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Orthuber

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[54] **CHANNEL PLATE ELECTRON MULTIPLIER ADJACENT COLOR DOT SCREEN**

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[44] Published under the Trial Voluntary Protest Program on January 28, 1975 as document no. B 395,478.

Related U.S. Application Data

[63] Continuation of Ser. No. 198,835, Nov. 15, 1971, abandoned.

[52] **U.S. Cl.** **313/105;** 313/495; 313/95

[51] **Int. Cl.²** **H01J 43/24;** H01J 37/22

[58] **Field of Search** 313/103, 104, 105

[56] **References Cited**

UNITED STATES PATENTS

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Attorney, Agent, or Firm—John T. O'Halloran; Menotti J. Lombardi, Jr.

[57] **ABSTRACT**

A phosphor deposition method including the step of illuminating the phosphor slurry on a tube faceplate through the channels of a channel-type electron multiplier array for use in the tube. For a color television picture tube, red, green and blue phosphors are sequentially fixed by the use of a multiplier having three sets of channels extending therethrough at three different angles. The different colored phosphors are then illuminated at the three different corresponding angles. Any misregistration may be corrected by the use of a lens device.

6 Claims, 8 Drawing Figures

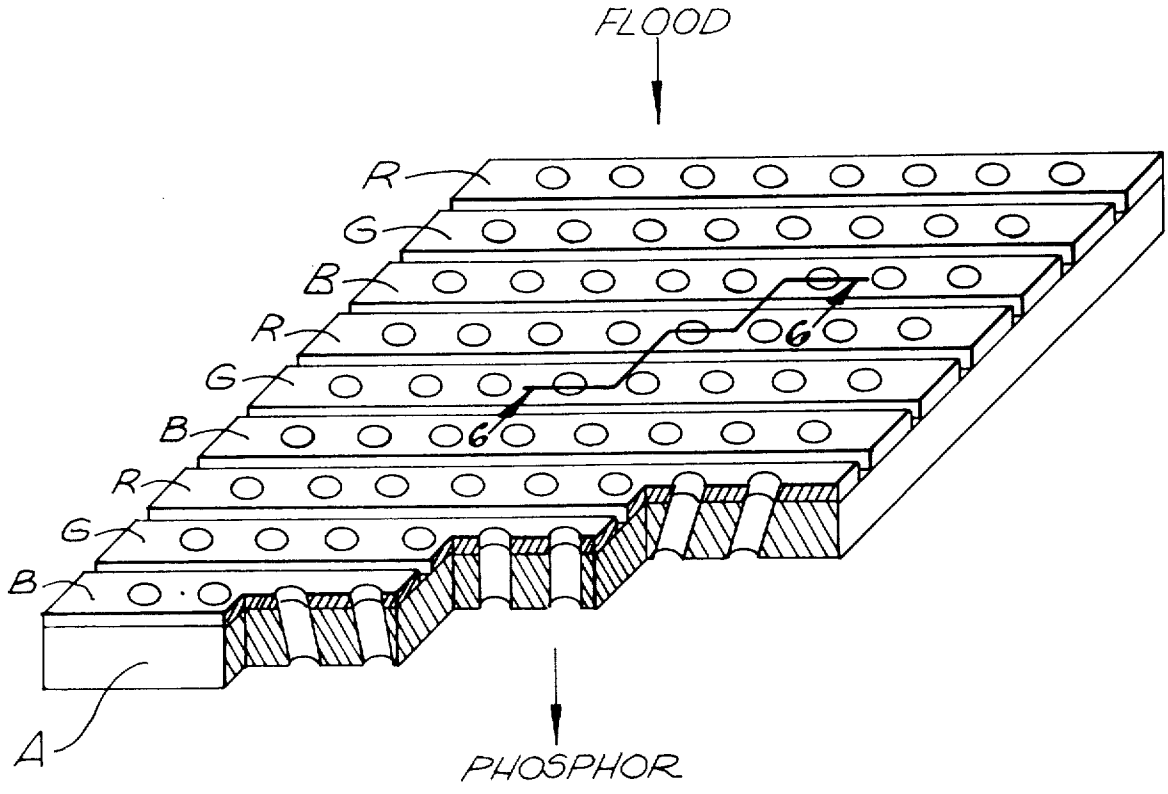


Fig. 1.

