

PATENT SPECIFICATION (11)

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(54) MANUFACTURING A LUMINESCENT SCREEN OF A SHADOW-MASK 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 a method of manufacturing a luminescent screen of a shadow-mask cathode-ray tube, said screen comprising a window on the inner surface of which are provided discrete areas of materials which are cathode-luminescent in different colours and which are separated by a light-absorbent material, the apertures in the shadow-mask being larger than the effective areas of the luminescent materials, in which method an apertured layer of the light-absorbent material is provided on the inner surface of the window using a photo-sensitive lacquer, after which the materials which are cathode-luminescent in different colours are provided successively.

A luminescent screen in which the discrete areas of the luminescent materials are separated by a light-absorbent material has the advantage that the same contrast can be obtained in the display with less tinting of the window material (normally glass). As a result the observed brightness of the display increases. Since the apertures in the shadow-mask are made larger than the areas of the luminescent materials, the impact areas of the electron beams of the tube on the screen are larger than the areas of the luminescent materials during operation of the tube provided that the mask and the screen have the same potential. (Areas of the luminescent materials are to be understood to mean herein the effective areas thereof, that is to say the areas which are directly present on the screen and which thus contribute to the display). Only some of the electrons of a given electron beam which pass through a given aperture in the mask

impinge upon the associated effective area, the remainder impinging upon the light-absorbing material present around it. This situation in which the size of each effective luminescent area determines the actual luminescent area is that which is desirable if optimum performance is to be obtained with such a display screen which includes a light-absorbent material.

An apertured layer of light-absorbent material may be provided on the tube window in various ways.

For example, it may be done in the way described in United States Patent Specification 3,146,368, in which the window is coated with a layer of a photo-sensitive lacquer having such properties that parts thereof which have been exposed to radiation are soluble in a solvent in which unexposed parts are insoluble. The layer of lacquer is exposed to radiation where the luminescent areas are to be provided afterwards, and the exposed parts are then removed by means of the said solvent. The light-absorbent material may be either present in a solution of the lacquer or it may be provided after exposing the lacquer to radiation.

As an alternative the light-absorbent material may be provided in the way disclosed in British Patent Specification 1,180,195. In this method the window is coated with a layer of a photo-sensitive lacquer having such properties that parts which have been exposed to radiation are insoluble in a solvent in which non-exposed parts are soluble. The layer is exposed where the effective luminescent areas are to be present afterwards and the unexposed parts are dissolved. A dispersion of colloidal graphite in water is then provided on the window partly coated with exposed photo-sensitive lacquer, which dispersion, after drying, adheres to both the uncoated window and to the photo-sensitive lacquer present. The photo-sensitive lacquer with the graphite particles adhering thereto is then removed by means of a material

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which chemically attacks the hardened lacquer.

5 The lacquer is exposed through a shadow-mask in both cases. If the luminescent screen comprises three different luminescent materials, the exposure has normally to be carried out three times, the completion of each step leaving a light-absorbent layer having
10 apertures which determine the size of the effective luminescent areas which are to be provided afterwards. Since the size of the apertures in the light-absorbent layer is determined by the size of the parts of the photo-sensitive lacquer hardened as a result
15 of the exposures, said parts determine the size of the effective luminescent areas.

The result is that if, for example, a photo-sensitive lacquer is used which becomes insoluble after exposure, and if the apertures
20 in the shadow mask already have the size which they will have in the finished tube at the time of providing the light-absorbent layer, parts of the photo-sensitive lacquer have to be hardened during the exposures
25 which parts are smaller than the apertures in the shadow mask. A problem is that, when three luminescent materials are provided, the photo-sensitive lacquer has to be exposed three times. As a result, after
30 each exposure the photo-sensitive layer comprises a large number of hardened parts which are each surrounded, as a result of the penumbral effect, by a part which has
35 been exposed but has not been sufficiently hardened to become insoluble. These surrounding parts must be prevented from becoming sufficiently hardened by the cumulative effect of a subsequent exposure, (which
40 would not result in sufficient hardening by itself). This cumulative effect can be prevented by suitably choosing the light distribution behind each mask hole and by making
45 the photo-sensitive layer meet certain requirements. It is desirable to use thin photo-sensitive layers (thickness approximately 1 micron).

It has been found that the photo-sensitive lacquer tends to form a smooth surface over
50 the inner surface of the window. For several reasons it is preferred that the inner surface of the window of a cathode-ray tube should not be smooth. By slightly roughening this surface certain irregularities which may
55 occur in the glass, for example air inclusions, can be prevented from becoming visible during the use of the tube. Such a slightly roughened inner surface may comprise, over a distance of 1 cm, approximately
60 70 pits each having a depth between 3 and 7 microns and a maximum diameter between 50 and 100 microns. This may be obtained by pressing the glass in a die having a
65 roughened surface. It has been found, however, that, *inter alia* as a result of the pro-

perties of the die, the inner surface of the window normally also becomes undulated. For example, approximately 10 undulations having a depth of 10 to 15 microns may appear over a distance of 1 cm. The pattern of the pits is superimposed upon the pattern of the undulations. Since the photo-sensitive lacquer tends to form a smooth surface over the inner surface of the window, considerable differences in the thickness of the photo-sensitive layer occur as a result of the undulations. The result of this is that, during the exposures, a considerable spread occurs in the size of the hardened parts of the photo-sensitive layer, and in the shape of the hardened parts. The result of this is that an undesirable spread occurs in the diameter or width of the apertures in the light-absorbent material, as do undesirable deviations therein from the desired shape. It is an object of the invention to mitigate said drawbacks.

