July 11, 1939. A. M. SKELLETT 2,165,308

CATHODE RAY DEVICE

Filed March 31, 1937

FIG. 1

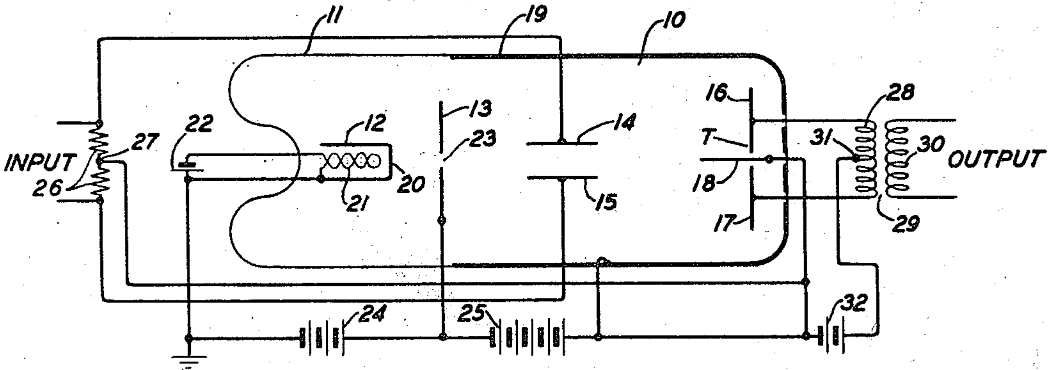


FIG. 2

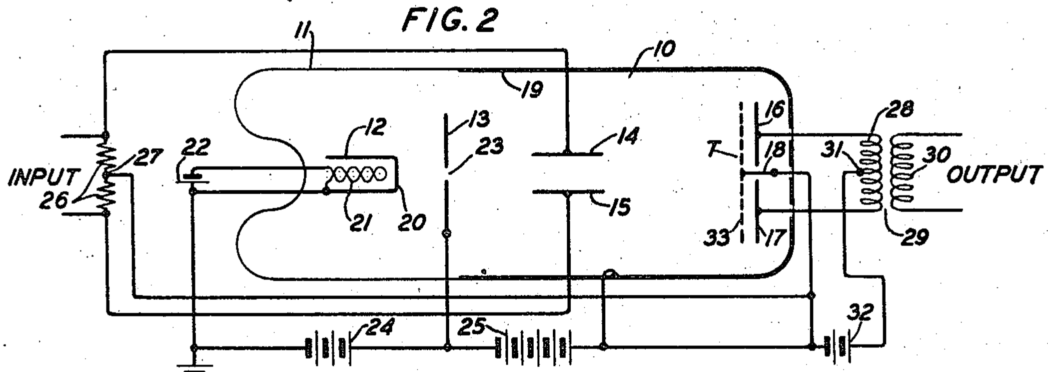
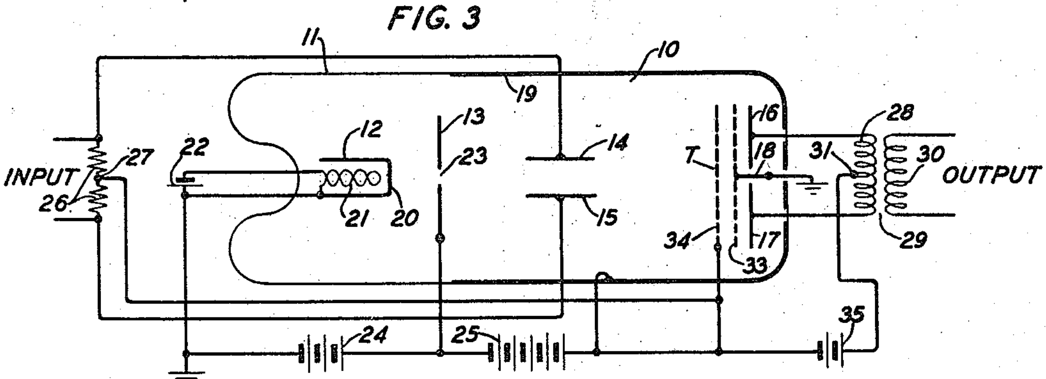


FIG. 3



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CATHODE RAY DEVICE

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11 Claims. (Cl. 250—27)

This invention relates to cathode ray devices and more specifically to cathode ray devices having a target member comprising two or more ray receiving elements.

