

SPECIFICATION

Colour television display tubes with deflection unit

5 The invention provides a colour television display tube of the type in which the electron beams lie substantially in a single plane on which plane the longitudinal axis lies, the central one of said beams, when undeflected, substantially coinciding with the longitudinal axis, and having a display screen and an electron gun assembly for producing said electron beams, and a deflection unit mounted on said display tube such that their longitudinal axes substantially coincide, said deflection unit comprising a field deflection coil, a line deflection coil and an annular core member of soft magnetic material surrounding at least the line deflection coil. A line deflection coil is to be understood to mean in this connection a combination consisting of two diametrically oppositely arranged line coil portions for deflecting an electron beam in a first (horizontal) direction and a field deflection coil is to be understood to mean in this connection a combination consisting of two diametrically oppositely arranged field coil portions for deflecting an electron beam in a (vertical) direction transverse to the first direction. The line and field coils may all be of the saddle type and are surrounded by the annular member of soft-magnetic material (the core) or the line coil may be of the saddle type and be surrounded by the core, while the field coils are wound toroidally on the core, this latter case being a hybrid system.

For displaying (colour) television pictures, certain electron-optical requirements are imposed upon the combination of the display tube and the electron beam deflection unit.

It holds, for example, that the raster reproduced on the display screen must be rectangular and undistorted within certain narrow limits. Furthermore, the definition of the picture from the centre towards the edge of the screen may decrease only to a restricted non-disturbing extent.

For the colour display tube having a shadow mask there are two additional requirements.

45 The colour selection in a shadow mask tube is obtained by an eccentric arrangement of the three electron guns in such manner that the phosphor dots of a given colour are hit only by the electrons of the corresponding beam through the holes in the mask. In order to obtain a colour-pure image it is required that the relative colour selection angles of the three beams should remain unvaried upon deflection. This is the landing requirement. When this condition is not satisfied it is possible that colour spots will occur.

A second equally important requirement is that the targets of the three electron beams should coincide with each other throughout the screen so that the pictures in the three primary colours fully converge. This is the convergence requirement. When this requirement is not satisfied, disturbing colour edges at brightness and colour transitions occur.

Of great importance in the further development of colour television display systems was the introduction of the "in-line gun" display tube in which the

electron guns are arranged in one plane. The basic idea of this design is that it is possible with this arrangement to obtain automatic convergence (self-convergence) throughout the display screen while using astigmatic deflection fields. A correct level of astigmatism for the field deflection coil will be described hereinafter.

For a good level of astigmatism for the field deflection coil its magnetic field should show a barrel-shaped variation in the middle and at the end facing the display screen of the deflection unit. If this variation is realized with normal (straight wound) toroidal field deflection coil or with normal saddle-shaped field deflection coil (having a constant average window aperture), then this means necessarily that the generated magnetic field has a barrel-shaped variation everywhere, and so also on the side of the deflection unit adjacent the electron gun. Since it is usual to position the three electron guns in the sequence red, green, blue this results in the green beam lagging behind the centre of the red beam and the blue beam during deflection. This resulting deflection error of the field deflection coil is termed coma.

It is possible to mitigate coma by winding the field deflection coil in a special manner: for this purpose, a toroidal field coil should be wound "obliquely", and a saddle-shaped field coil should be wound so that the average window aperture varies in the axial direction. However, the disadvantage of this solution is that, apart from the complicated winding process, it introduces East-West substantial raster distortion.

It is the object of the invention to provide a colour television display tube of the kind mentioned in the preamble in which it is possible to produce a substantially coma-free field deflection magnetic field with an East-West raster distortion which is as small as possible.

