

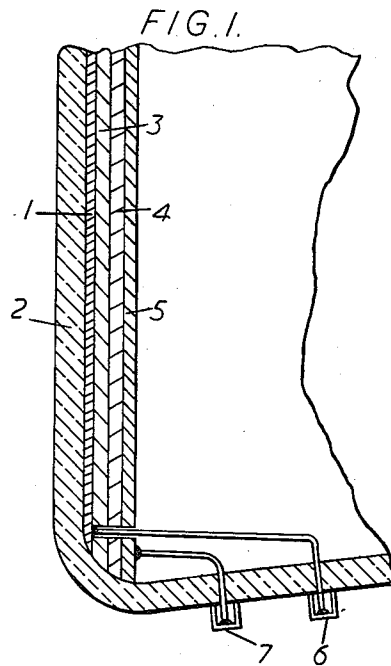
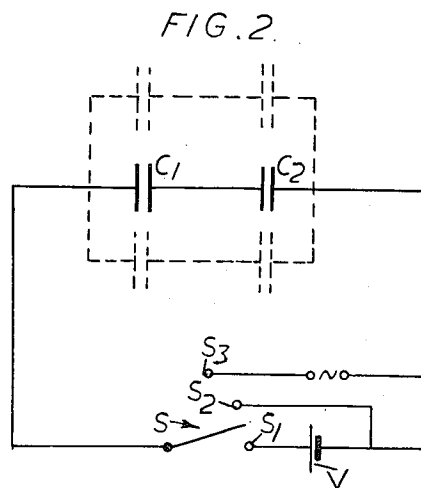
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G. C. TURNER

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DIRECT VIEWING CATHODE-RAY STORAGE TUBES

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Inventor
GEORGE C. TURNER

By
Cameron, Kerkham & Sutton
Attorneys

1

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DIRECT VIEWING CATHODE-RAY STORAGE TUBES

George Christie Turner, Moss Side, Manchester, England, assignor to Ferranti, Limited, Hollinwood, Lancashire, England, a company of Great Britain and Northern Ireland

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This invention relates to direct-viewing cathode-ray storage tubes.

Direct-viewing cathode-ray storage tubes usually include a wire mesh storage screen and the resolution of such tubes is limited by the fineness of the wire mesh screen. Wire mesh screens having five hundred or more lines to the inch are very difficult to manufacture and the size of such screens is also limited by the mechanical difficulties involved in rigidly mounting the screen inside cathode-ray tube envelopes. Furthermore, with very fine screens, the number of electrons which pass through the screen to produce the visible image are considerably reduced due to reflection of electrons by the screen, and the brightness of the visible image is therefore appreciably reduced.

Accordingly it is an object of the present invention to provide a direct-viewing cathode-ray storage tube which does not include a mesh screen and which, therefore, is capable of greater resolution than known direct-viewing cathode-ray storage tubes.

According to the present invention a direct-viewing cathode-ray storage tube includes a screen comprising, in the following order, a transparent layer of an electrically conductive material on a transparent base, a layer of an electroluminescent phosphor, a layer of ferro-electric material which becomes electrically conductive when subjected to electron bombardment and which is stable at all temperatures to which it is likely to be subjected during manufacture of the storage tube, and a layer of electrically conductive material, the electron beam, in operation, being incident on the last named layer, and electrical connections from the exterior of the storage tube to the layer of transparent electrically conductive material and to the layer of electrically conductive material.

Said transparent base may be the glass face-plate of the cathode-ray tube envelope.

The invention will now be described by way of example with reference to the accompanying drawings in which

FIGURE 1 is a sectional view of part of a direct-viewing cathode-ray storage tube in accordance with the invention, and

FIGURE 2 is a schematic drawing to illustrate the operation of the storage tube referred to in FIGURE 1.

Referring now to FIGURE 1 of the drawings a direct-viewing cathode-ray storage tube includes a single electron gun (not shown) and the usual accelerating and scanning means (not shown). The screen of the storage tube comprises a layer 1 of gold applied to the glass face-plate 2 of the storage tube envelope, the layer 1 of gold being so thin as to be transparent as well as electrically conductive. The layer 1 is covered by a layer 3 of electroluminescent phosphor, the layer 3 is covered by a layer 4 of barium titanate which is ferro-electric material which remains stable at all temperatures to which the storage tube is subjected during manufacture, and the layer 4 is covered by a layer 5 of aluminium. Electrical connectinos 6 and 7 are provided to the layer 1 of gold and to the layer 5 of aluminium respectively.

One method of operating the storage tube as described above is as follows. To write an image into the storage

2

tube a direct current potential is applied between the layers 1 and 5 and the screen is scanned by the electron beam modulated so that where a dark area is required in the image the electron beam penetrates the layer 5 of aluminium and causes bombardment induced conductivity to occur in the layer 4 of barium titanate. After the whole screen has been scanned the direct current potential between the layers 1 and 5 is removed and the layers 1 and 5 are connected together, the image thus being stored for reasons described hereafter. To view the image an alternating current field is applied between the layers 1 and 5 and this causes the electroluminescent phosphor to fluoresce in the regions in front of the areas of the layer 4 in which bombardment induced conductivity did not occur. To erase the picture it is necessary to connect the layers 1 and 5 together and then scan the screen with the electron beam at such intensity as to cause bombardment induced conductivity to occur over the whole of the layer 4 of barium titanate.