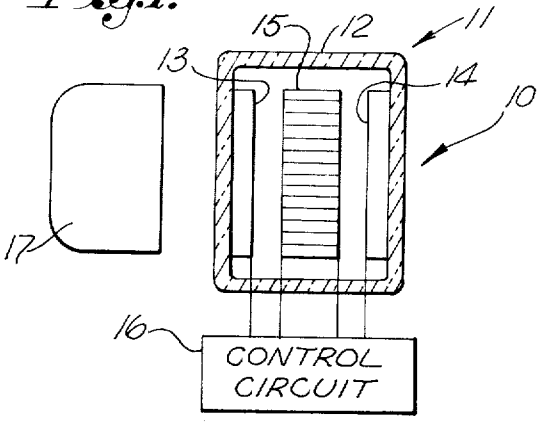


Fig. 2.

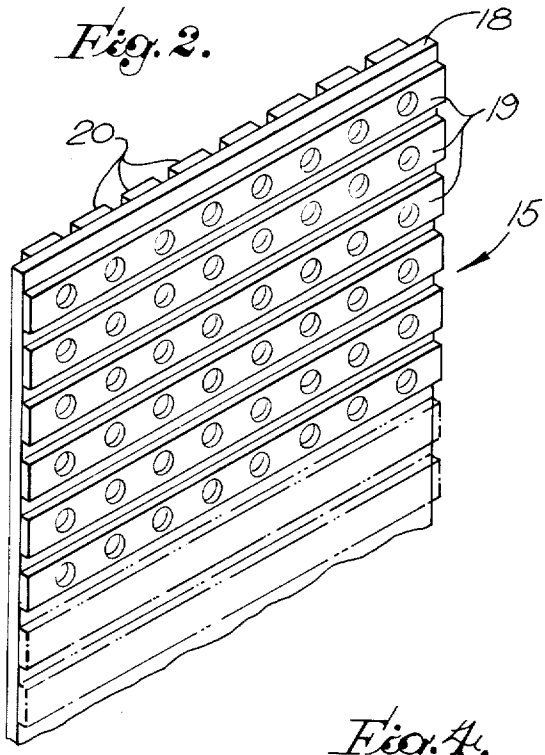


Fig. 3.

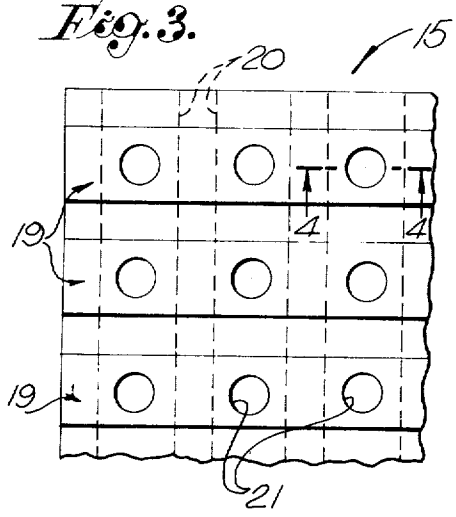
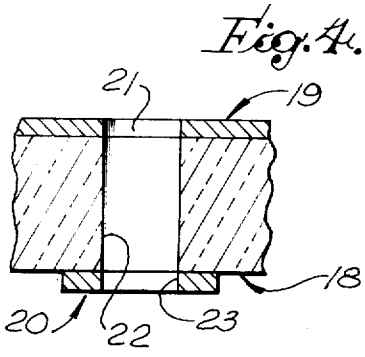


Fig. 4.



