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[54] LIGHT-CONDUCTING MEMBER FOR PHOTOELECTRIC CODE SENSOR

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[52] **U.S. Cl.** .....**250/227**, 250/216, 250/219 D, 350/96 R, 350/189
[51] **Int. Cl.** **G02b 5/14**
[58] **Field of Search**.....250/216, 227, 219 DC, 219 D; 350/189, 96, 191

[56] **References Cited**

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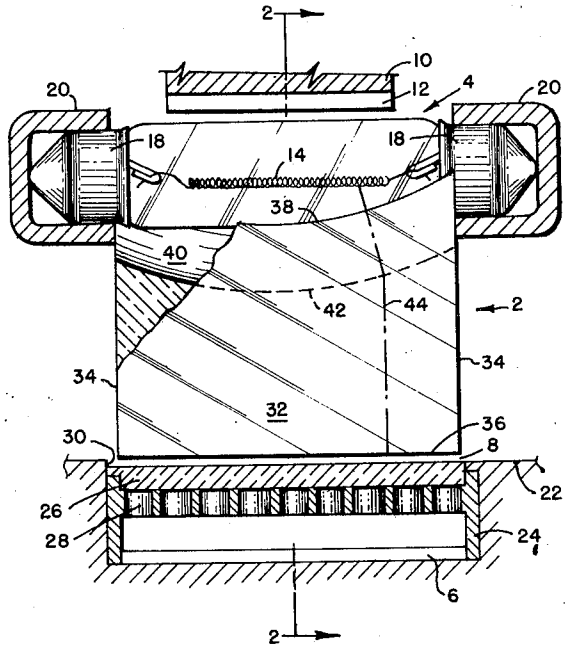
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[57] **ABSTRACT**

A light-conducting member for an apparatus which photoelectrically senses successive columns of coded data-indicating perforations in a punched tape. The light-conducting member is of a transparent material, located above the tape, and conducts light from a single elongated light bulb onto the tape. A phototransistor array is located beneath the tape and senses light passing through the perforations. The top surface of the light-conducting member receives the light from the bulb and contains a trough portion extending substantially parallel to the columns of perforations and elongated bulb. The bottom of the trough is concave and symmetrical about a plane perpendicular to the columns. The bottom surface of the light-conducting member emits the light received on its top surface, is planar and located perpendicular to the plane about which the trough is symmetrical. The bottom surface is also elongated in a direction parallel to the columns to emit light to all the apertures in each column. Preferably, the light-conducting member has two planar side surfaces located in converging planes which intersect beneath the bottom surface. The insides of these side surfaces are adapted to reflect at least some of the light directed onto the top surface and direct such light onto the bottom surface.

10 Claims, 2 Drawing Figures



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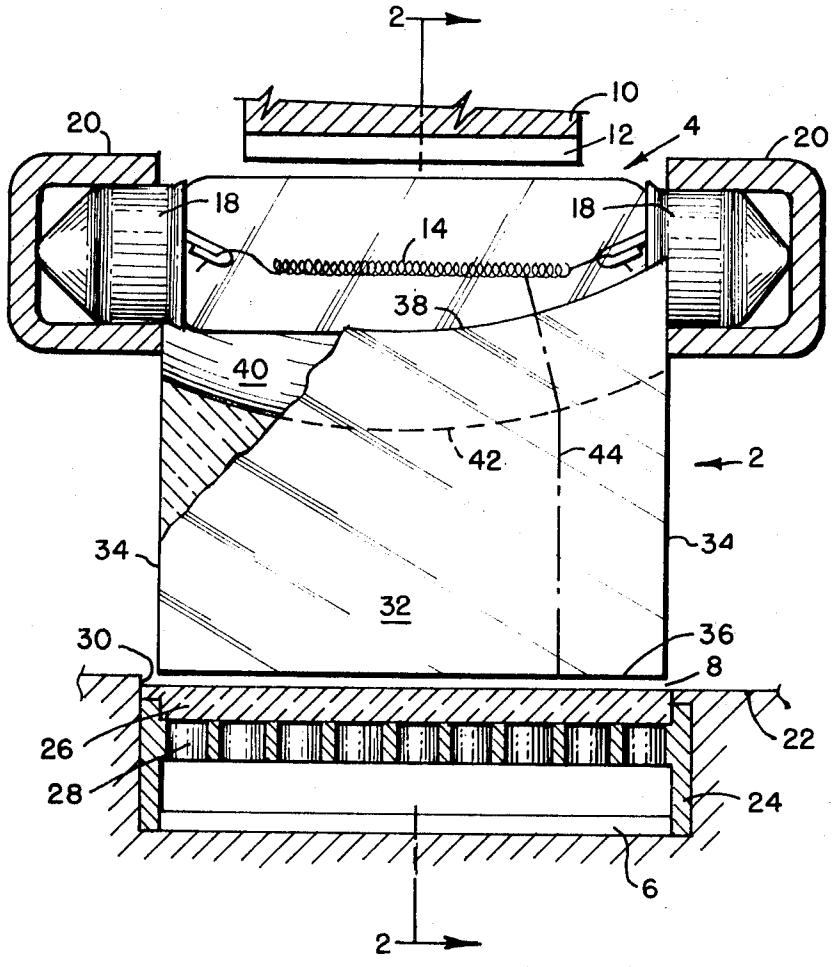


