Feb. 6, 1951 | H. P. STEIER | 2,540,635

CESIATED MONOSCOPE

Filed May 27, 1948

Fig. 1.

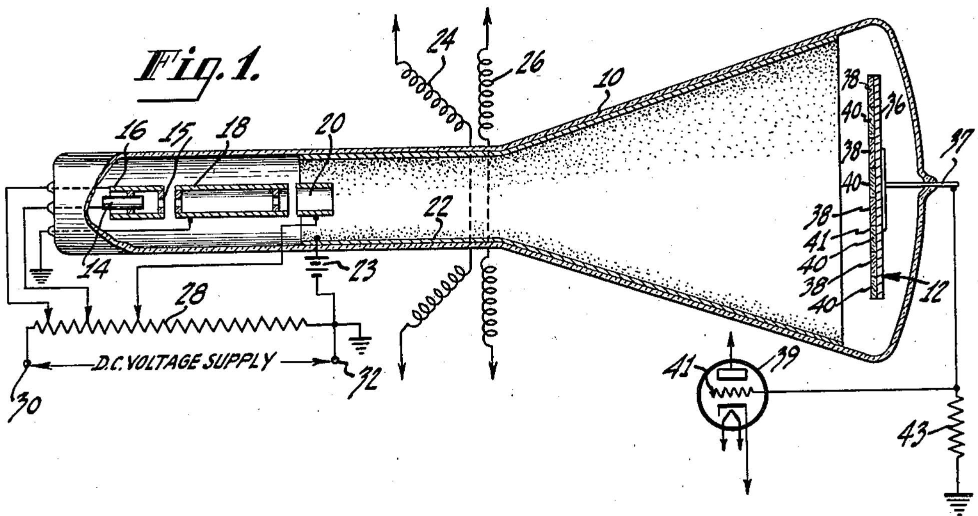


Fig. 2.

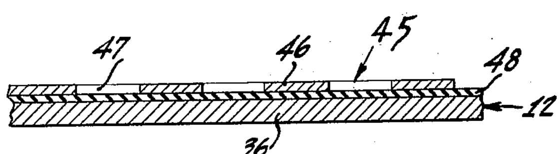


Fig. 3.

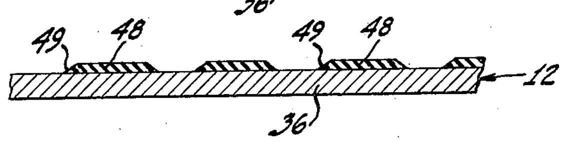


Fig. 4.

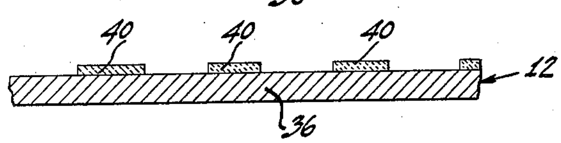
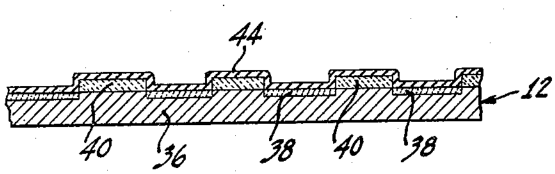


Fig. 5.



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CESIATED MONOSCOPE

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11 Claims. (Cl. 250—164)

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My invention relates to improvements in cathode ray signal generator tubes and particularly to an improved target electrode for use in such tubes.

In the usual form of cathode ray signal generator tube such as is used for developing signals representative of a single picture it is customary to scan with an electron beam a target having on its scanned surface a pattern or picture outline composed of a material having secondary electron emission characteristics different from those of the rest of the target. Thus, it has been customary to print or otherwise apply a pattern or picture upon a metal foundation using material such as a carbon ink having different secondary electron emitting properties than the metal.

Printing a target electrode with carbon ink has many objections and limitations. Difficulties have arisen in the non-uniformity of the printing due to such causes as uneven spreading of the ink, the varying of pressure in the printing process, the non-uniformity in size of the carbon particles used, etc., all which result in non-uniform target surfaces. Also, printing targets with ink depends upon humidity and temperature conditions. These difficulties result in target designs which vary from target to target making it difficult to standardize the generator tube.