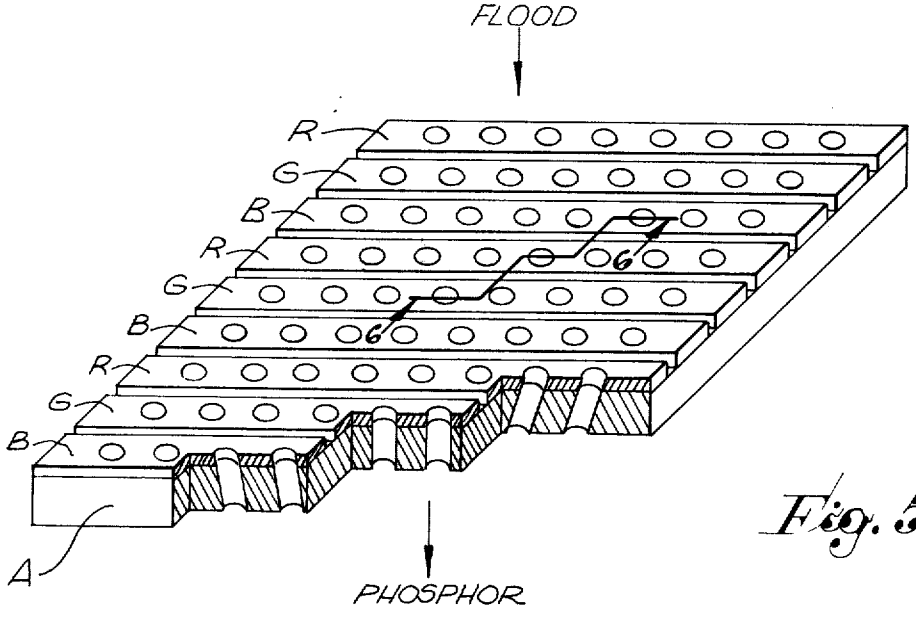


Fig. 5.

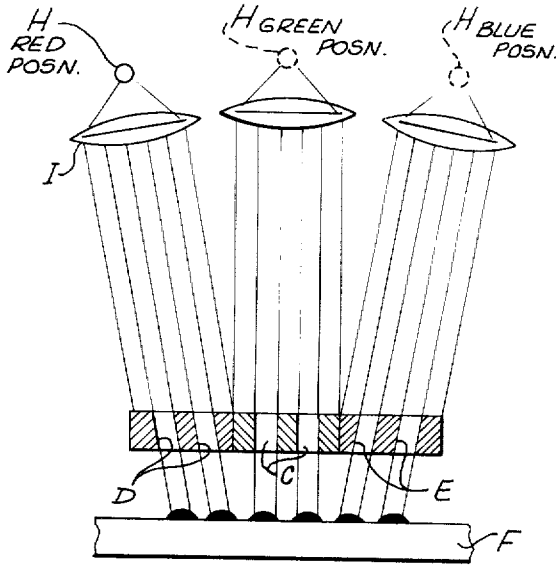


Fig. 6.

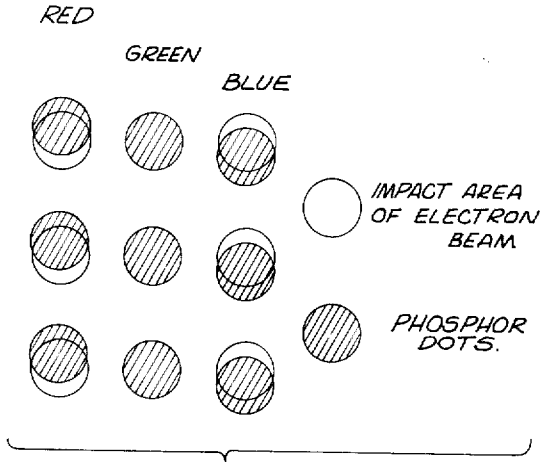


Fig. 7.

DEFLECTION OF FIXING LIGHT BEAM TO TRANSFORM PHOSPHOR DOT-PATTERN INTO PHOSPHOR LINE PATTERN.

