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Park et al.

[11] **3,762,284**

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[54] **METHOD AND APPARATUS FOR GRADING THE SCREEN OF A BLACK SURROUND COLOR TUBE**

[75] Inventors: **Yong S. Park**, Hanover Park; **Raymond J. Pekosh**, Niles, both of Ill.

[73] Assignee: **Zenith Radio Corporation**, Chicago, Ill.

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[52] **U.S. Cl.** ..... **95/1 R**, 96/36.1

[51] **Int. Cl.** **G03b 27/00**

[58] **Field of Search** 95/1; 96/36.1

[56] **References Cited**

UNITED STATES PATENTS

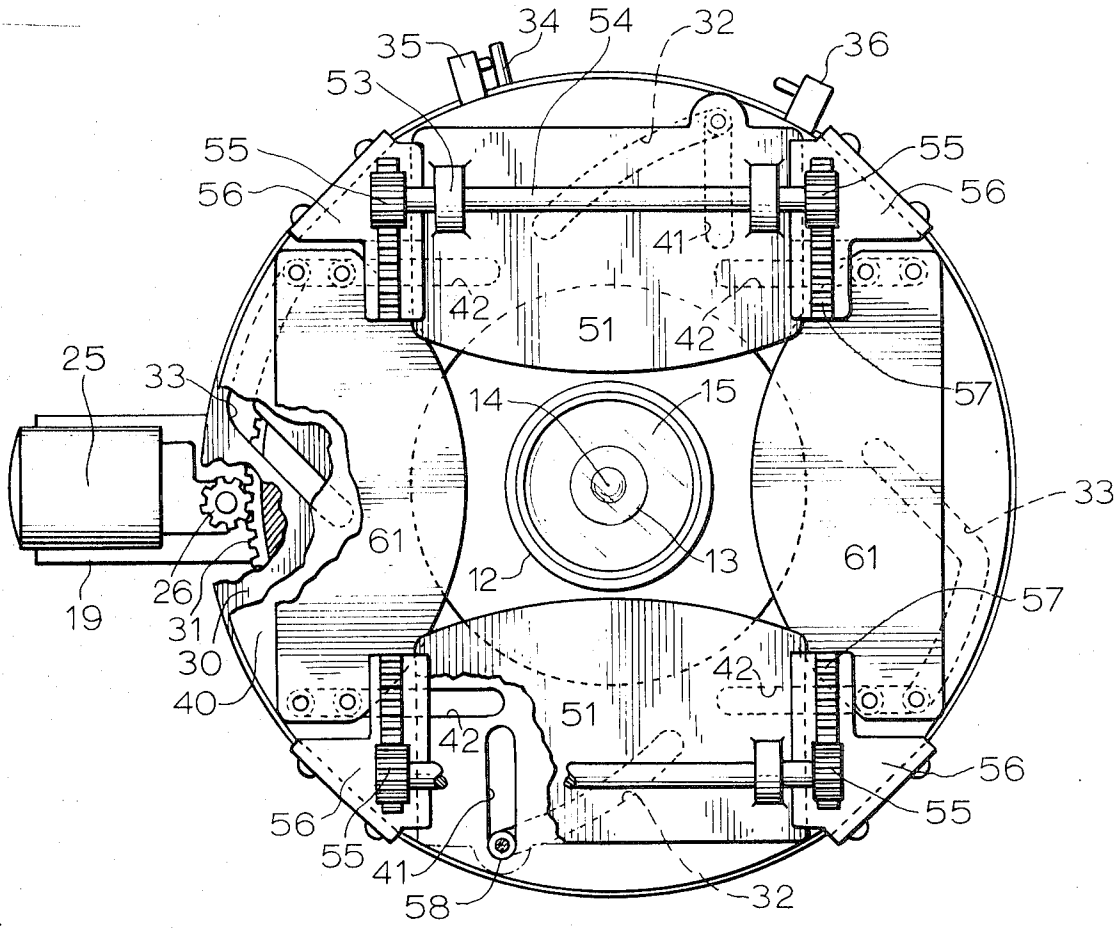
3,259,038 7/1966 Burdick et al. ..... 95/1 R

Primary Examiner—Samuel S. Matthews
Assistant Examiner—Richard M. Sheer
Attorney—Nicholas A. Camasto et al.

