

## SPECIFICATION

**A colour display tube and a method of manufacturing the same**

- 5 The invention relates to a method of manufacturing a colour display tube and to a colour display tube manufactured according to said method.
- 10 In a colour display tube of the "delta" type, three electron guns are accommodated in the neck of the tube in a triangular arrangement. The points of intersection of the axes of the guns with a plane perpendicular to the tube
- 15 axis constitute the corner points of an equilateral triangle.
- In a colour display tube of the "in-line" type three electron guns are arranged in the tube neck in such manner that the axes of the
- 20 three guns are situated mainly in one plane while the axis of the central electron gun coincides substantially with the axis of the display tube. The two outermost electron guns are situated symmetrically with respect to the
- 25 central gun.
- As long as the electron beams generated by the electron guns are not deflected, the three electron beams, both in tubes of the "delta" type and of the "in-line" type, must coincide
- 30 in the centre of the display screen (static convergence). However, because of defects in the manufacture of the display tube, for example, the electron guns are not sealed quite symmetrically with respect to the tube axis,
- 35 deviations of the frame shape, the colour purity and the static convergence occur, it is desirable to correct for the mentioned deviations.
- A colour display tube of the "in-line" type
- 40 in which this connection is possible, is disclosed in British Patent Application No. 12472/75 (Serial No. 1507122). This earlier application describes a colour display tube in which the deviations are corrected by the
- 45 magnetisation of a ring of magnetisable material as a result of which magnetisation a static magnetic multipole is formed around the paths of the electron beams. The ring is provided in or around the tube neck. In the
- 50 method described in the said Patent Application the colour display tube is actuated and data regarding the value and the direction of the convergence errors of the electron guns are established. Using the data the polarity
- 55 and strength of the magnetic multipole necessary to correct the frame, shape colour purity and convergence errors are determined. The magnetisation of the configuration which may consist of a ring, a ribbon or a number of rods
- 60 or blocks grouped around the electron paths, may be carried out in a number of manners. It is possible, for example, first to magnetize the configuration to full saturation, after which demagnetisation to the desired value is carried
- 65 out with an opposite field. A disadvantage of

- this method is that with a combination of, for example, a 2, 4 and 6-pole field the polarity and strength of the magnetisation vary strongly and frequently, dependent on the
- 70 place on the ring, and hence also the polarity and strength of the full magnetisation used in this method. Moreover it appears that the required demagnetising field has no linear relationship with the required correction field.
- 75 Due to this non-linearity it is not possible to use a combined 2, 4 and 6-pole field for the demagnetisation. It is impossible to carry out successively the 2, 4 and 6-pole magnetisation since for each magnetisation the ring has
- 80 to be magnetised fully so that the preceding magnetisation is erased again. The possibility of successively magnetising various places on the ring is very complicated and is not readily possible if the ring is situated in the tube neck
- 85 since the stray field of the field necessary for the magnetisation again at least partly demagnetises the already magnetised parts.
- Accordingly it is desired to obtain a combined multipole by one total magnetisation.
- 90 According to the present invention there is provided a method of manufacturing a colour display tube in which magnetic poles are provided in or around the neck of the envelope and around the paths of the electron
- 95 beams, which poles generate a substantially permanent static multipole magnetic field for the correction of any errors in static convergence and optionally any errors in frame shape and colour purity of the colour display
- 100 tube, the method comprising providing an element of magnetisable material around the paths of the electron beams and magnetising the element by energizing a magnetisation device with a combination of currents with
- 105 which a static multipole magnetic field is generated, the magnetisation being produced by means of a decaying alternating magnetic field which initially drives the magnetisable material on either side of the hysteresis curve
- 110 into saturation.
- In the method in accordance with the present invention, after the decay of the alternating magnetic field, a substantially permanent magnetisation remains in the material of the
- 115 magnetised element which neutralizes the externally applied magnetic field and is hence directed oppositely thereto. After switching off the externally applied magnetic field, a magnetic multipole field remains as a result of the
- 120 element magnetized as a multipole. The desired magnetisation may be determined in a number of ways. By observing and/or measuring for example the deviations in the frame shape, colour purity and convergence, the
- 125 desired multipole can be determined experimentally and the correction may be carried out by magnetisation of the magnetisable element. If small deviations are then still found, the method is repeated once or several more
- 130 times with corrected currents. In this manner,

by repeating the method in accordance with the invention, it is possible to produce a static multipole magnetic field which can apply a complete correction of the errors in frame

- 5 shape, colour purity and convergence. Preceding the magnetisation, residual magnetisation, if any, in the element may be erased by means of a magnetic field.

