Dec. 15, 1959 E. A. SACK, JR 2,917,667

DISPLAY SYSTEMS

Filed Dec. 14, 1956 4 Sheets-Sheet 1

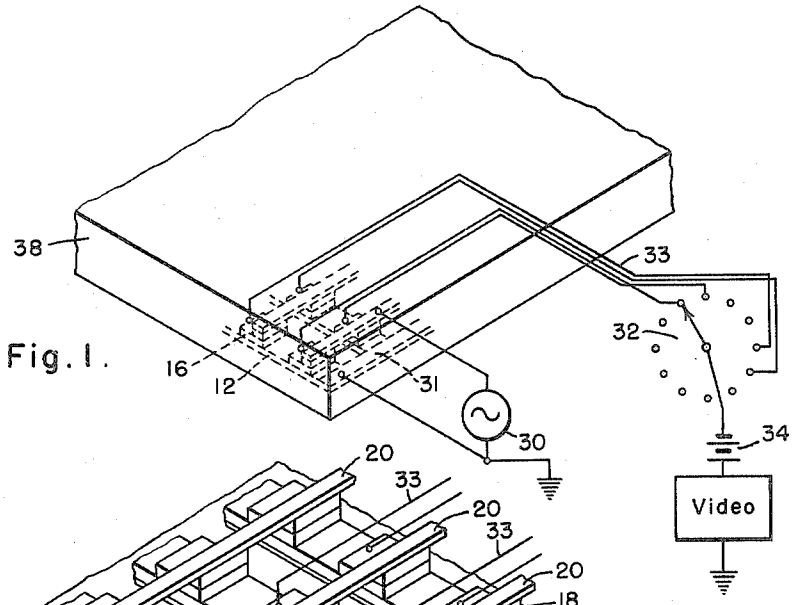


Fig. 1.

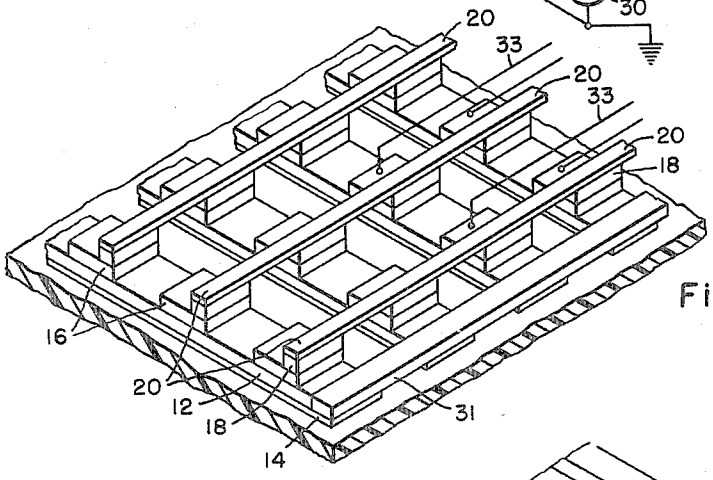


Fig. 2.

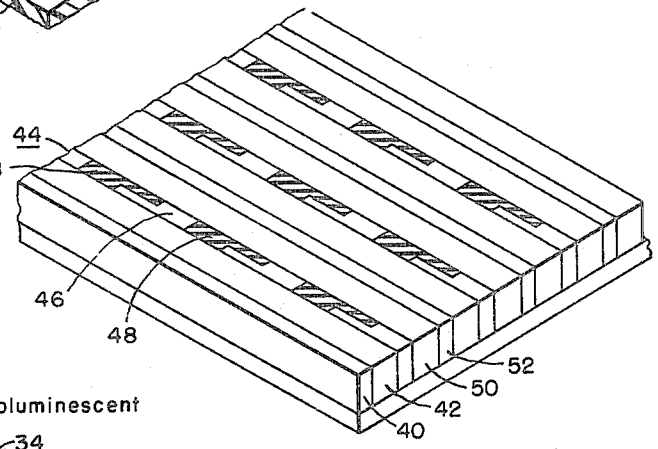


Fig. 3.

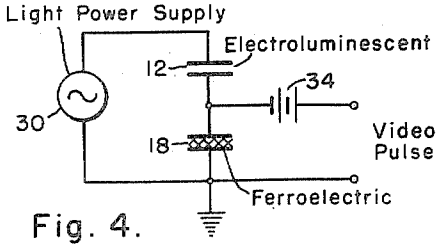


Fig. 4.

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BY

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ATTORNEY

Fig. 5.

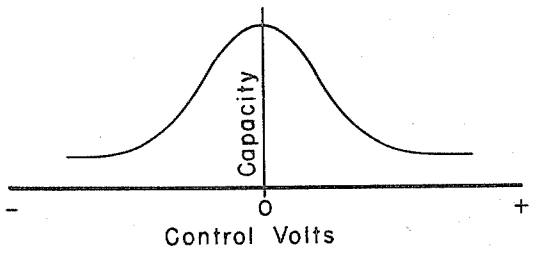


Fig. 6.