Cathode ray devices in which a beam is deflected periodically between the elements of a so-called "divided" target, i. e., for example, a target which consists of two distinct parts electrically insulated from each other, have been used in the past as amplifiers, detectors, switching mechanisms, oscillators, etc. A particular advantage of this type of tube, as for example when it is used in an amplifying circuit, is that any variations in emission from the tube cathode or any variations in the potentials of the anode and control elements due to changes in the supply potential, will produce opposite variations in the divided output (i. e., the target) circuit (which variation tends to cancel each other), with the result that greatly reduced tube noise will be impressed upon the input of a subsequent amplifying stage.

It has been found that in tubes of this type, secondary electrons emitted from one portion of the target or anode are attracted toward the other portion of the target or anode to produce an objectionable distortion in the output circuit.

It is an object of this invention to provide novel means for preventing or minimizing the deleterious effects of this secondary emission.

Another object of this invention is to provide in cathode ray apparatus of the type just mentioned, a novel arrangement of target and associated auxiliary electrode or electrodes which results in very effective control of the secondary electrons emitted from the target.

Another object is to provide an arrangement of electrodes in the path of the cathode beam such that the beam will simultaneously impinge upon a plurality of beam receiving electrodes and at the same time the secondary electrons emitted therefrom will be effectively controlled.

Several illustrative embodiments of the invention are herein described in detail.

In the first of these arrangements, hereinafter described in greater detail, there is provided a cathode ray tube having a cathode, two accelerating anodes, a pair of deflecting plates across which the input potential is applied, a divided target comprising a pair of plates or anodes located in a plane which is at right angles to the axis of the tube, each plate preferably having a large effective area compared with the area in said plane between the plates, and a shield or partition plate mounted between and extending out in front of the two plates in a plane which is perpendicular to the plane of the target. The elements of the tube are connected in such a way that it acts as an amplifier. A valuable property of circuit arrangements of this type is that both input and output circuits are balanced with respect to the last accelerating member in the tube. This accelerating member is in this case a metallic coating on the inside walls of the tube, the shield or partition member being placed at the potential of this coating. The anode plates are connected to the primary side of an output transformer, the mid-tap of this primary winding being connected to the positive side of a source of potential the negative terminal of which is connected to the conducting coating in the tube. As the shield is negatively polarized with respect to the static potential of the anode plates, it serves to repel the secondary electrons emitted from the anode plates, when contacted by the cathode ray beam, back to the plate from whence they were emitted. The partition serves as a mechanical as well as an electrical barrier to the passage of secondary electrons between the two anode plates.

It is to be understood that, in certain aspects, the invention is applicable to any type of connection to which a cathode ray tube having a divided target is applicable, and to any form of divided target cathode beam tube, as for example, one in which the target elements are not in the same plane or are not designed to receive the beam at the same instant.

In another arrangement, a grid member is mounted parallel to and in front of the target which is preferably a pair of plates, this grid being placed at a negative potential with respect to the anode plates but at a high positive potential with respect to the cathode of the tube. The grid serves to repel the secondary electrons back to the part of the target from whence the emission came.

In a third arrangement, a second grid is used in addition to that of the second arrangement. The grid nearer the anode plate is placed at substantially ground potential and the other grid is placed at a potential near to or less than that of the anode plate. In this modification the grid farther away from the anode plate, being positively polarized, acts to impart an acceleration to the beam while the one nearer the plate serves to repel the secondary electrons emitted by the plates in a manner similar to the arrangement disclosed in the preceding paragraph. The partition or screen between the plates may also be used with this arrangement, and also with the second arrangement in a manner similar to that described in connection with the first arrangement, to improve the efficiency by acting as a mechanical as well as an electrical barrier to the passage of secondary electrons between the plates.

