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(54) EXPOSURE APPARATUS USED FOR MANUFACTURE OF A COLOR CATHODE-RAY TUBE PHOSPHOR SCREEN

(71) We, HITACHI LTD., 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 an exposure apparatus used for manufacture of color cathode-ray tube phosphor screens.

For production of a color cathode-ray tube, it is general to light-expose a phosphor material and photosensitive material coated on the inner surface of a face-plate through a shadow mask or color selection electrode, thus obtaining an ordinary color phosphor screen or a so-called black matrix type phosphor screen in which light-absorbing substance is filled between phosphor dots or phosphor stripes.

In a prior art exposure apparatus of a certain type, beams of light emitted from an exposure light source are passed through a condenser lens and projected on a face-plate through a shadow mask. With this construction, however, loss of light energy within the condenser lens is so large that the total amount of light emitted from the light source is utilized at efficiency of only several percents to several ten percents, resulting in a shortcoming that a long exposure time is required.

To obviate this shortcoming, a countermeasure has been proposed wherein the beams of light are directly projected on the face-plate without being passed through the condenser lens. An exposure apparatus according to this countermeasure comprises a device frame to which the face-plate is mounted, and a light source housing located in the frame to which the light source is mounted. In the light source housing is provided cooling means for eliminating heat generated by the light source itself. The cooling means may be of a water cooling type using water or a gas cooling type using air or Freon (Registered Trade Mark). In order to obtain a highly precise array of phosphor dots, it is necessary to determine the relative position between the face-plate and the light source accurately. To this end, the face-plate is placed on a first adjustment member which supports the face-plate while serving for an accurate positioning thereof, and the light source housing is placed on a second adjustment member for a similar purpose. The relative positioning between the face-plate and the light source is accomplished by manipulating the second adjustment member in relation to a reference of the first adjustment member while lightening the light source which has been mounted in the light source housing. For example, this may be accomplished by means of an alignment mechanism using a microscope for viewing the position of the light source. This measure, however, is disadvantageous in that not only troublesome positioning work is required every time that the light source is exchanged but also exposure operation is prevented during the exchange, thus greatly reducing the rate of operation of the exposure apparatus.

An object of this invention is to provide an exposure apparatus capable of eliminating the prior art shortcomings and ensuring a highly efficient exposure operation.

According to the invention, there is provided an exposure apparatus used for the manufacture of a color cathode-ray tube phosphor screen comprising: a device frame to which a face-plate is to be mounted; a light source housing; a correction lens disposed between the position at which said face-plate is to be mounted and said light source housing; and an exposure light source having a light emitting portion, a base member rigidly secured to said light emitting portion, and a supporting and

adjusting means removably secured to said light source housing with co-operating surfaces on the housing and the supporting and adjusting means providing for accurate positioning of the supporting and adjusting means relative to the housing, said supporting and adjusting means supporting the base member and hence the light emitting portion within the light source housing and being capable of adjustment when demounted from the housing for aligning the light emitting portion positionally in relation to said cooperating surface of the supporting and adjusting means whereby the light emitting portion will be accurately aligned with the light source housing when the supporting and adjusting means is mounted therein.

This invention will become further apparent when reading the following detailed description given by way of example with reference to the accompanying drawings, in which:

Figure 1 is a schematic section view of one example of prior art exposure apparatus;

Figure 2 is a sectional view of another example of prior art exposure apparatus;

Figure 3 is a sectional view of one embodiment of an exposure apparatus according to this invention;

Figure 4 is a sectional view of another embodiment of an exposure apparatus according to this invention, partly exploded to show an exposure light source;

Figure 5 is a sectional view of still another embodiment of an exposure apparatus according to this invention; and

Figure 6 is a sectional view of an exposure light source as used in the application of Figure 5.

Prior to describing preferred embodiments of this invention, examples of prior art exposure apparatus will be described with reference to Figures 1 and 2.

