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ELECTROLUMINESCENT DEVICE

Filed Aug. 29, 1957

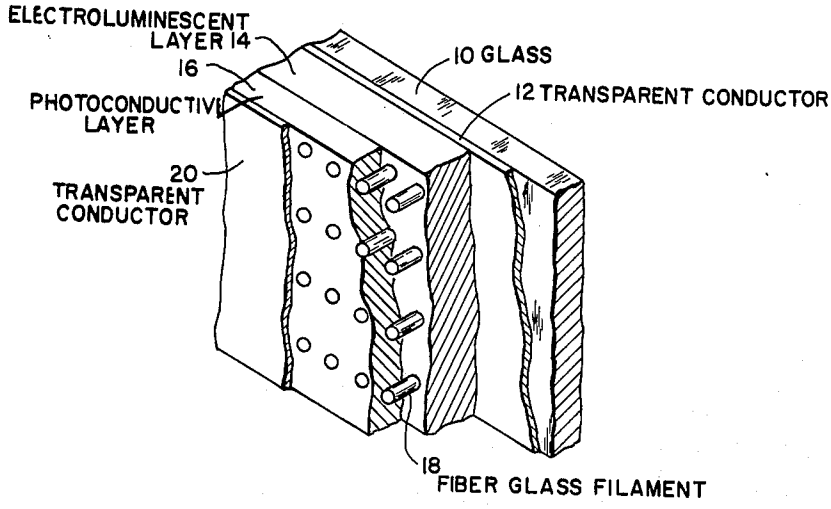


FIG. 1

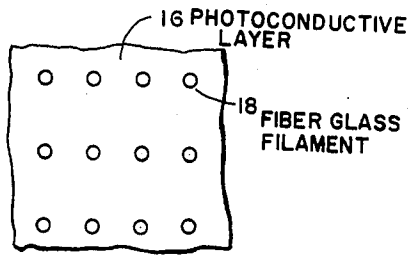


FIG. 2a

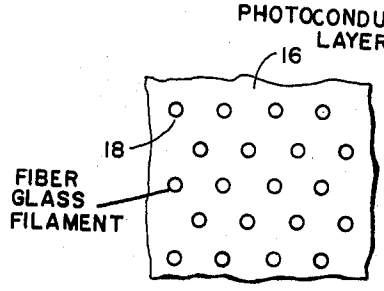


FIG. 2b

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ELECTROLUMINESCENT DEVICE

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2 Claims. (Cl. 250—213)

My invention is directed toward solid state image intensifiers.

A solid state image intensifier is a device which reproduces with increased intensity an incoming image signal, such as a light signal.

In its simplest form, an intensifier comprises an electroluminescent layer, one side of which is coated with a first transparent electrically conductive film; a photoconductive layer, one side of which is in contact with the other side of the electroluminescent layer; and a second transparent electrically conductive film applied over the other side of the photoconductive layer. A voltage is applied between the two films.

The electrical characteristics of the electroluminescent and photoconductive layers are chosen such that the dark impedance of the photoconductive layer is high relative to the impedance of the electroluminescent layer. Hence, in the absence of an image signal most of the voltage drop across the two layers produced by the applied voltage appears across the photoconductive layer, and there is little or no excitation of the electroluminescent layer. However, when the image signal irradiates the photoconductive layer, the impedance of the photoconductive layer decreases, and a larger fraction of the total voltage drop appears across the electroluminescent layer; as a result, the intensity of the light emitted from the electroluminescent layer is sharply increased.

An intensifier of this type, however, has one serious disadvantage; its sensitivity, as defined by the ratio of the intensity of the emitted light to the intensity of the incident light, is inherently low.

More particularly, since the impedance of the photoconductive layer increases with increasing thickness of the layer and since its dark impedance must be high relative to that of the electroluminescent layer, the photoconductive layer must be relatively thick. The photoconductive effect, however, is primarily confined to the surface of the photoconductive layer. Hence, for a relatively thick layer, changes in the image signal produce only small percentage changes in the impedance of the photoconductive layer, and the sensitivity of the intensifier is necessarily poor.

Various techniques have been developed for increasing the sensitivity of image intensifiers. One type of intensifier having improved sensitivity is disclosed in the copending application of Frederick Koury, Serial No. 651,791, filed April 9, 1957. In this arrangement, the interstices of an integral glass matrix formed by cutting grooves in mutually perpendicular directions in a glass plate are filled with photoconductive material; the resultant structure is used in substitution for the solid uniform photoconductive layer in an image intensifier of the type hitherto described. In this Koury arrangement, the incident light is not confined to a single photoconductive surface but rather affects all photoconductive surfaces adjacent each portion of the glass matrix, thus enhancing the photoconductive effect and sharply increasing the sensitivity of the intensifier.

However, the image resolution of any intensifier employing a glass or other transparent matrix depends upon the number of elements per unit area of the matrix. When mechanical cutting operations are utilized in producing such a matrix, the minimum dimensions of each

element (and hence the maximum resolution) obtainable are limited by the finite dimensions of the saw blades or other cutting tools required.