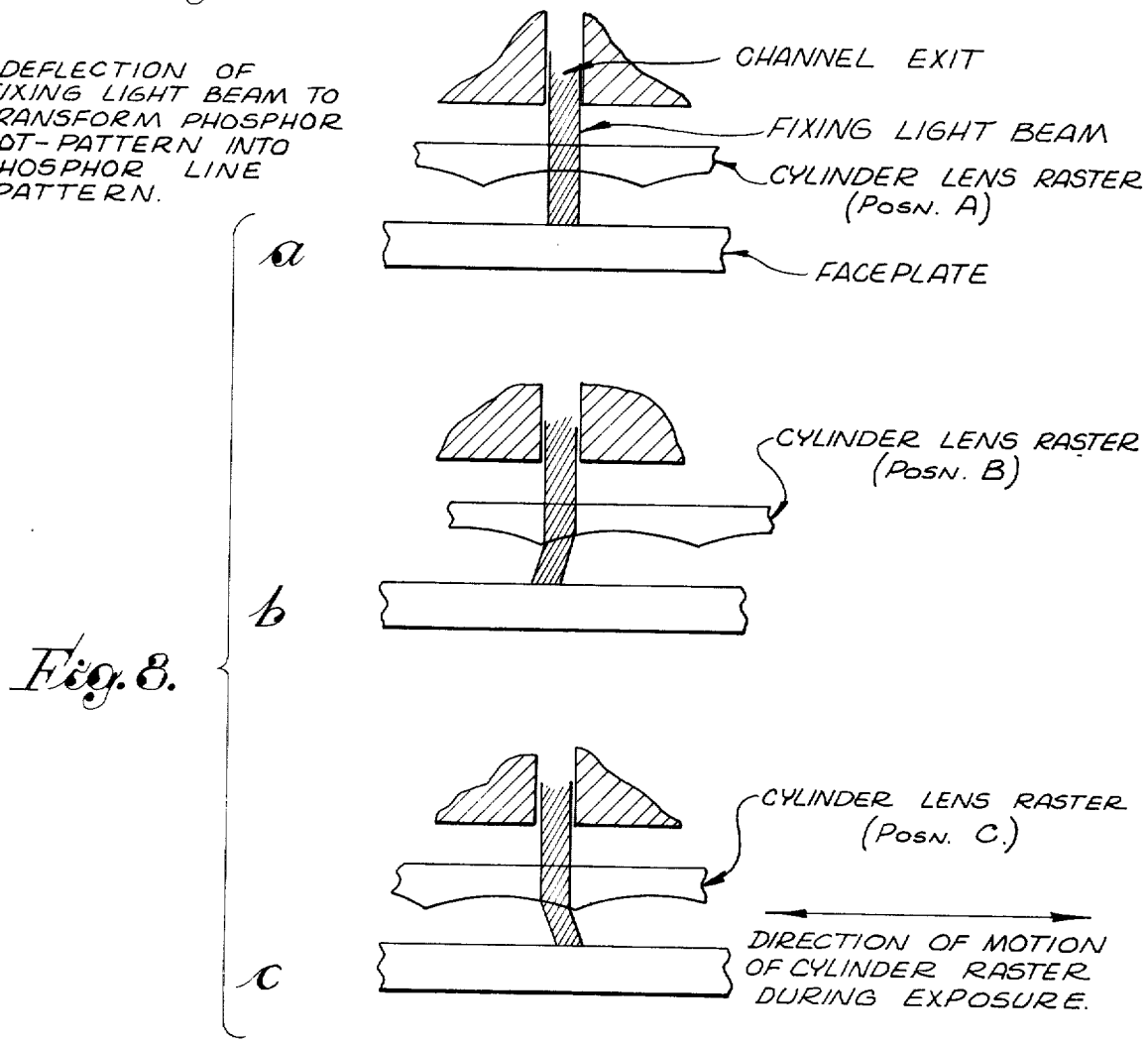


Fig. 8.

CHANNEL PLATE ELECTRON MULTIPLIER ADJACENT COLOR DOT SCREEN

This is a continuation of application Ser. No. 198,835, filed Nov. 15, 1971, and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to luminescent phosphor deposition, and more particularly, to a method of and apparatus for accurately registering phosphor dots adjacent the output side of a channel-type electron multiplier array.

