

July 17, 1956

A. M. MORRELL

2,755,402

COLOR KINESCOPIES OF THE MASKED-TARGET DOT-SCREEN VARIETY

Filed Sept. 28, 1953

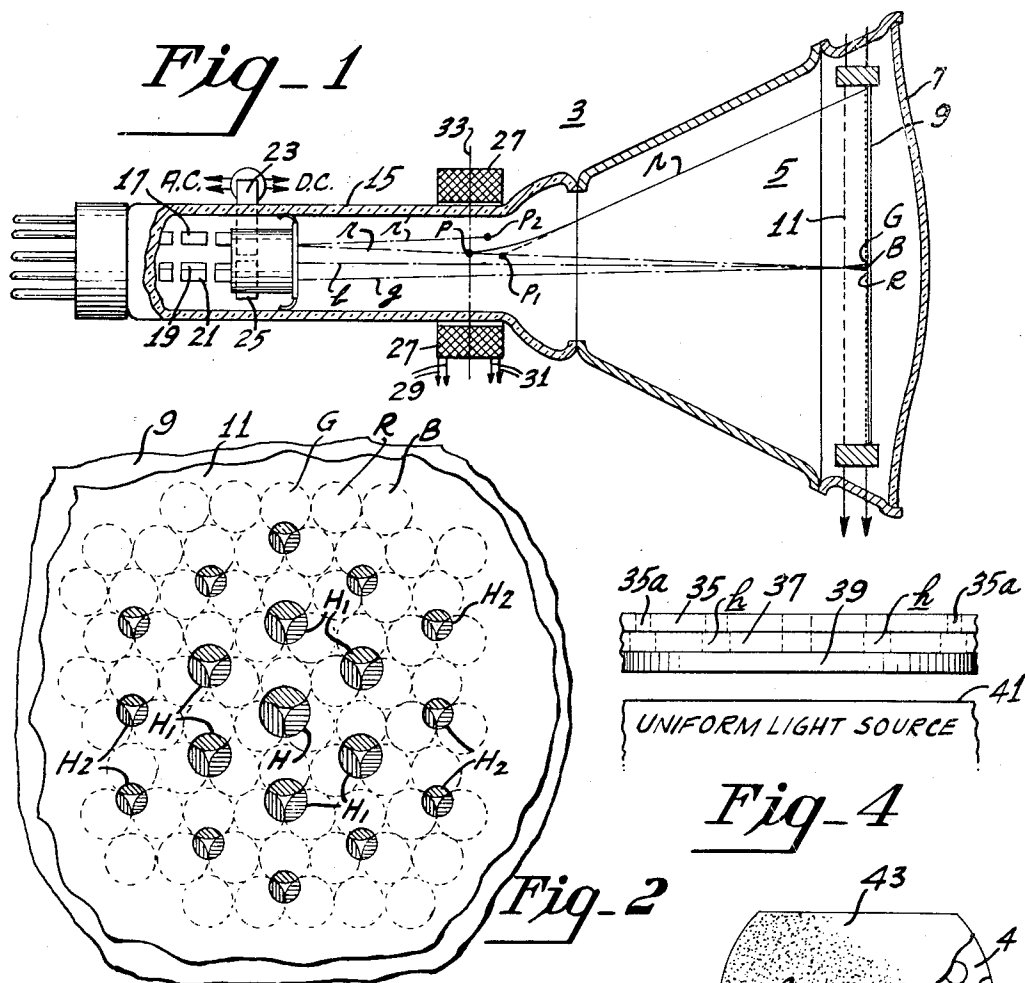
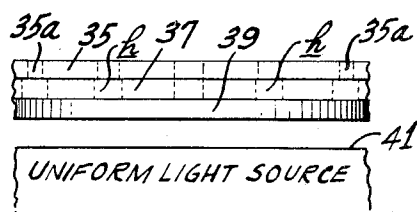


