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PROCESS FOR PHOTOGRAPHICALLY
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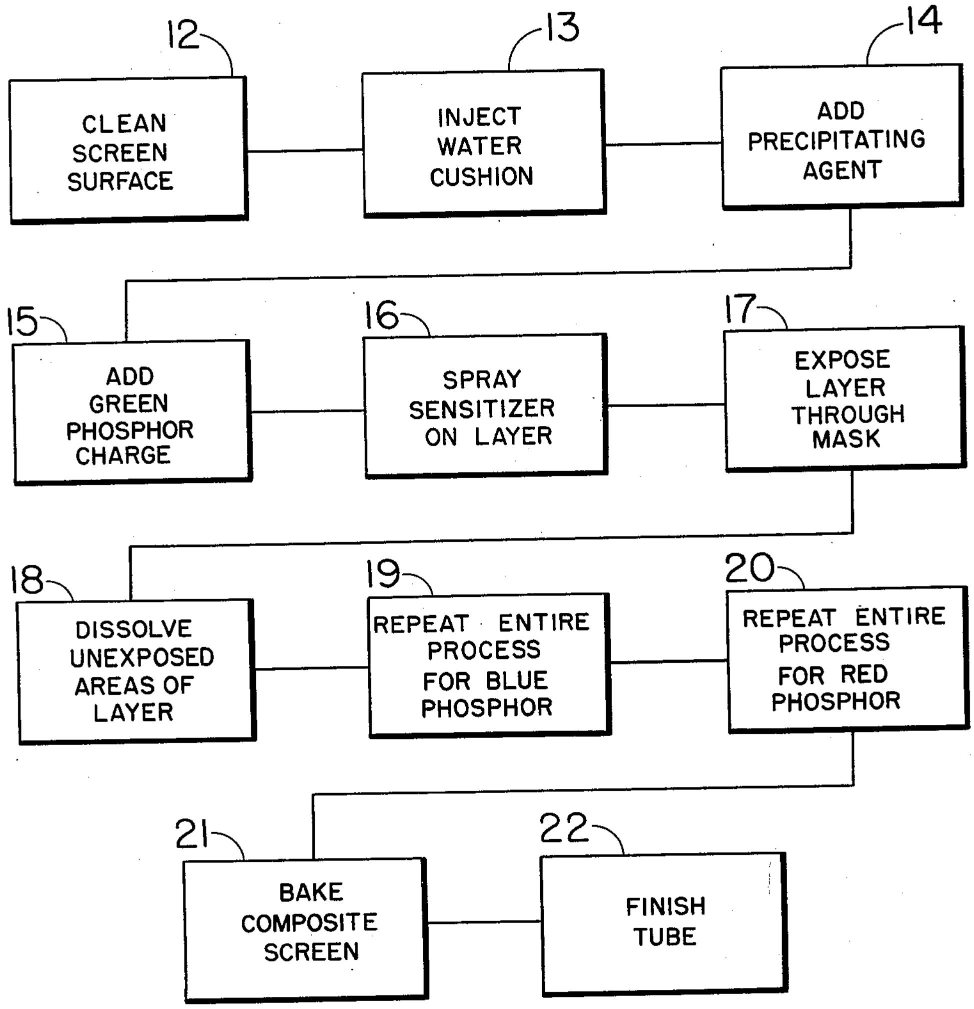

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PROCESS FOR PHOTOGRAPHICALLY FORMING COLOR SCREENS

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This invention relates in general to color television and in particular to the preparation of luminescent screens for color television picture tubes.

A variety of methods have been proposed and, in some cases, fairly thoroughly explored for producing color television picture tubes of the aperture mask type. These methods may be divided, roughly, into classes. The first of these classes would be silk-screen printing, the second photographic reproduction, and several others which are presently of lesser importance. These last include letter-press printing, electrostatic printing, and settling of phosphors through masks. The silk-screen process is the one which, at this time, has received the greatest amount of promotion and has, in fact, been used to produce a sizable number of tubes. A tremendous amount of money has been spent and an enormous concentration of engineering effort has been focused upon this process. In the words of a large commercial television manufacturer, $25,000,000 will have been spent by the end of the year 1953 in pioneering, research, and development of color television. No little part of this fund has been used in development of the picture tube itself, using silk-screen printing methods. Despite these colossal statistics, severe limitations remain. If the silk-screen process is used to produce picture tubes, the technique practically demands that the plate upon which the phosphors are deposited be flat. As has been pointed out in some detail in the co-pending application of Norman F. Fyler and William E. Rowe entitled "Color Picture Tube," Serial No. 358,712, filed June 1, 1953, which application is assigned to the same assignee as the present application, it has proven quite undesirable to construct picture tubes having such a flat screen surface. A much more efficient and practical tube results when, as taught by the above-cited application, a curved screen and curved mask are used.

The difficulty which arises immediately, however, is in forming the screens of tubes having curved screen surfaces. As has been indicated above, the silk-screen process is not easily adaptable to the deposition of phosphors on surfaces other than planar. Work has also been done in the past with photographic methods of forming master patterns for planar tubes. A process akin to contact printing is employed to form the phosphor screen from the master pattern. However, no practical photographic methods have been devised to form phosphor screens directly upon a curved surface in the manner required for a curved screen-curved mask color television picture tube.