Channel-type electron multiplier arrays, by themselves, are well known in the art. They often include a perforated glass plate having a multitude of holes therethrough long in comparison to their diameters. The glass plate is treated so that the internal surfaces of the holes support secondary emission. A conductive layer is then sometimes fixed to each side of the glass plate, each layer having a hole in registration with each of the plate holes.

A multiplier array having this type of construction, but utilizing perpendicular conductive strips instead of the said layers is disclosed in U.S. Pat. No. 3,541,254. This patent discloses structures for use in a black and white or color television picture tube.

It is a rather simple matter to deposit phosphor on the faceplate of a TV picture tube for use as a black and white screen. However, the manufacture of a color screen for the color tube disclosed in said patent is often difficult to achieve.

SUMMARY OF THE INVENTION

In accordance with the present invention, the above-described and other difficulties of the prior art have been overcome by illuminating phosphor slurry on a faceplate through the holes in a channel-type electron multiplier array or the like.

One outstanding feature of the invention resides in making holes through the multiplier array at different angles for the selective illumination of and fixing of different color phosphors.

Still another feature of the invention resides in the utilization of a lens to spread the fixing illumination to provide good phosphor registration.

The above-described and other advantages of the present invention will be better understood from the following detailed description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings which are to be regarded as merely illustrative:

FIG. 1 is a diagrammatic view of a television receiving system;

FIG. 2 is a perspective view of a channel-type electron multiplier array employed with the system of FIG. 1;

FIG. 3 is a broken away front elevational view of the multiplier array shown in FIG. 2;

FIG. 4 is a horizontal sectional view of the multiplier array taken on the line 4—4 shown in FIG. 3;

FIG. 5 is a broken away perspective view of a multiplier array constructed in accordance with the present invention;

FIG. 6 is a diagrammatic view of the method of phosphor deposition in accordance with the present invention;

FIG. 7 is a diagram illustrating possible phosphor misregistration; and

FIG. 8 illustrates the operation of a method of overcoming any misregistration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, a television receiving system is disclosed at 10 which may be identical to one of those disclosed in the said patent. For example, a picture tube 11 has a transparent evacuated envelope 12. A photocathode 13 is fixed to one side of the envelope 12. A phosphor screen 14 is fixed to the other side. A device which will be referred to herein as a multichannel array (MCA) is indicated at 15 between photocathode 13 and phosphor screen 14. A control circuit 16 is connected to photocathode 13, MCA 15 and phosphor screen 14. A lamp 17 illuminates photocathode 13.

Shown in FIG. 2, MCA 15 includes a glass or ceramic plate 18, horizontal conductive strips 19 and vertical conductive strips 20. If desired, strips 20 may be identical to strips 19. Strips 19 are fixed to one side of plate 18, and strips 20 are fixed to the other side thereof. Note will be taken that strips 20 run in a direction generally perpendicular to strips 19.

As shown in FIGS. 3 and 4, each strip 19 has a plurality of holes 21 therethrough. The same is true of holes 22 in plate 18 and holes 23 in strips 20. For each hole 21 in a strip 19, there is a corresponding hole 22 in plate 18, and vice versa. For each hole 22 in plate 18, there is also a hole 23 in a strip 20. For example, for each hole 21, shown in FIG. 3, there is actually one hole 22 in registration with each hole 21, and a hole 23 in registration with each hole 22.

In a conventional channel-type electron multiplier array, a dielectric plate, often made of glass, is employed with holes therethrough, the surfaces defining the holes being approximately cylindrical. Thus, the construction of the dielectric plates, to be described in connection with FIGS. 5, 6 and 8, are made of glass and have cylindrical holes therethrough with surfaces which will support secondary emission.

In FIGS. 2, 3 and 4, the strips 19 and 20 are selectively maintained at potentials to gate electron transmission in only one plate hole at a time. A more detailed description of the structure and operation of the MCA 15 is given in the said patent.

The deposition of red, green and blue phosphor elements in the familiar Shadowmask tube—and also in the Multichannel Array Color Kinescope (MACK tube)—requires extremely accurate registration between the array of phosphor elements on the tube faceplate and a densely perforated plate which, in the case of the first tube, is the shadowmask and, in the case of the MACK tube, the gateable multichannel array (MCA).

