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Miller et al.

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[54] SYSTEM AND METHOD FOR MAKING  
MULTIGRADED TV MASKS[75] Inventors: Gerald M. Miller, Sylvania, Ohio;  
George M. Munter, Roseville, Minn.[73] Assignee: Buckbee-Mears Company, St. Paul,  
Minn.

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## Related U.S. Application Data

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1969, abandoned.

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[51] Int. Cl. .... G03b 27/26

[58] Field of Search ..... 95/1

[56]

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Primary Examiner—John M. Horan

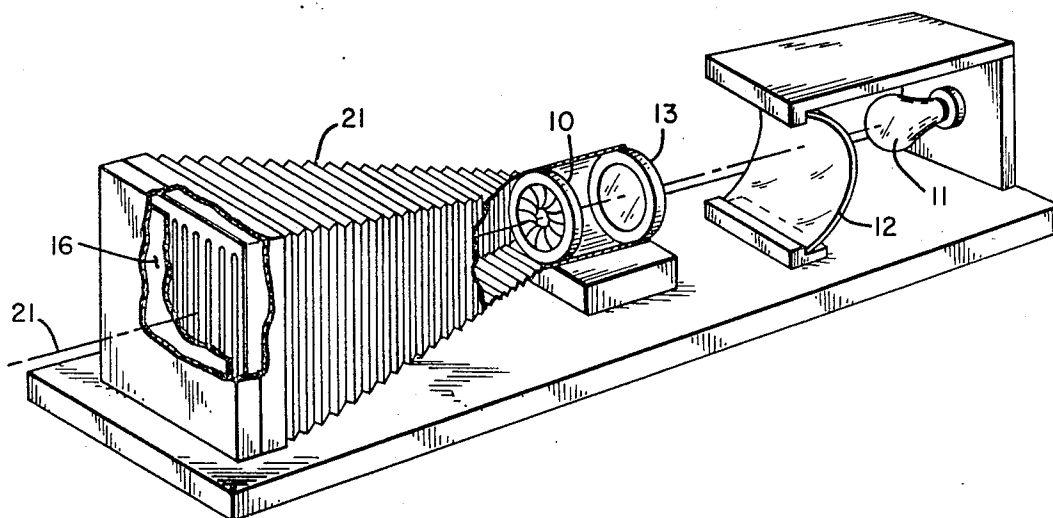
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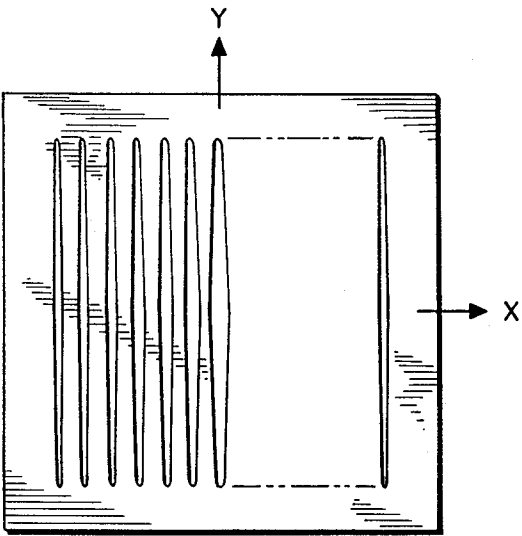
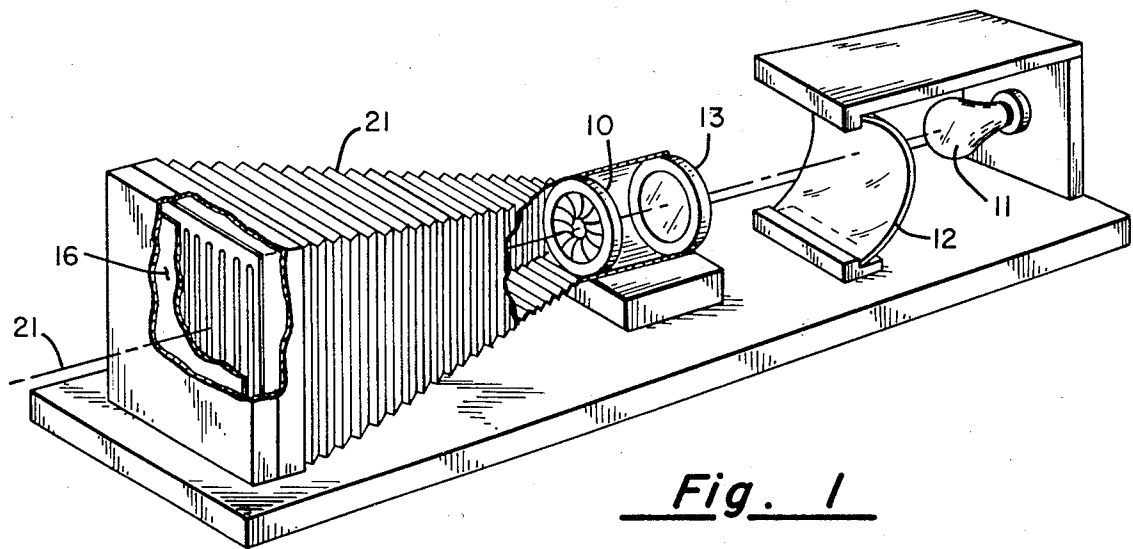
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## ABSTRACT