[57] **ABSTRACT**

The process of screening a black surround on the faceplate of a rectangular color tube incorporating an automatic shading mechanism in the lighthouse varying the distribution of actinic energy over the sensitized coating on the faceplate for controlling the image size of the projected shadow mask apertures in a particular manner to produce images of decreasing area from the center to the edge of the faceplate with images of similar area located along a substantially rectangular locus centered with respect to the faceplate. The mechanism for controlling the exposure intensity over the faceplate comprises two pairs of movable plates for repetitively shading areas of the faceplate from the energy source.

5 Claims, 3 Drawing Figures



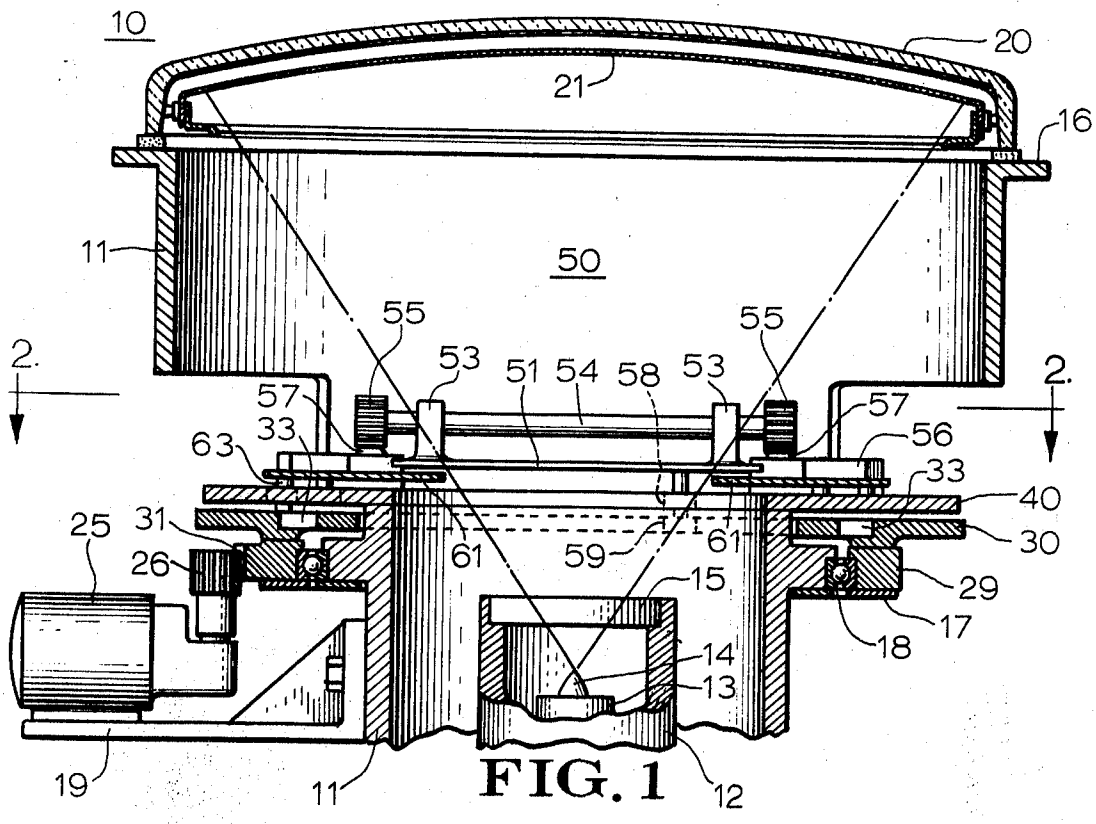

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FIG. 1

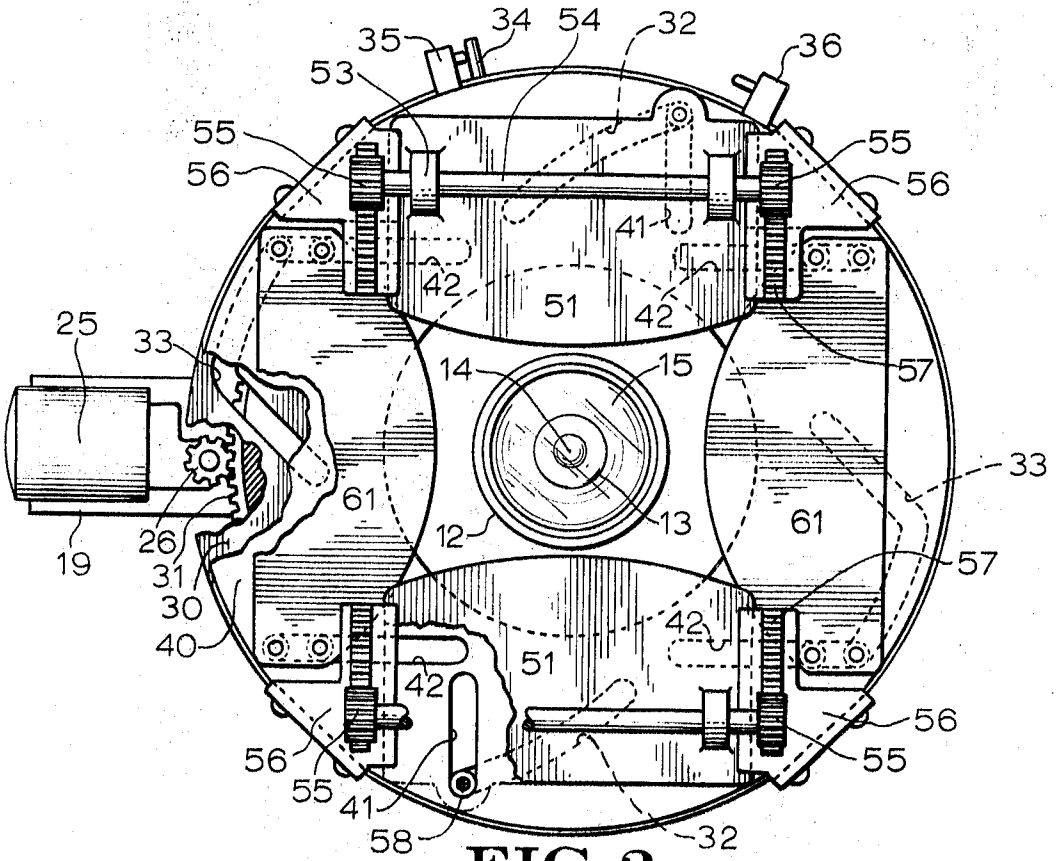

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FIG. 2

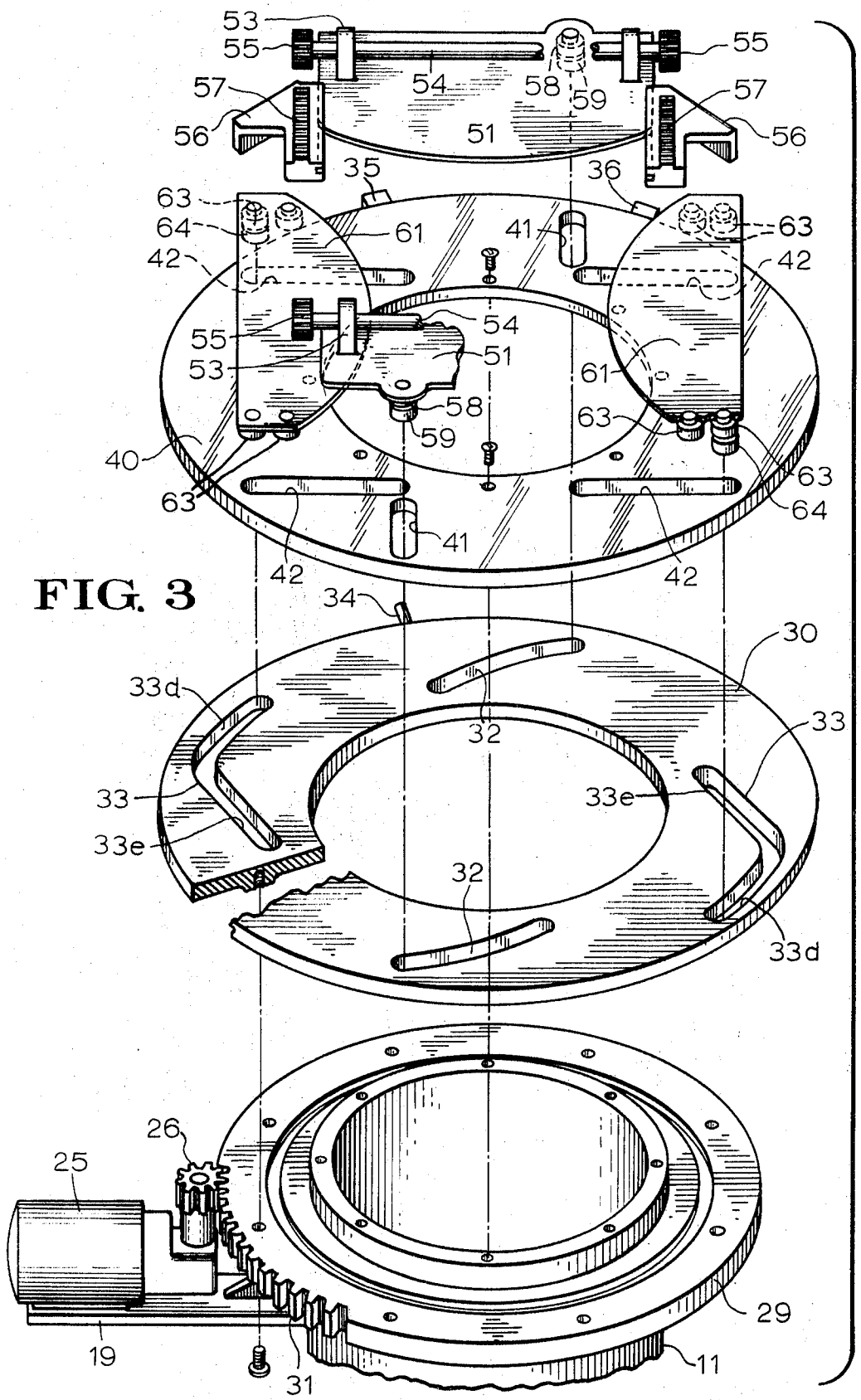

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FIG. 3

METHOD AND APPARATUS FOR GRADING THE SCREEN OF A BLACK SURROUND COLOR TUBE

RELATED APPLICATION

This application is related to an application entitled "A RECTANGULAR GRADE BLACK SURROUND SCREEN" in the name of Leonard Dietch, filed Apr. 4, 1972, Ser. No. 240,931, and assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

The present invention concerns the grade pattern of viewable image elements or phosphor deposits on the faceplate of a color television picture tube. The image elements in a conventional tri-gun shadow mask color cathode ray tube comprise deposits of light emitting phosphors having different color responses. The term "viewable" indicates the maximum area of light emitting surface, which in a conventional tube is limited by the area of the electron beam impinging thereon.

