May 26, 1970 D. J. DONAHUE ET AL 3,514,287

PHOTOGRAPHIC METHOD FOR MAKING TRI-COLORED CATHODE RAY SCREEN

Filed Oct. 9, 1961

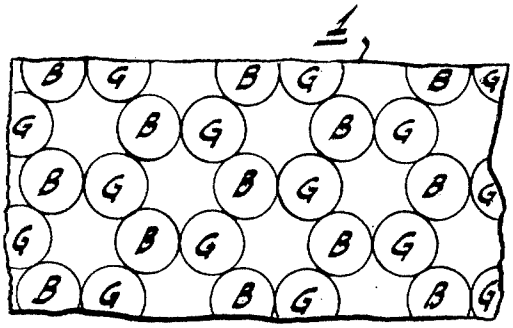


Fig. 1.

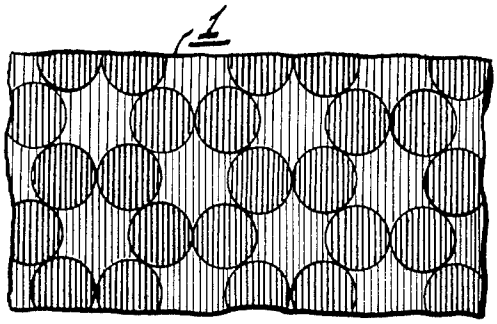


Fig. 2.

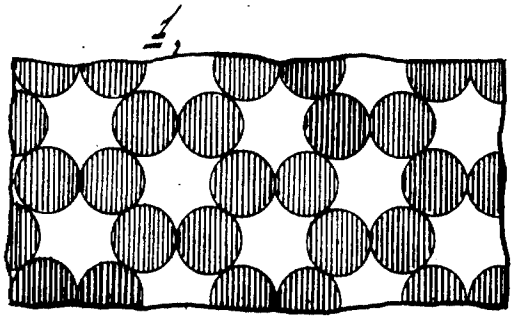


Fig. 3.

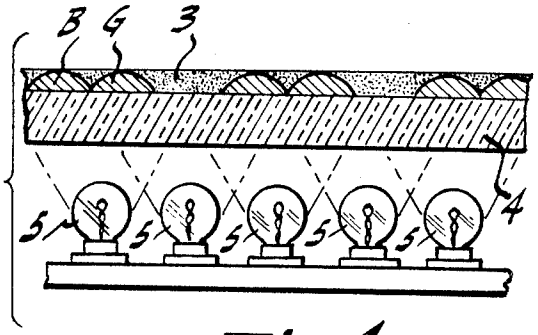


Fig. 4.

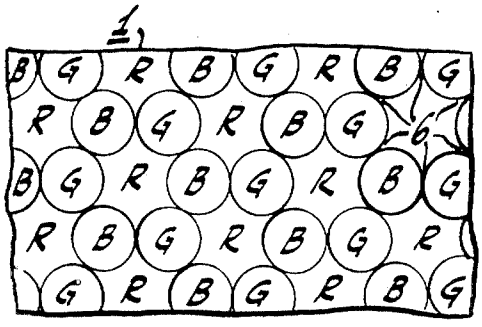


Fig. 5.

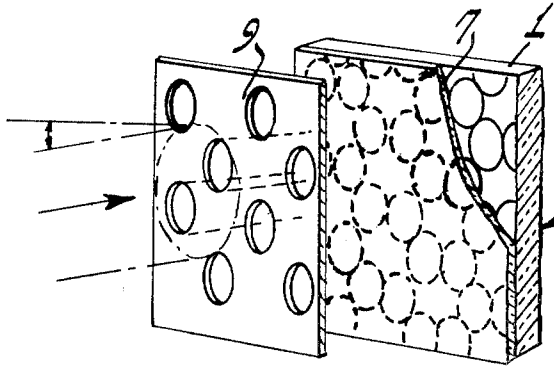


Fig. 6.

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United States Patent Office 3,514,287 Patented May 26, 1970

3,514,287

PHOTOGRAPHIC METHOD FOR MAKING TRI-COLORED CATHODE RAY SCREEN

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Filed Oct. 9, 1961, Ser. No. 143,927
Int. Cl. G03c 5/16; H01j 29/18
U.S. Cl. 96—36.1 6 Claims

This invention relates to improvements in color-phosphor screens and has special reference to improvements in the so-called direct photographic method of laying down a mosaic of color-phosphors on a glass substrate for use as the electron-sensitive screen of a color-kinescope or the like.

