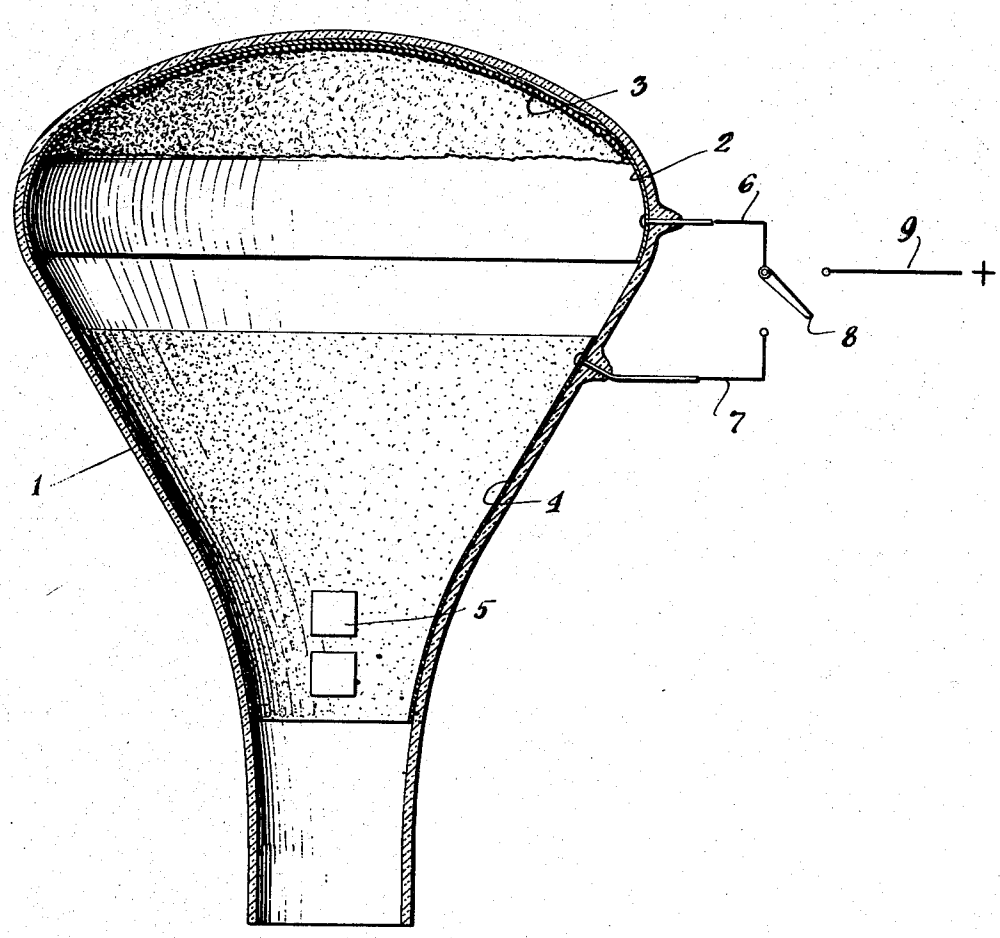
March 30, 1948. S. J. KOCH ET AL 2,438,668

CATHODE-RAY TUBE SCREEN AND PROCESS

Filed April 28, 1944



Stanley J. Koch
Robert E. Rutherford
INVENTORS

BY

Charles W. Mortimer

ATTORNEY

Patented Mar. 30, 1948

2,438,668

UNITED STATES PATENT OFFICE

2,438,668

CATHODE-RAY TUBE SCREEN AND PROCESS

Stanley J. Koch, Clifton, and Robert E. Rutherford, Rutherford, N. J., assignors to Allen B. Du Mont Laboratories, Inc., Passaic, N. J., a corporation of Delaware

Application April 28, 1944, Serial No. 533,116

1 Claim. (Cl. 250—164)

1

This invention relates to luminescent screens, and particularly to such screens when used as cathode-ray tube screens. The invention also relates to the method of producing screens of this character. A cathode-ray tube is usually a source of light, the light appearing generally as a trace of short or extended length against an unilluminated background. Reference is made to the article by R. R. Law, page 511 of the August, 1939, issue of Proceedings of the Institute of Radio Engineers.

Heretofore the general practice has been to use white or light-colored screen material. The present invention provides means whereby the screen appears dark before electron excitation, thus providing better contrast for the traces. This is particularly useful in connection with the production of screens for tubes that are to be used for purposes where contrast of light and shade is important and also where it is desired to have details brought out clearly.