FIG. 1

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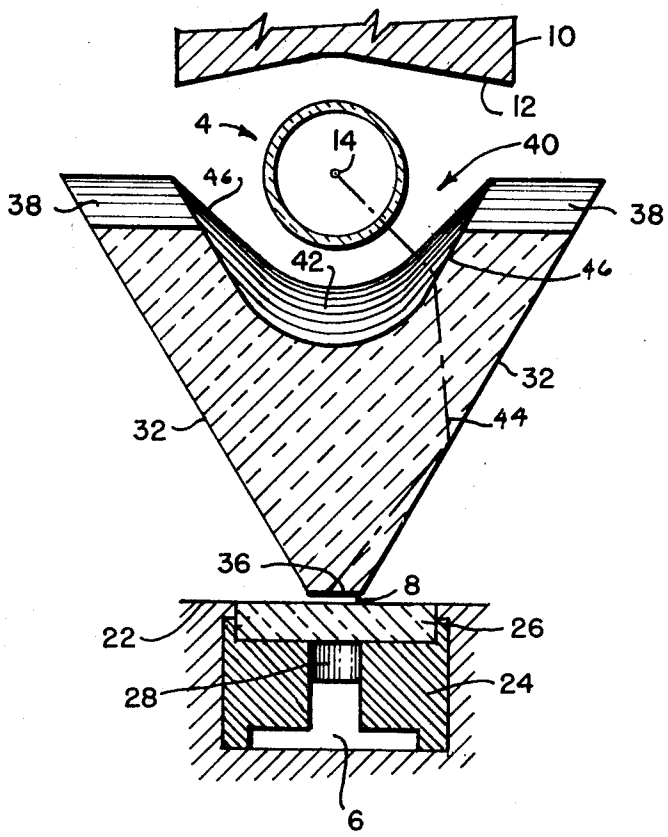


FIG. 2

LIGHT-CONDUCTING MEMBER FOR PHOTOELECTRIC CODE SENSOR

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for photoelectrically sensing perforations in a perforated member and, more particularly, to a light-conducting member for such an apparatus.

It is a common practice in the data processing field to indicate data by columns of coded perforations in a perforated member such as a punched tape or card. Several ways of sensing these data-indicating perforations are known and apparatus for doing this photoelectrically have been developed. Generally, with such photoelectric apparatus, light is directed toward an array of photosensitive elements but interrupted at all times by the perforated member except when perforations occur in the light path. When a column of perforations occurs, some of the light passes through each perforation in the column and onto a photosensitive element which thereby provides an electrical signal indicative of the perforation.

Such apparatus must possess good "light-to-dark" ratios, i.e., the ability to distinguish between a perforation and no perforation in the poorer grades of perforated material. The poorer grades of perforated material allow some light to pass through the material itself and present a problem.

Photoelectric sensing apparatus must also provide uniform light intensity across each of the columns of perforations so that all the photosensitive elements will provide substantially the same signals when sensing perforations. Without such uniformity, each of the photosensitive elements must be adjusted to compensate for the difference in light intensity.

In order to provide uniform light on the perforated member several approaches have been tried. One approach provides a light source for each photosensitive element. However, some differences in light intensity must exist between these several light sources necessitating some adjustment in the photosensitive elements. Another approach uses a single point light source with fiber optics elements extending from the light source toward each of the photocells. Since only a single light source is being used, differences in light intensity existing between several sources of light are avoided. However, photoelectric apparatus employing fiber optic methods are relatively expensive.

SUMMARY OF THE INVENTION

According to the invention, an apparatus for photoelectrically sensing perforations in a perforated member is provided which is inexpensive, utilizes a single light source, provides uniform light without requiring fiber optics or adjustment of the photosensitive elements, and has a good light-to-dark ratio.