In one example of prior art exposure apparatus as schematically and diagrammatically shown in Figure 1, beams of light emitted from a super high pressure mercury lamp 1 serving as an exposure light source pass first through a condenser lens 2, then through a correcting lens 3 for approximating the light beams to the locus of electron means of a color cathode-ray tube and a light quantity correcting filter 5 for correcting the difference in light quantities between the central portion and the peripheral portion of a light-permeable face-plate 4 and finally through a shadow mask or color section electrode 6 mounted to the face-plate 4 to expose a phosphor material and photo-sensitive material coated on the inner surface of the face-plate 4. In this exposure apparatus, however, loss of light energy within the condenser lens 2 is so large that the total light flux emitted from the mercury lamp 1 is utilized for exposure operation at an efficiency of only several percents to several ten percents resulting in a longer exposure time.

A countermeasure for this shortcoming has been proposed wherein the light beams from the supper high pressure mercury lamp 1 is used directly for exposure without being passed through any condenser lens, as shown in Figure 2. In Figure 2, a device frame 7 has on its upper portion an adjustment member 8 adapted to support and position the face-plate 4. Inside the frame 7 is provided a light source housing 9 called a "lamp house" in which the mercury lamp 1 is mounted. The light source housing 9 also constitutes a chamber in which a cooling medium is passed for eliminating heat generated in the mercury lamp 1 itself. Numeral 10 designates a transparent window such as made of glass, and numeral 11 designates an adjustment member adapted to support and position the housing 9. During exposure operation, it is necessary to maintain a highly accurate relative positional relationship between the face-plate 4 and the inner volume portion (or effective light emitting portion) of a quartz tube 1a standing for a substantial light emitting source of the mercury lamp 1 in order that trios of blue, green and red phosphor dots or stripes may be formed on the inner surface of face-plate 4 with high accuracy. The relative positioning between the quartz tube 1a of mercury lamp 1 and the adjustment member 8 adapted to support and position the face-plate 4 is accomplished by manipulating the adjustment member 11 located beneath the housing 9 in relation to a reference of the adjustment member 8 while lightening the mercury lamp 1 which has been mounted in the housing 9. This measure, however, requires positioning work in every event of exchanging the mercury lamp, during which exposure operation is prevented, thus greatly reducing the rate of operation of the exposure apparatus.

In addition, an exposure light source such as super high pressure mercury lamp which is a glass product tends to suffer from an inherent problem arising from the fact that the center of the light emitting portion does not lie on the center axis of a base member of the light source to which the light emitting section is rigidly secured.

In the later described embodiment the light source receiving portion of the light source housing accommodates a coupling section of the exposure light source, which coupling section holds the light emitting section of the light source at a predetermined position and is accommodated in the light source receiving portion in a predetermined relationship. Various configurations may be adopted of the light source receiving

portion and the coupling section. In a preferred example, the light source receiving portion includes a cylindrical aperture which is provided at a selected location of the light source hosuing and has a predetermined diameter and the coupling section has a cylindrical portion which fits the cylindrical aperture of the light source receiving portion. Alternatively, the aperture of the light source receiving portion may have a polygonal cross section and the coupling section may have a configuration fitting the polygonal aperture.

An accurate positional relationship between the light emitting section and the coupling section can be accomplished by fixing and holding the light emitting section in relation to the light source receiving section at a desired position on the basis of a predetermined portion of the coupling section. Thereafter, this coupling section is coupled with the light source receiving portion so that the accurate positioning of the exposure light source can be achieved.

Preferably, as a reference in the light emitting section side for alignment is selected not the outer periphery of the light source tube but a portion contributing to the light emission, i.e. an inner volume portion of the tube (or effective light emitting portion). This is because the outer and inner diameters of the tube generally deviate in their centers from each other.

In a certain type of exposure apparatus, a cooling medium is passed inside the light source housing to cool the light source. When such an exposure apparatus is used, it is preferable to carry out the aligning operation between the light emitting section and the coupling section in an atmosphere of a medium identical to the cooling medium which is used in the exposure apparatus or light source housing.

The following description will be given in terms of preferred embodiments of this invention with reference to Figures 3 to 6. In Figures 3 to 6, component parts same as or similar to those of Figures 1 and 2 are designated at the same reference numerals.