In order to cope with this very difficult problem of precise registration between two parts extending over the large area of 20 to 25 inches diameter, the manufacturers of shadowmask tubes make use of a procedure generally designated as "lighthouse screening." This procedure consists in essence in an optical simulation of the red, green and blue writing electron beam trajectories for all beam deflection states combined with sequential application of the red, green and blue

phosphor dots out of a suspension of the color phosphors in a photosensitive binder which by exposure to the simulating light beams becomes insoluble and, thus, fixed at the correct positions on the faceplate. This method is well-known and generally used in the manufacture of shadowmask tubes.

It should be emphasized that the "lighthouse screening" process is carried out by illumination of the color phosphor slurry on the faceplate through the same individual mask which will later be combined in the same tube with the particular phosphor dot array under preparation. In this way, random variations in hole position and spacing between individual masks are compensated and do not lead to misregistration. Besides, the shadowmask is automatically aligned with its replication as phosphor dot pattern.

Some features of lighthouse screening made the method desirable for the manufacturing of the MACK tube as well. However, it requires certain modification. The reason for this is twofold:

a. In the so far considered multichannel arrays, all channels were aligned parallel. Thus, in illuminating this plate, all channels will transmit light beams simultaneously, which makes it impossible to fix phosphor elements of different colors in three sequential steps.

b. If it is attempted to simulate the shadowmask lighthouse process by masking the MCA so that only every third vertical column of channels is illuminated and then to illuminate the MCA from three different directions sequentially, there will still be no satisfactory separation of the resulting traces on the faceplate since, due to the large length-to-diameter ratio of the MCA channels, the transmission of light will essentially be parallel to the channel axis regardless of the direction of light incidence.

It would be possible to perform sequential exposure through such a mask restricting illumination to every third column of MCA channels at each exposure and shifting this mask with respect to the MCP perpendicular to the direction of the columns by one strip width between each exposure. This method appears, however, to be very difficult with respect to accomplishing precise registration between mask and MCA between exposures.

A method is disclosed herein which simplifies the phosphor deposition process but requires a modified MCA configuration as shown in FIG. **5**.

Extending from left to right on top of the MCA and facing the flood source, gating strips R, G and B are shown in FIG. **5**. These correspond to the vertical gating strips which control electron admission to the channels ending opposite the R (red), G (green) and B (blue) columns of phosphor strips on the faceplate.

The channels controlled by the "G strips" are shown to penetrate the MCA base A in a direction perpendicular to the surface of the MCA, while the channels controlled by R and G strips are tilted against the G channels in opposite directions. The tilting direction is preferentially chosen thus that the axes of the tilted channels through one gating strip remain in a plane containing the center line of the corresponding gating strip. Using this type of an MCA, the phosphor deposition method is illustrated in FIG. **6**.

FIG. **6** shows, side-by-side, segments of the modified MCA of FIG. **5** with perpendicular "G channels" C tilted "R" and "B" channels D and E, respectively, mounted close to, e.g. about, ⅛ to ½ inch from the faceplate F and parallel to it.

As in the case of lighthouse screening of a shadowmask tube, the MCA preferably should be mounted in such a fashion that it can be removed and remounted repeatedly in the same position relative to the faceplate with a tolerance of 1/1000 inch or less.

At the top of FIG. **6**, a long, tubular light source H, e.g., mercury discharge, is located with its long axis perpencidular to the vertical gating strips (designated B, R and G, in FIG. **5**) with a spectral composition actinic with respect to the phosphor suspension used. (The drawing shows one illuminator in three sequentially assumed positions.) The light source is collimated in one direction into a sheet beam by a cylinder lens I with an axis parallel to the axis of the tubular light source, so that light rays approaching the MCA travel in parallel planes. The sheet of one-dimensionally collimated light should be wide enough to cover the width of the display area of the MCA (16 inches for a 20 inch diameter tube).