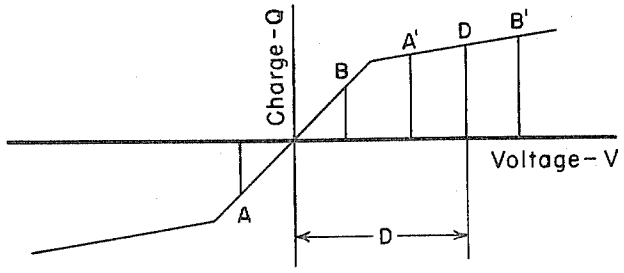
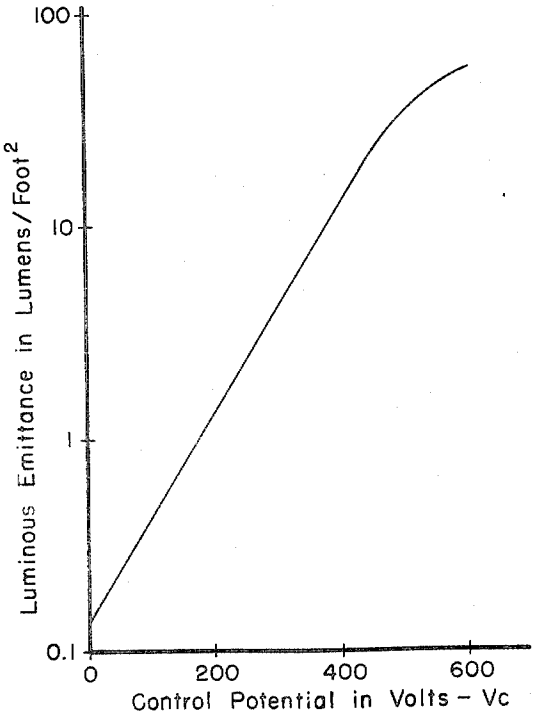


Fig. 7.



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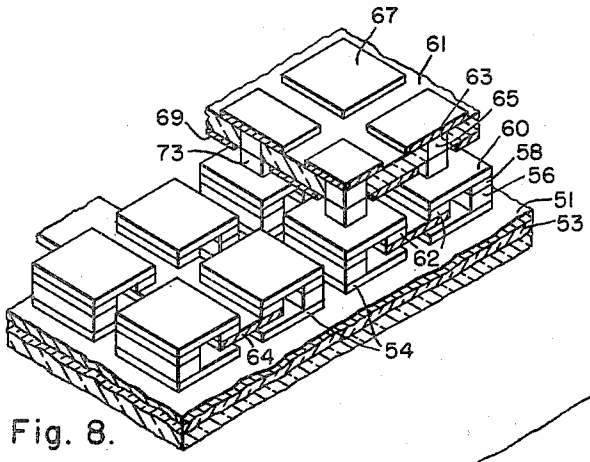


Fig. 8.

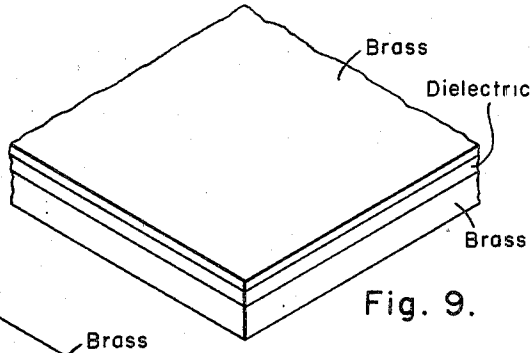


Fig. 9.

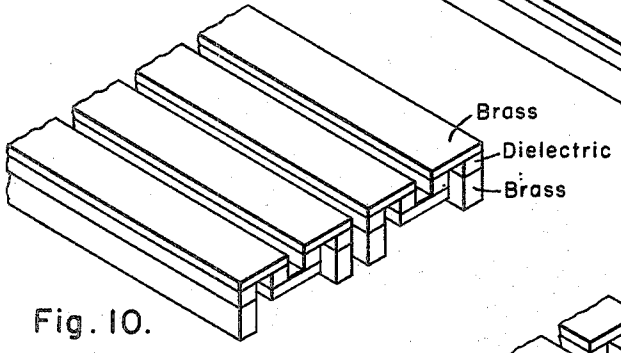


Fig. 10.

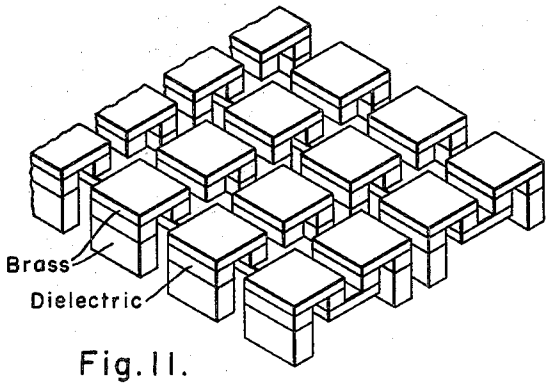


Fig. 11.

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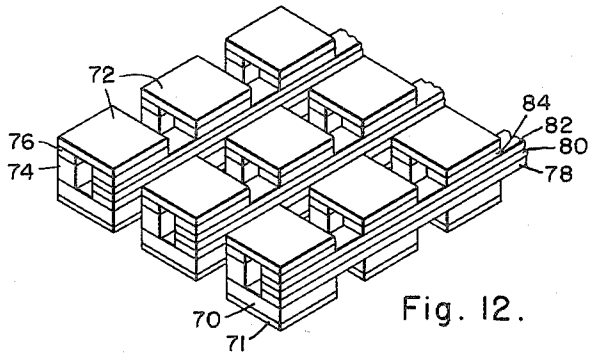


Fig. 12.

