Nov. 7, 1961 R. R. CHAMBERLIN 3,008,065

ELECTROLUMINESCENT INDICATORS

Filed Feb. 26, 1958 2 Sheets-Sheet 1

FIG. 7

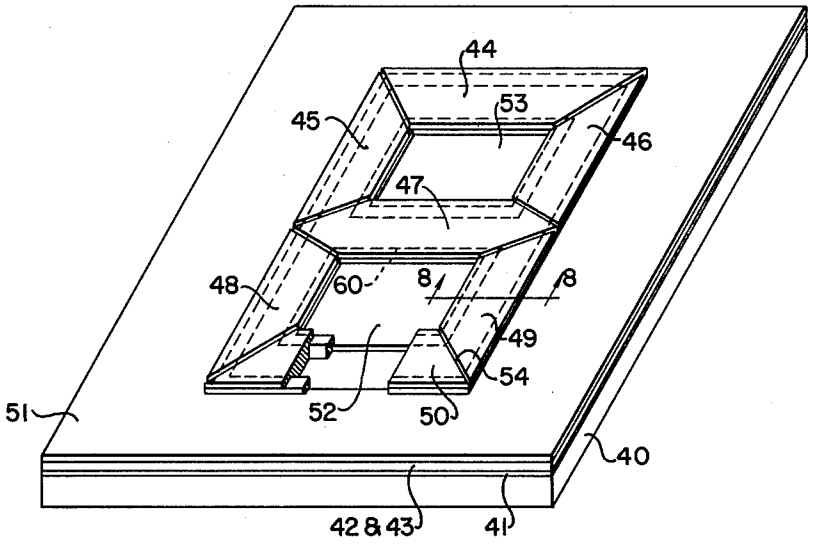


FIG. 8

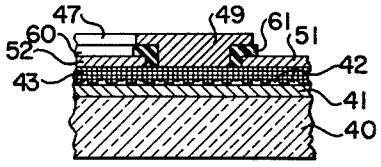


FIG. 1

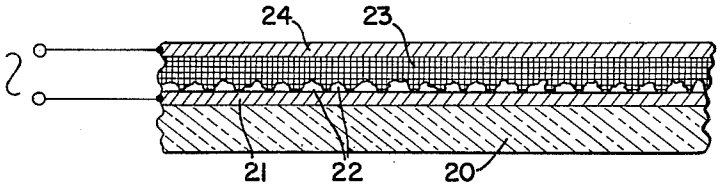
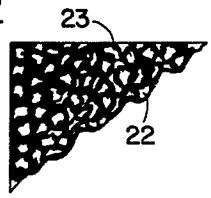


