Aug. 29, 1939. R. B. JANES 2,171,213

TELEVISION TRANSMITTING TUBE AND ELECTRODE STRUCTURE

Filed Nov. 30, 1937

Fig. 1

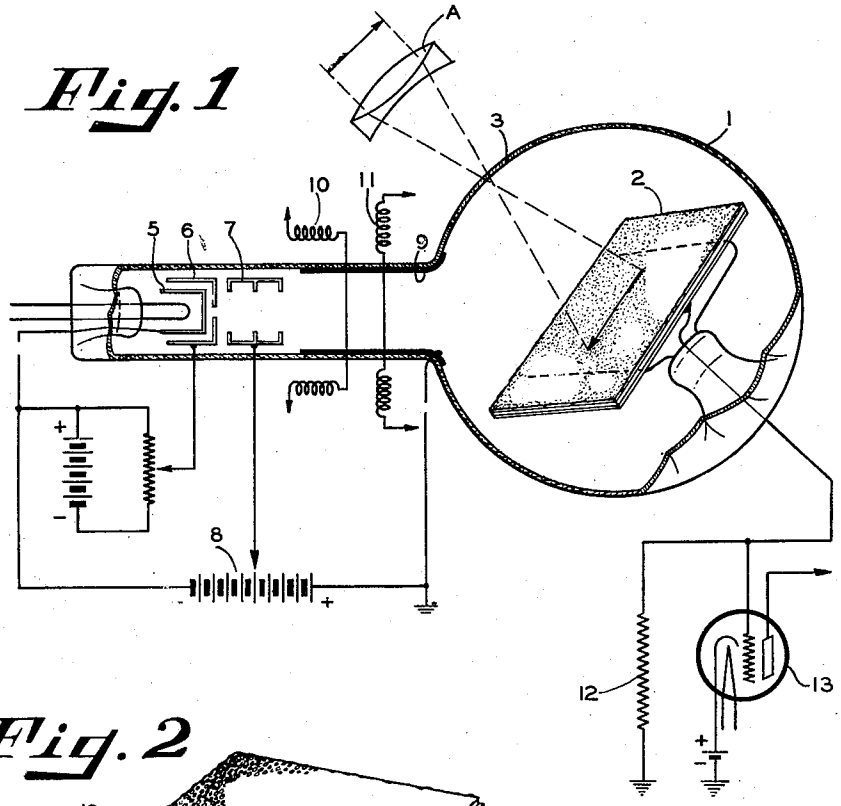


Fig. 2

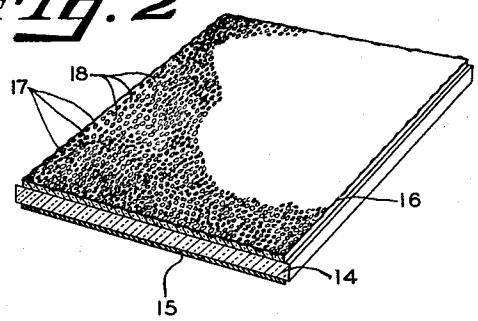
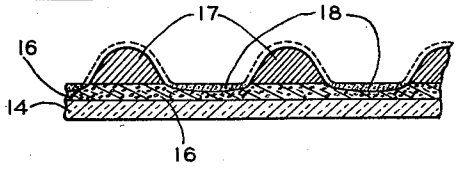


Fig. 3



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TELEVISION TRANSMITTING TUBE AND ELECTRODE STRUCTURE

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9 Claims. (Cl. 250—27.5)

My invention relates to improvements in cathode ray television, and particularly to an improved photosensitive screen or target electrode of the single-sided mosaic type which has on the front or illuminated surface a great number of discrete mutually insulated photoelectrically sensitive elements.

It has been found that in a cathode ray tube with the conventional mosaic electrode having on the front surface of an insulating base such as a sheet of mica or other insulation discrete elements or particles of silver photosensitized by exposure to caesium vapor, the best results are obtained when the tube is subjected during exhaust to a treatment which renders the surface conductivity and resultant leakage between particles very low and enables the discrete particles or elements to store electrostatic charges as a function of the illumination and to retain the charges until the charged particles are swept by the scanning beam. However, the photosensitivity of the silver particles is considerably less than the maximum obtainable, and the optimum amount of caesium cannot be used.

The principal object of my invention is to provide an improved cathode ray tube having a mosaic type target electrode of greater photosensitivity than a conventional electrode having the same surface leakage.

