

Sept. 21, 1937.

R. H. VARIAN ET AL

2,093,699

CATHODE RAY TUBE

Filed March 8, 1932

Fig. 1.

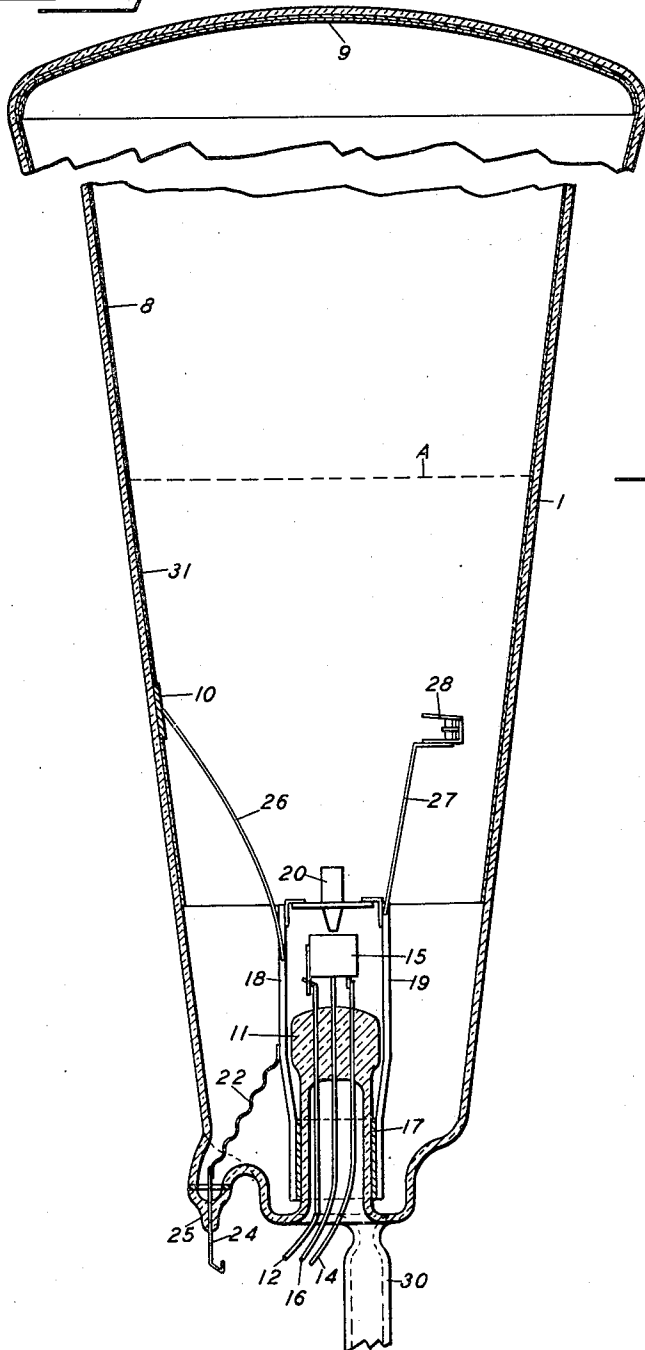
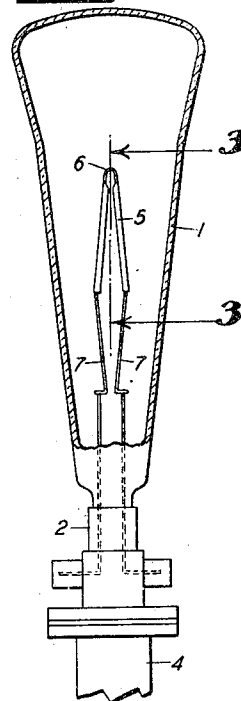


Fig. 3.



Fig. 2.



RUSSELL H. VARIAN &
BERNARD C. GARDNER
INVENTORS,

BY *Donald K. Lippincott*

ATTORNEY

UNITED STATES PATENT OFFICE

2,093,699

CATHODE RAY TUBE

Russell H. Varian and Bernard C. Gardner, Philadelphia, Pa., assignors to Farnsworth Television Incorporated, a corporation of California

Application March 8, 1932, Serial No. 597,486

10 Claims. (Cl. 250—27.5)

This invention relates to cathode ray tubes, such as cathode ray oscillographs and oscil-lights or television reproducers.