A method for forming a multigraded negative by utilizing an arcuate shaped light diffuser of uniform thickness.

3 Claims, 2 Drawing Figures





INVENTOR  
GERALD M. MILLER  
GEORGE M. MUNTER

BY

*Styer & Jacobson*  
ATTORNEYS

# SYSTEM AND METHOD FOR MAKING MULTIGRADED TV MASKS

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of our application filed July 2, 1969, Ser. No. 838,459, now abandoned, and assigned to the same assignee as the present invention.

## BACKGROUND OF THE INVENTION

1. Field of the Invention. This invention relates generally to shadow masks for colored television tubes and, more specifically, to a method and system of forming shadow masks having differently graded openings along the horizontal and vertical axis of the masks.

2. Description of the Prior Art. In a colored picture tube a shadow mask is located between the electron gun at the rear of the tube and the phosphor coated face plate at the front or viewing face of the tube. The electron beam from the electron gun passes through the openings or apertures in the shadow mask and impinges upon a suitable color producing phosphor on the face plate. Typically, the openings in the shadow mask may be circular, hexagonal or elongated. In a mask having elongated openings, the openings extend vertically from the bottom of the mask to the top of the mask. In masks having elongated openings, it is necessary to have the width of the openings at the center of the mask larger than the width of the openings at the edges of the mask. In addition, it is necessary that the width of the openings are smaller at a given vertical distance from the center of the mask than at the same given horizontal distance from the center of the mask. This requires having a predetermined grading of the width of the openings in a horizontal x axis and a different predetermined grading of the width of the openings in the vertical y axis.

Briefly, the specific problem is how to produce a mask having a set of elongated openings that have a predetermined graded orientation in the x axis and a predetermined different graded orientation in the mutually perpendicular y axis.

Typically, the openings in the shadow mask can vary from .006 to .003 inch with the openings spaced about .020 inch apart. With these small dimensions and the number of graded openings required for each shadow mask, it is apparent that it would be extremely costly and difficult to produce a mask that has the proper number of openings as well as the desired grading through such techniques as scribing a multigraded pattern on a negative and then using photoprinting techniques to form a multigraded pattern in photoresist on the mask. However, once the multigraded pattern had been printed in photoresist on the mask, the mask could be etched using well known etching techniques.

The present invention eliminates the costly and difficult intermediate step of preparing a multigraded negative pattern through such process as scribing and the like by using optical techniques that utilize an arcuate or curved diffuser of uniform thickness that diminishes the intensity of light projected through a non-graded pattern to produce a multigraded pattern on a plate located behind the non-graded pattern.

## BRIEF SUMMARY OF THE INVENTION

Briefly, the present invention comprises a system having an arcuate shaped light diffuser of uniform thickness that diffuses light horizontally and vertically before transmitting the light through a plurality of non-graded openings onto a photosensitive plate. Because of the arcuate shaped light diffuser the light diffuses more in one axis than in the mutually perpendicular axis. This diffused light, when projected through a set of non-graded openings, produces a multigraded master image on a photosensitive plate which is located behind the non-graded image. The multigraded master image on the photosensitive plate can then be developed and printed to form a master pattern for photoprinting the multigraded image in photoresist on the shadow mask. Once the multigraded pattern has been formed on the mask the mask openings can be etched through conventional techniques.

## BRIEF SUMMARY OF THE DRAWINGS

FIG. 1 is a schematic view showing the components of the system for producing the multigraded mask; and

FIG. 2 is a view showing the appearance of the mask on the photosensitive plate after exposure in the present system.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, FIG. 1 shows, in schematic form, a system for producing a master with multigraded openings. The system comprises a revolving light source 11, a bowed or arcuate light diffuser 12 which is the heart of the present system and a camera 20 which holds a focusing lens 13, an aperture 10, a negative contact of a scribed or ruled master 14 and a photosensitive plate 16 located adjacent master 14. For the purposes of this invention, adjacent is taken to mean that master 14 is near to plate 16 or at some small distance from plate 16 but not in contact with plate 16.

