

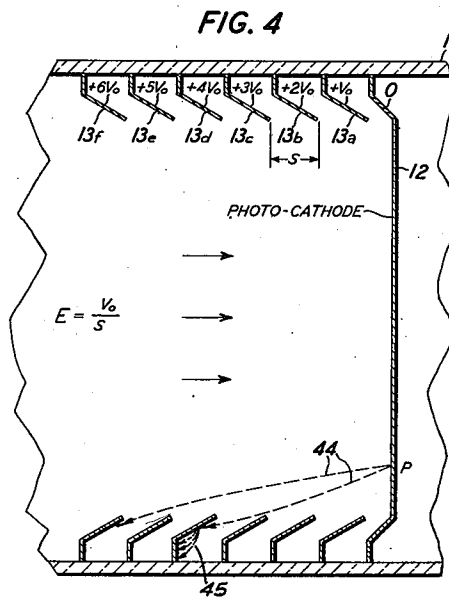
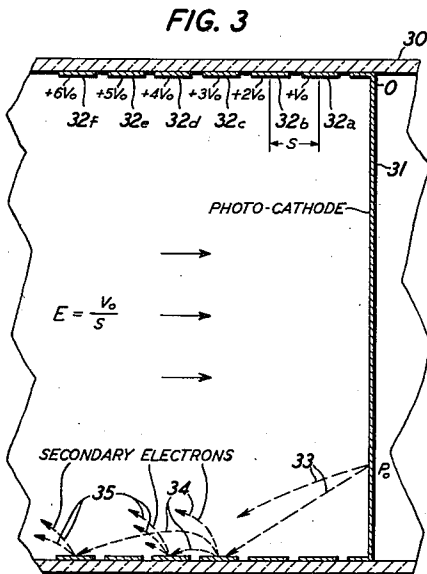
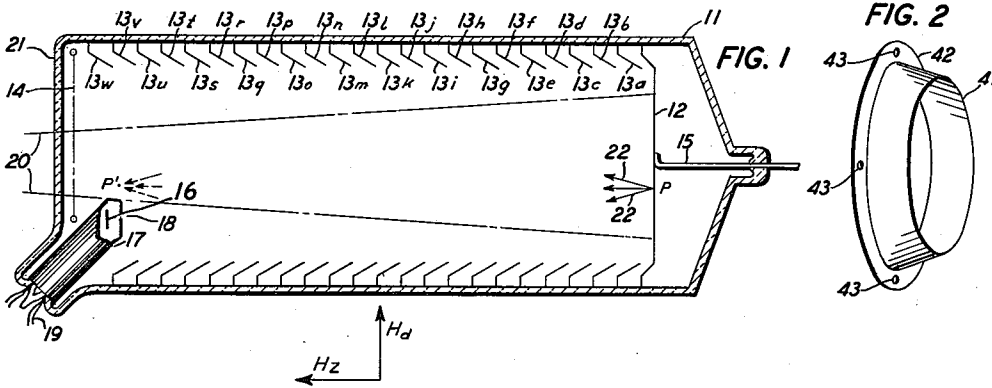
Jan. 1, 1952

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2,580,697

IMAGE DISSECTOR TUBE

Filed June 30, 1949



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2,580,697

IMAGE DISSECTOR TUBE

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Application June 30, 1949, Serial No. 102,296

9 Claims. (Cl. 313-106)

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This invention relates to electron camera tubes and more specifically to electron camera tubes of the dissector type.

It is an object of this invention to reduce certain distortions heretofore generally encountered in television camera tubes of the dissector type and produced by unwanted secondary emission therein.