In contradistinction, I have invented an image intensifier which retains high sensitivity and further is characterized by a higher degree of resolution than heretofore obtainable.

Accordingly it is an object of the present invention to provide a new and improved image intensifier.

Another object is to increase the resolution of an image intensifier without impairing the sensitivity thereof.

Still another object is to increase the resolution of an image intensifier through the use of a plurality of closely spaced discrete light-transparent elements, each of which has an extremely small cross sectional area.

These and other objects of my invention will either be explained or will become apparent hereinafter.

In accordance with the principles of my invention, I provide a sandwich-like structure comprising, in the order named, a first transparent electrically conductive film; an electroluminescent layer applied over the first film; a matrix layer applied over the electroluminescent layer; and a second transparent electrically conductive film applied over the matrix layer.

The matrix layer comprises a photoconductive layer having a plurality of closely spaced discrete light-transparent elements embedded therein and extending through the entire thickness thereof. These elements are substantially parallel and are formed from short segments of extremely fine filaments of fiber glass or other transparent material.

When a voltage is applied between the two films and an image signal irradiates the matrix, a high sensitivity is obtained in the manner previously discussed. Further, however, the cross sectional area of each element is much smaller than any corresponding element in an integral glass matrix with a corresponding increase in image resolution.

The matrix layer can be formed, for example, by coating each of a plurality of light-transparent filaments with a photoconductive material, then bundling and bonding the coated filaments together to form a rod of desired shape and size, and finally cutting transversely through the rod to produce a thin sheet consisting of separated transparent parallel columns embedded in photoconductive material.

An illustrative embodiment of my invention will now be described with reference to the accompanying drawings, wherein

FIG. 1 shows a solid state image intensifier in accordance with the invention; and

FIGS. 2*a* and 2*b* show alternative methods of arranging light-transparent elements in a photoconductive layer.

Referring now to FIG. 1, there is shown a transparent glass base plate **10**, one side of which is coated with a first transparent electrically conductive film **12**. An electroluminescent layer **14** is applied over film **12**. In turn, a matrix layer comprising a photoconductive layer **16** containing a plurality of discretely spaced, parallel, light-transparent elements, as for example, short segments of extremely fine continuous fiber glass filaments **18** embedded in layer **16** and extending through the entire thickness thereof is applied over layer **14**. A second transparent electrically conductive film **20** is applied over the matrix layer.

When a voltage is applied between films **12** and **20** and an image signal irradiates the matrix layer, the device of FIG. 1 functions as an image intensifier in the manner indicated, the high resolution being obtained because the filaments **18** are closely spaced and have extremely small cross sectional areas.

In forming the matrix layer, individual filaments are first sprayed with photoconductive material, such as activated cadmium sulphide dispersed in a suitable lacquer; the coated filaments are then arranged into a bundle of suitable shape and size; the bundle is then fired in a furnaceto bond the photoconductive material to the filaments; and the fired bundle is then cut through transversely to produce a thin matrix layer which as viewed in cross section can have the structure shown in FIG. 2*a* or FIG. 2*b*.

The portion of the structure shown in FIG. 1 which includes glass plate **10**, conductive film **12** and the electroluminescent layer **14**, is then prepared in known manner, the matrix layer is applied over the electroluminescent layer and bonded thereto by firing same in a furnace; finally the second conductive film **20** is applied over the matrix layer to complete the structure.

Further details in the formation and the composition of the above described layers and films will be found in the aforementioned copending application.

While I have shown and pointed out my invention as applied above, it will be apparent to those skilled in the art that many modifications can be made within the scope and sphere of my invention as defined in the claims which follow.

What is claimed is:

1. In combination, an electroluminescent layer, one surface of which is coated with a first transparent electrically conductive film; a matrix layer applied over the other surface of said electroluminescent layer, the surface of said matrix layer remote from said electroluminescent layer being coated with a second transparent electrically conductive film, said matrix layer including a photoconductive layer provided with a plurality of discretely spaced light-transparent fiber glass filament elements embedded therein and extending through the entire thickness thereof, said elements being substantially parallel to each other and arranged into a plurality of horizontal arrays, the elements in any odd numbered array being vertically aligned with the corresponding elements in all other odd numbered arrays, the elements in any even numbered arrays being vertically aligned with the corresponding elements in all even numbered arrays, the elements in any odd numbered array being out of vertical alignment with the corresponding elements in any even numbered array.

2. In an image storage apparatus, a plurality of optical fibers arranged in an array, each of said fibers having a longitudinal surface and transverse ends, at least a portion of said longitudinal surface having a coating of photoconductive material substantially extending between said ends and in contact with the coating of the adjacent optical fibers of the array, a substantially continuous conductor layer making electrical contact with one of the transverse ends of the array and the coating of photoconductive material substantially extending to said one transverse end, an electroluminescent layer in contact with the other transverse ends of the array of optical fibers and the coating of photoconductive material substantially extending to said other transverse end, and means for securing said optical fibers into said array.

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