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GB 822911
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GB 722282
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(54) **Colour display C.R.T.**

(57) A colour display apparatus (eg a small television receiver), includes a colour display tube in which a modulated electron beam (10) enters a repelling trajectory control field (E) formed between a mesh electrode (24) or etched sheet and a planar electrode (18) at an acute angle α and follows a parabolic trajectory to approach a striped target at substantially the same constant angle (α) irrespective of the range(s) of the trajectory. The mesh electrode (24) comprises parallel conductors extending parallel to the phosphor stripes and are spaced at a pitch corresponding to that of the phosphor stripes. Target electrode (16) is held at a potential such that the electron beam (10) passing through the space between a pair of the conductors is focused and deflected onto a phosphor line of the target. A coloured picture can be produced using a single electron beam by spot wobbling or line sequential scanning. In a triple beam in line electron gun (Figure 3 not shown), each beam has its own different trajectory, the trajectories coinciding in the apertures of the mesh, each being focussed and deflected by the mesh-target p.d. Further arrangements are described w.r.t. Figures 4-7 (not shown) including electron mirror (68) and screening electrode (66) (Figure 6). Field scanning may be electrostatic or magnetic and is described w.r.t. Figures 2,5 (not shown). Thin film screen printing or settling processes may be used, any misalignements between mesh and phosphors being connected electrically. Dimensions are exemplified.

The phosphor stripes can be printed or otherwise applied to a substantially flat area of a faceplate without the mesh being present because any misalignment between the target and the mesh can be corrected electrically.

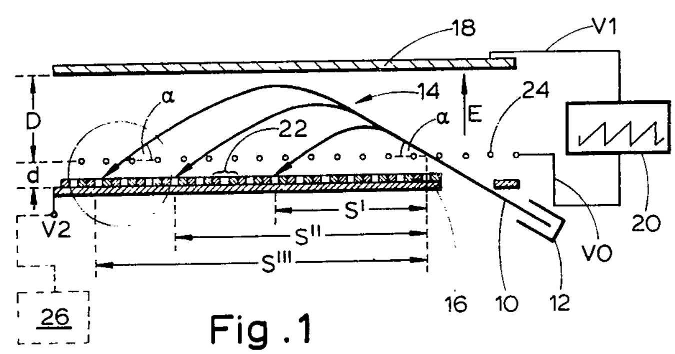

Fig .1

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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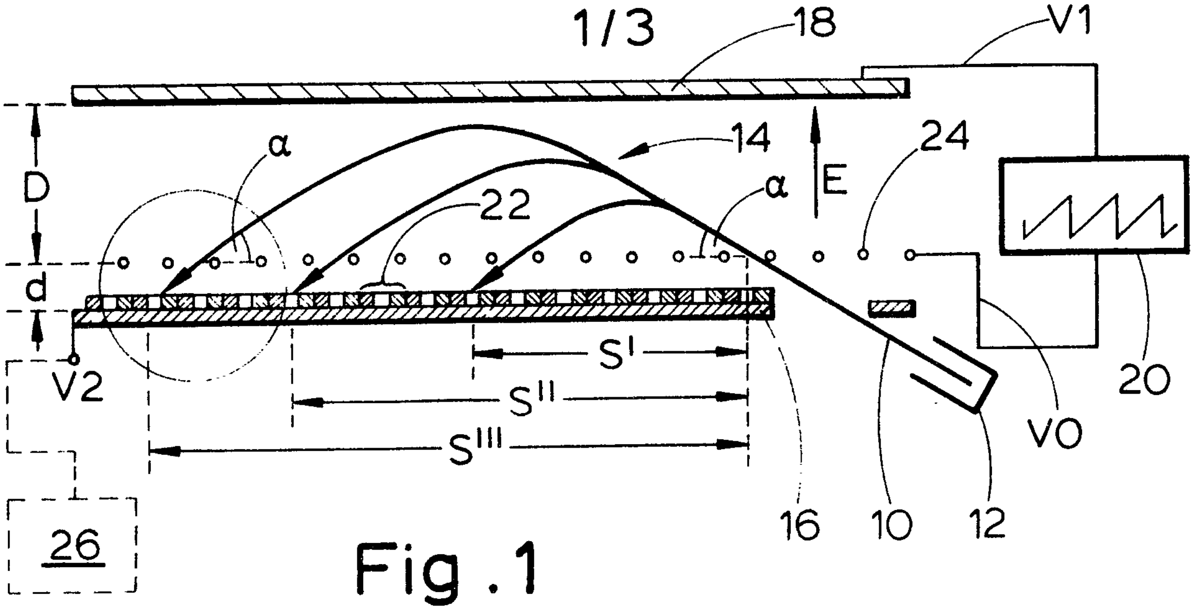