Among the objects of our invention are: To provide a cathode ray tube capable of carrying relatively heavy current without accumulating local charges upon its fluorescent screen; to provide a cathode ray tube wherein the cathode ray beam, after passing through the accelerating anode, passes into a substantially equipotential space and therefore travels at substantially constant velocity; to provide a cathode ray tube wherein the fluorescent screen is deposited upon a transparent layer of metal which acts as an auxiliary anode; to provide a method of forming such a metal layer of great uniformity and transparency; to provide such a method which is adapted to quantity production routine; and to provide a cathode ray tube structure and method of producing the same which facilitates the degassing of the tube walls, does not interfere with degassing the tube elements, and provides a large area of "getter", to produce a tube which will not become gassy with use.

Other objects of our invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but we do not limit ourselves to the embodiment of our invention herein described, as various forms may be adopted within the scope of the claims.

Referring to the drawing:

Figure 1 is a longitudinal section through the tube of our invention, certain of the layers deposited on the envelope being shown in a greatly exaggerated scale, and portions of the structure being broken away to conserve space in the drawing.

Figure 2 is an elevation of the tube envelope showing the equipment temporarily sealed therein for depositing the transparent metal layer, a portion of the envelope being shown in section.

Figure 3 is a sectional view of the metal strip from which the coating on the envelope is evaporated, the plane of projection being indicated by the line 3—3 of Figure 2.

Considered broadly the tube of our invention comprises the usual vitreous envelope, usually of flasklike shape, having an electron gun or means for projecting a beam of cathode rays positioned in the neck of the envelope. The inner walls of the envelope, with the exception of that portion immediately surrounding the electron gun, have an inner layer or coating of metal which is so thin as to offer no material obstruction to the

passage of light, and a fluorescent screen is applied to the end of the tube corresponding to the bottom of the flask over this metallic coating. The metallic coating is preferably connected to the electron gun by means of a layer of gas-absorbent metal or "getter" which is deposited on the walls of the tube after the latter is evacuated and which partly or entirely surrounds the electron gun.

In order to produce the tube as thus described the metal which is to be deposited as the conductive coating within the tube is formed into a strip, which is temporarily sealed into the tube, and the latter is evacuated. The strip is then heated electrically to a temperature which causes the metal slowly to evaporate, the walls of the envelope having first been heated to a temperature which will drive out the adsorbed gases. In this process the strip is so positioned within the envelope that the evaporated metal will condense only on those portions of the walls which are relatively remote from the neck thereof. After a sufficient quantity of metal has been deposited the envelope is removed from the pump, the metal strip and its connections are removed, and the electrical elements of the tube, comprising the electron gun, are inserted and sealed into place. The tube is then re-exhausted, this process being facilitated by the fact that the metal layer deposited during the foregoing process is substantially gas-free. The tube elements may be heated by induction in the usual manner, and the getter "flashed" at the conclusion of the heating to achieve the final chemical cleanup of the tube. A metallic getter is used, and the getter cap or holder is so positioned that the evaporating getter will form a layer which in part overlies the transparent metal layer and which substantially surrounds the elements of the tube. The operation is completed by sealing the tube off of the pump in the usual manner.

The invention may best be understood by reference to the accompanying drawing, Figure 2 whereof shows the envelope 1, usually of glass, sealed temporarily to a collar 2 which may be conveniently made of brass. The temporary seal may be made with DeKhotinsky cement but is preferably made, for production purposes, by means of a compressed rubber gasket. The collar 2 is secured to a vacuum line 4.

The metal used to form the transparent coating within the tube may be of platinum, tungsten, palladium or gold, all of which have been successfully used, but is preferably nickel. The

metal is formed into a strip 5, which is bent into a V-shape as shown. The two arms of the V are bent into a channel section, so that the strip will maintain sufficient strength to be self-supporting even at the evaporating temperature, the bend or angle 6 of the V being left flat. This arrangement presents a relatively broad surface of the metal toward those portions of the tube which it is desired to coat.

The two arms of the V are welded or otherwise electrically connected to copper lead wires 7, which are brought out through the collar 2 and at least one of which must be insulated therefrom. In the manufacture of large tubes the lower ends of these wires may be water-cooled in order to prevent excessive heating thereof. Means for accomplishing this are well known and are not shown or described in detail since they are not the subject of this invention.

The envelope is then evacuated, the usual baking process being resorted to in order to drive adsorbed gases from its walls. As high a vacuum as is feasible is obtained in this step of the process, the tube preferably being left on the pump line during the entire time when it is being carried out.