In one embodiment, as shown in Figure 3, a coupling section 13 which is to be coupled with a light source receiving portion 9b of a light source housing 9 and is associated with a quartz tube 1a serving as a light emitting section of super high pressure mercury lamp 1 comprises a base member 1c rigidly secured to the quartz tube 1a of the mercury lamp, and a supporting and adjusting means comprising a first eccentric ring 14 having a hole 14a in which the base member 1c is fitted rotatably, and a second eccentric ring 15 which has a hole 15a and is fitted rotatably to the first eccentric ring 14 and the light source receiving portion 9b of the housing 9. The inner and outer diameters of each of the first eccentric ring 14 and the second eccentric ring 15 are offset. Accordingly, the center of the coupling section 13 can be aligned with that of the effective light emitting portion of the quartz tube 1a by making rotational adjustment of each of the eccentric rings 14 and 15 to an optimum position while observing the offset of the center of the inner volume portion of the quartz tube 1a with respect to the base member 1c of mercury lamp 1. This work is carried out in advance of mounting the mercury lamp 1 on the light source receiving portion 9b of the housing 9. Since the light source receiving portion 9b of the housing 9 has previously been positioned and fixed, with accuracy sufficient for exposure operation, in relation to the adjustment member 8 adapted to support and position the face-plate 4, the highly accurate relative positional relationship between the face-plate 4 and the inner volume portion of the quartz tube 1a of the mercury lamp 1 serving as the effective light emitting portion can be ensured when the mercury lamp 1 is mounted to the light source receiving portion 9b of the housing 9. Though the case of aligning the inner volume portion of the quartz tube 1a with the central axis of the coupling section 13 has been shown and described, this particular alignment operation is not essential. For example, the alignment operation may be carried out in such a manner that a predetermined portion of the quartz tube 1a is located at a predetermined position which is shifted from the central axis of the coupling section 13 by a predetermined distance. Also, while the embodiment of Figure 3 has been exemplified with two eccentric rings, obviously, the use of three or more eccentric rings may provide more accurate adjustment. The supporting and adjusting means and the housing have co-operating surfaces which enable the supporting and adjusting means readily to be accurately removably mounted to the housing means whereby the quartz tube will be accurately aligned with the housing when the supporting and adjusting means is mounted therein.

Referring to Figure 4 specifically showing an exposure light source of another embodiment of this invention, a coupling section 16 to be coupled with a light source receiving portion of a light source housing 9 provided for a super high pressure mercury lamp 1 comprises a base member 1*c* rigidly secured to a quartz tube 1*a* of the mercury lamp 1, a frame member 17, and screws 18 and 19. The screw 18 serves to adjust the position of the mercury lamp 1 in Z or vertical direction and the other screw 19 does so in X or horizontal direction. The screw 18 is provided with a relatively large plate 18*a* by which the mercury lamp 1 is supported. The

plate 18*a* is welded to the screw body 18, as shown, after the mounting of the latter in the frame member 17. Alternatively, the plate 18*a* may be detachable from the screw body. The screw 19 has a threaded portion with which the base member 1*c* is coupled and another portion to be associated with the frame member 17, which latter portion is not threaded. A spring 20 is applied around a portion of the screw 19 between the base member 1*c* and the frame member 17 thereby to permit the mercury lamp 1 to reciprocate in the X-direction. For adjusting the mercury lamp 1 on a plane in the direction perpendicular to X-direction, that is, in Y-direction, a screw similar to the screw 19 may also be provided. The screws 18 and 19 are adjusted in advance of mounting the mercury lamp 1 to the housing 9 in such a manner that the center of the inner volume portion of the quartz tube 1a is aligned with that of the coupling section 16, and thereafter, like the foregoing embodiment of Figure 3, the mercury lamp can be mounted to the housing with a higher accuracy for ensuring the positional relationship between the mercury lamp and the face-plate, the coupling section 16 including supporting and adjusting means removably securable to the housing.

It will be appreciated that by adding a mechanism such as screw 19 of Figure 4, the Y-direction adjustment can be assured in the embodiment of Figure 3. Obviously, the eccentric ring mechanism of Figure 3 and the X, Y and Z slide mechanism of Figure 4 may be used in combination.