It is an object of my invention to provide a cathode ray tube of the signal generating type wherein the pattern carried by the target and scanned by the electron beam has the desired uniform properties. It is a further object of my invention to provide such a tube wherein the signal response is uniform and the variation between the operation of various tubes in electrical properties is negligible. It is a still further object of my invention to provide a tube and electrode structure therefor, which may be easily manufactured and in which the processing steps may be varied over wide limits without unduly affecting the electrical properties of the tube.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will be best understood by reference to the following description taken in connection with the accompanying drawing, in which:

Figure 1 is a cross-sectional view of a signal generating tube embodying my invention.

Figures 2 through 5 inclusive are sectional views of the target electrode of the tube of Figure 1 showing the target at various stages of its manufacture.

In Figure 1, the signal generator tube comprises an envelope 10 of glass or vitreous material having a cylindrical neck portion enclosing a conventional electron gun structure and a conical section enclosing a target electrode 12. Envelope 10 is highly evacuated.

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The electron gun, mounted in the neck section of envelope 10, comprises a thermionic cathode electrode 14 having activated oxides of barium and strontium fixed to a plate closing one end of the cylinder 14. The oxides, well-known in the art, provide a source of electrons when heated to appropriate temperatures. Mounted close to the end plate of cylinder 14 is a control grid 15 comprising an apertured plate closing the end of a supporting cylinder 16. In a successfully operated tube of this type, grid 15 is normally maintained at close to a negative 50 volts relative to the cathode potential during tube operation. A tubular accelerating electrode 18 is mounted coaxial with the cathode 14 and is maintained at close to 1,000 volts positive relative to cathode potential. A second tubular electrode 20 maintained at close to 300 volts positive relative to cathode potential provides electrostatic focusing of the electron beam on the target electrode 12. An anode electrode 22 comprises a wall coating of conductive material, such as colloidal graphite, extending from a point adjacent focusing electrode 20 onto the conical portion of the envelope 10 to a point closely adjacent to the target electrode 12. Anode 22 is maintained at close to 1,050 volts positive relative to cathode potential and provides with electrode 20 further focusing fields for the electron beam. The electron beam generated and focused by the electrode gun structure, just described, is caused to sweep over the target 12 by any appropriate means such as, for example, perpendicular magnetic fields provided by two pairs of conventional deflection coils 24 and 26 respectively. Coils 24 and 26 are connected to appropriate circuits (not shown) for providing the required deflecting fields, as is well known in the art. In this manner the electron beam is caused to scan the target electrode 12 in any desired manner.

The target electrode 12 consists of a metal plate 36 arranged transversely to the path of the electron beam. The surface of the metal plate 36 facing the electron gun is coated on successive portions thereof with a film of chromium oxide 40 and a film of aluminum oxide 38. As will be described below, the chromium oxide layer 40 may be put down on the surface of plate 36 in any desired manner and design. The aluminum oxide layer 38 covers all portions of the surface of plate 36 lying between the chromium oxide portions 40. The aluminum plate 36 is connected by a lead 37 passing through the envelope wall 10 to a high resistance 43, which is grounded as is shown. The various electrodes of the signal generator tube are provided with appropriate potentials by being connected, as shown in Figure 1, to a D. C. voltage supply tnrough a voltage divider 28 connected across the terminals 30 and 32 of the supply. Terminal 32 is grounded as is shown and a battery 23 is connected between terminal 32 and anode coating 22. This arrangement maintains the anode electrode 22 at approximately 50 volts positive relative to the grounded target electrode 12. The voltages described as being applied to the various electrodes of tube 10, are for illustration only, and are those which have been used on a successfully operated sample of the tube. However, these voltages are in no way limiting. The invention is not confined to these values and other potentials may also be used successfully.

The operation of the tube of Figure 1 is such that an electron beam is developed and focused by the gun structure upon the target electrode 12. Upon being scanned across the target surface by the deflecting fields of coils 24 and 26, the electron beam will strike the surface of the chromium oxide and the aluminum oxide films, 40 and 38 respectively, at an energy of around 1,000 volts. As the electron beam scans across the surface of target 12, a secondary electron emission is initiated from both the aluminum oxide and the chromium oxide surface and changes the potential of these areas relative to that of the signal plate 36. However, the secondary emission from the aluminum oxide surfaces 38 is much greater than that from the chromium oxide surfaces 40. Thus, during tube operation, the secondary emission from the aluminum oxide surface produces, by capacity coupling, a much stronger signal in the circuit of signal plate 36 than is produced by secondary emission from the chromium oxide surfaces.

