

SPECIFICATION

Colour display tube and method of manufacturing the same

5 The invention relates to a colour display tube and to a method of manufacturing the same.

Generally a colour display tube comprises in an evacuated envelope means to generate a
10 number of electron beams, a display screen comprising a large number of regions luminescing in different colours, and colour selection means comprising a metal plate having a large number of apertures which assign each
15 electron beam to luminescent regions of one colour, in which apertures an electron lens is formed.

Such a colour display tube of the post-focusing type is disclosed in British Patent Specification No. 1,496,949.

20 The object of post-focusing is to increase the brightness of the displayed picture by increasing the transmission of the colour selection means. In tubes without post-focusing a very large part, for example 80 to 85%, of the electrons is intercepted by the so-called shadow mask. By the use of post-focusing the apertures in the colour selection means can be enlarged since as a result of the focusing in
30 the apertures the electron spots on the screen are considerably smaller than the apertures so that nevertheless sufficient landing tolerance exists. In the above mentioned patent specification electrostatic lenses are formed in the apertures of the shadow mask, which lenses focus the electron beams in one direction and defocus them in the direction normal thereto.

An embodiment described in the British Patent Specification No. 1,496,949 shows
40 colour selection means consisting of a metal plate which has the said apertures and conductive strips between rows of the apertures, which strips are interconnection and are secured against the said metal plate while being
45 insulated from the metal plate. This known embodiment is characterized in that it consists of three layers placed one against the other, namely two conductive layers with an insulating layer inbetween. With a potential difference between the set of conductive strips and the metal plate an electrostatic lens is formed which converges in one direction and diverges in the direction normal thereto.

In this known embodiment with conductive
55 strips having a thickness of 1 μm and a thickness of the insulating material of 50 μm , the focusing voltage between the conductive strips and the plate must therefore be approximately 2.6 kV with colour selection means
60 which are situated at approximately 2 mm distance from the display screen and which are provided with square apertures having a pitch of 750 μm and a width of 500 μm .

It is the object of the invention to provide a
65 colour display tube of the post-focusing type

in which the lens action in the apertures of the colour selection means is equally strong as in the said embodiment but with a considerably lower focusing voltage.

70 According to the invention there is provided a colour display tube comprising in an evacuated envelope means to generate a number of electron beams, a display screen comprising a large number of regions luminescing in different colours, and colour selection means comprising a metal plate having a large number of apertures which assign each electron beam to luminescent regions of its respective colour, in which apertures a two element electron lens is
75 formed, characterized in that the metal plate is covered on one side with an insulating film on which a metal film is provided, said insulating film and metal film moreover extending on two oppositely located parts of the wall of each aperture to form one element of each electron lens, which parts are separated by other wall parts comprising the metal of the plate which form the other element of each electron lens.

90 By providing such a two element lens in a colour display tube a quadrupole lens is formed in each aperture because the electrodes generating the quadrupole field are situated on the walls of each aperture and
95 located in one plane. The lens strength moreover becomes larger as the plate is thicker.

The focusing voltage may be lower and will be approximately 600 V with a colour selection means with square apertures having a
100 width of 500 μm and a mutual pitch of 750 μm located at a distance of approximately 9 mm from the display screen.

The insulating film may be a lacquer, a glass or a suitable synthetic resin. The metal
105 film on one side of the plate and on two oppositely located parts of the wall of each aperture may be obtained by vapour deposition of a metal, by spraying a metal paint or by means of photoetching methods. The non-coated insulation material is dissolved or etched away.

In one embodiment the metal plate consists of aluminium on which an insulating aluminium oxide film is obtained by anodizing. In
115 order to prevent differences in expansion as much as possible, an aluminium film is preferably vapour-deposited in addition on the aluminium oxide layer.

One method of manufacturing a colour selection means for a colour display tube of the post-focusing type as above defined is as follows. The colour selection means is obtained by providing apertures of the desired shape in an aluminium plate, anodizing the
125 plate on at least one side and also the walls of each aperture, covering the at least one anodised side of the plate with an aluminium film by causing a number of aluminium particles to be deposited, the direction of incidence of the
130 aluminium particles during coating being cho-

sen to be so that two oppositely located wall parts of the apertures are also covered with an aluminium film, and etching away the non-coated part of the aluminium oxide obtained by anodizing from the other wall parts of the apertures. Solvents which do dissolve the aluminium oxide but do not dissolve the aluminium are known (for example, from J. Electrochem. Soc. 121 (1974) 1019).

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

Figure 1 is a sectional view of a colour display tube in accordance with the invention,

Figure 2 explains in detail the principle of the quadrupole post-focusing,

Figure 3 is a perspective view of a known embodiment,

Figure 4 is a perspective view of the starting material for manufacturing colour selection means,

Figures 5 and 9 explain the method of manufacturing the colour selection means,

Figure 10 shows colour selection means for a colour display tube of the post-focusing type in accordance with the invention, and

Figure 11 explains the operation of said colour selection means.