It has been known for a long time that when luminescent screens are activated by a cathode-ray beam, for example, that is caused to scan the surface of such screens, the trace of the end of the beam along the screen surface produces streaks or lines of light along the luminescent material provided the beam is of sufficient intensity. The persistence of light on the particles of luminescent material for a short time and the persistence of the effect on the retina of the eye of the observer serve adequately to enable the observer to read or recognize the pattern such as a signal, or image or picture, that is produced.

It has been found, however, that when the electron beam is out of focus the effect is blurred. Besides, light reflection with prior tubes is such that the contrast of light and dark portions on the pattern is lessened so that the picture or other signal to be observed on the screen does not stand out so clearly because portions, that should be at the moment dark or illuminated to a predetermined extent only by the cathode-ray beam, are in fact illuminated by light emanating from other points on the screen that are illuminated at the same moment.

Besides, light may enter the tube along the sides thereof and reach the luminescent material on the inside surface of the tube face and decrease the contrast by illuminating to some extent parts that should not be thus illuminated.

Also, sources of light in position for light therefrom to reach the outside front face or large end of the tube is often reflected from the front end

2

of the tube, thus rendering certain portions of the picture or image obscure.

Cathode-ray tubes are now extensively used or operated so that the light appears generally as a trace, which may be of short or medium or extended length against an unilluminated background. Heretofore, screen material has been used that is white or light-colored, this material being placed upon the inside surface of the large end of the tube, thus causing the face of the tube to look white or nearly so. By the present invention means are provided whereby the screen appears to be dark when it is not subjected to excitation. In this way better contrast is provided for the traces or lines produced by the electron beam as it sweeps the screen.

Not only do the points where light is generated on fluorescent or luminescent screens located on the surfaces of cathode-ray tubes serve as sources from which light reaches other portions of such surfaces, thereby illuminating such portions unintentionally and changing the intended illumination, but also this unintended illumination decreases the light contrast that is desired at different areas of the screen. Better light contrast is obtained by the present invention.

The objectionable effect of the light that passed through the glass tubes of the prior art from the inner to the outer surface of the face of such tubes and was reflected from the outer face to the fluorescent layer, thus producing halation and further decreasing the contrast, is also obviated or very greatly decreased by the present invention.

By this invention a more satisfactory performance of the tube is secured and a decidedly clearer signal or picture is obtained than can be obtained with the tubes now in use.

The invention may be understood from the description in connection with the accompanying drawing, in which:

The single figure is a section through a tube illustrating the invention.

In carrying out the present invention a layer of very small particles of suitable material, which absorbs visual light to a sufficient extent, is applied to the inside surface of the face of the cathode-ray tube between said surface and said fluorescent layer. This causes the face of the tube to appear dark or black when viewed from the inside or the outside. When the particles of material are not black, black material may be put on the particles to give the black effect when desired. The small particles are applied in such

a way that the light generated by said fluorescent material, by means of an electron beam, enables optical effects to be avoided that would cause halation. Another layer of this sort may be applied to the outside surface of the face of the tube, in which case each layer is preferably made thinner than when only one such layer is used. In all cases the inside layer at least should be made of material that is electrically conductive.

The invention may be understood from the description in connection with the accompanying drawing, which is a longitudinal section, partly broken away, showing the large end portion of a cathode-ray tube.

In the drawing, reference character 1 indicates the portion of a glass cathode-ray tube that is coated on the inside with a layer 2 of very small particles of suitable material. Platinum has been found to be particularly useful as the coating material, although palladium and other dark electrically conductive material may be used. These particles are preferably of approximate molecular dimensions in size and may be applied to the face of the tube, for example, by sputtering or by vaporization or chemically.

The following is a specific example of applying the metal coating 2:

The glass blank or tube 1 to be coated, having been chemically cleaned is connected to a vacuum system and thoroughly exhausted to a vacuum of about 10^{-6} mm. of mercury. The tube is then baked or heated while still under vacuum to 400° C. for about 15 minutes. The tube is then allowed to cool and argon gas is introduced into the tube. A sputtering ring with platinum foil thereon is introduced into the tube and this ring and a terminal extending through the wall of the tube are connected to opposite sides of an external source of high voltage supply in the known way, and the gas pressure is adjusted so that the cathode glow covers the area to be coated. The sputtering is continued until the proper thickness of metal layer has been reached.

This proper thickness of the metal layer may be determined by the use of reflected light. This is done by causing light from a convenient source to shine on the outside glass surface of the end of the tube that is being coated. The reflected light is caused to shine upon a photocell. The output of the photocell is connected to a meter. The difference in the meter reading from the start of the coating process to the finish is used to determine the thickness of the metal coating.