The invention provides a colour television display tube of the type in which the electron beams lie substantially in a single plane on which plane the longitudinal axis lies, the central one of said beams, when undeflected, substantially coinciding with said longitudinal axis, and having a display screen for providing a rectangular display and an electron gun assembly for producing said electron beams, and a deflection unit mounted on said display tube such that their longitudinal axes substantially coincide and having a first and second end and a middle therebetween such that the said first end faces said display screen whilst the said second end is adjacent said electron gun assembly, said deflection unit comprising a saddle shaped line deflection coil consisting of two diametrically oppositely arranged line coil portions which when energised with the unit mounted on a display tube deflect the electron beams in a first direction, a field deflection coil surrounding said line deflection coil, said field deflection coil consisting of two diametrically arranged field deflection coil portions which when energised with the unit mounted on a display tube deflect the electron beams in a direction transverse to said first direction, two soft-magnetic segments located diametrically opposite to each other radially outside the line deflection coil and within the magnetic field, when generated, of the field deflection coil, said

segments being positioned adjacent the second end of said deflection unit and an annular core member of soft magnetic material surrounding at least the line deflection coil, the deflection unit, when energised, producing a magnetic field resulting from said field deflection coil in planes perpendicular to said longitudinal axis which is strongly pin-cushion shaped at said second and comparatively weakly barrel-shaped at said first end and at the middle of said deflection unit, the level of the pin-cushion shaping at the second end in relation to the level of barrel shaping at the first end and at the middle being such that the integral of H_z component (as herein referred to) along the longitudinal axis of said deflection unit is small so as to provide a substantially coma free deflection field whilst the level of barrel shaping at said first end is such as to minimise East-West raster distortion which H_z components is zero towards the said second end between the second end and the middle.

By forming each segment as a semi-cylindrical member from soft-magnetic sheet material makes them easy to assemble – in particular in a deflection unit with so-called shell-type coils – on the plastic coil support (the so-called cap), for example, by adhering them to the cap before the field coils are provided.

The above and other features of the invention will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which:–

Figure 1 is a diagrammatic longitudinal sectional view of a colour television display tube according to the invention;

Figure 2 is a diagrammatic elevation of a cross-sectional view of the colour display tube and its deflection unit shown in Figure 1 taken on the line II-II;

Figure 3 is a perspective view of soft-magnetic segments shown in Figure 2;

Figure 4 is a view corresponding to that of Figure 3 showing a different construction;

Figure 5 shows diagrammatically the deflection fields which are generated in a conventional "in-line gun" colour display tube at the screen end of the deflection unit;

Figures 6 and 7 are graphic representations of the value of the parameter H_z along the z -axis of display tubes having conventional deflection units,

Figure 8 shows diagrammatically the value of the parameter H_z along the z -axis of a display tube and its deflection unit according to the invention, and

Figures 9, 10 and 11 show the field deflection magnetic fields generated.

Figures 1 and 2 show a colour display tube 1 having a display screen 2, a neck 3 and an electron gun assembly 4. An electron beam deflection unit 5 is mounted on the display tube 1. The deflection unit 5 comprises an annular member 6 of magnetically permeable material which surrounds a line deflection coil 7 and a field deflection coil 8. The deflection coils 7 and 8 in the present case each consist of a pair of coil portions 11, 12 and 13, 14, respectively, of the shell-type, that is to say that their ends adjacent the electron gun assembly of the tube extend parallel to

the longitudinal axis z of the display tube 1. However, the invention is not restricted to the use of this type of coil.

Segments 9 and 10 are arranged between the deflection windings 7 and 8 in such manner that segment 9 is under field deflection coil portion 13 and segment 10 is under field deflection coil portion 14. As a result of this, the segments 9 and 10 extend in a direction mainly transverse to the magnetic field produced by the field deflection coil 8. While Figure 3 shows segments 9 and 10 each consisting of one piece (in which the dimension in the longitudinal z -direction is, for example, 20 millimetres for a deflection unit for an in-line gun 110° display tube having a 26 inch display screen and having a so-called thick-neck construction), the division of the segments 9 and 10 into an equal number of separate sections, for example 9A, 9B and 10A, 10B (Figure 4), presents the additional advantage that the (2nd order) effect of line coma can be reduced. The segments 9A, 9B and 10A, 10B each have the same shape and are positioned symmetrically. They may be manufactured from any soft magnetic sheet material having a permeability $\mu > 100$.

The effect of the segments will be explained in detail hereinafter.

When an in-line gun colour display tube is combined with a deflection unit of the astigmatic type which has a magnetic field distribution in which, as shown in Figure 5, that for the field deflection is barrel-shaped and that for the line deflection is cushion-shaped, automatic convergence is possible in principle.

