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B3A 75

(54) SHADOW MASK FOR COLOUR DISPLAY TUBE

(71) We, N.V. PHILIPS' GLOEILAMPENFABRIEKEN, a limited liability Company, organised and established under the laws of the Kingdom of the Netherlands, of Emmasingel 29, Eindhoven, the Netherlands 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:—

The invention relates to a shadow mask for a colour display tube, the mask comprising a metal sheet having a large number of substantially parallel rows of elongate apertures which extend along the rows, each pair of successive apertures in a row being separated by a bridge.

The invention also relates to a method of manufacturing a reproduction mask for manufacturing such a shadow mask, to such a reproduction mask, to a method of manufacturing such a shadow mask, and to a colour display tube comprising such a shadow mask.

Such a shadow mask is used in a colour display tube comprising an evacuated envelope containing three electron guns for generating coplanar electron beams, and including a display screen with a large number of parallel stripes luminescing in three different colours, the shadow mask being located in the envelope adjacent said display screen with the rows of apertures extending parallel to the luminescent stripes. The three electron guns are situated with their axes in a common plane at a small angle to each other (the so-called colour selection angle) so that the electron beams each impinge only upon luminescent stripes of a respective colour.

Such a shadow mask is known from United States Patent Specification 3,844,005, which discloses a shadow mask the dimensions of the apertures of which increase from the edge towards the centre of the shadow mask and the width of the bridges hence decreases. The object of this is to improve the brightness of the picture. However, it has been found that a picture with a non-uniform brightness is obtained. It is not possible to increases only the width of the elongate apertures in the centre of the shadow mask to an unlimited extent and to keep the dimensions of the bridges constant since in that case the colour purity of the colour display tube deteriorates, which means that an electron beam impinges upon luminescent regions of different colours.

Narrowing the bridges throughout the shadow mask is not possible either, since in that case the shadow mask becomes very weak in the direction at right angles to the rows of elongate apertures. This can result in destruction of the bridges of the shadow mask during drape drawing, particularly in the corners of the shadow mask.

According to the first aspect of the invention, the invention provides a shadow mask for a colour display tube, the mask comprising a metal sheet having a large number of substantially parallel rows of elongate apertures which extend along the rows, each pair of successive apertures in a row being separated by a bridge, wherein for each row, all the bridges of that row have substantially the same width measured along the row, and wherein the bridges in at least the three outermost rows nearest each of two opposite edges of the shadow mask are at least 20% wider (measured along the rows) than the bridges of a row at the centre of the shadow mask, the latter bridges having a width between 120 μm and 150 μm. It has been found that such a shadow mask is not so easily destroyed during the drape drawing process in which it is formed into its curved shape.

The widths of the bridge may increase progressively from row to row from the centre to said edges of the shadow mask; the widths may increase from the centre of the mask in substantially equal steps from row to row. There is thus not a very marked change in the electron transmission of the mask from one row to another.

The known starting material in manufacturing shadow masks is a thin metal sheet,

in general of iron. Said sheet is covered on both sides with a layer of photosensitive lacquer. Reproduction masks are laid on said layers of lacquer and the lacquer is exposed to light by means of said masks in the places where the reproduction masks are transparent. The lacquer is then developed, the lacquer being removed in the places where apertures are to be provided in the shadow mask. The sheet is then exposed to an etchant which dissolves the metal in those places which are no longer protected by the lacquer, so that cavities are formed on both sides of the sheet. As etching is continued, the cavities of both sides of the sheet unite so that a pattern of apertures is formed. It is of importance that the centres of the cavities on both sides should be situated exactly opposite to each other over the whole sheet or should be shifted relative to each other in an accurate and known manner.

It is to be noted that the term "reproduction mask" is to be understood to include a positive or negative copy of a reproduction mask which has the same pattern of transparent and opaque regions as the shadow mask. A positive copy is to be understood to mean a sheet which is opaque except where the apertures of the shadow mask are reproduced as transparent regions, and a negative copy is to be understood to mean a sheet which is transparent except where the apertures of the shadow mask are reproduced as opaque regions. Reproduction masks may be both so-called working masks which are used directly in manufacturing the shadow mask, and reproduction masks for manufacturing other reproduction masks, for example so-called master masks.

