United States Patent

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[54] **METHOD OF SCREENING A COLOR CATHODE-RAY TUBE**
1 Claim, 6 Drawing Figs.

[52] **U.S. Cl.** ..... **96/36.1,** 117/33.5 CM, 96/1.2, 96/36, 313/92 B
[51] **Int. Cl.** **G03c 5/00**
[50] **Field of Search** ..... 96/36.1, 3 C, 35, 1.2; 313/92 B, 92 PD, 92 F; 117/33.5 CM, 33.5 C, 33.5 CP

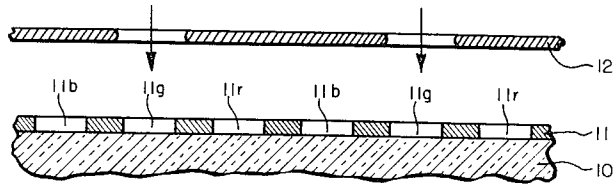
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ABSTRACT: A multiplicity of dots of clear polyvinyl alcohol (PVA) are formed on the inner surface of the screen of a color cathode-ray tube, these dots covering the space separated elemental areas of the screen that are intended to receive deposits of different phosphor materials characteristics of a color tube having a mosaic or triad type of screen. A slurry of colloidal graphite is applied over the entire screen, constituting an overcoat of the PVA dots. The graphite coating is dried to fit it securely to the screen portions that surround the PVA dots. Hydrogen peroxide is applied to the screen to release the adherence of the PVA dots to the screen. A stream of water applied to the screen washes off the PVA dots with their overcoat of colloidal graphite and exposes elemental areas of the screen in which assigned ones of the various color phosphor materials are then deposited.



