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ELECTRON DISCHARGE DEVICE

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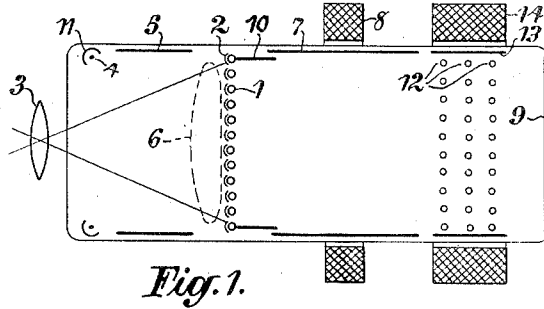


Fig. 1.

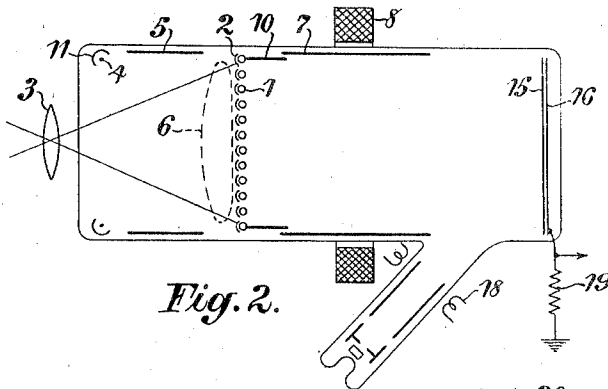


Fig. 2.

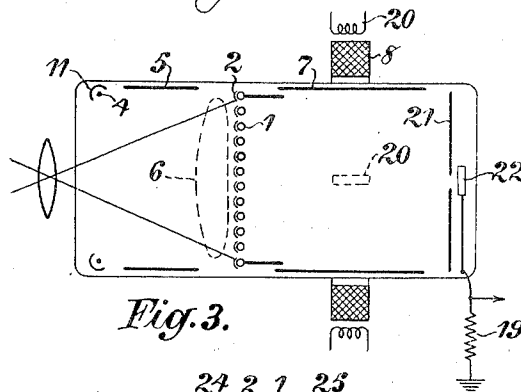


Fig. 3.

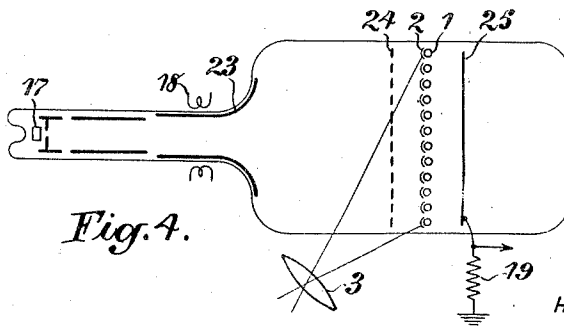


Fig. 4.

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ELECTRON DISCHARGE DEVICE

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4 Claims. (Cl. 250—150)

This invention relates to electron discharge devices and more particularly but not exclusively to electron discharge devices for use in the conversion of an optical image into electrical signals suitable for use in television transmitting systems.

It has been proposed to employ in television transmitting systems an electron discharge device in which a photo-sensitive mosaic screen is formed on a grid structure the optical image for transmission being projected on to the mosaic screen which thereby emits photo-electrons causing the elements of the screen to become charged according to the intensity of the incident light. A continuous substantially uniform stream of primary electrons is projected on to the mosaic screen the charges accumulated on the screen and cause a varying number of primary electrons to be drawn through the interstices of the grid which has the effect of modulating the primary electrons. The electron image which passes through the grid is focussed on to a substantially non-photo-sensitive mosaic screen which is scanned by a scanning beam of cathode rays and the scanning action generates picture signals in a signal plate associated with the last mentioned screen. Alternatively, it has been suggested to focus the electrons drawn through the grid on to a fluorescent screen, the device, in this case, acting as a light transformer. The electrons passing through the grid might also be scanned as a whole over a target electrode according to the method of the so-called image dissector.

In these devices it is of course necessary to employ the primary electrons for restoring the elements of the photo-sensitive mosaic screen to a datum potential and some difficulties might arise in discharging the elements and restoring them to the datum potential between each frame period. Moreover, since the spray of electrons is continuously acting it is possible that the mosaic screen may accumulate a charge due to the presence of the continuous stream which is such as to cause, when the image is projected onto the screen, an incorrect potential to be acquired by the screen on the emission of photo-electrons.

It is the object of the present invention to provide an improved electron discharge device of the kind in which the principle of modulating an electron beam is used but in which the disadvantages above-mentioned are reduced or avoided.

According to the invention an electron discharge device is provided comprising a mosaic screen formed upon a grid or grille structure which is pervious to electrons, the mosaic screen being composed of a multiplicity of photo-voltaic cells whereby, on the projection of an optical image thereon, the cells assume different potentials, means for generating a stream of electrons which, due to the potentials assumed by said photo-voltaic cells, are in operation modulated and drawn through the interstices in the grid and a further electrode or screen onto which said modulated stream is projected. The further electrode or screen may be a fluorescent screen or a substantially non-photo-sensitive mosaic screen or the further screen may be an apertured electrode over which the electron image drawn through the photo-voltaic mosaic screen is scanned; or it may be a collecting electrode or a multiplying electrode. The means for generating electrons may comprise one or more thermionic electron emitting cathodes arranged to generate relatively slow-speed electrons which may be caused to form a virtual cathode adjacent to the photo-voltaic screen. Alternatively, the photo-voltaic screen may be scanned by a low velocity beam of electrons, the modulated stream being collected by said collecting electrode to generate picture signals. Or a high velocity scanning beam may be used which releases secondary electrons from a special electrode, for example a grid in front of the grid carrying the photo-voltaic mosaic which are modulated as aforesaid.

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 in which:

Figure 1 illustrates one form of electron discharge device according to the invention, and

Figures 2, 3 and 4 illustrate further modifications of the invention.

As shown in Figure 1, the photo-voltaic screen is formed on a grid or grille 1 on one side of which is a layer of selenium or cuprous oxide, or other suitable material, to form photo-voltaic cells. On the surface of the selenium or cuprous oxide, a transparent metal layer is provided of mosaic structure which forms, together with the selenium or cuprous oxide, a large number of minute photo-voltaic cells. The cells may be of the so-called "back" or "front" wall type. These cells are indicated at 2. An optical image is projected on to the cells 2 through a suitable

optical system indicated at 3, the cells assuming different potentials according to the intensity of the incident light these potentials being either negative or positive with respect to the grid depending on whether "front wall" or "back wall" cells are used. A continuous electron beam is directed towards the surface of the screen having the photo-voltaic cells, the beam being of cross-sectional area substantially the same as that of the area of the screen. The electrons may be generated from one or more cathodes 4 in the form of emissive filaments and arranged about the axis of the envelope, not shown, in which the elements of the device are mounted, in such positions as to be outside the path of the light rays projected through the optical system 3. The cathodes may be partly surrounded by screens 11, which may be held at a suitable potential with respect to the cathodes 4, in order to obtain a focussing action for directing the spray of electrons towards the grid 1. The electrons from the cathode 4 are accelerated by an anode 5 the grid 1 being maintained at such a potential that the electron beam from the cathode 4 is substantially prevented from passing through the grid 1, only a small substantially constant current passing therethrough. In some cases it may be advantageous to cause the electrons from the cathodes 4 to form a virtual cathode in front of the photo-voltaic cells as indicated by the dotted line 6. When an optical image is projected onto the grid 1 the potentials acquired by the photo-voltaic cells cause a varying number of electrons to pass through the interstices of the grid, these electrons being accelerated by a second anode 7 and focussed by a magnetic focussing coil 8 or by electrostatic focussing means onto a screen 9. The grid 1 is surrounded by a ring electrode 10 to aid in focussing the electrons drawn through the interstices of the grid. The potentials acquired by the cells of the photo-voltaic screen, in effect, exercise a modulating action on the primary electrons from the cathodes 4 so that an electron image is drawn through the interstices of the grid 1 and focussed onto the screen 9 which is adapted to be rendered luminous under the impact of electrons.

With the arrangement described, the photo-voltaic cells do not require to be discharged as in the case of photo-electric mosaic screens, since the potential difference of the cells is only maintained so long as light is being projected thereon. Furthermore, the grid and the cells may be maintained at such a potential with respect to the cathodes 4 that substantially no electrons can be collected by the grid or by the cells.

If desired, before the electron image emanating from the screen 1 is projected onto the screen 9 it may be subjected to electron multiplication for which purpose one or more secondary electron emitting grids 12 are provided, as shown, the electrons passing through the grids being accelerated by an accelerating electrode 13 and focussed by a coil 14 before being projected onto the screen 9.

The embodiments of the invention shown in Figure 2 illustrate an arrangement similar to that shown in Figure 1, with the exception that the screen 9 is replaced by a substantially non-photo-sensitive mosaic screen 15 associated with a signal plate 16. The electron image emanating from the grid 1 is projected onto the mosaic screen 15 causing the latter to acquire negative potentials according to the intensity of elemen-

tary areas of the electron image, the elements of the mosaic screen 15 being periodically restored to a datum potential by scanning with a cathode ray beam. The cathode ray beam is generated by an electron gun 17 and deflected over the surface of the screen 15 by scanning means 18, restoration of the elements of the screen 15 to the datum potential generating in a resistance 19 picture signals suitable for television transmission. If desired the single-sided mosaic screen 15 may be replaced by a double-sided mosaic.

With the arrangement shown in Figure 2 the electron image may be caused to impinge on the screen 15 with such a high velocity that the elements of the mosaic screen emit secondary electrons in greater number than the incident primary electrons so that each element of the mosaic screen acquires a positive charge dependent on the incident primary electrons. In such circumstances it may be advantageous to arrange that the velocity of the scanning beam corresponds to a potential higher than the second cross-over point of the secondary emitting substance of the mosaic screen. If a curve is plotted with the ratio of the number of secondary electrons emitted to the number of primary electrons as ordinates and the velocity of the incident primary electrons as abscissae, it is found that from zero this curve rises to a point where the ratio of secondary electrons to primary electrons is unity, continues to rise as the voltage difference increases to a peak value where the ratio of secondary electrons to primary electrons reaches its maximum value, then falls with increasing voltage differences to a point where the ratio is again unity and continues to fall below this point where the ratio is less than unity. The second point on the curve where the ratio is again unity is called the second cross-over point. Where the mosaic screen is restored to a datum potential at the second cross-over point the velocity of the incident primary electrons is so chosen that a maximum number of secondary electrons are emitted by the mosaic screen when the incident primary electrons impinge thereon.

Figure 3 of the drawing illustrates a further form of the invention which is similar to that shown in Figure 1 with the exception that the electron image emanating from the grid 1 is caused to be scanned by scanning means 20 over an apertured electrode 21 behind which is arranged a collecting electrode 22 connected to a signal resistance 19. The arrangement shown in Figure 3 operates in accordance with the so-called image dissector. If desired, with the arrangement shown in Figures 2 and 3, one or more stages of electron multiplication may be incorporated prior to the mosaic screen 15 of Figure 2 or the apertured electrode 21 of Figure 3.

Figure 4 of the drawing illustrates yet a further form of the invention in which the grid 1 with the photo-voltaic cells 2 as above described are arranged to be scanned by a beam of electrons. In this case the optical image may be projected obliquely onto the photo-voltaic cells 2 through the lens 3 and the photo-voltaic cells are scanned by a beam of electrons generated from an electron gun 17, the beam being deflected over the cells 2 by deflecting means 18. The scanning beam of electrons may impinge on the grid 1 with a low velocity and for this purpose a high velocity beam may be generated and accelerated towards the grid structure 1 by the usual second anode 23

and further accelerated by a grid electrode 24 disposed in front of grid 1 and maintained more positive than the second anode 23, the grid in this case being maintained at or about the potential of the second anode 23. With such an arrangement the electrons of the scanning beam are decelerated prior to the grid 1 and do not impinge on the grid with a high velocity. The modulated electron stream passing through the interstices of the grid 1 is collected by a collecting electrode 25 connected to a signal resistance 19 across which picture signals are developed. If desired, the grid electrode 24 in front of the grid 1 may be scanned by a high velocity scanning beam which is of a sufficient velocity to generate secondary electrons when the beam impinges on this electrode 24, the secondary electrons being modulated by the potential differences of the photo-voltaic elements and serving to generate picture signals as described above. In this case the grid may be formed similarly to a louvre so as to substantially prevent high velocity electrons from impinging on the grid 1. If desired, before collecting the modulated electron stream on the electrode 25 it may be subjected to the action of one or more stages of electron multiplication. The collecting electrode 25 may, if desired, be replaced by a screen adapted to be rendered luminous under the impact of electrons.

If desired the electron image emanating from the grids 1 above described may be accelerated and focussed onto a further but insulated grid structure which acquires potentials according to the incident electrons, the potentials of this further grid causing modulation of another electron stream; one or more of these additional grids may be employed, as desired.

If desired the electrons which are modulated by the potentials on the grid 1 may be derived by the provision of a photo-sensitive cathode disposed in front of the grid 1 and flooded with a constant source of light or alternatively the optical image may be projected through a semi-transparent photo-cathode on to the grid 1, the photo electrons liberated forming in effect the virtual cathode 6. In the former case the optical image may be projected obliquely onto the cells 2, or vice versa.

We claim:

1. An electron discharge device comprising an electron pervious mosaic screen structure, a plu-

5 rality of photo-voltaic cells positioned on one side of said screen, said screen structure being adapted to receive an optical image on the side thereof on which the voltaic cells are positioned, a source of primary electrons comprising an annular cathode surrounding the optical axis and positioned adjacent the side of the screen upon which the light image is projected, means for directing the electrons from said source so as to form a flooding beam covering substantially the entire screen surface, the photo-voltaic cells of said electron pervious screen being adapted to assume electrical charges in accordance with the intensity of the light image projected thereon so that the flooding stream of electrons in passing through the electron pervious screen will be modulated in accordance with the charges, a target electrode having an area commensurate to the area of said screen structure positioned parallel to and spaced from the electron pervious screen and on the side thereof opposite the side on which the voltaic cells are positioned, and means for focusing and directing the modulated flooding stream of electrons which are permitted to pass through the electron pervious screen onto said target electrode.

2. An electron discharge device as defined in claim 1 wherein said target electrode is a non-photo-sensitive mosaic screen having a signal plate associated therewith, and an electron gun structure for producing a focused high velocity beam of electrons for scanning the mosaic screen.

3. An electron discharge device as defined in claim 1 comprising in addition a plurality of secondary electron emissive screens positioned in parallel planes between the electron pervious screen and the target electrode whereby the modulated flooding stream of electrons may be increased in intensity by secondary electron multiplication, and means for focusing and directing the secondary electrons upon said target electrode.

4. An electron storage device as defined in claim 1 wherein said source of primary electrons is so positioned as to produce a virtual cathode in the region near the surface of the electron pervious screen upon which the photo-voltaic cells are positioned.

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