During screening of the color tube faceplate, successive exposures, through the shadow mask, are made in a lighthouse. The exposures are taken with the faceplate and exposure source occupying relatively different positions, corresponding to the different electron gun positions in the finished tube, with the faceplate coated with a photosensitive slurry bearing a phosphor of an appropriate primary color. The size of the ultimate phosphor deposits on the faceplate is in part determined by the length and intensity of exposure, and under normal conditions, the phosphor deposits are larger than the projected areas of the corresponding apertures in the shadow mask.

Recently, color television picture tubes having elemental phosphor deposits separated from one another over the faceplate, with the spaces between phosphor deposits filled with a light absorptive material, have found widespread commercial acceptance. This type of color television picture tube, commonly referred to as a black surround tube, is fully described in U.S. Pat. No. 3,146,368 issued Aug. 25, 1964 in the name of Joseph P. Fiore et al. and assigned to the assignee of the present invention. In one method of manufacturing a black surround tube, a matrix of opaque, non-reflective material is initially deposited on the inner surface of the faceplate. The matrix defines a plurality of phosphor receiving holes arranged in triads, which holes determine the viewable area of the later applied phosphor deposits since the black surround is opaque. Thus the maximum light emitting area is restricted by the black surround hole area even though the cross-section area of the electron beam impinging on the phosphor deposit may be greater than that of the hole. In such tubes the purity tolerance or guard band may be reversed with numerous advantages in brightness and contrast characteristics as fully set out in the above-mentioned Fiore et al. patent. Thus a negative tolerance or guard band means that the electron beam area is larger than the effective phosphor dot area. The negative tolerance may be photographically achieved as set out in the Fiore et al patent or may be attained by enlarging the shadow mask apertures after screening has been performed.

As indicated in the aforementioned copending Dietch application, a black surround with holes having areas graded in accordance with a rectangular pattern affords desirable benefits in terms of brightness and guard band. The areas of the holes in the black surround may be controlled by appropriately shading the faceplate with its photosensitized coating during exposure since the sizes of the images projected through the shadow mask apertures are a function of exposure intensity and duration. Particularly, a "shader" plate comprising a glass plate or other transparent substrate having a deposited metal of micro thickness for attenuating the exposure rays may be employed in the lighthouse between the exposure source and shadow mask. The intensity distribution of the exposure energy can thus be controlled to achieve the desired hole area grading pattern.

Accordingly, it is an object of the invention to provide an improved method of screening a color cathode ray tube of the black surround type.

It is a specific object of the invention to provide an improved method of screening a black surround color cathode ray tube which enhances purity.

Another object of this invention is to provide a novel method of producing a black surround color tube screen having viewable image elements diminishing in area from the center to the edge and characterized in that image elements of similar area are disposed along a substantially rectangular locus centered with respect to the faceplate.

A further object of the invention is to provide a novel shading mechanism for use in a lighthouse to produce a predetermined exposure energy intensity distribution over the photosensitized faceplate of a color tube.

SUMMARY OF THE INVENTION

In accordance with the present invention, a novel method of screening to achieve such a black surround provides an automatic shading mechanism operable during exposure for shading portions of the photosensitized coating on the faceplate to produce the desired energy distribution pattern. The shading mechanism is arranged to vary the exposure energy intensity distribution over the faceplate in a manner to produce image elements having sizes arranged according to the desired rectangular grading pattern.

The particular structure producing the rectangular grade energy distribution over the faceplate comprises two pairs of shading plates rectilinearly movable along paths parallel to the major and minor axes of the faceplate.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings in the several figures of which like reference numerals identify like elements, and in which:

FIG. 1 is a cross sectional view of a lighthouse incorporating shading mechanism embodying the invention;

FIG. 2 is a view of the shading mechanism taken along the lines 2—2 of FIg. 1; and