The anode electrode 22 operated at a voltage positive with respect to the target electrode 12 acts as a collector for practically all of the secondary electrons emitted from the target surfaces 38 and 40. Collector electrode 22 and target electrode 12 are connected in a common circuit with battery 23 and load resistor 43. The current flow through the load resistor has two components: one, the flow of beam electrons to the target electrode 12 and, two, the flow of secondary electrons from the target electrode 12 to the conductor electrode 22. The current in the load resistor 43 is equal to the difference between these two components. Since the secondary electron emission current varies as the beam moves over successive areas 38 and 40 of the target electrode, a video signal current which represents the pattern formed by areas 38 and 44 will flow in the load resistor 43. The voltage drop across the resistor 43 is used for the television reproduction of the target pattern formed by areas 38 and 40 by joining the conductor 37 to the control grid 41 of an amplifier tube 39 which is in turn connected into the appropriate circuits.

The areas of the target surface covered by chromium oxide portion 40 and aluminum oxide portion 38, having a relatively different secondary electron emission, may be formed into any desired pattern or design. The formation of the pattern electrode 12 is somewhat involved and is described in detail as follows:

The metal plate 36 (Figure 2) comprises a thin aluminum foil upon which is deposited a layer 48 of sensitized albumen, made from albumen mixed with potassium dichromate or ammonium dichromate as a sensitizer. This material is well known to the photo-engraving art. Over the albumen layer 48 is placed a transparency or negative 45. This negative or transparency may be made by photographing a large black and white drawing of the pattern which it is desired to reproduce on the target electrode. The transparency or negative formed consists of opaque areas 46 and transparent areas 47 and is placed in close contact with the emulsion layer 48. Upon the exposure of the target 12, of Figure 2, to a "blue" light from carbon arc lamps, the portions of the albumen emulsion exposed through the transparency 45 are rendered insoluble, due to a photo-chemical action of the dichromate and albumen. The negative or transparency 45 is removed and the target electrode 12 is washed in water to remove the soluble or unexposed portions of the albumen. What is left is shown in Figure 3, in which insoluble portions of the albumen 48 remain on the metal plate 36. Also there are formed partially hardened areas 49 created by light leaking around the edges of the masked areas 48.

To remove the partially hardened portions 49 at the edges of the hard albumen portions 48, the target plate 12 is further washed in a saturated solution of sodium chloride in water with about 30 cc. of concentrated acetic acid per 300 cc. of the sodium chloride solution. Afterward the plate is further washed with distilled water. The treatment leaves the hardened albumen areas 48 with cleanly defined edges.

At this point the image or pattern formed on the target plate 12 by the hardened albumen areas 48 may be made more apparent for inspection by dipping the plate in an aniline dye, usually purple. The target 12 is then mounted in the envelope of the tube 10 in a position shown in Figure 1. The mounting structure may be of any desired design, which is not shown in the figure. The bulb and neck of envelope 10 are sealed together while carbon dioxide or forming gas is passed into the tube at about four to five cubic feet a minute. This expediency prevents undue burning of the image material 48 on the target plate 12. The anode coating 22 is applied to the inner surface of the envelope 10 and the bulb is baked out in air. After the seal has been made, the electron gun structure is mounted within the tube and the tube exhausted, degassed, and the cathode activated in a conventional manner, well known in the art. During this processing of the tube, the organic albumen 48 is burned off and there is left behind a layer of chromium oxide 40 (Fig. 4) formed from the dichromate sensitier used. Oxygen is introduced into the tube 10 at a pressure of approximately 2 atmospheres and the aluminum plate 12 is heated for example, by high frequency induction, to a visible red temperature for a period of three minutes. This results in forming a heavy layer of aluminum oxide 38 (Fig. 5) on the surface of the aluminum plate 36 between the portions of the target surface coated by the chromium oxide pattern 40. The oxygen is removed from the bulb envelope 10 and the tube is exhausted and sealed off in the normal manner.

A thin film or layer 44 of caesium material is then put down over the surface of the target 12. This may be formed by vaporizing a pellet of caesium within the envelope. The vaporized metal will condense upon the target surface. For example, a 10 milligram pellet of caesium is attached to a refractory filament or placed on a capsule approximately two and one-half inches from the target surface. Upon heating the filament by a passage of current therethrough or the capsule by a high frequency field, the caesium material is vaporized and condenses upon the target surface. The thickness of the caesium film **44** is rather critical, as it must remain permeable to the primary electrons of the scanning beam and to the secondary electrons emitted from the chromium oxide and aluminum oxide portions of the target surface. However, the caesium film should be sufficiently thick to provide a semi-conducting layer over the target surface exposed to the scanning electron beam. A caesium layer of approximately 1000 Å. has been found to possess the desired properties.

