

PATENT SPECIFICATION (11)

1 335 653

DRAWINGS ATTACHED

1 335 653

- (21) Application No. 22063/72 (22) Filed 11 May 1972 (19)
 (31) Convention Application No. 7 106 619 (32) Filed 14 May 1971 in
 (33) Netherlands (NL)
 (44) Complete Specification published 31 Oct. 1973
 (51) International Classification H01J 9/20
 (52) Index at acceptance



H1D 4A7 4F2B 4F2E 4F2Y 4H1 4HY 4K4 4K7D 4K7Y

(54) EXPOSURE DEVICE FOR MANUFACTURING A DISPLAY SCREEN OF
 A COLOUR DISPLAY CATHODE RAY TUBE

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an exposure device for manufacturing a display screen of a colour display cathode ray tube, which device comprises a light source for illuminating selected areas of a photosensitive layer provided on a light-permeable support through holes in a colour selection mask so that the locations of said areas are determined by the locations of said holes.

In a known type of colour television display tube the display screen consists of a large number of phosphor dots which are arranged in groups of three on a support. The dots of each group luminesce red, green and blue respectively on bombardment by an electron beam. A black non-reflective layer may be provided between the phosphor dots to absorb ambient light and thus contribute to the contrast of the display. The patterns of phosphor dots are manufactured, colour by colour, using a photosensitive layer which is exposed in an exposure device and is then developed. The black non-reflective layer is generally provided previously, also using a photosensitive layer which is exposed three times in succession at the places where the red, the green and the blue phosphor dots respectively are to be provided afterwards. The method results in a black layer having apertures at the places where the phosphor dots are to be provided.

During operation of the tube three electron beams are generated therein, which beams carry red, green and blue picture information, respectively, and which must therefore only impinge upon phosphor dots which luminesce in the corresponding colour. This is achieved by providing a colour selection (shadow) mask in the tube. The

mask has an aperture corresponding to each group of three phosphor dots. The three electron beams are converged at the mask and pass through it at an angle to each other. Said angle and the distance between the mask and the display screen are such that the impact areas of the electron beams on the screen do not overlap each other.

The phosphor dots are provided where the electron beams impinge on the screen. In order to ensure that this is so, and that the dots coincide with the apertures in the black non-reflecting layer, the photosensitive layer is exposed using a light source and the same colour selection mask as is provided in the completed tube. Each photosensitive layer is illuminated through the pattern of holes in the colour selection mask. Since the colour selection mask is at the same distance from the photosensitive layer as it is from the display screen in the completed tube, optimum coincidence of the areas of impact of the electron beams with the phosphor dots and the apertures in the black non-reflective layer can be obtained. Since, however, this optimum coincidence still involves certain tolerances, some overlap must exist between phosphor dots and impact areas, i.e. either the areas must be larger than the phosphor dots so that each area always completely covers its phosphor dot, or the area must be smaller than the phosphor dot so that the area is always completely within the phosphor dot.

It is obvious that the aforementioned black non-reflective layer is more effective with small phosphor dots than with large ones, because the contrast is increased when the non-reflective layer has a comparatively large area relative to the area of the phosphor dots. Tubes constructed with such a layer are therefore preferably provided with phosphor dots which are smaller than the impact areas of the electron beams. The size of the impact areas is determined by the size of the holes in the colour selection mask. The size of the phosphor dots and the apertures in the black non-reflective layer is, however, also determined

[Price 25p]

during manufacture by the size of the holes in the colour selection mask and, unless special steps are taken will hence be approximately equal to or slightly larger than the size of the impact areas of the electron beams.

It is an object of the invention to provide an exposure device in which the light distribution on the support side of the holes in the colour selection mask can be controlled. Another object of the invention is to provide an exposure device with which both phosphor dots and apertures in the black non-reflective layer can be obtained which are smaller than the holes in the colour selection mask, without the size of said holes being temporarily reduced during the exposure step or being enlarged after the exposure step by, for example, re-etching.

The invention provides an exposure device for manufacturing a display screen of a colour display cathode ray tube, said screen comprising cathodo-luminescent material on a light-permeable support, which device comprises a light source for illuminating selected areas of a photosensitive layer provided on said support through holes in a colour selection mask, optical means capable of producing, as seen from the mask, a virtual displacement of the light source having at least a component parallel to a tangent plane at the centre of the support, and means for rotating said optical means about an axis of rotation which is at right angles to said plane.

Rotation of the optical means during the exposure of a photosensitive layer will effectively produce, in combination with the said virtual displacement, an annular light source. As a result of this, a light distribution can be obtained on the support side of each hole of the colour selection mask such that the illumination of the corresponding area of the photosensitive layer falls off on each side of a small central portion thereof. By a suitable choice of the properties of the photosensitive layer and the exposure time used, this property may be used to obtain phosphor dots and apertures in the black non-reflective layer which are considerably smaller than the holes in the colour selection mask.

It should be noted that the use of such penumbra effects is disclosed in an article in the "Journal of the Society of Motion Picture and Television Engineers" vol. 65, no. 8, August, 1956, pp. 407-410, in which article it is also stated that annular light sources are *inter alia* suitable for this purpose. The construction of an annular light source which has sufficient intensity is, however, not described.

An embodiment of the invention will now be described, by way of example, with refer-

ence to the accompanying diagrammatic drawing, which shows an exposure device.