A high current is then passed at low voltage through the connecting leads 7 and strip 5, to raise the latter to a temperature at which evaporation of the metal will take place. This temperature will, of course, vary with the metal used, the proper temperature being obtainable from the vapor-pressure-temperature curve of the particular material. Since very slow evaporation is desired in order that the process may be fully under control, the temperature should not be greatly in excess of the critical evaporation temperature.

The evaporated metal condenses upon the walls of the envelope, its distribution thereon being predicated largely upon the position of the strip within the tube. It will be seen that relatively broad evaporating surfaces are presented toward the walls of the tube immediately surrounding the strip, while a smaller surface is presented toward the window at the end of the tube, and that the strip is mounted well above the neck of the envelope. The result is that a thin but uniform film is deposited upon the end of the tube, a thicker coat on the sides of the tube, and that what little vapor does pass downward toward the neck of the envelope is condensed long before it reaches that portion of the neck which eventually surrounds the electron gun. The process should be stopped when a barely perceptible film has formed on the end of the tube, at which time the sides of the tube will be somewhat darkened, even becoming quite opaque at the portion nearest the ends of the strip. The lower limit of the coating is shown approximately by the dotted line A in Figure 1, the coating 8 being enormously exaggerated in thickness in the drawing.

The apparatus is then permitted to cool and air is readmitted to the envelope and the temporary seal to the collar 2 is released. The fluorescent screen 9 is then deposited on the end or window of the tube, over the metal coating.

A contact 10, preferably of platinum, is next affixed to the wall of the tube. This contact may be of platinum foil, or it may be deposited chemically from a solution, such as a platinizing solution. The stem 11 is then sealed in place, this stem, in the example shown, carrying a lead

12 to which a control electrode 15 is secured, and a pair of leads 14 and 16 supplying a filament or heater. This construction is illustrative only and any electron gun adapted to project a beam of electrons is perfectly satisfactory.

Surrounding the stem is a band 17 carrying supports 18 and 19 to which the anode 20 is fastened. An anode lead 22 of corrugated ribbon connects the support 18 with a terminal 24 sealed through a side tubulation 25.

A spring 26 is welded to the support 18, this spring preferably being formed of tungsten. It rests against the contact 10 to make electrical connection therewith from the anode.

Secured to the support 19 is a wire 27 which carries a getter cap 28, this cap being so formed as to project a getter laterally rather than longitudinally of the tube.

The tube is exhausted through the usual tubulation 30. In the process such little gas as has been adsorbed by the coating 8 may be driven out in the usual "baking" process. A high frequency inductance coil is then brought down around the elements of the electron gun, raising these to the necessary high temperature for degasification. After the elements have been maintained at this temperature for some time, the getter, which may be magnesium, caesium, or other material of well known usefulness for this purpose, is flashed. The getter deposits upon the walls of the tube, overlapping the lower portion of the transparent coating somewhat, along the dotted line A, and forming an electrical connection with the contact 10 and thence to the anode.

The getter coating within the tube is indicated by the reference character 31, it being understood that this coating is extremely thin and that the showing in the drawing is greatly exaggerated as to thickness.

The termination of the coating 8 at some distance from the electrode structure greatly facilitates the inductive heating of this structure since it prevents its shielding by a conducting layer. The flashing of the getter, however, completes the layer, so that when the tube is in use the electron beam projected through the anode travels in a space entirely surrounded by conductors at substantially anode potential.

Within this space the electrons are not subjected to any electrostatic forces, although they may be deflected by electromagnetic means. Their paths are therefore subject to much more definite computation than in tubes of the usual construction.

Although the metallic coating across the end of the tube is very transparent, the resistance between the fluorescent screen and the anode is only of the order of from 200 to 500 ohms. The potential drop between the screen and the anode, even with currents of several milliamperes, is therefore a few volts at most, which, in comparison with the anode potential, which may be as high as 5,000 volts, is negligible. In tubes without the conductive coating the cathode stream impinging on the fluorescent screen may produce extremely high localized charges, which decelerate approaching electrons and may greatly reduce the brilliancy of the tube. In gassy tubes, or those with relatively low current capacity, these charges may leak off at such a rate that relatively stable operation is produced, but in high vacuum tubes of high current capacity satisfactory operation is obtained only through secondary electron emission from the screen, and it is sometimes extremely difficult to establish said sec-

ondary emission. Our invention obviates these difficulties.