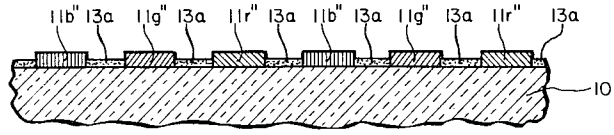


FIG. 1

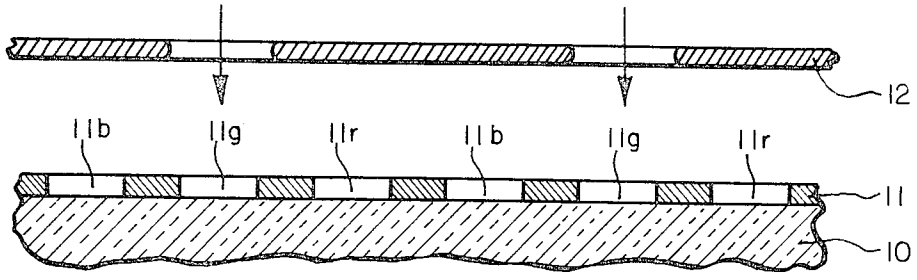


FIG. 2

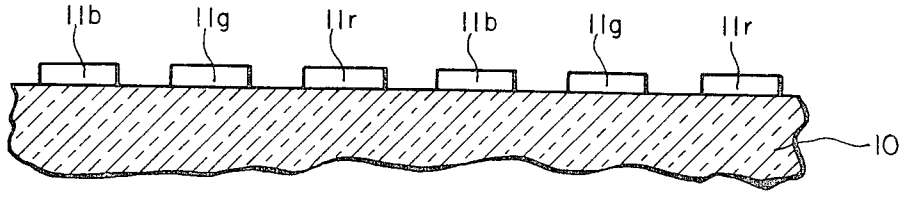


FIG. 3

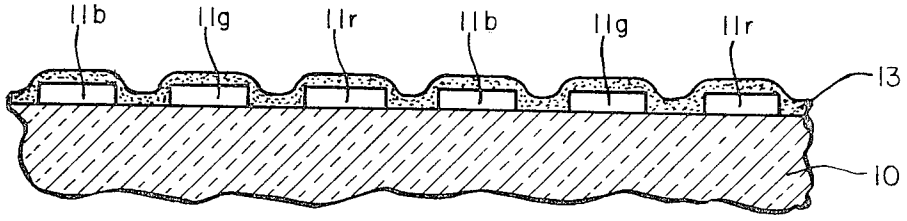


FIG. 4

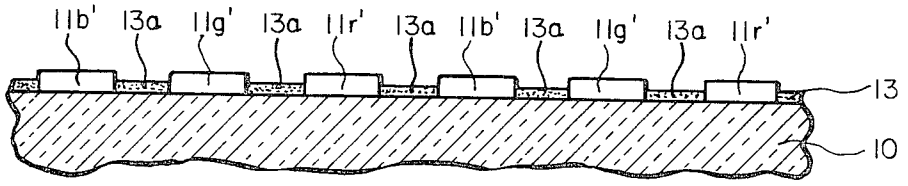
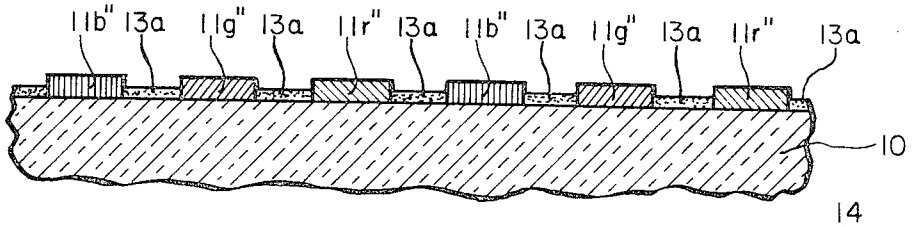


FIG. 5



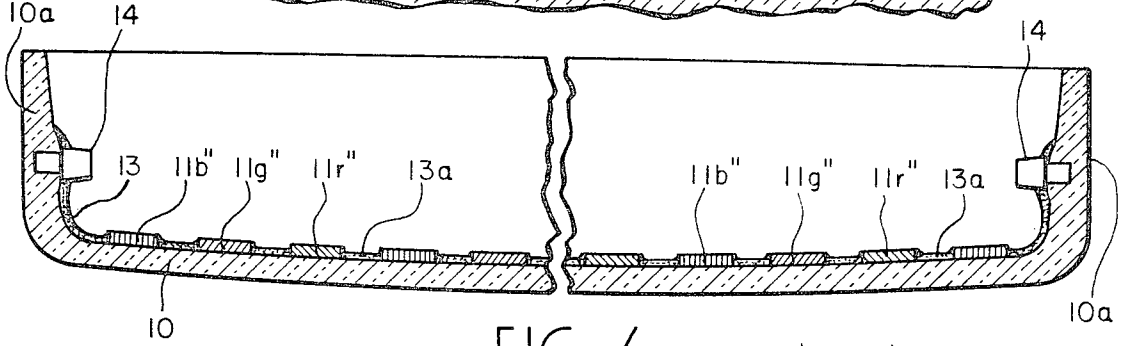


FIG. 6

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METHOD OF SCREENING A COLOR CATHODE-RAY TUBE

RELATED APPLICATION

The present invention is a further development of the screening method described and claimed in application, Ser. No. 773,830, filed Nov. 6, 1968, in the name of Sam H. Kaplan and assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

The present invention, in common with the related Kaplan applications, concerns the processing of a "black surround" screen for a color picture cathode-ray tube. Such a screen is characterized by interleaved sets of deposits of different phosphor materials separated from one another by a light-absorbing pigment. A principal benefit realized with such a screen is a distinct improvement in both contrast and brightness as explained in U.S. Pat. No. 3,146,368, issued on Aug. 25, 1964, to Joseph P. Fiore et al. which describes and claims the structure of the black surround screen.

The improvement in image reproduction contributed by the black surround feature may be advantageously employed whether the phosphor deposits are in the form of stripes or dots. The latter is more frequently used commercially and, for convenience, the discussion will be continued on the assumption that the screen under process is a field of dot triads with each triad comprising a dot of green, a dot of blue, and a dot of red phosphor, as well understood in the art, plus a pigment or light-absorbing material surrounding the dots of the triads.