Fig.1

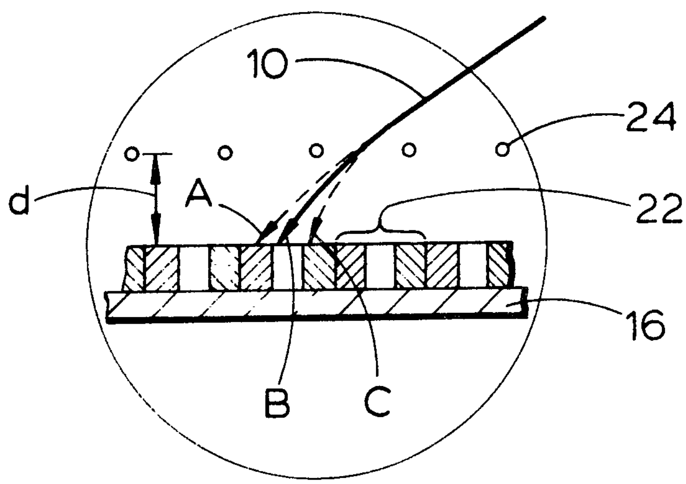

Fig.1A

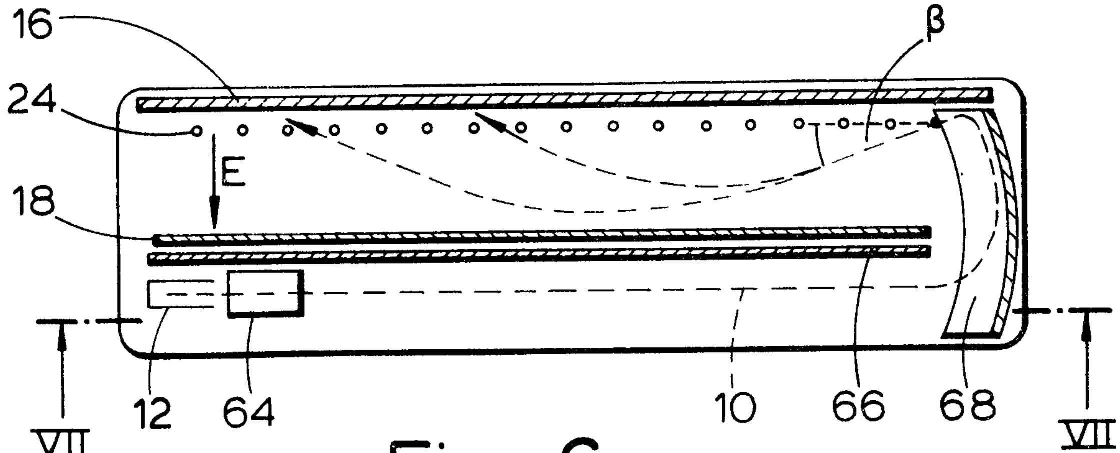

Fig.6

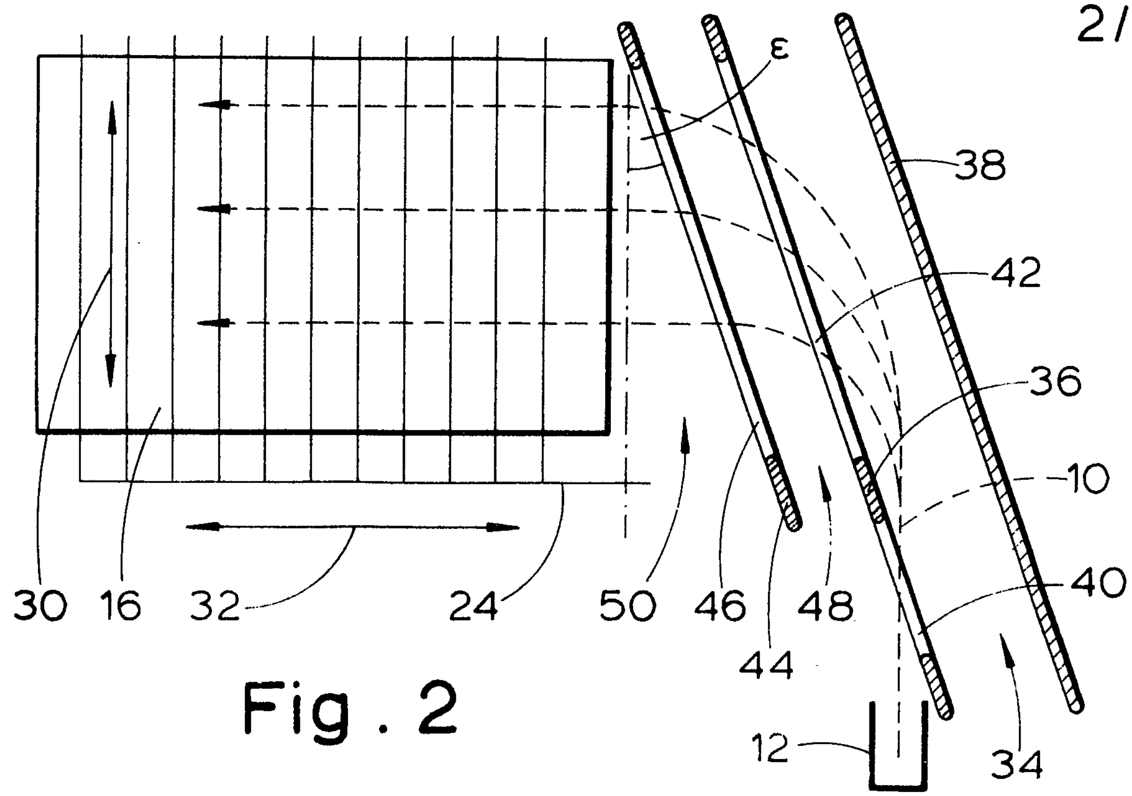

Fig . 2

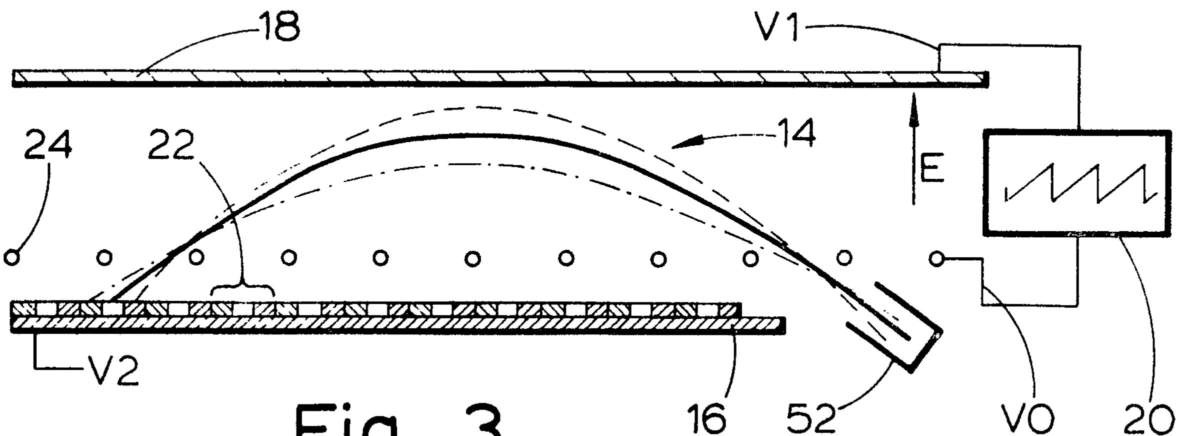

Fig . 3