As described hereinbefore, in order to obtain a good astigmatism level for the field deflection coil, the magnetic field for that deflection coil should have a barrel-shaped variation in the centre and at the display screen end of the deflection unit. In the case of straight-wound toroidal field deflection coils i.e. where the turns lie in radial planes which pass through the longitudinal axis of the core this means necessarily that the magnetic field has a barrel-shaped variation everywhere, hence also at the end adjacent the gun assembly. This results in the green beam lagging behind the centre of the red beam (R) and the blue beam (B) (Figure 5). This deflection error is termed coma. Figure 6 is a graph which represents the variation along the z -axis of the parameter H_z known from the technical literature for a straight-wound toroidal field deflection coils. Where H_z is positive the field configuration in a plane perpendicular to the z -axis is cushion-shaped and where H_z is negative it is barrel-shaped. For the description and the measurement of H_z reference is made to the article by R. Vonk in Philips Technical Review, Volume 32, 1971 No. 3/4, pp. 61-72. For a coma-free magnetic field, the value of H_z integrated in the axial direction must be small. For straight-wound toroidal frame coils, however, this value is considerable.

The raster defects as they are generated by a deflection unit are determined in particular by the shape of the deflecting magnetic fields at the display screen end of the unit.

A barrel-shaped variation of the magnetic field of the field deflection coil in this area stimulates a

cushion-shaped East-West raster distortion. In the case of straight-wound toroidal field deflection coil the extent of barrel-shape of the magnetic field is comparatively low so that the resulting East-West pin-cushion distortion turns out to be comparatively low (8% is typical).

A possible way of correcting the frame coma is to wind the toroidal field deflection coil "obliquely". It can then be achieved that the magnetic field at the electron gun end of the field deflection coil becomes cushion-shaped so that the coma is precorrected as it were for the coma influence of the barrel-shaped magnetic field farther on at the display screen end of the deflection unit. The variation of the magnetic field parameter H_z will then be as indicated in Figure 7. The zero crossing of H_z lies near the deflection centre P. The integrated value is now small. In order to arrive at a good level for astigmatism in these coils the magnetic field on the display screen end of the deflection unit is much more strongly barrel-shaped than in the case of the straight-wound field deflection coils. This is the reason why these coils produce a greater pin-cushion-shaped East-West raster distortion (in this case 14% is typical).

As regards the magnetic field shapes which can be generated and the results with respect to astigmatism, coma and raster defects, roughly the same conclusions hold for field deflection coils of the saddle-type (including also the so-called shell-type coil) as described for the toroidal field deflection coils.

At a given axial position the configuration of the magnetic deflection field is determined by the distribution of the conductors of the coil in the corresponding part of the coil between the front end and the rear end. A measure for this distribution is the "average window opening". The window opening is expressed as the opening angle θ with respect to the axis of the deflection unit. A saddle coil having an average window opening which is constant along the z-axis generates an H_z function which is analogous to that of a straight-wound toroidal coil. A saddle coil having an average window opening which varies along the z-axis may generate an H_z function which is analogous to that of an "obliquely" wound toroidal field deflection coil. This means that for a saddle-shaped coil with varying window openings it also holds that since the field deflection coil is made coma-free a larger East-West raster distortion will be the result than when coma is permitted.

The invention is based on the consideration that in order to obtain a combination of a coma-free field deflection magnetic field and an optimum East-West raster distortion a variation of the parameter H_z is required as is shown in Figure 8. In this case the zero crossing of H_z is situated considerably before the field deflection centre P 2 towards the gun end of the deflection unit. The favourable effect of this shape of H_z variation can be explained as follows. The integral H_z provides a small value so that the generated coma can be negligibly small. The field deflection magnetic field is barrel-shaped in the middle and at the display screen end of the deflection unit, the astigmatism level of the field deflection coil may be improved with nevertheless a small barrel-shape of the field deflection magnetic field at the display

screen end. This promotes a smaller East-West pin-cushion-shaped distortion.