FIG. 2



INVENTOR
RHODES R. CHAMBERLIN
BY Louis A. Kline
Justen & Compton
HIS ATTORNEYS

FIG. 3

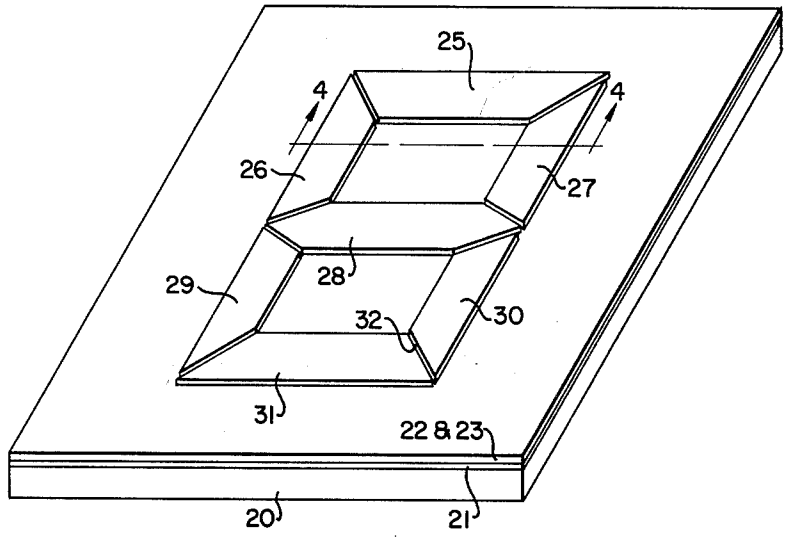


FIG. 4

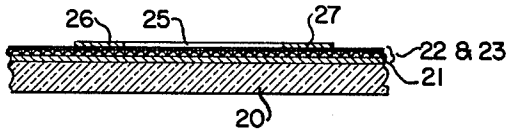


FIG. 5

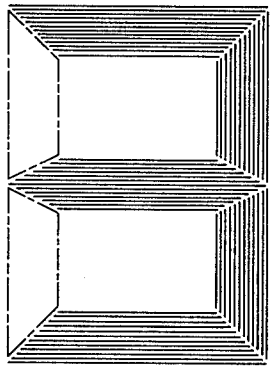
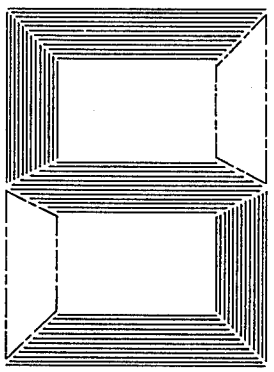


FIG. 6



INVENTOR
RHODES R. CHAMBERLIN
BY Louis A Kline
Justin S Compton
HIS ATTORNEYS

United States Patent Office

3,008,065
Patented Nov. 7, 1961

3,008,065

ELECTROLUMINESCENT INDICATORS

Rhodes R. Chamberlin, Centerville, Ohio, assignor to The National Cash Register Company, Dayton, Ohio, a corporation of Maryland

Filed Feb. 26, 1958, Ser. No. 717,779
7 Claims. (Cl. 313—108)

This invention relates to an improved visual indicating device consisting of a transparent or translucent panel on the back side of which are coated a plurality of materials which include an electroluminescent material. A layer next to the transparent panel is of electric conducting material which is a substantially transparent deposit of tin oxide or equivalent. The tin oxide is obtained by coating the transparent panel with a very thin layer of tin chloride and thereafter oxidizing said tin chloride coating in an oxygen-rich atmosphere by heat.

On the side of the tin oxide coating not in contact with the panel are scattered particles of the electroluminescent material, such as activated zinc sulphide, the particles being in contact with the transparent panel and being of the order of 40 microns or less in diameter.

One of the features of the invention is to coat the particles of the electroluminescent material with black paint, lacquer, or equivalent light-absorbing material, so that, when the particles of the electroluminescent material are energized by an electric field, so as to become luminescent, they will show up plainly through the transparent panel against this black background with a minimum of unwanted reflections of light from the front of the panel. As the black coating extends down between the particles of electroluminescent material, halo phenomena are eliminated. That part of the electroluminescent material next to the panel is not coated, so the luminescence will show through. Over the black coating is placed a thin layer of electrically conductive silver paint, which in the first embodiment of the invention is a matrix composed of the elemental lines of the various indicia to be delineated, and the tin oxide elements and the silver coating are connected to alternating or pulsating electric current, which causes those electroluminescent particles in the electric field to luminesce. Various indicia may be delineated by connecting specific elements of the matrix to the source of electric potential.

FIG. 1 is a cross section through the indicating device, showing the various layers but no matrix configuration, this view being shown to indicate the relative positions of the layers. The translucent panel is shown by reference numeral **20**. The tin oxide electrically conductive layer, which is substantially transparent, is shown at **21**. Particles **22** are of the electroluminescent material. Numeral **23** represents the black background coating, extending on the back and sides of particles **22**, and **24** represents the other electric conducting coating, which may be of silver paint.