Another object of my invention is to provide an improved and highly sensitized mosaic type electrode having greater photosensitivity and greater transverse resistance than the conventional mosaic electrodes heretofore used.

In accordance with my invention the resistance between the individual photosensitized elements of the target or mosaic electrode is made considerably greater than in the conventional mosaic electrode. To this end there is formed on an insulating base, such as a sheet of mica, an intermediate insulating layer or film of an oxide higher than the monoxide of a metal capable of forming two or more oxides, both good electrical insulators, the higher oxide being partially or wholly reducible to a lower oxide by an alkali metal, such as caesium. The individual mosaic particles, usually of silver, are formed on the surface of the intermediate insulating layer, are oxidized, and then photosensitized with caesium or other light sensitive alkali metals during the evacuation of the tube. The alkali metal, such as caesium, which condenses between the particles and on the intermediate layer does not form a conductive path between particles, probably because it reacts with the oxide layer and is thereby converted into a non-conductor. As a consequence the resistance between the particles is much greater than in a conventional mosaic electrode, and a greater amount of caesium, for example, may be used and optimum photosensitivity obtained without objectionable electrical leakage between particles.

Other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a diagrammatic view illustrating one form of a television device incorporating my invention,

Figure 2 is a view of the photosensitive mosaic electrode shown in Figure 1, and

Figure 3 is a greatly enlarged fragmentary sectional view of the electrode shown in Figure 2.

In the illustrative embodiment of my invention shown in Fig. 1 the tube comprises a highly evacuated glass envelope or bulb 1 with a tubular arm or neck section enclosing a conventional type electron gun and a spherical section enclosing a flat target or mosaic electrode 2 so positioned that its front surface may be scanned by a beam of electrons from the electron gun and also may have projected upon it the optical image to be transmitted. Since the image is produced from an object situated outside the tube, that portion or window 3 of the spherical section opposite the electrode 2 is made optically uniform so that the image to be transmitted may be projected upon the mosaic electrode 2 with a minimum of distortion by the lens system 4.

The electron gun assembly is of the conventional type, and comprises a cathode 5 from which an electron stream may be drawn, a control electrode 6 connected to the usual biasing battery, and a first anode 7 maintained positive with respect to the cathode 5 by a battery 8. The electron stream leaving the first anode 7 is accelerated and concentrated into an electron scanning beam focused on the front surface of the mosaic electrode 2 by a second anode 9, which is preferably a conductive coating on the surface of the envelope 1 near the neck of the bulb but removed from the window through which is projected the optical image to be transmitted. Conventional deflection means, such as deflection coils 10 and 11, may be used to sweep the beam in a horizontal and vertical plane, respectively, to scan the target. It is obvious that convenional electrostatic deflection plates may be substituted for one or both of the deflection coils if desired. The electrode 2 is connected through the impedance

12 to ground and to the collector electrode or second anode 9, and in operation the current flow in this circuit produces a voltage drop across the impedance 12 which may be impressed on the input of a translating device 13, further amplified and applied to a transmitting network in a manner well known in the art.

In accordance with my invention, as best shown in Fig. 2, my new and improved mosaic electrode comprises an insulating foundation sheet or base, such as a sheet of mica, coated on one side with a film of metal such as a film of platinum or other electrically conducting material which serves as a signal electrode from which the picture signals may be obtained. The other or front side of the sheet of mica has on its surface an intermediate insulating layer or film of a metal oxide which is of high electrical resistance and a good insulator and which reacts with caesium at temperatures attained by the electrode during manufacture of the tube. The oxide layer or film is preferably composed of the higher oxides of metals such as manganese, vanadium, chromium or tin. The mosaic surface which is scanned with an electron beam and on which the optical image to be transmitted is focused is formed of small mutually separated particles upon the intermediate insulating layer so that it is coextensive with the film of metal or other electrically conducting material on the opposite side of the sheet of mica. The individual particles are preferably photosensitized with caesium or other photosensitive alkali metal in the usual way of vaporizing the metal, such as caesium, adjacent the mosaic electrode and allowing it to condense upon the individually separated particles. Any caesium which is deposited on the intermediate oxide layer or film between the particles to be photosensitized seems to react with the material composing the intermediate oxide layer without decreasing the electrical resistance of the layer. Apparently the caesium reduces a portion of the oxide and is converted into caesium oxide, and probably reduces some of the higher oxide to a lower oxide which is also an insulator, so that the caesium does not destroy the insulation between the particles. The material between the particles remains an electrical insulator after enough caesium deposits on the higher oxide layer to produce objectionable conductivity if the caesium remained in the metallic form.