One well-known form of cathode-ray television pick-up device is called the dissector. In the usual dissector tube, an image of the object is formed on a photoelectric cathode, thereby giving rise to a stream of electrons various elemental portions of a cross-section of which, taken at a plane containing a scanning aperture in front of a pick-up electrode, correspond respectively to the elemental areas of the optical image on the cathode. The electrons are accelerated towards a scanning aperture by an axial electrostatic field. In order to use the tube as a television pick-up device, three independently variable magnetic fields are usually necessary. First, an axial magnetic field is required to form an electron image at the end of the tube remote from the photocathode. Next, two transverse magnetic fields, known as the horizontal and vertical deflecting (or sweep) fields, are required in order to deflect the electron stream from side to side and up and down and thus displace the electron image in these directions. By means of these two transverse magnetic fields, it is possible to move all elemental parts of the electron image in succession over a fixed aperture located in the image or "scanning" plane. The number of electrons received by the pick-up electrode directly behind the scanning aperture depends on the electron density of that portion of the electron image which falls on the aperture, and hence in turn is proportional to the light intensity falling on the corresponding element of the cathode surface. In certain special applications, such as those in which the material to be scanned is a moving film, only one deflecting field is necessary.

In television systems employing the usual dissector tube as a pick-up device, it has been noted that the picture produced on the screen of the receiving tube has been distorted due, at least in part, to the fact that the magnetic sweep coil and, in some cases, the focusing coil and also the electrode structure producing the electrostatic fields in the dissector have been so formed as to produce non-uniform fields. In a copending application of the present inventor, Serial No. 36,001, filed June 30, 1948 (which issued as Patent 2,505,060 on April 25, 1950, and which is a

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division of application Serial No. 770,639, filed August 26, 1947, and which issued as Patent 2,535,810 on December 26, 1950), it is disclosed that the geometric distortions produced in the dissector type tube can be greatly minimized by using substantially uniform accelerating, focusing and deflecting fields and there is described therein an arrangement for producing substantially uniform accelerating fields, the application referring to an earlier application (now B. M. Oliver Patent 2,278,478, issued April 7, 1942) for an arrangement for producing substantially uniform magnetic focusing and deflecting fields.

In the arrangement disclosed in the above-identified application, Serial No. 36,001, a dissector tube is shown having a multiplicity of accelerating rings at uniform intervals along the axis of the tube which are placed at progressively higher potentials in the direction from the cathode to the scanning plane. A metal cap, of mesh material for example, is located at the anode end of the tube. A substantially uniform electric field throughout the useful volume of the dissector is produced by this electrode arrangement. Tests on this tube, however, show that distortions are still present in the received picture. Measurements taken show that when there is no deflecting field present, that is, when just the electric field and the axial magnetic focusing field are used, the end mesh current is about twice the photocathode current. Under moderate deflections of the photocurrent stream, the end mesh current rises to some twenty to thirty times cathode current, showing that the photoelectrons from the cathode are striking the accelerating rings and producing secondary electrons. These secondaries in turn are accelerated down the tube and are deflected into other rings to produce even more secondaries. The result is a large space charge in the tube which distorts the electric field and hence the picture, the tube being, in other words, a fair electron multiplier.

It is another object of this invention to greatly reduce the above-described electron multiplication in electron camera tubes of the dissector type.

These and related objects are attained in accordance with the invention by providing cone-shaped rings with flanges in place of the usual cylindrical rings. It has been found that this ring structure causes a much smaller amount of total secondary emission than the type of ring structure heretofore used.

The invention will be more readily understood by referring to the following description taken

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in connection with the accompanying drawings forming a part thereof in which:

Fig. 1 is a schematic view, partly in cross-section taken in a plane containing the longitudinal axis of the tube, of a complete dissector tube embodying the principles of this invention;

Fig. 2 is a perspective view of one of the conical accelerating rings constructed in accordance with the invention;

Fig. 3 is an enlarged cross-sectional view of a portion of a dissector tube of the type shown in Fig. 1 except that it embodies the conventional cylindrical accelerating rings of a prior art dissector tube; and

Fig. 4 is an enlarged cross-sectional view of a portion of the dissector tube shown in Fig. 1.

Referring more specifically to the drawing, Fig. 1 shows, by way of example for purposes of illustration, a television camera tube 10 of a type known as a "Farnsworth dissector" but having variations therein in accordance with the invention. For convenience in the description and simplicity in the drawing, the usual horizontal sweep winding, vertical sweep winding and focusing winding have not been shown but preferably these windings are of the types disclosed in the copending application Serial No. 36,001 and in the references to the prior art made therein.