If the height of the display field (12 inches for 20 inch tube diameter) is not covered fully by the illuminated field, the illuminator may be shifted with a constant velocity in a direction parallel to the vertical gating strips and thus perpendicular to the tubular lamp and cylinder lens axis during exposure of the slurry coated faceplate to cover the entire display area.

This arrangement permits screening in the following steps:

Step 1: With the MCA removed, the blue phosphor is applied to the faceplate in a photosensitive slurry.

Step 2: The MCA is positioned preferably in a precision mounting fixture.

Step 3: The faceplate is illuminated with the light source in the right-hand position of FIG. **6** by a sheet beam collimated in the plane of FIG. **6** but not necessarily perpendicular to the plane of the drawing. If the sheet beam does not cover the entire display height, the light source is shifted parallel to the gating strips (until the entire display area has been covered) without changing direction of the beam and MCA to light source distance. Due to the large length-to-diameter ratio of the channels, only channels tilted parallel to the plane of the illuminating sheet (the "B" channels) transmit light and photochemically fix the blue phosphor underneath the "B" channels.

Step 4: The unilluminated blue phosphor slurry is washed out by conventional methods.

Steps 5, 6, 7 and 8: Like Steps 1 to 4, but with green phosphor and with perpendicular illumination.

Steps 9, 10, 11 and 12: Like Steps 1 to 4, but with red phosphor and with illumination as shown in the left-hand side of FIG. **6**.

The resulting dot pattern will have the appearance shown below in FIG. **7** with the blue and red dots slightly shifted up or down against the green dots, the shift being parallel to the vertical gating strips. Unlike the dot pattern in a shadowmask tube, these dots will register in the completed MACK tube with the positions of electron beam impact only in a direction perpendicular to the vertical gating strips but not parallel to this direction, as indicated in FIG. **7**.

The reason for this difference is that, while in the shadowmask tube, the fixing light beams and the electron beams follow identical straight trajectories between the mask holes and the phosphor, this is not the case in the MACK tube. Here the light beams for red and blue are

not perpendicular to the MCA and phosphor, whereas all electron beams (red, green and blue) being generated in the output section of the channels traverse the MCA-phosphor space in an essentially perpendicular direction with respect to MCA and phosphor.

To overcome this difficulty, a further modification of the above-described procedure may be made as shown in FIG. **8**. FIG. **8** shows the exit section of a channel with a fixing light beam leaving it. Before impinging on the photosensitive phosphor suspension on the faceplate, the beam has to pass a unit designated as "cylinder lens raster," which is a transparent element of optically clear glass, quartz or plastic provided on one side with a multitude of parallel cylindrical surfaces as shown. Its area is preferably equal to or larger than the MCA display area. Depending on the relative position of this cylinder lens raster with respect to the channel exits, the fixing beam passes the cylinder lens raster either essentially undeflected (position A), deflected to the left (position B) or deflected to the right (position C).

Thus, if the cylinder lens raster is inserted during exposure of the phosphor suspension in the space between MCA and faceplate in such an orientation that the elemental cylinder lenses intersect the vertical gating strips under a 90° angle and is moved sideways during exposure, as indicated in FIG. **8**, the dot pattern of FIG. **7** will be changed into a pattern of strips extending vertically across the faceplate and parallel to the vertical gating strips. The illuminated dot on the faceplate must be displaced by motion of the cylinder lens raster with an amplitude of at least +½ of the channel axis spacing.

In the FIG. **8** illustration, the width of the cylindrical elements on the cylinder lens raster is shown approximately four times the channel diameter and, thus, motion of the lens raster is necessary to accomplish a transformation of the dot pattern into a strip pattern. However, with a tight array of cylinder lenses with a width of a small fraction of a channel diameter, spreading of the dots into continuous strips may be accomplished without motion of the cylinder lens raster. Mutually insulated vertical strips of red, blue and green phosphor have been assumed in all preceding discussions of the MACK tube. This type of pattern requires registration of gating strips, channel columns, and phosphor strips only in the direction perpendicular to the length axis of gating strips and phosphor strips, which is assured by the method of the present invention. Registration along gating strips and phosphor strips is not necessary with this pattern.