When the electron beam scans the target surface, the potential of the aluminum oxide areas **38** are driven more positively than are the chromium oxide areas with reference to the potential of the signal plate **36**, as described above. To produce a clear and distinct signal from all portions of the target surface, each elemental area should be discharged to the reference potential of the signal plate **36**, between successive scansions of the electron beam. Since chromium oxide is an excellent insulator, there is an insufficient leakage of current between the charged surface of the chromium oxide areas **40** and the signal plate **36** to return the chromium oxide areas **40** to signal plate potential between scans. Consequently, during tube operation, these chromium oxide portions of the target become more and more charged until the secondary emission signal from these areas is radically changed and the picture signal will reverse polarity. The caesium film **44** eliminates these difficulties by providing a semi-conducting path between the chromium oxide portions of the target surface and the signal plate **36**, and its supporting structure. Thus, between successive scansions of the electron beam, any particular portion of the target surface which has been charged by the beam, will tend to be discharged to the potential of plate **36** through the semi-conducting film **44**.

The aluminum plate **36** is obtained from aluminum foil developed for advertising and packing purposes. It is approximately 4 mils thick although this thickness is not critical. However, the surface of the foil should have a bright finish, as imparted to it by the method of rolling the metal, which is done commercially for labels, wrapping, etc. The surface should have no scratches which can be seen in reflected light. The target plate **36** is not necessarily limited to aluminum. Other metals may be used which are easily oxidized and whose oxides will provide secondary emission characteristics of the desired type.

The particular method of forming the target electrode **12** as described above need not be entirely limited to the materials used. The transparency or negative **45** may be of any desired form such as an opaque metallic screen or stencil. Also, the transparency **45** is not necessarily limited to a black and white pattern but may be formed from any photograph and the pattern design printed upon plate **36** through a halftone screen.

The semi-conducting film **44** need not be limited to caesium as it is possible also to use a thin aluminum or beryllium film or any metallic layer which would not reduce the secondary emission from the aluminum oxide and yet would provide the desired degree of conductivity.

A target having a signal generating tube constructed according to my invention eliminates the difficulties inherent in a signal electrode formed from carbon printing. The signal electrode according to this invention, is not limited in picture resolution to the extent that carbon printing is. With this new process it is possible to form on the target surface up to 2000 elements per inch, which is better resolution than needed at the present time for television purposes. The television picture resulting from the use of the signal target of this invention shows greatly improved contrast and freedom from blemishes. The resulting increased contrast makes possible the use of less amplification and the production of an image signal freer of noise. The process of target formation, according to this invention, makes possible an accurate half-tone gray scale reproduction. The target formation also results in the possibility of increased definition, as for example, an increased number of lines or elements in a given pattern height.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention.

What I claim as new is:

1. A signal generating device comprising an envelope, an electron gun structure within said envelope for developing a beam of electrons of predetermined energy, a target electrode within said envelope transverse to the normal direction of the electron beam to be scanned thereby, the target surface including a first portion thereof having a secondary electron emission greater than unity when struck by said electron beam and a second portion having a secondary electron emission ratio different from that of said first portion when struck by said electron beam, and a thin conductive coating connecting said target surface portions.

2. A signal generating tube comprising an envelope, an electron gun within said envelope for developing a beam of electrons of predetermined energy along a normal path, a target electrode within said envelope having a surface thereof transverse to the normal path of said electron beam to be scanned thereby, a portion of said target surface having a secondary electron emission greater than unity when struck by said electron beam, the remainder of said target surface having a secondary emission ratio different from that of said first portion when struck by said electron beam, and a conductive coating over said target surface.

3. A signal generating tube comprising an envelope, an electron gun within said envelope for developing a beam of electrons of predetermined energy along a normal path, a target electrode within said envelope having a surface thereof transverse to the normal path of said electron beam to be scanned thereby, an insulating material deposited over spaced portions of said target surface, said material having a secondary emission when struck by said electron beam, said target surface between said spaced portions having a secondary emission greater than that of said insulating material when struck by said electron

beam, and a conductive coating over said target surface connecting said insulating material to the target surface between said spaced portions.