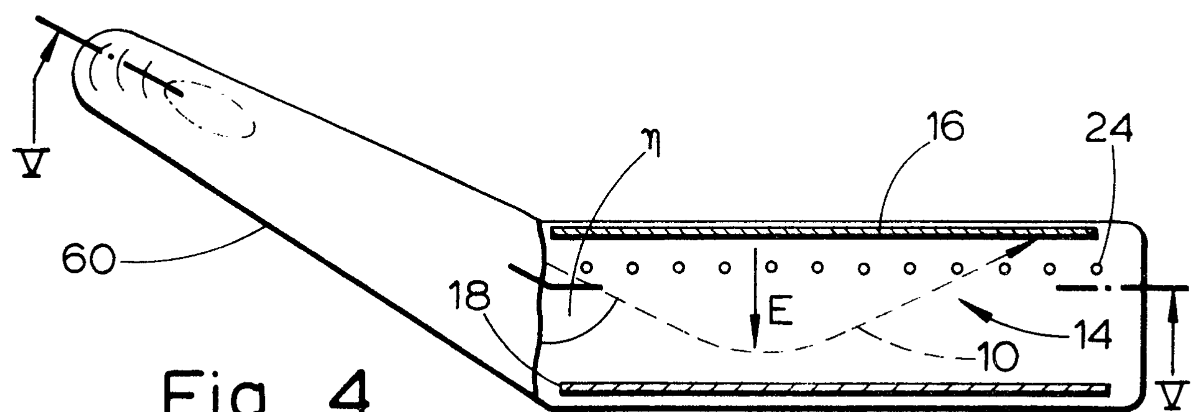

Fig . 4

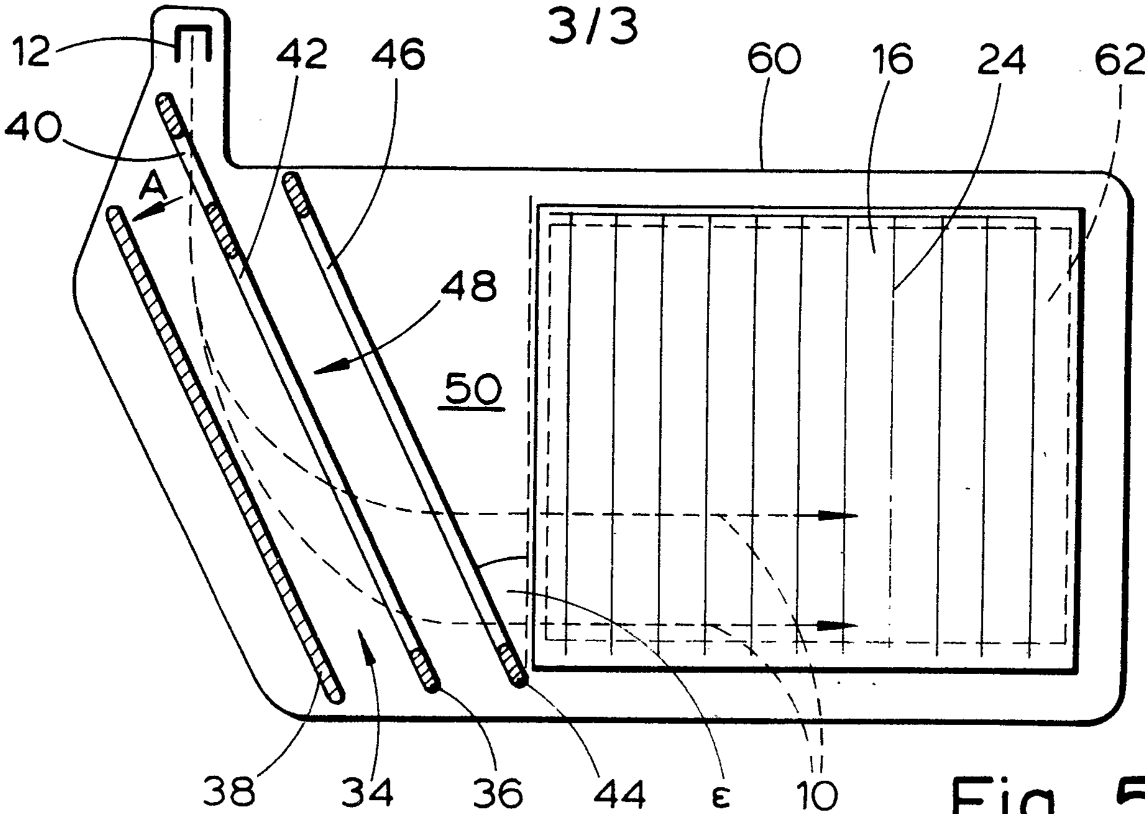

Fig. 5

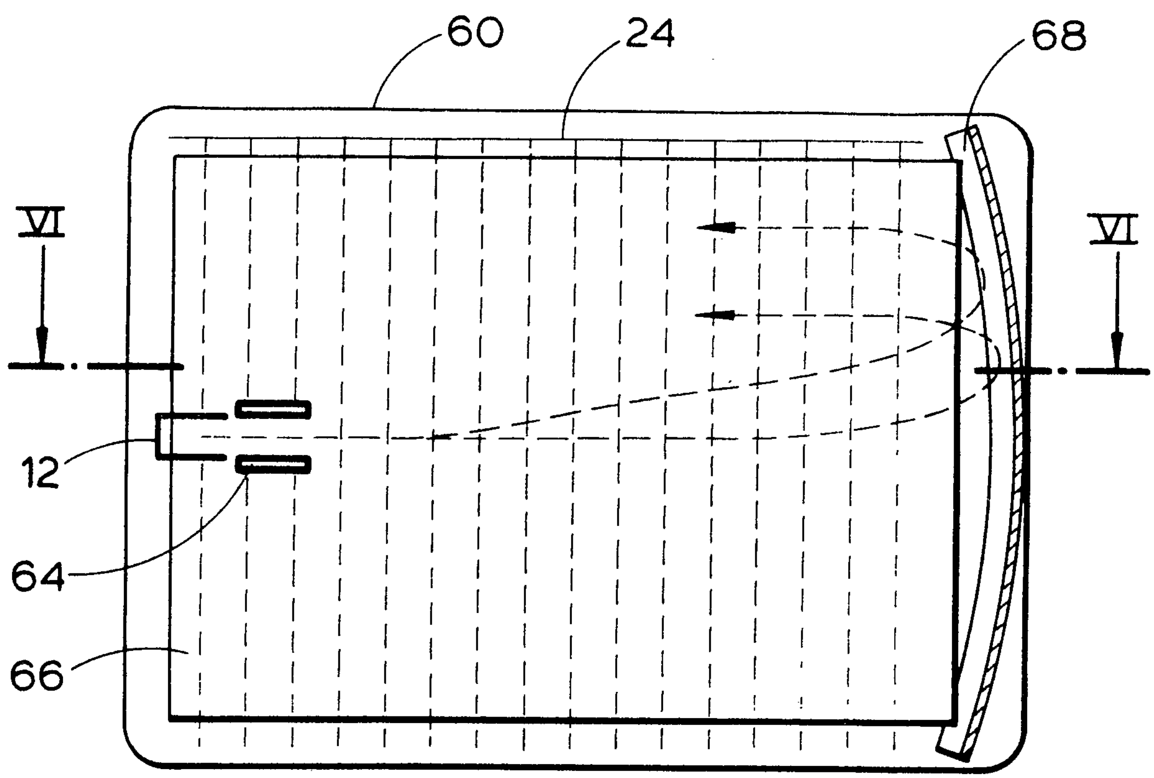

Fig. 7

SPECIFICATION

Colour display apparatus and tube therefor

The present invention relates to a colour display tube and to an apparatus including the colour display tube. More particularly the present invention relates to a compact colour display tube of small dimensions with a screen typically of 12.3 cm (5 inches) diagonal.