A preferred construction of the deflection unit for use with the invention has for the field deflection coil a wire distribution chosen to generate the magnetic field having a weak barrel-shape in the middle (Figure 10) and at the display screen end (Figure 9). The strong pin-cushion shape over a small area at the electron gun end (Figure 11) is generated by using segments of thin, soft-magnetic material as shape-determining elements for the field deflection magnetic field. A simple embodiment consists of two semi-cylindrical pieces or segments of sheet material placed diametrically with respect to each other in the field deflection field such as is shown in Figures 2 and 3. Parameters influencing the effect of these field-forming elements are the axial length and the width of the gaps between them. Knowing measures may be taken to suppress eddy currents, if any (choice of high-ohmic material, laminated sheet).

It is essential for good operation that the segments, when viewed from the longitudinal axis of the deflection unit, must be situated outside the line deflection coil so as to not or only slightly influence the line deflection magnetic field. In fact the segments then operate as a kind of extension of the yoke ring for the line deflection coil. If on the contrary the segments, when viewed from the longitudinal axis, were situated within the line deflection coil, a strong, generally undesired, influence of the line deflection magnetic field would be produced.

CLAIMS

1. A colour television display tube of the type in which the electron beams lie substantially in a single plane on which plane the longitudinal axis lies, the central one of said beams, when undeflected substantially coinciding with said longitudinal axis, and having a display screen for providing a rectangular display and an electron gun assembly for producing said electron beams, and a deflection unit mounted on said display tube such that their longitudinal axes substantially coincide and having a first and second end and a middle therebetween such that the said first end faces said display screen whilst the said second end is adjacent said electron gun assembly, said deflection unit comprising a saddle shaped line deflection coil consisting of two diametrically oppositely arranged line coil portions which when energised with the unit mounted on a display tube deflect the electron beams in a first direction, a field deflection coil surrounding said line deflection coil, said field deflection coil consisting of two diametrically arranged field deflection coil portions which when energised with the unit mounted on a display tube deflect the electron beams in a direction transverse to said first direction, two soft-magnetic segments located diametrically opposite to each other radially outside the line deflection coil and within the magnetic field, when generated, of the field deflection coil, said segments being positioned adjacent the second end of said deflection unit and an annular core member of soft-magnetic material surrounding at least the line deflection coil, the deflection unit, when energised, producing a magnetic field resulting from said field deflection coil in planes perpen-



cushion-shaped East-West raster distortion. In the case of straight-wound toroidal field deflection coil the extent of barrel-shape of the magnetic field is comparatively low so that the resulting East-West cushion distortion turns out to be comparatively (8% is typical).

A possible way of correcting the frame coma is to wind the toroidal field deflection coil "obliquely". It can then be achieved that the magnetic field at the electron gun end of the field deflection coil becomes cushion-shaped so that the coma is precorrected as it were for the coma influence of the barrel-shaped magnetic field farther on at the display screen end of the deflection unit. The variation of the magnetic field parameter H_z will then be as indicated in Figure 7. The zero crossing of H_z lies near the deflection centre P. The integrated value is now small. In order to arrive at a good level for astigmatism in these coils the magnetic field on the display screen end of the deflection unit is much more strongly barrel-shaped than in the case of the straight-wound field deflection coils. This is the reason why these coils produce a greater pin-cushion-shaped East-West raster distortion (in this case 14% is typical).

As regards the magnetic field shapes which can be generated and the results with respect to astigmatism, coma and raster defects, roughly the same conclusions hold for field deflection coils of the saddle-type (including also the so-called shell-type coil) as described for the toroidal field deflection coils.

At a given axial position the configuration of the magnetic deflection field is determined by the distribution of the conductors of the coil in the corresponding part of the coil between the front end and the rear end. A measure for this distribution is the "average window opening". The window opening is expressed as the opening angle θ with respect to the axis of the deflection unit. A saddle coil having an average window opening which is constant along the z-axis generates an H_z function which is analogous to that of a straight-wound toroidal coil. A saddle coil having an average window opening which varies along the z-axis may generate an H_z function which is analogous to that of an "obliquely" wound toroidal field deflection coil. This means that for a saddle-shaped coil with varying window openings it also holds that since the field deflection coil is made coma-free a larger East-West raster distortion will be the result than when coma is permitted.