According to one aspect the invention provides a method of manufacturing a luminescent screen of a shadow-mask cathode-ray tube, said screen comprising a window on the inner surface of which are provided discrete areas of materials which are cathodo-luminescent in different colours and which are separated by light-absorbent material, the apertures in the shadow-mask being larger than the effective areas of the luminescent materials, in which method the window is provided having a slightly rough inner surface and an apertured layer of the light-absorbent material is provided on said slightly rough inner surface using a photo-sensitive lacquer, after which the materials which are cathodo-luminescent in different colours are provided successively, any undulations which have a spatial frequency between 5 and 50 cm⁻¹ and which are present on said slightly rough inner surface when said apertured layer is provided having a depth of less than 1 micron.

Such undulations may be completely absent.

According to another aspect the invention provides a shadow-mask cathode-ray tube having a luminescent screen comprising a window on a slightly rough inner surface of which are discrete areas of materials which are cathodo-luminescent in different colours, and which are separated by a light-absorbent material, the apertures in the shadow-mask being larger than the effective areas of the luminescent materials, any undulations present on said slightly rough inner surface which have a spatial frequency between 5 and 50 cm⁻¹ having a depth less than 1 micron.

If such a window is used only a very small spread in the size of comparable apertures in the light-absorbent layer need occur and the

apertures need not substantially deviate from the desired shape. This of course also applies to the effective luminescent areas, the size of which need then not be influenced by the condition of the inner surface of the window.

5 A window having an inner surface on which any undulations having a spatial frequency between 5 and 50 cm^{-1} have a depth of less than 1 micron can be obtained by
10 polishing a window which does not have this property or by pressing the window using a die having a surface such that any undulations produced with such a spatial frequency
15 on the inner surface of the window are less than 1 micron deep.

WHAT WE CLAIM IS:—

20 1. A method of manufacturing a luminescent screen of a shadow-mask cathode-ray tube, said screen comprising a window on the inner surface of which are provided discrete areas of materials which are cathodo-luminescent in different colours, and which
25 are separated by a light-absorbent material, the apertures in the shadow-mask being larger than the effective areas of the luminescent materials, in which method the window is provided having a slightly rough inner
30 surface and an apertured layer of the light-absorbent material is provided on said slightly rough inner surface using a photo-

sensitive lacquer, after which the materials which are cathodo-luminescent in different colours are provided successively, any undulations which have a spatial frequency between 5 and 50 cm^{-1} and which are present on said slightly rough inner surface when
40 said apertured layer is provided having a depth of less than 1 micron.

2. A shadow-mask cathode-ray tube having a screen manufactured by a method as claimed in Claim 1.

3. A shadow-mask cathode-ray tube having a luminescent screen comprising a window on a slightly rough inner surface of which are discrete areas of materials which are cathodo-luminescent in different colours, and which are separated by a light-absorbent material, the apertures in the shadow-mask
45 being larger than the effective areas of the luminescent materials any undulations present on said slightly rough inner surface which have a spatial frequency between 5 and 50 cm^{-1} having a depth less than 1
55 micron.

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apertures need not substantially deviate from the desired shape. This of course also applies to the effective luminescent areas, the size of which need then not be influenced by the condition of the inner surface of the window.

5 A window having an inner surface on which any undulations having a spatial frequency between 5 and 50 cm^{-1} have a depth of less than 1 micron can be obtained by polishing a window which does not have this property or by pressing the window using a die having a surface such that any undulations produced with such a spatial frequency on the inner surface of the window are less than 1 micron deep.

WHAT WE CLAIM IS:—

20 1. A method of manufacturing a luminescent screen of a shadow-mask cathode-ray tube, said screen comprising a window on the inner surface of which are provided discrete areas of materials which are cathodo-luminescent in different colours, and which are separated by a light-absorbent material, the apertures in the shadow-mask being larger than the effective areas of the luminescent materials, in which method the window is provided having a slightly rough inner surface and an apertured layer of the light-absorbent material is provided on said slightly rough inner surface using a photo-

sensitive lacquer, after which the materials which are cathodo-luminescent in different colours are provided successively, any undulations which have a spatial frequency between 5 and 50 cm^{-1} and which are present on said slightly rough inner surface when said apertured layer is provided having a depth of less than 1 micron.

2. A shadow-mask cathode-ray tube having a screen manufactured by a method as claimed in Claim 1.

3. A shadow-mask cathode-ray tube having a luminescent screen comprising a window on a slightly rough inner surface of which are discrete areas of materials which are cathodo-luminescent in different colours, and which are separated by a light-absorbent material, the apertures in the shadow-mask being larger than the effective areas of the luminescent materials any undulations present on said slightly rough inner surface which have a spatial frequency between 5 and 50 cm^{-1} having a depth less than 1 micron.

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