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E. E. MAYAUD ET AL
METHOD FOR PRINTING NEGATIVE TOLERANCE MATRIX SCREEN
STRUCTURE FOR A CATHODE-RAY TUBE

3,788,846

Filed June 28, 1971

2 Sheets-Sheet 1

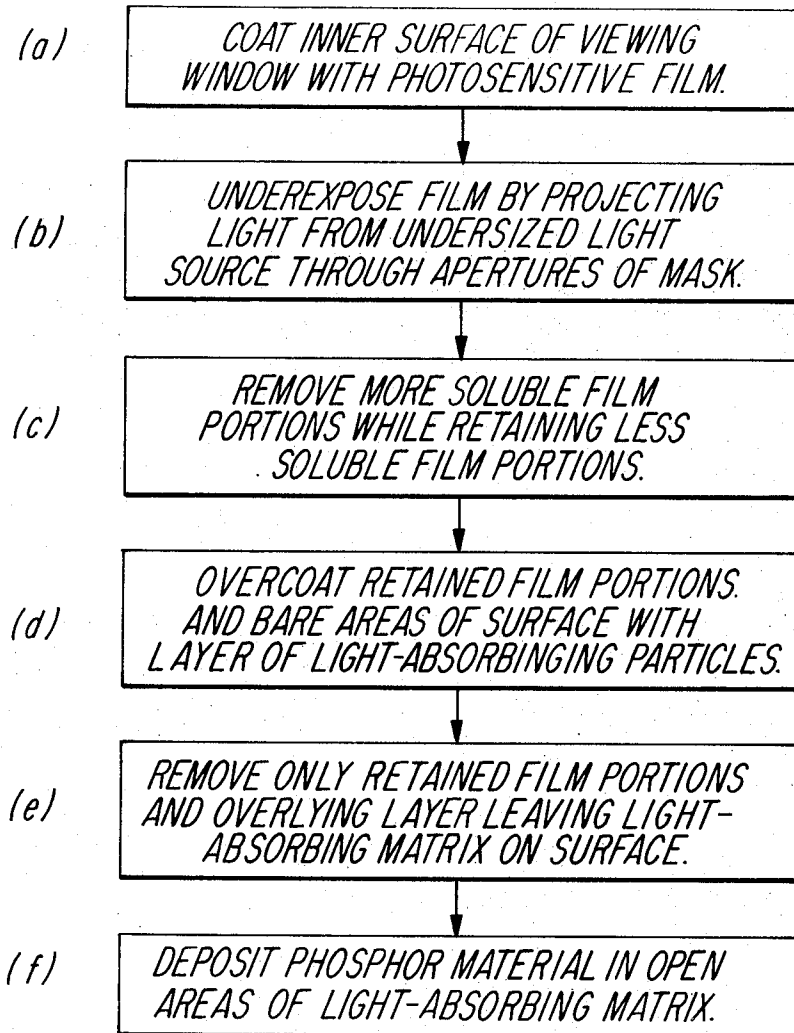


Fig. 1

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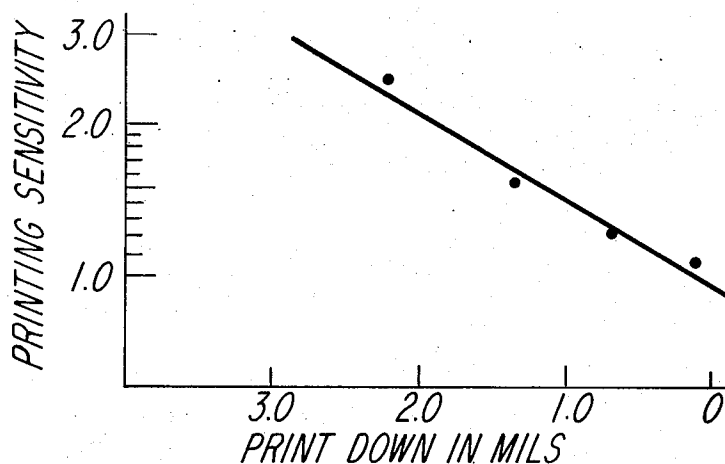