- 10 The method may be carried out by determining the required correction field prior to the magnetisation and after the possible erasing of the residual magnetisation, by correcting the errors in the convergence, the colour purity and the frame shape of the displayed picture by means of a combination of currents through the magnetising device, after which the magnetisation is produced by reversing the direction of the combination of currents, increasing the current strength and simultaneously producing the said decaying alternating magnetic field.

- 20 The correction field, obtained with a magnetising device and measured along the axis of the electron beams, may be generally longer than the multipole correction field generated by the magnetised element. As a result the correction of the deviations will have to be carried out in a shorter area along the axis, which is possible only with a stronger field.
- 30 During the magnetisation, a combination of currents which in strength and direction is in the proportion of  $m:1$  to the combination of currents which is necessary to generate a correction multipole field with the magnetising device, where  $m$  is, for example  $-3$ , should flow through the magnetisation device. The value of  $m$  depends on the ratio between the length of the correction multipole field generated by means of the magnetising device to the effective field length of the magnetised element. This depends upon a number of factors, for example, the diameter of the neck, the kind of material, the shape and the place of the element, and can be established experimentally. If it proves, upon checking, that the corrections with the magnetised element are too large or too small, the magnetisation process can be repeated with varied magnetisation currents.

- 50 The decaying alternating magnetic field can be generated by superimposing a decaying alternating current on the combination of currents through the magnetisation device (for example, a device as disclosed in British Patent Application No. 12472/76). (Serial No. 1507122). The decaying alternating magnetic field may be generated in the magnetisation device by means of a separate system of coils. In order to obtain a substantially equal influence of all parts of the element by the decaying alternating field it is recommendable not only to cause the alternating field to decay but also to cause it to vary its direction continuously. The system of coils may therefore consist of at least two coils and the decaying

alternating currents through the coils may be shifted in phase with respect to each other. The mains frequency (50 or 60 Hz) has given good results. The phase shift, when using coils or coil pairs the axes of which enclose angles of  $120^\circ$  with each other, may simply be obtained from a three-phase mains.

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

Figure 1 is a diagrammatic sectional view of a known colour display tube of the "in-line" type having an external static convergence unit.

- 80 Figure 2 shows the pinion transmission used in the unit of Fig. 1.

Figure 3 is a diagrammatic longitudinal sectional view of a colour display tube with a ring which has not yet been magnetized and of which the outermost electron beams do not converge satisfactorily.

Figure 4 is a section on the line IV-IV of Fig. 3.

Figure 5 is a diagrammatic longitudinal sectional view of a colour display tube in which convergence by means of the magnetisation device has been obtained.

Figure 6 is a view from the line VI-VI of Fig. 5.

Figure 7 shows the magnetisation of a ring arranged in the system of electron guns.

Figure 8 is a view on the line VIII-VIII of Fig. 7.

Figure 9 shows a diagrammatic longitudinal sectional view of a colour display tube with a magnetised ring with which the convergence error, as shown in Fig. 4, is removed.

Figure 10 is a view on the line X-X of Fig. 9.

Figures 11 and 12 show two types of devices suitable for magnetisation in accordance with the method of the present invention, and

Figures 13 to 18 show parts of another type of magnetisation unit.