FIG. 2 is a much-enlarged representation of a portion of the translucent panel **20** as viewed from the front, the black background being given the same reference numeral, **23**, as in FIG. 1, and the electroluminescent particles being given the reference numeral **22**, as in FIG. 1. The tin oxide coating, being so thin, and for all practical purposes transparent, does not show in FIG. 2 or diminish the luminescence appearing by the glowing of the electroluminescent particles when energized by the electric field.

This forms the broad aspect of the invention, in which a black non-reflective background is provided to make the unilluminated portion appear black, as viewed through panel **20**, as contrasted to the luminescent particles.

In order to indicate data, the silver coating may be put on the black coating in matrix form, as shown in

FIG. 3, to form the first embodiment of the invention, where elements **25** to **31** inclusive may be given individual electric leads which may be energized selectively as desired to form a pulsating or alternating potential gradient between the chosen elements of the matrix and the tin oxide layer to make the electroluminescent particles in the potential path luminesce. The particular matrix shown can be differentially controlled by the electric leads to form the digit numbers of the decimal system, including zero, and some of the letters of the alphabet. For instance, to portray a zero, all of the matrix elements except the element **28** are connected to the electric source, which will give a fairly accurate outline of the digit "zero." In the same manner, if elements **25**, **26**, and **29** are provided with electric energy, a fairly good representation of the decimal digit "7" will appear on the front of the panel. To represent the "8," all of the elements of the matrix are provided with electric energy, and so on.

It is to be readily understood that these elements of the matrix must be electrically insulated from one another, and hence they do not quite meet but form at their nearest approach to each other channels such as channel **32** (FIG. 3), which insulates the adjoining elements.

Not only does the black or other light-absorbing coating extend down between the particles of electroluminescent material and prevent the light from one particle from extending sidewise to form an undesired halo effect, but the black coating has to be a non-conductor of electricity with a high dielectric strength, such as a nitro-cellulose film dyed black with nigrosine.

As has been said, any transparent electrically conductive coating may be substituted for the tin oxide coating, and, in a similar manner, any electrically conductive coating may be substituted for the silver coating comprising the matrix elements, the latter being chosen as most desirable because it is easily applied as a paint by suspending silver powder in a dryable film-forming material.

One form of activating the electroluminescent particles of zinc sulphide, as a particular electroluminescent material, is to treat the powdered zinc sulphide with copper chloride. The electroluminescent particles themselves may be secured to the transparent panel by transparent solutions of a drying adhesive such as ethyl cellulose dissolved in xylene.

FIG. 4 is a cross section taken on the line 4—4 of FIG. 3.

FIG. 5 shows, by the shaded lines, the elements of the matrix necessary to be furnished with electric potential to form an E, as the matrix may be used, as has been said, to form some of the letters of the alphabet.

FIG. 6 shows, by the shaded lines, the elements of the matrix necessary to be furnished with electric potential to represent the number "2".

In a second embodiment of the invention, there is provided, as in the first embodiment, a transparent or translucent panel **40** (see FIGS. 7 and 8), the viewer observing the luminescent indicia from the front of the panel, which is the bottom of the indicator as seen in FIGS. 7 and 8. Similarly, there is provided a continuous substantially transparent electrically conductive coating **41**, such as that described in the first embodiment as layer **21** (FIGS. 1, 3, and 4). Referring again to FIGS. 7 and 8, on top of the electrically conductive layer **41**, discrete particles of solid electroluminescent material **42**, having a particle size of 40 microns or less, are applied with a transparent binder, which, although securing the individual particles to the electrically conductive layer, does not fill the space between the discrete particles sidewise. Over the particles, as in the first embodiment, is coated a black or substantially light-absorbing film **43** of di-

electric material, which coats over and between the electroluminescent particles but does not cover that part of the surface of them that is in contact with the panel 40 and which may be observed therethrough. So far, this second construction is like the first embodiment of the invention.