Fig. 2

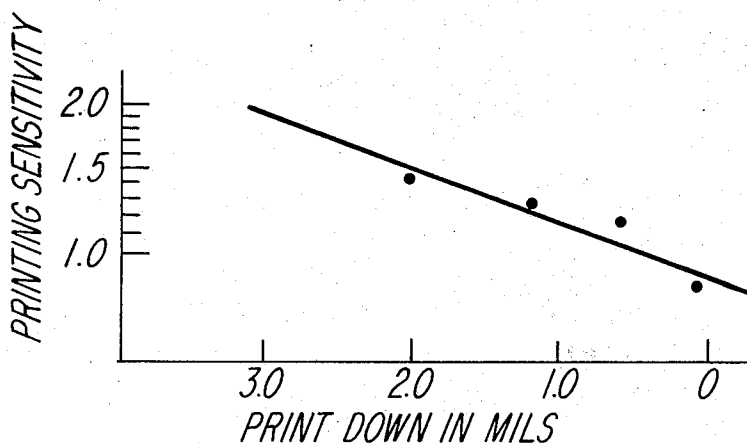


Fig. 3

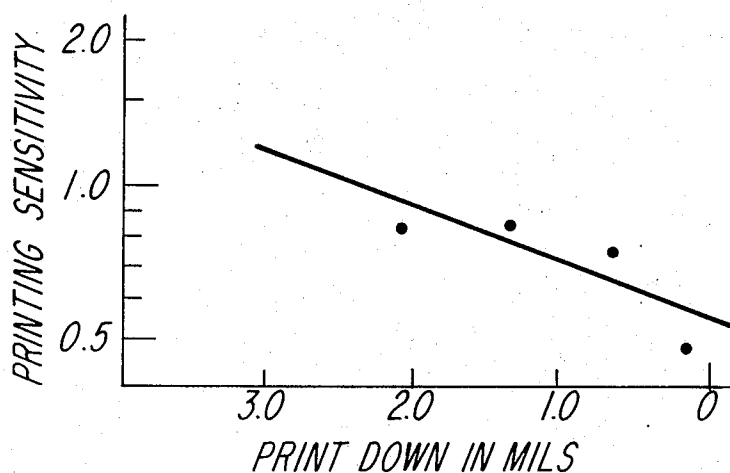


Fig. 4

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1

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METHOD FOR PRINTING NEGATIVE TOLERANCE MATRIX SCREEN STRUCTURE FOR A CATHODE-RAY TUBE

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Int. Cl. G03c 5/00

U.S. Cl. 96—36.1

7 Claims

ABSTRACT OF THE DISCLOSURE

A light-absorbing matrix is produced by under-exposing a film of light-sensitive material by projecting light through an apertured mask of the tube incident on the film from a small-area light source, developing the under-exposed film, using the developed film to produce a light-absorbing matrix, and then filling the holes in the matrix with phosphor material.

BACKGROUND OF THE INVENTION

This invention relates to a novel method for printing a negative-tolerance-matrix screen structure for a cathode-ray tube.

Color television picture tubes which include a light-absorbing matrix as a part of the luminescent screen structure have been described previously, for example in U.S. Pat. Nos. 2,842,697 to F. G. Bingley and in 3,146,368 to J. P. Fiore et al. These patents described television picture tubes of the apertured-mask type in which a light-absorbing matrix is located on the inner surface of the viewing window of the tube. In this structure, the matrix has a multiplicity of holes therein, each trio of holes being registered with an aperture in the mask, and each phosphor element filling one hole in the matrix. In the positive-tolerance-type-matrix screen structure, the mask aperture defines an electron spot during tube operation which is smaller than the hole in the matrix. In the negative-tolerance-type-matrix screen structure, the mask aperture defines an electron spot during tube operation that is larger than the hole in the matrix.

In view of numerous practical problems of manufacturing, it is desirable to deposit first the matrix and then the phosphor elements by photographic processes in which the apertured mask is used as a photographic master. One practical method for achieving this, sometimes referred to as reverse printing, is disclosed in U.S. Pat. No. 3,558,310 to Edith E. Mayaud.

One form of reverse printing comprises coating the inner surface of the viewing window of a cathode-ray tube with a film of polymeric material whose solubility is altered when it is exposed to light, and then positioning the mask in spaced relation with respect to the coated surface. Next, the film is subjected to a normal exposure or an overexposure by projecting the required amount of light through the apertures of the mask incident upon the film from a small area light source having an equivalent circular diameter of about 0.130 inch or larger. Following exposure, the film is developed by removing the more soluble regions of the film. At this point in the process, each retained film region is the same shape as but larger than the mask aperture used to expose it. The developed film is overcoated with a layer of light-absorbing material. Then, the retained film regions and the overlying light-absorbing material are removed while the light-absorbing material is retained in the adjacent areas of the surface, thereby producing a light-absorbing matrix comprised of a light-absorbing layer having therein an array of holes, each hole being the same shape as but larger than the mask aperture used to expose it. Finally, arrays of differently light-emitting phosphor materials are deposited

2

in the open areas or holes of the matrix by projection exposure through the mask using a small area light source.

