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(54) COLOUR TELEVISION DISPLAY TUBE

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED of Abacus House, 33 Gutter Lane, London, EC2V 8AH, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The invention relates to a colour television display tube.

For generating an electron beam in a picture display tube, the electrodes of the electrode systems mounted in the tube for that purpose are often operated at very different voltages. Voltage differences of 20 kV between electrodes situated at short distance from each other are quite usual, in particular in display tubes for displaying coloured pictures. With such voltage differences, electrical flash-overs may occur between the electrodes and, when no special measures are taken, may be associated with currents rising very rapidly in time and reaching values of 500 A and higher. *Via* inductive or capacitive couplings, said currents may seriously damage certain components, in particular semiconductor components, in the electronic circuit of the television receiver, while the electrode system itself may also be damaged.

British Patent Specification 1,226,728 discloses a television display tube, which, in order to restrict the detrimental results of such an electrical flash-over, has a resistive layer which is provided on an internal wall part of the tube envelope. Although with such a resistive layer good results can be obtained as regards the safety of the electronic circuit of the television receiver, the use of said layer proves to present some problems in other respects. Notably problems occur whiche are associated with the fact that a switched-on television receiver may be a source of interference for a radio receiver placed in the proximity thereof which is tuned to a transmitter in the long or medium waveband. This interference is caused for a considerable part by the video signal. During operation of the display tube, the display screen is scanned with electron beams modulated according to the video signal. A part of said beams reaches the display screen *via* apertures in the colour selection means, while the part of the beams which is not passed through impinges upon the colour selection means themselves. As a result of this, the electrical potential of the colour selection means and the display screen fluctuates in accordance with the amplitude of the video signal. Said fluctuations are transmitted as interference radiation by the display screen.

It is the object of the invention to provide a colour television display tube having an internal resistive layer, in which measures are taken to reduce the abovementioned interference radiation.

According to the present invention there is provided a colour television display tube comprising in an evacuated envelope an electrode system for generating at least two electron beams, a display screen consisting of a plurality of regions luminescing in different colours and provided on an internal wall part of the envelope which forms the display window, an electrically resistive layer extending on an internal wall part of the envelope between the electrode system and the display screen, an apertured colour selection means for assigning each electron beam to luminescent regions of one colour, which colour selection means is situated in the envelope at a predetermined distance from the display screen and is connected electrically to the display screen, and at least one metal contact spring electrically connecting the colour selection means, to the resistive layer *via* a contact face provided on the resistive layer, said contact

fact consisting of a material having an electrical conductivity which exceeds that of the material of the resistive layer and having an area which is greater than the contacting region between the spring and the contact face.

The invention is based on the recognition resulting from experiments that the interference radiation transmitted by the tube is smaller provided the electrical connection between the colour selection means and the resistive layer represents a smaller electrical resistance. In tubes having an internal resistive layer, said resistance is mainly determined by the contact resistance between the contact spring and the resistive layer. By using the invention, the effective contact surface area between the resistive layer and the contact spring is enlarged, which results in a reduction of the contact resistance. In a practical case, in which the resistive layer had a resistance of approximately 1000 ohms per square, a contact resistance of approximately 5000 ohms was measured without the use of the invention. After providing a low-ohmic contact face on the resistive layer, approximately 5 cm^2 in area, a resistance of approximately 25 ohms per square, the contact resistance proved to have been reduced by approximatley a factor 100. All this resulted in a reduction of the interference radiation level by approximately 10 dB. In this specification by low ohmic is meant that the electrical conductivity of the contact face is at least a factor of 10 larger than that of the resistive layer. Possible tolerances inthe location of a contact spuring are compensated for by giving the low-ohmic contact face an area of at least 5 cm^2. A contact face in the form of a strip of low-ohmic material provided on the resistive layer has been found to be particularly favourable. By providing a strip of low ohmic material a good electrical coupling is obtained between both the colour selection means and the display screen and the capacitor formed by the inner coating of the tube (the resistive layer) and the usual low-ohmic coating provided on the outside of the tube and connceted to the chassis of the television receiver. More than one contact spring may be used, in which case the contact faces associated with said springs may comprise a single strip of the low-ohmic material, which strip can be provided on the wall of the tube in one operation.

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 a colour television display tube in accordance with the invention,

Figure 2 shows the cone of the tube shown in Figure 1 provided with an internal resistive layer, and

Figure 3 shows a possible connection of a gettering device in a display tube as shown in Figure 1.