Turning to Figure 5, still another embodiment uses a super high pressure mercury lamp 1 having a quartz tube 1a whose inner volume portion is aligned with the central axis of a coupling section 21 within 0.05 mm accuracies. A light source housing 9 is positioned and fixed previously such that a light source receiving portion 9b of the housing 9 is positioned with respect to an adjustment member 8 with an accuracy necessary and sufficient for exposure operation. Then, when the coupling section 21 centered with the center of the inner volume portion of the quartz 5ube 1a is mounted in the light source receiving portion 9b of the housing 9 which has previously been positioned and fixed, a highly accurate relative positional relationship between the face-plate 4 and the quartz tube 1a of mercury lamp 1 serving as an effective light emitting portion can be ensured.

Figure 6 shows the detail of the super high pressure mercury lamp of the embodiment of Figure 5. It will be seen from Figure 6 that a center C of the inner volume portion of the quartz tube 1a of a mercury lamp 1 deviates from the center axis of a base member 1c' rigidly secured to the quartz tube 1a. Thus, a second member 22 whose outer periphery is to be intimately fitted with the inner wall of the light source receiving portion of the light source housing is prepared, cement material 23 well known in the technical field of lamp production is filled in a gap between the second member 22 and the base member 1c', and the mercury lamp 1 is moved in the direction designated at arrow A by the aid of an appropriate means (not shown) so that the center C of the inner volume of the quartz tube 1a of mercury lamp 1 may lie on the center axis CA of the second member 22. Thereafter, the cement material 23 is heated, cooled and solidfied to obtain an intended exposure light source.

It is to be noted that the foregoing embodiments have been explained by way of the super high pressure mercury lamp as exposure light source but the exposure light source is not limited thereto nd may be of any desired types for use in color cathode-ray tube phosphor screen exposure.

Also, in the foregoing embodiments, there has been shown and described the case where the light source receiving portion 9b of the light source housing has a cylindrical configuration and the coupling section of the exposure light source has a cylindrical outer periphery portion coinciding with the cylindrical configuration of the receiving portion 9b. Further, the alignment between the center of the light emitting portion and the central axis of the coupling section has been explained. However, it should be noted that the configurations of the light source receiving portion and the coupling section and the alignment operation are not limited to such special examples as apparent from the earlier-mentioned description.

It is preferable to carry out the aligning operation in an atmosphere of a medium identical to a cooling medium such as water, air or Freon used for cooling the light source in the exposure apparatus.

As has been explained, the exposure light source is quickly exchangeable and mountable with ease and high accuracy.

WHAT WE CLAIM IS:-

1. An exposure apparatus used for the manufacture of a color cathode-ray tube phosphor screen comprising: a device frame to which a face-plate is to be mounted; a light source housing; a correction lens disposed between the position at which said face-plate is to be mounted and said light source housing; and an exposure light source having a light emitting portion, a base member rigidly secured to said light emitting portion, and a supporting and adjusting means removably secured to said light source housing with co-operating surfaces on the housing and the supporting and adjusting means providing for accurate posi-

tioning of the supporting and adjusting means relative to the housing, said supporting and adjusting means supporting the base member and hence the light emitting portion within the light source housing and being capable of adjustment when demounted from the housing for aligning the light emitting portion positionally in relation to said cooperating surface of the supporting and adjusting means whereby the light emitting portion will be accurately aligned with the light source housing when the supporting and adjusting means is mounted therein.

2. An exposure apparatus according to claim 1, wherein said supporting and adjusting means comprises a plurality of eccentric rings each having an inner diameter and an outer diameter offset from each other.

3. An exposure apparatus according to claim 1 or 2, wherein said supporting and adjusting means comprises a member for moving said light emitting portion in at least two different directions.

4. An exposure apparatus according to claim 1, wherein said supporting and adjusting means comprises a member provided with said cooperating surface and cement material secured between such members and said base member.