Where a negative tolerance matrix screen structure is desired, it has been necessary in most previous processes, to alter the mask by enlarging the mask apertures therein after the photographic steps are completed. By one prior process, the mask is fabricated with undersized apertures and, later, the mask is etched to enlarge the apertures to their full size after the phosphor materials are deposited. By another prior process, the mask is fabricated with full-sized apertures which are lined with another material prior to the photographic steps and then, after the photographic steps are completed, the lining is removed from the apertures. By still another prior process, the mask is made with full-sized apertures therein and with a temporary mask attached thereto, the temporary mask having under-sized apertures in register with the full-sized apertures in the permanent mask. After the photographic steps are completed, the temporary mask is removed from the permanent mask. In each of these prior processes, it is necessary to prepare a special mask structure prior to the photographic steps and then to alter that mask structure after the photographic steps are completed.

In still another prior process, described in the above-cited Mayaud patent, after the film regions are deposited photographically using the permanent mask with full-sized apertures therein, the edges of the retained film regions are eroded in a controlled manner to reduce the sizes thereof. Then, the process is continued in the usual manner thereby producing a matrix with smaller holes therein than would be normally produced which are also smaller than the mask apertures. While this process produces useful negative tolerance matrix screen structures, it has been found to be difficult to control the process in factory production.

SUMMARY OF THE INVENTION

The novel method follows generally the procedure described in the above-cited Mayaud patent, except that the film of photosensitive polymeric material is under-exposed instead of normally-exposed or over-exposed. This requires a reduction in the amount of light (average brightness times duration of exposure) to which the film is exposed. By using less-than-normal exposure, it is possible to "print-down"; that is, produce retained film regions which are identical in shape but smaller in size than the mask apertures which are used during photographic exposure to produce them.

To achieve this "print-down" it has been found desirable to reduce the size of the light source to have an equivalent circular diameter of about 0.060 to 0.130 inch, in order to reduce the printing sensitivity of the process to a practical range of about 1.5 and less. It has also been found to be desirable to reduce the thickness of the film to have a weight of about 0.10 to 0.30 milligrams per square centimeter (instead of 0.40 mg./cm.² and higher previously used) in order to improve the adherence of the exposed film areas during the developing step. Where the degree of under-exposure is great, it is also desirable to subject the film to a blanket or flood exposure which is insufficient by itself to produce film portions which adhere to the surface. The combination of two exposures (the flood exposure and the image under-exposure) produces, after development, retained film regions which are sharply defined and strongly adherent to the support surface.

In the novel method, both the matrix and the phosphor elements may be printed directly from the final or permanent apertured mask without aperture enlargement or other alteration to the mask subsequent to the photographic steps. By the novel method, both the matrix and the phosphor elements may be printed by a reverse print-

ing process without alteration to the film regions which are intermediate in the process. The novel method may be adequately controlled in factory operations to produce a relatively high yield of useful screen structures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow-sheet diagram of a preferred method for practicing the invention.

FIG. 2 is a graph showing the relationship between the amount of print down versus printing sensitivity for one set of fabricating conditions.

FIG. 3 is a graph illustrating the relationship of the amount of print down versus printing sensitivity for a second set of fabricating conditions.

FIG. 4 is a graph illustrating the relationship of the amount of print down versus printing sensitivity for a third set of fabricating conditions.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Example

FIG. 1 illustrates several steps in a preferred method for practicing the invention. First, the inner surface of the viewing window of a cathode-ray tube is cleaned in the usual way and then coated with a film of photosensitive polymeric material as indicated in FIG. 1(a). In this example, the film is prepared by depositing on the surface a quantity of a liquid mixture comprised of about 3-weight-percent polyvinyl alcohol, 0.75-weight-percent acrylic emulsion, about 0.25-weight-percent titanium dioxide, about 0.5-weight-percent sodium dichromate, about 0.012-weight-percent wetting agent, and the balance water. The viscosity of the mixture is about 11 to 14 centipoises. The viewing window is rotated and tilted so that the liquid mixture spreads evenly over and coats the surface. During the later stages, heat is applied so that the water in the coating is evaporated, thereby forming a dry film of about 0.1 milligram per square centimeter (mg./cm.^2).