Various proposals have been made for a compact monochrome display tube. One proposal disclosed in published French patent specification 2,391,556 relates to a cathode ray tube having its electron gun mounted so that its axis is substantially parallel to the plane of the screen of the cathode ray tube. The envelope of this tube is substantially rectangular with a dished rear section and a flat, optically transparent front section. A fluorescent screen is provided in the dished portion and is viewed from the front section, that is the same side as is impinged upon by the electron beam. The electron beam is scanned vertically and horizontally by plates provided in the electron gun prior to the beam entering a trajectory area between the screen and the face-plate, both of which have electrodes which are maintained at different voltages, the net effect of which is to deflect the beam onto the screen. A problem with this display tube is that it is difficult to keep the shape of the spot constant because amongst other things the beam impinges on the screen at different angles. The changing shape of the beam as it impinges on the screen makes it unsuitable for use in a colour display tube in which the spot size should be substantially constant.

Another prior proposal for a compact monochrome display tube is disclosed in British Patent Specification 865,667.

In this prior specification embodiments are disclosed in which an electron beam is produced by an electron gun whose axis is inclined or is parallel to the plane containing a fluorescent screen. At a predetermined point in the trajectory of the electron beam it enters a field produced by two electrodes at different potentials; one of the electrodes being associated with the screen. The beam which enters the field at a constant angle β follows a parabolic path to impinge upon the screen at a certain angle α which is the same irrespective of the various trajectories. The range is altered, conveniently at field frequencies, by applying a signal at field time base frequency to that one of the field producing electrodes opposite the screen. By means of deflection electrodes the electron beam can be scanned at line frequencies thus a raster scan can be achieved.

By making a spot land on a screen at the same angle for all parabolic trajectories then the spot will always have substantially the same shape and hence could be used in the production of a colour display.

This fact has been used in the flat cathode ray tube for displaying colour television, disclosed in British Patent Specification No. 1,223,723. In that prior specification an orthogonally focussed, signel electron beam passes through a frame scanning means and is deflected through 225°C in order that it can enter a trajectory control space at an angle of 45°. The trajectory control space is defined by a planar reflecting or repelling electrode and a woven mesh screen grid between which electrode and grid a sawtooth voltage having a line scanning frequency is applied. The beam is then decelerated by a colour switching electrode of the Venetian blind type, the potential of which colour switching electrode is modulated at a high frequency, produced for example by mixing the colour subcarrier and its first harmonic, so that the electron beam is deflected onto a particular phosphor of a band of at least two parallel phosphor lines as it line scans across a screen on the side of the Venetian blind electrode remote from the screen grid. The provision of a screen grid and a Venetian blind type electrode having a large number of louvres makes the construction of the tube complicated, costly and unsuitable for use with compact display tubes having screens of the order of 12.5 cm. diagonal. A venetian blind type of electrode for such a small size of display tube would be fragile and difficult to make because not only would the spacing between adjacent louvres have to be substantially less than 1 mm. to avoid losing resolution but also each louvre has to be set at exactly the same angle.

Accordingly it is an object of the present invention to provide a compact colour display apparatus which uses at least one electron beam and does not require a decelerating electrode.

According to the present invention there is provided a colour display tube having an envelope in which there are provided means for producing an electron beam, a target including a target electrode and parallel bands of phosphors, the phosphors of each band luminescing in different colours when impinged upon by the electron beam, a mesh electrode mounted adjacent to but spaced from the target, a planar electrode extending substantially parallel to the mesh electrode and defining therewith a trajectory control space, and means for introducing the electrode beam along an inclined path into the trajectory control space, the mesh and planar electrodes in use being at different voltages so that the electron beam follows a parabolic trajectory and approaches the target at a substantially constant angle, wherein the mesh electrode comprises a plurality of substantialy parallel conductors which are spaced apart by a distance corresponding to the width of a band of phosphor lines and being arranged parallel thereto, the target electrode in use being at such a potential relative to the mesh electrode that the electron beam is deflected and focused on to a phosphor line.

In an embodiment of the display tube in accordance with the present invention means are provided for deflecting the electron beam in a direction parallel to the phosphor lines. Thus a raster scan can be established with field/frame scanning taking place along the lines and line scanning taking place in a direction transverse to the lines. In order to produce a colour display when the electron beam producing means comprises a single electron gun, either a source of spot-wobbling frequency, e.g. the colour sub carrier frequency, may be connected to the target electrode so that decoding of the signal actually takes place on the screen, or the phosphors are scanned line sequentially in which case the electron beam scans at three times the line frequency. In the case of using a triple beam in-line electron gun, the trajectories of each beam remain substantially constant relative to each other during each line scan therefore each beam can be focused onto its associated phosphor by the potential difference between the mesh electrode and the target electrode.

The target may comprise a substantially flat glass plate on which the target electrode and the bands of phosphor lines are provided. The phosphor lines may be applied by screen printing. Thus compared with the manufacture of a conventional colour cathode ray tube, the application of the phosphors can be done without the mesh electrode having to be present, any misalignment between the conductors of the mesh electrode and the phosphor lines can be corrected by adjusting the potential difference between the mesh and first electrodes.