5. An exposure apparatus according to any one of claims 1 to 4, wherein a peripheral portion of said supporting and adjusting means has a configuration which coincides with a portion of said light source housing to provide the co-operating surface, said portion of said light source housing and said peripheral portion of said supporting and adjusting means being cylindrical.

6. An exposure apparatus according to claim 5, wherein said supporting and adjusting means serves to position the center of said light emitting portion on a central axis of the cylindrical peripheral portion of said supporting and adjusting means.

7. An exposure apparatus substantially as hereinbefore described with reference to and as shown by Figure 3, Figure 4 or Figures 5 and 6 of the accompanying drawings.

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FIG. 1 PRIOR ART

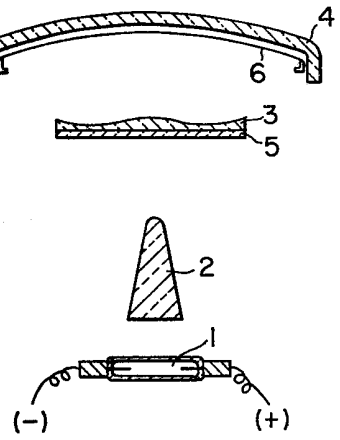


FIG. 2 PRIOR ART

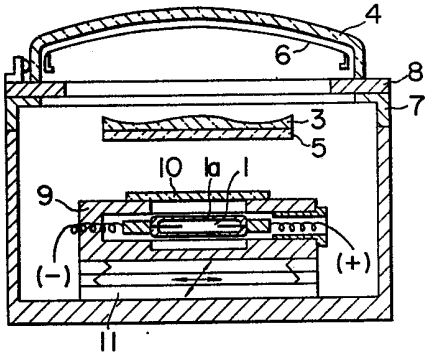
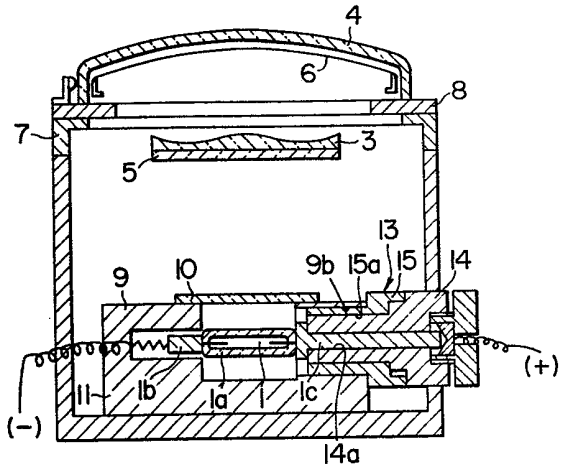


FIG. 3


4
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8
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11
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1a
1c
14a

FIG. 4

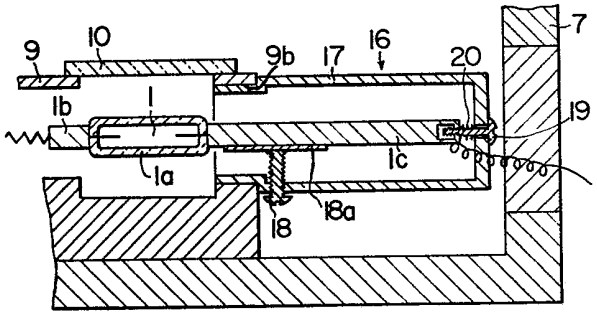
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FIG. 5

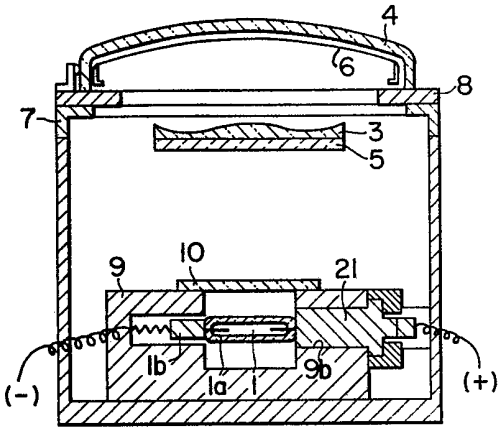

FIG. 6