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ELECTRON DISCHARGE DEVICES

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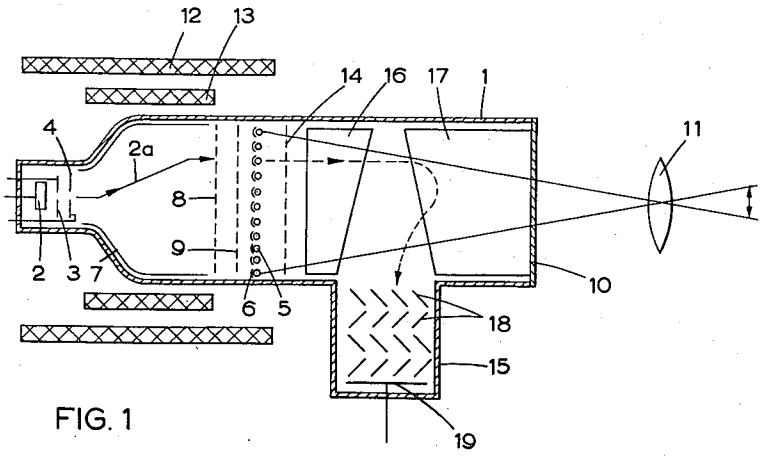


FIG. 1

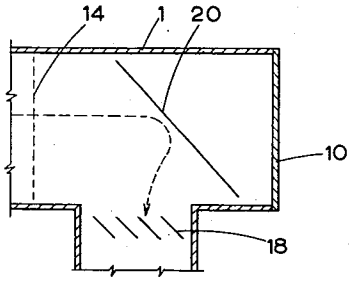


FIG. 2

Inventor
H. G. Lubszynski
By Pennie Edmonds Morton Taylor & Adams
Attys.

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ELECTRON DISCHARGE DEVICES

Hans Gerhard Lubszynski, Waltham, St. Lawrence, England, assignor to Electric & Musical Industries Limited, Hayes, Middlesex, England, a company of Great Britain

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15 Claims. (Cl. 313—65)

This invention relates to electron discharge devices which are suitable for use as television pick-up tubes and for other purposes.

A television pick-up tube has been proposed in U.S. patent specification No. 2,280,999 having a target electrode comprising an opaque foraminated member having on one side thereof a light sensitive surface which was arranged to be scanned by an electron beam. The axis of the electron gun which generated the scanning beam was arranged normal to the target electrode and an optical image was arranged to be projected onto the light sensitive surface of the target electrode, the axis of the optical system being oblique to the target electrode. When light is shone onto the light sensitive surface, elemental areas of said surface acquire different potentials and such potentials are restored to an equilibrium potential by scanning with the electron beam. Some of the electrons of the beam not utilised for restoring the elements to an equilibrium potential pass through the interstices of the foraminated member until the target surface is restored to equilibrium potential so that the scanning beam is in effect modulated by the potentials of elemental areas of the target electrode, the electrons passing through said interstices being directed into an electron multiplier in order to generate picture signals. This known arrangement is unsatisfactory on account of the necessity of projecting the optical image on the same side of the target electrode as that which is scanned by the electron beam, and in particular the oblique incident light beam or oblique scanning beam which is necessary in the prior proposal is also undesirable.

The object of the present invention is to provide an improved electron discharge device employing a foraminated target electrode but in which the necessity of projecting the optical image onto the same side of the target electrode as that scanned by the electron beam is avoided.

According to the present invention there is provided an electron discharge device having a target electrode comprising a substantially transparent foraminated member, a light sensitive surface on one side of said member, said member being so arranged that an optical image can be projected through said member onto said light sensitive surface so as to cause elemental areas of said surface to change in potential depending on the intensity of the elemental areas of said optical image, and means for generating electrons which can be projected onto said member so as to restore said elemental areas of said surface to an equilibrium potential and means for causing some of said electrons to pass through the interstices of said member during the restoration period.

Preferably the light sensitive surface of said target electrode is scanned by an electron beam, the axis of the electron gun for generating said beam being disposed normal to said target electrode and said optical image may be arranged to be projected through a window of an envelope in which said target electrode and electron gun are mounted, with the axis of the optical system normal to said target electrode. The light sensitive surface may

be of any suitable form and may for example comprise a mosaic or photo-emissive elements, or may for example comprise a layer of material exhibiting a photo-voltaic effect. A low velocity scanning beam is employed and the arrangement may be such that the light sensitive surface is brought to an equilibrium potential corresponding substantially to that of the potential of the cathode which generates said electrons. It is preferable to cause the electrons which pass through the interstices of the target electrode to be directed into an electron multiplier prior to collection by a signal electrode.

In order that the said invention may be clearly understood and readily carried into effect, it will now be more fully described with reference to the accompanying drawings in which:

Figure 1 illustrates diagrammatically an electron discharge device according to one embodiment of the invention, and

Figure 2 illustrates diagrammatically a modification of the device shown in Figure 1.