The present invention also relates to a display apparatus including the colour display tube in accordance with the present invention, first means for producing a first potential difference between the mesh and planar electrodes to define the trajectory control field, and second means for producing a second potential difference between the target and mesh electrodes to deflect and focus the or each electron beam on to a phosphor line.

The present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figures 1, 1A and *2* are diagrammatic drawings which serve to illustrate the principle of the invention and two possible manners in which a colour display can be produced using a single electron beam, Figure 1A being an enlarged view of the encircled portion of Figure 1,

Figure 3 is another diagrammatic drawing illustrating a manner in which a colour display can be produced using three in-line electron beams,

Figure 4 is an end elevational view partly in section of a colour display tube,

Figure 5 is a view taken on the line V-V of Figure 4, and

Figures 6 and *7* represent views of another embodiment of a display tube which has an electron mirror, Figure 6 being a view on the line VI-VI of Figure 7 which itself is a view on the line VII-VII of Figure 6.

In order to facilitate the understanding of the present invention corresponding reference numerals and letters will be used to indicate corresponding parts. Further as the theory relating to obtaining parabolic trajectories of an electron beam is discussed in detail in British Patent Specification No. 865,667, it will not be repeated in the present specification.

Accordingly it is sufficient to say that if an electron beam 10 from an electron gun 12 enters at an angle α into a trajectory control space 14 comprising a mesh electrode 24 and a planar electrode 18 held at voltages V0 and V1 which produce a repelling field E (V1 being more negative than V0) then the beam 10 will follow a parabolic trajectory through the control space and pass through the interstices of the mesh electrode 24 at a constant, acute angle α. The range S of the beam 10 is determined by the field intensity which may be varied by varying the voltage V1 of the repelling electrode 18. Thus, in the case of a low intensity field, the range will be relatively great as indicated by S''', conversely a high intensity field will cause the range to be relatively small as indicated by S'. Intermediate ranges indicated by S'' will be obtained for values of field intensity between the high and low values. Conveniently the electron beam 10 can be made to scan linearly across the electrode 24 by applying an appropriately changing voltage V1 to the electrode 18 by for example a time base circuit 20 which in a television receiver could be the line time base circuit. Because the electron beam 10 passes at a constant angle α through the mesh electrode 24 then the electron beam produced will be of a substantially constant size and shape anywhere on the mesh electrode.

In the diagram of Figure 1 a target is provided in the form of triplets 22 of phosphor lines on a (transparent) target electrode 16 carried by a transparent faceplate (not shown). The triplets 22 extend normal to the plane of the drawing. The conductive mesh electrode 24 may be a wire mesh or an etched sheet, comprises a plurality of spaced parallel conductors which are aligned with the triplets 22 of phosphor lines. Conveniently the mesh electrode 24 is arranged so that the electron beam 10 passing through the interstices in the mesh can be made to land on a designated triplet of phosphor lines. However in the event of a misalignment then the voltage V2 applied to the target electrode can be adjusted to correct for any mislanding of the electron beam 10. A voltage V2 is applied to the target electrode 16, V2 is greater than V0 and the potential difference is adjusted so that the electron beam 10 is focused and deflected onto a selected phosphor line of a triplet 22 at any one instant.

In the case of a single beam electron gun 12 it can be made to scan in the frame direction by a technique such as will be described with reference to Figure 2 or by applying orthodox angular deflection prior to entry into the control space 14. Reverting to Figure 1 assuming that the electron beam 10, which has been suitably modulated, is line scanning in a direction transverse to the phosphor lines, then a colour picture can be produced in a number of ways.

One way is a dot-sequential or spot wobbling technique in which a signal at the chrominance sub-carrier frequency is applied to the target electrode 16 by a high frequency source 26 shown in broken lines producing a suitable signal at 4.43 MHz. Another way is by line sequential scanning in which the corresponding first phosphor of each of the triplets 22 is scanned, then the second phosphor and finally the third phosphor in each of the triplets is scanned, the complete scanning of a triplet being completed in the period of one single line scan, for example 64 μS.

Turning now to Figure 2; a means of producing field/frame scan of the electron beam 10 will be described. For ease of identification the field/frame scanning direction is indicated by the double headed arrow 30 and the line scanning direction is indicated by the double headed arrow 32. The phosphor lines (not shown) and conductors of the mesh 24 extend in the direction of the arrow 30.

In order to produce a frame scan, a duplicate of the line scan means is provided. An auxiliary trajectory control space 34 is formed by two parallel, auxiliary control electrodes 36, 38. The control electrode 36 has an aperture 40 through which the electron beam 10 from the electron gun 12 enters at an acute angle into the repelling field between the energised electrodes 36,38. The range of the parabolic trajectory of the electron beam is determined by the repelling voltage applied to the electrode 38. This voltage may be controlled by another time base circuit (not shown) operating at field scanning frequency. The deflected electron beam passes through an elongate slot 42 provided in the electrode 36.

