Storage circuit for ferroelectric display screen

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STORAGE CIRCUIT FOR FERROELECTRIC DISPLAY SCREEN

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This invention relates to display systems, and more particularly to display systems having a panel-like screen structure which is formed of ferroelectric ceramic cells or elements.

The most common display systems utilize a conventional cathode ray tube by which an electron beam is used for supplying energy for producing the light output from a phosphor display screen and also for distributing the video information over the screen area. In a scanned display, the electron beam of the cathode ray tube excites a particular point on the phosphor screen once every scan period and the decay time of the phosphor and the persistence of the eye combine to produce the impression of a continuous light output from the screen. Cathode ray tubes are deficient at times particularly in that their use does not provide adequate screen brightness and additionally produces a degree of flicker and objectionable line structure in the image provided for the viewer.

One object of this invention resides in improved circuitry for supplying information to a display screen which is formed of ferroelectric cells or elements in order to provide for continuity of light output over the entire display screen for a desired time interval.

Another object resides in improved capacitative storage circuits for transferring information to a display screen formed of ferroelectric cells or elements.

A more specific object resides in an arrangement of an air gap or ionic switch for the charge capacitative storage circuits which is effective to establish a potential on the ferroelectric elements corresponding to the information signal.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings, wherein:

FIG. 1 is a diagram showing the potential current characteristics of the air gap or switch of FIG. 2.

FIG. 2 is a greatly enlarged detail of a display screen which is representative of ferroelectric cells incorporated therein and shown greatly enlarged;

FIG. 3 is a diagram showing the potential current characteristics of the air gap or switch of FIG. 2.

FIG. 4 is a schematic showing of the capacitative storage circuit;

FIGS. 4a and 4b are potential diagrams for the input and output respectively of the capacitative storage circuit of FIG. 4.

FIG. 5 is a schematic showing of a group of capacitative storage circuits of FIG. 4 arranged for supplying information to and storing information in the representative group of cells of FIG. 1.

Referring to FIG. 1, the display screen 10 will be understood to be formed of number of small ferroelectric elements or cells 11, a small group of which are shown greatly enlarged in the figure. In an actual model, a screen of approximately 4" x 8" contained 8192 cells or 256 cells to the square inch and provided an effective operating display structure. Regardless of the actual number of elements used to form a screen, the functions of the elements or cells 11 are those of emitting light in accordance with the applied video control potential.

An article by E. A. Sack published in the Proceedings of IRE for October, 1958, at page 1695, describes one type of screen in which the ferroelectric cells were developed from the ceramic form of barium strontium titanate and the electroluminescence utilized in the screen was of the intrinsic type consisting of a phosphor powder for emitting light under the action of a changing electric field. The cells or elements were mounted on a laminate of transparent material, and all recognizable due to their miniature size, the screen provided in effect a configuration of electroluminescent and ferroelectric capacitors.

In another article by E. A. Sack and others published in the April, 1962 issue of Proceedings of the IRE, the operation of an electroluminiscent ferroelectric screen is explained in some detail. By way of general explanation of the operation of such a display screen, it may be stated that information is supplied to one row of cells at a time, starting at the top and stepping consecutively toward the bottom of the screen. The 4" x 8" screen of FIG. 1 would thus have 480 horizontal cells formed in 128 vertical columns. Target information in the form of a computer word is fed from an information source to a translator which generates the characters for the display screen. The translator selects from its memory all of the targets which touch the top row of the screen 10 and generates a spatial geometry of signals which represent the target character forms. Information for the first row of the screen is then fed to apparatus known as display column drivers and immediately thereafter the translator supplies a row select signal to apparatus known as the row drivers for triggering the signals into the top row of the screen. The cycle is then repeated for each successive row until the entire panel has been scanned and all targets which fall into the panel area are displayed. Due to the excellent storage characteristics of the screen, the target images may be retained until further update information becomes available.

Pulse actuated switches play an important role in signal distribution systems for electroluminescent ferroelectric display screens. In these systems the information signal in the form of D.C. potentials is transferred to the cells or elements of the display screen by pulse actuated switches and the D.C. potential retained on the cells or elements until new information for those elements is received. Since the cells or elements function as capacitors for storing information, the pulse actuated switch must be capable of changing the charge on a capacitor during a short time interval and retain it for a much longer period.

In FIG. 2, is shown a structure which forms one type of switch in the form of an air gap termed an ionic switch and which has been operated successfully in signal distribution. The disclosure of FIG. 2 shows the switch structure enlarged substantially and in unassembled condition as a convenient way of explaining the switch construction. Each ionic switch assembly is fabricated from two mirror halves. As shown in FIG. 2, the two switch carriers 15 are employed as supports for electrodes 16—16 which have a gap 18 therebetween. The electrodes are formed, for example, of platinum-iridium metal ribbon and during fabrication the ribbons 16 are attached by a layer 17 of epoxy resin to a pattern of the switch carriers 15. The resulting composite structure is then separated by cutting the ribbons and subassemblies, as shown in FIG. 2, are provided from which air gaps or ionic switches can be produced. The surfaces 18 on each of the carriers 15—15 provide a reference plane which permits the two sub-
assemblies to be secured together with their surfaces 18—18 in contact to provide air gaps G having the desired spacings between the electrodes 16—16 and a switch structure will be provided for each of the cells 11 of the screen.

Known capacitative storage circuits utilizing ionic switches or sparks have required high switching potentials and large amounts of energy to achieve the switch and transfer information to the display screen. The diagram of FIG. 3 is for the purpose of illustrating the potential current characteristics of an air gap or ionic switch of the type shown in FIG. 2. Consider this air gap or switch as being formed between the two platinum-iridium electrodes 16 of 0.05 mm. cross section and the gap formed therebetween to be 5 microns. The switching burst or initial breakdown potential for the gap G is indicated at $E_b$ and within the range of approximately 350 to 400 volts. The constant sustaining potential indicated at $E_s$ and which is maintained across the gap after the initial breakdown is approximately 330 volts for currents up to 10 milliamperes. With such structure, variations in gap spacing of from about 2 to 8 microns will change the sustaining potential by only a few volts.

FIG. 4 shows a capacitative storage circuit utilizing an air gap or ionic switch, of the type shown in FIG. 2, for operating the cells or elements 11 of the display screen. The circuit consists of a resistor $R$, which represents source resistance as well as any other required resistances of the input, the gap G formed between the platinum-iridium electrodes 16 and a storage capacitor C. In FIG. 4a, the input to this circuit is supplied with the information potentials which vary between $E_s$ and $E_b$ which is less than the 330 volts sustaining voltage on the electrodes 16—16. At the desired time the switching burst of between 350 and 400 volts is superimposed on the information potential to be stored on capacitor C and after the termination of the burst this potential remains on the storage capacitor C until a new burst is applied.

As shown in FIG. 4a, the switching burst consists of an air gap being formed between two electrodes which are spaced apart 2 to 8 microns and operative to transmit information current from the first bus lines to the storage elements when a switching potential of between 350 and 400 volts is supplied to the capacitors of the storage circuits through the second bus lines.

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