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M. R. WEINGARTEN
APPARATUS FOR USE IN THE MANUFACTURE OF MOSAIC
SCREENS FOR COLOR-KINESCOPIES, ETC.

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2 Sheets-Sheet 1

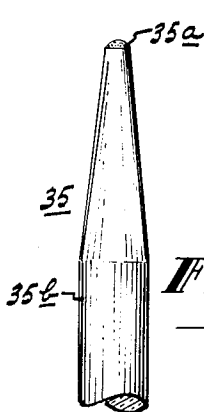
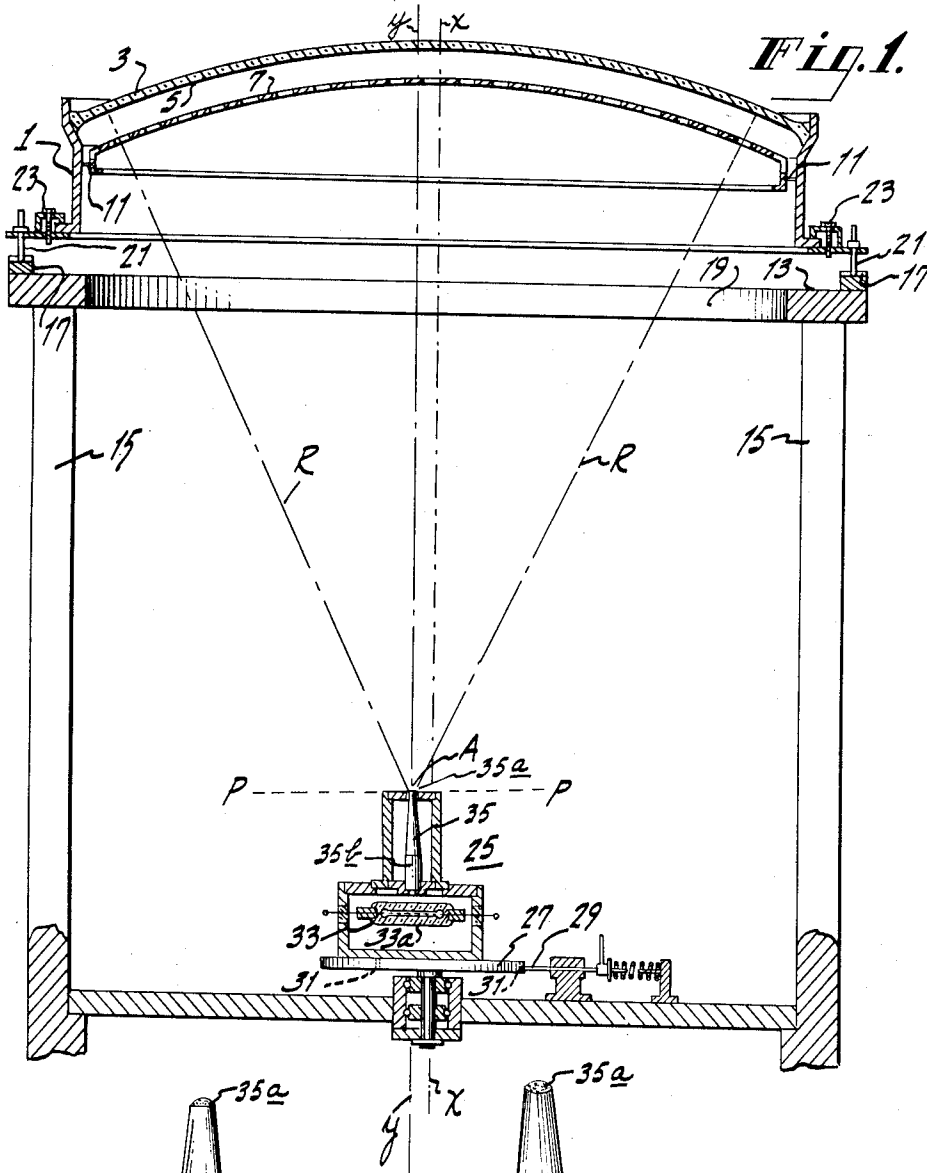


Fig. 2.

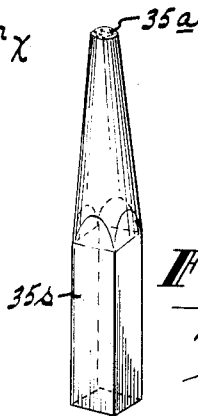


Fig. 3.

