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COLD CATHODE DISPLAY DEVICE

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The present invention relates to display devices or panels such as may be used with television receivers or the like and comprises a novel device which yields a bright image, has a long useful life and is relatively economical to manufacture and to operate.

Two general types of display devices are well known in the art. The cathode ray tube in which the location of a luminous spot on the phosphor screen is varied by control of the deflection of an electron beam represents one known type of display device. An electroluminescent panel in which the location of the luminescent spot on the panel is varied by control of the application of alternating potentials across different pairs of conductors of arrays positioned on opposite sides of a layer of electroluminescent phosphor material represents the other known type of display device. The device of the present invention differs radically from the above mentioned prior art devices although employing some of the features of each. Like the cathode ray tube, the new device is evacuated and employs a phosphor screen which luminesces when bombarded by electrons. The source of electrons is a cold cathode of the type which, once electron emission is initiated, provides a self-sustaining copious flow of electrons. The cathode covers an area substantially equal to that of the phosphor screen. Between the cathode and phosphor screen is a grid which when maintained at a potential above that of the cathode maintains electron emission. Two arrays of mutually perpendicular parallel conductors, comparable physically to those employed in electroluminescent devices, are positioned between the grid and screen and control the location of the luminous spot in response to selective application of control potentials thereto. The conductors of these arrays correspond in function to control and screen grids of an electronic amplifier.

For a better understanding of the invention and of the advantages thereof reference may be had to the accompanying drawing of which:

Fig. 1 is a plan view, partly broken away, of a display device embodying the invention, the electrical connections and suitable associated circuit being also shown;

Fig. 2 is a fragmentary vertical sectional view taken on the line 2—2 of Fig. 1; and

Fig. 3 is a graph explanatory of the operation of the device of Fig. 1.

The new display device includes a front panel 2 of glass or other light transmitting material and a rear panel 4 which may be of metal or of glass having a conductive coating applied to the inner surface thereof. The space between the panels 2 and 4 is evacuated and their peripheries are hermetically joined, as shown in Fig. 2, by flanges 6. On the inner surface of the panel 4 is a coating 8 of a material adapted to emit electrons. The coating, which serves as a cold cathode, is preferably magnesium oxide in the form of a uniform distribution of microscopic sponge-like structures. Such a coating, once electron emission is initiated, will emit a copious stream of electrons so long as an electrode positive with respect

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to the coating is provided for collection of the emitted electrons. Positioned within the enclosure provided by the panels 2 and 4 and adjacent the cathode coating 8 is a grid 10 for sustaining electron emission from the cathode. Two arrays, 12 and 14, of mutually perpendicular conductors are positioned between the grid 10 and the panel 2. In the particular embodiment of the invention illustrated in the drawing the conductors of array 12 are vertically disposed and the conductors of array 14 are horizontally disposed. On the inner surface of panel 2 is a transparent conductive film 16 of stannic oxide or the like and on the film 16 is a layer 18 of cathodo-luminescent phosphor material such as a mixture of suitably activated zinc and cadmium sulfides. In order to initiate electron emission from the cathode 8, a source of ultraviolet radiation, such as an electroluminescent device 20 is provided within the enclosure. The starter 20 may be, and preferably is, of the type disclosed in applicant's copending application, Serial No. 745,149, filed June 27, 1958, to which reference may be had for a detailed description thereof. Briefly, the starter comprises a glass or quartz sheet 22 having a transparent conductive film 24 thereon, a layer 26 of dielectric material in which an electroluminescent phosphor is embedded and an outer conductive film 28, the two conductive films being connected to a suitable external source 30 of alternating current by leads 32 which are sealed through the flange 6 of the device. Alternatively, if the wall member 4 is of glass or other transparent material, the starter 20 may be omitted and electron emission initiated by external means, for example by excitation with high frequency energy from a Tesla coil.

Before discussing circuit connections for the display device, a brief explanation will be given of the function of the elements so far identified. The coating 8, in conjunction with the sustaining grid 10, corresponds to a cathode of a vacuum tube, the conductive film 16 corresponds to the anode of a vacuum tube and arrays 12 and 14 correspond, respectively, to control and screen grids of such a tube. If in each array all conductors but one are grounded, then the potentials applied to the two ungrounded conductors will control the electron stream to that small portion of the film 16 which is aligned with the point of cross-over of such two conductors. The luminosity of the phosphor material on such small portion of film 16 will also depend upon the voltages impressed on the two conductors. More specifically, if the film 16 is maintained at 350 volts above cathode potential and if the one conductor of array 14 under consideration is maintained at 150 volts, then the current to film 16 will vary with the voltage applied to the conductor of array 12 in accordance with the curve of Fig. 3 wherein anode current is represented as a function of the voltage of such latter conductor.

Thus when control potentials are sequentially applied to the conductors of each array, control of electron flow and consequently control of luminosity of the phosphor layer will be effected over sequential small areas of the conductive film and phosphor material. When the display panel is to be used with a television receiver, the sequential application of voltage to the horizontal conductors of array 14 should be synchronized with the vertical sweep frequency and the applied voltages to the vertical conductors of array 12 should be controlled by the video signal and the sequential application thereof synchronized with the horizontal sweep frequency of the receiver. Such a circuit arrangement is diagrammatically shown in Fig. 1.