According to a second aspect of the invention, the invention provides a method of manufacturing a reproduction mask, as herein defined, for manufacturing a shadow mask embodying the invention, the method comprising the steps of twice exposing photosensitive material on a first sheet through a first array of elongate, light-pervious regions of substantially the same dimensions extending along substantially parallel lines on a light-impervious backround to produce on the first sheet a second array of elongate regions, corresponding to the bridges, extending along substantially parallel lines, wherein the first array and the first sheet are rotated relative to one another between the two exposures so that the widths of the exposed and developed elongate regions of the second array are at least 20% greater for the regions corresponding to the bridges in at least the said three outermost rows nearest each of two opposite edges of the mask than for the regions at the centre of the array, and then exposing photosensitve material on a second sheet through both the first sheet and a third array of alternately light-pervious and light-impervious, substantially parallel-sided strips disposed substantially perpendicular to the lines of the second array so as to expose on the second sheet the pattern of the reproduction mask.

According to a further aspect of the invention, the invention provides a method of manufacturing a shadow mask for a colour display tube, wherein photosensitive material on a metal sheet to form the shadow mask is exposed through a reproduction mask embodying the invention.

Emodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:—

Figure 1 is a perspective view, partly cut away, of a colour display tube embodying the invention;

Figure 2 is a fragmentary view of the shadow mask and display screen of the tube of Figure 1 (ringed by the line II);

Figure 3 shows an edge portion of a known shadow mask;

Figure 4 shows an edge portion of the shadow mask in the tube of Figure 1 (ringed by the line IV);

Figure 5 shows part of an array of strips used in making a reproduction mask;

Figure 6 shows part of an array of elongate regions used in making a reproduction mask;

Figure 7 shows part of a known reproduction mask;

Figure 8 shows part of an array produced by two exposures of the array of Figure 6;

Figure 9 shows schematically part of the array of Figure 8 after development, and

Figure 10 shows part of a reproduction mask embodying the invention.

Figure 1 shows a cathode ray tube comprising a shadow mask 12, the mask and the tube each embodying the invention. In a glass envelope 1 are three electron guns 2, 3 and 4 which generate three electron beams 5, 6 and 7 respectively, the beams passing through apertures 13 in the shadow mask 12 to impinge on phosphor stripes 11, 10 and 9 respectively upon the display screen 8, the stripes luminescing in three respective colours. The electron guns 2, 3 and 4 are situated with their axes in a common plane which is normal to the phosphor stripes 9, 10 and 11 on the display screen 8. Such triplets of phosphor stripes are provided on the screen by means of a known photographic process.

Figure 2 shows part of the shadow mask 12 and the adjacent display screen 8. The shadow mask has a large number of rows of elongate apertures 13 separated by bridges 14. Said bridges generally have a width

(measured along the rows) of 150 μm, while the length of the apertures is approximately 650 μm. The spacing of the rows of apertures is usually 700 μm. The thickness of the sheet material from which shadow masks are manufactured is usually 100 μm to 150 μm.

Figure 3 shows an edge portion of a known shadow mask with corresponding reference numerals. The apertures have a length of 625 μm and the bridges are 150 μm wide everywhere. In order to increase the transmission, the apertures may alternatively be longer and the bridges narrower, but this has proved to present problems in drape drawing shadow masks: the bridges are so narrow (e.g. 120 μm) that they may be easily destroyed, in particular at the edge 18 and in the corners of the mask.

Figure 4 shows an edge portion of the shadow mask 12 of the tube of Figure 1. The bridges 14′ in each of the four outermost rows of apertures, nearest the edge 18, are in this case 30% wider than the bridges 14 of the remaining rows. With the usual shadow mask thicknesses, this has been found to be sufficient to prevent destruction at the edge 18 and in particular in the corners of the shadow mask during drape drawing. It is alternatively possible to increase the widths of the bridges in each row progressively, and suitably in substantially equal steps, from row to row, from the row at the centre of the shadow mask to the rows at two opposite edges 18. This is favourable for the brightness across the screen because there is not a very marked change between adjacent rows in the electron transmission of the mask.

Figures 5, 6 and 7 are used to illustrate steps in manufacturing a reproduction mask for the manufacture of a shadow mask. Figure 5 shows a part of an array of light-impervious strip-like regions 16 alternating with light-pervious regions. Figure 6 shows an array of elongate light-pervious regions 17 of substantially uniform dimensions extending along parrallel lines on a light-impervious background.

Contact printing on photosensitive material of negative copies of the arrays of Figures 5 and 6 provides a known reproduction mask having light-pervious regions 19 as shown in Figure 7. This is a positive copy; it is, of course, also possible to manufacture a negative copy by contact printing in an analogous manner.