In making the mosaic electrode 2, a thin sheet of insulating material, such as the mica sheet 14, of uniform thickness and having a plane surface is coated on one side with a thin continuous film of electrically conducting material such as the platinum film 15. The other or front side of the mica sheet 14 is then coated with a thin film of metal such as manganese, vanadium, chromium or tin by placing the mica sheet in a sealed glass envelope which may be evacuated, vaporizing the metal and condensing it in a thin film on the front surface of the mica sheet. The metal is then exposed to oxygen and oxidized, preferably to one of its higher oxides, to form an intermediate insulating layer or film 16 which, if the above metals are used, is a film or layer of manganese dioxide, vanadic oxide, chromic oxide or stannic oxide.

The coating of the mica with the film of metal which is subsequently oxidized to form the intermediate oxide layer 16 may conveniently be done by mounting within a sealed envelope a tungsten filament which may be heated to incandescence and which carries the metal with which the mica sheet is to be coated. The envelope is evacuated and the filament heated to vaporize or flash off enough of the metal with which it is coated to produce the desired film on the mica. For example, I have obtained good results with a 4" x 5" mica sheet by placing the filament approximately eight inches from the surface of the mica and curving the mica sheet to form a cylindrical surface with the center of curvature at the filament. For coating the mica with manganese I prefer to evaporate about 3 mgs. of manganese from the manganese coated tungsten filament to a mica surface of approximately 20 square inches, and thus deposit about 0.1 mg. of the metal on the mica to form a film about 10 to 15 atoms thick. By this procedure I obtain on the front surface of the mica sheet a thin film of metal, which is then oxidized to a higher oxide than the monoxide, such as to the dioxide, by introducing oxygen into the evacuated envelope to a pressure of 100 mm. of mercury and baking the envelope for approximately ten minutes at 250° C. The manganese film on the mica sheet may, however, be oxidized by heating the sheet in air to about 250° C., but I prefer the former method as I believe less contamination results by oxidizing the metal in the presence of oxygen within the envelope.

To produce the photosensitive mosaic the mica sheet is removed from the evacuated envelope and the intermediate insulating layer 16 of oxide is dusted with a finely divided metal compound, such as silver oxide, and the dusted sheet is inserted into an air atmosphere furnace at a temperature of the order of 800° C. for a period of the order of fifteen seconds to reduce the silver oxide to silver, and to cause individual and minute portions of the silver to be drawn up by surface tension to form a multiplicity of microscopic particles 17 spaced from each other, the number and average size of the particles in a unit area being sufficient to satisfy the operating requirements in the way of detail of picture reproduction.

The mosaic surface may be formed, however, in a variety of ways in addition to the method described. Thus, for example, instead of using a metal compound which is applied to the insulating film 16 and is subsequently reduced and drawn by surface tension into individual particles, a thin continuous film of silver may be deposited upon the oxide film. The silver film may be broken up into individual particles by a heat treatment similar to that above indicated.

The mica sheet carrying the particles or individual elements on the intermediate layer or film 16 of oxide is then mounted in the tube, as shown in Fig. 1, the tube evacuated, oxygen admitted to oxidize the silver particles, the tube again evacuated, and the silver particles photosensitized by exposure to caesium vapor in the usual way. Somewhat more caesium may be used than in the photosensitization of the conventional mosaic electrode and thereby greater photosensitivity is obtained without a correspondingly greater surface leakage.

During the exposure of the particles to caesium vapor some caesium condenses on the surface of the intermediate insulating layer 16, such as the areas 18, and tends to form a metallic film which may act as a conducting bridge electrically connecting the individual particles and consequently reducing the electrical resistance from particle to particle. When, in accordance with the usual practice, the tube is baked at a temperature of approximately 200° C. for 5 to 10 minutes to

cause the caesium on the oxidized silver particles 17 to photosensitize the particles, the caesium on the areas 18 seems to react with the oxide on which it deposited, as the paths between the particles become of high resistance and the particles are found to be very well insulated from one another.