Fig-4

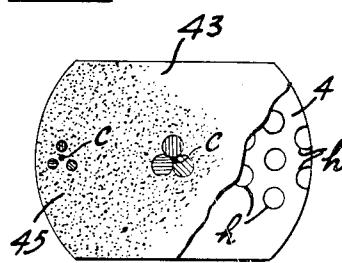
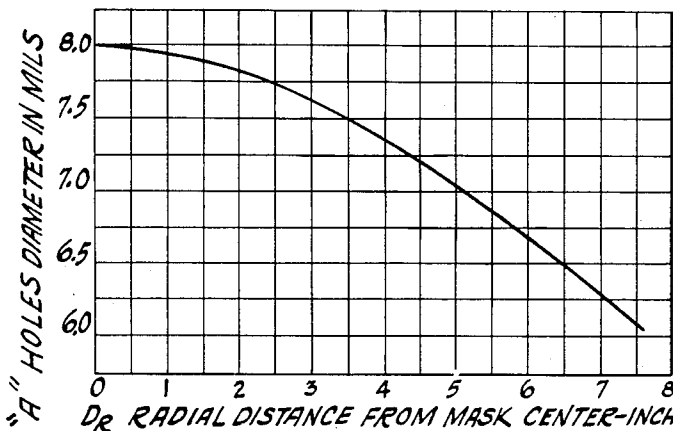


Fig-5



INVENTOR.
ALBERT M. MORRELL

BY *Rodolph M. Maler*
ATTORNEY

1

2,755,402

COLOR KINESCOPES OF THE MASKED-TARGET
DOT-SCREEN VARIETYAlbert M. Morrell, East Petersburg, Pa., assignor to Radio
Corporation of America, a corporation of Delaware

Application September 28, 1953, Serial No. 382,620

6 Claims. (Cl. 313—70)

This invention relates to improvements in color-kinescopes of the so-called "masked-target dot-screen" variety. Such color kinescopes are exemplified by Goldsmith 2,630,542 and Schroeder 2,595,548 (Fig. 6).

Color-kinescopes of the kind with which the present invention is especially concerned usually contain three electron-guns (i. e., one for each of the primary colors). The guns are trained upon a bi-part screen-unit consisting, essentially, of (i) a transparent viewing screen having a target-surface made up of a multiplicity of groups of different (e. g., red, blue and green) dot-like color-emissive areas and (ii) a foraminous electrode or "shadow-mask" mounted adjacent to the target surface of the screen. Electrons from the three guns approach the screen-unit along a plurality of angularly related paths which, ideally, converge in the plane of the mask and pass through the mask-apertures in the form of miniature beams or "jets" which strike the dots of the particular color allotted to each gun.

The color-dots on the screen-plate of color-tubes of the subject variety are usually contiguous one another. Hence, if the diameter of an electron "jet" at the plane of the screen is the same as the diameter of a color-dot (as it must be if maximum light-output is to be achieved), the jet will illuminate more than one color unless it impinges squarely on the center of the particular dot toward which it was directed.

An electron-jet will impinge squarely on the right dot only if the virtual area of origin of the beam from which that jet was derived is at a particular fixed point or "color center" in the tube's plane-of-deflection. Usually, however, there is no such fixed point. That is to say, during the scanning movements the color-centers of the beams move $\frac{1}{16}$ ", more or less, along the central axis of the tube, as determined by the maximum angle through which the beams are deflected during said scanning movements. Furthermore, when, as is usually the case, the kinescope is provided with one or more auxiliary coils or magnets for "dynamically converging" the three beams throughout the scanning movement, the color-centers are shifted in off-axis directions. Stray magnetic-fields may also cause undesired movement of the color-centers. Such axial and off-axis movements of the color-centers cause the electron-jets to strike the color-dots off-center and to infringe upon the adjacent dots of other color-response characteristics. As a consequence, color-purity is adversely affected, especially near the edges of the screen where the beams approach the limit of their scanning movement.

Accordingly, the principal object of the present invention is to provide an effective yet simple and inexpensive method of and means for minimizing color-dilution resulting from shifting of the "color-centers" of the electron-beams during their scanning movement in color-tubes of the "masked-target dot-screen" variety.

The foregoing and related objects are achieved in accordance with the preferred embodiment of the present invention by decreasing the relative diameter of the electron-jets, with respect to the diameter of the individual

2

color-areas, as a function of the instantaneous distance of the electron-beams from the center of the mask during the beams scanning movement. Thus, as the beams approach the boundaries of the screen, the electron-jets, derived from said beams, gradually decrease in size and, as consequence, may strike the dot-like color areas off-center without infringing upon the next adjacent color-area or areas.