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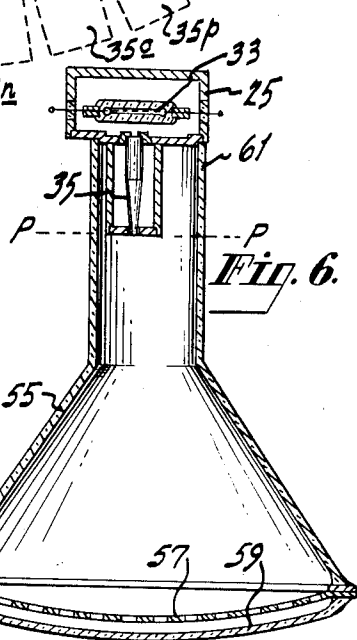
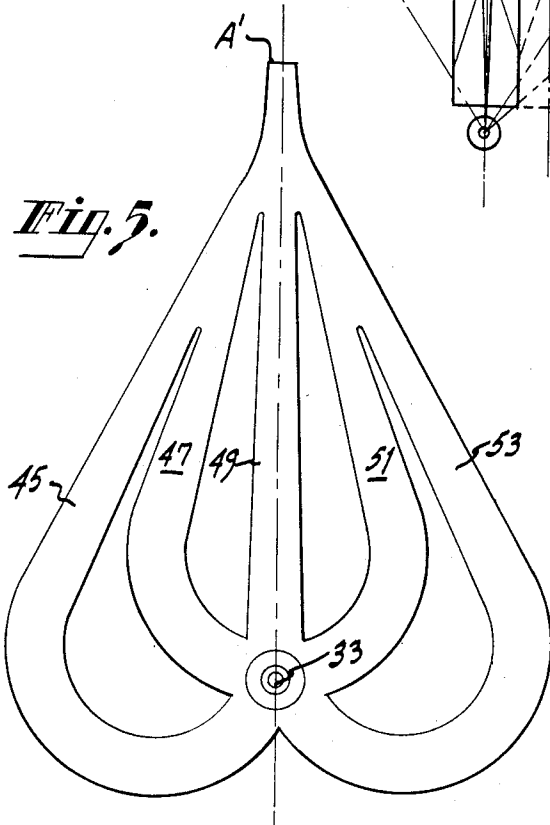
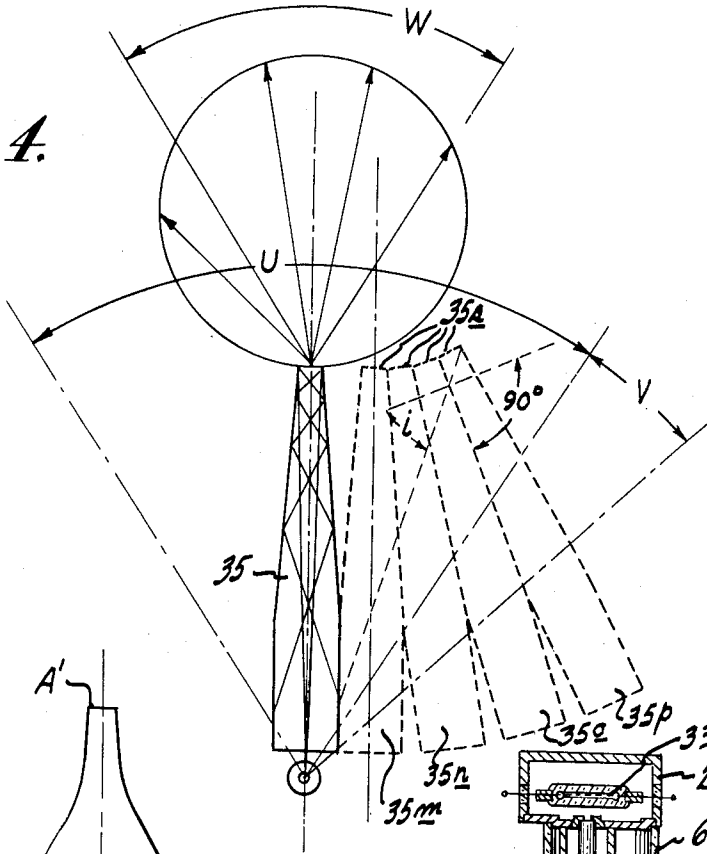
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1

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APPARATUS FOR USE IN THE MANUFACTURE OF MOSAIC SCREENS FOR COLOR-KINESCOPIES, ETC.