While I do not wish to be restricted to any particular theory it seems probable that the caesium which deposits on the areas 18 between the individual silver particles 17 reacts with the oxide forming the intermediate insulating layer 16, probably reducing the higher oxides of the metal to a lower oxide and converting the caesium to caesium oxide, thus producing a mixture or material of negligible electrical conductivity when the electrode is in use. The electrical resistance between the particles is found to be high, probably because the lower oxides are good insulators, and the caesium oxide formed by the reaction of the caesium with the higher oxides has higher electrical resistance than the pure caesium.

From the foregoing description it will be apparent that various other modifications may be made in my invention without departing from the spirit and scope thereof and I desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim:

1. A cathode ray television transmitting tube comprising an envelope having a transparent window, an electrode assembly including a non-conducting base exposed to said window, an intermediate thin layer of an electrically insulating higher oxide than the monoxide of a metal selected from the group consisting of manganese, tin, vanadium and chromium as a continuous coating on one side of said base, a multiplicity of discrete photosensitive particles each of minute size on said intermediate thin layer, and an electrically conducting material on the opposite side of said non-conducting base.

2. A cathode ray television transmitting tube comprising an envelope having a transparent window, an electrode assembly including a non-conducting base exposed to said window, a continuous intermediate thin layer of manganese dioxide on one side of said base, a multiplicity of discrete photosensitive particles each of minute size on said intermediate layer, and an electrically conducting material on the opposite side of said non-conducting base.

3. A mosaic electrode including a base, a mosaic of mutually separated light sensitive particles supported by said base, a layer on said base and between the particles and the base of an electrically insulating oxide of a metal higher than the monoxide which when exposed to an alkali metal reacts with said alkali metal to render negligible the surface electrical conductivity of said layer and a material containing the reaction products of said layer with an alkali metal between said separated particles.

4. A mosaic electrode comprising a sheet of insulating material, a mosaic of minute photosensitive separated particles supported by said sheet, an intermediate layer of a higher oxide than the monoxide of a metal selected from the group consisting of manganese, tin, vanadium and chromium between said particles and said sheet, a material on said sheet consisting at the surface between the particles of the lower oxide than the said higher oxide and of the reaction products of an alkali metal with the higher oxide, and an electrical conductor coextensive with said mosaic on the opposite side of said sheet of insulating material.

5. A light sensitive mosaic electrode comprising a sheet of insulating material, an intermediate layer of a higher oxide of manganese than manganous oxide on one side of said sheet, a mosaic of minute individually separated photosensitive particles on said intermediate layer and an electrical conductor coextensive with said mosaic on the opposite side of said sheet of insulating material.

6. A light sensitive mosaic electrode comprising a sheet of insulating material, a layer of manganese dioxide on one side of said sheet, a mosaic of minute individually separated photosensitive particles on said layer, a material including manganese oxide between the separated particles, and an electrical conductor coextensive with said mosaic on the opposite side of said sheet of insulating material.

7. The process of forming a mosaic light sensitive surface on a non-conducting base which comprises depositing on said base a thin film of metal selected from the group consisting of manganese, tin, vanadium and chromium, oxidizing the metal film to form a layer of a higher oxide than the monoxide, forming a multiplicity of discrete metallic particles on the layer of oxide, oxidizing the metallic particles, exposing the non-conducting base and the oxidized metallic particles to the vapor of an alkali metal, and heating the base in the presence of the alkali metal to photosensitize the metallic particles and reduce the intermediate oxide film between the particles to a lower oxide than the oxide comprising the film.

8. The process of forming a mosaic light sensitive surface of an insulating base which comprises depositing on the base a thin film of manganese, oxidizing the said film to form a layer of a higher oxide than the monoxide, forming a multiplicity of discrete metallic particles on the layer of higher oxide, oxidizing the metallic particles, exposing the oxidized particles and the layer of higher oxide between said particles to the vapor of an alkali metal, and heating said base in the presence of the alkali metal to photosensitize said particles and to reduce the layer of higher oxide between the particles to a lower form of oxide than the layer of higher oxide.

9. The process of forming a mosaic light sensitive surface on an insulating base which comprises depositing on the base a thin film of manganese, oxidizing the thin film to form a layer of manganese dioxide, forming a multiplicity of discrete metallic particles on said layer of dioxide, oxidizing the metallic particles, exposing the oxidized particles and the manganese dioxide layer between the particles to caesium vapor, and heating said base in the presence of the caesium to photosensitize said particles and to reduce the manganese dioxide layer between the particles to a manganous oxide.

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