As shown in Fig. 1 the conductors of array 12 are brought out through external leads 12a to terminals 12b adapted to be sequentially engaged by a rotating switch arm 34 the rate of rotation of which is synchronized

with the horizontal sweep voltage. A source of voltage modulated by the video signal, illustrated diagrammatically at 36, is connected to the arm 34 to sequentially impress control voltages upon the conductors 12. To provide effective grounding of the conductors of array 12 when no controlling voltage is impressed thereon, the end of each remote from a terminal 12b is connected to ground through a high resistor 38 of the order of 1 megohm. The horizontal conductors of array 14 are similarly connected by means of conductors 14a to terminals 14b adapted to be sequentially engaged by a rotating arm 40. The other ends of the conductors of array 14 are connected to ground through resistors 42, the rate of rotation of arm 40 being synchronized with the vertical sweep frequency. A source of direct current energy, indicated as a battery 42, has its negative terminal grounded and its positive terminal connected to the conductive film 16 of the display device by a lead 44. A point of intermediate voltage of the battery 42 is connected to the arm 40 and to the grid electrode 10. Panel 4, if of metal, or the conductive film thereon if of glass, is grounded as indicated at 46.

With the above described arrangement once electron emission is initiated from the cathode 8 the emission is sustained by the potential applied to grid 10. During rotation of the arms 34 and 40 sequential small areas of the phosphor layer 18 will luminesce under control of the video signal as heretofore described.

Any known means may be provided for properly synchronizing the rotation of arms 34 and 40 with the horizontal and vertical sweep frequencies. In the particular circuit of Fig. 1, one suitable type of synchronizing means is disclosed as comprising a pivoted pawl 48 which is biased by a spring 50 into engagement with stop 52 in which position the end of the pawl arrests movement of the rotating arm. A solenoid 54 connected to the horizontal sweep generator, through a rectifier 56, in the case of the control of arm 34, attracts the pawl 48 during the fly back period thus synchronizing rotation of the arm 34 with the horizontal sweep frequency, the arm 34 being driven at slightly above synchronous frequency through a friction clutch or the like. In the case of the arm 40 the solenoid 54 will be energized during the fly back period of the vertical sweep and the arm 40 will be rotated at a rate slightly above the vertical frequency. Details of the synchronizing means are not believed necessary as instrumentalities for properly synchronizing the rotation of the arms 34 and 40 are well known in the art. For example, a single revolution clutch could be employed instead of the particular construction illustrated.

It will be understood that for purposes of clarity in the drawing relatively few conductors have been shown in each of the arrays 12 and 14. Obviously for television purposes a greater number of conductors would be employed depending upon the resolution desired for the display and depending also upon the size of the device.

It will be apparent from the foregoing description that the invention provides a display device operating on novel principles. It will yield a much brighter picture than can be obtained from electroluminescent panels. It will have a much longer life than electroluminescent panels. It does not require the high potentials necessary for cathode ray tubes and can be more economically manufactured than such tubes. Although the device has been described with particular reference to television receivers obviously the display device could be used for radar or other display purposes.

The following is claimed:

1. A display device comprising two generally parallel

wall members hermetically sealed together about their peripheries to form a single evacuated envelope, one of said wall members being of transparent electrical insulating material and the other of said wall members being electrically conductive at least on its inner surface, a porous coating on the inner surface of said last mentioned wall member of a cold cathode material capable, once electron emission has been initiated, of self-sustained electron emission, a grid electrode within the envelope spaced from the cold cathode coating, a first array of parallel conductors within the envelope spaced from said grid electrode, a second array of parallel conductors within the envelope spaced from said first array and with the conductors thereof angularly disposed with respect to the conductors of the first array, a transparent conductive film on the inner surface of said transparent wall member and a phosphor layer on said conductive film, said grid when maintained at a potential above that of the cathode coating serving to sustain electron emission, said film, when maintained at a potential above that of said grid serving to receive electrons from said cathode under control of selective application of control potentials to conductors of said arrays, said phosphor layer emitting light when bombarded by electrons traveling to said film.

2. The display device according to claim 1 including means within the envelope for initiating electron emission from said cathode coating, said means comprising an electroluminescent device adapted, when energized, to illuminate the coating with ultraviolet light.

3. The display device according to claim 1 wherein one end of each conductor of each array is connected, externally of the envelope, to ground through a high resistor and the other ends of the conductors of one array are connected to one set of terminals and the other ends of the conductors of the other array are connected to a second set of terminals, and means for sequentially applying control voltages to said sets of terminals.

4. The display device according to claim 1 wherein said cathode coating is magnesium oxide in the form of microscopic sponge-like structures.

5. A display device comprising two generally parallel wall members hermetically sealed together about their peripheries to form an evacuated envelope, one of said wall members being of transparent electrical insulating material and the other of said wall members having an inner conductive surface, a coating on said inner surface of said last mentioned wall member of magnesium oxide in the form of microscopic sponge-like structures, a grid electrode within the envelope generally parallel to and spaced from said coating, a first array of parallel conductors within the envelope spaced from said grid electrode, a second array of parallel conductors within the envelope spaced from said first array and with the conductors thereof perpendicularly disposed with respect to the conductors of said first array, a transparent conductive film on the inner surface of said transparent wall member, a phosphor layer on said conductive film, means for maintaining said grid electrode and said conductive films at potentials, positive with respect to said coating and means for selectively applying control potentials to conductors of said arrays to control the location on said phosphor layer of bombardment by electrons emitted from said coating.

References Cited in the file of this patent

UNITED STATES PATENTS

2,313,286	Okolicsanyi	Mar. 9, 1943
2,670,402	Marks	Feb. 23, 1954