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1 Claim. (Cl. 95—1)

This invention relates to apparatus for use in the manufacture of color-kinescopes and other cathode-ray "CR" tubes of the kind having a plane-of-deflection and a screen-unit comprising a mask containing a multiplicity of systematically arranged apertures through which beam-electrons pass along different angularly related paths in their transit from said plane-of-deflection to respectively different ones of the dot-like or line-like elemental areas on the mosaic target-surface of a nearby screen-electrode.

While there are several possible ways of making color-screens of the mosaic variety they are usually made, commercially, either by the "silk-screen" printing method of Law U.S.P. 2,625,734 or by the "direct photographic methods" described by Law in copending application Serial No. 239,358. Both methods use a light-box or "lighthouse" comprising (i) a pedestal or table upon which a photographically sensitive glass-plate (which, in accordance with the latter method, may be the screen-plate, per se) and the "mask" of the screen-unit are supported in the required spaced-apart relationship and (ii) a source of light located at a point corresponding to the position of one of the electron-beams in the plane-of-deflection of the finished tube.

The brightness and the dimensions of the source, or "virtual" source of light in such lighthouses must of course be chosen with a careful regard to such factors as (i) the size and shape of the phosphor dots or other elemental areas which are to make up the mosaic pattern on the color-screen of the finished tube and (ii) the physical and chemical properties of the photographic emulsion used in plotting said pattern. Up to now the optical system employed in lighthouses of the general character described comprised a primary source of light such, for example, as an ultra-violet lamp, and a secondary or "virtual" source consisting of a stopping aperture containing an optically dense light-diffusing disk. The presence of the stopping aperture and its diffusion disk in the path of the light rays seriously decreases the quantity of light available at the emulsion coated plate and has dictated an exposure time of from twenty to ninety minutes. Obviously, such long exposure times contribute materially to the high cost of present day color-kinescopes and similar mosaic-screen tubes.

Accordingly, the principal object of the present invention is to provide an improved photographic "lighthouse" and one which by reason of a more efficient utilization of light-rays from an ultra-violet lamp or other conventional source of light shall effect substantial savings in exposure time and a consequent reduction in the cost of manufacturing color-screens of the subject variety.

It might at first glance appear that the foregoing object could be achieved simply by omitting the diffusion disk from the stopping aperture, or by increasing the dimensions of the aperture and said disk. However, when the diffusion disk is omitted, or made less dense, the light-rays contain an image of the primary source which is manifest by non-uniform illumination of the screen. To increase the dimensions of the aperture and its diffusion

2

disk beyond the critical size results in overlapping of the elemental areas on the mosaic screen.

The present invention provides a simple, inexpensive, compact and trouble-free means for deriving from a primary source of light a secondary "spot" source of light of great intensity and of the uniform distribution required to achieve a mosaic pattern having elemental areas of the size shape and distribution desired in a high quality color-screen. Stated generally, the foregoing objects and advantages are achieved in accordance with the invention by the provision of an optical system wherein the image of the primary source is suppressed by multiple reflection (instead of by an optically dense diffusion disk) and by conducting (instead of projecting) the light between the primary source to the secondary source or "point" from whence it is directed to the screen or screen-unit.

The invention is described in greater detail in connection with the accompanying two sheets of drawings wherein:

Fig. 1 is an elevational view, partly in section, of a photographic "lighthouse" having an optical system constructed in accordance with the principle of the present invention and showing the mask and screen-plate of a color-kinescope set up with the emulsion covered target-surface of said plate in a position to record the pattern with which the light rays from the optical system are endowed in passing through the systematic pattern of apertures in said mask;

Fig. 2 is an enlarged fragmentary view in perspective of the light-conduit of the optical system in the "lighthouse" of Fig. 1;

Fig. 3 is a view in perspective a light-conduit of an alternative form suitable for use in the said "lighthouse";

Fig. 4 is an enlarged view of the optical system of Fig. 1; the drawing being marked with lines indicative of its optical properties and performance;

Fig. 5 is a side elevational view of a multi channel light-conduit which may be used in the apparatus of Fig. 1;

Fig. 6 shows the optical system of the "lighthouse" of Fig. 1 disposed with its light-conduit projecting into the open neck of color-kinescope, so that the envelope itself comprises the "base" upon which the emulsion covered screen-plate of the kinescope is supported.

