Aug. 12, 1941. L. E. FLORY ET AL 2,251,992

PICTURE TRANSMITTER TUBE

Filed June 15, 1938

FIG. 1.

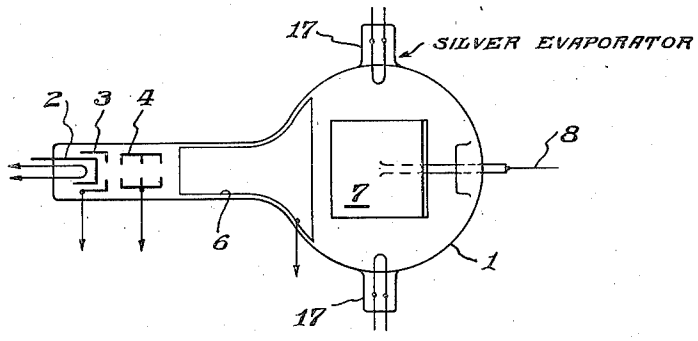


FIG. 2.

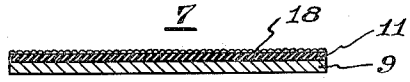


FIG. 3.

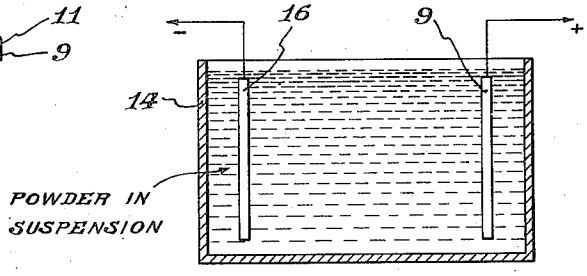
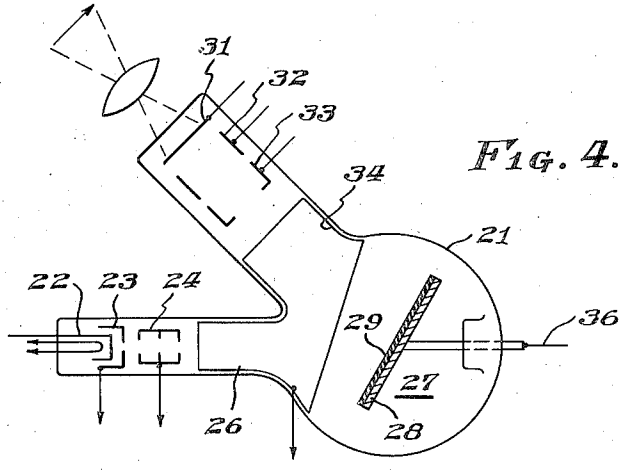


FIG. 4.



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2,251,992

PICTURE TRANSMITTER TUBE

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Application June 15, 1938, Serial No. 213,740

6 Claims. (Cl. 250—153)

Our invention relates to cathode ray tubes designed for picture transmission and particularly to tubes of this type having therein a novel screen structure to be scanned by the cathode ray.

In the past, various screen or mosaic structures have been proposed for cathode ray picture transmitter tubes. Tubes of this type having the screen structure which was the preferred structure prior to our invention are described in an article by Zworykin, entitled "The iconoscope—A modern version of the electric eye," appearing in The Proceedings of the Institute of Radio Engineers for January, 1934, and in an article by Zworykin, Morton and Flory entitled "Theory and operation of the iconoscope" appearing in the Proceedings of the Institute of Radio Engineers for August, 1937. The preferred screen described in these articles comprised a sheet of mica having its back side coated with metal to form a signal plate and having on its front side a mosaic of photo-electric elements.

An object of our invention is to provide an improved cathode ray tube of the above-mentioned type.

A further object of our invention is to provide an improved screen structure or mosaic for cathode ray tubes of the above-mentioned type which does not require the use of a sheet of mica.

A further object of our invention is to provide an improved cathode ray tube of the type in which an electron image is formed on an insulating surface which is being scanned by a cathode ray.

A still further object of our invention is to provide an improved method of making a screen structure or mosaic for cathode ray picture transmitter tubes.

In accordance with one embodiment of our invention, the insulating sheet or layer between the mosaic of photo-electric elements and the signal plate comprises a layer of an insulating powder such as china clay, this layer of powder replacing the mica sheet formerly employed.