Fig. 1 is a diagrammatic sectional view of a known colour display tube of the "in-line" type. Three electron guns 5, 6 and 7 generating electron beams 8, 9 and 10, respectively, are accommodated in a neck 4 of a glass envelope 1 which is composed of a display window 2, a funnel-shaped part 3 and the neck 4. The axes of the electron guns are situated in one plane, the plane of the drawing. The axis of the central electron gun 6 coincides substantially with the tube axis 11. The three electron guns debouch into a sleeve 16 which is situated coaxially in the neck 4. On its inside the display window 2 has a large number of triplets of phosphor lines. Each triplet comprises a line consisting of a phosphor luminescing green, a line consisting of a phosphor luminescing blue, and a line consisting of a phosphor luminescing red. All triplets together constitute the display screen 12. The

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phosphor lines are normal to the plane of the drawing. A shadow mask 13 in which a very large number of elongate apertures 14 are provided through which the electron beams 8, 9 and 10 pass is arranged in front of the display screen. The electron beams are deflected in the horizontal direction (in the plane of the drawing) and in the vertical direction (at right angles thereto) by a system 15 of deflection coils. The three electron guns are assembled so that the axes thereof enclose a small angle with each other. As a result of this the generated electron beams pass through the apertures 14 at said angle, the so-called colour selection angle, and each impinge only upon phosphor lines of one colour.

A display tube has a good static convergence if the three electron beams, when they are not deflected, intersect each other substantially in the centre of the display screen. It has been found, however, that the static convergence often is not good, no more than the frame shape and the colour purity, which may be the result of an insufficiently accurate assembly of the guns and/or sealing of the electron guns in the tube neck. In order to produce the static convergence, upto now externally adjustable correction units were added to the tube. They consist of a number of pairs of multipoles consisting of magnetic rings, for example four two-poles (two horizontal and two vertical), two four-poles and two six-poles. The rings of each pair are coupled together by means of a pinion transmission (see Fig. 2) as a result of which the rings are rotatable with respect to each other to an equal extent. By rotating the rings with respect to each other and/or together, the strength and/or direction of the two-, four- or six-pole field is adjusted. It will be obvious that the control of a display tube with such a device is complicated and time-consuming. Moreover, such a correction unit is material-consuming since for a combination of multipoles at least eight rings are necessary which in addition have to be provided around the neck so as to be rotatable with respect to each other.

In British Patent Application No. 12472/76 (Serial No. 1507122 the complicated correction unit has been replaced by one or more magnetised rings, which rings are situated in or around the tube neck or in or around the electron guns.

However, it has proved difficult with the magnetising methods known so far to provide a combination of multipoles in the ring by magnetisation.

The method in accordance with the invention provides a solution.

For clarity, identical components in the following figures will be referred to by the same reference numerals as in Fig. 1.

Fig. 3 is a diagrammatic sectional view of a display tube in which the electron beams do

not converge in the horizontal direction. As is known, the outermost electron beams can be deflected more or less in the opposite direction by means of a four-pole field, so for example towards the central beam or away therefrom. It is also possible to move the beams upwards and downwards. By means of a six-pole field the beams can be deflected more or less in the same direction. For simplification the invention will be explained with reference to a display tube which requires only a four-pole field correction. The convergence errors in the horizontal direction of the electron beams 8 and 10 are in this case equally large but opposite.

Fig. 4 is a sectional view on the line IV-IV of Fig. 3. On the internal periphery of the sleeve 16, an element in the form of a ring 18 of an alloy of Fe, Co, V and Cr (known as Vicalloy) which can be readily magnetised, is provided. The ring may alternatively be provided in other places in or around the tube neck and around the paths of the electron beams. Instead of a ring it is alternatively possible to use an element in the form of a ribbon or in the form of an arrangement of rods or blocks of magnetisable material.

In Figs. 5 and 6, a device 19 for generating a controllable multipole magnetic field is provided around the neck 4 and the ring 18. 2-, 4- or 6-pole fields and combinations thereof can be generated by means of the device 19. For the tube shown in Fig. 3 only a four-pole correction field is necessary. The coils of the device 19, which device will be described in detail hereinafter, are in this case energized as four-poles until the point of intersection S of the three electron beams which in Fig. 3 was situated outside the tube lies on the display screen 12. The current I through the coils of the device originates from the direct current source B which supplies a current  $-mI_1$  ( $m$  is an experimentally determined constant  $> 1$ ) which is supplied to the coils via the current divider and commutator A. The current can be adjusted per coil so as to generate the desired multipole field. In this phase of the method the alternating current source C does not yet supply current ( $i = 0$ ).

