Feb. 10, 1970 J. W. SCHWARTZ 3,494,267

METHOD AND MEANS FOR PRODUCING COLOR TELEVISION PICTURE TUBES

Filed Oct. 3, 1966

Fig. 1.

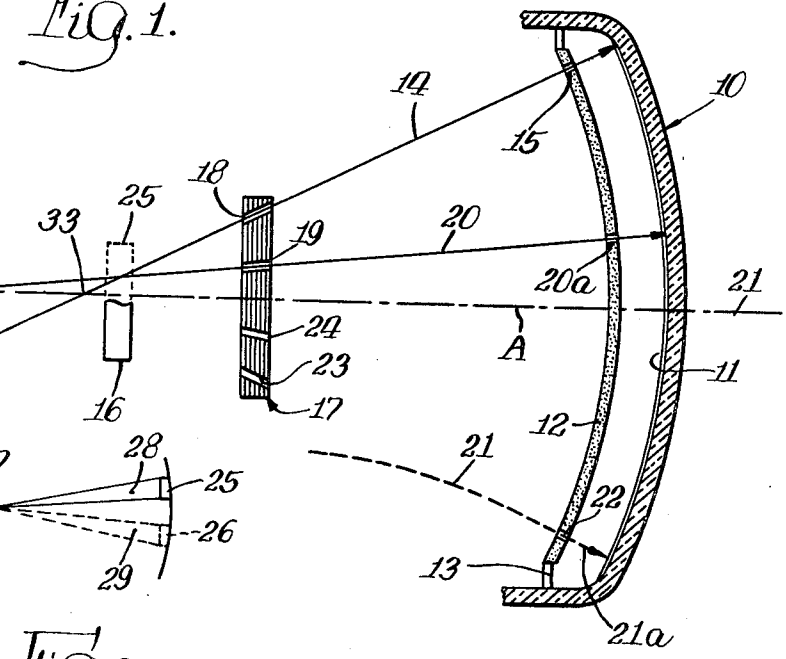


Fig. 2.

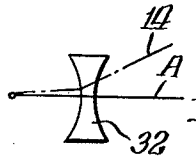


Fig. 3.

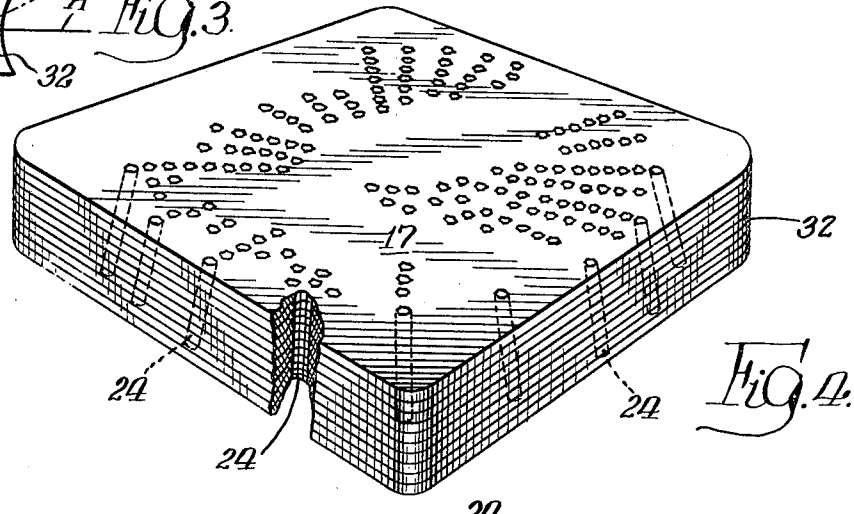


Fig. 4.

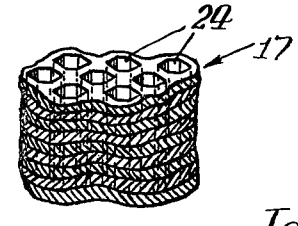


Fig. 5.

INVENTOR.
James W. Schwartz,
BY
Dawson, Tilton, Fallon, Lungmus & Alexander
Attys.