The top layer has electrically conductive matrix elements 44 to 50 inclusive, to which electric leads may be connected and differentially supplied with alternating or pulsating electric energy to cause the particles 42 to glow according to the configuration desired. However, in this second embodiment, it is desired to have the indicia appear dark on a luminescent background. Therefore, the areas 51, 52, and 53 are coated with electrically conductive films and are constantly supplied with electric energy of either the alternating or the pulsating type. In order to represent the desired indicia, no electrical energy is supplied to those elements of the matrix which delineate said desired indicia, and all the other elements of the matrix are supplied with electric energy. It is to be understood that the areas 44 to 50 are spaced slightly apart, so as to be electrically discrete; that is to say, the application of electrical energy to one area will not affect an adjacent area.

In the event it is desired to indicate a "0," areas 47, 51, 52, and 53 are supplied with electric energy, which causes luminescence of the particles 42 thereunder, leaving the particles under areas 44, 45, 46, 48, 49, and 50 unilluminated to show the "0" in black against a luminescent background.

The spacing apart of elements of the matrix between themselves is sidewise, which will leave a slight black line, like line 54, in the indicia, if the adjacent elements 49 and 50 are electrically energized.

If it be desired that there be no discontinuity in the indicia caused by the electrical independence between the background areas 51, 52, and 53 and the adjacent element areas of the indicia, then the elements of the matrix may slightly overlap the adjacent background areas 51, 52, and 53 with which they are associated, the electrical insulation being provided by dielectric material, such as one of the plastic films, such as polysytrene or polyethylene. Such overlapping of electrically conducting areas is best seen in FIG. 8, where insulating material 60 is interposed between overlapping element 47 and area 52 and between overlapping element 49 and area 52 (see also FIG. 7). In a similar manner, insulating material 61 is interposed between overlapping element 49 and area 51. This prevents interruption of a continuous luminescent condition on the panel caused by adjacent electrically energized elements of the matrix and the matrix background.

What is claimed is:

1. In an electroluminescent indicating device having a light-transmitting panel to be viewed from a front surface and said panel having a rear surface provided with a first electrode consisting of a light-transmitting layer of electrically conductive material forming a base electrode; a layer of discrete, but closely spaced, electroluminescent particles of material on the electrically conductive layer; a layer of light-absorbing dielectric material covering each particle individually except for the portions of the particles next to the base electrode so that, when said particles are made luminescent, they may be seen from the front of the panel, said light-absorbing layer giving greater contrast because it not only eliminates the glare of incident light but also prevents halo effects between adjacent luminescent and non-luminescent particles; and elements forming a second electrode, positioned on said layer of dielectric material, the elements being positioned to form a matrix adapted to electrically cooperate with the base electrode, said matrix electrode elements being electrically insulated from each other but arranged so that at least one can be selectively electrically energized together with respect to the base electrode to establish an electric field therebetween which periodically changes in value to cause the electroluminescent particles to luminesce in accordance with the pattern of the selectively energized elements of the matrix to represent data as seen from the front of the panel.

2. In an electroluminescent indicating device having a light-transmitting panel to be viewed from a front surface and said panel having a rear surface provided with a light-transmitting layer of electrically conductive material forming a base electrode; a layer of discrete, but closely spaced, electroluminescent particles of material on the electrically conductive base electrode; a layer of light-absorbing dielectric material covering the electroluminescent particles individually except for the portions of the particles next to the base electrode layer; a shaped data-representing electrode on the layer of dielectric material so that when a source of operating electric potential is applied to the electrodes, which potential changes periodically, the electroluminescent particles luminesce in a pattern corresponding to the shaped electrode; said light-absorbing layer giving improved contrast between the luminescent pattern and the non-luminescent portion of the panel because it not only eliminates the glare of incident light but also prevents halo effects between adjacent luminescent and non-luminescent particles.