As explained in the aforeidentified Kaplan application, there is a choice of forming the phosphor dots and then filling the spaces between such dots with light-absorbing pigment or, alternatively, of first applying the pigment to selected portions of the screen area followed by the formation of dot triads. Experience has proved the latter to be more attractive because it affords latitude in the screening of the phosphor dots, especially where this utilized the techniques of photoresist printing, which is not available if the dots are applied before the surround or light-absorbing material. The process to which the Kaplan application is directed permits the pigment to be applied prior to the formation of the phosphor dots and, at the same time, protects against undesired cross contamination.

One attractive process specifically disclosed by Kaplan has certain features in common with a preferred embodiment of the present invention. In particular, in accordance with both process embodiments clear dots of PVA are initially formed on the screen by multiple exposure through the color-selection electrode or shadow mask of the tube. This technique properly locates the PVA dots so that they cover and protect those elemental areas of the screen that are to receive deposits of respectively assigned ones of the different phosphor materials. Kaplan treats the PVA dots to be opaque to actinic radiation, such as ultraviolet light, and then covers the entire screen with another photosensitive slurry having suspended therein a pigment or light-absorbing material. Exposure of the screen from the surface opposite that on which the coating have been applied fixes the pigment slurry into all of the portions of the screen that are interposed between the dots of clear PVA and washing the screen with water removes the residue or unexposed part of the pigment slurry, especially that which had covered, or was an overcoat with respect to, the PVA dots. From this point forward the various phosphors are deposited in any conventional manner over the PVA dots and the PVA is ultimately eliminated in bakeout, leaving deposits of the various phosphors appropriately positioned on the screen and surrounded by the light-absorbing pigment.

While the Kaplan process is acceptable in the manufacture of black surround color tubes and has been successfully employed for that purpose, the present invention is a desired improvement because of the simplification it affords as well as savings in cost and processing times.

Another approach features initially covering the entire screen area with a negative resist carrying a pigment in suspension and thereafter exposing those portions of the resist coating that overly elemental areas of the screen intended to receive deposits of phosphor material. Subsequent washing of the screen in a solvent for the resist removes all exposed portions of the coating and prepares the screen for phosphor deposition. This process, at least in the present state of the art, is subject to certain instabilities of the resist, is expensive from the standpoint of materials, and requires explosion proofing of the screening apparatus.

Accordingly, it is an object of the invention to provide and improved method of screening a color image reproducing device featuring black surround.

It is another and specific object of the invention to provide a simplified and faster process of screening such a color tube.

A further object of the invention is to provide the screen of a color cathode-ray tube with an improved black surround or light-absorbing material.

SUMMARY OF THE INVENTION

As stated, the invention concerns a method of forming on the screen of a color image reproducing device a multiplicity of interleaved sets of deposits of different phosphor materials separated from one another by a light-absorbing material. The method comprises the following steps. There is applied over interleaved sets of elemental areas of the screen, separated from one another and designated to receive assigned ones of the phosphor materials, a coating of a first material whose adherence to the screen is subject to attack by a predetermined active agent. Thereafter, there is deposited in the spaces between such interleaved sets of elemental areas a coating of a second material comprising an inorganic pigment having light-absorbing capabilities and whose adherence to the screen is substantially immune to attack by said active agent. Next, the screen is treated with such active agent and the first-mentioned coating material is removed from the aforesaid interleaved sets of elemental areas of the screen.

In a specific embodiment, the interleaved sets of elemental areas have a generally circular configuration and the first coating material is sensitized polyvinyl alcohol which, accordingly, is applied as a series of spaced interleaved dots. The second-coating material is a slurry of colloidal graphite and the active agent is an oxidant, such as hydrogen peroxide, which in effect releases or breaks the adherence of the PVA dots to the screen. A jet of water directed to the screen washes off the PVA dots and with them any colloidal graphite that had been deposited as an overcoat. The screen is now in condition to receive dot type deposits of the various phosphor materials in any conventional manner to complete the mosaic type of screen having, for the three color additive color system presently in use, a myriad of dot triads.

