over that predetermined minimum light intensity required to cause said one photocell to provide an output signal whereby the lamp illumination is held to a desired level.

2. The tape reader described in claim **1** wherein the regulating circuit includes a current limiting device in series with the lamp, whereby the regulating circuit causes the current limiting device to decrease the current flow through the lamp by an amount depending on the excess illumination over that required to cause said one photocell to produce a sprocket output signal whereby lamp illumination is held to a desired level.

3. The tape reader described in claim **1** wherein an output signal circuit is connected to each photocell and operating to provide an output signal only when a perforation in the tape is opposite each photocell and the illumination through the perforation is sufficient to cause the potential across the photocells to be the same as the potential across the said one photocell opposite the sprocket hole.

4. The tape reader described in claim **3** wherein the output signal circuit connected to each photocell produces an output signal only when the potential across the terminals of the photocells is zero, whereby the operation of the photocells will be independent of temperature.

5. The tape reader described in claim **1** wherein said plurality of photocells is in the form of a strip of photocells, whereby their physical and electrical characteristics are generally similar.

6. The tape reader described in claim **1** wherein the lamp regulating feedback circuit comprises a differential amplifier and a current limiting device in series with said lamp, said differential amplifier constructed to provide an output proportional to the excess light intensity from the lamp over said predetermined minimum light intensity, said differential amplifier connected to said current limiting device in such a way that the operation of the differential amplifier decreases the current flow through the lamp by an amount dependent on and proportional to the output of the differential amplifier.

7. The tape reader rescribed in claim **6** wherein said differential amplifier comprises two transistors, the base of one transistor connected to a reference voltage, the emitters of both transistors connected together, the base of the other transistor connected to the terminal of said one photocell whereby during operation of the differential amplifier the base of said other transistor is maintained at the reference potential independently of temperature.

8. The tape reader described in claim **1** wherein a differential amplifier is associated with and connected to each photocell, each differential amplifier biased to provide an output signal only when a perforation in the tape is opposite each photocell and the illumination through the perforation is sufficient to cause the potential across each photocell to be the same as the potential across the photocell opposite the sprocket hole.

9. The tape reader described in claim **8** wherein all the photocells are in the form of a strip of photocells whereby their physical and electrical characteristics are generally similar, one terminal of all the photocells connected to a common reference potential, each of said differential amplifiers comprising two transistors, the base of one transistor connected to the reference potential, the emitters of said transistors connected together, the base of the other transistor connected to the other terminal of the associated photocell, each differential amplifier biased to provide an output signal when the potential on the base of said other transistor is at the reference potential whereby the base of said other transistor is maintained at the reference potential independently of temperature and both terminals of each associated photocell will be at the same reference potential when the associated differential amplifier provides an output signal whereby the operation of the photocells will be independent of temperature when the light intensity is just sufficient to cause the differential amplifiers to start operating.

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WALTER STOLWEIN, *Primary Examiner.*

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