As shown in the drawings the device comprises an evacuated envelope **1** having at one end an electron gun comprising a cathode **2**, a cathode screen **3** and a limiter electrode **4**. Disposed in a plane normal to the axis of the electron gun is a target electrode which comprises a substantially transparent foraminated member indicated at **5**. This foraminated member may be made of glass the interstices in which may be made in the manner disclosed in "Industrial and Engineering Chemistry" volume 45, No. 1, on pages 115 to 118. On the side of the member **5** facing the electron gun is a light sensitive surface indicated at **6**. This light sensitive surface may comprise a mosaic of photo-electric elements which may be formed on said surface of the member **5** by evaporating a suitable metal such as antimony through the interstices of a mesh and thereafter sensitising the conducting elements so formed, or the photo-mosaic may be formed by aggregating a thin layer of silver evaporated onto the surface of the member **5** and then rendering the elements so formed photo-sensitive. Any other suitable light sensitive mosaic surface may be employed such as one exhibiting a photo-voltaic effect. The target electrode is preferably of the charge storage type. Between the member **5** and the limiter electrode **4** is a wall anode **7** and at the end of the wall anode facing the mmeber **5** is a mesh **8** which may, if desired, be connected to the wall anode **7**, the mesh **8** serving to function as an ion trap mesh. Between the mesh **8** and the member **5** is a further mesh electrode **9** which may be arranged to serve as a stabilising mesh as is known in television pick-up tubes employing a low velocity scanning beam, and may also be disposed sufficiently close to the target electrode so as to constitute a common electrode for the capacities of the mosaic elements. At the end of the envelope **1** remote from the cathode **2** is a glass window **10** arranged parallel to the plane of the member **5** and through which an optical image can be projected through an optical system indicated conventionally at **11**. The optical system **11** is arranged with its axis normal to the plane of the member **5**. When an optical image is projected onto the member **5**, light from the image passes through the member **5** onto the light sensitive surface **6**. The elemental areas of the light sensitive surface acquire different potentials and in the case of a photo-emissive surface photo-electrons will be emitted from the emissive surface **6** and will be collected by the meshes **8** and **9** and the anode **7**. The beam of electrons issuing from the electron gun is focussed by a solenoid coil **12** surrounding the space between the gun and the target electrode and is scanned over the surface of the light sensitive surface **6** by means of scanning coils indicated at **13**. The electron beam indicated at **2a** preferably impinges on the sensi-

tive surface 6 with a low velocity and with normal incidence and since in the case of a photo-emissive surface elemental surfaces thereof become charged positively due to the emission of photo-electrons, electrons will be collected by the photo-mosaic surface from the scanning beam so that elemental areas are restored to an equilibrium potential corresponding substantially to that of the potential of the cathode 2. During the time required for restoring elemental areas to said equilibrium potential some of the electrons of the scanning beam will pass through the interstices of the member 5, and in order to draw said electrons through the interstices an electrode 14 is provided on the side of the member 5 remote from the light sensitive surface 6. This electrode 14 preferably comprises a mesh electrode as shown. The path of the electrons passing through the interstices in the member 5 is indicated by the dotted line, and these electrons are collected and serve to generate picture signals. Preferably electrons passing through the interstices of said member 5 are directed into an electron multiplier, the multiplier being preferably disposed out of the optical path. In the drawings the electron multiplier is contained in a lateral portion 15 of the envelope 1, and in order to direct electrons passing through the interstices of the member 5 into said multiplier a pair of cylindrical electrodes 16 and 17 are provided surrounding the axis of the envelope without obstructing the light path, these electrodes in operation of the device being maintained at suitable potentials so as to constitute an electron mirror to reflect the electrons in the manner indicated by the dotted line into the electron multiplier. The electron multiplier may be as shown diagrammatically in the drawings as comprising several multiplying stages each comprising a plurality of obliquely disposed slats 18 having secondary electron emitting surfaces, electrons from the first series of slats passing to the subsequent series of slats, the final multiplied electrons being collected by a collecting electrode 19 and serve to set up picture signals across an impedance connected to the collecting electrode 19. Any other suitable construction of electron multiplier may of course be employed.

If desired instead of employing a separate electrode 14 for causing electrons to pass through the intersices of the member 5, a substantially transparent conducting coating may be provided directly on the surface of the member 5 remote from the surface having the light sensitive surface, such as transparent conducting coating being for example a "Nesa" coating. Such coating may constitute the aforesaid common electrode in which case the mesh 9 may be spaced further away from the target electrode. In cases where lag of moving objects is not of prime importance the capacity between adjacent mosaic elements may be utilised for storage purposes.