A further feature of the invention is the use of colloidal graphite as the light-absorbing material which contributes further distinctive advantages. Graphite has desirable gettering properties which is an especially attractive addition to a color tube and furthermore it is conductive so that its use may be of unique advantage in electrostatic screening, for example. Its conductive properties are also attractive in that the graphite may extend from the screen area to the circumscribing flange, even to contact the studs provided in such a flange for the purpose of supporting the color-selection electrode or shadow mask. This is a desirable and simple method to extend a conductive connection to the shadow mask.

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 drawing, in the several figures of which like reference numerals identify like elements, and in which:

FIGS. 1–5 are fragmentary cross sectional views, on an enlarged scale, or a color cathode-ray tube showing sequential process steps involved in practicing one embodiment of the invention; and

FIG. 6 is a cross-sectional view, on a reduced scale, of the faceplate section of a picture-tube tube screened in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The envelope of a shadow mask color tube has a faceplate section that is initially separated from the conically shaped envelope portion which is a convenience in screening. A small or fragmentary portion **10** of such a faceplate is represented in FIG. 1 and, after it has been made chemically clean, it is coated with a removable layer **11** of a first-coating material whose adherence to the screen is subject to attack by a predetermined active agent. It is desirable that this layer be ultimately confined to cover interleaved sets of elemental areas of the screen that are separated from one another and are designated to receive assigned ones of the phosphor materials. This is readily accomplished, in one specific process embodiment of the invention by the utilization of an organic-photosensitive material for layer **11**. An especially convenient material is polyvinyl alcohol sensitized with ammonium dichromate which is particularly convenient in that it is normally soluble in water. Accordingly, layer **11** of PVA is initially applied over the entire inner surface of screen **10** to establish a surface condition therefor that may be altered by exposure to actinic energy or radiation, such as ultraviolet light. This layer is organic and contains no ingredient that is not readily removable through volatilization which is here used in the broad sense to encompass removal by conversion to a vapor state or decomposition through heat or chemical treatment.

After PVA layer **11** has been dried, selected portions thereof are exposed to actinic energy to establish in the layer interleaved sets of images of those elemental areas of the screen that are to receive assigned ones of the phosphor materials. This is conveniently accomplished in a step analogous to that conventionally taken in photoresist screening to define the elemental areas of the screen which are to receive a particular phosphor and to distinguish them from the other portions of the screen. The discrimination is easily obtained by exposing layer **11** through the shadow mask **12** of the tube in process. For that purpose, such a mask having a plurality of electron permeable portions or apertures is installed in the usual way within the faceplate portion of the tube envelope and this subassembly is then supported in an exposure position in any known form of exposure chamber or lighthouse having an energy source which directs ultraviolet light to elemental areas of the screen through the transparent portions of the shadow mask. If the light source is positioned to simulate, for example, the electron gun of the tube in process which is to excite the green phosphor material, the ultraviolet light will be confined to expose only those portions **11***g* of layer **11** which overlie elemental areas of screen **10** assigned to receive deposits of green phosphor. After this exposure step, portions **11***b* of layer **11** are similarly exposed, these constituting the portions that overlie elemental areas of screen **10** that are to receive deposits of blue phosphor. To achieve their exposure, it is only necessary to change the position of the light source so that it now simulates the electron gun of the tube intended to energize the blue phosphor dots. In a third position of the light source, where it simulates the red electron gun of the tube, a third set of small portions **11***r* of layer **11** are exposed sand these portions overlie elemental areas of the screen intended to receive red phosphor. In short, as a consequence of the multiple exposures, there are established in layer **11** interleaved sets of images of elemental areas of the screen that are separated from one another and are to receive assigned ones of the phosphor materials. The multiple exposures may be made in a single lighthouse which has provisions for changing the relative positions of the screen and light source or, alternatively, three separate light sources or chambers may be used with each adjusted to accomplish exposure of one of the interleaved sets of images.

While this will be recognized as an exposure technique very similar to that of photoresist color screening, there is one significant distinction to be observed, namely, the exposed elemental areas of layer **11** are smaller in size than the transparent portions of apertures of the shadow mask as used in the completed tube. The correct relative size may be realized in a variety of ways. One that suggests itself directly involves coating the shadow mask initially to temporarily close down the size of its apertures so that the dimensions of the phosphor dots determined by exposure through the shadow mask, are properly related to the final size of the mask apertures. After the mask has been used in screening, the coating is removed from the mask and the desired relation of dot size to aperture size of the mask shall have been attained.