It is, therefore, a primary object of the present invention to provide a simple process for forming luminescent screens for color television picture tubes of the curved screen-curved mask type.

It is a further object to provide a practical photographic method for forming screens for color television picture tubes having curved screens and curved aperture masks.

It is another object to provide a screen fabricating process which avoids the complexity and precision work associated with silk-screen techniques.

It is still another object to provide a screen fabricating process which permits any desired configuration of phosphors to be formed on a curved surface.

In general, the present invention consists in a photographic process for constructing color television picture tubes. An example of the particular type of tube to which this process applies is disclosed in the co-pending application identified hereinabove. Each of the required phosphors is settled through a water cushion on the screen surface of a tube according to well-known screen settling techniques. A silica gel formed by activating a soluble silicate acts to bind the phosphor to the screen. Settling screens through a water cushion is presently almost universally used by black-and-white picture tube manufacturers. Some variations in constituents and sequence of injecting materials exist among different manufacturers, but the generic process using a silica gel as the binder of the phosphor to glass is retained.

Following the deposition of each phosphor, a photosensitive resist material is either sprayed or floated on to saturate the phosphor. Exposures of the layer of phosphors and photosensitive resist material are made through the aperture mask of the tube itself in proper sequence and location. Photosensitive resist material between the exposed areas is developed away and carries with it the phosphors deposited in those areas. Conventional tube manufacturing methods are then applied to finish the tube. For a better understanding of the invention, together with other and further objects, features, and advantages, reference should be made to the following description which is to be read in connection with the acompanying drawing the single FIGURE of which is a block diagram indicating the process steps involved in preparing a color television picture tube screen in accordance with the present invention.

Referring now to the drawing, block 12 represents the first operation performed on the surface which is to form the screen of the picture tube. This surface is the interior of the screen end of a conventional spherical or cylindrical face picture tube bulb, either round or rectangular, which has been cut on a plane perpendicular to the longitudinal axis of the bulb. The cut is made within a few inches of the screen itself, and a metallic flange is sealed to the cut surface. A similar flange is sealed to the other cut surface of the conical portion of the bulb.

The interior surface of the bowl-shaped screen end is thoroughly cleaned, as shown at 12. At 13, a volume of deionized water sufficient to cover the screen surface to a depth of about two inches is deposited in the screen end. At 14, a small amount of precipitating agent is added to the water cushion followed at 15 by the first phosphor charge which may be the green color-generating phosphor. This phosphor charge consists of any one of several available compounds well known in the art for generating green light upon excitation, the phosphor being intimately mixed with a quantity of a soluble silicate solution.

The silicate solution, upon meeting the previously added precipitating agent, forms a gel which entraps the phosphor particles as they settle resulting in the formation of a thin gel layer firmly bound to the screen surface. The layer contains a uniform distribution of phosphor over the entire screen surface. The water through which the screen materials are settled is decanted after settling is complete.

Block 16 represents the step of adding any known water soluble photosensitive resist material as potassium dichromate. The damp gel-phosphor layer is preferably sprayed to saturation with a suitable sensitizer, although the sensitizer may be floated on to saturate the phosphor layer if desired. Following this, the screen end is baked at relatively low temperatures, resulting in the entire layer being hardened to a point where it becomes tightly adherent to the glass of the screen end of the tube. At this point, with the photo-sensitive resist material dry, it must be protected from bright light until the next process step is begun.

This next step, indicated by block 17, is the exposing of the sensitized layer. The aperture mask which substantially conforms in shape to the screen surface and which is to be used in the tube itself is placed in the position relative to the screen which it is to occupy in the finished tube. A spot source of light is placed in a position which corresponds to the position to be occupied by the beam which will emanate from the electron gun to be used to energize the green color-generating phosphors. The spot source is preferably of high intensity such as an argon arc.

In this step, the actual aperture mask to be used in the tube itself is the master pattern. The phosphor layer itself is properly spaced from the mask. The light beam from the spot source is oriented exactly as the electron beam from the "green gun" will be at the deflection center in the finished tube. Hence, the optical analogy to the picture tube itself is complete and exposed areas on the screen layer are only those upon which the "green beam" will impinge in the finished tube.

The following step is the development of the screen layer to remove phosphor in unexposed areas. This is done as noted in block 18 by bathing the surface with deionized water to which a detergent has been added. The phosphor, silica gel and photosensitive resist material mixture, where it is not hardened by exposure, is thus removed. A light spray of deionized water is then used to remove any traces of detergent, leaving the "green dots" bound to the screen surface. Finally, a gel hardening solution which may consist of a weak solution of formic acid in deionized water is used to further insure adhesion of the dots.

Block 19 indicates the settling, exposure, development, excess removal and fixing of the "blue phosphor" dots. This procedure is in every detail the same as that described above for the "green phosphor" dots except that the phosphor used is one of several commercially available for generating a blue light. Also, of course, the arc lamp is relocated to the position which corresponds to that of electron beams emanating from the "blue gun" in the finished tube.