In Fig. 1, 1 designates the cylindrical metal or glass side wall of the "front end" of a color-kinescope (not shown) of the 3-gun shadow-mask variety at that stage of its manufacture whereat the inner or "target" surface of its face-plate or screen 3 has been provided with a coating 5 comprising a photographic emulsion for recording the mosaic pattern impressed thereon by reason of the presence of the tube's shadow mask 7 in the path of light rays R emanating from a point A (later described) corresponding to a point transversed by one of the three electron-beams in the tube's plane-of-deflection. Assuming that the point A in the virtual plane-of-deflection P—P is the one traversed by the "red" beam in such a kinescope, then the emulsion coating 5 on the target surface of the screen 3 may contain a red-phosphor such, for example as manganese activated zinc phosphate. (Alternatively, as taught by Rosenthal in copending application Serial No. 654,902, now abandoned, the phosphor particles may be applied by "dusting" said particles onto the light-exposed areas of the emulsion coating 5 subsequent to the removal, by the development process, of the unexposed areas.)

The apertured shadow-mask 7 (which, like the screen-plate 3, is here shown in the form of a circular section of spherical shell), is removably supported on the inner surface of the side-wall 1 as on three or more pins 11 to permit the mask to be removed from the assembly

during the three emulsion-coating and developing operations incident to laying down the three (red, blue and green) color-phosphors. It is of course necessary that the screen-unit (i.e. the screen 3 and its apertured mask 7) be aligned very accurately with respect to the point A and, to this end, the metal cylinder 1 within which said unit is supported, and the top 13 of the table or pedestal 15 upon which said cylinder is mounted are provided with a suitable indexing mechanism. The indexing mechanism here shown comprises three radially extending V-blocks 17 disposed in circumferentially spaced relationship about the central opening 19 in the table-top 13 and a similar number of pins 21 secured to a removable flange 23 about the lower edge of the cylinder 1 within which the screen-unit is mounted. The pins 21 have rounded terminals which engage the slanting sides of the V-grooves in the blocks 17 and hence provide a self-leveling, self-centering support which holds the screen-unit accurately centered on the vertical axis X—X of the pedestal.

The optical system of the lighthouse of Fig. 1 is contained within a box 25 which is mounted on a turntable or turret 27 for rotation about the central axis X—X of the lighthouse. The turntable 27 serves to bring the point A of the system to the position of any one of the three beams in the plane-of-deflection of the 3-gun color-kinescope in which the screen-unit 3, 7 is to be used. An indexing mechanism comprising a spring loaded plunger 29 which seats in appropriately spaced dwells 31 in the rim of the turntable 27 ensures the accurate location of the point A of the optical system.

The primary source of light of the optical system in the box 25 preferably comprises an ultra-violet lamp 33, such as a General Electric Co. one kilowatt high pressure mercury arc lamp, type BH6. Ultra-violet rays of a wavelength of from say, 3200 to 4500 Angstroms, are preferred because their use permits the described screen-plotting operation to be carried out practically in daylight. This small mercury-vapor lamp or tube 33 has a light-emitting central portion 33a about one inch long which is disposed with its center on an axis y—y corresponding to the axis of one of the electron-beams and parallel to the central axis x—x of the lighthouse when the turntable 27 is in any one of its three previously described positions.

In accordance with the invention, the rays R from the lamp 33 are conducted (instead of being projected) along the axis y—y to the secondary-source or point A in the virtual plane-of-deflection P—P through a tapered light conduit 35 constituted essentially of a material having a high index of refraction and of high transparency to rays of the particular wavelengths employed. Having regard also to the heat generated as an incident to the operation of the lamp 33, the conduit 35 is preferably constituted of quartz or of heat resisting glass, such as "pyrex." Optically clear fused quartz is to be preferred to "pyrex" since when the latter material was tried a somewhat longer exposure time was required to produce a mosaic screen-pattern of the desired high quality.