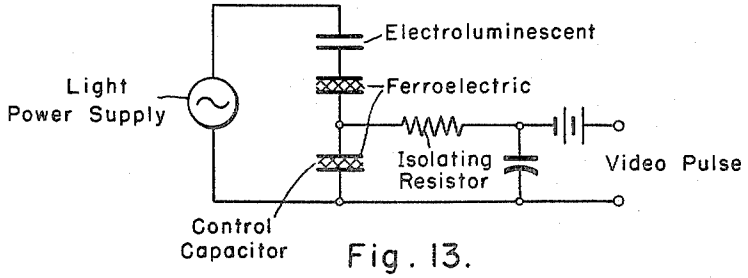


Fig. 13.

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Patented Dec. 15, 1959

2,917,667

DISPLAY SYSTEMS

Edgar A. Sack, Jr., Penn Township, Allegheny County, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application December 14, 1956, Serial No. 628,421

7 Claims. (Cl. 315—169)

This invention relates to display systems and, more particularly, to storage type display devices.

The most common display tube is the conventional cathode ray tube. In the cathode ray tube, it is necessary for an electron beam to supply the energy to produce the light output from a phosphor screen, as well as distribute the video intelligence over the entire screen area. This requires that the electron beam excite a particular point on the phosphor screen once every frame, and the decay time of the phosphor and the perisistence of the eye must combine to produce the impression of continuous light output. If a high average brightness is desired, it is found that the design requirements for sufficient electron beam power become prohibitive. The present cathode ray tube not only lacks in adequate brightness but also exhibits a certain amount of flicker and objectionable line structure as far as the viewer is concerned. The present type cathode ray tube is also the primary limitation in reduction of the depth of television receivers.

It is, accordingly, an object of this invention to provide a display device of thin panel-like structure.

It is another object of this invention to provide a display device substantially avoiding any flicker in the display.

It is another object to provide a method and means of providing continuity or storage of light output over an entire display screen for a desired time interval.

It is still another object to provide a method and means of controlling the light continuity from a display screen in accordance with control signals.

It is another object to provide a display device for conversion of information in the form of a sequence of electrical impulses which appear in a single conductor and follow one another in time into a space pattern of electrical conditions, which conditions can induce in substantial independence of the passage of time light emission until they are deliberately altered by control signals.

It is another object to provide means for impressing an electric field across a phosphor screen to provide light output and to control the intensity of the light output at elemental areas of the screen in accordance with a controlling signal.

It is another object to utilize a voltage or charge sensitive capacitor to control the light output from each elemental area of a display screen.

These and other objects are effected by my invention as will be apparent from the following description taken in accordance with the accompanying drawings throughout which like reference characters indicate like parts, and in which:

Fig. 1 illustrates a display screen embodying the principles of my invention;

Fig. 2 is an enlarged sectional view of a portion of the screen in Fig. 1;

Fig. 3 is an enlarged perspective view of a modified screen similar to the arrangement in Fig. 2;

Fig. 4 illustrates a circuit for purpose of explanation of the screen structures shown in Figs. 2 and 3;

Fig. 5 is a curve illustrating properties of a ferroelectric element;

Fig. 6 is a curve illustrating properties of a nonlinear capacitor;

Fig. 7 is a curve illustrating the control characteristics of a screen element, such as illustrated in Figs. 2 and 3;

Fig. 8 is a perspective view of a portion of a screen structure in accordance with the principles of my invention;

Figs. 9 through 11 illustrate steps in the fabrication of the screen structure illustrated in Fig. 8;

Fig. 12 is a modified screen structure similar to that shown in Fig. 8; and

Fig. 13 illustrates a circuit for purpose of explanation of the screen in Figs. 8 and 12.

Referring in detail to Figs. 1 and 2, there is shown one embodiment of my invention and constructed in acacordance with my invention. The screen structure illustrated in Fig. 2 is comprised of a plurality of parallel strips **12** of phosphor material exhibiting the property of electroluminescence. If the method of manufacture lends itself to the structure the phosphor material layer may be a sheet the size of the entire screen or an element area the size of each elemental display area of the screen. The phosphors which exhibit the property of electroluminescence are known as electroluminophors. Examples of suitable phosphors for this application are zinc sulfide-copper and manganese activated, and zinc sulfide-copper activated, to mention a few of these well known phosphors. The phosphor material may be dispersed within a suitable plastic dielectric matrix or an inorganic material such as glass.

Deposited on the front surface of each phosphor strip **12** with respect to the viewer is a coating **14** of a suitable light transmitting electrical conductor material such as stannic oxide which serves as the front electrode of the light emission portion of the screen structure. Other light transmitting and electrical conductive coatings may be used. Deposited on the rear surface of each strip **12** are a plurality of elemental areas **16** of a suitable electrically conductive material, such as silver or aluminum, for example. The number of conductive elements **16** which may be referred to as the back plate elements of the light emitting portion of the display screen is determined by the amount of resolution desired in the image device. This consideration also determines the number of phosphor strips **12**. The front electrode **14** and the plurality of back plate electrodes **16** provide means for impressing an electric field across the electroluminescent phosphor layer **12** and make up the light emitting portion of each elemental display area of the screen. This type of light producing device is discussed more fully in an article entitled, "Electroluminescence and Related Topics" by G. Destriau and H. F. Ivey in the December 1955 issue of the Proceedings of the I.R.E.