The invention provides an apparatus for photoelectrically sensing columns of data-indicating perforations in a perforated member which comprises sensing means located beneath the perforated member for sensing light passing through any perforations present, a light source located above the perforated member, and a transparent light-conducting member interposed between the light source and perforated member. The conducting member receives light on its top surface and emits at least part of this light from its bottom surface. Its top surface contains a portion which forms a trough extending substantially parallel to the columns of perforations. The bottom surface is in a plane located parallel to the perforated member and is elongated in a direction substantially parallel to the trough. The bottom of the trough is concave and symmetrical about a plane extending across the trough and perpendicular to the bottom surface. Preferably, the concave curve forming the bottom of the trough is an arc of a circle. Also, preferably, the light-conducting member has two planar side surfaces which are in converging planes and intersect between the bottom surface. The insides of the side surfaces are adapted to reflect at least some of the light passing through the top surface and direct such light onto the bottom surface.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a simplified elevation view, partly in section, of a preferred embodiment of a perforation sensing apparatus incorporating the invention.

FIG. 2 is a section taken along line 2—2 in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1 and 2 show a tape reader for sensing the data-indicating perforations in a punched paper tape (not shown) in which light from a single light bulb 4 is transmitted by a light-conducting member 2 across a gap 8 onto a photosensing device 6. The punched tape contains successive columns of perforations and is continually passed through the gap 8. In FIG. 1, the tape moves into the plane of the drawing and in FIG. 2 moves across the drawing. As is conventional, the tape contains eight data-indicating perforations in each column. The tape also contains an additional aperture in each column, the tape's sprocket holes, which are engaged by a sprocket wheel (not shown) to move the tape. When sensed by the device, the sprocket holes are used to provide timing signals, each signal indicating the presence of one column of perforations.

The photosensing device 6 contains an aligned array of phototransistors. Any suitable conventional device may be utilized, for example, the phototransistor array marketed by Fairchild SemiConductor Corp. designated FPA700. The tape passes above the photosensing device 6 such that each perforation in each of its columns is aligned with and passes over one of the phototransistors in the array. There are nine phototransistors in the array: eight are used to sense the data-indicating perforations and the ninth for sensing the sprocket holes.

The phototransistor array is mounted in a member 24 which is located in the frame 22 of the reader. The member 24 contains nine apertures 28, each of which is located directly above and aligned with one of the phototransistors in the array 6. Also located within the frame 22 and partially mounted in the member 24 is a glass plate 26. The punched tape when passing through the reader rides on the top surface of the glass plate 26. To guide the tape, a notch 30 is provided on the reader's frame 22 against which an edge of the tape rides. This keeps the perforations in the tape aligned with the transistors in the array 6. The glass plate serves to keep dust and paper particles from settling on the phototransistors.

The light bulb 4 is elongated in a direction substantially parallel to the columns of perforations in the tape and contains an elongated filament 14. The bulb is mounted in a conventional manner by having its ends 18 clamped within a pair of spring mounting elements 20. The mounting elements also serve as the bulb's electrical contacts and have electrical connections (not shown) to provide the filament 14 with the necessary current to energize the bulb. A reflector 10 having a reflecting surface 12 is mounted within the reader above the bulb 4. The reflector captures some of the light which is directed upwardly from the bulb and redirects this light downwardly toward the light conducting member 2. The reflecting surface 12 of the reflector 10 is preferably concave as seen in FIG. 2 to enhance its efficiency.

Referring now to the light-conducting member 2, it is made of a transparent material, preferably, clear lucite. Light from the light bulb passes through its top surface and is emitted from its bottom surface. Its bottom surface 36 is located in a plane lying parallel to the tape. The bottom surface 36 is also elongated in a direction parallel to the elongated bulb to extend across a complete column of perforations in the tape.

The top surface of the light-conducting member is formed by two curved surfaces 38 located on opposite sides of a trough 40. The trough 40 extends substantially parallel to the elongated bulb 4 which is partially located within it. The trough also extends substantially parallel to the elongated bottom surface 36, i.e., they are elongated in substantially the same directions. The bottom 42 of the trough 40 is concave and defined by a circular arc as shown in FIG. 1. As also

shown in FIG. 1, the bottom 42 of the trough 40 is symmetrical about a plane extending across the trough and perpendicular to the bottom surface 36. The curved surfaces 38 are curved in only one direction and are parallel to the curve forming the bottom of the trough as shown in FIG. 1.

As shown in FIG. 2, the trough 40 is symmetrical about a plane extending along the trough and perpendicular to the bottom surface 36. It is made up of circular segments located in planes extending across the trough. The sides 46 of the trough connecting the circular segments to the curved surface 38 are straight lines.