Figure 8 illustrates a step in the manufacture of an array for making a reproduction mask embodying the invention. Photosensitive material on a transparent sheet is exposed twice through the array of Figure 6 (as indicated by the solid and dashed lines I and II respectively in Figure 8), the sheet and the array being rotated relative to one another about their common centre *c* between the exposures so that the width *b* of the regions 17 (corresponding to the bridges in the mask) in the three rows situated nearest the edge 18 is at least 20% larger than the width of the regions in the row through the centre *c*. In this manner, the array shown in Figure 9 is obtained which, in combination with a negative copy of the array shown in Figure 5, is used to make by contact printing a reproduction mask embodying the invention, as shown in Figure 10. The widths of the bridges are constant along each individual row but increase in substantially equal steps from one row to another outwards from the centre. It is alternatively possible to make the second exposure through only the part of the array of Figure 6 which is situated near each of the two opposite edges by screening the remainder of the array during the second exposure. This results in only a few rows of apertures, for example four, nearest the edge 18 having wider bridges 14, as shown in Figure 4.

The elongate apertures 13 are often rounded off at their ends 20 owing to the etching treatment, as illustrated in Figure 4.

WHAT WE CLAIM IS:—

1. A shadow mask for a colour display tube, the mask comprising a metal sheet having a large number of substantially parallel rows of elongate apertures which extend along the rows, each pair of successive apertures in a row being separated by a bridge, wherein for each row, all the bridges of that row have substantially the same width measured along the row, and wherein the bridges in at least the three outermost rows nearest each of two opposite edges of the shadow mask are at least 20% wider (measured along the rows) than the bridges of a row at the centre of the shadow mask, the latter bridges having a width between 120 μm and 150 μm.

2. A shadow mask as claimed in Claim 1 wherein the widths of the bridges increase progressively from row to row from the centre to said edges of the shadow mask.

3. A shadow mask as claimed in Claim 2 wherein the widths of the bridges increase from the centre of the mask in substantially equal steps from row to row.

4. A shadow mask for a colour display tube, substantially as herein described with reference to Figure 4 of the accompanying drawings.

5. A method of manufacturing a reproduction mask, as herein defined, for manufacturing a shadow mask as claimed in any preceding claim, comprising the steps of twice exposing photosensitive material on a first sheet through a first array of elongate,

light-pervious regions of substantially the same dimensions extending along substantially parallel lines on a light-impervious background to produce on the first sheet a second array of elongate regions, corresponding to the bridges, extending along substantially parallel lines, wherein the first array and the first sheet are rotated relative to one another between the two exposures so that the widths of the exposed and developed elongate regions of the second array are at least 20% greater for the regions corresponding to the bridges in at least the said three outermost rows nearest each of two opposite edges of the mask than for the regions at the centre of the array, and then exposing photosensitive material on a second sheet through both the first sheet and a third array of alternately light-pervious and light-impervious, substantially parallel-sided strips disposed substantially perpendicular to the lines of the second array so as to expose on the second sheet the pattern of the reproduction mask.

6. A method of manufacturing a reproduction mask as herein defined, substantially as herein described with reference to Figures 5, 6, 8, 9 and 10 of the accompanying drawings.

7. A reproduction mask, as herein defined, manufactured by a method as claimed in claim 5 or 6.

8. A reproduction mask as herein defined, substantially as herein described with reference to Figure 10 of the accompanying drawings.

9. A method of manufacturing a shadow mask for a colour display tube, wherein photosensitive material on a metal sheet to form the shadow mask is exposed through a reproduction mask as claimed in claim 7 or 8.

10. A colour display tube comprising a shadow mask as claimed in any of claims 1 to 4.

11. A colour display tube comprising a shadow mask, substantially as herein described with reference to Figures 1, 2 and 4 of the accompanying drawings.