The next step is to under-expose the film by projecting light from a small area light source through the mask apertures as indicated in FIG. 1(b). The apertured mask of the tube is positioned above the film, and the assembly is placed in a lighthouse. A lighthouse is an apparatus designed to expose the photosensitive film on the viewing window to a pattern of film-hardening light in the correct positions and dimensions, as is well known in the art of color picture tube making. Suitable lighthouses and their operation are described in U.S. patent applications Ser. No. 39,269, filed May 21, 1970, by N. R. Goldstein, and Ser. No. 844,852, filed July 21, 1969, by Harry R. Frey, now Pat. No. 3,592,112. In this example, the mask has substantially circular apertures therein with a diameter of about 15 mils at the center thereof and about 13 mils at the corners thereof, and a center-to-center spacing between apertures of about 28 mils near the center of the mask. Light for exposing the film is produced by a 1000-watt BH-6 mercury vapor lamp. The light from the lamp is passed through a light pipe or collimator and emerges from a tip, referred to herein as the small area light source, which has an equivalent circular diameter of about 0.080 inch (80 mils).

During the exposure, light rays from the small area light source are projected through the apertures in the mask incident upon the film of light-sensitive material. The incident light causes areas of the film to harden (that is, become insoluble in water) in substantially the identical shape as the projected light passing through the apertures. The duration of exposure is about 5 minutes.

The exposure through the mask is repeated three times, each time with the light incident at a slightly different angle so that the film is hardened in groups of three dots from each aperture, as in the usual method of apertured-mask-screen manufacture. At this point in the method, there are, for each mask aperture, three hardened circular areas of dots each about 15.5 mils in diameter at the

center. Each circular area has a graded hardening of about 2 mils wide within and adjacent its periphery.

Following exposure, the assembly is removed from the lighthouse and the mask is separated from the viewing window. The exposed film is subjected to flushing with a forced spray of water for about 30 seconds in order to remove the more soluble portions of the film while retaining the less soluble film portions in place as indicated in FIG. 1(c). After this flushing to develop the stencil, the viewing window is rinsed with water and then dried. At this point in the method, the viewing-window surface carries an adherent stencil comprised of bare or open areas of the window surface and of dots of hardened polymeric film coated on the surface. The dots are about 13.5 mils in diameter at the center. This reduction in diameter of the hardened areas as compared to the size of the mask apertures results from the under-exposure of the film and from the use of the smaller-than-normal-sized light source (tip of the collimator or light pipe) during the photographic exposure, which results in the dissolution of the extreme edges of the circular area, which are only slightly hardened during exposure.

The stencil is now overcoated with a composition comprised of light-absorbing pigment particles, as indicated in FIG. 1(d). In this example, the overcoating is produced by applying to the stencil a slurry containing about 4.0 weight-percent colloidal graphite in water and then drying the layer. It is desirable to include a trace of wetting agent in the overcoating slurry in order to facilitate the spreading of the slurry over the stencil. The overcoating is dried thoroughly for about 1.5 minutes with the aid of heat. After drying, the overcoating adheres both to the dots and to the bare areas of the window surface.

Then, while the viewing window is still warm, a chemically-digestive agent for the dots of hardened polymeric film is applied to the overcoating. In this example, the digestive agent is an aqueous solution containing about 5-weight-percent hydrogen peroxide. If desired, the solution may be applied to the overcoating as a spray under pressure. The hydrogen peroxide penetrates the overcoating and the dots, causing the dots of hardened polymeric material to swell and soften. Subsequent flushing with water removes the softened dots together with the immediately overlying portions of the overcoating, but leaves behind and in place that portion of the overcoating which is adhered directly to the surface of the viewing window at the open areas of the stencil, as indicated in FIG. 1(e). At this point, the product is a viewing window carrying a light-absorbing (black) matrix having a multiplicity of circular holes therethrough about 13.5 mils in diameter at the center and somewhat smaller in the corners thereof.