When the proper thickness of the coating has been reached the gas is pumped out of the tube, and when a high vacuum has been reached (10^{-6} mm. of mercury) the tube is baked at 400° C. for 15 minutes. This is very important as it causes the molecules to fuse together and lower the resistance of the coating.

The tube is then allowed to cool and it is then removed from the vacuum system. The tube is then ready for the screen of fluorescent material to be applied thereto in the usual way.

The platinum or other dark layer 2 may be applied as a plurality of superposed very thin coatings. The optimum thickness for best results can be ascertained by trial and such thickness as produces the best contrast of light is generally preferable, although brilliance, sharpness and gradation of light are to be taken into consideration in determining the optimum thickness of the layer 2.

With this invention there is less danger of burning the screen by the cathode-ray beam; whatever screen burning may take place does not show as prominently as with tubes of the prior art; and it is less difficult to keep the beam correctly focussed. A coating 3 of fine particles of luminescent material is applied to the layer 2 of conducting material, which coating may be of any of the materials now ordinarily used for this purpose.

It has been found that when the layer 2 is made of conducting material such as platinum, for example, the electrical charges which would ordinarily accumulate and charge the fluorescent material are dissipated so that a great increase of the light level is produced.

A layer 4 of conducting material such as carbon or Aquadag, for example, is applied to the inside of the tube and is maintained at the desired potential in the usual way to serve as the intensifier for the electron beam.

Provision is made for bringing the conducting layer 2 into electrical connection either with the intensifier 4 for the electron beam or with an external source of potential. Terminals 6 and 7 extend through the wall of the tube 1, the terminal 6 being connected to the layer 2 and terminal 7 being connected to the intensifier 4. A switch 8 is provided to connect the layer 2 to the intensifier 4 or to a lead 9 from a suitable source of positive potential whenever desired.

The gun structure for generating the cathode-ray beam and causing it to scan the luminescent material is not shown as this may be done by any of the gun structures already known for this purpose. A deflecting plate is indicated at 5.

By using the screen or coating 2 described above, it has been found that the contrast of light generated by the cathode-ray beam which may be controlled to produce different intensities of light on the screen 2 is improved; there is decidedly less halation around illuminated areas; and the size of the illuminated spot on the screen is kept more uniform than has heretofore been the case. Since the electrically conducting layer 2 is kept at a positive potential no negative charges accumulate and no space charge remains thereon since the electrons reaching the luminescent material as well as secondary electrons are immediately removed.

Also, light from illuminated spots, which light produces halation rings on the outer surface of the face 1 and is in part reflected back to the inner surface of the glass, is not again reflected to the outer surface of the glass because it is absorbed due to the presence of the black particles 2. That is, there is very little, if any, light reflection from the internal glass surface.

Neither daylight nor artificial light from the outside impinging upon the end of the tube 1 interferes as much with the clarity of the signal or picture on the screen 3 as it does without this invention.

The lines on the face of the tube 1 that are produced with the cathode-ray tube in accordance with this invention are so clear and stand out so sharply on the background that they may be projected onto a large screen so that the projected image is many times as large as that on the screen, and details are clearly visible.

The moving signal or picture produced on the face of a cathode-ray tube made in accordance with this invention is such that it can be projected upon a moving picture screen by a lens system so as to be observed by a large audience.

In such cases best results may be obtained by using ultra-violet light and a black screen of translucent material.

What is claimed is:

A cathode-ray tube having a layer of approximately molecular particles of electrically conductive material fused together on the inner surface of the outer end thereof, a layer of fluorescent material on said layer, a layer of conducting material on the inside of said tube separated from said layer of particles and means to connect and disconnect said layer of fused particles and said layer of conducting material.

STANLEY J. KOCH.
ROBERT E. RUTHERFORD.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,982,373	Clinker et al.	Nov. 27, 1934
2,090,922	Von Ardenne	Aug. 24, 1937
2,121,356	Knoll	June 21, 1938
2,155,465	Behne et al.	Apr. 25, 1939
2,171,970	Brett et al.	Sept. 5, 1939
2,185,590	Epstein	Jan. 2, 1940
2,197,625	Teves et al.	Apr. 16, 1940
2,242,644	De Boer	May 20, 1941

FOREIGN PATENTS

Number	Country	Date
15,015/33	Australia	Nov. 1, 1934
424,632	Great Britain	Feb. 21, 1935
430,809	Great Britain	June 25, 1935
500,314	Great Britain	Feb. 7, 1939