

## SPECIFICATION

## Deflection unit for an in-line gun colour display cathode-ray tube

The invention relates to a method of

- 5 assembling electromagnetic deflection units for deflecting the beams in colour display cathode-ray tubes of the in-line type and having display screens of at least two different sizes.

- For some time now colour display tubes have  
10 been used in which three electron guns lie in a single plane on which the longitudinal axis of the display tube also lies; this type of display tube usually being referred to as "in-line". For reducing convergence errors of the electron beams use is generally made of a deflection unit having a field deflection coil which generates a magnetic field of the pin-cushion shaped type, and having a line deflection coil which generates a magnetic field of the barrel-shaped type. In particular such a  
15 deflection unit may use the combination of a saddle-shaped line deflection coil with a field deflection coil wound toroidally on the yoke ring.

- However, the use of such a deflection unit with a given geometry to produce a self converging  
25 display with a display tube of the in-line gun type only results in complete elimination of convergence errors with one given screen size. So either the main geometry has to be varied to make a given deflection unit to be self-convergent with a  
30 different screen size, or extra correction means have to be provided. From the point of view of manufacture, however, it is extraordinarily attractive to be able to provide a deflection unit which is self-convergent with different screen  
35 sizes without it being necessary for the main geometry of line and field deflection coils to be varied and without it being necessary to provide extra correction means.

- The invention provides a method of assembling  
40 electromagnetic deflection units for deflecting the electron beams in colour display cathode-ray tubes of at least two different display screen sizes but having other features similar, said display tubes being of the type in which the electron  
45 beams lie substantially in a single plane on which plane the longitudinal axis of said display tube also lies, the central one of said beams, when undeflected, substantially coinciding with said longitudinal axis, and having a display screen provided with stripes, said method comprising:—  
50 a) the provision of a plurality of deflection coils, one for each deflection unit, of a first type for the deflection when in operation on display tubes of the above type of the electron beams in a first  
55 direction, which deflection coils are substantially identical (as herein defined) for different display screen sizes,

- b) mounting one of a plurality of deflection coils of a second type for the deflection when in  
60 operation on display tubes of the above type of the electron beams in a second direction transverse to said first direction on each deflection coil of the first type to form pairs of deflection coils, the deflection coils being designed to provide

- 65 convergence on the axes, said second type deflection coils also being substantially identical (as herein defined) for different display screen sizes, and

- c) spacing like ends of each pair of first and  
70 second type deflection coils, which ends with a deflection unit mounted on a display tube are closest to the display screen, by a given distance which is a predetermined function of the display screen size to provide self convergence also at the  
75 corners of the display screen whereby the said given distance is determined by the screen size of the display tube on which the deflection unit is intended to be mounted and is made larger for larger sizes of display screen, the method  
80 providing a plurality of electromagnetic deflection units each respectively for one of a number of display tubes having mutually different screen sizes which units in combination with display tubes of the appropriate screen sizes provide  
85 displays which are self-converging not only on the axes but also at the corners of the display screen.

- Both the first and the second type deflection coils may be saddle-shaped and each second type deflection coil may also be surrounded by a yoke  
90 ring. The use of deflection coils with a flat rear end (so-called shell winding) can facilitate the movement of such coils with respect to each other.

- Alternatively, each second type deflection coil  
95 may be provided toroidally around the yoke ring which makes the movement of this deflection coil (together with the yoke ring) particularly simple so that such a (hybrid) construction can very easily be made suitable for several display screen sizes for a  
100 given series or family of display tubes.

- If  $\Delta S$  represents the increase in the given distance then  $\Delta S$  may equal  $\alpha \Delta Z_2$ , where  $\Delta Z_2$  is the increase or change in distance between the said  
105 end of the first deflection coil and the display screen, and  $\alpha$  lies between 0.05 and 0.3. In the example to be described in relation to the accompanying drawings the value of  $\alpha$  is approximately 0.1. Dependent on the design of the deflection unit,  $\alpha$  may vary between the limits  
110 given, so that the distance  $\Delta S$  over which the second deflection coil has to be moved with respect to the first may be smaller or larger dependent on the design of the display tube.

- For a given design of deflection unit, by varying  
115 the given distance between the first and second deflection coils it is possible to reduce the anisotropic astigmatism in the corners, and hence self convergence at the corners, when the axes are self-converging to substantially zero for any  
120 display screen size of a distinct series or family of display tubes (for example, a 90° series with 14, 16 and 18 and 20 inch display screens). In order to maintain full convergence on the axes it may sometimes be necessary to slightly vary the  
125 distribution of the conductors which form the coil windings (within a few degrees). The main geometry however, remains unvaried and thus the deflection coils are defined as being substantially identical. Thus deflection units assembled

according to the invention have the distinct advantage that for a series of display tubes having different display screen sizes the deflection units can be produced by using substantially identical first type deflection coils and substantially identical second type deflection coils for the various sizes, and only the distance between the deflection coils need to be changed.