The light-absorbing (black) matrix is now rinsed with water and dried for about 4 minutes with the aid of heat. Then, the viewing window is processed in the usual way to photodeposit successfully red-emitting phosphor dots, green-emitting phosphor dots and blue-emitting phosphor dots in the holes of the matrix, as indicated in FIG. 1(f). The dots of a particular emission characteristic are deposited by coating the matrix with a photosensitive phosphor composition, and then exposing the coating from a small area light source by the usual photographic technique using the same aperture mask in the same position as a photographic master in the process. It is preferred to use a somewhat larger light source, preferably 0.100 inch (100 mils) in diameter. This produces somewhat larger phosphor dots than the corresponding matrix holes, adding tolerance to the process, but not so large as to overlap the phosphor dots into adjacent matrix holes.

The luminescent-screen structure may now be processed in the usual way to apply a reflective metal layer on top of the phosphor dots and the black matrix. The screen structure is baked and assembled with the aperture mask into a cathode-ray tube in the usual way. A suitable process for filming and metallizing the screen structure is described in U.S. patent application Ser. Nos. 693,058 filed

Dec. 26, 1967 and 760,364 filed Sept. 17, 1968, now Pat. Nos. 3,582,389 and 3,582,390, by Theodore A. Saulnier.

SOME GENERAL CONSIDERATIONS AND ALTERNATIVES

The particular steps described in the example may be varied within limits and still fall within the scope of the invention. Generally, the technology disclosed in the above-cited Pat. No. 3,558,310 to Edith E. Mayaud may be applied to the novel method. In particular, the choice of the photosensitive material for making the stencil, the photoexposure of the film for making the stencil and the development of the stencil as taught therein apply to the novel method. The term "film" is used herein to describe a layer which is substantially free of cracks that extend through the film. Some suitable film formulations and methods of application are disclosed in U.S. patent application Ser. No. 864,197 filed Oct. 6, 1969, now Pat. No. 3,623,867 by T. A. Saulnier. Also, the overcoating material and its application to the stencil and the subsequent graphic-image development may be the same as is disclosed in the above-cited patent. Some methods for producing an overcoating of light-absorbing particles are disclosed in U.S. patent application Ser. No. 887,267 filed Dec. 29, 1969, now Pat. No. 3,652,323 by B. K. Smith.

The novel method differs from the process as disclosed in the above-cited Pat. No. 3,558,310 in the discovery of a set of conditions which permit the direct photographic deposition of a light-absorbing matrix having therein holes of reduced size and of the phosphor elements filling the matrix holes using a mask having therein the full-sized apertures used during the operation of the tube.

One important condition for making the light-absorbing matrix is that the film is under-exposed. The greater the amount of underexposure, the greater will be the print down and the greater the chance of poor adherence. In this disclosure, "R" is the diameter of a matrix hole and "B" the diameter of the mask aperture used to print it (assuming that the apertures are circular). A normal exposure is defined as an exposure which results in $R/B=1.0$. Overexposure is defined as an exposure which gives a matrix hole larger than the mask aperture from which it was printed; i.e. R/B is >1.0 . Underexposure is defined as an exposure giving a matrix hole smaller than the mask aperture from which it was printed; i.e. R/B is <1.0 . The "print down" is the difference between R and A for a matrix hole produced by underexposure. The "exposure" is the amount of light used to expose the film. In this specification, the relative value of the exposure is product obtained by multiplying the relative value for the average brightness of the light field and by the duration or time of the exposure. Thus, a brighter light source may require a shorter exposure time. With a few trials, a normal exposure is easily determined for any particular exposure apparatus. From this, further trials with decreasing exposures result in greater print down, until the exposure is insufficient to produce the necessary adherence to retain the stencil on the surface of the viewing window. Experience has shown that the useful range of exposure conditions for producing commercial-quality negative-tolerance matrix-screen structures using the novel method exists when the "printing sensitivity" is less than 1.5. "Printing sensitivity" is the ratio of the percentage change in matrix transmission for a percent change in exposure. When the printing sensitivity is greater than 1.5, poor matrix quality results in which mottle and adherence are problems. Mottle is the overall appearance of blotchiness of the screen to a viewer, which results from random variations in the amount of light-absorbing material deposited.