As presently practiced the direct photographic method of making color-phosphor screens of various dot-like and line-like mosaic varieties consists essentially of the following steps:

(i) applying to the target surace of a glass screen-plate a slurry layer comprising phosphor particles of one color contained in a photosensitized organic gel, e.g., dichromated polyvinyl alcohol;

(ii) drying the slurry layer;

(iii) exposing said phosphor-containing photosensitized layer to actinic rays through the apertures in a suitable optical stencil or mask whereby photographically to record the pattern of dots (or lines) of said one color upon said target surface;

(iv) washing the plate to develop the photograph thereon;

(v) drying the phosphor-containing photograph;

(vi) repeating the preceding steps for each of the other colors, with the source of actinic rays disposed at an appropriately different position with respect to said stencil; and, finally

(vii) baking-out the screen to volatilize and remove the light-hardened polyvinyl alcohol or other organic gel therefrom.

In the direct photographic method, above described, the body color of the phosphor in any given slurry layer is a major factor in determining the exposure time required to record the pattern of the stencil in the photosensitized gel of that layer. In the manufacture of present day color-screens, the slurry layer that contains the green-emitting phosphor (e.g., zinc cadmium sulfide) and the one that contains the blue-emitting phosphor (e.g., silver activated zinc sulfide) are of light body colors, and each requires an exposure time of less than 10 minutes (actually about 8 minutes). On the other hand, the slurry layer that contains the red-emitting phosphor (e.g., silver activated zinc cadmium sulfide) has a dark body color, and requires an exposure time of more than 20 minutes (actually 24 minutes). The long exposure time required to form the red-emitting elemental areas of the mosaic is due to its dark body color and is a significant factor in determining the cost of present day color-kinescopes.

Accordingly, it is an object of the present invention to cut costs by effecting a substantial reduction in exposure time.

The foregoing and related objects are achieved in accordance with the invention by (i) laying down those elementary areas of the mosaic that are allotted to the color-phosphors of the relatively light body-colors in any usual way (e.g., with the stencil and a point source of light disposed on the target side of the glass screen-plate), (ii) subjecting said elementary areas of the mosaic to the action of a thermally decomposable organic dye to render them temporarily opaque to actinic rays, (iii) covering said target surface and the opaque phosphor-containing

areas thereon with a photosensitized organic gel containing phosphor particles of the relatively dark body-color, then (iv) flood-lighting or otherwise exposing the entire obverse surface of the screen-plate to harden those photosensitized areas of the gel which are not shielded from said rays by said temporarily opaque elemental areas of said mosaic. The screen-plate may then be washed to develop the resulting photograph by removing the unhardened areas of the gel, and thereafter baked to remove both the light-hardened gel and the thermally decomposable organic dye.

If the pre-formed elemental areas of the mosaic are inherently sufficiently opaque to the actinic rays employed in forming the dark body color phosphor areas, the dyeing step may be omitted. Thus, said areas need not be dyed where the concentration of the light body-color phosphor particles is sufficient to render them opaque, or when the gel in which said particles are contained has been "tanned" by prolonged exposure. In using the pre-formed elemental areas of the mosaic as the stencil for laying down the phosphor of the dark body-color, the exposure time of the latter has, in practice, been reduced to a value even lower than that required in laying down the elementary areas of the phosphors of the light body-colors.

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

FIG. 1 is a partial plan view of a tri-color phosphor mosaic in that stage of its manufacture whereat the elemental areas of the mosaic which are allotted to two of the three colors have already been laid down in the form of circular dots B (blue) and G (green) on the target surface of a glass screen-plate;

FIG. 2 is a view similar to FIG. 1 but with the drawing shaded to indicate that the screen-plate and the phosphor dots thereon have been treated with an opaque dye;

FIG. 3 is a view similar to FIG. 1 but with the dye removed from the bare parts of the glass and confined to the phosphor dots;

FIG. 4 is a sectional view of the screen of FIG. 3 after being coated over its target surface with a phosphor slurry of the third color, and with the entire obverse surface of the screen-plate exposed to actinic rays whereby to harden those areas of the slurry which are not shielded from said rays by the temporarily opaque elemental areas of the mosaic;

FIG. 5 is a partial plan view of a tri-color phosphor dot-screen made in accordance with the method of the invention; and

FIG. 6 is a view in perspective showing the dot-like mosaic of FIG. 5 provided with a specular metal layer and used as the screen element of a target assembly of a color-kinescope of the "masked target" variety.