The invention will be more readily understood from the following description taken in connection with the accompanying drawing forming a part thereof in which:

Fig. 1 shows a cathode ray tube embodying the principles of this invention;

Fig. 2 shows a second embodiment of the invention; and

Fig. 3 shows a third embodiment of the invention.

Referring more particularly to the drawing, Fig. 1 discloses a cathode ray tube 10 connected in such a manner that it acts as an amplifier for signals. It is to be understood, however, that this hook-up is merely shown by way of example as the principles embodied in this invention apply equally well to situations where a cathode ray tube is used as an oscillator, a modulator, a rectifier, or a switching device. In a broader aspect, the invention is applicable to all kinds of cathode ray tubes.

The cathode ray device 10 preferably comprises an exhausted envelope 11 enclosing a cathode 12, an accelerating anode 13, a pair of deflecting plates 14 and 15, a divided target T comprising the plates 16 and 17, and a screen or partition member 18 located between the plates. A metallic coating 19 is located on the inside of the envelope and extends from the region near the accelerating anode 13 to the end of the tube wherein the target T is located. The cathode 12 comprises a cylinder upon which a thin, thermionically emissive oxide coating 20 is placed. The cathode 12 is indirectly heated by means of a filament 21 which receives current from a suitable source of potential such as, for example, the battery 21. The cathode 12 is preferably grounded. The anode 13 comprises a metallic plate having an aperture 23 therein, which aperture may take any desired shape such as a circle, a square or rectangle, depending upon the shape of the beam desired. The plate 13 is placed at a high positive potential with respect to the cathode 12 by means of a suitable source of potential such as the battery 24. The coating 19 is placed at a still higher positive potential with respect to the apertured plate 13 by means of a suitable source of potential such as the battery 25. The apertured plate and the conducting coating 19 act as an electron lens to focus the stream of electrons into a beam which is directed towards the target T. Any other suitable electron focussing system may be used, if desired, the only criterion being that a sharp spot of the desired cross-section is obtained.

This beam may be deflected by means of varying potentials applied across the deflecting plates 14 and 15. Connected across the plates 14 and 15 is an input resistance 26 through which pass currents used to control the deflection of the beam. These currents may be voice or image currents, or they may be currents with a wave form having a periodically recurring pattern, either of a sinusoidal or non-sinusoidal form. The mid-point 27 of the input resistance 26 is preferably placed at the same potential as that of the conducting coating 19 and the shield or partition member 18. The input resistance 26 may be replaced, if desired, by the center-tapped secondary of a transformer.

The anode or target plates 16 and 17 are preferably connected to the primary winding 28 of an output transformer 29, the secondary winding 30 of which is connected to any suitable output circuit such as, for example, another amplifying stage, a loud-speaker, or a television image reproducing device. The mid-tap 31 of the primary winding 28 is connected through a suitable source of potential 32 to the conducting coating 19. By means of this arrangement, the shield or partition member 18 has a potential applied to it which is negative with respect to the direct current potential applied to the anode plates 16 and 17 but which is positive with respect to that of the cathode. The potential of the source of potential 32 should be chosen with care. For example, if the potential of the shield or partition member 18 is too low with respect to that of the anode or target plates 16 and 17, the beam will be divided in two and the two parts deflected; while if the member 18 is at too high a potential with respect to that of the plates 16 and 17, secondary electrons from these plates will be attracted to it. Ordinarily a few volts will suffice for the potential of the battery 32.

In one form of the invention which has proven satisfactory, the plates 16 and 17 are separated by a very narrow gap, of the order of one twentieth of an inch, and this gap is filled by the partition member 18 and two thin sheets of insulating mica which are placed one on either side of the partition member.