The current  $I_1$  is a measure of the strength of the required correction field. The correction field of the multipole of the device 19 extends over a larger length of the electron paths than the magnetic field generated later by the magnetised ring. Therefore the field of the ring is to be  $m$ -times stronger to produce the same correction.

Fig. 7 shows the step of the method in which the ring 18 is magnetised to provide a four-pole field. As follows from the above, in this embodiment of the method the current through the coils of the device must be  $-mI_1$  during the magnetisation, so must traverse in the reverse direction and be  $m$  times as large.

Moreover, the alternating current source C

supplies a decaying alternating current ( $i = i_1 > 0$ ) to the device with which the decaying alternating field is generated. When the alternating current is switched on, it must be so large that the ring is fully magnetized on either side of the hysteresis curve. When the alternating field has decayed, the ring 18 is magnetised, in this case as a four-pole field (Fig. 8). It is, of course, alternatively possible to magnetise the ring as a six-pole field or as a two-pole field or to provide combinations of the multipoles in the ring and to correct therewith other convergence errors, colour purity and frame shape errors. It is also possible to use said corrections in colour display tubes of the "delta" type.

Fig. 9 shows the display tube shown in Figure 3 but in this case provided with a ring 18 magnetised according to the method described with reference to Figs. 5 and 7. The convergence correction takes place only by the magnetised ring 18 present in sleeve 16. The provision of the required multipole field takes place in the display tube factory and complicated adjustments and adjustable convergence units (Fig. 2) may be omitted.

Fig. 10 is a cross-sectional view on the line X-X of Fig. 9.

Fig. 11 shows a magnetisation device 19 comprising eight coils 20 with which the convergence (see Fig. 5) and the magnetisation (see Fig. 7) are carried out. For generating the decaying alternating magnetic field, two pairs of coils 21 and 22 extending in this case at right angles to each other are incorporated in the device. The current  $i_1$  through one pair 21 is shifted in phase through  $90^\circ$  with respect to the current  $i_2$  through the other pair 22, so that the decaying alternating magnetic field changes its direction during the decay and is a field circulating through the ring 18. Fig. 12 shows a magnetisation device disclosed in British Patent Application No. 12472/76. (Serial No. 1507122). In this case, the decaying alternating current may be superimposed on the direct current through the coils 23 so that extra coils are not necessary in the device. The coils 23 are wound around a yoke 24.

The magnetisation unit may alternatively be composed of a combination of electrical conductors and coils as is shown diagrammatically in Figs. 13 to 18.

Fig. 13 is a sectional view of the neck of a display tube at the area of a ring 18 to be magnetised. A two-pole field for corrections in the horizontal direction is generated in this case by causing currents to flow through the conductors 25, 26, 27 and 28 in the direction as shown in the figure. The conductors may be single wires or wire bundles forming part of one or more coils or turns and extending parallel to the tube axis at the area of the ring 18.

Fig. 14 shows how in an analogous manner

a four-pole field for corrections of the outermost beams 8 and 10 in the horizontal direction can be generated by electrical conductors 29, 30, 31 and 32. A four-pole field for correction of the outermost beams 8 and 10 in the vertical direction is substantially the same. However, the system of conductors is rotated through  $45^\circ$  with respect to the neck and the axis of the tube.

Fig. 15 shows in an analogous manner a six-pole field for correction in the horizontal direction with conductors 33 to 38. By means of a combination of conductors (wires or wire bundles) with which 2-, 4- and 6-pole fields can be generated all combinations of two-, four- and six-pole fields with the desired strength can be obtained by variations of the currents through said conductors.