In the accompanying drawing, the invention is illustrated as applied to the manufacture of a 3-color phosphor mosaic made up of a multiplicity (usually 300,000 or more) of "triads" (i.e., groups of three) of blue (B), green (G), and red (R) color-phosphor dots. FIG. 1 shows such a screen in that stage of its manufacture whereat the dot-like elementary areas of the mosaic that are allotted to the color-phosphors of the two light body-colors have already been laid down in the form of non-porous yet translucent circular dots G (green) and B (blue) on the inner or target surface of a glass screen-plate **1**. At this stage the phosphor particles of which the dots G and B are respectively made up are contained in a light-hardened photosensitized organic gel such, for example, as polyvinyl alcohol. The phosphor particles may be added to the gel either before or after the separate patterns (G and B) have been formed.

In the latter case, if the gel has already been hardened, it may be rendered tacky, e.g., by treating it with sodium hydroxide prior to "dusting on" the phosphor particles of the appropriate color.

To permit the screen-plate and its phosphor dots G and B to be used as an optical stencil in laying down the third (dark body-color) phosphor it is desirable to render the translucent gel in said dots as opaque as possible to the actinic rays employed in forming the elementary areas or dots of the third color. One way of accomplishing this is by subjecting the target surface of the screen-plate, and hence the gel in the green and blue phosphor dots, to the action of a solution containing thermally decomposable organic dye, permitting the dye to dry and thereafter washing the plate to remove the dye from the bare glass which lies between the now opaque dots G and B. One dye especially suitable for this purpose is "Congo red," used in a solution of 2 grams of dye dissolved in 100 milliliters of demineralized water. Although other dyes (e.g., Pontacyl Rubine R and Pontamine Fast Red 8 BLX and Chromacyl Pink-BN) may be used for the purpose, "Congo red" is preferrred because (a) it is highly adsorbed by the light-hardened polyvinyl alcohol of the phosphor dots G and B, and (b) it increases the opacity of the dots by a factor of from 5 to 10. The dye solution may be applied to the target surface of the plate in the form of a spray, or by rinsing. FIG. 2 shows the target surface of the screen-plate covered all over with the dye and FIG. 3 shows the screen-plate subsequent to being washed, i.e., with the dye (indicated by the hatching) removed from the bare glass between the dots B and G.

The dots B and G which contain the phosphors of the lighter body-colors having been rendered opaque by the dye, the screen-plate is now in a condition to have the third phosphor applied. To this end, the target surface of the screen-plate, and the preformed dots B and G thereon, are first covered with a photosensitized slurry layer **3** (FIG. 4) containing the particles of the dark body-color phosphor. One satisfactory slurry formulation is:

Phosphor=275 gms. red phosphor (silver activated zinc cadmium sulfide)
Oragnic gel=550 gms. polyvinyl alcohol solution (10% p.v.a. by weight)
Humectant=22 gms. ethylene glycol
Photosensitizer=55 gms. ammonium dichromate
Carrier=375 gms. demineralized water

The humectant in this otherwise conventional slurry serves to rewet and to swell the organic gel in the previously developed phosphor-containing elementary areas B and G of the mosaic, and thus minimizes intermingling of the color-phosphor in the last applied slurry layer with the color phosphor in either of the previously developed elementary areas B, G.

When the slurry layer **3**, FIG. 4, has been dried, preferably at room temperature, the obverse surface **4** of the screen-plate is presented to a source of actinic rays, exemplified by a bank of ultra-violet emitting fluorescent lamps **5**, to harden those photosensitized areas of the gel which are not shielded from said rays by the temporarily opaque areas G and B of the mosaic. The fact that the light rays may be diffused in passing through the glass, or scattered by some imperfection in the glass, is of no significance, because the gel in the first applied dots G and B has already been hardened by the rays employed in forming said dots.

In one practical embodiment of the invention, involving the manufacture of a 3-color, 21" screen, wherein a bank of six General Electric Co. BL360 lamps were disposed about 6 inches in front of the screen-plate, the exposure time for the phosphor-containing gel of the preceding formula was 7 minutes. Upon developing the resulting photograph in the usual way, i.e., by spraying it with water to remove the unhardened phosphor-containing gel, the unique mosaic pattern of phosphor dots G, B, R, shown in FIG. 5, was obtained.

The pattern of the 3-color phosphor-dot screen shown in FIG. 5 is similar in two respects with the pattern employed in present-day color-kinescopes, that is to say (a) the dots are tangent to each other and (b) are arranged in "hexagonal" pattern, i.e., 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 pattern of this screen, however, differs from that of a conventional 3-color dot-screen in that here the dots (R) of the dark-body color, instead of being circular in outline, have sixe ceretoid cusps **6** which cover the otherwise bare glass between the dots of the other two color-phosphors (G and B). As a consequence, when, as is usually the case, the target surface of the screen is provided with an electron-transparent specular metal layer **7** (FIG. 6) no ambient light can reach the specular metal through the glass and the screen is thus free from the optically disturbing effect known as "aluminum shine," which shine is characteristic of the phosphor screens of the prior art wherein all of the dots are circular.