FIG. 3 is an exploded perspective view of a portion of the shading mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a lighthouse 10 including a hous-

ing 11, a light assembly 12 and an exposure surface 16, is shown. The faceplate or panel 20 of a conventional color picture tube is shown mounted in position on exposure surface 16. A conventional aperture type shadow mask 21 is mounted closely adjacent the inner surface of panel 20. The inner surface of faceplate 20 is conventionally coated with a photosensitive material such as polyvinyl alcohol (pva) sensitized with ammonium dichromate, whose solubility in water is changed in response to ultraviolet light. Light assembly 12 includes an ultraviolet light source 13, a collimator 14 and a lens 15. Collimator 14 emits the ultraviolet rays at its tip and is generally designed to simulate a point source. Lens 15 is indicated in block form and may comprise any of a well-known number of configurations for displacing the light rays falling on faceplate 20 to compensate for the differences in trajectories between light rays and electron beams in a color tube. Lighthouse 10 may be conventional in all respects with the exception of shading mechanism 50 located between light source 13 and the exposure surface 16.

Conventional photosensitive coatings such as pva snesitized with ammonium dichromate respond to ultraviolet light in a manner determined by both the exposure duration and intensity. Generally speaking, a longer exposure or a higher intensity exposure results in a larger area of insolubilized pva. Consequently, if the shadow mask apertures are circular, the latent images of those apertures formed in the coating will be circular, but of a size determined by the intensity and duration of exposure.

While the tip of the collimator simulates a point source of light and radiates substantially equally in all directions throughout the deflection angle of the color tube, a peaking of intensity in the central area of the faceplate occurs because the tip is not located at the center of the radius of curvature of the faceplate. Thus the intensity distribution of the light energy falling on the inner surface of faceplate 20 decreases from center to edge. In a rectangular panel the extremities of the diagonals are farthest from the light source and, therefore, the intensity is lowest. This type of energy distribution will not result in the desirable rectangular grade pattern for the exposed areas of the coating.

The shading mechanism for obtaining the desired light distribution will best be understood by referring to FIGS. 1, 2 and 3 together. As shown in FIG. 1, a support plate 17 is mounted to the lower portion of lighthouse 11 and supports a bearing 18. A cam plate support 29 is mounted for rotational movement on bearing 18. A movable cam plate 30 is either attached to cam plate support 29 or may be formed integrally therewith. A stationary drive plate 40 is affixed to housing 11 in overlying relationship with cam plate 30. A pair of vertical shading plates 61 are mounted in drive plate 40 rectilinear movement toward and away from each other along a path parallel to the major axis of faceplate 20. Four rack supports 56 are fastened about the circumference of drive plate 40 and partially overlie vertical shading plates 61. The rack supports carry a pair of horizontal shading plates 51 which similarly are mounted for rectilinear motion toward and away from each other, but along a path parallel to the minor axis of faceplate 20. Each rack support includes a rack 57 with a mating pinion 55, mounted on a shaft 54, which is journalled in a pair of bearing supports 53 affixed to the horizontal shading plates.

A stationary guide plate 40 includes a plurality of guide slots, two for each vertical shading plate and one for each horizontal shading plate. The vertical guide slots 42 and the horizontal guide slots 41 are adapted to receive vertical guide pins 63 and horizontal guide pins 58, respectively, on the bottom of each shading plate. Horizontal guide pin 58 has an extension terminating in a horizontal drive pin 59 engaging a horizontal cam 32 in cam plate 30. While each vertical shading plate 61 has two pairs of guide pins 63, only one of the guide pins has an extension terminating in a vertical drive pin 64 engaging a vertical cam 33 in cam plate 30.

Movable cam plate 30 includes a partial gear ring 31 attached to, or formed as part of its circumference. A reversible motor 25, mounted from the lighthouse by a bracket 19, powers a drive gear 26 in engagement with gear ring 31. A cycling pin 34 is mounted to the circumference of cam plate 30 for alternately engaging and operating a pair of reversing switches 35 and 36 which are shown affixed to stationary guide plate 40. The reversing switches change the direction of rotation of motor 25 in a cyclical manner, and drive gear 26 rotates cam plate 30 back and forth between the positions determined by the switches.