4. A signal generating tube comprising an envelope, an electron gun within said envelope for developing a beam of electrons of predetermined energy along a normal path, a target electrode having a metal sheet transverse to the normal path of said electron beam to be scanned thereby, an insulating material deposited over spaced portions of said metal sheet, said material having a secondary emission when struck by said electron beam, the surface of said metal sheet between said spaced portions having an oxide coating with a secondary emission greater than that of said insulating material when struck by said electron beam, and a thin metal film coating said insulating material and said oxide coating.

5. A signal generating tube comprising an envelope, an electron gun within said envelope for developing a beam of electrons of predetermined energy along a normal path, a target electrode having a metal sheet transverse to the normal path of said electron beam to be scanned thereby, a metal oxide material deposited over spaced portions of said metal sheet, said material having a secondary emission when struck by said electron beam, the surface of said metal plate between said spaced portions having an oxide coating with a secondary emission greater than that of said metal oxide material when struck by said electron beam, and a conductive film over said target connecting said metal oxide material to said oxide coating between said spaced portions.

6. A signal generating tube comprising an envelope, an electron gun within said envelope for developing a beam of electrons along a normal path, a target electrode having an aluminum sheet transverse to the normal path of said electron beam to be scanned thereby, a chromium oxide layer on spaced portions of the surface of the aluminum sheet facing said electron gun, an aluminum oxide coating on said surface of the aluminum sheet between said spaced portions, a conductive film over said surface of said aluminum sheet connecting said spaced portions to said aluminum oxide coating.

7. A signal generating tube comprising an envelope, an electron gun within said envelope for developing a beam of electrons along a normal path, a target electrode having an aluminum sheet transverse to the normal path of said electron beam to be scanned thereby, a chromium oxide layer on spaced portions of the surface of the aluminum sheet facing said electron gun, an aluminum oxide coating on said surface of the aluminum sheet between said spaced portions, a thin film of caesium metal on said surface of said aluminum sheet connecting said chromium oxide layer to said aluminum oxide coating.

8. A signal generating tube comprising an envelope, means within said envelope for developing a beam of electrons along a normal path, said means including an electron source and an electrode adapted to be maintained during tube operation at a positive potential relative to said electron source, a target electrode having a metal sheet transverse to the normal path of said electron beam to be scanned thereby, means for connecting said target metal sheet to a source of positive potential between that of said electron source and of said electron, an insulating material deposited over spaced portions of said metal sheet, said material having a secondary emission when struck by said electron beam, the surface of said metal sheet between said spaced portions having an oxide coating with a secondary emission greater than that of said insulating material when struck by said electron beam, and a thin metal film connecting said insulating material and said oxide coating to said metal sheet.

9. A signal generating tube comprising an envelope, means within said envelope for developing a beam of electrons along a normal path, said means including an electron source and an electrode adapted to be maintained during tube operation at a positive potential relative to said electron source, a target electrode having an aluminum sheet transverse to the normal path of said electron beam to be scanned thereby, means for connecting said aluminum target sheet to a source of positive potential between that of said electron source and of said electrode, a chromium oxide layer deposited over spaced portions of said aluminum sheet facing said gun, the surface of said aluminum sheet between said spaced portions having an aluminum oxide coating with a secondary emission greater than that of said chromium oxide layer when struck by said electron beam, a thin metal film connecting said chromium oxide layer and said aluminum oxide coating to said aluminum sheet.

10. The method of making a target for a signal generating tube, said method comprising the steps of, coating a surface of a metal plate with albumen sensitized with a metal oxygen salt, exposing said albumen coating to light through a transparency for masking portions thereof from said light, removing the masked portions of said albumen coating from said plate, heating said metal plate to burn off the residual albumen coating and to change the residual metal salt therein to a metal oxide, oxidizing the surface of the plate not covered with the metal oxide coating, and forming a thin metal film on the coated surface of the metal plate.

11. The method of making a target for a signal generating tube, said method comprising the steps of, coating a surface of an aluminum plate with albumen sensitized with a chromium oxygen salt, exposing said albumen coating to light through a transparency for masking portions thereof from said light, removing the masked portions of said albumen coating from said plate, heating said metal plate to burn off the residual albumen coating and to change the residual chromium salt therein to chromium oxide, oxidizing the surface of the aluminum plate not covered with the chromium oxide coating, and forming a thin metal film on the coated surface of the aluminum plate.

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