In accordance with another embodiment of our invention, a layer of insulating powder is formed on a conducting plate and so positioned in a combination image tube and cathode ray tube that an electric image is formed directly on the powder, the powder layer being scanned by the cathode ray to produce picture signals.

The invention will be better understood from the following description, taken in connection with the accompanying drawing in which

Figure 1 is a view of a cathode ray picture transmitter tube embodying our invention,

Figure 2 is an enlarged view, in section, of the screen structure of mosaic used in the tube shown in Fig. 1,

Figure 3 is a view which is referred to in describing our improved screen structure, and

Figure 4 is a view of a combination image tube and cathode ray picture transmitter tube embodying our invention.

Referring to Fig. 1, our invention is shown applied to a cathode ray picture transmitter tube of the type described in the above-mentioned article by Zworykin. It comprises an evacuated envelope 1 having therein an electron gun comprising an indirectly heated cathode 2, a control electrode 3, a first anode 4, and a second anode 6 and a screen structure 7. A light image is projected upon the screen 7 whereby a corresponding electrostatic image is formed thereon. This is scanned by the cathode ray produced by the electron gun whereby picture signals appear in the output conductor 8.

In accordance with our invention, the screen 7 is made as illustrated in Fig. 2. It comprises a conducting signal plate 9 which may be a polished metal plate or it may be a glass plate with a metal coating. If a glass plate is used, the metal surface may be formed by evaporating aluminum or some other metal upon the glass surface, or a metal such as platinum may be deposited chemically upon the glass.

In place of the mica sheet commonly used, a layer 11 of insulating powder such as china clay is formed upon the polished metal surface of plate 9 or upon the metal coating if a glass plate is used.

China clay, which is one of the most satisfactory materials found to date for the layer 11, is also known as kaolin or by the mineral name kaolinite. Other powdered materials have been found satisfactory. Such materials, for example, are powdered mica, aluminum silicate, powdered quartz, titanium oxide and MgO.

The powder layer 11 may be put on the plate 9 by various methods as by spraying it on, by settling it on by the process well known in making fluorescent screens, by evaporating a liquid in which the powder is suspended or by cataphoreses. The latter method is preferred and is practiced as illustrated in Fig. 3.

Referring to Fig. 3, the powder is held in suspension in a liquid which may be in either an insulating or a metal container 14. The signal plate 9 is placed in this liquid and opposite the plate 9 is placed an electrode 16. By applying a suitable D. C. potential between the plate 9

and the electrode 16 the suspended powder is caused to move over to the plate 9 and deposit thereon as a uniform coating, this movement of the powder to an electrode being due to a difference in the dielectric constants of the powder and the liquid.

Whether the powder goes to the negative electrode or to the positive electrode depends upon the particular powder and liquid used. The china clay goes to the positive electrode, at least in the cases where it is suspended in either acetone or water.

Generally a dispersing agent of some kind should be employed to prevent the suspended powder from collecting the lumps or coagulating. With china clay in acetone, about $\frac{1}{10}$ of 1% nitrocellulose may be added for this purpose. With china clay in water, a few drops of ammonia may be added.

The insulating powder should have the following properties, all of which are found in the above-mentioned powders: (1) It should be very fine grained; (2) it should be chemically inert under the conditions required for activating or processing the tube; (3) it should have a low vapor pressure; and (4) it should have a high resistance.

The screen 7 preferably is sensitized in the assembled tube in the usual way. Silver is evaporated upon the powder layer from tungsten filaments which have silver beads thereon. There is one of these heaters in each side of the tube, one of the heaters being indicated at 17.

Oxygen is then admitted to the tube and the silver is oxidized by an electric discharge. A photosensitive material such as caesium is admitted after the oxygen has been pumped out and the tube is then baked. The resulting layer on the powder is indicated at 18. It consists of a multitude of very small discontinuous photosensitive elements or globules as is well known in the art.

The layer of treated silver on the powder layer is unnecessary if the screen structure is used in a combination image tube and cathode ray tube of the type illustrated in Fig. 4.

Referring to Fig. 4, the tube comprises an evacuated envelope 21 having therein an electron gun comprising an indirectly heated cathode 22, a control electrode 23, a first anode 24 and a second anode 26, and a screen structure 27.

The screen 27 consists of a conducting signal plate 28 and a powder layer 29, the elements 28 and 29 corresponding to the elements 9 and 11, respectively, of Fig. 2.

