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Display tube.

The invention relates to a display tube comprising an evacuated envelope consisting of a display window, a cone, and a neck, in which is provided an electron gun for generating an electron beam which is focused to form
5 a spot on a display screen provided on the inside of the display window, said beam being deflected across said display screen in two substantially mutually perpendicular directions by pincushion-shaped deflection fields of a system of deflection coils.

10 Such a display tube is used, for example, in a device for displaying symbols and/or figures generated, for example, by a computer. Such a display tube is also termed a D.G.D.-tube (D.G.D. = Data Graphic Display).

15 Such a display tube is known, for example, from "Philips Data Handbook", Electron Tubes, part 8, July, 1983, Monitor Tubes.

In such tubes deflection coils are used in which the generated horizontal deflection field, and usually also the vertical deflection field, is made pincushion-
20 shaped to minimize the frame distortion. As is known, however, such pincushion-shaped deflection fields also influence the shape of the electron beam and hence the shape of the spot on the display screen which is formed by said beam. In D.G.D.-tubes it is highly desirable for
25 the spot not to have too great variation in dimensions over the whole display screen, so that symbols and figures are displayed substantially equally sharply in the centre, in the corners and at the edge of the display screen. In order to reduce deflection defocusing it is
30 known to use field shapers in colour display tubes (see, for example, US 4,346,327).

It is the object of the invention to provide structurally simple field shapers for a display tube of the type mentioned in the opening paragraph which can be provided in a simple manner.

5 This object is achieved using an inventive display tube of the kind mentioned in the opening paragraph, in that the edge fields of the deflection fields on the electron gun side of the system of deflection coils are deformed by means of field shapers such that
10 they are barrel-shaped, which field shapers comprise four substantially flat plates of a ferromagnetic material which are arranged around the electron beam and extend away from the electron beam substantially in the deflection directions and which are disposed at a substantially
15 equal distance from the gun end.

The local barrel-shaped distortion of the deflection fields results in that the spot distortion is considerably reduced at the edge but in particular in the corners of the display screen. The field shapers can
20 simply be cut from ferromagnetic sheet material and be secured to the centring plate at the gun end. Moreover, it has been found that such field shapers may result in an increase of the deflection sensitivity.

If extra plates of ferromagnetic material are
25 present at the ends of at least two of the plates remote from the electron beam, which plates are situated in line with a deflection direction, said extra plates extending substantially perpendicularly to the field to be shaped, the barrel-shaped distortion of the field
30 is still somewhat more pronounced, but there is substantially no increase of the deflection sensitivity. Because in many types of coils the horizontal deflection field extends less far towards the electron gun than the vertical deflection field, the field shapers for the
35 horizontal deflection field preferably extend from the gun over a larger distance along the electron beam than the field shapers for the vertical deflection field.

This is the case in particular in so-called "hybrid" deflection coils (deflection coils with both saddle-shaped and toroidal coils).

5 The plates extending away from the electron beam in the deflection directions preferably comprise slots extending in the deflection directions so as to prevent eddy currents in the field shapers. For that purpose, the extra plates of ferromagnetic material may also comprise slots. Said slots are important in
10 particular in the field shapers or parts of field shapers extending substantially perpendicularly to the horizontal field, because said deflection field varies with the highest frequencies (horizontal frequency).

It is to be noted that the prior European
15 Patent Application EP-A-112 567, which pertains to the prior art in the contracting states of Germany and Great Britain (section 54 (3) EPC), shows a display tube of the type mentioned in the opening paragraph, in which the edge fields of the pincushion-shaped deflection fields
20 are rendered barrel-shaped on the side of the electron gun by four field shapers. The field shapers shown in EP-A-112 567, however, do not comprise four substantially flat plates which extend away from the electron beam substantially in the directions of deflection, and they
25 are not secured at a substantially equal distance from the gun end. The plates of the field shaper according to the invention are substantially flat, i.e., they are single flat plates or an assembly of folded flat plates.

30 The invention will now be described in greater detail, by means of examples and with reference to the accompanying drawings, in which

Figure 1 is a perspective view partly broken away of a display tube according to the invention,

35 Figure 2 is a perspective view of an electron gun according to the invention,

Figure 3 shows the barrel-shaped distortion of a pincushion-shaped deflection field by field shapers

according to the invention,

Figure 4 shows the magnetic field strength B divided by the applied field strength B_{EXT} in per cent, as a function of the distance to the axis of the electron gun in the deflection direction of the field shown in Figure 3, and

Figure 5 shows the same as in Fig. 4, but in the direction perpendicular to the deflection direction of the field shown in Figure 3,

Figure 6 shows the barrel-shaped distortion of a pincushion shaped deflection field by another type of field shapers according to the invention,

Figure 7 shows the magnetic field strength B divided by the applied field strength B_{EXT} in per cent, as a function of the distance to the axis of the electron gun in the deflection direction of the field shown in Figure 6,

Figure 8 shows the same as in Fig. 7, but in the direction perpendicular to the deflection direction of the field shown in Figure 6, and

Figure 9 is a cross-sectional view of a T-shaped field shaper.

Figure 1 is a perspective view partly broken away of a display tube according to the invention.

This tube comprises in the neck of a glass envelope 1 which consists of a display window 2, a cone 3 and said neck 4, an electron gun 5 for generating an electron beam 6. Said electron beam 6 is focused on a display screen 7 to form a spot 8. The display screen 7 is provided on the inside of the display window 2.

The electron beam is deflected across the display screen 7 in two mutually perpendicular directions x , y by means of the system of deflection coils 9. In order to prevent or considerably reduce frame distortion of the frame written on the display screen 7 by means of the electron beam 6, the deflection fields have been made pincushion-shaped. The resulting deflection defocusing can be

reduced by means of the field shapers as shown in Figure 2. These field shapers are provided at the end 10 of the electron gun 5 facing the system of deflection coils 9. The tube has a base 11 with connection pins 12.