When no signal current flows through the input resistance 26, the beam is evenly divided between the plates 16 and 17. This is true because the mid-point of the input resistance 26 is connected to the conducting coating 19. Thus it can be said that the potentials applied across the deflecting plates 14 and 15 are always balanced with respect to the potential of the conducting coating 19. This tends to eliminate the distortion and loss of focus of the beam which would occur if one of the deflecting plates 14, 15 were placed at a fixed potential.

No current flows in the output circuit when there are no signals flowing through the input resistance 26 as substantially equal currents will flow to anode plates 16 and 17 and any variations in emission from the cathode 12 with their corresponding variations in cathode to accelerating anode potential and accelerating anode to target potential, will cause equal variations in the two anode currents. As the output circuit connected to the anodes is connected, as shown, in push-pull manner, equal variations in the anode current due to the usual sources of tube noise will balance out and greatly reduced noise will be heard in the output circuit when no signals are flowing through the input resistance 26.

When the two deflecting plates or control electrodes 14, 15 have their potentials varied by the input signals which are to be amplified, the electron beam will be deflected in a manner similar to the deflection usually experienced in a cathode ray oscillograph. These deflections of this beam will vary the anode current differentially, and the differential variations will produce useful amplified output from the tube.

In the undeflected position of the beam the tube noise referred to above is for the most part balanced out as far as the output circuit is concerned. Now for a small signal the deflection of the beam is small and the balancing out of the noise is less than it is for the undeflected position; that is, the noise will increase slightly for a small signal. As the signal is increased, the noise will also increase due to the greater unbalance until at maximum signal amplitude the noise will also be at a maximum. Over the working range of amplitudes, the signal-to-noise ratio will be more nearly constant than the ordinary amplifier and the ratio will be substantially higher at low signal levels than it is for the ordinary amplifier.

The operation as given in the preceding paragraphs is complicated by the fact that due to the high velocity of the beam, secondary electrons are emitted from the anode or target plates 16 and 17 which tend to flow to the other plate, thus distorting the signal. This movement of secondary electrons from one plate to another is prevented or substantially minimized in the present invention by providing the shield or partition member 18 negatively polarized with respect to the plates, which is located between the two plates and extends axially of the tube. Inasmuch as this partition member 18 is at a negative potential with respect to the plates 16 or 17, it acts to repel secondary electrons emitted from the plates 16 and 17 and thus tends to cause these electrons to go back to the same plate from which they were emitted, thereby eliminating distortion in the output signal.

In the arrangement shown in Fig. 2, a grid member 33 is placed in front of the anode or target plates 16 and 17. This grid member 33 is electrically connected to the partition or shield member 18 so that the repelling field caused by the relatively negative partition and screen extends over a larger surface than would be possible with just the partition member 18 alone as in Fig. 1. When the grid 33 is used, the partition member 18 need not be as long in the direction of the axis of the tube as in Fig. 1 although it might extend out in front of the grid member 33. The action of the grid 33 is similar in one respect to the action of a screen grid in a pentode tube in that it accelerates the cathode ray beam because of its relatively high positive potential with respect to the cathode. In another respect it is similar to a suppressor grid in a pentode in that it tends to suppress the secondary emission from the anode plates 16 and 17. The grid 33, however, in Fig. 2 prevents secondary electrons emitted from either of the plates 16 or 17 from going to the other plate as compared with the function of the suppressor grid in an ordinary pentode which is to suppress the electron emission from the plate to the screen grid. The grid 33 also acts to shield the output electrodes from the input electrodes and in this respect it is similar in function to the screen grid in a tetrode or pentode. For these reasons, it is obvious that the grid in this tube is not exactly analogous to either the screen or the suppressor grid in a tetrode or pentode tube but performs some of the functions of both.

The description of the rest of the tube shown in Fig. 2 and the method of operation except with respect to the means for suppressing the secondary emission from the anode plates 16 and 17 is similar to that above described in connection with Fig. 1.