In the drawing the exposure device comprises a housing 1 which supports a light-permeable faceplate portion 2 of a colour television display cathode ray tube. A photosensitive layer 3 on the faceplate 2 is exposed through holes 4 in a colour selection mask 5 which is mounted adjacent the faceplate 2 by means not shown.

The exposure is performed by means of a light source 6 comprising a gas discharge tube 7 and a quartz cone 8. Light (normally visible or ultra-violet) from the tube 7 is concentrated by the cone 8 at the tip 9 thereof, which thus effectively forms a point light source. A correction lens 10 brings the apparent position of the light source into substantial coincidence with the deflection point of the corresponding electron beam in the completed display tube. A second lens 11 is mounted in a worm-wheel 12 which is rotated by means of a worm 13. The variation in thickness shown for the lens 11 is the same in all planes which cut it and are parallel to the plane of the drawing. I.e. the thickness of lens 11 is constant in each plane of that family of planes which are parallel both to each other and to the axis of rotation and are perpendicular to the plane of the paper. Neglecting slight curvature of the lens surface 14, the lens 11 is substantially a prism and produces a virtual displacement (as seen from the mask) of the tip 9 of the light source having at least a component parallel to a tangent plane at the centre of the face plate. This lateral displacement lies in the plane of the drawing if the lens 11 is in the position shown. Rotation of the lens 11 causes the virtual light source to describe a circle about the axis of rotation 15 of the lens so that an annular light source is effectively obtained. Axis 15 is at right angles to the tangent plane at the centre of the faceplate.

As an alternative the lens 11 may be rotationally symmetrical about its axis, the lens axis being parallel to but not coinciding with the axis of rotation 15. Such a symmetrical lens can give the desired virtual displacement of the light source if the light source 9 is not situated on the optical axis of said lens. Because of the rotational symmetry, such as a lens can be easy to manufacture.

As a further alternative the lens 11 may be replaced by a plane-parallel plate, normals to the surface of which make an acute angle with the axis of rotation. As is known, such a plane-parallel plate produces a sideways displacement of a light beam incident thereon at an acute angle and hence can produce the desired virtual displacement of the light source.

The exposure device may be used to

manufacture the usual colour television display cathode ray tubes having red, green and blue phosphor dots separated by a black non-reflective layer or tubes having groups of different numbers of dots and/or different primary colours, either with or without a black non-reflective layer.

The gas discharge tube 7 and quartz cone 8 may be replaced in principle by any light source which, viewed from a point on the colour selection mask, is effectively a point source.

WHAT WE CLAIM IS:—

1. An exposure device for manufacturing a display screen of a colour display cathode ray tube, said screen comprising cathodo luminescent material on a light-permeable support, which device comprises a light source for illuminating selected areas of a photosensitive layer provided on said support through holes in a colour selection mask so that the locations of said areas are determined by the locations of said holes, optical means capable of producing, as seen from the mask, a virtual displacement of the light source having at least a component parallel to a tangent plane at the centre of the support, and means for rotating said optical means about an axis of rotation which is at right angles to said plane.

2. A device as claimed in Claim 1, wherein said optical means comprises a lens which is rotationally symmetrical about its axis, said lens being parallel to but not coinciding with said axis of rotation.

3. A device as claimed in Claim 1, wherein said optical means comprises a lens the thickness of which is constant in each plane of one family of planes which are parallel to both each other and to said axis of rotation.

4. A device as claimed in Claim 3, wherein said lens is substantially a prism.

5. A device as claimed in Claim 1, wherein said optical means comprises a plane-parallel plate normals to the surfaces of which make an acute angle with the axis of rotation.

6. An exposure device substantially as described herein with reference to the drawing.

7. A colour display cathode ray tube manufactured using an exposure device as claimed in any of Claims 1 to 6.

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manufacture the usual colour television display cathode ray tubes having red, green and blue phosphor dots separated by a black non-reflective layer or tubes having groups of different numbers of dots and/or different primary colours, either with or without a black non-reflective layer.

The gas discharge tube 7 and quartz cone 8 may be replaced in principle by any light source which, viewed from a point on the colour selection mask, is effectively a point source.

WHAT WE CLAIM IS:—

- 15 1. An exposure device for manufacturing a display screen of a colour display cathode ray tube, said screen comprising cathodo luminescent material on a light-permeable support, which device comprises
- 20 a light source for illuminating selected areas of a photosensitive layer provided on said support through holes in a colour selection mask so that the locations of said areas are determined by the locations of said holes,
- 25 optical means capable of producing, as seen from the mask, a virtual displacement of the light source having at least a component parallel to a tangent plane at the centre of the support, and means for rotating said
- 30 optical means about an axis of rotation which is at right angles to said plane.

2. A device as claimed in Claim 1, wherein said optical means comprises a lens which is rotationally symmetrical about its axis, said lens being parallel to but not coinciding with said axis of rotation. 35

3. A device as claimed in Claim 1, wherein said optical means comprises a lens the thickness of which is constant in each plane of one family of planes which are parallel to both each other and to said axis of rotation. 40

4. A device as claimed in Claim 3, wherein said lens is substantially a prism.

5. A device as claimed in Claim 1, wherein said optical means comprises a plane-parallel plate normals to the surfaces of which make an acute angle with the axis of rotation. 45

6. An exposure device substantially as described herein with reference to the drawing. 50

7. A colour display cathode ray tube manufactured using an exposure device as claimed in any of Claims 1 to 6. 55

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1973
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.