5 Figure 2 is a perspective view of the electron gun 5 of the tube shown in Figure 1. This electron gun has a control grid (G-1) 20, a second grid (G-2) 21 and a focusing lens consisting of the electrodes 22, 23 and 24 (G-3, G-4 and G-5, respectively). The cathode, not
10 visible, is present in the control grid. The voltages applied to the electrodes are indicated in the Figure. A centring plate 26 having apertures 25 is secured to electrode 24. Centring springs for centring the electron gun in the tube neck are secured to said plate, which
15 centring springs are not shown in the Figure. The edge field of the pincushion-shaped deflection fields of the system of deflection coils 9 (see Figure 1) is made barrel-shaped by the field shapers 27, 28, 29 and 30, as will be explained hereinafter with reference to the
20 following Figures. Slots 31 to reduce the occurrence of eddy currents are provided in the field shapers 28 and 30 which are perpendicular to the horizontal field. Of course it is also possible to provide the field shapers 27 and 29 with such slots. The field shapers
25 have a length, for example, of 10 mm measured in the direction of the electron gun axis 32. The width is, for example, 4.8 mm and the thickness 0.25 mm. The field shapers may be cut from sheet material consisting of NiFe (with 48% of Ni) and may be secured to the centring
30 plate 26 by means of spotwelds.

The results recorded in the Table below are obtained with the above-described electron gun.

	Spot dimensions (mm)		Without field shapers	With field shapers
5	Centre	dx dy	0.70 0.70	0.70 0.70
	N/S	dx dy average increase	1.05 1.10 55%	0.93 0.95 35%
10	E/W	dx dy average increase	1.15 1.15 65%	1.15 1.08 60%
	angle	dx dy average increase	1.29 1.15 75%	1.05 0.92 40%

$\leftarrow$ dx and dy are the spot dimensions in mm in the centre of the display screen, on the upper and lower sides of the display screen (N/S), on the left and right-hand sides of the display screen (E/W) and in the corners of the display screen. By using the invention the average increase of the spot dimensions (in %) is considerably reduced especially in the corners of the display screen. The spot dimensions apply to an electron beam current of approximately 100 μ A in a display tube having a picture diagonal of 31 cm and 90° deflection of the electron beam.

It is possible to make one set of field shapers, for example field shapers 27 and 29, longer (for example 14 mm) than the field shapers 28 and 30. As a result of this the average increase of the spot on the left and right-hand sides of the display screen (E/W) is reduced further as compared with the above Table.

Figure 3 shows the barrel-shaped distortion of a pincushion-shaped horizontal deflection field by the field shapers 27, 28, 29 and 30, a number of field lines 40 of which are shown.

Figure 4 shows the magnetic field strength B divided by the applied field strength B_{EXT} in per cent. as a function of the distance to the axis 32 of the electron gun 5 in the deflection direction of the Figure 3 field. This normalized field strength is larger than 100 % in the centre ($x = 0$), as a result of which the deflection sensitivity increases somewhat.

Figure 5 shows the magnetic field strength B divided by the applied field strength B_{EXT} in per cent. as a function of the distance to the axis 32 of the electron gun 5 in the direction of the field 40 shown in Figure 3.

Figure 6 shows the barrel-shaped distortion of a pincushion-shaped horizontal deflection field by T-shaped field shapers 127, 128, 129, 130, a number of field lines 50 of which are shown. At the ends 51 of the plates remote from the electron beam 6 and extending away from the electron beam, extra plates 52 and 53 of ferromagnetic material are secured which extend substantially perpendicularly to the field to be shaped. The plates 52 extend substantially perpendicularly to the horizontal field shown and the plates 53 extend substantially perpendicularly to the vertical field not shown.

Figures 7 and 8 are analogous to Figures 4 and 5. In the centre the normalized field strength is approximately 100 %. The field is made clearly barrel-shaped by means of the field shapers shown in Figure 3. No increase of the deflection sensitivity occurs.

Figure 9 is a cross-sectional view of a T-shaped field shaper 60 which is manufactured from one piece of sheet material. The radius of curvature of the end 61 may be chosen to be as small as possible so as to obtain a field which is optimally barrel-shaped.

CLAIMS:

1. A display tube comprising an evacuated envelope (1) consisting of a display window (2), a cone (3), and a neck (4), in which is provided an electron gun (5) for generating an electron beam (6) which is focused to form a spot (8) on a display screen (7) provided on the inside of the display window, said beam being deflected across said display screen in two substantially mutually perpendicular directions by pincushion-shaped deflection fields of a system of deflection coils (9), the edge fields of said deflection fields on the electron gun side of the system of deflection coils being deformed by means of field shapers such that they are barrel-shaped, which field shapers comprise four substantially flat plates (27-30) of ferromagnetic material which are arranged around the electron beam and extend away from the electron beam substantially in the directions of deflection and which are disposed at a substantially equal distance from the gun end (10).
2. A display tube as claimed in Claim 1, characterized in that at the ends of at least two of the plates remote from the electron beam, which plates are situated in line with a deflection direction, extra plates (52,53) of a ferromagnetic material are present which extend substantially perpendicularly to the field to be shaped.
3. A display tube as claimed in Claim 1 or 2, characterized in that the field shapers for the horizontal deflection field extend from the gun over a larger distance along the electron beam than the field shapers for the vertical deflection field.
4. A display tube as claimed in any one of the preceding Claims, characterized in that at least the

plates extending away from the electron beam in the deflection directions comprise slots.

5. A display tube as claimed in Claim 4, characterized in that in addition the extra plates
5 comprise slots.

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