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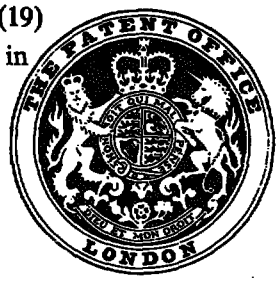

(54) LIGHT INTENSITY DISTRIBUTION CORRECTING FILTER AND MANUFACTURING METHOD OF THE SAME

(71) We, HITACHI, LIMITED, a Corporation organized under the laws of Japan of 5-1, 1-chome, Marunouchi, Chiyoda-ku, Tokyo, Japan 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 light intensity distribution correcting filter for use with an exposure apparatus for use in the formation of a color picture tube phosphor screen, and a manufacturing method of the same.

According to one aspect of the invention there is provided a light intensity distribution correcting filter for use with an exposure apparatus for use in the manufacture of a color picture tube phosphor screen comprising an effective surface notionally divided into a plurality of small rectangular regions arranged in lattice fashion with each having a predetermined light-transmittivity, wherein each of the small regions comprises on its surface at least one opaque strip portion lying across the small region and extending parallel to one pair of sides of the small region with the remainder of the region being transparent, the width of the opaque strip portions of the different regions being determined dependent on the light-transmittivity required for the various small regions, whereby the light intensity distribution correcting filter is given an intended light-transmittivity distribution with different ones of the small regions being given different light-transmittivities dependent solely upon the width of the opaque strips lying across such regions.

According to another aspect of the invention there is provided a method of manufacturing a light intensity distribution correcting filter, for use in an exposure apparatus for use in the manufacture of a color picture tube phosphor screen and having an effective surface notionally divided into a plurality of small rectangular regions arranged in lattice fashion each having a predetermined light-transmittivity, said manufacturing method comprising the steps of: contouring on a transparent sheet a section corresponding to the effective surface and consisting of a plurality of small sections corresponding to the small regions; preparing an original by making opaque each of the small sections except for at least one strip portion having a width inversely proportional to a light-transmittivity required for the corresponding small region and lying across the small section and extending parallel to a pair of sides of the small section; and transferring optically and in reversed light-transmittivity, the original onto a substrate coated with emulsion.

Certain prior art and the present invention as well as the advantages of the latter will be described in detail with reference to the accompanying drawings, in which:

Figure 1 is a schematic sectional view of an exposure apparatus for use in the manufacture of a color picture tube phosphor screen.

Figure 2 (a) is a diagrammatic representation of an effective surface of a light intensity distribution correcting filter divided into a plurality of small regions;

Figure 2 (b) is a graph showing a distribution of light-transmittivity along line B-B of the light intensity distribution correcting filter shown in Figures 2 (a).

Figure 3 is a diagrammatic representation of one example of one small region of a light intensity distribution correcting filter in accordance with the invention;

Figure 4 is a diagrammatic representation of one example of a light intensity distribution correcting filter in accordance with the invention;

Figure 5 is a diagrammatic representation of an original for the manufacture of the light intensity distribution correcting filter shown in Figure 4; and

Figure 6 is a diagrammatic representation of another example of one small region of a light intensity distribution correcting filter in accordance with the invention.

In a color picture tube, a phosphor screen is constituted with a plurality of arrays of tricolor - red, blue and green - phosphor dots or stripes deposited on the inner surface of a panel.

The phosphor dots or stripes are selectively excited by electron beams emitted from electron guns toward the phosphor screen through a color selection electrode, thereby having an intended picture being displayed.

The phosphor screen is generally formed through the use of an exposure apparatus 10 as shown in Figure 1. More particularly, in the exposure apparatus 10, a photosensitive slurry layer 14 including phosphors and formed on the inner surface of the panel is exposed to a light-beam A which is emitted from a light source 11 and passed through a correcting lens 12 for correcting the path of the light beam and apertures in a color selection electrode 13, such as a shadow mask, which is spaced a predetermined distance from the correcting lens and disposed in a predetermined positional relationship to the slurry layer to be exposed. Photosensitive slurry coated on a part being exposed to light is sensitized in this manner and then developed to form an intended single color, for example, red-emitting phosphor dot or stripe. A similar process is repeated for two other colors, for example, blue and green, and eventually a phosphor screen including intended phosphor dot or stripe arrays is formed.

In this case, the size of the phosphor dot or the width of the phosphor stripe developed on the phosphor screen is determined dependent on the quantity of exposure light which in turn is predetermined dependent on position of that phosphor dot or stripe on the phosphor screen. Usually, in order to obtain a correct exposure light quantity distribution in accordance with the position of each of dots or stripes to be formed on the phosphor screen, a light intensity distribution correcting filter 15 having a suitable light-transmittivity distribution is interposed between the light source 11 and the color selection electrode 13 (beneath the correcting lens 12 in this example).