The invention is described in greater detail in connection with the accompanying single sheet of drawings wherein:

Fig. 1 is a partly diagrammatic longitudinal sectional view of a 3-gun tri-color kinescope of the "shadow-mask dot-screen" variety, the drawing being marked with lines indicative of the shift in the color-centers of its three dynamically converged beams as they approach their maximum angle of deflection;

Fig. 2 is a fragmentary rear elevational view of the screen-unit of the color-kinescope of Fig. 1, showing a variation in size of the mask-holes, as dictated by the present invention;

Fig. 3 is a chart showing a preferred correlation between mask-hole diameter and radial distances of said holes from the center of the mask;

Fig. 4 is a fragmentary side elevational view of a light-box including a variable-density filter and a photographic plate which may be used in plotting the size and relative locations of the mask-apertures of Fig. 2; and

Fig. 5 is a rear elevation of a color-screen unit showing an alternative embodiment of the invention.

The color-kinescope shown in Fig. 1 comprises an evacuated glass or metal envelope 3 having a main chamber 5 which terminates at its large end in a window 7 through which the obverse face of the glass viewing screen 9 of a bi-part screen unit 9—11 is visible. As shown more clearly in Fig. 2, the viewing screen 9 is of the well-known "dot-screen" variety. As in Fig. 6 of Schroeder 2,595,548, it is provided on its rear or target surface with a multiplicity (e. g., 300,000 or more) of groups of red (R), blue (B) and green (G) phosphor dots arranged in a "hexagonal" pattern, that is to say, each dot is surrounded by six other dots, alternate ones of said other dots being of a second color and the intermediate ones of said other dots being of a third color. The dots are preferably, but not necessarily, all of the same size and may be laid down on the screen-plate by any suitable method, such, for example, as the silk (or metal) screen method described in Law 2,625,734.

The other element or "shadow mask" of the screen-unit comprises a thin metal plate 11 containing a multiplicity of apertures arranged in the same (hexagonal) pattern as the ray-sensitive screen-areas; there being one mask-aperture for each group (of three) dot-like screen-areas. In accordance with the present invention and as described later on in this specification, the apertures or holes H, H1, H2, etc. in the mask are not of a uniform size but, as shown in Fig. 2, are of substantially uniformly decreasing sizes as measured outwardly from the center of the array.

The other or small end of the envelope 3 terminates in a tubular glass neck 15 which contains a battery of three electron-guns 17, 19 and 21 each of which is allotted to a particular screen color. The guns are arranged delta (Δ) fashion as disclosed in Schroeder 2,595,548 and, in the instant case, are shown provided with internal pole pieces 23, 25 for maintaining the beams converged in the plane of the mask 11 throughout the scanning movement, as in applicant's copending application, Serial No. 364,041, now U. S. Patent 2,752,520, patented June 26, 1956. Here, as in the Schroeder patent the required horizontal and vertical scanning movements are applied to all three of the electron beams *r*, *b* and *g* by a common deflecting yoke 27 which will be understood to comprise two pairs

of electromagnetic coils (indicated by the double current-leads 29—31) disposed at right angles to each other on the neck 15. As indicated by the single vertical line 33 the "normal" plane-of-deflection (or "center-of-scan") for the three beams *r* (red), *b* (blue) and *g* (green) extends through the scanning yoke 27.

The "plane-of-deflection" or "center-of-scan," mentioned in the preceding paragraph, may be defined as the plane or virtual plane in which the three "color-centers" are located, i. e. the points in which the axis of each deflected beam, when extended rearwardly, intersects the axis of origin of that beam. When the three beams are undeflected, i. e., when they are directed to the center of the target, the "normal" plane-of-deflection usually crosses the central axis of the tube at or near the center of the yoke 27, as indicated by the line 33, and the color-centers of the several undeflected beams lie in said plane as indicated by the points P.