We claim:

1. A cathode ray tube comprising a vitreous envelope having a flattened portion to provide a viewing screen, a transparent layer of relatively hard metal formed on the inner surface of said flattened portion, a fluorescent coating covering said metal layer, an electron gun comprising a cathode and an accelerating anode within the envelope and positioned to bombard said coating, the portion of said envelope surrounding said electron gun being free of said metal layer, a second layer of relatively soft conducting material deposited on the portion of said envelope surrounding said electron gun and overlying a portion of said first mentioned layer, and an electrical connection joining said second layer and said electron gun.

2. A cathode ray tube comprising a vitreous envelope having a flattened portion to provide a viewing screen, a transparent layer of metal formed on the inner surface of said flattened portion, a fluorescent coating covering said metal layer, an electron gun comprising a cathode and an accelerating anode within the envelope and positioned to bombard said coating and comprising a cathode and an anode, and a contact secured to the inner wall of said envelope and connected to said anode and said metal layer, inside of said envelope.

3. A cathode ray tube comprising a vitreous envelope having a flattened portion to provide a viewing screen, a transparent layer of metal having a relatively high melting point formed on the inner surface of said flattened portion, a fluorescent coating covering said metal layer, an electron gun comprising a cathode and an accelerating anode within the envelope and positioned to bombard said coating and comprising a cathode and an anode, a contact secured to the inner wall of said envelope and connected to said anode, and a layer of getter metal having a relatively low melting point on the wall of said envelope connecting said contact and said first mentioned metal layer.

4. The method of constructing a vacuum tube having a vitreous envelope, and an electrode structure to be mounted therein, which comprises exhausting the envelope, heating the walls of said envelope to drive out adsorbed gases, evaporating metal having a relatively high melting point within said envelope, condensing the evaporated metal upon a portion of the walls of said envelope which will not immediately surround the electrode structure, readmitting air into said envelope, sealing in said electrode structure, re-evacuating the envelope, degassing the condensed metal and said structure by induction, and evaporating a metallic getter onto the walls of the envelope to complete the conductive coating to a point surrounding the electrode structure.

5. In a cathode ray tube comprising a vitreous envelope containing an electron gun comprising a cathode and an adjacent accelerating anode adapted to project a beam of cathode rays in one end of said envelope, a fluorescent screen on the

inner surface of the other end of said envelope in the path of said beam, and a thin adherent conducting layer of metal deposited on the surface of said envelope completely surrounding all of the path between said gun and said screen.

6. A cathode ray tube comprising an envelope, an electron gun having a cathode and an apertured anode adapted to project a beam of cathode rays in one end of said envelope, a fluorescent screen on the inner surface of the other end of said envelope in the path of said beam, and a thin adherent conducting layer of metal deposited on the surface of said envelope completely surrounding all of the path between said gun and said screen, and means for electrically connecting said layer of metal to said anode inside of said tube.

7. A cathode ray tube comprising an envelope, an electron gun having a cathode and an apertured anode adapted to project a beam of cathode rays in one end of said envelope, a fluorescent screen on the inner surface of the other end of said envelope in the path of said beam, a thin adherent conducting layer of metal deposited on the surface of said envelope completely surrounding all of the path between said gun and said screen and underlying said screen, and means for electrically connecting said layer of metal to said anode inside of said tube.

8. A cathode ray tube comprising an envelope having an electrode end and a viewing end, an electron gun having a cathode and closely adjacent perforated anode positioned in said electrode end and adapted to project an electron stream toward said viewing end, an adherent conductive and continuous metallic film covering the entire inner surface of said envelope between said gun and said viewing end and in addition surrounding said gun, said film including said viewing end, and a luminescent screen mounted on said viewing end, the portion of said film covered by said screen being translucent.

9. A cathode ray tube comprising an envelope having an electrode end and a viewing end, an electron gun having a cathode and closely adjacent perforated anode positioned in said electrode end and adapted to project an electron stream toward said viewing end, an adherent conductive and continuous metallic film covering the entire inner surface of said envelope between said gun and said viewing end, said film including said viewing end, and a luminescent screen mounted on said viewing end, the portion of said film covered by said screen being translucent, said film being electrically connected to said anode inside of said tube.

10. A cathode ray tube comprising a vitreous envelope having a flattened portion to provide a viewing screen, a transparent layer of metal formed on the inner surface of said flattened portion, a fluorescent coating covering said metal layer, an electron gun comprising a cathode and an adjacent accelerating anode within the envelope and positioned to bombard said coating, and means inside of said envelope for electrically connecting the metal layer to said anode.

RUSSELL H. VARIAN.

BERNARD C. GARDNER.