Another electrode 44 having an elongate slot 46 is arranged parallel to the electrodes 36, 38. The electrode 44 is held at a higher D.C. potential than that of the electrode 36 and forms a constant acceleration space 48. After passing through the slot 46 the electron beam enters a field free triangular shaped space 50 before entering the trajectory control space 14 (Figure 1). The selection of the apex angle ϵ of the space 50 is chosen so that the successive trajectory planes are parallel to the side edges of the screen.

Figure 3 shows diagrammatically a colour display tube comprising a triple beam in-line electron gun 52.

Three electron beams, one for each primary colour, enter the trajectory control space 14 between a planar electrode 18 and a mesh electrode 24 at slightly different acute angles. The mesh electrode 24 comprises parallel conductors is disposed adjacent to, but spaced from, the electrode 16. The electrodes 24 and 18 are at voltages V0 and V1, respectively, V1 being less than V0 to provide a repelling field E. As in Figure 1, triplets 22 phosphor lines extending normal to the plane of the drawing are disposed on a target electrode 16 which is held at a voltage V2 which is greater than V0. The electron beams follow respective parabolic trajectories, the ranges of which are determined by the size of the field E and the entry angles of the beams. The three electron beams coincide as they pass through the mesh electrode 24 and the outermost beams cross over. The beams are focused and bent slightly on to the phosphors in a direction perpendicular to the conductors of the mesh 24 by the effect of the fact that V2 is greater than V0.

The frame scanning of the electron beams is done by deflecting the beam prior to its entering the trajectory control space, for example as is done in Figure 2. Line scanning is done by varying V1 relative to V0, for example by using a timebase circuit 20.

In the illustrated embodiments the line and frame scanning may be carried out the opposite way round to that described but it is generally preferred to carry out the frame scanning before the electron beams enter the trajectory control space.

A number of different tube constructions which can be operated in the ways described in Figures 1 to 3 will be discussed with reference to Figures 4 to 7. For convenience the discussion will be of a single beam electron gun tube but it is to be understood that such tubes could comprise a triple beam electron gun.

Figures 4 and 5 show diagrammatically two views of a display system suitable for a television receiver or the like, Figure 5 being a section taken along the line V-V of Figure 4. Specific voltages and angles are given by way of illustration to assist understanding of the description.

In an envelope 60, the electron beam 10 from the electron gun 12 enters, through an aperture 40, into the auxiliary trajectory space 34 extending between the control electrodes 36 and 38 of the auxiliary system. The beam enters at an angle of, say, 65° to the lines of force of the control field A set up by auxiliary electrodes 36 and 38.

The cathode of gun 12 may be grounded, and the electrode 36 and the final anode of the gun may both be at a constant D.C. potential of, say, 1.1 KV with respect to said cathode so that the energy of the electrons on entry at 40 is 1.1 KeV. The field A is determined by the potential of the control electrode 38 and the latter may be varied with a sawtooth waveform between say 500V and 810V to effect a frame scan along the operative length of the exit slot 42 provided in the second control electrode 36. Thus by varying the voltage on the electrode 38 the beam is constrained to emerge through this slot at a moving point but at a constant orientation.

The beam then enters a uniform accelerating field 48 of substantially uniform and constant intensity set up by an elongate planar electrode 44 held at a D.C. potential of, say, 5 Kv (with respect to the cathode) and arranged parallel to electrodes 36 and 38. The beam is deflected by field 48 through a constant angle of, say, 40° and, since its angle of entry into the space of field 48 is constant, its angle of exit is also constant.

The beam emerges through a further slot 46 in the electrode 44 into the triangular field-free space 50. This space has an apex angle ε; if the above values are adopted, angle ε is given a value of 25° to ensure that the successive trajectory planes are parallel to the side edges of the target or picture screen 62 (the latter are vertical when the gun axis is positioned horizontally), comprising triplets of phosphor lines (not shown).

The beam then enters a substantially uniform field in the main trajectory space 14 at an angle η (Figure 4) of e.g. 65° to the line of force. The plane of the beam in the chambers containing fields A, 48 and 50 is therefore tilted by 25° with respect to the parallel electrodes 18 and 24 which set up the control field E, as will be seen from Figure 4. The mesh electrode 24 is disposed adjacent to but spaced from the target electrode 16. The line scan is generated by variations of the potential V1 of the repeller electrode 18 between say 2.0 and 3.75 KV, the mesh electrode 24 remaining at a potential V0 which is equal to the potential of 5 KV applied to the electrode 44. The target electrode 16 is held at a voltage V2 which is greater than that applied to the mesh electrode 24. The colour image to be displayed may be produced by line sequential scanning or spot wobbling as discussed with respect to Figure 1.

A further two-dimensional scanning and display arrangement suitable for television and like purposes will now be described with reference to Figures 6 and 7.

From an electron gun 12, a beam 10 of, say 5 KeV electrons in a field-free space passes through frame deflection means (which may be magnetic although shown as electrostatic deflection plates 64) which sweep it across a part-toroidal or substantially part-toroidal conductive electron mirror 68. This mirror 68 serves three purposes:-

1) It bends the beam through about 200°.

2) It displaces the beam from the rearward field-free space towards the luminescent target (not shown) on electrode 16.