In the arrangement shown in Fig. 3, two grids are mounted in front of the plates 16 and 17 instead of the single grid of Fig. 2. The grid 33 nearer the anode plate is connected to the partition member 18 and to ground. The grid 34, which is farther away from the anode plate than the grid 33, is connected to the mid-terminal 31 of the primary winding 28 of the output transformer 29 through a source of potential 35 which is comparable in potential to that of the source of potential 32 in Figs. 1 and 2. In some instances the battery 35 may be omitted as the device is operative without it. Although the use of the partition member 18 improves the efficiency of the device, the flow of secondary electrons between the plates is greatly reduced by the action of the grid members 33 and 34 alone and a satisfactory device is provided with the partition member 18 omitted. In the preferred arrangement, however, grids 33 and 34 and the member 18 are all used. The grid 34 acts, by reason of the fact that it is at the same potential as the conducting coating 19, to impart an acceleration to the beam which does not vary when the plates 16 and 17 change in potential, while the grid 33 which is at a negative potential with respect to the anode plates 16 and 17 acts to prevent or substantially minimize by its action the flow of secondarily emitted electrons from one anode plate to the other. The grid 34 also acts to shield the input electrodes from the output electrodes in a manner similar to the action of the grid 33 of Fig. 2. Due to the fact that the anode 34 is at a high positive potential, the screen 33 may be placed at a potential which is much more negative with respect to the anode plates 16 and 17 than would be possible in Fig. 2 where only the single grid is used. In Fig. 2, if the grid 33 were placed at too low a negative potential it would tend to disturb the focus of the beam.

It should be noted that in an ordinary pentode tube the suppressor grid suppresses the secondary emission from the anode to the screen grid but in the device shown in Fig. 3 the grid most nearly corresponding to a pentode suppressor grid, i. e., the grid 33, suppresses the secondary emission between the anodes. With the exception of the difference in the operation of the means for preventing secondarily emitted electrons from going between the plates 16 and 17, the description of the rest of the apparatus and the operation of the device is similar to that given above in connection with Figs. 1 and 2.

Various other modifications and arrangements may obviously be made without departing from the spirit of the invention, the scope of which is defined by the appended claims.

What is claimed is:

1. A cathode ray device comprising means for generating a beam of electrons, a plurality of anodes, means for deflecting said beam from one anode to another, and means for preventing cross-currents between said anodes due to secondary electrons emitted from one reaching the other comprising two separate grids each of which lies in the path of said beam in each of its deflected positions and one of which is nearer said anodes than the other.

2. A cathode ray device comprising means for generating a beam of electrons, a plurality of anodes spaced a small distance apart, means for deflecting said beam from one anode to another, and two separate grids each located between said generating means and each of said anodes for substantially preventing secondary electrons emitted from one anode from reaching another, said grids being parallel to each other and one of them being nearer said anodes than the other.

3. A cathode ray device comprising means for generating a beam of electrons, a plurality of anodes, means for deflecting said beam from one anode to another, and two grids located between said generating means and said anodes in serial relation to each other with respect to said beam for substantially preventing secondary electrons emitted from one anode from reaching another, the grid farther away from said anodes being placed at a potential near that of said anodes, and the grid nearer said anodes being placed at a potential negative with respect to the po-

tential of the grid farther away from said anodes.

4. A cathode ray device comprising means for generating a beam of electrons, means comprising an accelerating anode for accelerating said beam, a pair of deflecting plates, means including an input resistance for applying signals to said deflecting plates to deflect said beam in accordance therewith, a pair of target plates in the path of said beam, a grid member parallel to said target plates and located between said deflecting plates and said target plates, a second grid member parallel to said first grid member and on the side of said grid member remote from said plates, a partition member extending between said plates and located axially of the device, said partition member being electrically connected to said first grid member and to ground, and means for connecting said plates to the primary winding of an output transformer, the mid-point of said primary winding being connected through a source of potential to said second grid member, said second grid member being electrically connected to the mid-point of the input resistance and to the beam accelerating anode.