Another and commercially more acceptable way of achieving a similar result is the subject of application, Ser. No. 811,318, filed Mar. 28, 1969, in the name of Sam H. Kaplan and assigned to the assignee of the present invention. That application discloses a process in which the apertures of shadow mask **12** are initially formed of the proper size for use in screening and, after the screening has taken place, the shadow mask is re-etched to open up or enlarge its apertures to a desired final size. This has an advantage in precisely controlling the dimensions of the phosphor dots and also in attaining uniformity of size and configuration of the dots.

By whichever approach the selected portions **11***g*, **11***b* and **11***r* of coating **11** are exposed, the resulting interleaved sets of images are next developed by removing all unexposed portions of photosensitive layer **11**, producing the screen condition of FIG. **2**. Inasmuch as the photosensitive material as applied to screen **10** is soluble in water and all exposed portions thereof have become insoluble, washing the screen after the three exposure steps removes all of the unexposed portions of layer **11** and the screen of FIG. **2** may be described as having clear deposits or dots of PVA separated from one another by screen areas which are bare and which are to receive a pigment or a material having light-absorbing capabilities. It should be noted in passing that the process up to this point is the same as that described in Kaplan application, Ser. No. 773,830. At this point, however, the process of the present invention departs distinctly and materially from that of the referenced application.

In practicing the present invention, the next step constitutes depositing at least in the spaces between the elemental areas of the screen that are covered by dots of clear PVA a coating of a second material comprising an inorganic pigment having light-absorbing capabilities and whose adherence to the screen is substantially immune to attack by the aforementioned active agent which destroys the adherence of the PVA dots **11***g*, **11***b*, *r*to the screen. This is a necessary difference in the characteristics of the materials which makes possible a highly desirable simplification in the overall process which will become apparent as the process description continues.

While the second coating material may be confined to only the areas surrounding the clear PVA dots, it is much more convenient to apply a second coating **13** over the entirety of the screen as indicated in FIG. **3** in which case portions of the second coating are applied over the clear PVA dots in the nature of an overcoat to such dots. Preferably, layer **13** is applied as a slurry and also preferably it is a colloid having in suspension fine pulverulant inorganic material that has light-absorbing capabilities. A variety of materials may be used such as fine powders of metals or oxides of metals, for example black iron oxide, powdered mica, molybdenum disulphide, manganous carbonate, ceramic black and graphite. Certain of these materials exhibit light-absorbing properties as applied to the screen of the tube although that is not necessary and is not the case with other acceptable materials such as manganese carbonate. As explained in U.S. Letter Pat. No. 3,365,292 is-

sued on Jan. 23, 1968 in the name of Joseph P. Fiore et al. and assigned to the assignee of the present invention, manganous carbonate has little absorption for actinic light as applied to the screen but during bake out it experiences a chemical conversion, changing to manganese dioxide which is black. Accordingly, it is only necessary that the material have light-absorbing capabilities and be absorptive of light as it exists in the finished tube. As stated above, there is a distinct preference for the use of colloidal graphite for the second coating layer **13**.

There are currently available on a commercial basis both natural and synthetic graphites. It is believed that the natural graphites exist as platelets and, in any event, they are known to have a grey reflective surface and are less desirable for use in the process under consideration than synthetic graphite which is found to be much blacker. Commercially available colloidal graphites usually contain both a dispersing agent and a resin binder although the specific composition is frequently a trade secret of the particular supplier. A commercial preparation of colloidal graphite widely used in the manufacture of color picture tubes is available under the trade name "Aquadag" and as supplied has approximately a 22 percent solid content. When used for layer **13** in the present process, the colloid is diluted to 3 percent solid with deionized water and when slurried over screen **10** forms an opaque coat. The aquadag coating is now fixed by drying; it may be air dried or heated to approximately 85° F. which is sufficient to evaporate the water content of the coating. Drying for a period of 5 minutes under a 750 watt heater, while rotating the panel at a rate of 5–8 r.p.m. and directing an air blower on the screen, has given satisfactory results.