As previously mentioned, the dye normally employed in the practice of the invention is of a kind that decomposes when subjected to heat. It is thus removed, with the organic gel, when the screen is "baked-out," subsequent to being aluminized in the usual way. As indicated by the presence of an apertured mask **9** in FIG. 6, the dot-screen of the invention, as herein described, may be used as the screen element of the color-kinescope of the well-known masked target variety.

What is claimed is:

1. Method of laying down the last color-phosphor of a multicolor phosphor mosaic upon a glass screen-plate having a target-surface upon which the elemental areas of the mosaic that are allotted to other than the last of said color-phosphors have previously been applied, said method comprising: covering said target surface and the previously applied elemental phosphor covered areas thereon with a layer of photosensitized light-hardenable organic gel containing particles of said last color-phosphor, exposing the entire obverse surface of said glass screen-plate to actinic rays to harden those parts of said layer that are not shielded from said rays by said previously applied phosphors, and thereafter washing said screen-plate to remove the unexposed portions of said layer.

2. Method of laying down a mosaic pattern of color-phosphor particles of respectively light and dark body-colors upon the target surface of a translucent screen-plate, said method comprising: depositing upon said target surface those elemental areas of said mosaic that are allotted to the color-phosphor particles of said light body-color, covering said target surface and the phosphor containing areas thereon, with a photosensitized light-hardenable organic gel containing phosphor particles of said dark body-color, exposing the entire obverse surface of said translucent screen-plate to actinic rays to harden those photosensitized areas of said layer which are not shielded from said rays by said elemental areas of said mosaic, and then developing the resulting photograph.

3. In a method of applying the third color-phosphor of a 3-color phosphor-mosaic to a glass screen-plate having a target-surface upon which the elemental areas of the mosaic that are allotted to two of said three color-phosphors have already been applied, the step which comprises: subjecting said two elemental areas of said mosaic to the action of an organic dye to render said elemental areas opaque to actinic rays and thus to permit said elemental areas to be used as the opaque areas of an optical stencil in photographically laying down the third of said color-phosphors upon said screen-plate with the

aid of a light-source positioned adjacent to the obverse surface of said screen-plate.

4. Method of laying down the third color-phosphor of a 3-color phosphor-mosaic upon a glass screen-plate having a target-surface upon which the elemental areas of the mosaic that are allotted to two of said three color-phosphors have already been applied, said method comprising: subjecting said elemental areas of said mosaic to the action of an organic dye to render said elemental areas opaque to actinic rays, covering said target-surface with a layer of photosensitized light-hardenable organic gel containing phosphor particles of the other of said three colors, exposing the entire obverse surface of said glass screen-plate to actinic rays whereby to harden those parts of said layer which are not shielded from said rays by said opaque elemental areas of said mosaic, and thereafter baking said screen-plate to remove said organic gel and said organic dye therefrom.

5. Method of laying down a mosaic pattern of color-phosphor particles of respectively light and dark body-colors upon the target surface of a translucent screen-plate, said method comprising: depositing upon said target surface those elemental areas of said mosaic that are allotted to the color-phosphor particles of said light body-color, subjecting said elemental areas of said mosaic to the action of an organic dye to render said areas opaque to actinic rays, covering said target surface, and the opaque phosphor-containing areas thereon, with a photosensitized light-hardenable organic gel containing phosphor particles of said dark body-color, exposing the entire obverse surface of said translucent screen-plate to actinic rays to harden those photosensitized areas of said layer that are not shielded from said rays by said opaque elemental areas of said mosaic, developing the resulting photograph, and thereafter baking said screen-plate to remove said light-hardened organic gel and said organic dye therefrom.

6. A method of manufacturing a display screen for a cathode ray tube comprising the steps of depositing at least two luminescent materials emitting light of different spectral distributions when excited by electrons on selected areas of a transparent support, placing over the selected areas of the support a filter relatively opaque to radiation transmitted through the support; depositing another luminescent material mixed with a photosensitive hardenable binder on areas of said support between the areas covered by the first luminescent material, said latter luminescent material emitting light of a different spectral distribution than that of said first mentioned luminescent materials, exposing the binder through the support to radiation which is capable of hardening the binder except for the areas covered by the first mentioned luminescent materials, and removing the unexposed binder covering the first mentioned luminescent materials.

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117—33.5; 313—92