By way of explanation, electroluminescence was first completely disclosed by G. Destriau in London, Edinburgh and Dublin Philosophical Magazine, series 7, volume 38, No. 285, pages 700–737 (October 1947), article titled "The New Phenomenon of Electrophotoluminescence." In the phenomenon of electroluminescence, selected phosphor materials are placed within the influence of an electric field, such as by sandwiching the phosphor material between two spaced electrodes and applying an alternating potential between these electrodes. The resulting electric field which is created across the electrodes

excites the phosphor material to luminescence, and the phosphor materials which display this electroluminescence are thus termed "field responsive." Such phosphor materials are normally admixed with a dielectric material, or a separate layer of dielectric material is included between the electrodes, in order to prevent any arcing thereacross which would short out the electroluminescent cell, but a separate dielectric material is only desirable and not mandatory for the cells may be operated under some conditions without any dielectric where the applied electric field is as high as 100 kv. per centimeter. Normally the spaced electrodes are parallel, but they need not be, as where graded field intensities are desired.

The control portion of each display area of the screen consists essentially of a voltage or charge sensitive capacitor which is made up of the back plate electrodes **16** of the light producing portion and a plurality of electrically conducting bars **20** with a layer **18** of a suitable dielectric material positioned between each back plate element **16** and conducting bar **20**. In the specific embodiment shown, each conducting bar **20** extends across the entire screen structure transverse to the phosphor strips **12** and is connected to a dielectric layer **18** on each of the phosphor strips **12**. The dielectric material may be of a non-linear substantially reactive ferroelectric dielectric material selected from the group which includes, for example, barium titanate, barium-strontium titanate, barium stannate, sodium columbate, sodium tantalate, potassium columbate, and potassium tantalate.

All of the conducting bars **20** are connected to a main supply bus bar (not shown) which is, in turn, connected to one terminal of a light power supply source **30**. In a specific embodiment shown, the source **30** is an alternating voltage source of the order of 300 volts and 2,000 cycles per second. The other terminal of the light power source **30** is connected to the transparent conductive front electrodes **14** by means of a common bus bar **31** of the light emitting portion of the screen.

It is also necessary to provide means of impressing a voltage or charge on the back plate electrode **16**. In the specific embodiment shown, an electrode lead **33** is provided from each of the back plate electrodes **16** and is connected to a switching member **32** through which a control voltage or charge may be supplied and distributed to each of the elements of the display screen in a sequential or any desired manner. The control voltage or charge consists of the video intelligence obtained from a suitable receiver and is connected to the switching means **32**. It may also be desirable in some applications that the control voltage or charge contain an additional bias provided by means of a battery **34** in series with the video supply. The resulting screen display device may be embedded in a suitable transparent resin **38** such as polyethylmethacrylate, polyesters or silicones for the purpose of support and protection in handling.

A screen structure comprised of a suitable number of display areas for television would be difficult to assemble element by element. One simple and economical method of fabricating the screen structure shown in Fig. 2 is to prepare a thin flat dielectric sheet of approximately 10 mils in thickness. The sheet is then sprayed on both sides with a silver paint thinned with toluol until the dielectric is completely covered.

The dielectric material provided in the control elements may be of any suitable material whose differential permittivity is a function of applied bias voltage or charge. One particular class of materials that are particularly useful in this application are ferroelectric dielectric materials. The preparation of the titanate ceramics is fully disclosed in an article entitled "Preparation of Reproducible Barium Titanate" by R. M. Callahan and J. F. Murray, page 131 of the May 1954 issue of the "Bulletin" of the American Ceramic Society. The preparation of the dielectric sheets is also discussed in U.S. Patent 2,439,446, entitled, "Process for Producing Dielectric Sheets" by W. J. Lies and issued January 30, 1951. Various ceramic mixtures that may be utilized are also found in U.S. Patents 2,402,515, 2,402,516, 2,402,517, 2,436,839 and 2,452,532.

The coated dielectric member may then be baked in an oven for 15 to 30 minutes at a temperature of about 700° C. Both sides of the ceramic member are then tinned with a suitable solder, such as 36% lead, 62% tin and 2% silver. Two brass sheets of suitable thickness dependent on the strength desired and of similar dimensions as the ceramic member are also tinned on one side with a similar solder as used on the dielectric member. The ceramic member is then positioned between the two brass sheets with the tinned side of the brass sheets adjacent the ceramic member. The sandwich of the two brass sheets and the ceramic member are heated to a temperature of about 320° C. and then cooled. The laminated edges of the sandwich are ground off to remove any silver or solder which might short out the capacitor. This structure is shown in Fig. 9.

The next step in the preparation of the screen is the deposition of the field-responsive phosphor onto the one surface of the exposed sandwich. There are many well-known methods of accomplishing this, and as a specific example, the finely-divided phosphor material, for example zinc sulfide activated by copper, may be admixed with a solvent such as butyl acetate and with a polyvinyl chloride lacquer. The proportions of the constituents are not critical and may be varied within wide limits, but as a specific example, three parts by weight of phosphor may be mixed with 50 parts by weight of thinner and 35 parts by weight of polyvinyl chloride lacquer. The foregoing admixture may be sprayed in a plurality of coatings, for example, four, according to the desired thickness, drying between each coating. Other dielectrics and solvents may be substituted for the foregoing specific examples, as is well known.