It is next necessary to remove all of the coating materials from screen **10** except for the graphite coating over those portions of the screen which intervene the of clear PVA **11***g*, **11***b*, **11***r* and this is made feasible, even as a commercial production process, by having distinguishing characteristics of the two layers **11** and **13** of coating materials. More specifically, and as stated above, the material of layer **11** is characterized by the fact that it yields to an active agent and loses its adherence to screen **10**, whereas the material of layer **13** is substantially immune to the influence of the that active agent. The active agents available are, of course, dependent upon the materials used in these two layers and with PVA as layer **11** and colloidal graphite as layer **13**, a number of different active agents are available. For example, resort may be had to a chemical stripper which would react with the PVA in the manner of a solvent or an oxidant to free or lift the dot off the panel. It is also known that heating of the panel effects a similar oxidation and removes the PVA dot and even a second exposure, further to polymerize the PVA to such an extent that the dots are freed, is a possibility. In a commercial operation where speed is of the essence, the most satisfactory approach appears to be the use of chemical strippers and here again, a variety of materials are available. Strong oxidizing agents such as hydrogen peroxide, potassium dichromate, chromic acid and sulphuric acid are useful for this purpose. While concentrated sulphuric acid of 90 percent concentration releases the PVA dots quickly and with sharp lines of delineation gsurrounding graphite ba chemical stripper of 30 percent hydrogen peroxide and 70 percent water is acceptable and preferred from the standpoint of the operators involved. A quantity of hydrogen peroxide is poured into the center of the screen and slurried to uniformly coat the screen. The manner of application of the stripper is of no particular consequence; it may be applied through pouring, spinning, spraying and the like. After a processing interval of about **30** seconds, the excess solution is poured off and the screen is then washed with a fluid spray for an interval from 30 seconds to a minute. The spray may be either air or water under pressure but deionized water is presently being employed. A pressure of 25 p.s.i. has been found acceptable.

The chemical stripper or active agent, in reacting with PVA dots **11***g* , **11***b* , **11***r* and effecting oxidation so weakens or destroys the adherence of the dots to screen **10** that they are easily and quickly washed off by the fluid stream and, with them, the overcoat of graphite is simultaneously removed. In this manner, the elemental areas of the screen that are to receive phosphor materials are exposed as indicated in FIG. **4** by designations **11***g'*, **11***b b'*, **11***r'*. Each of these exposed elemental areas of the screen is totally surrounded by the residue of colloidal graphite designated **13***a*. In short, treating the screen with the active agent or chemical stripper removes the PVA dots preparatory to screening the phosphor materials which may be accomplished in any conventional manner.

The screen is now coated with the various phosphor materials to present the final structure of FIG. **5** in which the elemental areas **11***g''*, **11***b''* and **11***r''* designate deposits of green, blue and red phosphors, respectively, which are individually surrounded by colloidal graphite deposits **13***a*. The in which the phosphors are deposited is of no particular consequence to the present invention. A variety of schemes are known including slurrying, dusting and electrophotography. Phosphors in commercial production of color tubes are frequently applied through slurry screening but since that method of applying phosphors is well known, there is no need to repeat them with any degree of detail. Suffice it to say, a photosensitive resist including a suspension of the phosphor in process is applied over the entire screen and only those elemental areas intended to receive that particular phosphor are subjected to ultraviolet light directed to the screen through shadow mask **12** in much the same manner as heretofore described in conjunction with FIG. **1**. Thereafter, the screen is washed to develop the phosphor deposits of that particular color by removing the slurry from all elemental areas of the screen except those which have been exposed and are intended to accept the particular phosphor in process. Since the black surround material **13***a* has been previously applied, there is considerable latitude in depositing the phosphor inasmuch as only the phosphor deposited in the elemental areas surrounded by the pigment coating **13***a* contributes to image reproduction. Any phosphor that overlays the pigment material is ineffective. After the phosphors are applied, the screen is first filmed and then aluminized through techniques well known to the art. This completes the screening process and all of the organic constituents of the materials deposited on screen **10** are removed during bakeout. during