The thickness of the light-sensitive film is important with respect to the factors of exposure and adherence. The thickness of the film is best controlled by controlling the viscosity of the film coating composition. All viscosities disclosed herein are at 25° C. Too high a viscosity

for the amount of print down desired results in poor adherence. Too low a viscosity results in bridging between stencil dots (and matrix holes), and too great a printing sensitivity to roughness and uneven contour of the glass support, and variations in mask-to-film spacing. When exposing is carried out without a flood exposure, the resist viscosity should be kept between 9 and 20 cps. (centipoises); the best viscosity is 11 to 12 cps. when maximum print down is desired. A viscosity of 9 to 11 cps. is ideal for making a matrix screen with a print down of 1.5 mils in the center and 3.0 mils in the corners. When a flood-exposure step is used during exposure of the film, a higher viscosity is usable; here a viscosity of 14 to 15 cps. is preferred. A viscosity range of 9 to 30 cps. is usable. A flood exposure is simply an overall or blanket exposure of substantial areas of the film which is less than that required to produce adhering film portions. A flood exposure may be carried out before, during, or after the image under-exposure. Flood exposure of the film is useful to reduce exposure times or to improve adherence, provided the overall printing sensitivity is not above 1.5. Exposure times of 0.1 to 10 minutes are considered to be practical.

With smaller matrix holes, a very thin film having a weight of about 0.10 mg./cm.² gives the best adherence compatible with processing latitude at a maximum amount of print down. With larger matrix holes, at or nearly as large as the mask apertures, bridging between holes and matrix hole deformation sometimes occurs with such thin films. This may be due to light overlap in the film during exposure from the larger mask apertures, which may cause some of the film between the light spots to harden. Bridging is where adjacent hardened dots are connected with hardened film material, and results in a connection between adjacent matrix holes. By raising the film weight to about 0.20 to 0.30 mg./cm.², bridging and hole deformation are greatly suppressed. By using a more concentrated film coating formulation (Stock II below), with a viscosity of 20 cps. and over, for example, matrix holes as large as 15.5 mils can be printed in a single film from 15 mil mask apertures before bridging and hole deformation become a problem, whereas, using Stock I below, with a viscosity of 10 cps. and a film weight of 0.1 mg./cm.², bridging and its accompanying difficulties may be unacceptable at about 14 mils matrix hole size. Although the mechanism of bridging suppression using thicker films is not clearly understood, it appears that the thicker films permit removal of the bridging by undercutting it during the film development step.

The choice of film thickness is determined by the print-down required. For example, where it is desired to print the smallest possible matrix holes (greatest print down) from a given size of light source, the thinnest film is chosen in order to get best adherence. When the film is too thin, the retained film dots will be difficult to etch out during peroxide reversal. The optimum film weight for maximum print down is around 0.10 mg./cm.². Where a matrix hole at or near the mask-aperture size is desired (least print down), the thickest film compatible with good adherence, spreading, and freedom from mottle is chosen; this weight would be around 0.30 mg./cm.², and gives the least problems from bridging and light overlap. Where some intermediate amount of print down is desired, an intermediate film weight is used (stock III below) so as to have both good adherence and minimum bridging difficulties. Such film weights are, of course, only examples and are to some degree a function of the resist used to form the matrix hole. However, the principle of choosing the optimum film weight to match the desired print down remains the same regardless of the film formulation chosen to form the matrix hole.

The following film coating formulations or stocks have been used successfully to make good-quality negative-tolerance matrix screens by the novel method. All percents are by weight. Stock II is used when minimum print down is desired; Stock I, when maximum print down

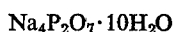
is desired; and Stock III, when an intermediate amount of print down is desired.

Stock I

Same as Stock II except that 2961 g. water is added instead of 1461 g. Stock I has a viscosity of about 10 cps. at 25° C. and gives a dry film weight of about 0.1 mg./cm.².

Stock II

To a 10% suspension of titanium dioxide TiO₂ which contains about 0.05% sodium pyrophosphate



and the balance water add with stirring the following ingredients in this order:

20.5 g. 5% aqueous solution of a wetting agent, such as Pluronic L72

1461 g. water

1013 g. 10% polyvinyl alcohol, such as Vinol 540 marketed by Air Products & Chemical Co., Edison, N.J.

228 g. 22½% acrylic resin, such as C72, marketed by Rohm & Haas, Philadelphia, Pa.

152 g. 10% sodium dichromate Na₂Cr₂O₇ · 2H₂O

This Stock II had a viscosity of about 30 cps. (centipoises) at 25° C. and gives a dry film weight of about 0.3 mg./cm.² in the process of the example.