The light intensity distribution correcting filter 15 is manufactured to have an appropriate transmittivity distribution by means of a process such as an evaporation process wherein the light intensity distribution of a light source is measured and a filter substrate is subjected to vapor deposition of an opaque substance such as aluminum, to a thickness distribution meeting an intended light intensity distribution based on the measured light intensity distribution, or alternatively a photographic process wherein a photographic dry plate coated with suitable photosensitive emulsion is exposed to light in accordance with an intended light intensity distribution. Thus, a filter having a light-transmittivity distribution in accordance with the exposed light quantity is manufactured. The process just mentioned above, however, has great difficulties in giving the filter an accurate transmittivity distribution and especially in local fine adjustment of the transmittivity. Accordingly, a complete light intensity distribution correction by using such a light intensity distribution correcting filter 15 is almost impossible.

Recently, a so-called black matrix type color picture tube is put on the market wherein carbon is coated around the phosphor dots or stripes on the phosphor screen 14. In this case, a black matrix is first formed on the inner surface of the panel in a similar manner to the phosphor screen exposure method as mentioned above and matrix holes or stripes vacant of the carbon coating are filled with phosphors by the above phosphor screen exposure method to form a phosphor screen. In the black matrix type color picture tube, since substantially all parts of individual phosphor dots or stripes participate in displaying a viewable image, it is very important to form the these phosphor dots or stripes with an accurate dimensional relationship therebetween in order to reduce white color fading or a reproduced picture. However, the formation of the phosphor dots or stripes, in accurate dimensions that is, formation of the matrix holes or stripe in the black matrix in accurate dimensions requires an accurate adjustment of the light quantity distribution and to this end, it is necessary to make more accurate the transmittivity distribution of the light-intensity distribution correcting filter than that of the prior art.

For this background, it has been proposed, for example, by British Patent Specification No. 1481,979, to use a light intensity distribution correcting filter whose effective surface is divided into a plurality of small regions having different light-transmittivities to give the filter an intended transmittivity distribution. According to one example of this proposed light intensity distribution correcting filter, glass segments each having an intended light-transmittivity are set in array of the small regions as shown in Figures 2 (a). According to another example, a filter substrate made of transparent material has a plurality of small regions and each of the small regions is deposited with opaque substance, for example, aluminium, which occupies a part of the small region, the area of the part being determined in accordance with an intended transmittivity of the region.

As shown in Figure 2 (a), a light intensity

distribution correcting filter 21 comprises a filter surface divided into a plurality of small grilled regions 22i (i = 1, 2, ---, n), each of the small regions having an intended transmittivity. The light intensity distribution correcting filter 21 has a transmittivity distribution on line B-B as shown in Figure 2 (b)' at a broken line B. This broken line B defines transmittivity characteristics for small regions 22_5 through 22_{12} of the filter which are determined so as to approximate to an ideal transmittivity distribution on line B-B of the light intensity distribution correcting filter 21 as shown in Figure 2 (b) at a curve C. In this manner, the transmittivity for each of the small regions 22_i is determined dependent on the ideal transmittivity distribution characteristic of light intensity distribution correcting filter.

In view of ease of production, the light intensity distribution correcting filter having its transmittivity varied stepwise as shown in Figures 2 (b) at broken line B by dividing the filter surface into a plurality of small regions is superior to the filter having a continuously variable transmittivity distribution as shown in Figures 2 (b) at curve C, but difficulties still remain in giving each of the small contoured regions an accurate transmittivity.

An object of this invention is to provide a light intensity distribution correcting filter whose individual small regions in the filter surface can easily be formed to have a specific transmittivity.

Another object of this invention is to provide a manufacturing method of a light intensity distribution correcting filter capable of easily making individual small regions in the filter surface have a specific transmittivity.

In order to make the small regions 22_i (Figure 2) of the filter surface having a predetermined transmittivity, according to the present invention, each of the small regions is formed with a 100% transmittivity portion and a 0 (zero)% transmittivity portion and the ratio of the area of 100% transmittivity portion to the total area of the small region is made equal to the predetermined transmittivity. As shown in Figure 3, to obtain D% transmittivity for the small region 22_1 of Figure 2, for example, a strip portion 31_1 having a width of (100-D)% with respect to the width d of the small region 22_1, that is, a width of d(1-D/100) is made opaque to light and an area 32_1 of the remainder is made substantially 100% transparent to light. This permits the small region 22_1 to have an average transmittivity of D%. Accordingly, over the entirety of the filter surface, as shown in Figure 4, completely opaque strip portions 31_1, 31_2, ---- respectively associated with individual small regions and each having a predetermined width proportioned to the intended transmittivity thereof are formed on the transparent substrate. In this manner, a light intensity distribution correcting filter corresponding to that of Figure 2 can be obtained.