The camera tube 10 comprises an evacuated envelope 11 enclosing a photocathode 12, a number of accelerating electrodes 13a to 13w, inclusive, an end mesh electrode 14, a connection 15 to the cathode 12, and a pick-up electrode or anode 16 housed in a chamber 17 which also includes an electron multiplier. The housing 17 has a small aperture 18 directly in front of the pick-up electrode 16 which preferably forms the first electrode of the electron multiplier in the housing 17. In order to simplify and clarify the drawing, the individual leads which are normally brought out through the glass envelope 11 in order that each of the accelerating electrodes 13a to 13w can be independently connected to an external supply of electric potential are not shown, but it should be understood that in an actual tube these connections are provided. Similarly, the internal construction of the electron multiplier in the housing 17 is not shown but this construction is in accordance with principles well known in the art. The leads 19 to the various dynodes of the electron multiplier are brought out through a reentrant seal which extends into the housing 17 and serves as a mechanical support for this housing. The support ring for the end mesh member 14 is deformed and a portion of accelerating electrode 13w is cut away in order to allow space for the multiplier housing 17 to extend into the tube in the position shown in Fig. 1.

By means of any suitable external source of potential (not shown), accelerating ring 13a is fixed at a potential V_0 volts more positive than the photocathode 12. Progressing down the tube in the direction from the cathode 12 toward the multiplier in the housing 17 (that is, from right to left in Fig. 1), each accelerating ring 13b, 13c, . . . 13u, 13v, 13w is placed at a potential V_0 volts positive with respect to the previous accelerating ring, i. e., ring 13c is V_0 volts more positive than ring 13b, ring 13d is V_0 volts more positive than ring 13c and so on. Likewise, the end mesh member 14 is V_0 volts more positive than accelerating ring 13w. As is well known in the art, this configuration of uniformly spaced rings with equal potential differences between adjacent pairs together with the plane cathode

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12 and end mesh member 14 produces a substantially uniform electric field within the evacuated envelope 11. In the arrangement shown, the electric field is substantially parallel to the axis of the tube 10 and normal to the plane of the photocathode 12. The sense of the electric field is such as to accelerate electrons away from the photocathode 12. If S is the separation between adjacent rings 13 measured along the axis of the tube, and if V_0 is the potential difference between adjacent rings 13, the strength of the electric field is

$$\frac{V_0}{S}$$

Light rays 20 from any suitable optical system enter the tube through the transparent end 21 of the glass envelope 11, pass through the openings in the end mesh member 14, and form an optical image on the photocathode 12. Electrons are emitted from each point on this photocathode at a rate proportional to the light intensity falling on that point. As is well known, photoelectrons are emitted with various initial velocities ranging from zero up to one or two electron volts. This initial velocity may have a component tangential to the emitting surface, with any direction equally likely. Consider the electrons leaving any particular point P on the cathode 12. As the electrons leave the surface and are accelerated down the tube (that is, towards the left in Fig. 1) by the electric field, they also diffuse radially because of the different tangential components of initial velocity and, therefore, follow paths as indicated by the arrows 22. An electron from point P, having zero tangential component of initial velocity will, under the influence of the electric field, be accelerated straight down the tube along a path parallel to the axis thereof, and a short time later pass through a point P' in the plane of the aperture 18. If now a uniform magnetic field is applied to the tube, parallel to the axis thereof, that is, in the Z direction as indicated by the arrow H_z , then the paths of any electron, whatever the initial tangential velocity, will be a helix which crosses at some point farther down the tube the path of an electron with zero tangential velocity. Thus, by properly choosing the strength of the applied uniform magnetic field, H_z , all electrons from the point P can be made to pass through a point extremely close to P'. For every point on the cathode there will, therefore, be a corresponding image point in the plane of the aperture 18. Moreover, a substantially undistorted electron image of the light distribution on the cathode 12 is formed in the plane of the aperture 18. If now, a uniform transverse magnetic field H_a is applied to the tube, this electron image is displaced sideways, and by suitably varying the magnitude and direction of H_a , any part of this image can be caused to fall through the aperture 18 and thus produce from the electron multiplier in the housing 17 a current proportional to the light intensity falling on the corresponding point on the photocathode. The magnetic field, H_a , can conveniently be the resultant field from two uniform field coils, one oriented so as to displace the electron image horizontally, the other oriented so as to displace the image vertically. The three coils employed to produce the uniform focusing field, H_z , and the two components of the deflecting field H_a can be constructed according to the disclosure in United States Patent 2,278,478, issued April 7, 1942, to B. M. Oliver.