Stock III

Same as Stock II except that 1680 g. water is added instead of 1461 g. This Stock III has a viscosity of about 20 cps. at 25° C. and gives a dry film weight of about 0.2 mg./cm.².

Another important condition is that the light source have a smaller-than-normal area. The phrase "equivalent circular diameter" is used herein to define a light source which performs substantially as a circular light source of the indicated diameter. For the exposures used to make the matrix, the optimum equivalent circular diameter is about 80 mils, with a range of 60 to 130 mils. Too small a light source permits a smaller print down, and has too low a light output, resulting in excessively long exposure times. Also, diffraction effects limit the amount of print down which can be attained with very small area light sources. Too large a light source permits a larger print down, but a mottled and nonuniform screen results due to excessive sensitivity to lighthouse and processing non-uniformities.

The graphs shown in FIGS. 2, 3 and 4 illustrate some typical relationships for printing sensitivity and print down for several sets of exposure conditions used for printing negative-tolerance matrix-screen structures for 23V" picture tubes by the novel method. These tubes employ an apertured mask having about 15-mil diameter center mask apertures, about 28-mil center-to-center spacing of the center-mask apertures, and about 15-mil diameter corner-mask apertures.

FIGS. 2, 3 and 4 were generated from the same 23V" panel-mask assembly. Each panel was divided into quadrants with each quadrant receiving a different exposure time through the same intensity control filter. For FIG. 2, they were 2.75, 3.00, 3.25 and 3.50 minutes. For FIG. 3, they were 3.25, 3.50, 3.75 and 4.00 minutes. For FIG. 4, the exposure times were 13, 15, 17 and 19 minutes. The relative exposure is the product of exposure time in minutes times the current in microamperes used to operate the lamp in the lighthouse. This product yields a relative value for exposure. After processing the panel, the matrix-hole sizes were measured and the relative hole area of the matrix computed in each quadrant. A graph (not shown) was made of matrix-hole size as the ordinate and exposure as the abscissa for the collimator size evaluated, as a convenient way to provide average values of hole size versus exposure. A plot (such as shown in FIGS. 2, 3 and 4) is made of printing sensitivity (P.S.) versus print

down. Printing sensitivity is defined as percent change in matrix-hole area per percent change in exposure

$$(\text{P.S.} = \text{percent} \Delta A / \text{percent} \Delta E)$$

Print down is defined as the difference between mask aperture diameter and matrix hole diameter.

For FIG. 2, the method employed a 100-mil equivalent-diameter light source, and a film weight of about 0.20 mg./cm.² prepared from a film coating formulation at a viscosity of about 20 centipoises and containing about 6.6 weight-percent sodium-dichromate sensitizer with respect to the weight of polyvinyl alcohol present.

For FIG. 3, the method employed a 100-mil equivalent-diameter light source, and a film weight of about 0.10 mg./cm.² prepared from a film coating formulation at a viscosity of about 12 centipoises and containing about 6.6 weight-percent sodium dichromate with respect to the weight of polyvinyl alcohol present.

For FIG. 4, the method employed an 80-mil equivalent-diameter light source and a film weight of about 0.10 mg./cm.² prepared from a film coating formulation at a viscosity of about 12 centipoises and containing about 13.2 weight-percent sodium dichromate with respect to the weight of polyvinyl alcohol present.

Each of FIGS. 2, 3 and 4 has four points plotted showing the actual results at about the center of the screen obtained in carrying out the novel method. The graphs illustrate that up to about 2.5 mils of print down at the center of the screen can be obtained under the four different exposure conditions.

Experience has shown that the mask aperture sizes and the center-to-center spacings of the apertures are important. For the 23V" mask, which has a center-to-center aperture spacing of 28 mils; the mask aperture size should be between about 14.5 to 15.3 mils in the center and about 12.5 to 13.5 mils in the corners. Mask apertures varying substantially from these optimum sizes may exhibit printing sensitivities over areas of the screen which are higher than 1.5 and yield a matrix which has a mottled appearance. Too large an aperture size may cause bridging at the desired matrix hole size. Too small a mask aperture size may result in poor tolerance in the finished tube and poor white uniformity.