The invention is based on the consideration that in order to obtain a combination of a coma-free field deflection magnetic field and an optimum East-West raster distortion a variation of the parameter H_z is required as is shown in Figure 8. In this case the zero crossing of H_z is situated considerably before the field deflection centre P 2 towards the gun end of the deflection unit. The favourable effect of this shape of H_z variation can be explained as follows. The integral H_z provides a small value so that the generated coma can be negligibly small. The field deflection magnetic field is barrel-shaped in the middle and at the display screen end of the deflection unit, the astigmatism level of the field deflection coil may be improved with nevertheless a small barrel-shape of the field deflection magnetic field at the display

screen end. This promotes a smaller East-West pin-cushion-shaped distortion.

A preferred construction of the deflection unit for use with the invention has for the field deflection coil a wire distribution chosen to generate the magnetic field having a weak barrel-shape in the middle (Figure 10) and at the display screen end (Figure 9). The strong pin-cushion shape over a small area at the electron gun end (Figure 11) is generated by using segments of thin, soft-magnetic material as shape-determining elements for the field deflection magnetic field. A simple embodiment consists of two semi-cylindrical pieces or segments of sheet material placed diametrically with respect to each other in the field deflection field such as is shown in Figures 2 and 3. Parameters influencing the effect of these field-forming elements are the axial length and the width of the gaps between them. Knowing measures may be taken to suppress eddy currents, if any (choice of high-ohmic material, laminated sheet).

It is essential for good operation that the segments, when viewed from the longitudinal axis of the deflection unit, must be situated outside the line deflection coil so as to not or only slightly influence the line deflection magnetic field. In fact the segments then operate as a kind of extension of the yoke ring for the line deflection coil. If on the contrary the segments, when viewed from the longitudinal axis, were situated within the line deflection coil, a strong, generally undesired, influence of the line deflection magnetic field would be produced.

CLAIMS

1. A colour television display tube of the type in which the electron beams lie substantially in a single plane on which plane the longitudinal axis lies, the central one of said beams, when undeflected substantially coinciding with said longitudinal axis, and having a display screen for providing a rectangular display and an electron gun assembly for producing said electron beams, and a deflection unit mounted on said display tube such that their longitudinal axes substantially coincide and having a first and second end and a middle therebetween such that the said first end faces said display screen whilst the said second end is adjacent said electron gun assembly, said deflection unit comprising a saddle shaped line deflection coil consisting of two diametrically oppositely arranged line coil portions which when energised with the unit mounted on a display tube deflect the electron beams in a first direction, a field deflection coil surrounding said line deflection coil, said field deflection coil consisting of two diametrically arranged field deflection coil portions which when energised with the unit mounted on a display tube deflect the electron beams in a direction transverse to said first direction, two soft-magnetic segments located diametrically opposite to each other radially outside the line deflection coil and within the magnetic field, when generated, of the field deflection coil, said segments being positioned adjacent the second end of said deflection unit and an annular core member of soft-magnetic material surrounding at least the line deflection coil, the deflection unit, when energised, producing a magnetic field resulting from said field deflection coil in planes perpen-



- dicular to said longitudinal axis which is strongly pin-cushion shaped at said second end and comparatively weakly barrel-shaped at said first end and at the middle of said deflection unit, the level of the
- 5 pin-cushion shaping at the second end in relation to the level of barrel shaping at the first end and at the middle being such that the integral of the H_2 component (as herein referred to) along the longitudinal axis of said deflection unit is small so as to provide a
- 10 substantially coma free deflection field whilst the level of barrel shaping at said first end is such as to minimise East-West raster distortion which H_2 component is zero towards the said second end between the second end and the middle.
- 15 2. A colour television display tube as claimed in Claim 1, in which each segment is formed by a semi-cylindrical member of sheet material one member being provided at a previously determined distance from the other.
- 20 3. A colour television display tube as claimed in Claim 1, in which each segment is formed by a plurality of part-cylindrical members of sheet material which are provided at previously determined distances from each other.
- 25 4. A colour television display tube substantially as herein described with reference to Figures 1, 2, 3, 4, 8, 9, 10 and 11 of the accompanying drawings.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd.,
Berwick-upon-Tweed, 1983.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

THE PATENT OFFICE

28 JAN 1983

RECEIVED BY HAND