In operating the device shown in Figure 1 of the drawings the cathode 2 may be maintained at zero potential, the electrode 3 at a negative potential, the limiter electrode 4 at a positive potential of 325 volts, the wall anode 7 at a positive potential of 300 volts, the mesh electrode 8 at 300 volts, the mesh electrode 9 at a positive potential of 5 to 20 volts, the mesh electrode 14 at a positive potential of say 3–350 volts depending on the spacing between the electrode 14 and the target electrode, the electrode 16 at a positive potential of 350 volts, the electrode 17 at a negative potential and the first stage of the multiplier 18 at a positive potential of 500 volts and the succeeding stages and the collecting electrode 19 at progressively increasing positive potentials.

Instead of employing the electrodes 16 and 17 to form an electron mirror the arrangement shown in Figure 2 of the drawings may be employed, in which there is arranged obliquely to the axis of the envelope 1 a transparent support 20 for example of glass having on its surface facing the member 5 a substantially transparent conducting coating such as a "Nesa" coating which in operation is maintained at zero or a negative potential

to cause reflection of the electrons. Further if desired the support 20 having said conducting coating may have a coating of substantially non-photo-emissive secondary electron emissive material such as magnesium or aluminium oxide so that it forms the first electrode of the multiplier 18, the conducting coating being maintained at a suitable potential so as to cause the electrons passing through the interstices of the member 5 to impinge on said first electrode with a sufficient velocity to cause the release of secondary electrons.

What I claim is:

1. An electron discharge device having a target electrode comprising a substantially transparent foraminated member, a light sensitive surface on one side of said member, and said member is positioned so that an optical image can be projected through said member onto said light sensitive surface to cause elemental areas of said surface to change in potential by an amount dependent upon the intensity of corresponding elemental areas of said optical image, means facing said light-sensitive surface for generating electrons for projection towards said member during a restoration period, so that said elemental areas of said light sensitive surface are restored to an equilibrium potential, means for causing some of said electrons to pass through the foramina of said member during said restoration period and means for collecting said last mentioned electrons.

2. An electron discharge device according to claim 1 in which said means for generating electrons comprises an electron gun facing the light sensitive surface on said foraminated member, with the axis of said electron gun substantially normal to said member.

3. An electron discharge device according to claim 1 comprising a window opposite to the surface of said foraminated member remote from the side thereof having said light sensitive surface, and said window is positioned so that an optical image can be projected therethrough along an axis normal to the plane of said foraminated member and through said member onto said light sensitive surface.

4. An electron discharge device according to claim 1 wherein said light sensitive surface comprises a mosaic of photo-emissive elements.

5. An electron discharge device having a target electrode comprising a substantially transparent foraminated member, a mosaic of photo-emissive elements on one side of said member, a window opposite to the surface of said member remote from the side thereof having said mosaic elements said window being positioned so that an optical image can be projected therethrough along an axis normal to the plane of said foraminated member and through said member onto said mosaic elements, to cause said mosaic elements to change in potential by an amount dependent upon the intensity of corresponding elemental areas of said optical image, an electron gun for generating electrons for projection towards said member during a restoration period so that said mosaic elements are restored to an equilibrium potential, said electron gun facing said mosaic elements on said foraminated member with the axis of said electron gun substantially normal to said member, means for causing some of said electrons to pass through the foramina of said member during said restoration period, and means for collecting said last mentioned electrons.

6. An electron discharge device according to claim 1 comprising an electron multiplier disposed away from the axis of said device, and means for causing electrons passing through the foramina of said member to pass into said multiplier.

7. An electron discharge device according to claim 6 wherein the means for causing said electrons to pass into said multiplier comprises a pair of cylindrical electrodes surrounding the axis of said device without obstructing the optical path from said optical image to said forami-

nated member, said electrodes being capable of forming an electron mirror.

8. An electron discharge device according to claim 6, wherein the means for causing said electrons to pass into said multiplier comprises a transparent support disposed in the optical path from said optical image to said foraminated member, and a substantially transparent conducting coating on said support for causing reflection of said electrons.

9. An electron discharge device according to claim 6 wherein the means for causing said electrons to pass into said multiplier comprises a transparent support disposed in the optical path from said optical image to said foraminated member, and a substantially transparent conducting coating on said support which coating is secondary electron emissive.

10. An electron discharge device according to claim 1 wherein said foraminated member is made of glass.

11. An electron discharge device according to claim 1 comprising electrodes between said electron generating means and said foraminated member for causing the electron beam from said gun to scan said foraminated member at a low velocity.

12. An electron discharge device according to claim 1 in which said means for causing some of said electrons to pass through the foramina of said member comprises an electrode on the side of said foraminated member remote from the side having said light sensitive surface, for drawing electrons through said foramina.

13. An electron discharge device according to claim 12 wherein said electrode comprises a substantially transparent electrically conducting coating on said foraminated member.

14. Apparatus including an electron discharge device according to claim 1 and means for projecting said optical image through said foraminated member on to said light sensitive surface along an axis substantially normal to the plane of said foraminated member.

15. Apparatus including an electron discharge device according to claim 5 and means for projecting said optical image through said foraminated member on to said mosaic elements along an axis substantially normal to the plane of said foraminated member.

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