As shown more clearly in Fig. 2, the conduit 35 comprises a solid quartz rod of cylindrical shape near its base 35b and tapering in the form of a truncated cone to the apex 35a, which is located at the "point" A in Fig. 1. The apex may be flat, as in Fig. 1, or hemispherical as shown in Fig. 2. The diameter of the apex is chosen to produce the correct size of phosphor dot (or "line") on the screen 3, and is a function of tube geometry, brightness of source and exposure time. Instead of a cylindrical base, the conduit may, as shown in Fig. 3, have a base 35s of square cross-section which gradually blends into the conical shape as it approaches the apex 35a.

Fig. 4 illustrates how the optical system of the lighthouse operates to collect, conduct and project the opti-

mum quantity of light from the remotely disposed lamp 33 onto the screen unit (3, 7 Fig. 1) while suppressing the image of the lamp or "primary source" 33. This drawing shows the path of the light rays constructed, geometrically, as indicated by the dotted lines, to show the tapered conduit 35 in adjacent mirror positions 35m, 35n etc. such that the paths of the rays become virtually straight lines. Where the light rays intersect the dotted mirrored apex surfaces 35s in the drawing the light rays reach the real apex surface 35a by multiple internal reflections, as indicated by the solid lines in the conduit 35. The only light rays V which do not reach the apex of the conduit have an angle of incidence i , at some internal reflection point, less than the critical angle of the particular conduit material. Because the light rays U that do reach the apex go through several reflections within the conduit 35 the primary source 33 is no longer imaged; hence a very lightly etched diffusing surface on the apex suffices to make the virtual source A of uniform intensity over the entire cone angle W. Here, obviously, a much larger percentage of light reaches the screen (3 Fig. 1) than in the prior art wherein the secondary source comprises a stopping aperture containing an optically dense diffusing disk.

The invention is not limited to the use of a single channel light-conduit. Thus, referring now to Fig. 5, it is possible further to improve the light output by the use of several quartz rods 45, 47, 49, 51, 53 disposed about the periphery of the lamp 33, to collect a greater proportion of the available light, and fused together adjacent to their ends to provide a single secondary-source or apex A'.

Referring now to Fig. 6: as taught by Dr. Zworykin in copending application Serial No. 400,040, the Law "direct photographic" methods of laying down a mosaic pattern of color-phosphors may be carried out in a CR tube 55 wherein the mask 57 and screen 59 are already permanently mounted within the tube. Thus, instead of employing a pedestal or table, similar to the one shown in Fig. 1, in the photographic plotting operations, the envelope of the tube per se may be used as the "lighthouse." The optical system of the present invention lends itself readily to Zworykin's teachings which, thus far, have been limited in their useful application to tubes having a neck of sufficient diameter to accommodate a primary source of light. In accordance with the present invention the primary source, i.e. the lamp 33 may be disposed beyond the open neck 61 of the envelope and the light from said source conducted to the tube's plane-of-deflection P—P through a light conduit 35 which fits easily within said neck.

From the foregoing description it should now be apparent that the present invention provides a simple, inexpensive, compact and trouble-free means for deriving, from a primary source of light, a secondary "spot" source of light of great intensity and of the uniform (shadow-free) distribution required to achieve a mosaic pattern having elemental areas of the size, shape and distribution desired in a high quality color-screen.

What is claimed is:

Apparatus for photographically recording upon an emulsion covered surface the relative locations of the elemental areas of a screen of the mosaic variety for use in an electron-tube of the kind containing an apertured mask through which beam-electrons pass along different angularly related paths in their transit from different points in a plane-of-deflection to respectively different ones of said elemental mosaic screen areas, said apparatus comprising: a base having an opening therein to permit the passage therethrough of light rays emanating from any of several spaced points in a reference plane corresponding to said plane-of-deflection, means disposed on said base for holding said mask and said emulsion covered surface in the same relative position with respect to said reference plane that said mask and said screen

are to occupy with respect to said plane-of-deflection in said electron-tube whereby said emulsion is exposed to the pattern of light with which said light rays are endowed by the presence of said apertured mask in their path, a turntable mounted for movement in a plane spaced from said reference plane, a source of light mounted on said turntable, a light-conduit mounted on said turntable with its input terminal adjacent to said light-source and its output terminal adjacent to said reference plane, and indexing means associated with said turntable for moving said light-conduit to a position whereat its output terminal is in register with a selected one of said points in said reference plane.

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