The envelope 21 also includes an image tube section comprising a transparent photosensitive cathode 31, and electrostatic focusing ring electrodes 32 and 33 and the accelerating electrode 34. When a light image is projected upon the cathode 31, electrons are released therefrom in accordance with the light intensity and an electron image is focused upon the screen 27 by means of the ring electrodes 32 and 33. An image tube of this general design is described and claimed in Patent No. 2,189,321, issued February 6, 1940, in the name of G. A. Morton and assigned to the Radio Corporation of America. It will be understood that the electron image may be focused upon the screen 27 by means of electromagnetic focusing, if desired, or by another suitable electron lens.

In a combination tube of this type, it is not necessary to form a silver coating on the powder layer 29 or to deliberately sensitize it in any way. Actually the surface of layer 29 is sensitized during the process of sensitizing the cathode 31 because of the caesium or other photoelectric sensitizing metal going over to the layer 29. The introduction of oxygen during the process of sensitizing the cathode 31 also plays a part in sensitizing the layer 29.

The process employed in sensitizing the cathode 31 preferably is the same as that described in Patent No. 2,189,322, issued February 6, 1940, in the name of Leslie E. Flory and assigned to the Radio Corporation of America. This process is carried out after the tube has been completely assembled. Briefly, the process comprises evacuating the tube, evaporating silver upon a transparent supporting surface, admitting oxygen and oxidizing the silver by a glow discharge, again evacuating the tube, admitting caesium or the like, and then baking the tube. Preferably a very thin final layer of silver is evaporated upon the cathode 31 after the caesiating step and the tube is again baked as the final step.

It will be understood that if during the time an electron image is projected on the screen by the image tube, the surface of the screen 27 is scanned by the cathode ray produced by the electron gun, picture signals appear in the output conductor 36 leading from the signal plate 28.

The powder layers of screens 7 and 27 do not include any binder in the preferred embodiments, although when some powders are used the finished layer may include a binder. In most cases, however, if the liquid in which the powder is suspended during the process of forming the powder layer is a binder or contains a binder, the binder is evaporated out of the finished product. Thus, if the powder is china clay, the layers 11 and 29 consist of china clay only, there being no binder included.

It may be noted that in Figs. 2 and 4 of the drawing, the thickness of the layer of insulating powder is greatly exaggerated since the true thickness of the powder cannot readily be illustrated. There is nothing critical about the thickness of the powder layer but it may be mentioned by way of example, that if a china clay layer is used in the tube shown in Fig. 1, a thickness of two mils will be found satisfactory.

We claim as our invention:

1. In a cathode ray picture transmitter tube, means for producing an electron beam, a screen structure so positioned that its front side may be scanned, said screen structure comprising a nonforaminous conducting plate and a layer of discrete powder particles of insulating material on the front side of and directly in contact with said plate, said layer of powder being substantially nonconducting when being scanned by said beam and also when light is projected thereon whereby there may be electrostatic storage.

2. The invention according to claim 1 further characterized in that said screen structure includes a layer of discontinuous photosensitive elements on said layer of powder.

3. A screen structure for cathode ray picture transmitter tubes which comprises a continuous conducting surface, a layer of discrete adherent particles of insulating powder on and directly in contact with said surface and a layer of discontinuous photo-sensitive elements on said layer of powder, said layer of powder being substantially nonconducting at all times during operation of the tube whereby there may be electrostatic storage.

4. In combination, an evacuated envelope hav-

ing therein a screen structure, means for producing a cathode ray and directing it against the front side of said screen, and image tube means for projecting an electron image of a view to be transmitted upon the front side of said screen, said screen comprising a conducting surface and a layer of insulating powder on the front side thereof and directly in contact therewith, said layer of powder comprising discrete adherent particles and being substantially nonconducting while being scanned by said beam and during the remaining periods of the tube operation whereby there may be electrostatic storage.

5. The invention according to claim 4 characterized in that said image tube means includes a photosensitive cathode which has been sensitized after the complete assembly of the tube whereby said powder layer is sensitized.

6. In a cathode ray picture transmitter tube, means for producing an electron beam, a screen structure so positioned that its front side may be scanned, said screen structure comprising a continuous conducting surface and a layer of discrete powder particles of insulating material on the front side of and directly in contact with said conducting surface, said layer of powder being substantially nonconducting when being scanned by said beam and also when light is projected thereon, whereby there may be electrostatic storage.

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GEORGE A. MORTON.