From the foregoing, it will be appreciated that any device incorporating a channel-type electron multiplier may be constructed in accordance with the method of the present invention.

Although only one set of conductive strips have been shown in FIG. **5**, it is to be understood that another set of, more or less, perpendicular strips may be employed therewith.

Although only a few conductive strips have been illustrated in, for example, FIG. **5**, it is to be understood that a great many more strips, both vertical and horizontal, may be employed. A much larger number of holes may also be employed. Note will be taken that resolution may be increased by increasing the number of holes.

The MCA holes may also be relatively small. Plate hole **22** may be much longer than shown in FIG. **4** in relation to the diameter thereof. However, FIG. **4** is a greatly enlarged view in any event.

The dielectric or glass plates of the present invention may also be circular or some other shape other than rectangular, if desired.

As described previously in connection with FIG. **5**, the red holes are disposed at an angle relative to the normal. The blue holes may be disposed at the same angle in the opposite direction. This angle may be small because generally the depth of the holes is much greater than shown in FIG. **5**, and much greater than the hole diameter. Thus, the angle is preferably less than 90°, as small as possible, but not smaller than arctan D/L, where D is the hole diameter and L is the hole length.

SUMMARY

In accordance with the present invention, a multiplier plate of the type described in connection with FIG. **5**, or an equivalent thereto, is needed. The different color phosphors are exposed through the three sets of holes, i.e., the red holes, the green holes and the blue holes. Exposure through one set of holes does not cause exposure through either of the other two sets of holes when the said angle is greater than arctan D/L. This is true because the light cannot get through any one of either of the two other sets.

During each exposure, the cylinder lens raster, shown in FIG. **6**, may be moved horizontally, as viewed in FIG. **8**, to achieve exposure in a line, if desired. This, therefore, will compensate for any misregistration, as shown in FIG. **7**, if desired.

If the faceplate is sufficiently close to the dielectric plate which provides electron multiplication, the cylinder lens raster may be omitted because the misregistration of FIG. **7** may then be imperceptible.

The word "fix" as used herein and in the claims to follow, when used in connection with the phosphor or photosensitive slurry is hereby defined to mean "photochemically fix."

What is claimed is:

1. A device for registering color phosphor dots in a television tube comprising, a phosphor screen coated with color dots, a dielectric channel plate electron multiplier positioned adjacent said phosphor screen, said channel plate including a plurality of parallel columns of holes therethrough between opposite sides of said plate, said holes having resistive secondary emissive surfaces therein, electrodes on said opposite sides having corresponding holes coinciding with said dielectric plate holes, one of said electrodes on one side including a plurality of spaced parallel electrodes along respective columns of holes, the holes in each respective column having a common axial angle through said plate with respect to the plane of said screen different from the angle of the holes in each adjacent column, each column of holes with respective different common angles being repetitive in every third column across said plate, and each column of holes being aligned with a corresponding column of phosphor dots on said screen.

2. The device of claim **1** wherein each column of holes is associated with a selected phosphor dot color.

3. The invention as defined in claim **1**, wherein the axes of the holes of one of every three columns are inclined at a predetermined angle less than 90° in one direction from the normal with respect to the plane of said screen, the axes of the holes of the second of said columns being normal to said plane and the axes of the

holes of the third of said columns being inclined at the same said predetermined angle less than 90° but in a direction opposite said one direction.

4. The invention as defined in claim **3**, including a further plurality of spaced parallel electrodes on the other side of said plate over respective rows of said plate holes transverse to the columns on said one side, said further electrodes having corresponding holes therethrough in registration with each plate hole in each respective row.

5. The invention as defined in claim **4**, wherein said holes have cylindrical internal surfaces, said predetermined angle being less than 90° and greater than arctan D/L, where D is the diameter of said holes, and L is the length thereof.

6. The invention as defined in claim **3**, wherein said holes have cylindrical internal surfaces, said predetermined angle being less than 90° and greater than arctan D/L, where D is the diameter of said holes, and L is the length thereof.

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