If the electric field and all the magnetic fields

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are uniform, the displacement of the electron image can be made substantially proportional to the strength of the deflecting field, so that linear scanning of the image results with linear sweep currents in the deflecting coils. In addition, a negligible amount of defocusing of the electron image will result. The formation of the electron image under deflection and means for minimizing distortions of this image are described in the last above-identified Oliver patent.

At times when the electron image is considerably deflected by the deflecting field H_d , electrons from certain parts of the cathode will strike the accelerating rings. Fig. 3 shows a cross-section of a dissector tube with conventional cylindrical accelerating rings 32a, 32b, 32c, 32d, 32e, 32f, Electrons leaving a point P_0 on photocathode 31, under conditions of large deflection of the electron image, follow trajectories indicated by the broken lines 33, and strike accelerating rings 32c and 32d. The impact of the photoelectrons ejects a greater number of secondary electrons which follow trajectories indicated by the broken lines 34. The secondary electrons are also deflected against other accelerating rings and liberate more secondary electrons 35. Since the number of secondary electrons is multiplied, by a factor which may be greater than unity, upon each successive impact a considerable space current may develop. In an experimental tube under certain conditions of deflection, a current was collected by the end mesh which was thirty times as large as the photocathode current. The accelerating rings were thus acting as the dynodes of a rather good electron multiplier.

This large space current in the tube results in a high space charge which distorts the electric accelerating field. The distorted electric field distorts and defocuses the electron image under deflection. When the signal from the dissector tube is then reproduced in a viewing tube, the resulting picture will be deformed and blurred in certain areas.

Fig. 2 is a perspective view of an accelerating electrode 13 constructed according to the principles of this invention. The electrode comprises a frustro-conical portion 41, surrounded by a flange 42. The flange 42 preferably contains a number of holes 43 through which mounting rods (not shown) can conveniently be passed.

Fig. 4 is a cross-sectional view of a dissector tube embodying accelerating electrodes 13a, 13b, 13c, 13d, 13e and 13f of the type shown in Fig. 2. Electrons leaving point P on the photocathode 12 will, under deflection, follow paths such as those indicated by the broken lines 44. These electrons will thus strike the accelerating electrodes 13d, 13e and 13f. If, however, the angle between any element of the conical section of the electrodes and the axis of the tube is slightly greater than the maximum angle of arrival of any electron with respect to the axis of the tube, then electrons can strike only the outer surface of the conical portion of the accelerating electrodes or the surface of the flange toward the cathode. In either case, the secondary electrons produced are trapped in the space between two electrodes and the glass envelope 11. Because of the electric field between the electrodes, the secondary electrons are forced to return to the emitting electrode as shown by the broken lines 45. As a result, the secondaries produce substantially no current from any electrode, and

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substantially no space charge is produced by secondaries in the central image space of the tube. The electric field remains substantially uniform as the electron image is deflected, and the picture obtained from the tube is quite free from geometric distortion and defocusing.

Obviously, various changes can be made in the embodiment disclosed without departing from the spirit of the invention.

10 What is claimed is:

1. A cathode-ray television transmitter tube of the type wherein an electron beam of relatively large cross-sectional area compared with the size of an elemental area of an object to be televised is formed, comprising a photoelectric cathode for emitting electrons to be formed into said beam, a pick-up electrode upon which electrons from said beam are caused to strike, and means mounted inside the tube and including a plurality of axially spaced frustro-conically-shaped rings for accelerating said beam towards said electrode.