The fact that the plane-of-deflection, and hence the color centers of the beams, are not fixed but gradually shift their positions as the beams depart from the center of the screen unit, is illustrated in Fig. 1 wherein the "red" beam *r* is shown in solid lines at one limit of its scanning movement. Here it will be observed, the path of the beam curves outwardly as it leaves the yoke 27 and, thereafter, moves in a straight line to the screen unit. If this straight portion of the red beam-path *r* is projected rearwardly, as indicated by the broken line-segment, it will intersect the axis of origin of the red beam at a new "color center" P¹ which is removed $\frac{1}{16}$ " or so forwardly of its original color-center P. The shifting of the color-centers is especially complicated when, as in Fig. 1, "dynamic convergence" is employed. For example, where the kinescope is provided with internal pole pieces 23—25 (as in applicant's copending application Serial No. 364,041, now U. S. P. 2,752,520), or with an auxiliary electromagnetic coil, or electrostatic lens system not shown, for maintaining the three beams converged in the plane of the mask throughout their scanning movement. The color-centers ordinarily shift in a direction normal to the above described "forward" shift, so that the actual color-center is at some radially displaced "forward" location such as the point P². As previously mentioned, it is the constant shifting of the color-centers during the scanning movement that causes the electron-jets in the mask-to-screen space to strike the phosphor-dots (R, B and G) off-center.

In applying the invention to a three-gun shadow mask tube employing dynamically converged beams, wherein the diameter of the screen was approximately 16 inches, and wherein the target surface of the screen contained 342,000 groups of red, blue and green phosphor dots (i. e., a total of 1,026,000 dots), each approximately .0136 of an inch in diameter, it was found that color-dilution resulting from shifting of the color centers of the three electron-beams was substantially eliminated by the use of a graded-hole shadow-mask wherein the holes were approximately .008 of an inch in diameter adjacent to the center of the mask and gradually decreased in diameter to approximately .006 of an inch at the edges, or limit of scan, as indicated by the curve in the chart of Fig. 3. As in a conventional shadow mask tube, the jets expand slightly in their transit to the screen. Thus, a jet formed by an .008" hole near the center of the mask covered an area of about .011" of a .0136" phosphor dot. Having regard for manufacturing tolerances, this is about the optimum coverage for maximum light output. However, since the jets formed by the graded mask-holes gradually decrease in diameter as the beams approach the limits of their scanning movements, they covered less and less of the total area of each dot. As a consequence, although the jet "wobbled" (as a result of the shift in the color center of the beam from which that jet was derived) and struck the color-dots off-center, it did so without overlapping the periphery of that dot

or impinging upon the adjacent dots. The decreased light output at the edges of the screen caused by the smaller holes was scarcely noticeable since the decrease was gradual and was less than two-to-one compared with the center of the screen.

There are several ways of making a graded-hole shadow-mask and the present invention is not especially concerned with the particular technique selected for its manufacture. However, in the interest of completeness, one such technique is illustrated in Fig. 4. This technique or method involves the use of a photographic plate 35, a shadow-mask 37 having apertures *h* of uniform size and a so-called graded light-filter 39. The uniform apertures in this mask 37 must of course have the same (hexagonal) pattern of distribution as that desired in the graded mask and may be formed, for example, in the manner disclosed in Law 2,625,734. Graded light-filters are well known in the photographic art and may be made either (a) by photographing a white back-ground which is illuminated in such a way (e. g., as by a spot-light) as to provide high brightness at the center of the photograph and decreasing brightness toward its edges or (b) by exposing a photographic plate or film close to a point source of light and then photographically reversing the exposed film. When the graded filter 39, the uniformly apertured mask 37 and the photographic plate 35 are exposed to a uniform light source 41, as in Fig. 4, more light will pass through the center of the filter 39 and mask 37 than through their intermediate and edge portions. Hence in the resulting dot-like photographic pattern on the plate 35 the dots 35a are of decreasing diameter in the direction of the edges of the plate. This graded-dot pattern is then reproduced, photographically, on the blank metal sheet (not shown) from which the shadow-mask is to be formed and is subjected to an acid bath which provides the sheet with a graded pattern of apertures corresponding to the graded dot-like photographic pattern 35a on the plate 35. Instead of using a conventional photographic plate in the plotting operation and subsequently transferring the dot-like photograph thereon to the mask-blank, the blank itself may be coated with a photographic emulsion and exposed directly to the light rays passing through the mask.