3. In an electroluminescent data indicating device having a light-transmitting panel to be viewed from a front surface and said panel having a rear surface provided with a light-transmitting layer of electrically conductive material forming a base electrode; a layer of discrete, but closely spaced, electroluminescent particles of material on the electrically conductive base electrode; a layer of light-absorbing dielectric material covering the particles individually except for the portions of the particles next to the conductive base electrode; a plurality of shaped electrodes on the layer of dielectric material so that when a source of periodic operating electric potential is applied to selected ones of the shaped electrodes to energize them, it will cause the electroluminescent particles to luminesce in a pattern corresponding to the electrically energized selected shaped electrodes, said light-absorbing layer giving greater contrast between the luminescent pattern and the non-luminescent portion of the panel because it not only eliminates the glare of incident light but also prevents halo effects between adjacent luminescent and non-luminescent particles.

4. An electroluminescent indicating device including a supporting panel of light-transmitting material, to be viewed from one side, and the other side of the panel having on it, first, a light-transmitting layer of material which is electrically conductive and which serves as a continuous base electrode; second, a layer of finely-divided discrete, but closely spaced, particles of material on the base electrode, said particles glowing with a distinctively colored light when subjected to an electric field which is changed periodically in value; a dielectric light-absorbing covering over and between the particles, but not covering the surfaces of the particles in contact with the base electrode, said dielectric coating having a color which contrasts with the color of the particles, when said particles are made to glow; and a character-controlling electrode adjacent the dielectric material which separates it from the luminescent particles, whereby when electric energy of periodic change in value is applied to the electrodes, the particles will luminesce and contrast in color to the dielectric material to form a clear-cut character corresponding in outline to the character-controlling electrode.

5. An electroluminescent indicating device including a supporting panel of light-transmitting material, to be viewed from one side, and the other side of the panel having on it, first, a light-transmitting layer of material which is electrically conductive and which serves as a continuous base electrode; second, a layer of finely-divided dielectric, discrete, but closely spaced, particles of material on the base electrode, said particles glowing with a distinc-

tively colored light when subjected to an electric field which is changed periodically in value; a dielectric light-absorbing covering over and between the particles, said dielectric coating having a color which contrasts with the color of the particles, when said particles are made to glow; and at least one character-controlling electrode which is separated from the luminescent particles by the dielectric material and which may be differentially selected for energization by periodically applied electric energy in conjunction with the base electrode for the formation of selected character outlines.

6. An electroluminescent indicating device including a supporting panel of light-transmitting material, to be viewed from one side, and the other side of the panel having on it, first, a light-transmitting layer of material which is electrically conductive and which serves as a continuous base electrode; a layer of finely-divided dielectric discrete, but closely spaced particles of material on the base electrode, said particles glowing with a distinctively colored light when subjected to an electric field which is changed periodically in value; a dielectric light-absorbing black covering over and between the particles, but not covering the surfaces of the particles in contact with the base electrode; and a character-controlling electrode adjacent the dielectric material which separates it from the luminescent particles, whereby when electric energy of a periodic change in value is applied to the electrodes, the particles will luminesce and contrast with the black dielectric material to form a clear-cut character as seen from the viewing side of the panel.

7. An electroluminescent indicating device including a supporting panel of light-transmitting material, to be viewed from one side, and the other side of the panel having on it, first, a light-transmitting layer of material which is electrically conductive and which serves as a continuous base electrode; a layer of finely-divided dielectric discrete, but closely spaced particles of material on the base electrode, said particles glowing with a distinctively colored light when subjected to an electric field which is changed periodically in value; a dielectric light-absorbing black covering over and between the particles, but not covering the surfaces of the particles in contact with the base electrodes; and at least one character-controlling electrode which is separated from the luminescent particles by the dielectric material and which may be differentially selected for energization in conjunction with the base electrode for the formation of selected character outlines.

References Cited in the file of this patent

UNITED STATES PATENTS

1,965,586	Foulke	July 10, 1934
2,566,349	Mager	Sept. 4, 1951
2,698,915	Piper	Jan. 4, 1955
2,721,808	Roberts	Oct. 25, 1955
2,728,870	Gungle	Dec. 27, 1955
2,911,553	Joormann	Nov. 3, 1959