The front electrode **14** which is an electrical conductive and light transmitting electrode may also be evaporated onto the surface of the phosphor layer. One material suitable for evaporation is gold. Another possible front electrode is to use an electrical conductive member sold under the trademark Nesa by Pittsburgs Plate Glass Company. This would be formed apart from the structure and pressed onto the phosphor layer. The resulting sandwich which consists of both the ferroelectric sandwich and the electroluminescent sandwich may be fabricated by properly cutting and milling the sandwich to obtain the structure shown in Fig. 2. In a specific device shown in Fig. 2, two perpendicular cuts would be sufficient to fabricate the entire screen structure.

In the above description, the utilization of the evaporated or spraying technique of depositing a phosphor layer dispersed in a dielectric material has been described. It may be desirable in some applications to utilize a sintered phosphor layer, an enameled phosphor layer or an evaporated phosphor layer. As a specific example of a sintered layer, a phosphor may be prepared by mixing zinc sulfide 100 mole parts, zinc oxide 1 mole part, potassium chloride .5 mole part and copper chloride .3 mole part. This mixture is fixed in SO_2 at 900° C. for one hour and then washed in dilute hydrochloric acid. The phosphor is then pressed under a pressure of 30,000 pounds per square inch and then sintered in nitrogen at a temperature of 1050° C. for two hours. The resulting pellet may then be cut into slices of 1 to 5 millimeters in thickness.

In the operation of the device shown in Figs. 1 and 2, the light power source **30** provides sufficient excitation of an electroluminescent strip **12** to cause the emission of light therefrom. By the insertion of the control elements, as illustrated by the circuit in Fig. 4 in series with the

voltage source 30, it is possible to control the intensity of the light emission from the isolated areas of the electroluminescent strip 12. If a current source were utilized as the light power source, the control elements would be in parallel with the electroluminescent cell.

Reference is had to the circuit shown in Fig. 4 of the screen structure shown in Figs. 1 and 2 for an explanation of the detail operation of the device. The light power supply or carrier power supply 30 is an alternating potential which is applied overall to the screen structure across each of the elemental voltage divider configurations consisting of the electroluminescent layer 12 and the control layer 18. The light power supply provides the energy required to excite the electroluminescent layer. The video pulses applied to the circuit are the pulses of electrical voltage or charge which are representative of the light level desired of a particular element during a certain period. In practice the video wave received is usually a continuously varying wave received from the video detector or other source of the receiver. The video wave is normally an alternating wave shape having both positive and negative values. This wave may be broken up into short segments and the average height of the segments being indicative of the average brightness of the corresponding screen element. This information may be fed through an amplifier and then to a commutator which supplies a charge or voltage to the desired element in a short time interval or during a long time interval if desired.

The bias voltage battery 34 provides a constant voltage or bias and is connected across the control element either continuously or only during the time that the video pulse is being admitted (in the latter case it may be indistinguishable from the video pulse). The bias charge or voltage will appear across the element at all times. The purpose of this voltage is to assure that the control element operates over the optimum portion of its characteristic. In Fig. 5 a plot of the capacitance of a ferroelectric capacitor with respect to a control voltage or bias impressed across the capacitor is illustrated. If the video information as supplied by the detector is a wave shape going both negative and positive, then in the absence of a bias the same change of capacitance might be obtained in both negative and positive direction. Such a situation would obviously be unsatisfactory. To remedy this difficulty a constant bias potential is either subtracted or added to the video yielding a control potential of either entirely negative or positive values.

When a small control signal is applied a small decrease in capacitance is obtained which leaves a large part of the light power potential applied across the electroluminescent material resulting in a large light output. As the control signal goes to a larger value a larger decrease in capacitance is obtained across the control layer resulting in the alternating light power potential appearing primarily across the control element instead of across the electroluminescent layer. This causes the screen element to emit only a small amount of light output from the electroluminescent layer.

The control signal which is applied across the control layer is the algebraic sum of voltage or charge of the bias and the video pulses. It is the total control signal which the voltage or charge sensitive capacitor actually sees. The part of the light power supply which also happens to be appearing across the capacitor is not included as a part of the control potential.

A linear or normal capacitor of mica or air dielectric has a charge versus voltage curve theoretically in the form of a straight line. In the case of a nonlinear capacitor the charge versus voltage curve might be similar to that shown in Fig. 6. If we assume that an alternating potential light power supply is applied to the capacitor, then the potential applied to the capacitor in each cycle would move the element from a point A to a point B on the curve and return. The capacitance of an element is defined as

$$\frac{\Delta Q}{\Delta V}$$

The element presents a certain reactance at its terminals to the external circuit and, if the applied potential is symmetrical, then the average voltage applied is zero. If we now assume for purposes of explanation that in addition to the previously mentioned alternating potential applied to the capacitor a constant control signal is applied of a magnitude D, then the alternating potential causes the excursion from A' to B' on the curve during each cycle. From the expression for capacitance it is obvious that the capacitance is then smaller than in the first case where a constant potential was not applied, since ΔV remains the same but ΔQ is diminished. Since the capacitance is smaller the reactance which the capacitor presents to the external circuit is larger as a result of applying a control signal on this type of capacitor known as a nonlinear capacitor. It should be noted that a curve illustrative of a physically realizable nonlinear capacitor does not in general exhibit the sharp breaks shown for purposes of illustration in Fig. 6, but instead is rather a smooth curve. The electrical behavior under the application of the control potential however is similar.