3) It renders all the trajectory planes of the reflected beam paths parallel.

The beam then enters the opposing control field E between the mesh electrode 24 and the repelling planar electrode 18 e.g. at an angle of 70° to the lines of force (i.e. an angle β of 20° to electrode 16). The mesh electrode 24 (with the picture screen) is maintained at 5 KV, and by varying the voltage on the electrode 18 the line scan is generated. The target electrode 16 is at a voltage greater than that of the electrode 18. Screening between the rear space and the front trajectory control space is effected with the aid of a plate electrode 66.

The envelope 60 of the two tube constructions described may comprise at least two parts joined together using a suitable frit seal (not shown). One of the parts may comprise a generally flat faceplate and the other of the parts may be generally dished shaped and contain the gun and the majority of the electrodes. Because the final part of the trajectory of the or each electron beam is controlled by the voltages applied to the target electrode 16 and the mesh electrode 24 any misalignment between the triplets of phosphor stripes and the conductors of the mesh electrode can be corrected electrically. Accordingly the phosphors can be applied to the faceplate by a thin film screen printing process or settling process. Accordingly there is no need for the precise alignment of phosphor lines with the apertures in the colour selection electrode as is necessary with conventional colour display tubes.

In a practical embodiment of a 12.5 cm diagonal screen, i.e. 100 mm x 76 mm, display tube in accordance with the invention, there are 330 phosphor triplets, each of pitch width 0.3 mm and comprising phosphor stripes of 80 μm width separated by black light absorbing stripes of 20 μm. The mesh electrode 24 may comprise parallel wires of 0.05 mm. diameter with pitch or spacing of 0.3 mm, or an etched metal sheet having columns of vertically elongate apertures of 1 mm. by 0.3 mm, the elongate apertures in each column being offset vertically relative to the elongate apertures in the or each adjoining column by 0.5 mm, the width of the metal between adjacent columns and adjacent apertures in a column being 0.05 mm.

In the case of a display tube having such a size of screen and a distance D = 25 mm. (Figure 1) between the mesh electrode 24 and the planar repeller electrode 18 and an entry angle α = 30°, a full 100 mm. line scan of the screen will be achieved theoretically using the following calculated conditions, namely VO = 5 KV, and V1 varying from 1.5 KV to 3.7 KV.

In order to focus and deflect the electron beam onto the phosphors of a triplet of phosphors in such a display tube operated under the above conditions it has been calculated that a voltage V2A = 10.0 KV will deflect the electron beam 10 to the phosphor A (Figure 1A), V2B = 10.35 KV will deflect the beam to phosphor B and V2C = 10.72 KV will deflect the beam to phosphor C; the spot size being of the order of 0.06 mm.

CLAIMS

1. A colour display tube having an envelope in which there are provided means for producing an electron beam, a target including a target electrode and parallel bands of phosphors, the phosphors of each band luminescing in different colours when impinged upon by the electron beam, a mesh electrode mounted adjacent to, but spaced from the target, a planar electrode extending substantially parallel to the mesh electrode and defining therewith a trajectory control space, and means for introducing the electron beam along an inclined path into the trajectory control space, the mesh and planar electrodes in use being at different voltages so that the electron beam follows a parabolic trajectory and approaches the target at a substantially constant angle, wherein the mesh electrode comprises a plurality of substantially parallel conductors which are spaced apart by a distance corresponding to the width of a band of phosphor lines and being arranged parallel thereto, the target electrode in use being at such a potential relative to the mesh electrode that the electron beam is deflected and focused onto a phosphor line.

2. A display tube as claimed in Claim 1, wherein means are provided for deflecting the electron beam in a direction parallel to the phosphor lines.

3. A display tube as claimed in Claim 1 or 2, wherein the target comprises a substantially flat glass plate on which the first electrode and the triplets of phosphor lines are provided.

4. A display tube as claimed in Claim 3, wherein the phosphor lines are screen printed onto the glass plate.

5. A display tube as claimed in any one of Claims 1 to 4, wherein the means for producing an electron beam is a single beam electron gun.

6. A display tube as claimed in any one of Claims 1 to 4, wherein the means for producing an electron beam is a triple beam in-line electron gun.

7. A colour display tube constructed and arranged to operate substantially as hereinbefore described with reference to Figures 1 to 5 of the accompanying drawings.

8. A colour display tube constructed and

arranged to operate substantially as hereinbefore described with reference to Figures 1 to 3 and 6 and 7 of the accompanying drawings.

9. A display apparatus including a colour display tube as claimed in any one of Claims 1 to 8, first means for applying a first potential difference between the mesh and planar electrodes to define the trajectory control field, and second means for applying a second potential difference between the target and the mesh electrodes to deflect and focus the or each electron beam onto a phosphor line.

10. A display apparatus as claimed in Claim 9, further including time base scanning voltage means coupled to the planar electrode.

11. A display apparatus as claimed in Claim 9 or 10, further comprising a signal source coupled to the target electrode for applying spot wobbling to the electron beam incident on the target.

12. A display apparatus substantially as hereinbefore described.

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