2. A cathode-ray television transmitter tube of the type wherein an electron beam of relatively large cross-sectional area compared with the size of an elemental area of an object to be televised is formed, comprising a photoelectric cathode for emitting electrons to be formed into said beam, a pick-up electrode upon which electrons from said beam are caused to strike, and means mounted inside the tube and including a plurality of axially spaced frustro-conically-shaped rings for accelerating said beam towards said electrode, each of said frustro-conically-shaped rings having its smaller diameter nearer the cathode.

3. A cathode-ray television transmitter tube of the type wherein an electron beam of relatively large cross-sectional area compared with the size of an elemental area of an object to be televised is formed, comprising a photoelectric cathode for emitting electrons to be formed into said beam, a pick-up electrode upon which electrons from said beam are caused to strike, and means mounted inside the tube and including a plurality of axially spaced frustro-conically-shaped rings for accelerating said beam towards said electrode, each of said rings having a flange member in a plane which is at right angles to the longitudinal axis of the tube.

4. A cathode-ray television transmitter tube of the type wherein an electron beam of relatively large cross-sectional area compared with the size of an elemental area of an object to be televised is formed, comprising a photoelectric cathode for emitting electrons to be formed into said beam, a pick-up electrode upon which electrons from said beams are caused to strike, means mounted inside the tube and including a plurality of axially spaced frustro-conically-shaped rings for accelerating said beam towards said electrode, each of said rings having a flange member in a plane which is at right angles to the longitudinal axis of the tube, and each of the frustro-conically-shaped portions of said rings having its cross-section of smaller diameter near the photocathode.

5. A cathode-ray television transmitter tube of the type wherein an electron beam of relatively large cross-sectional area compared with the size of an elemental area of an object to be televised is formed, comprising a photoelectric cathode for emitting electrons to be formed into said beam, a pick-up electrode upon which electrons from said beam are caused to strike, means mounted inside the tube and including a plurality of ax-

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ially spaced frustro-conically-shaped rings for accelerating said beam towards said electrode, and means for applying a different potential to each ring, the potentials increasing in the direction from photocathode to pick-up electrode.

6. A cathode-ray television transmitter tube of the type wherein an electron beam of relatively large cross-sectional area compared with the size of an elemental area of an object to be televised is formed, comprising a photoelectric cathode for emitting electrons to be formed into said beam, a pick-up electrode upon which electrons from said beam are caused to strike, means mounted inside the tube and including a plurality of axially spaced frustro-conically-shaped rings for accelerating said beam towards said electrode, and means for applying a different potential to each ring, the potentials increasing in the direction from photocathode to pick-up electrode by uniform amounts.

7. A cathode-ray television transmitter tube of the type wherein an electron beam of relatively large cross-sectional area compared with the size of an elemental area of an object to be televised is formed, comprising a photoelectric cathode for emitting electrons to be formed into said beam, a pick-up electrode upon which electrons from said beam are caused to strike, and means mounted inside the tube and including a plurality of axially spaced accelerating members for accelerating said beam towards said electrode, each of said members having portions which act as a barrier to secondary electrons emitted from one

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electrode member and which would otherwise be directed to a following electrode member.

8. A cathode-ray television transmitter tube of the type wherein an electron beam of relatively large cross-sectional area compared with the size of an elemental area of an object to be televised is formed, comprising a photoelectric cathode for emitting electrons to be formed into said beam, a pick-up electrode upon which electrons from said beam are caused to strike, and means mounted inside the tube and including a plurality of axially spaced electrode elements for accelerating said beam towards said electrode, each of said electrode elements comprising a member having an opening therein which is smaller at the end toward the photocathode than at the other end thereof.

9. The combination of elements as in claim 8 in further combination with means for applying a different potential to each ring, the potentials increasing in the direction from photocathode to pick-up electrode by uniform amounts.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,135,615	Farnsworth	Nov. 8, 1938
2,222,181	Morton	Nov. 19, 1940
2,278,478	Oliver	Apr. 7, 1942