The tube shown in Fig. 1 comprises a glass envelope 1, means 2 to generate three electron beams 3, 4 and 5, a display screen 6, colour selection means 7 and deflection coils 8. The electron beams 3, 4 and 5 are generated in one plane, the plane of the drawing of Fig. 1, and are deflected over the display screen 6 by means of the deflection coils 8. The display screen 6 consists of a large number of phosphor strips which luminesce in red, green and blue and the longitudinal direction of which is normal to the plane of the drawing of Fig. 1. During normal operation of the tube the phosphor strips are vertical and Fig. 1 thus represents a horizontal sectional view of the tube. The colour selection means 7 comprise a large number of apertures 9 which are shown diagrammatically only in Fig. 1. The three electron beams 3, 4 and 5 pass through the apertures 9 at a small angle to each other and consequently each impinge only upon phosphor strips of one colour. The apertures 9 in the colour selection means 7 are thus very accurately positioned with respect to the phosphor strips of the display screen 6. In each aperture 9 a quadrupole lens is formed. Fig. 2 shows diagrammatically such a quadrupole lens. Shown is a part of the colour selection means 7 and one of the apertures 9. The potential variation along the edge of the aperture 9 is denoted by +, -, +, - in such manner that a quadrupole field is formed. The electron beam which passes through the aperture 9 is focused in the horizontally shown plane and is defocused in the vertically shown plane so that, when the display screen is positioned exactly in the horizontal focus, the

electron spot 10 is formed.

It is recommended not to focus exactly on the display screen 6 so that a slightly wider electron spot is obtained. It is only of minor influence on the focusing when the electron beam passes through the aperture 9 at a small angle; as a result of this the colour selection of the three electron beams 3, 4 and 5 takes place quite analogously to that in the known shadow mask tube without post-focusing. However, as a result of the strong focusing the aperture 9 can be much larger than in the known shadow mask tube without post-focusing so that many more electrons impinge upon the display screen and a considerably brighter picture is formed. The de-focusing in the vertical direction need not be a disadvantage when phosphor strips are used which are parallel to the longitudinal direction of the spot 10.

Fig. 3 shows prior art colour selection means. The colour selection means 7 in this case consist of an iron plate 11 which has apertures 9 and a large number of conductive strips of which two are denoted by 12 and 13 between the apertures 9. The conductive strips are insulated from the iron plate by means of insulation material 15. The plate 11 has a thickness of 150 μm . The insulation material 15 is an aluminium oxide layer of 50 μm thick. The conductive strips consist of vapour-deposited aluminium and are 1 μm thick. The apertures 9 are 500 $\times$ 500 μm and their pitch is 750 μm so that the transmission of the colour selection means is approximately 44%. At a potential of the display screen 6 of 25 kV, a potential of the plate 11 of likewise 25 kV, and a potential of the conductive strips 12 and 13 of 22.4 kV, the focal distance of the lenses is 13 mm with normal incidence in the centre of the display screen. The electron spots in the centre of the display screen are approximately 0.10 mm wide and in the corners approximately 0.09 mm wide and there is no focusing ring visible on the display screen. The width of the phosphor strips R, G and B is 0.13 mm. As a result of the insulation material 15 the focusing voltage between the plate 11 and the conductive strips 12 and 13 must be approximately 2600 V.

It is desired to provide a construction in which an equally strong lens is obtained with a considerably lower voltage between the plate and the conductive strips.

Such a construction and a method of manufacturing thereof will be described with reference to the following figures.

Fig. 4 is a perspective view of a part of an aluminium plate 16 which serves as starting material for an embodiment of the colour selection means. The plate has a large number of apertures 17 which in this case are also square and have a width of 500 μm . However, the apertures may alternatively be more or less oval or circular.

Fig. 5 is a sectional view of the aluminium plate 16 shown in Fig. 4. The thickness of this plate in this case is 300 μm .

Fig. 6 shows how the plate 16 has been provided with an aluminium oxide skin 18 by anodizing. The thickness of said aluminium oxide skin in this case is 50 μm .

Fig. 7 shows how the vapour disposition of a metal film, in this case an aluminium film, takes place from the sources 19. The vapour deposition sources are arranged so that the aluminium particles 20 impinge upon the plate 16 at an angle and thus also cover two oppositely located parts 21 and 22 of the wall of the apertures 17 with an aluminium film. Instead of the vapour deposition sources, nebulizers with which a metal paint is sprayed may alternatively be used. It is alternatively possible to cover two oppositely located parts of the wall of each aperture with a conductive film by means of a photoetching method and exposure by means of two light sources.