The theory of operation of the storage tube when operated in the manner described above is as follows. The screen may be considered to consist of discrete areas which may be electrically represented by two series connected capacitors, one of which represents the capacitance between the layer 1 and the interface of layers 3 and 4, the other representing the capacitance between the interface of layers 3 and 4 and the layer 5. These capacitors representing one such area are shown in FIGURE 2 and designated C_1 and C_2 respectively, the capacitors representing neighbouring areas being shown in broken line. Also shown in FIGURE 2 is a switch S which may make contact with any one of three contacts S_1 , S_2 , S_3 by means of which a direct current potential, shown schematically as a battery V, may be connected across the capacitors C_1 and C_2 , the left-hand plate of C_1 may be connected to the right-hand plate of C_2 , or an alternating current potential may be connected across the capacitors C_1 and C_2 .

When writing information into the tube the switch S initially makes with contact S_1 thus connecting a direct current potential of V volts across the capacitors C_1 and C_2 , the potential distribution between the capacitors depending upon their separate capacitances. When the electron beam strikes the capacitor C_2 , i.e. the layer 4 of barium titanate, no variation occurs in the potential distribution between the capacitors C_1 and C_2 if the beam has not sufficient energy to cause bombardment induced conductivity. In the areas where the electron beam does cause bombardment induced conductivity, however, the capacitor C_2 is effectively short circuited and the whole of the potential of V volts appears across the capacitor C_1 . Therefore, after the electron beam has passed the area the capacitor C_1 is left with a potential of V volts, the capacitor C_2 having zero volts.

When the whole of the screen has been scanned by the electron beam the position of switch S is changed to make with contact S_2 , thus connecting the left-hand plate of capacitor C_1 to the right-hand plate of capacitor C_2 . In areas where the capacitor C_2 was not short circuited this results in a potential of considerably less than V volts occurring across the capacitor C_2 , but in areas where the capacitor C_2 was short circuited almost the full potential of V volts now appears across C_2 in opposite polarity to the potential across C_1 . The image is thus stored on the screen and will remain stored until the potentials across the capacitors leak away. The time required for this to occur depends on the material used for the layer of ferro-electric material and in the case of barium titanate the time required is several hours.

To view the image stored in the tube the switch S is changed to make with contact S_3 thus connecting an alternating current across the capacitors C_1 and C_2 . The capacity of the capacitor C_2 , and hence its impedance to

alternating current, is a function of the direct current volts across it due to its dielectric of barium titanate. Areas in which the full potential of V volts appears across the capacitor C_2 will offer more impedance to the alternating current than areas in which there are less than V volts across the capacitor C_2 . Therefore in areas where bombardment induced conductivity has occurred a smaller alternating current field will be applied to the electro-luminescent phosphor causing it to fluoresce less brightly than in areas where bombardment induced conductivity has not occurred. The stored image may be viewed any number of times or for any length of time during the storage period.

To erase the stored image the switch S is changed to make contact S_2 and the whole screen is scanned with the electron beam at sufficient intensity to cause bombardment induced conductivity over the whole of the layer 4 of barium titanate. This effectively short circuits all of the capacitors C_2 thus removing the direct current potentials across the capacitors C_1 . The switch S may then be changed to make with contact S_1 in readiness for the next image to be stored.

With the kind of storage tube described above the image, when viewed, appears dark on a light background. A light image on a dark background, if required, may be obtained by applying a suitable direct current bias to the alternating voltage supply connected to the switch contact S_3 .

It will be appreciated that the storage tube described above is capable of very high resolution since the only limit on the resolution is the spot diameter of the electron beam.

What we claim is:

1. In a direct-viewing cathode-ray storage tube of the type including an electron beam producing gun and an envelope having a glass face-plate, a screen comprising, in the following order from the face-plate, a transparent layer of an electrically conductive material on a transparent base, a layer of an electro-luminescent phosphor, a layer of ferro-electric material which becomes electrically conductive when subjected to electron bombardment and which is stable at all temperatures to which it is likely to be subjected during manufacture of the storage tube, and a layer of electrically conductive material, each of said layers being substantially coextensive in area with face-plate, the electron beam, in operation, being incident on the last named layer, and electrical connections from the exterior of the storage tube to the transparent layer of electrically conductive material and to the layer of electrically conductive material.

2. A direct-viewing cathode-ray storage tube as claimed in claim 1 in which said transparent base is the glass face-plate of the cathode-ray tube envelope.

3. A direct-viewing cathode-ray storage tube as claimed in claim 1 in which said layer of ferro-electric material is a layer of barium titanate.

4. A direct-viewing cathode-ray storage tube as claimed in claim 1 in which said transparent layer of electrically conductive material is a transparent layer of gold.

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