The tube shown in a horizontal sectional view in Figure 1 comprises a glass envelope consisting of a display window 1, a cone 2 and a neck 3. Positioned in the neck 3 is an electrode system *4* comprising three electron guns for generating three electron beams 5, 6 and 7. The electron beams are generated in one plane (here the plane of the drawing) and are directed onto a display screen 8 which is provided internally on the display window 1 and consists of a large number of phosphor strips coated with an aluminium layer and luminescing in red, green and blue and the longitudinal direction of which is normal to the plane through the electron guns (here the plane of the drawing). On their way to the display screen 8, the electron beams 5, 6 and 7 are deflected over the display screen 8 by means of a number of deflection coils 9 arranged coaxially around the tube axis and then pass through a colour selection electrode 10 consisting of a metal plate having elongate apertures 11 the longitudinal direction of which is parallel to the phosphor strips of the display screen 8. The three electron beams 5, 6 and 7 pass through the apertures 11 at a small angle with each other and consequently each impinge only upon phosphor strips of one colour. The tube furthermore comprises an internal resistive layer 12 and a readily conductive layer 13 provided on the outside of the cone 2. The resistive layer 12 has a thickness of approximately 10 microns and consists of 1 part by weight of graphite powder, 6 to 10 parts by weight of iron oxide powder (Fe_2O_3) and 1.5 to 3 parts by weight of an inorganic binder, for example potassium silicate or sodium silicate. The resistive layer 12 is connected to a high-voltage contact 14 provided in the cone of the tube. The colour selection electrode 10 is connected to the display screen 8 by means of a number of contact springs 15. A metal screening cone 16 is connected on the one hand to the colour selection electrode 10 and on the other hand to the resistive layer 12 by means of two contact springs 17. During operation of the tube, the layer 12 is at an operating potential of approximately 25 kV and the layer 13 is at earth potential because it is connected to the chassis of the receiver. The layers 12 and 13, with the glass of the cone therebetween as a dielectric, constitute a capacitor which serves as a smoothing capacitor for the high voltage. Said capacitor discharges when an electrical flash-over occurs in the electrode

system *4*, for example, between the electrode 18 and the electrode 19 situated at a short distance therefrom. The value of the current pulse occurring in said discharge, however, is restricted by the resistive layer 12 and particularly by the part thereof extending over the neck-cone transition and in the neck. The resistance represented by the resistive layer in dynamic conditions, that is during the above-mentioned electrical flash-over, generally is lower than in static conditions. Static conditions is to be understood to mean herein the resistance defined as the quotient of a voltage difference of a few tension of volts set up across the resistive layer and the current consequently flowing through the resistive layer. For the above-given composition of the layer the dynamic resistance is approximately 500 ohms and the static resistance is approximately 2000 ohms.

The use of a resistive layer reduces the interference radiation transmitted by the tube. In this connection the contact resistance between the contact springs 17 and the resistive layer 12 proves to be of particular importance in the sense that the quantity of interference radiation is smaller as said contact resistance is lower. In order to obtain a low contact resistance, a low-ohmic contact face is provided by the face of a strip 20 on the resistive layer 12 at the area where the contact springs 17 press against the wall of the tube. Said strip 20 consists of a low-ohmic material of the composition 60-90 parts by weight of graphite and 10-40 parts by weight of an inorganic binder, for example potassium silicate or sodium silicate. Such a material may be provided in the form of an aqueous suspenion by means of a brush. Instead of this material, however, other good conductors may also be used, for example aluminium. The strip 20 has a width of approximately 5 cm and, as shown in Figure 2, constitutes a closed ring on the inner surface of the cone 2. As a result of its large contact area, such a ring moreover provides a good electrical coupling between on the one hand the colour selection electrode 10 and the display screen 8 and on the other hand the capacitor constituted by the resistive layer 12 and the external layer 13.

As is known, a layer of gettering material of, for example, barium, strontium, calcium or magnesium, is deposited on the wall of the tube after evacuating the tube so as to getter the residual gases in the tube. In the conventional display tube the holder from which said gettering material is released by heating is connected to the electrode system either directly or by means of a metal strip. This conventional connection method cannot be used in a display tube in accordance with the invention because in that case a part of the gettering metal would be deposited on the resistive layer 12 at the area of the neck and the neck-cone transition, so that the resistive layer is short-circuited. Furthermore, in the case of an electrical flash-over, sliding sparks may occur along the connection strip of the holder. Figure 3 shows an example of a possible connection of the getter holder in which these problems are avoided. In this example the said gettering holder 30 is connected to the high-voltage connection 14 by means of a connection strip 31.