The light-conducting member 2 also has a pair of side surfaces 32. These side surfaces 32 are planar and extend between the curved surfaces 38 of the top surface and the bottom surface 36. They are in converging planes which intersect beneath the bottom surface so that the light-conducting member 2 is tapered toward its bottom. Also, the side surfaces are essentially perpendicular to planes extending across the trough, including the plane about which the bottom of the trough is symmetrical. The insides of the side surfaces 32 are reflective so that at least some of the light from filament 14 which is directed onto and passes through the top surface of the light-conducting member is reflected by the side surfaces onto the bottom surface 36. Since the bottom surface 36 is adjacent the gap 8 through which the tape moves, light is thereby directed into the gap and onto the tape.

The light-conducting member 2 also includes a pair of opposed end surfaces 34. These end surfaces are located in planes perpendicular to the bottom surface 36 and to the punched tape. However, the shape and orientation of the end surfaces 34 are not critical to the invention.

To illustrate the invention, as shown in FIG. 2, at least some light 44 from the filament 14 is directed into the trough 40 formed in the top surface of the light-conducting member. At least some of this light is refracted as it passes through the top surface at this point. When the light 44 reaches the insides of the side surfaces 32 it is reflected downwardly toward the bottom surface 36.

As shown in FIG. 1, some light 44 from the filament 14 directed into the trough 40 will also be refracted within planes extending parallel to the trough. The angle by which the light 44 shown in FIG. 1 is refracted in these planes is such that it will meet the bottom surface 36 perpendicularly. With light from the filament 14 being refracted in this manner, a band of light is directed into the gap 8 which is of uniform intensity.

The light emitted from the bottom surface of the light-conducting member then passes through any perforations present in the tape. Each of the phototransistors in the photosensing device 6 senses the light passing through a perforation and, thus, the reader senses the data-indicating perforations.

It will be appreciated that various changes in the form and details of the above-described preferred embodiment may be effected by persons of ordinary skill without departing from the true spirit and scope of the invention.

What is claimed is:

1. An apparatus for sensing perforations arranged in a column in a perforated manner, the apparatus comprising:
   a. sensing means located beneath the perforated member and containing a plurality of photosensing elements, each said photosensing element being adapted to sense light passing through one of said perforations in said column;
   b. a light source located above said perforated member; and
   c. a light-conducting member of homogeneous material interposed between said light source and perforated member, said conducting member receiving light from the light source on its top surface and emitting at least part of said light from its bottom surface onto the perforated member, said bottom surface being elongated and located in a plane substantially parallel to said perforated member, at least a portion of said top surface forming a trough extending substantially parallel to said elongated bottom surface, the bottom of said trough being concave and symmetrical about a first plane substantially perpendicular to said bottom surface and extending across said trough.

2. The apparatus as recited in claim 1 wherein said light source comprises a single elongated bulb extending substantially parallel to said trough.

3. The apparatus as recited in claim 1 wherein said trough is symmetrical about a second plane extending along said trough, and substantially perpendicular to said bottom surface.

4. The apparatus as recited in claim 1 wherein said concave bottom of said trough is on a circular arc.

5. The apparatus as recited in claim 1 wherein said light-conducting member also has two essentially planar side surfaces extending between said top and bottom surfaces, said side surfaces being in converging planes which intersect beneath said bottom surface, the inside of said side surfaces being adapted to reflect at least some of said light passing through said top surface such that at least some of said light is directed onto said bottom surface.

6. An apparatus for sensing perforations arranged in a column in a perforated member, the apparatus comprising:
   a. sensing means located beneath the perforated member and containing a plurality of photosensing elements, each said photosensing element being adapted to sense light passing through one of said perforations in said column;
   b. a light source located above said perforated member; and
   c. a light-conducting member, interposed between said light source and perforated member, said conducting member receiving light from the light source on its top surface and emitting at least part of said light from its bottom surface onto the perforated member, said bottom surface being elongated and located in a plane substantially parallel to said perforated member, at least a portion of said top surface forming a trough extending substantially parallel to said elongated bottom surface, said light-conducting member also having two essentially planar side surfaces extending between said top and bottom surfaces, said side surfaces being in converging planes which intersect beneath said bottom surface, the insides of said side surfaces being adapted to reflect at least some of said light passing through said top surface such that at least some of said light is directed onto said bottom surface.

7. The apparatus as recited in claim 6 wherein the bottom of said trough is concave and symmetrical about a first plane substantially perpendicular to said bottom surface and extending across said trough, and wherein said side surfaces are substantially perpendicular to said first plane.

8. The apparatus as recited in claim 6 wherein said light source comprises a single elongated bulb extending substantially parallel to said trough.

9. The apparatus as recited in claim 7 wherein said trough is symmetrical about a second plane extending along said trough and substantially perpendicular to said bottom surface.

10. The apparatus as recited in claim 9 wherein said concave bottom of said trough is on a circular arc.

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