The decaying alternating magnetic field in a magnetisation unit with conductors as shown in Figs. 13, 14 and 15 can be obtained by means of coils positioned coaxially around the neck and the conductors extending as shown in Fig. 16, 17 or 18. By energizing the coils 39 and 40 with a decaying alternating current, a decaying alternating magnetic field is generated. A better influencing of the ring 18 by the decaying alternating field is obtained when a system of coils having coils 41 and 42 is provided, which system is rotated  $90^\circ$  with respect to the coils 39 and 40 and the decaying alternating current through the coils 41 and 42 should then preferably be shifted  $90^\circ$  in phase with respect to the decaying alternating current through the coils 39 and 40.

It is alternatively possible to generate the decaying alternating magnetic field with one or more systems of coils as shown in Fig. 18. The coils 43, 44 and 45 are situated symmetrically around the tube axis and are energized with decaying alternating currents which are shifted  $120^\circ$  in phase with respect to each other (for example from a three-phase mains).

## CLAIMS

1. A method of manufacturing a colour display tube in which magnetic poles are provided in or around the neck of the envelope and around the paths of the electron beams, which poles generate a substantially permanent static multipole magnetic field for the correction of any errors in static convergence and optionally any errors in frame shape and colour purity of the colour display tube, the method comprising providing an element of magnetisable material around the paths of the electron beams, and magnetising the element by energising a magnetisation device with a combination of currents with which a static multipole magnetic field is generated, the magnetisation being produced by means of a decaying alternating magnetic field which initially drives the magnetisable material on either side of the hysteresis curve



supplies a decaying alternating current ( $i = i_1 > 0$ ) to the device with which the decaying alternating field is generated. When the alternating current is switched on, it must be so large that the ring is fully magnetized on either side of the hysteresis curve. When the alternating field has decayed, the ring 18 is magnetised, in this case as a four-pole field (Fig. 8). It is, of course, alternatively possible to magnetise the ring as a six-pole field or as a two-pole field or to provide combinations of the multipoles in the ring and to correct therewith other convergence errors, colour purity and frame shape errors. It is also possible to use said corrections in colour display tubes of the "delta" type.

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It is alternatively possible to generate the decaying alternating magnetic field with one or more systems of coils as shown in Fig. 18. The coils 43, 44 and 45 are situated symmetrically around the tube axis and are energized with decaying alternating currents which are shifted  $120^\circ$  in phase with respect to each other (for example from a three-phase mains).

## CLAIMS

1. A method of manufacturing a colour display tube in which magnetic poles are provided in or around the neck of the envelope and around the paths of the electron beams, which poles generate a substantially permanent static multipole magnetic field for the correction of any errors in static convergence and optionally any errors in frame shape and colour purity of the colour display tube, the method comprising providing an element of magnetisable material around the paths of the electron beams, and magnetising the element by energising a magnetisation device with a combination of currents with which a static multipole magnetic field is generated, the magnetisation being produced by means of a decaying alternating magnetic field which initially drives the magnetisable material on either side of the hysteresis curve



into saturation.

2. A method as claimed in Claim 1, wherein prior to the magnetisation, any residual magnetisation in the element is erased with an alternating magnetic field.

3. A method as claimed in Claim 1 or 2, wherein prior to the magnetisation the required correction field is determined by correcting at least the errors in the convergence

of the display picture with a combination of currents through the magnetisation device, after which the magnetisation is produced by reversing the direction of the combination of currents, increasing the current strength, and simultaneously generating the said decaying alternating magnetic field.

4. A method as claimed in Claim 1, 2 or 3, wherein the decaying alternating magnetic field is generated by means of a separate system of coils in the magnetisation device.

5. A method as claimed in Claim 4, wherein the decaying alternating magnetic field varies its direction continuously.

6. A method as claimed in Claim 5, wherein the system of coils is composed of at least two coils and the decaying alternating currents through the coils are shifted in phase with respect to each other.

7. A method as claimed in any of the preceding Claims, wherein the frequency of the decaying alternating current is substantially the mains frequency.

8. A method of manufacturing a colour display tube, substantially as hereinbefore described with reference to Figs. 3 to 18 of the accompanying drawings.

9. A colour display tube manufactured by means of the method as claimed in any one of the preceding Claims.

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