When applied to the exposure apparatus, the light intensity distribution correcting filter of the invention is usually moving longitudinally of the small region of the filter at a uniform speed through an amplitude equal to a longitudinal pitch between two adjacent small regions and at the same time, moving laterally of the small region at another uniform speed through an amplitude equal to a lateral pitch between the two adjacent small regions. As a result, each of the small regions provides the same effect as if it has a predetermined transmittivity in average which is continuously variable, so that it is possible for the filter of this invention to obtain a similar effect to that of a light intensity distribution correcting filter having a smooth overall transmittivity distribution.

A manufacturing method of the light intensity distribution correcting filter of this invention will be described hereinafter. An original having a pattern of transparent and opaque portions whose transparencies are reverse to those of the filter of Figure 4 as shown in Figure 5, is drawn on a transparent sheet such as, for example, a transparent paper or a glass plate on the same scale as Figure 4 or on either magnified or reduced scale. An X-Y plotter generally used for making drawings may be applicable to the drawing of this original. When drawing the original by means of the plotter, it is possible to fill in, for example, a portion 44_1 of Figure 5 corresponding to the portion 32_1 of Figure 4 in black within a region 42_1 of Figure 5 corresponding to the region 22_1 of Figure 4 by drawing solid lines, for example, in the longitudinal direction (Y-direction) as changing the position of X-direction by the minimum pitch of the plotter. Accordingly, this operation is repeated for individual small regions of Figure 5 thereby to complete the original of Figure 5 reverse to Figure 4. The pattern of the original thus prepared is inversely transferred onto a substrate coated with emulsion of high γ (gamma) value such as, for example, a photographic dry plate or a photographic film by means of photograpnic technique while reducing or magnifying the scale of the pattern in accordance with the size of a desired light intensity distribution correcting filter, whereby the light intensity distribution correcting filter having a pattern of Figure 4 can be manufactured. Additionally describing, the gamma of photgraphic emulsion is defined by an incline of the linear portion of the characteristic curve of the photographic emulsion.

While in the foregoing embodiment, as shown in Figures 3 and 4, the light intensity distribution correcting filter having the longitudinal opaque strips across the small reg-

ions has been described, the same holds true for a light intensity distribution correcting filter having lateral opaque strips across the small regions. Further, Figure 3 has shown the formation of one opaque portion within one contoured small region, but the opaque portion may be divided into two or more opaque portions within one small region as shown in Figure 6. In this case, it will easily be seen that a total $d_1 + d_2$ of widths of two opaque strip portions corresponds to d(1 -D/100).

As has been described, the light intensity distribution correcting filter having the desired transmittivity distribution achieves an almost complete light intensity distribution correction on the phosphor screen, when used for the exposure of apparatus. Further, the above described manufacturing method permits the manufacture of the light intensity distribution correcting filter with ease and high accuracy.

WHAT WE CLAIM IS:-

1. A light intensity distribution correcting filter for use with an exposure apparatus for use in the manufacture of a color picture tube phosphor screen comprising an effective surface notionally divided into a plurality of small rectangular regions arranged in lattice fashion with each having a predetermined light-transmittivity, wherein each of the small regions comprises on its surface at least one opaque strip portion lying across the small region and extending parallel to one pair of sides of the small region with the remainder of the region being transparent, the width of the opaque strip portions of the different regions being determined dependent on the light-transmittivity required for the various small regions, whereby the light intensity distribution correcting filter is given an intended light-transmittivity distribution with different ones of the small regions being given different light-transmittivities dependent solely upon the width of the opaque strips lying across such regions.

2. A light intensity distribution correcting filter according to claim 1, wherein for each region, said width of said opaque strip portion is d(1 -D/100), where D represents the percent light-transmittivity required for that region and d represents the length of the other pair of sides of the small region.

3. A light intensity distribution correcting filter according to claim 1, wherein each of said small regions comprises a plurality of opaque strip portions.

4. A light intensity distribution correcting filter according to claim 3, wherein for each small region the total of the widths of the opaque strip portions extending across such region is d(1 - D/100), where D represents the percent light-transmittivity required for that small region and d represents the length of the other pair of sides of the small region.