United States Patent Office 3,494,267
Patented Feb. 10, 1970

3,494,267

METHOD AND MEANS FOR PRODUCING COLOR TELEVISION PICTURE TUBES

James W. Schwartz, Western Springs, Ill., assignor to National Video Corporation, a corporation of Illinois

Filed Oct. 3, 1966, Ser. No. 583,867
Int. Cl. G02b 27/00; H01j 9/00
U.S. Cl. 95—1 7 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for producing color television picture tubes consisting of a photosensitized surface, a shadow mask, a light source, and an opaque control element having a plurality of channels therein. The opaque control element is positioned between the light source and the shadow mask and the channels of the control element define linear extensions of the electron-beam path segments which exist between the shadow mask and the photosensitized surface. The channels have an axial length which is relatively long compared to their cross-sectional dimension. The control element is constructed by superimposing a plurality of plates which have their channel openings defined by the coordinates of the electron-beam path segments.

This invention relates to a method and means for producing color television picture tubes and, more particularly, for establishing the cathodo-luminescent phosphor dots in the screen of a color television picture tube.

The invention provides a method and means for directing actinic rays to predetermined locations on the screen-providing substrate so that the green, blue and red dots are properly positioned—so as to be in register with electron beams emanating from the various guns after the beams have passed through openings in the shadow mask associated with the screen.

Conventionally, these dots are formed by directing ultra-violet rays against a substrate coated on the face-plate portion of the color tube. The rays insolubilize selected areas of the polymeric substrate which remain after washing away the remaining soluble portions of the substrate. Usually the phosphor powder is applied prior to washing so that discrete areas or "dots" of phosphor particles are arranged on the screen after washing. This operation is performed three times to provide the green, blue and red fields. Finally, baking converts the polymeric material to the finished screen.

A number of difficulties exist in the contemporary procedure. One stems from the different behavior of the actinic rays and the electrons beams. The actinic rays used to develop the dots travel in straight lines from their source to the target substrate so that the path portion between the shadow mask and screen, if extended, would pass through the source. This is not true of the electron beams ultimately employed to cause the dots to scintillate or luminesce. The path portion of the beam between the shadow mask and the screen, if extended, would not intercept its source. Thus, it has been necessary to employ an optical system to properly direct the actinic rays. This, however, is the lesser difficulty facing those who provide optical systems. A major difficulty stems from the fact that the electron guns which provide the electron beams are located off-axis. Normally, the three guns are spaced apart 120° a definite distance from the tube axis. This has necessitated the provision of complex optical systems and changes in geometry of the mask relative to the screen as seen for example in U.S. Patent No. 2,885,935, which describes an aspheric asymmetric lens

and variable mask-to-screen spacing. Even with extraordinary expedients of this nature, the phosphor dots are improperly established insofar as providing targets for the electron beams for maximum brightness and clarity.

The instant invention avoids the foregoing difficulties and provides a method and means for establishing the dots where they should be for best registration of the beam with its associated phosphor dots, and provision of such constitutes an important object of the invention. The invention is characterized by a new approach to the problem—departing from reliance on refractive optics to approximate beam paths. Instead, the behavior pattern of the electron beams in tracing the raster is utilized along with a unique control element—not a lens, although in certain aspects the control element may be augmented by a lens—and further with a novel light source. The light source in combination with the control element selectively directs light rays in such a manner as to insure, in combination with the shadow mask, the development of dots in proper position. For this purpose, a source of discrete dimension is employed. The provision of such an arrangement and method of utilization constitute another object of the invention. Other objects and advantages of the invention may be seen in the details of construction and operation as set down in this specification.

The invention is explained in conjunction with the accompanying drawing, in which—

FIG. 1 is a schematic representation of a face plate of a color television tube associated with the novel control element and source of the invention;

FIG. 2 is a schematic representation of ray paths used to explain the invention;

FIG. 3 is a schematic representation of a modified source making use of a refractive element;

FIG. 4 is an enlarged partially-schematic and partially-broken away perspective view of the control element of FIG. 1; and

FIG. 5 is a fragmentary enlarged perspective view of a portion of the control element of FIG. 4.

In the illustration given and with particular reference to FIG. 1, the numeral **10** designates generally a face plate of a color television tube (for example, No. 23EGP22 of National Video Corporation manufacture). After the screen **11** has been suitably established, the face plate **10** is fused to the remaining funnel portion of the tube (not shown) and equipped with the usual electron gun mechanism (also not shown). These are omitted since the instant invention has to do with the establishment of the phosphor dots and at that stage of manufacture, the face plate **10** merely has associated therewith the usual shadow mask **12** suitably supported on posts **13** provided as part of the face plate **10**.