A grading of the brightness of the light field at the film during the exposing step may be used to provide a graded print down from center to corner. Where a center print down of 1.0-mil grading to a corner print down of 3.0 mils is desired, for example, it is necessary to grade the lighthouse light intensity from a center intensity of about 1.00 arbitrary units to a corner intensity of about 0.85 arbitrary units. This may be achieved by using an intensity-correcting filter for each lighthouse as described in U.S. patent application No. 844,852 filed July 25, 1969 by Harry R. Frey, now Pat. No. 3,592,112. This edge-over-center grading may vary between 0.80 to 1.0 for the 23V" and 25V" tubes; the preferred edge-over-center grading is about 0.9.

Since the phosphor dots are printed behind a matrix already formed, there is no need for print down as such. However, the sizes of the phosphor dots need to be controlled to prevent their overlap into adjacent matrix holes. Lightfield grading in the lighthouse may vary between an edge-over-center ratio of 0.8 up to 1.2 for the phosphor dots. In printing the phosphor elements in the matrix holes, light source size must also be properly chosen in order to get good phosphor adherence from the large mask apertures without overlap of phosphor dots into the adjoining holes of the matrix. A smaller light source has too low a light output, and long exposure times result. With too large a light source, phosphor dots with good adherence are too big when printed from the large negative tolerance mask aperture, so that they may overlap into adjacent matrix color holes. Light source sizes from about 80 to 130 mils equivalent diameter are usable.

We claim:

1. A photographic method for printing a screen structure for a cathode-ray tube, said tube having therein a supporting surface, an apertured mask in spaced relation with said surface, and a screen structure on said surface, said screen structure being comprised of screen elements each of which is smaller than and registered with an aperture in said mask, said method including

- (a) coating said surface with a film of a polymeric material whose solubility is altered when it is exposed to light, the weight of said film being in the range of about 0.1 to 0.3 milligrams per square centimeter,
- (b) positioning said mask in said spaced relation with respect to said coated surface,
- (c) exposing said film by projecting light from a small area light source having an equivalent circular diameter of about 0.060 to 0.130 inch through the apertures of said positioned mask incident upon said greater solubility and regions with lesser solubility, said regions of lesser solubility being smaller than the apertures used to expose them,
- (d) removing those regions of said film with greater solubility whereby to bare the areas of said surface underlying said regions of greater solubility, while retaining those regions of said film with lesser solubility,
- (e) overcoating said surface and said retained film regions with a composition that is adherent to said surface and containing light-absorbing particles therein,
- (f) removing at least a portion of said retained film regions and the overcoating composition thereon, while retaining the overcoating composition adhering to said surface,
- (g) and then depositing phosphor material on areas of said surface previously occupied by said removed portions of said retained film regions.

2. The method defined in claim 1 wherein said film in step (a) is comprised of polyvinyl alcohol and a dichromate sensitizer therefor.

3. The method defined in claim 2 wherein said film in step (a) is produced by coating said surface with a formulation having a viscosity of about 9 to 30 centipoises.

4. The method defined in claim 2 wherein, subsequent to step (b) and prior to step (d), said film is subjected also to a flood exposure which is insufficient by itself to produce film portions which adhere to said surface.

5. The method defined in claim 2 wherein said film in step (c) is exposed for about 0.1 to 10 minutes.

6. The method defined in claim 2 wherein step (g) comprises

- (i) coating the entire surface carrying said retained overcoating with a phosphor coating comprising phosphor particles, polyvinyl alcohol and a dichromate sensitizer for said alcohol,
- (ii) positioning said mask in said spaced relation with respect to said surface,
- (iii) exposing said phosphor coating by projecting light through the apertures of said positioned mask incident upon said coating, thereby producing in said coating regions of greater solubility and regions of lesser solubility,
- (iv) and then removing said coating regions of greater solubility while retaining said coating regions of lesser solubility.

7. The method defined in claim 6 wherein said exposing in step (iii) comprises projecting light from a small area light source having an equivalent circular diameter of about 0.080 inch.

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NORMAN G. TORCHIN, Primary Examiner

E. C. KIMLIN, Assistant Examiner

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,788,846 Dated January 29, 1974

Inventor(s) Edith Ellem Mayaud and Samuel Pearlman

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

FIG. I

change "ABSORBINGING" to
--ABSORBING--

move "(a)" "(b)" "(c)" "(d)"
"(e)" and "(f)" to within the
adjacent box

Column 7, line 58

change "23V"" to --23V--

Column 8, line 56

change "23V" and 25V"" to
--23V and 25V--

Column 9, lines 18 and 19

after "said" and before "greater"
add --film, thereby producing
in said film regions with--

Signed and sealed this 9th day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents