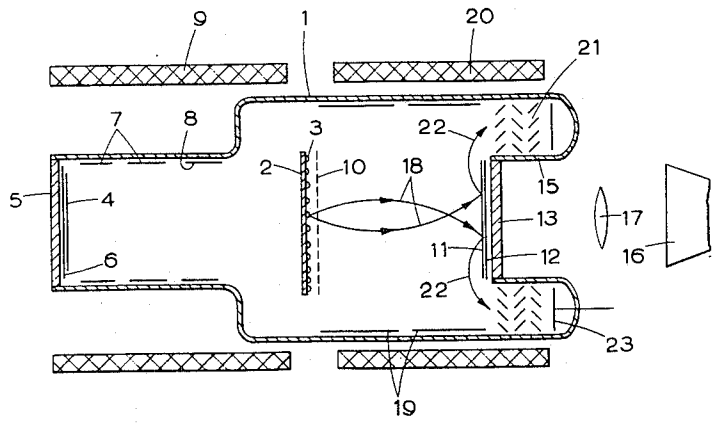
March 27, 1962 H. CASSMAN ETAL 3,027,478

ELECTRON DISCHARGE DEVICES

Filed Nov. 4, 1958



Inventors
H. Cassman
H. G. Lubszynski
By Glascock Downing & Seebold
Attys.

United States Patent Office

3,027,478
Patented Mar. 27, 1962

3,027,478

ELECTRON DISCHARGE DEVICES

Harry Cassman, Ealing, London, and Hans Gerhard Lubszynski, Waltham St. Lawrence, England, assignors to Electric & Musical Industries Limited, Hayes, Middlesex, England, a company of Great Britain

Filed Nov. 4, 1958, Ser. No. 771,829
Claims priority, application Great Britain Nov. 12, 1957
9 Claims. (Cl. 313—67)

This invention relates to electron discharge devices of the kind comprising a target having a photo-emissive surface adapted to be scanned by a light spot in order to generate signals from charges stored on said target. Such devices are suitable for the generation of picture signals for television and for other purposes.

In devices of the kind described it has been proposed to direct photo-electrons emitted from the photo-emissive mosaic when it is scanned by a light spot into a secondary electron multiplier. However, the disposition of the multiplier as previously proposed has resulted in an inconvenient geometrical construction of the envelope of the device and accordingly it is the object of the present invention to provide an improved device of the kind described employing a secondary electron emitting electrode in which a more convenient geometrical construction can be obtained.

According to the invention there is provided an electron discharge device comprising an envelope, a photo-emissive cathode adapted to receive an optical image, a target including a sheet of partially conducting material, means for directing photo-electrons released from said cathode onto said partially conducting sheet, said target having a photo-emissive surface remote from the surface of said sheet which receives said photo-electron image, a mesh or grid facing and adjacent to said photo-emissive surface, a substantially transparent electrically conducting electrode having a substantially transparent secondary electron emissive layer thereon facing the photo-emissive surface of said target through which a light spot can be caused to scan said photo-emissive surface, means for directing photo-electrons emitted by said photo-emissive surface as the result of said scanning onto said secondary electron emissive layer to cause the release of secondary electrons therefrom, means for applying a potential to said transparent electrically conducting electrode and means for collecting said secondary electrons.

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 drawing which illustrates diagrammatically an electron discharge device according to one embodiment of the invention.

As shown in the drawing the reference numeral 1 indicates an evacuated envelope having therein a target comprising a sheet 2 of transparent and partially conducting material such as a sheet of partially conducting glass and having on one side thereof a photoemissive surface in the form of a mosaic 3 of photo-emissive elements. Facing the side of the sheet 2 which is remote from the mosaic 3 is a photo-emissive cathode 4 which is mounted on an optical window 5 at the left-hand end of the envelope 1. The photo-emissive cathode 4 may be deposited on a substantially transparent conducting electrode 6 which may for example be made of a tin compound such as a Nesa coating. Between the cathode 4 and the target electrode is a pair of accelerating electrodes 7 and a decelerating electrode 8 and surrounding the space between the cathode 4 and the target electrode 2 is a solenoid coil 9 which serves to maintain photo-electrons released from the cathode 4 in focus as they pass from the cathode 4 to the target. The device shown

is particularly suitable as a pick-up tube for television apparatus and in operation of said tube an image of a subject for transmission will be projected through the window 5 onto the cathode 4 so as to release a photo-electric image which is accelerated by the electrodes 7 and then decelerated by the electrode 8 and focussed on the target by the coil 9, the photo-electric image impinging on the target 2 with such a velocity as to charge elemental areas of the target negatively. The negative charges set up on the side of the target facing the photo-electric cathode 4 leak through the partially conducting sheet 2 onto the side of the sheet having the photo-emissive mosaic 3, and in order to generate signals the photo-emissive mosaic is scanned by a light spot. Adjacent to the photo-emissive mosaic is a foraminated electrode in the form of a mesh or grid 10 which in operation of the device is maintained at a negative potential less than the negative potential acquired by the partially conducting sheet 2 or at a zero potential with respect thereto or at a slightly positive potential with respect thereto, so that when the photo-electric mosaic is scanned by the light spot, photo-electrons are released from the photo-emissive mosaic until the photo-emissive elements acquire a potential corresponding to the potential of the mesh 10. The photo-electrons which pass through the mesh 10 during the scanning operation are directed into an electron multiplier so as to generate picture signals. In the embodiment of the invention shown, the first electrode of the electron multiplier is a substantially transparent secondary electron emitting electrode 11 which may be made of a substantially transparent and substantially non-photo-sensitive photo-emissive material such as magnesium oxide or aluminum oxide, said layer being deposited on a substantially transparent electrically conducting coating such as one of a tin compound such as a Nesa coating 12, the conducting coating 12 and secondary electron emitting coating being preferably deposited directly on a window 13 arranged facing and parallel to the photo-emissive mosaic 3, the normals to the centres of the mosaic 3 and the window 13 being coincident. The window 13 is preferably formed in a re-entrant portion 15 of the envelope 1. Facing the window 13 is a cathode ray tube 16 which generates a scanning light spot which is focussed through the window 13 and the coating 12 and electrode 11 onto the photo-emissive mosaic 3 by means of an optical system indicated conventionally at 17. The paths of the photo-electrons passing through the mesh 10 from a spot scanning the mosaic 3 are indicated by the lines 18, the photo-electrons being accelerated by accelerating electrodes 19 onto the secondary emitting electrode 11. These electrodes 19 may also serve to focus the photo-electrons such focussing action being in addition to or instead of the use of a further focussing solenoid 20 surrounding the space between the mosaic 3 and the window 13. It is preferably arranged that the photo-electrons are out of focus when they impinge on the secondary electron emitting electrode 11 as shown by the lines 18. When the photo-electrons impinge on the secondary electron emitting electrode 11 secondary electrons are released and these secondary electrons may be collected to form the picture signals, although preferably they are subjected to further stages of electron multiplication. In the example shown the secondary electrons released from the electrode 11 are drawn into further stages of electron multiplication indicated at 21, the paths of the electrons emitted from the electrode 11 being indicated diagrammatically by the lines 22. The further stages of electron multiplication 21 may comprise a series of ring-shaped slats obliquely disposed with respect to the axis of the envelope 1 and arranged in the annular space surrounding the re-entrant portion 15.

The re-entrant portion 15 may in some cases be omitted and the electrode 11 formed on a separate support spaced from an end window of the envelope. The electrodes of the multiplier may be maintained at successively increasing potentials and the finally multiplied stream is collected by a collecting electrode 23 which in well known manner will be connected to a signal impedance across which picture signals are developed.

Alternatively the stages of electron multiplication 21 may be similar to the well known pin-wheel type of multiplier in which each stage comprises a series of radially disposed vanes set at an angle to the plane containing the vanes. Another type of multiplier which may be employed in the invention is one comprising a series of axially extending vanes carried by an annulus and set at an angle to the periphery thereof a plurality of said annuli and vanes being arranged one within the other. In such a multiplier the innermost annulus will be disposed so that secondary electrons from the electrode 11 will be directed thereinto and secondary electrons from the vanes of the innermost annulus will then pass to the next stage. In this case the re-entrant portion 15 of the envelope may be omitted and the electrode 11 formed on an end window. Any other suitable construction of multiplier may of course be employed.

In operation of the device shown the conducting electrode 6 may be maintained at zero potential, the electrodes 7 at positive potentials of 75 and 200 volts, the electrode 8 at a positive potential of 75 volts, the mesh 10 at a positive potential of 2 volts, the electrode 12 at a positive potential of 500 volts, both of the electrodes 19 at a positive potential of 250 volts or with the electrode 19 nearer the target 2 at 150 volts and the electrode 19 which is nearer the secondary electron emitting electrode 11 at 350 volts, and the first stage of the multiplier 21 at a positive potential of 750 volts, with the succeeding stages at substantially increasing potentials as is well known in the art.

What we claim is:

1. An electron discharge device comprising an envelope, a photo-emissive cathode adapted to receive an optical image, a target including a sheet of partially conducting material, means for directing photo-electrons released from said cathode onto said partially conducting sheet, said target having a photo-emissive surface remote from the surface of said sheet which receives said photo-electron image, a foraminated electrode facing and adjacent to said photo-emissive surface, a substantially transparent electrically conducting electrode having a substantially transparent secondary electron emissive coating thereon facing the photo-emissive surface of said target through which a light spot can be caused to scan said photo-emissive surface, means for directing photo-electrons emitted by said photo-emissive surface as the result of said scanning onto said secondary electron emissive coating to cause the release of secondary electrons therefrom, means whereby a potential can be applied to said transparent electrically conducting electrode and means for collecting said secondary electrons.

2. An electron discharge device comprising an envelope, a photo-emissive cathode adapted to receive an optical image, a target including a sheet of partially conducting material, means for directing photo-electrons released from said cathode onto said partially conducting sheet, said target having a photo-emissive surface remote from the surface of said sheet which receives said photo-electron image, a foraminated electrode facing and adjacent to said photo-emissive surface, a substantially transparent electrically conducting electrode having a substantially transparent secondary electron emissive coating facing the photo-emissive surface of said target through which a light spot can be caused to scan said photo-emissive surface, means for directing photo-electrons emitted by said photo-emissive surface as the result of said scanning onto said secondary electron emissive coating to cause the release of secondary electrons therefrom, means whereby a potential can be applied to said transparent electrically conducting electrode, a multi-stage electron multiplier of which the first stage comprises said secondary electron emissive electrode, said envelope being formed to provide an annular space surrounding the axis of said device and other electrodes of said multiplier being arranged in said annular space and means for collecting a final multiplied stream of electrons.

3. An electron discharge device according to claim 2 wherein said other electrodes of the multiplier extend in a direction away from the photo-emissive surface of said target.

4. An electron discharge device according to claim 1, wherein said substantially transparent secondary electron emitting electrode is disposed substantially parallel to the photo-emissive surface of said target.

5. An electron discharge device according to claim 1, wherein said envelope is formed with a re-entrant portion having a window therein adjacent to which is disposed said substantially transparent secondary electron emissive electrode, said electrode constituting the first stage of a multi-stage electron multiplier, other secondary electron emitting electrodes of said multiplier being disposed in the annular space surrounding said re-entrant portion.

6. An electron discharge device comprising an envelope, a photo-emissive cathode adapted to receive an optical image, a target including a sheet of partially conducting material, means for accelerating and means for decelerating, photo-electrons released from said cathode onto said partially conducting sheet whereby said sheet can be charged negatively by said photo-electrons, said target having a photo-emissive surface remote from the surface of said sheet which receives said photo-electron image, a foraminated electrode facing and adjacent to said photo-emissive surface, a substantially transparent electrically conducting electrode having a substantially transparent secondary electron emissive coating facing the photo-emissive surface of said target through which a light spot can be caused to scan said photo-emissive surface, means for directing photo-electrons emitted by said photo-emissive surface as the result of said scanning onto said secondary electron emissive coating to cause the release of secondary electrons therefrom, means whereby a potential can be applied to said transparent electrically conducting electrode and means for collecting said secondary electrons.

7. Apparatus, including an electron discharge device according to claim 1 and including means for generating a light spot and for causing said light spot to scan said photo-emissive surface through said substantially transparent secondary electron emitting electrode.

8. Apparatus including an electron discharge device according to claim 2 and including means for generating a light spot and for causing said light spot to scan said photo-emissive surface through said substantially transparent secondary electron emitting electrode.

9. A circuit arrangement embodying an electron discharge device according to claim 1, including a source of potential to apply an accelerating potential to said substantially transparent electrically conducting electrode to accelerate photo-electrons released from said photo-emissive surface onto said secondary electron emissive coating.

References Cited in the file of this patent

UNITED STATES PATENTS

2,618,761	Rose	Nov. 18, 1952
2,869,024	Bruining et al.	Jan. 13, 1959
2,875,371	Perkins	Feb. 24, 1959

FOREIGN PATENTS

558,599	Canada	June 10, 1958