The invention will now be described in greater detail, by way of example, with reference to the accompanying drawings. In the drawings:

Figure 1 shows diagrammatically a cathode-ray tube having a deflection unit mounted thereon;

Figure 2 shows diagrammatically a deflection unit assembled according to the invention suitable for use with a display tube of a first screen size,

Figure 3 shows diagrammatically the deflection unit of Figure 2, modified so as to be suitable for use with a display tube having a second, larger display screen size,

Figure 4 is a graph showing the magnetic fields generated in the axial direction by the deflection unit shown in Figure 2 and,

Figure 5 is a graph showing the magnetic fields generated in the axial direction by the deflection unit shown in Figure 3.

Figure 1 is a sectional view of a colour display tube of the in-line gun type having a display screen 2, a tube neck 3 and three electron guns 4 situated in one plane which passes through the longitudinal axis of the tube. A deflection unit 5 arranged on the display tube comprises a symmetrical magnetic yoke ring 6, a pair of saddle coils 7 for the line deflection (the line deflection coil) and a pair of coils 8 for the field deflection provided toroidally around the yoke ring 6 (the so-called field deflection coil).

It has been found that for a given geometry of line and field deflection coils, moving the position of the field deflection coil relative to the line deflection coil is very effective for correcting for third order anisotropic astigmatism in the corners of the screen. By providing such a movement of the field deflection coil an improvement in the prevention of the above astigmatism is obtained which is ten times greater than, for example, the improvement obtained by the same movement of the whole deflection unit (for which the axes are always converged).

Up till now it has been generally thought, that in the construction of a deflection unit for in-line gun display tubes there could be no deviation from the requirement accepted in the construction of a deflection unit for delta-gun display tubes, namely that the line and field deflection "points" should coincide and should continue to coincide upon deflection. The invention recognizes the fact that in a deflection unit destined for use in combination with those display tubes of the in-line gun type which have an (uninterrupted) line structure of the phosphors (phosphor stripes) on the screen, the location of line- and field deflection "points" can be optimised for convergence and raster quality. In practice, deflection does not suddenly take place at a single "point" or "points" but a gradual

bending of the beams takes place over a given region. However for convenience it will be assumed that such deflection takes place from a point.

In the last few years, the development of colour display systems can be characterized by the following two main features:

1) the delta arrangement of electron guns in the display tube has been replaced by an in-line arrangement, whilst the associated deflection unit has been developed from being non-self-converging with a delta-gun display tube to being self-converging with an in-line gun display tube,

2) the hexagonal mask structure of the display tube has been changed into a line structure.

Where the display system has to satisfy requirements as regards the convergence, raster shape and colour purity requirements can be derived which each of the components of the display system have to satisfy (for instance the specific wire distribution in the deflection coils for a self-converging system).

For colour purity, for a deflection unit which satisfies the requirements as to convergence, raster shape and unit position, it has been one of the objects of display tube designers to develop such an analogy of the electron optical properties of the deflection unit that during the manufacture of the display screen the exposure optics ensure that the (visual) exposure "point" and the deflection "point" coincide.

Because for a delta-gun display tube and an associated deflection unit which is non-self-converging the trio-distortion (and the variation in deflection point), upon deflection, results in conflicting requirements to be imposed upon the manufacturing exposure optics, a generally accepted requirement imposed from purity on the properties of the deflection unit is that in a delta-gun tube system the line and field deflection points will coincide and will go on coinciding upon deflection.

In in-line self-converging colour television display systems the variation in deflection point of line and field is already so different in character that it was deemed necessary at the time to abandon the hexagonal mask structure which was substantially ideal as regards purity properties (particularly the guard band) and to proceed to a line structure. This line structure has uninterrupted phosphor lines or stripes (which, with "visibility" requirements imposed upon the mask structure remaining the same, have half the width of the original round phosphor dot).

These uninterrupted phosphor lines or stripes produce the favourable result that in the direction in which they extend no beam mislanding can, in principle, occur. As a result of this a difference in position of the deflection point for the field deflection coil with respect to that for the line deflection coil can be permitted. In such a case it is in principle no longer important for purity whether line and field deflection points will also coincide at small angles of deflection.

In other words the generally accepted

requirements in a delta-gun display tube system that the deflection unit provides line and field deflection points which must coincide and continue to coincide upon deflection has been found to be inessential in an in-line gun display tube system when replacing the hexagonal mask structure in the display tube by a line mask structure and not as a result of the in-line arrangement of the electron guns.

Within the scope of the invention this is used in the assembly of the deflection unit 5 in a display tube having a screen 2' of a screen size different from that of the display screen 2.