Referring now to Fig. 5: The objects of the invention can also be achieved by the provision of a screen-unit 41—43 wherein the holes *h* in the shadow-mask 41 are of uniform (instead of non-uniform) diameter and the dots R, B and G on the screen-plate 43 are of non-uniform (instead of uniform) diameter. However, since the center of each color-dot in each group must remain a given distance from the center *c* of the corresponding mask aperture, any reduction in size of the color-dots can only be achieved by increasing the separation of the dots. Separating the color-dots exposes the light-reflecting electron-pervious metal (e. g., aluminum) film 45 on the target surface of the screen. Hence the light-reflected from the exposed portions of said film may distract the attention of the observer.

From the foregoing description it should now be apparent that the present invention provides an effective yet simple and inexpensive method of and means for minimizing color-dilution resulting from shifting of the color-centers of the electron-beams during their scanning movement in color-tubes of the "masked-target, dot-screen" variety.

What is claimed is:

1. A television screen-unit comprising a screen-plate having a dot-like pattern of ray-sensitive elements on the target surface thereof, in combination with a shadow-mask mounted in spaced relationship with respect to said target surface and containing a multiplicity of dot-like aperture elements arranged in a pattern which is systematically related to the pattern of dot-like elements on said screen-plate, the dot-like elements comprising one of said patterns being of substantially uniform diam-

5

eter and the dot-like elements comprising the other of said patterns diminishing in diameter outwardly from a region of maximum diameter near its center.

2. A television screen-unit comprising a screen having a target-surface made-up of a multiplicity of systematically arranged dot-like ray-sensitive areas of substantially uniform size, in combination with a shadow-mask disposed in spaced relationship with respect to said target-surface and containing a pattern of apertures which is systematically related to that of said dot-like ray-sensitive areas, the apertures in the outer portion of said pattern of apertures being smaller than those near its center.

3. A screen-unit comprising a screen having a target surface made up of a multiplicity of dot-like ray-sensitive areas of substantially uniform diameter, in combination with a shadow-mask disposed in registered relationship with said target surface and containing an array of dot-like apertures of different sizes decreasing in diameter outwardly from the center of said array.

4. In a color-kinescope of the kind wherein a plurality of electron-beams are subjected to a scanning movement and pass along discrete angularly related paths through the apertures of a foraminous mask in the form of electron-jets of reduced diameter in their transit to respectively different dot-like color-areas on a nearby screen, the improvement which comprises: means for altering the relative diameter of said electron-jets with respect to the diameter of said dot-like color-areas as a function of the instantaneous distance of said electron-beams from the center of said mask during said scanning movement.

5. In a multiple-beam color-kinescope wherein the electron-beams scan a screen-unit of the kind comprising a

6

mask containing a multiplicity of dot-like apertures through which beam-electrons normally pass in the form of electron-jets of reduced diameter in their transit to pre-selected dot-like color-areas on the target-surface of a nearby screen, the improvement which comprises: means for decreasing the relative diameter of said electron-jets with respect to the diameter of said color-areas as a function of the instantaneous distance of said electron-beams from the center of said mask.

6. In a multiple-beam color-kinescope wherein the electron-beams are subjected to dynamic convergence during the scanning of a screen-unit of the kind comprising a mask containing a multiplicity of dot-like apertures through which beam-electrons normally pass in the form of discrete electron-jets of reduced diameter in their transit to pre-selected dot-like color-areas of substantially uniform diameter on the target-surface of a nearby screen, the improvement which comprises: means for decreasing the relative diameter of said electron-jets with respect to the uniform diameter of said color-areas as a function of the instantaneous distance of said dynamically converged electron-beams from the center of said mask.

References Cited in the file of this patent

UNITED STATES PATENTS

2,611,099	Jenny	Sept. 16, 1952
2,663,821	Law	Dec. 22, 1953
2,675,501	Friend	Apr. 13, 1954
2,687,493	Kirkwood	Aug. 24, 1954
2,716,718	Sonnenfeldt	Aug. 30, 1955