The control elements in the circuit shown in Fig. 4 being capacitive in nature have a high leakage resistance and are capable of storing charge for a comparatively long period of time (for many minutes under optimum circumstances). In the case of resistive control elements the time of storage is relatively short. It should also be noted that the use of a capacitive control element does not dissipate large portions of the light power in the form of heat as in the case of a resistive type control element. It can also be shown that the response of the light power voltage division in a divider configuration to a change in the control element is substantially instantaneous provided the control element and the light producing element are of the same electrical type, namely capacitive. Otherwise, there is a considerable amount of time required for the transition. The response time of the capacitive type storage element is also essentially instantaneous compared to relatively sluggish response of certain resistive control elements, namely photoconductors.

The control element in the specific embodiment is a voltage or charge sensitive capacitor such as the ferroelectric materials which have a dielectric reactance characteristic which varies with changes in electric field strength applied thereto.

In the specific embodiment, the video pulse is applied to a screen element through the switching means 34 and a bias or charge is applied to the desired backplate electrode 16 and thereby alters the voltage division from the light power supply between the electroluminescent layer 12 and the ferroelectric layer 18. In this manner, the light emission from each elemental area of the screen can be controlled in accordance with the video pulse and thereby a pattern set up on the display device corresponding to the video pulse received. The method by which the bias or charge is applied to the back plate electrode 16 is irrelevant so far as this invention isconcerned so long as the biasing circuit does not permanently short out the electroluminescent cell 12 or swamp out the control exercised by the ferroelectric layer 18. The control signal will remain on until removed or modified in normal operation. Light will be produced in accordance with video information until the control signal is removed.

In Fig. 3, a modified screen structure is shown which eliminates the need of the light transparent conducting electrode. The screen structure consists of a conducting layer 40, a layer 42 of electroluminescent phosphor, a layer 44 including a plurality of conductive elements 46 insulated from each other by insulating portions 48, a

layer 50 of ferroelectric material and another conductive layer 52. This structure may be built up to include any desired number of cells. In the device shown in Fig. 3, the viewer would observe the laminated edge of the display areas. The light power supply would be connected across the layers 40 and 52 and the control potential would be applied to conductive elements 46. The conductive elements 46 serve as the control electrodes for the elemental display areas.

The control characteristics of the screen structure shown in Figs. 2 and 3, are illustrated in Fig. 7. It is apparent that the range in brightness of approximately 400 to 1 is entirely adequate for image presentation.

In the above explanation it is assumed that the control signal is large in magnitude in comparison to magnitude of the light power source. This requirement is important in the case of where the control signal is supplied from a voltage source. In the case where the control signal is supplied from a current source, the comparative values of the light power supply and control signal are not of primary concern.

If it is assumed that the magnitude of the varying light power supply voltage is not small in comparison with the control potential, then it is desirable to effectively decouple the light power supply from the element when the control signal is applied. For example, if the voltage from time varying light power supply is zero, then the full control voltage or charge will be applied and the element would produce the proper amount of light. However, if the voltage from the light power supply is such as to apply a potential of 200 volts to the control electrode at the instant the control signal is applied and has a value of 200 volts, then the control signal will not deposit charge on the control electrode. In this case, the element would not be properly affected by the control signal.

It is, therefore, necessary as previously stated to decouple the light power supply at the time the control signal is applied to the individual element. One possible method is to provide a switching means so that the light power source is disconnected from the line element while the control signal is applied. Another method is to effectively electrically decouple by circuit means associated with the control potential circuit. This circuit may be incorporated into the screen structure or provided exterior to the screen. Such a decoupling system is illustrated and explained with respect to Fig. 8 but it may be incorporated with any of the screen structure embodiments shown herein.

Referring in detail to Fig. 8, there is shown a modified screen structure in which two voltage or charge sensitive capacitors illustrated as ferroelectric layers are utilized within each control element. The light emitting portion of the screen structure again consists of a layer 51 of electroluminescent phosphor. The layer 51 has a transparent conductive coating 53 on one surface and serves as the front electrode and a plurality of conductive back plate elements 54 on the other surface of the phosphor layer 51. The control portion of the screen consists of a conductive element 56 in intimate contact with a portion of each back plate element 54 for correct spacing, a voltage or charge sensitive capacitor illustrated as a ferroelectric layer 58 of similar area and a conductive member 60 of similar area as the back plate electrode 54. The conductive element 60, which normally serves as the control electrode has also a layer 62 of dielectric material such as ferroelectric material separated from the other layer 58 and on the same surface thereof. A conducting bus bar 64 is connected to the layer 62. The conducting bus bars 64 are arranged to extend across the entire screen, and the control elements are formed so that two elements in each transverse row of control elements 54 are connected to one of the conducting bars 64. The conducting bars 64 may be connected in a similar manner to that shown in Fig. 1, and the light power supply is applied across the conducting bus bars 64 and the transparent conductive front electrode 53 of the electroluminescent layer 51. The control signal may be applied to the conductive control electrode 60 in a similar manner as that described with respect to Fig. 1.