In this manner it is achieved that the gettering material is not deposited on the neck and the neck-cone transition but on the wide part of the cone 2. Short-circuiting the resistive layer at this area reduces the above-mentioned interference radiation transmitted by the tube while the dynamic resistance oft he layer 12 is hardly influenced thereby during an electrical flash-over.

The invention is not restricted to tubes having an internal metal screening cone. The invention may alternatively be used in tubes without a metal screening cone or in tubes having an external screening cone. In those cases, for example, the contact springs 17 are directly secured to the frame of the colour selection electrode 10 and the low-ohmic contact faces or strip 20 are situated farther in the direction towards the display screen than is shown in Figure 1.

WHAT WE CLAIM IS:—

1. A colour television display tube comprising in an evacuated envelope an electrode system for generating at least two electron beams, a display screen consisting of a plurality of regions luminescing in different colours and provided on an internal wall part of the envelope which forms the display window, an electrically resistive-layer extending on an internal wall part of the envelope between the electrode system and the display screen, an apertured colour selection means for assigning each electron beam to luminescent regions of one colour, which colour selection means is situated in the envelope at a predetermined distance from the display screen and is connected electrically to the display screen, and at least one metal contact spring electrically connecting the colour selection means to the resistive layer *via* a contact face provided on the resistive layer, said contact face consisting of a material having an electrical conductivity which exceeds that of the material of the resistive layer and having an area which is greater than the contacting region between the spring and the contact face.

2. A colour television display tube as claimed in Claim 1, wherein the contact face has an area of at least 5 cm^2.

3. A colour television display tube as claimed in Claim 1 or 2, wherein the contact face consists of a strip of low-ohmic (as herein defined) material.

4. A colour television display tube as claimed in Claim 3, wherein the strip constitutes a closed ring.

5. A colour television display tube as claimed in Claim 3 or 4, in which the colour selection means is connected electrically to the resistive layer *via* at least two contact springs which press resiliently against the strip of low-ohmic material provided on the resistive layer.

6. A colour television display tube as claimed in any of the preceding Claims, wherein the resistive layer comprises 1 part by weight of graphite powder, 6 to 10 parts by weight of iron oxide powder (Fe_3O_3) and 1.5 to 3 parts by weight of alkalimetalsilicate, and the contact face comprises 60 to 90 parts by weight of graphite and 10 to 40 parts by weight of alkalimetalsilicate.

7. A colour television display tube constructed substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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1567653 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

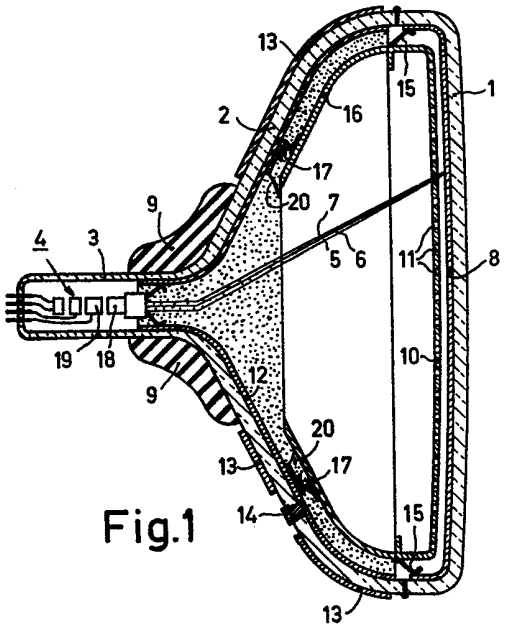

Fig.1

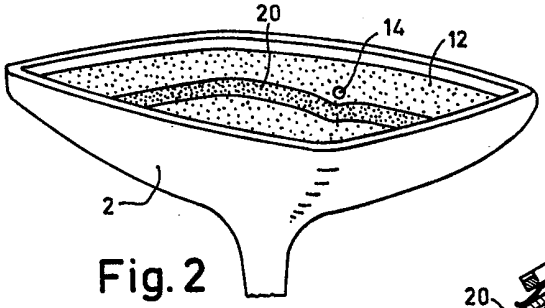

Fig. 2

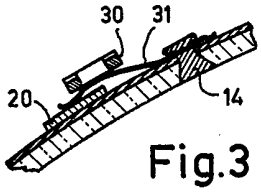

Fig.3