Horizontal cams 32 comprise arcuate slots in cam plate 30, engaged by horizontal drive pins 59 attached to the underside of shading plates 51. The vertical cams 33 approximate L-shaped slots in cam plate 30 engaged by vertical drive pins 34 attached to the underside of shading plates 61. As cam plate 30 rotates clockwise, horizontal drive pins 59 are forced inward by the action of horizontal cams 32. The line of travel of horizontal shading plates 51 is controlled by the action of guide pin 58 in guide slot 41 and the provision of the rack and pinion arrangement which precludes all but rectilinear movement. Vertical drive pins 64 remain substantially stationary during the first portion of clockwise movement of cam plate 30 while the pins are in the arcuate shaped dwell portions of the vertical cams indicated by 33*d*. Responsive to continued rotation of cam plate 30, drive pins 63 are driven rapidly inward by the effective portions of the vertical cams indicated by 33*e*. Thus as cam plate 30 rotates, horizontal shading plates 51 are brought towards each other at a constant rate, whereas the vertical plates are initially stationary and subsequently moved toward each other at a faster rate. When moved, the shading plates shadow portions of faceplate 20 from the light source.

When cam plate cycling pin 34 operates switch 36, motor reversal occurs and the cam plate is driven clockwise. Actions now reverse with the vertical shading plates being driven away from each other rapidly whereas the horizontal plates are driven at a slower rate.

The plates are shaped to resemble parabolas and their movements timed to produce a light distribution pattern over the faceplate for yielding a locus of rectangles of similar area images, with the image areas diminishing from center to edge, centered about the faceplate. The continual movement of the plates produces gradual light distribution changes from point-to-point across the faceplate and thus results in a uniform transition in image area size.

The provision of four vertical guide pins 63 cooperating with a pair of parallel guide slots 32 precludes the vertical shading plates from traveling in other than a rectilinear path. It will be appreciated that the guidance

arrangement for the vertical plates and for the horizontal plates may be used interchangeably, the criterion being that freedom from side movement be maintained.

It will be recognized that the size and shape of the plates may be varied along with timing of plate operations to produce a variety of shading patterns. This is of particular importance in a production area where adjustments may be made to compensate for the innumerable variables encountered in screening operations. This flexibility is not obtainable with fixed "shader" plates or lens coatings and is an extremely desirable attribute of the invention.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A lighthouse for exposing the rectangular faceplate of a color cathode ray tube comprising: a housing having an open end a light source within said housing said housing being adapted to receive over said open end the rectangular face-plate of a color cathode ray tube having a coating of photosensitized material on the inner surface thereof for exposure to said light source; a shading mechanism within said lighthouse interposed between said light source and said faceplate, said shading mechanism including; a set of movable shading plates, and means for moving said shading plates during exposure of the coating to said light source for shading portions of the coating from said light source to vary the energy distribution thereover in an intensity pattern decreasing from center to edge in accordance with a locus of substantially equal intensity rectangles centered about said faceplate.

2. A lighthouse as set forth in claim 1 wherein said set of shading plates comprise two opposed pairs of shading plates, a first opposed pair movable toward and away from each other along a path substantially parallel to the major axis of said faceplate and a second opposed pair similarly movable along a path substantially parallel to the minor axis of said faceplate.

3. A lighthouse as set forth in claim 2 wherein said shading plates include drive pins; and wherein said shading mechanism further includes cam surfaces cooperating with said drive pins for moving said plates.

4. A lighthouse as set forth in claim 3 wherein said cam surfaces are on a movable cam plate; and means moving said cam plate in an oscillatory manner during exposure.

5. A lighthouse as set forth in claim 4 wherein said cam surfaces include dwell portions for maintaining said first opposed pair of shading plates in a non-shading position during a portion of movement of said cam plate.

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