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1587881 COMPLETE SPECIFICATION

5 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

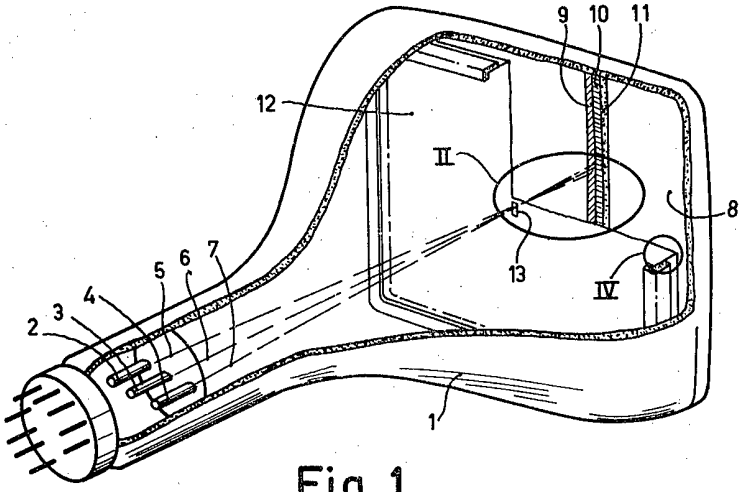

Fig.1

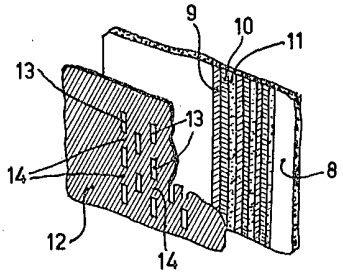

Fig.2

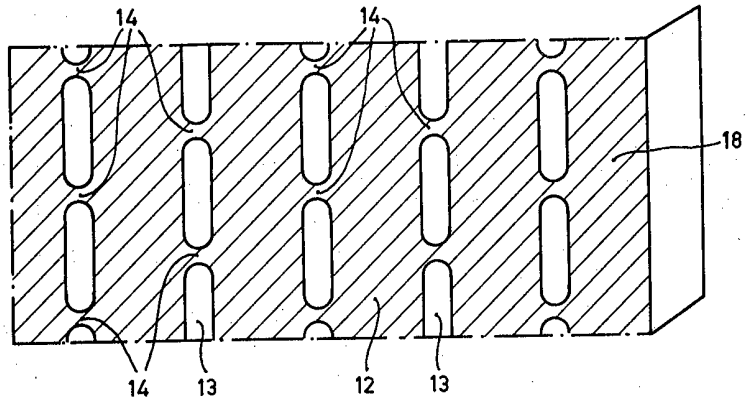

Fig. 3

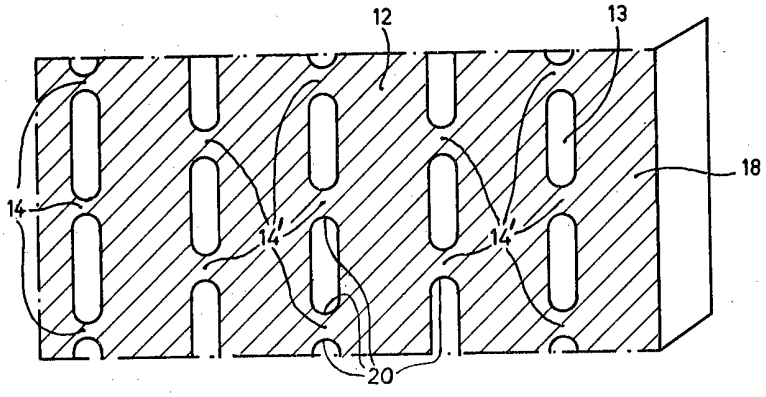