Fig. 8 shows diagrammatically the result of the provision of the metal film. The plate 16 is covered with an aluminium oxide layer 18. An aluminium film 23 is present on the layer 18 covering one side of the plate 16 and on the aluminium oxide layer 18 which moreover extends on two oppositely located sides of the apertures 17. The thickness of the aluminium film in this case is 1 μm . The parts 24 and 25 not covered with an aluminium film (part 25 is not visible) on the wall of the aperture are still coated with aluminium oxide. The colour selection means are obtained after the removal of the exposed aluminium oxide on the other side of the plate and on the parts 24, 25. The removal may be carried out in a solution of 5% H_3PO_4 and 2% CrO_3 in water at 85°C. After the removal, four electrodes are present on the walls of each aperture 17 formed by a set of two electrodes consisting of aluminium film on the vertical parts 21 and 22 of the wall of each aperture and a second set of two electrodes consisting of uncovered wall parts 24 and 25, as shown in Fig. 9.

Fig. 10 is a perspective view of a part of the colour selection means. The plate 16 having apertures 17 is coated with an aluminium oxide layer 18 and a metal film 23 on the side 26 and on parts 21 and 22 of the wall of each aperture. The parts 24 and 25 of the wall of each aperture are formed by the metal of the plate 16. With colour selection means shown in Fig. 10 assembled in a display tube at 9 mm in front of the display screen and having square apertures with a width of 500 μm and a mutual pitch of 750 μm in such manner that the electron transmission is approximately 44%, the following results are achieved which are explained with reference to Fig. 11. At a potential of 25 kV of the display screen 6 which is covered with the usual aluminium film and a potential of 24.4 kV on the film 23 and a potential on the plate

16 of 25 kV, the focal distance of the quadrupole lenses is approximately 13 mm in the centre of the display screen. The distance from the colour selection means 7 to the display screen 6 is approximately 9 mm so that the focus of the quadrupole lenses lies everywhere just slightly beyond the display screen. As a result of this it is prevented that a so-called focusing ring is visible on the display screen. The electron spots are then in the centre of the display screen approximately 0.10 mm wide and in the corners are approximately 0.09 mm wide. A suitable width of the phosphor strips R, G and B is then 0.13 mm. The remainder of the surface of the display screen 6 may or may not be coated with light-absorbing material.

A display screen for a tube in accordance with the invention can be manufactured by means of a known exposure method in which the colour selection means are displayed on a photosensitive layer on a window portion of the tube. In connection with the large transmission of the colour selection means according to the invention, the exposure method used should be suitable to reproduce the apertures 9 in a considerably narrowed manner. An exposure method suitable for this purpose uses two or more light sources at some distance from each other as described in British Patent Specification 1,396,918. Of course, a tube in accordance with the invention is also excellently suitable for so-called electronic exposure, in which the sensitive layer on the window portion is "exposed" by means of an electron beam.

CLAIMS

1. A colour display tube comprising in an evacuated envelope means to generate a number of electron beams, a display screen comprising a large number of regions luminescing in different colours, and colour selection means comprising a metal plate having a large number of apertures which assign each electron beam to luminescent regions of its respective colour, in which apertures a two element electron lens is formed, characterized in that the metal plate is covered on one side with an insulating film on which a metal film is provided, said insulating film and metal film moreover extending on two oppositely located parts of the wall of each aperture to form one element of each electron lens, which parts are separated by other wall parts comprising the metal of the plate which form the other element of each electron lens.

2. A colour display tube as claimed in Claim 1, characterized in that the metal plate is an aluminium plate and the insulating film is aluminium oxide.

3. A colour display tube as claimed in Claim 2, characterized in that the metal film is aluminium.

4. A method of manufacturing a colour

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16 of 25 kV, the focal distance of the quadrupole lenses is approximately 13 mm in the centre of the display screen. The distance from the colour selection means 7 to the display screen 6 is approximately 9 mm so that the focus of the quadrupole lenses lies everywhere just slightly beyond the display screen. As a result of this it is prevented that a so-called focusing ring is visible on the display screen. The electron spots are then in the centre of the display screen approximately 0.10 mm wide and in the corners are approximately 0.09 mm wide. A suitable width of the phosphor strips R, G and B is then 0.13 mm. The remainder of the surface of the display screen 6 may or may not be coated with light-absorbing material.

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2. A colour display tube as claimed in Claim 1, characterized in that the metal plate is an aluminium plate and the insulating film is aluminium oxide.

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4. A method of manufacturing a colour





display tube as claimed in Claim 3, characterized in that the colour selection means are obtained by providing apertures of the desired shape in an aluminium plate, anodizing said
5 plate on at least one side and also the walls of each aperture, covering the at least one anodised side of the plate with an aluminium film by causing a number of aluminium particles to be deposited, the direction of incidence of the
10 aluminium particles during coating being chosen to be so that two oppositely located wall parts of the apertures are also covered with an aluminium film, and etching away the non-covered part of the aluminium oxide obtained
15 by anodizing from the other wall parts of the apertures.

5. A colour display tube substantially as hereinbefore described with reference to and as shown in Figs. 1, 2, 4 to 6 and 8 to 11 of
20 the accompanying drawings.

6. A method of manufacturing a colour display tube as claimed in claim 4, substantially as hereinbefore described with reference to Figs. 4 to 10 of the accompanying drawings.
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