5. A method of manufacturing a light intensity distribution correcting filter, for use in an exposure apparatus for use in the manufacture of a color picture tube phosphor screen and having an effective surface notionally divided into a plurality of small rectangular regions arranged in lattice fashion each having a predetermined light-transmittivity, said manufacturing method comprising the steps of: contouring on a transparent sheet a section corresponding to the effective surface and consisting of a plurality of small sections corresponding to the small regions; preparing an original by making opaque each of the small sections except for at least one strip portion having a width inversely proportional to a light-transmittivity required for the corresponding small region and lying across the small section and extending parallel to a pair of sides of the small section; and transferring, optically and in reversed light-transmittivity, the original onto a substrate coated with emulsion.

6. A manufacturing method according to claim 5, wherein said width of said strip portion is d(1 - D/100), where d represents a length of the other pair of sides of the small section and D represents the percent light-transmittivity required for the small region corresponding to that small section.

7. A manufacturing method according to claim 5, wherein each of said small sections comprises a plurality of strip portions.

8. A manufacturing method according to claim 7, wherein the total of the widths of said strip portions in each section is d(1 - D/100), where d represents the length of the other pair of sides of the small section and D represents the percent light-transmittivity required for the small region corresponding to that small section.

9. A light intensity distribution correcting filter substantially as hereinbefore described with reference to and as shown by the accompanying drawings.

10. A method of manufacturing a light intensity distribution correcting filter substantially as hereinbefore described with reference to the accompanying drawings.

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As has been described, the light intensity distribution correcting filter having the desired transmittivity distribution achieves an almost complete light intensity distribution correction on the phosphor screen, when used for the exposure of apparatus. Further, the above described manufacturing method permits the manufacture of the light intensity distribution correcting filter with ease and high accuracy.

WHAT WE CLAIM IS:-

1. A light intensity distribution correcting filter for use with an exposure apparatus for use in the manufacture of a color picture tube phosphor screen comprising an effective surface notionally divided into a plurality of small rectangular regions arranged in lattice fashion with each having a predetermined light-transmittivity, wherein each of the small regions comprises on its surface at least one opaque strip portion lying across the small region and extending parallel to one pair of sides of the small region with the remainder of the region being transparent, the width of the opaque strip portions of the different regions being determined dependent on the light-transmittivity required for the various small regions, whereby the light intensity distribution correcting filter is given an intended light-transmittivity distribution with different ones of the small regions being given different light-transmittivities dependent solely upon the width of the opaque strips lying across such regions.

2. A light intensity distribution correcting filter according to claim 1, wherein for each region, said width of said opaque strip portion is d(1 -D/100), where D represents the percent light-transmittivity required for that region and d represents the length of the other pair of sides of the small region.

3. A light intensity distribution correcting filter according to claim 1, wherein each of said small regions comprises a plurality of opaque strip portions.

4. A light intensity distribution correcting filter according to claim 3, wherein for each small region the total of the widths of the opaque strip portions extending across such region is d(1 - D/100), where D represents the percent light-transmittivity required for that small region and d represents the length of the other pair of sides of the small region.

5. A method of manufacturing a light intensity distribution correcting filter, for use in an exposure apparatus for use in the manufacture of a color picture tube phosphor screen and having an effective surface notionally divided into a plurality of small rectangular regions arranged in lattice fashion each having a predetermined light-transmittivity, said manufacturing method comprising the steps of: contouring on a transparent sheet a section corresponding to the effective surface and consisting of a plurality of small sections corresponding to the small regions; preparing an original by making opaque each of the small sections except for at least one strip portion having a width inversely proportional to a light-transmittivity required for the corresponding small region and lying across the small section and extending parallel to a pair of sides of the small section; and transferring, optically and in reversed light-transmittivity, the original onto a substrate coated with emulsion.

6. A manufacturing method according to claim 5, wherein said width of said strip portion is d(1 - D/100), where d represents a length of the other pair of sides of the small section and D represents the percent light-transmittivity required for the small region corresponding to that small section.

7. A manufacturing method according to claim 5, wherein each of said small sections comprises a plurality of strip portions.

8. A manufacturing method according to claim 7, wherein the total of the widths of said strip portions in each section is d(1 - D/100), where d represents the length of the other pair of sides of the small section and D represents the percent light-transmittivity required for the small region corresponding to that small section.

9. A light intensity distribution correcting filter substantially as hereinbefore described with reference to and as shown by the accompanying drawings.

10. A method of manufacturing a light intensity distribution correcting filter substantially as hereinbefore described with reference to the accompanying drawings.

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