Referring to the individual components of the system, light source 11 comprises a conventional frosted bulb that is mounted in a socket that can be slowly rotated through 360° by a suitable means (not shown). The purpose of having a rotating light source is to eliminate the difference in luminous intensity inherent in filament bulbs which would produce an unevenness in photosensitive plate 16 in addition to the desired gradient that is introduced into the pattern on plate 16. Located next to the light source 11 is an arcuate shaped light diffuser 12 of uniform thickness which comprises the heart of the present invention. Light diffuser 12 comprises a sheet of flexible material such as acrylic resin which has been bent in an arcuate shape through the application of force on opposite ends of the sheet. The present invention utilizes a sheet of acrylic resin which is held in shape by force but it is apparent that the acrylic resin material could also be preformed in an arcuate shape so that it would not be necessary to support the edges in compression. Although acrylic resin is preferred for the light diffuser material, it is apparent that other types of material could equally well be used.

This type of light diffuser is not a lens and should not be confused with a lens. A lens has a varying thickness

from the center to the outside edge whereas light diffuser 12, in contrast, has a uniform thickness from the center to the outside edge. By having the diffuser located in front of light source 11, it diffuses the light causing a variation in the luminous intensity as it passes through the diffuser. With the bow in the light diffuser located along the vertical axis, it decreases the luminous intensity of the light more rapidly along the vertical axis than along the horizontal axis. Thus the center of photosensitive plate 16 receives the highest luminous intensity with the edges receiving the lowest luminous intensity.

In the absence of light diffuser 12, the luminous intensity of photosensitive plate 16 would vary uniformly in a direction radially outward from the center of photographic plate 16. However, by placing light diffuser 12 along optic axis 21, it causes the light to diffuse at a different rate along the vertical axis thus further diminishing the intensity of the light on the top and bottom half of photosensitive plate 16.

The amount of light diffusion can be controlled by varying the choice of the light diffusers, that is, the greater the curve the greater the diffusion and, consequently, the steeper the grade of the opening. Also, it will be apparent that the diffusion of the light can be further varied in the mutually perpendicular axis by placing a second bowed diffuser along the optical axis in series with diffuser 12. It is further envisioned that for certain application diffusers may be made in a hemispherical or oval shape to produce the desired light diffusion.

In operation of the system, the operator places his non-graded master 14 which may be formed through a scribed process or the like in front of a photosensitive plate 16 located at the back of the camera 20. Next, the operator activates light source 11 and also starts rotation of light source 11 about optic axis 21. The light from source 11 projects through diffuser 12, lens 13 and aperture 10 and onto the non-graded master plate 14. A portion of light passes through the opening in master plate 14 and onto photosensitive plate 16. The variation of the luminous intensity on the photosensitive plate 16 causes the pattern of parallel elongated opening in master 14 to become distorted into the appearance shown in FIG. 2.

While the present invention is shown and described in conjunction with a master utilizing a set of elongated openings, it will be apparent to those skilled in the art that the present invention could equally well be used to grade round holes, hexagonal holes or any other type

of pattern requiring a multigraded mask.

Also, in the present invention the acrylic resin diffuser 12 is a translucent white material as opposed to a clear acrylic resin. The purpose of using a translucent white material is to reduce the source concentration of light present with a conventional source such as a light bulb or an elongated tube type lamp. A typical material having a suitable degree of opacity for use is manufactured by Rohm Haas Company under the designation Plexiglas 2447. This example is given as being merely illustrative of a typical material that could be used and no limitation is intended thereto. Although it is preferred to use an acrylic resin material with a predetermined degree of opacity that transmits only a portion of the light, it is apparent that a clear arcuate shaped acrylic resin diffuser with a suitable light dispensing source could also be used. In this latter arrangement the suitable light source could constitute a conventional light bulb located behind a flat sheet of material having a suitable degree of opacity, such as the aforementioned acrylic resin. Furthermore, materials other than acrylic resin could be used but commercially available acrylic resins have been found to have both the desired degree of opacity and the uniformity of opacity throughout the sheet.

We claim:

1. An apparatus for producing a multigraded image comprising: a source of light energy located along an optical axis; said source of light energy including means for rotating the light source about said axis for at least 360° during exposure of the photosensitive plate; a diffuser for decreasing the intensity of the light projectible through the diffuser in a predetermined direction, said light diffuser having a uniform thickness and an arcuate shape, said diffuser located along said optical axis; a master plate having a set of openings and located along said optical axis on the opposite side of said diffuser from said source of light; and a photosensitive plate located adjacent said master plate and on the opposite side from said diffuser so that said light source exposes the portions of the photosensitive plate that are not shielded by said master plate in proportion to the intensity of the light arriving at said plate.

2. The apparatus of claim 1 wherein said master contains a plurality of parallel elongated openings of uniform width.

3. The apparatus of claim 1 wherein the set of openings in said master are of uniform width.

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