Fig. 4

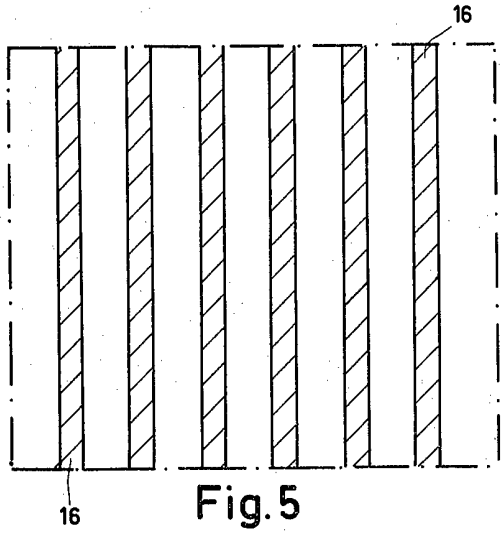

Fig.5

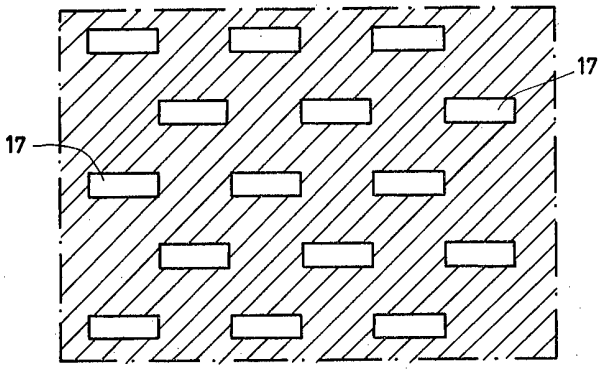

Fig.6

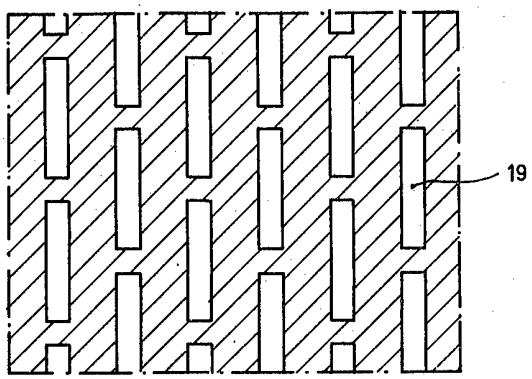

Fig.7

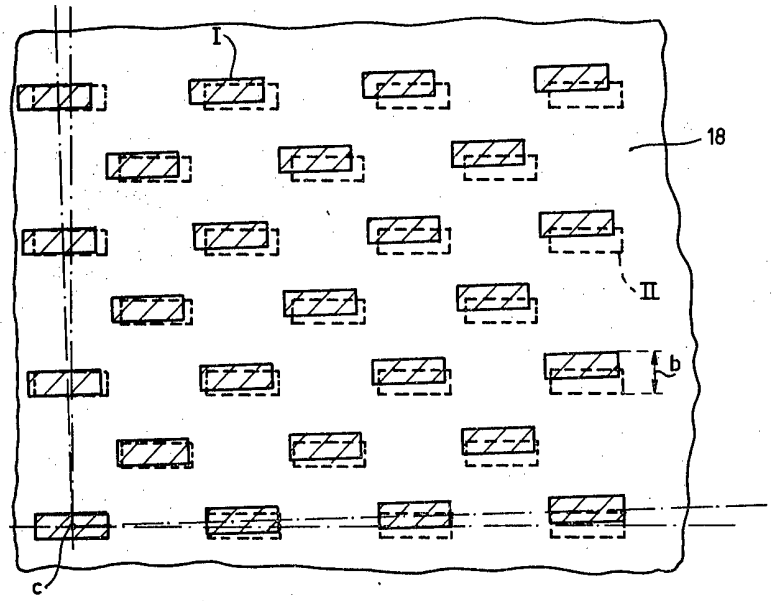

Fig.8

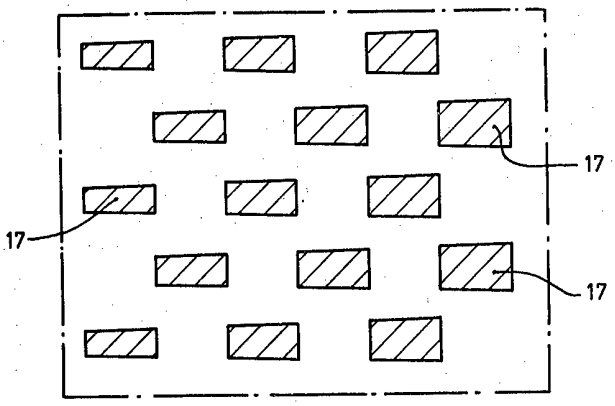

Fig. 9

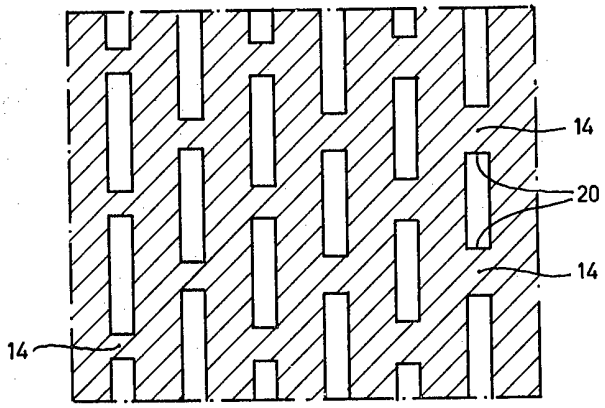

Fig. 10