5. A cathode ray device comprising means for generating a beam of electrons, an apertured plate placed at a positive potential with respect to said beam generating means for accelerating said beam, a conducting coating on the inside of said device connected at a potential which is positive with respect to said apertured plate for further accelerating said beam, an input resistance having two external terminals and a mid-tap, a pair of deflecting plates, means for connecting the external terminals of said input resistance to said deflecting plates, means for connecting the mid-tap of said input resistance to the conducting coating of said tube, a pair of plates in the path of said beam, said plates being connected to the primary winding of an output transformer, an electrode member between said plates, means for connecting said electrode member to said conducting coating and through a source of potential to the mid-tap of said primary winding of said transformer, and a pair of grid members between said plates and said deflecting plates, one of said grid members being connected to said electrode member.

6. A cathode ray device comprising means for generating a beam of electrons, a plurality of anodes, means for deflecting said beam from one anode to another, and two grids in serial relation to each other with respect to said beam and located between said beam generating means and said anodes for substantially preventing secondary electrons emitted from one anode from reaching another, the grid nearer said anodes being placed at a potential negative with respect to the potential of the grid farther away from said anodes.

7. A cathode ray device comprising means for generating a beam of electrons, a plurality of anodes, means for deflecting said beam from one anode to another, and two grids in serial relation to each other with respect to said beam and located between said generating means and said anodes for substantially preventing secondary electrons emitted from one anode from reaching another, the grid farther away from said anodes being placed at a potential substantially that of said anodes, and the grid nearer said anodes being placed at a potential which is negative with respect to the potential of the grid farther away from said anodes and which is substantially that of said beam generating means.

8. A cathode ray device comprising means for generating a beam of electrons, means comprising an accelerating anode for accelerating said beam, a pair of deflecting plates, means including an input resistance for applying signals to said deflecting plates to deflect said beam in accordance therewith, a pair of target plates in the path of said beam, a grid member substantially parallel to said target plates and located between said deflecting plates and said target plates, a second grid member substantially parallel to said first grid member and on the side of said first grid member remote from said plates, and means for connecting said target plates to the primary winding of an output transformer, the mid-point of said primary winding being connected through a source of potential to said second grid member, said second grid member being electrically connected to the mid-point of the input resistance and to the beam accelerating anode.

9. A cathode ray device comprising means for generating a beam of electrons, a plurality of anodes, means for deflecting said beam from one anode to another, and means located between said beam generating means and said anodes for substantially preventing secondary electrons emitted from one anode from reaching another, said last-mentioned means comprising two grids parallel to each other and to the plane of said anodes, and a partition member extending between said plates and located axially of the device, said partition member being electrically connected to the grid member nearest the plates.

10. A cathode ray device comprising means for generating a beam of electrons, means comprising an accelerating anode for accelerating said beam, a pair of plates for deflecting said beam, means for applying signals between said deflecting plates to deflect said beam in accordance therewith, a pair of target plates in the path of said deflected beam, a grid member parallel to said target plates and located between said deflecting plates and said target plates, a second grid member parallel to said first grid member and on the side of said grid member remote from said target plates, means for placing the second grid member at the same potential as said accelerating anode, and means for placing said first grid member at a potential which is negative with respect to that of said second grid member.

11. A cathode ray device comprising means including a cathode for generating a beam of electrons, means comprising an anode for accelerating said beam, a pair of deflecting plates, means for applying signals between said deflecting plates to deflect said beam in accordance therewith, a pair of target plates in the path of said deflecting means, a grid member parallel to raid target plates and located between said deflecting plates and said target plates, a second grid member parallel to said first grid member and on the side of said first grid member remote from said target plates, a partition member extending between said target plates and located axially of the device, said partition member being electrically connected to said first grid member and to the cathode of said beam generating means, and means for connecting said second grid member to the beam accelerating anode.

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