To prepare the control portion of the display screen, a sandwich is constructed for two brass sheets and a layer of suitable dielectric material positioned between the brass sheets in a manner previously described, as is shown in Fig. 9. The sandwich is then cut in one direction by suitable machining methods to obtain a structure such as illustrated in Fig. 10. A cut may then be made in the sandwich shown in Fig. 10 transverse to the first cut so as to form a control element, such as shown in Fig. 11. The control structure as thus fabricated is ready for assembly to the light producing portion of the screen. The phosphor strip or layer 51 may be prepared in a manner described with respect to Fig. 2 and provided with the transparent conductive sheet 53. The back plate electrodes 54 may be formed on the phosphor layer 51 by evaporating a suitable conductive material, such as silver, through a masked member. The control portion of the screen may be connected to the back plate elements 54 by applying a suitable conducting glue, paint or varnish to each of the back electrodes 54 and before the glue dries positioning the control element array over the light producing portion. The legs of the control elements are positioned on the conducting paint and held in this position until the conducting paint is dried.

The structure as described above will function with a current source as the control signal or if the control potential when used as a voltage source is sufficiently large enough in magnitude in comparison to the light power supply. By addition of a decoupling structure the screen may operate regardless of respective magnitudes of control signal or light power supply.

The decoupling structure consists of a sheet 61 of material of suitable dielectric properties having a plurality of apertures 63 therein corresponding to the number of light elements. In each of the apertures is a filling 65 of material of suitable electrical resistance characteristics such as carbon. A contact area 67 of a suitable conductive material is deposited over each aperture 63. The contact area 67 is one plate of the decoupling capacitor. On the opposite surface of the dielectric sheet 61 with respect to the contact electrode 67 is a conductive coating 69 with an uncovered area surrounding each aperture 63. This conductive coating serves as the other plate of the decoupling capacitor. A conductive support member 73 is provided from the resistive material 65 to each corresponding control electrode member 60.

A circuit for purpose of explanation of the screen structure, control structure and decoupling structure of the screen illustrated in Fig. 8 is shown in Fig. 13. The light power supply is connected in series with the electroluminescent cell and first and second capacitors. The capacitor which serves as a control capacitor is supplied with the control signal across its terminals. In addition to the bias battery and the video signals applied thereto it is necessary to provide some means of effectively decoupling the control capacitor from the light power source when the control potential is applied. By insertion of the isolating resistor and the by-pass or storage capacitor across the input terminal, the light power supply is effectively decoupled during application of the control potential. This decoupling circuit may be exterior to the screen or as illustrated in Fig. 8, a part of the screen. The isolating resistor is the resistance material 65 and the by-pass capacitor is the dielectric sheet 61 with the plates formed by contact area 67 and coating 69. A more completed description of this operation is found in U.S. Patent 2,888,593 issued May 26, 1959, entitled Cathode Ray Tube by E. Sack and A. Anderson and assigned to Westinghouse Electric Corporation.

The operation of the device is similar to the previous

embodiments in which the control voltage or charge is applied to the contact area 67 which is one terminal of the control capacitor. This modifies the voltage division across the series circuit and thereby modifies the light output of the electroluminescent area.

In Fig. 12, there is shown a modified version of the device shown in Fig. 8. The structure shown in Fig. 12 consists of a plurality of isolated light display areas including an electroluminescent phosphor layer 70 and a conductive control electrode 72 spaced therefrom. Sandwiched between the electroluminescent phosphor layer 70 and each conducting control electrode 72 are two leg portions. One leg consists of a conducitng layer 74 and a dielectric layer 76. The dielectric layer 76 being adjacent to the conductive control electrode 72. The other leg which is separated from the first leg consists of a conductive layer 78 in the form of a conductive bus bar, an insulating layer 80, and a second conductive layer 82 forming a bus bar and insulated from the first bus bar 78 by means of the insulating layer 80. A layer 84 of dielectric material is positioned between the bus bar 82 and the control electrode 72. The layer 84 of dielectric material is in contact with the conductive control element 72. In this structure, the light power supply is applied between the two conductive bus bars 78 and 82, and the control energy or signal may be applied by lead connected to each of the control electrodes 72. By applying the light power to the electroluminescent layer 70 in this manner, the conducting transparent film 71 is required to carry the current for only one and not a large number of screen elements. It is, therefore, possible to make the transparent film 71 thinner with resulting improvement in light transmission.

Referring to Figs. 13 and 4, the structure shown in Figs. 8 and 12 provides several advantages over the structures shown in Figs. 1, 2 and 3. The bias or control voltage, which is applied to the control element, does not appear across the electroluminescent cell during the major portion of display, at least, not after the initial charging transient. It is assumed that the resistance of the electroluminescent element is small in comparison with the resistance of the ferroelectric element. As a result, a larger light power voltage may be applied to the electroluminescent cell with an increase in maximum brightness without danger of breakdown. The dielectric capacitors are in series with the light power potential but essentially in parallel with the control signal. As a result, a given light power supply voltage results in a smaller excursion over the nonlinear characteristics of each capacitor control element, and the control signal can exert greater control. The dielectric capacitors can each be made larger for a given electroluminescent capacitor than in the two-element circuit illustrated in Fig. 4. Therefore, the dielectric capacitors are more easily handled.