In FIG. 1, the numeral **14** designates a given actinic ray which is seen to pass through an opening **15** in the shadow mask **12**. According to the invention, this ray **14** is established by the cooperation of a source **16** and a control element **17**. The control element **17** has a plurality of passages extending therethrough as at **18** relative to the ray **14** and **19** relative to the ray **20** which is seen to pass through an opening **20***a* in the screen **12**.

The precise design of the light control element **17** and the dimensions of the source **16** are functions of the known parameters of a given system, i.e., the glass envelope of the tube which includes the face plate **10** and screen **11**, shadow mask **12**, electron gun unit and electromagnetic convergence and deflection means. A given system necessarily determines the sweep paths of the electron beams and thus the pattern of dots which will give substantially proper scintillation or light emission. For example, a given electron beam **21** has a pre-

determined path in the operation of the color television tube in which it occurs. The beam path **21** is seen to pass through an opening **22** in the shadow mask **12** before impinging upon the target screen **11**. With the information on the path **21**, it is possible to determine the passage **23** in the control element **17** which will establish the same path segment **21***a* (between the mask and screen) as does the beam **21**.

In like fashion, the other beam segments (like that at **21***a*) determine other passages or channels **24**, etc., through the control element. It will be apparent that there is a beam path which coincides with a light ray—along the axis A. As the beam path departs more and more from the axis to impinge upon dots remote from the face plate center, there is greater divergence of the beam path segments from the corresponding light rays. The extensions of the beam path segments **21***a* do not intersect the axis A at a given point but converge so as to pass within a ring **25**. This then determines the minimum dimensions of the source **16**, i.e., a light source having dimensions so as to include the minimum bundle or plurality of actinic rays necessary to establish the plurality of path segments as at **21***a*.

For this purpose, it is not necessary to determine every beam path segment—only a representative number, of the order of fifty since there is a gradual transition of the slope of the beam path segments **21***a* in proceeding away from the axis and intermediate segments can be determined by interpolation. The original path segments are determined by placing the dots in a given system and experimentally observing the degree of misregister at about fifty points. Thereafter, the beam segments can be ascertained which correct this misregister. In some instances, misregister cannot be completely corrected because of the physical limitations of a given system, i.e., dot shape, mask-to-screen distance, etc. However, a good approximation can be made so that egregious misregister is eliminated—such as where a given beam impinges on parts of two or three dots. Thus, the beam target and the screen opening define each segment.

In FIG. 2, for example, the numeral **25** represents the correct position of a given dot while **26** represents its actual position as initially constructed within a given system. The rays that pass through an opening **27** of screen **12** to define the areas **25** and **26** are designated **28** and **29**, respectively. It will be seen that the correct source location **30** (for achieving area **25**) is spaced from the location **31** which resulted in the misregister area **26**. Thus, there is required a source of discrete dimension along with a control element to pass the ray **28** but filter out the ray **29**. In the actual system, a given "proper" area **25** will receive "developing" light rays from a discrete portion of the source since the particular screen opening **27** acts, in effect like a "pin-hole" camera. The opening **27** in a sense "sees" a group of passages **24** in the control element which permit light travel therethrough from the source. Other screen openings "see" other portions of the source (through the control element) hence the need for a source of some discrete dimension.

It will be appreciated that a light of this magnitude need not be positioned at the source but alternative constructions may be employed as by having a point source with a suitable lens constituting the element **16** so as to provide an effective light source so constructed as to include the minimum bundle of rays **14**, **20**, etc., previously determined necessary to establish the path segments **21***a*. In some instances, the lens arrangement may be more effective since as can be appreciated from FIG. 3, the rays appear to come from a more constricted source **31**, yet are adapted to impinge on the incident surface of the control element **17** without the need for intersecting passages **24**.