FIG. **6** shows the flange **10***a* that circumscribes screen area **10** and also indicates that the screen has been prepared to have the structure represented in FIG. **5**. Mounting studs **14** are provided in flange **10***a*, projecting inwardly and dimensioned to receive mounting springs of the color-selection electrode or shadow mask. The studs are **3** or **4** in number depending on the choice between a 3 and 4 point suspension for the shadow mask. Figure **6** makes clear that the graphite coating **13** may be extended from the screen area along flange **10***a* to coat mounting studs **14**. This is a convenient method of extending a conductive connection to the studs and also to the shadow mask when it is in operative position.

It will, of course, be understood that after the screening has been accomplished the apertures or the mask are made larger so that the phosphor dots and mask holes have the desired relative dimensions as described in Fiore et al. U.S. Pat. No. 3,146,368.

A distinguishing feature of the inventive process is the application of a protective coat to each of the elemental areas of the screen that is intended to receive a phosphor deposit and then the application of a light-absorbing material around the protective coating, with the protective coating of such nature that it may be removed with sharp demarcation relative to the encompassing pigment through a process which in no way adversely affects the pigment. Obviously, while PVA is a suitable protective coat and is readily eliminated as described, the invention is not confined to the use of that material. For example, instead of using dot deposits of clear PVA as a protective coat, each elemental area to be protected may be printed through silk screening using lacquers, resins or paints that are

soluble in organic solvents. Of course, other photoresists could be used such as Dynachem which is distributed by Eastman Kodak or, in general, any material that is readily and selectively removable by chemicals, such as solvents, or reagents may be employed.

Advantages derived from the inventive process are numerous. The PVA protective coat, for example, is most inexpensive; is readily deposited in selected areas of the screen and is water soluble whereas other processes, featuring the use of a reverse resist, are comparatively expensive. Moreover, the coating materials are stable and require no explosive proofing which is the case when certain reverse resists are used. Graphite is extremely opaque and, therefore, is most acceptable as a light-absorbing surround material. Its compatibility with cathode-ray tubes is well known and it contributes further gettering properties. At the same time, the exposure steps are reduced in number over other screening processes, such as that described in Kaplan application, Ser. No. 773,830.

Finally, the process is fast and makes possible well defined uniform phosphor deposits surrounded by light-absorbing pigment but yet free of cross contamination with the pigment. It has been discovered that chemical strippers of the PVA dots, for example, lift the overcoat of graphite away as the PVA dots are removed, making it possible to leave free of the pigment those elemental areas of the screen that are to receive phosphor deposits. Much the same advantageous result is realized where heat is used as the active agent for eliminating the phosphor dots at the proper point in the screening process. If the heating is conducted to the point that the PVA dots volatilize, the overcoat of graphite lies loosely in the areas that had previously been occupied by the PVA dots and is easily removed by an air or water jet to protect against cross contamination.

While particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that changes and modification 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.

I claim:

1. In the method of forming a dot triad screen on the image areas of a multicolored cathode ray tube having a multiplicity of interleaved sets of deposits of different colored phosphor material separated from one another by a light-absorbing and electrically conductive material, said tube having a flange surrounding said area with inwardly projecting studs for mounting a shadow mask, which method comprises the following steps:

coating said screen with a photosensitive material;

exposing selected portions of said screen to actinic light to establish in said coating interleaved sets of images of elemental areas of said screen that are separated from one another and are to receive assigned ones of said phosphor material;

depositing a coating of colloidal graphite in at least the spaces between said developed sets of images;

removing the unexposed portions of said photosensitive material which collectively constitute said developed sets of images to uncover said elemental areas of said screen that are to receive the deposits of different colored phosphor material such that no colloidal graphite remains in said elemental areas;

and depositing different colored phosphor materials in assigned ones of said interleaved sets of said elemental screen areas;

the improvement which comprises extending the deposition of graphite to said mounting studs to provide a conductive connection between said screen and said shadow mask.

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