Another important consideration of the systems shown herein is the input capacitance to the conrol signal applied to the network. If the capacitance of the electroluminescent cell is 1 micromicrofarad, the signal input capacitance for the network shown in Fig. 13 might be approximately 5 micromicrofarads. It is important to keep the capacitance as low as possible in view of the fact that a higher signal current is required with larger capacitance to effect a given change in control voltage in a given time.

The maximum sensitivity of the circuits occurs within the practical operating range of the conventional electroluimnescent layer.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various other changes and modifications without departing from the spirit and scope thereof.

I claim as my invention:

1. A device for reproducing a light image comprising a display screen having a multiplicity of independently controlled light emissive areas, said light producing areas comprising a first layer of electroluminescent material exhibiting the property of emitting radiation when subjected to a time varying electric field, a second layer of a material which exhibits the property of variable differential permittivity in response to an electrical signal, a source of time varying potential, circuit means connecting said first and second layer and said source in series, a signal source for applying an electrical signal to said second layer in accordance with the light value of the selected elemental area of the image to be reproduced to alter the voltage division between said layers, and circuit means connecting said signal source to said second layer for effectively decoupling said time varying potential from said signal source.

2. A device for reproducing an image comprising a display screen including a multiplicity of independently controllable light producing areas, said light producing areas comprised of spaced first, second and third electrically conductive electrodes, a dielectric body interposed between said first and second electrodes, said dielectric body comprised of a material such that its differential permittivity depends on a voltage impressed across said body, a phosphor layer disposed between said second and third electrodes of a material which emits radiation when subjected to a time varying electric field, a source of time varying potential connected to said first and third electrodes whereby an electrical field may be applied across said dielectric body and said phosphor layer, a signal source for supplying a signal to modify the voltage impressed across said dielectric body in accordance with the desired light value of the selected elemental area to alter the voltage division between said layers, and circuit means connecting said signal source to said dielectric body for effectively decoupling said time varying potential from said signal source.

3. A display device comprising a plurality of independently controllable light producing elements, said light producing elements responsive to a variation of an electrical field, control elements electrically connected to said light producing elements, a source of time varying potential connected in series with said light producing elements and said control elements, said control elements responsive to variation of electrical signals to cause corresponding variation in impedance thereof, and a signal source for supplying a control signal for one of said control elements corresponding to light value desired of said light producing element to alter the voltage division between said light producing element and said control element, and circuit means connecting said signal source to said control element to provide control thereof regardless of respective magnitudes of said control signal and said time varying potential.

4. A display device comprising a plurality of independently controllable light producing elements, said light producing elements comprising a layer of a phosphor material which exhibits the property of light emission in response to a time varying electric field, electrode members positioned on opposite surfaces of said layer of phosphor material for impressing an electric field across said layer of phosphor, a layer of ferroelectric material deposited on one of said electrode members, a conductive electrode deposited on the exposed surface of said layer of ferroelectric material, means for providing and impressing a time varying voltage across the series combination of said light producing layer and said ferroelectric layer, a signal source for supplying a signal for varying the differential permittivity of said ferroelectric material in accordance with the light output desired from the selected elements of said display device to alter the voltage division between said layers, and circuit means connecting said signal source to said dielectric material for effectively decoupling said time varying voltage from said signal source.

5. A device for producing a light image in response to

electrical video signals, comprising a screen structure including a plurality of spatial distributed independently controllable light producing elements, said light producing elements comprising a first material exhibiting the property of emitting radiations when subjected to a time varying electric field, a control element of a material whose effective capacitance is responsive to a biasing voltage connected to said light producing element, a source of time varying potential for providing an electric field across said light producing element and control element, a source for supplying a controlling signal corresponding to said electrical video signals to modify the effective capacitance of said control element to alter the voltage division between said light producing element and said control element, and circuit means connecting said control source to said control element for effectively decoupling said time varying potential from said control source.

6. A device for reproducing a light image comprising a display screen having a plurality of independently controlled light emissive areas, said light producing areas comprising an element of an electroluminescent material exhibiting the property of emitting radiation when subjected to a time varying electric field, a first non-linear dielectric capacitor element, a second non-linear dielectric capacitor element, a source of time varying potential, circuit means connecting said electroluminescent element, said first non-linear capacitor, said second non-linear capacitor, and said potential source in series in the order named, and means for applying an electrical signal to said second non-linear capacitor to modify its capacitance and alter the voltage across said electroluminescent element.

7. A device for reproducing a light image comprising a display screen having a plurality of independently controlled light emissive areas, said light producing areas comprising an element of an electroluminescent material exhibiting the property of emitting radiation when subjected to a time varying electric field, a first non-linear dielectric capacitor element, a second non-linear dielectric capacitor element, a source of time varying potential, circuit means connecting said electroluminescent element, said first non-linear capacitor, said second non-linear capacitor, and said potential source in series in the order named, a control source for supplying an electrical signal to said second non-linear capacitor in accordance with the light value of the selected elemental area of the image to be reproduced, circuit means connecting said control source to said second non-linear capacitor for applying control signals to said second non-linear capacitor, said circuit means effectively decoupling said time varying potential source from said control during the application of said control signal to provide full control to said second non-linear capacitor.

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