How this works will be described in detail with reference to Figures 2 and 3.

Figure 2 is a side elevation of the deflection unit 5 shown in Figure 1 and where the deflection unit 5 has the deflection coils mounted on a support of which the front part 9, the central part 10 and the rear part 11 are visible in the figure. The yoke ring 6 consists of two parts which are held together by clamping springs, one of which denoted by reference numeral 12 is visible in the figure. The field deflection coil 8 is wound toroidally around the yoke ring 6. Only the front end or edge 13 of the line deflection coil 7 is visible in the figure. In order that the deflection unit 5 provides a self-converging display on the screen 2 of a display tube 1 having a given screen size (for example a 90° tube with an 18" screen) the field deflection coil 8 has a given position with respect to the line deflection coil 7 in which position it is fixed by means of spacers 14 and 15. The distance between the front end 13 of the line deflection coil 7 and the front end of the field deflection coil 8 is denoted by S.

Figure 3 in which the same reference numerals are used for the same components as in Figures 1 and 2, shows that the distance S has been changed into the distance S' by removing the spacers 14 and 15, moving the field deflection coil 8 and fixing it in the new position by means of a spacer 16. The deflection unit 5 now provides a self-converging display on the screen 2' of a display tube having a second (larger) screen size (for example a 90° tube with a 20" screen), other features of the display tube being similar to that of the 18" screen display tube. For this purpose the field deflection coil 8 in the present case has been moved rearwards on the support by approximately 5 mm while the screen size has been increased by 2", which is shown in Figure 1 by the distance  $\Delta Z_s$  by which the distance from the front end 13 of the line deflection coil 7 to the display screen (2') has been increased.

In a deflection unit of the configuration shown in Figure 2, the line and field deflection magnetic fields have a distribution in the axial direction Z such that there is a place  $P_L$  (the Gauss line deflection point) having a peak value for the line deflection magnetic field  $H_L$  which lies at a given small distance D from the place  $P_B$  (the Gauss frame deflection point) having a peak value for the field deflection magnetic field  $H_B$ , as is shown in Figure 4.

When the deflection unit has the configuration as shown in Figure 3, it is found and shown in Figure 5 that the distance D' between the line deflection point and the field deflection point is greater than the corresponding distance shown in Figure 4.

When  $D' - D = \Delta D$ , the relationship holds that  $\Delta D = \beta \Delta Z_s$ , where  $\Delta Z_s$  is the change in the distance between the front end of the line deflection coil and the display screen, and  $\beta$  is a factor which depends on the specific design of the deflection unit, and  $\beta$  lies between 0.03 and 0.2.

The distance  $\Delta S$  over which the field deflection coil (together with the yoke ring) is moved, is slightly larger than the change  $\Delta D$  of the deflection point distance because when the field deflection coil is moved together with the yoke ring, the line field will also move slightly.  $\Delta S$  then has the following relationship:—

$$\Delta S = \alpha \Delta Z_s$$

where  $\alpha$  lies between 0.05 and 0.3.

In the above description the change in distance between the front ends of the line and field deflection coils is achieved by the use of different spacers. However the required change in spacing may also be achieved by providing the support on which the deflection coils are mounted with members which define the required distance, different supports being used for deflection units intended for display tubes of different display screen sizes. In such a case the supports can be readily moulded from an insulating material, the members being integral with the support.

#### CLAIMS

1. A method of assembling electromagnetic deflection units for deflecting the electron beams in colour display cathode-ray tubes of at least two different display screen sizes but having other features similar, said display tubes being of the type in which the electron beams lie substantially in a single plane on which plane the longitudinal axis of said display tube also lies, the central one of said beams, when undeflected, substantially coinciding with said longitudinal axis, and having a display screen provided with phosphor stripes, said method comprising:—

a) the provision of a plurality of deflection coils, one for each deflection unit, of a first type for the deflection when in operation on display tubes of the above type of the electron beams in a first direction, which deflection coils are substantially identical (as herein defined) for different display screen sizes,

b) mounting one of a plurality of deflection coils of a second type for the deflection when in operation on display tubes of the above type of the electron beams in a second direction transverse to said first direction on each deflection coil of the first type to form pairs of deflection coils, the deflection coils being designed to provide convergence on the axes, said second type deflection coils also being substantially identical



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Within the scope of the invention this is used in the assembly of the deflection unit 5 in a display tube having a screen 2' of a screen size different from that of the display screen 2.

How this works will be described in detail with reference to Figures 2 and 3.