It is thus seen that the same system parameters which determine the various light paths **14**, **20**, etc., i.e., the extensions of the beam path segments determine the position and direction of the various passages **18**, **19**, and **23** in the light-control element **17**. One advantageous way of achieving those is to develop, in effect, a light filter or element which is opaque to rays except those of a given direction by virtue of laminating a plurality of metal plates **32** each equipped with a plurality of openings. To permit achievement of a maximum number of openings **17** within a given space and without weakening the interstitial spaces, I make use of hexagonal-shaped openings as can be appreciated from a consideration of FIG. 5. In one embodiment of the invention, I laminate one hundred different plate layers **32** each equipped with ten thousand passage-defining openings **24**. A larger number of channels or passages can be employed but in such a case there is a problem of manufacture due to space limitation—based upon the ability of apparatus for developing such a large number of openings, each of which has a diagonal length of the order of 0.025" in an element which has an axial length of the order of ½" and an effective diameter of the order of 4". Using less than five hundred passage-defining openings **24** in each plate **32** develops an undesirable moire effect so that the screen **11** is not properly produced. The screen, when receiving light from only a few larger openings develops irregular-shaped, non-uniform thickness dots, yielding imperfect emission in use. I employ about ten thousand openings although numbers in the range of one thousand to one hundred thousand may be advantageously employed. These openings are arranged so that each opening effectively serves between ten and one hundred (on the average, thirty) of the three hundred thousand 0.010" openings in the screen **12** and conversely, each screen opening derives light from about one hundred of the control element openings.

It will be appreciated that other techniques and structures are available for the fabrication of the light-control element **17** such as photo-sensitive glass and cast plastic. In any event, each passage **24** is utilized to "develop" a plurality of areas on the screen substrate **11**. In this connection, it will be seen that the control element **17** initially makes a directional selection of the light rays emanating from the source **16** while the mask **12** makes a positional selection of such rays for the development of discrete areas in the photo-sensitized surface of the faceplate **10**. It is convenient to make the openings **24** using a photo-etch process in metal employing a suitable resist, the positions of the openings advantageously being determined by computer after the initial ray paths have been determined. By taking the information from fifty or so points, I ascertain by interpolation the paths necessary for the ten thousand openings. This was done, advantageously, by using a computer. The computer output which, in the illustrated case, was in the form of magnetic tape, presented one million sets of co-ordinates which were then utilized by a two axis numerically controlled milling machine to prepare the one hundred plates by indexing a collimated light source over the surface of the plates to provide exposed areas for etching. This procedure was repeated for each of the one hundred thousand plates, making a total of about one million individual openings, each set of one hundred openings in the stacked plates defining an individual light channel.

I further find it advantageous to position the control element **17** close enough to the screen **11** so as to be forward (in the direction of electron beam travel) of the various points where the extension of the electron-beam path segments **21***a* intersect the axis, i.e., ahead of the point **33** in FIG. 1.

While in the foregoing specification I have set down a detailed description of an embodiment of the invention for the purpose of explanation, many variations in the details hereingiven may be made by those skilled in the art without departing from the spirit and scope of the invention.

I claim:

1. In a process of manufacturing a color television tube wherein light is impinged on a photosensitized surface through a shadow mask to develop positions of phosphor dots, the step of directing said light through a plural channel opaque element positioned between a relatively-extended light source and said mask, said channels having an axial length relatively long compared to their cross-sectional dimension, said element channel each substantially defining a linear extension of an electron-beam path segment, said segment existing between said mask and said surface.

2. The process of claim 1 wherein said light source has an effective dimension such as to circumscribe all of the extensions defined by said channels.

3. The process of claim 1 in which said control element is constructed by indexing a numerically controlled device to locate channel-defining openings in a plurality of plates from coordinates defined by said path segments.

4. In a process of manufacturing a color television tube wherein light is impinged on a photosensitized surface through a shadow mask to develop positions of phosphor dots, the step of directing said light through a plural channel opaque element positioned between a relatively-extended light source and said mask, said channels having an axial length relatively long compared to their cross-sectional dimension, said element having between about one thousand and one hundred thousand different channels.

5. Apparatus for manufacturing a color television tube

comprising a light source and a light-control element adapted to be arranged in position adjacent a face-plate so that light rays from said source pass through said control element for impingement on a photo-sensitized surface on said face-plate, said element having a plurality of light passages extending therethrough with each passage being substantially a linear extension of the electron-beam path segment included between said face-plate and a shadow mask associated therewith, said source being of an effective extent so as to circumscribe all of the beam-path segment extensions corresponding to said passages.

6. The structure of claim 5 in which said control element is positioned sufficiently close to said face-plate as to lie ahead of the intersection of any of said extensions with the axis of the tube defined by said face-plate.

7. The structure of claim 5 in which said source includes a refractive element.

References Cited

UNITED STATES PATENTS

2,817,276	12/1957	Epstein et al.	95—1
2,941,457	6/1960	Weingarten	95—1
2,986,080	5/1961	Burdick	95—1

NORTON ANSHER, Primary Examiner

F. L. BRAUN, Assistant Examiner