Deposition of the "red phosphor" dots, as in block 20, is another repetition of the entire process with similar exceptions that a commercially available red light-generating phosphor is used and the spot source of light is oriented such that its beam corresponds with the electron beam emanating from the "red gun" in the finished tube.

A final baking in air is given to the completed screen as indicated at block 21 to remove any residue of the photosensitive resist material and a light coating of a silicate solution is placed on the finished screen. This coating is dried and the screen is ready for aluminization. Subsequently, the aperture mask is inserted, the flanges are welded, guns are sealed in the tube neck and the completed tube is evacuated in a conventional manner, as indicated at block 22.

The numerous limitations found in tubes made by the silk-screen process are notably absent in tubes made in accordance with the teaching of the present invention. The photographic process described herein is extremely flexible in that phosphor deposits whether dots, stripes, hexagons, or other shapes can be had and will, of course, conform to the aperture mask which is used as the master negative pattern. The size of the phosphor deposit is adjustable by proper choice of mask to screen spacing and adjustment of exposure time. The size and shape of the screen are no longer limited, projection photographic methods, as in the present invention, being easily adapted to any reasonable screen size or configuration. The inherent accuracy of light beams which, of course, correspond closely to the electron beams for which they are substituted, practically eliminates the engineering problems and precision work of the silk-screen technique.

Another very important factor is the use of the aperture or shadow mask of the tube itself as the pattern for laying down the phosphor screen. Since the screen is a faithful reproduction of the mask, the registration problem of mask and screen is tremendously simplified. Finally, the inclusion of steps in the process which are well known in the manufacture of black-and-white television tubes, such as settling the screen materials through a water cushion places the entire process in the realm of commercial feasibility, inasmuch as those steps of the process which are new are also easily adaptable to mass production techniques.

The process defined herein should not be limited to only the exact steps shown but only by the spirit and scope of the appended claims.

What is claimed is:

1. A process for forming a luminescent screen in a color television picture tube of the curved screen-curved mask type, said curved mask having a plurality of circular apertures symmetrically formed in substantially its entire surface, comprising the steps of settling phosphors through a liquid cushion on to the interior surface of the screen end of said tube, permeating a water soluble photosensitive resist material through said phosphors, exposing predetermined portions of the areas of said photosensitive resist material and of said phosphors to light through said curved mask, and developing and washing away unexposed areas of said photosensitive resist material and of said phosphors from said screen surface.

2. A process for forming a luminescent screen in a color television picture tube of the type having a curved viewing end, a curved aperture mask conforming to said viewing end, and at least a source of electrons comprising the steps of settling a phosphor layer through a liquid cushion on said viewing end, saturating said phosphor layer with photosensitive resist material, exposing said sensitized phosphor layer to light from a spot source of light to form discrete hardened areas of said sensitized layer corresponding in number and shape to the apertures in said aperture mask, developing away unhardened areas of said sensitized phosphor layer, baking said viewing end to remove residues of said photosensitive material, and disposing said sensitized source of electrons in a position previously occupied by said point source of light, wherein said photosensitive resist material is water soluble and water is used to develop away unexposed areas.

3. A process for forming a luminescent screen on the inner surface of the viewing end of a color television picture tube of the curved screen-curved mask type, characterized by covering the inner surface of the viewing end with deionized water to form a cushion thereon, adding a predetermined amount of a precipitating agent for a soluble silicate to the cushion, adding a mixture of particles of a phosphor material and an aqueous solution of a soluble silicate to the cushion, settling the gel resulting from the reaction of the precipitating agent and the soluble silicate to entrap the phosphor particles and to form on the inner surface of the viewing end a thin gel layer having a uniform distribution of the particles of phosphor therein, decanting the water cushion leaving the damp gel-phosphor layer, permeating the damp gel-phosphor layer with a water sensitive photosensitive resist material to form a gel-phosphor-resist layer, mounting a curved shadow mask behind the screen in the relation which it is to have in the finished tube, exposing discrete areas of

the gel-phosphor-resist layer to light from a point source located at a point of deflection which an electron beam from one of the electron guns is to have in the finished tube, developing a pattern from the gel-phosphor-resist layer by dissolving away the unexposed areas of the gel-phosphor-resist layer with deionized water, repeating the foregoing steps to form a second and a third pattern interlaced with the first pattern said first, second and third pattern being separate from each other, and heating the viewing end to an elevated temperature to remove any residue of the photosensitive resist material.

References Cited in the file of this patent

UNITED STATES PATENTS

2,328,292	Painter	Aug. 31, 1943
2,435,889	Kerridge	Feb. 10, 1948
2,446,915	Filmer	Aug. 10, 1948
2,625,734	Taw	Jan. 20, 1953
2,684,306	Brewer et al.	July 20, 1954

OTHER REFERENCES

Wall: "History of Three-Color Photography," American Photographic Publishing Co., Boston, Mass., 1925, pp. 483–484.

Leistener: "Photographic Engineering," vol. 1, No. 1, January 1950, pp. 7–15.

Levy et al.: "Sylvania Technologist," July 1953, pages 60–63.