Figure 2 is a side elevation of the deflection unit 5 shown in Figure 1 and where the deflection unit 5 has the deflection coils mounted on a support of which the front part 9, the central part 10 and the rear part 11 are visible in the figure. The yoke ring 6 consists of two parts which are held together by clamping springs, one of which denoted by reference numeral 12 is visible in the figure. The field deflection coil 8 is wound toroidally around the yoke ring 6. Only the front end or edge 13 of the line deflection coil 7 is visible in the figure. In order that the deflection unit 5 provides a self-converging display on the screen 2 of a display tube 1 having a given screen size (for example a 90° tube with an 18" screen) the field deflection coil 8 has a given position with respect to the line deflection coil 7 in which position it is fixed by means of spacers 14 and 15. The distance between the front end 13 of the line deflection coil 7 and the front end of the field deflection coil 8 is denoted by S.

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In a deflection unit of the configuration shown in Figure 2, the line and field deflection magnetic fields have a distribution in the axial direction Z such that there is a place  $P_L$  (the Gauss line deflection point) having a peak value for the line deflection magnetic field  $H_L$  which lies at a given small distance D from the place  $P_B$  (the Gauss frame deflection point) having a peak value for the field deflection magnetic field  $H_B$ , as is shown in Figure 4.

When the deflection unit has the configuration as shown in Figure 3, it is found and shown in Figure 5 that the distance D' between the line deflection point and the field deflection point is greater than the corresponding distance shown in Figure 4.

When  $D' - D = \Delta D$ , the relationship holds that  $\Delta D = \beta \Delta Z_s$ , where  $\Delta Z_s$  is the change in the distance between the front end of the line deflection coil and the display screen, and  $\beta$  is a factor which depends on the specific design of the deflection unit, and  $\beta$  lies between 0.03 and 0.2.

The distance  $\Delta S$  over which the field deflection coil (together with the yoke ring) is moved, is slightly larger than the change  $\Delta D$  of the deflection point distance because when the field deflection coil is moved together with the yoke ring, the line field will also move slightly.  $\Delta S$  then has the following relationship:—

$$\Delta S = \alpha \Delta Z_s$$

where  $\alpha$  lies between 0.05 and 0.3.

In the above description the change in distance between the front ends of the line and field deflection coils is achieved by the use of different spacers. However the required change in spacing may also be achieved by providing the support on which the deflection coils are mounted with members which define the required distance, different supports being used for deflection units intended for display tubes of different display screen sizes. In such a case the supports can be readily moulded from an insulating material, the members being integral with the support.

#### CLAIMS

1. A method of assembling electromagnetic deflection units for deflecting the electron beams in colour display cathode-ray tubes of at least two different display screen sizes but having other features similar, said display tubes being of the type in which the electron beams lie substantially in a single plane on which plane the longitudinal axis of said display tube also lies, the central one of said beams, when undeflected, substantially coinciding with said longitudinal axis, and having a display screen provided with phosphor stripes, said method comprising:—

a) the provision of a plurality of deflection coils, one for each deflection unit, of a first type for the deflection when in operation on display tubes of the above type of the electron beams in a first direction, which deflection coils are substantially identical (as herein defined) for different display screen sizes,

b) mounting one of a plurality of deflection coils of a second type for the deflection when in operation on display tubes of the above type of the electron beams in a second direction transverse to said first direction on each deflection coil of the first type to form pairs of deflection coils, the deflection coils being designed to provide convergence on the axes, said second type deflection coils also being substantially identical



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(as herein defined) for different display screen sizes, and

c) spacing like ends of each pair of first and second type deflection coils, which ends with a deflection unit mounted on a display tube are closest to the display screen, by a given distance which is a predetermined function of the display screen size to provide self convergence also at the corners of the display screen whereby the said given distance is determined by the screen size of the display tube on which the deflection unit is intended to be mounted and is made larger for larger sizes of display screen, the method providing a plurality of electromagnetic deflection units each respectively for one of a number of display tubes having mutually different screen sizes which units in combination with display tubes of the appropriate screen sizes provide displays which are self-converging not only on the axes but also at the corners of the display screen.

2. A method as claimed in Claim 1, in which when  $\Delta S$  is an increase in the said given distance,

$$\Delta S = \alpha \Delta Z_s,$$

where  $\Delta Z_s$  is the increase in distance between the said end of said first deflection coil and said display screen for an increase in size of the display screen, and  $\alpha$  lies between 0.05 and 0.3.

3. A method as claimed in Claim 1 or 2, in which the given distance between the said ends of said first and second type deflection coils is obtained by providing spacers between corresponding ends of said deflection coils.

4. A method as claimed in Claim 1 or 2, in which the given distance between the said ends of said first and second type deflection coils is provided by members integrally moulded on a support on which said deflection coils are mounted, different supports being employed for deflection units intended for different sizes of display screen.

5. A method of assembling a plurality of electromagnetic deflection units for respectively deflecting the electron beams in one of a number of colour display cathode-ray tubes of mutually different display screen sizes, substantially as herein described with reference to the accompanying drawings.