

Sept. 10, 1940.

F. GRAY

2,214,019

ELECTRONIC SWITCHING DEVICE

Filed Oct. 30, 1937

2 Sheets-Sheet 1

FIG. 1

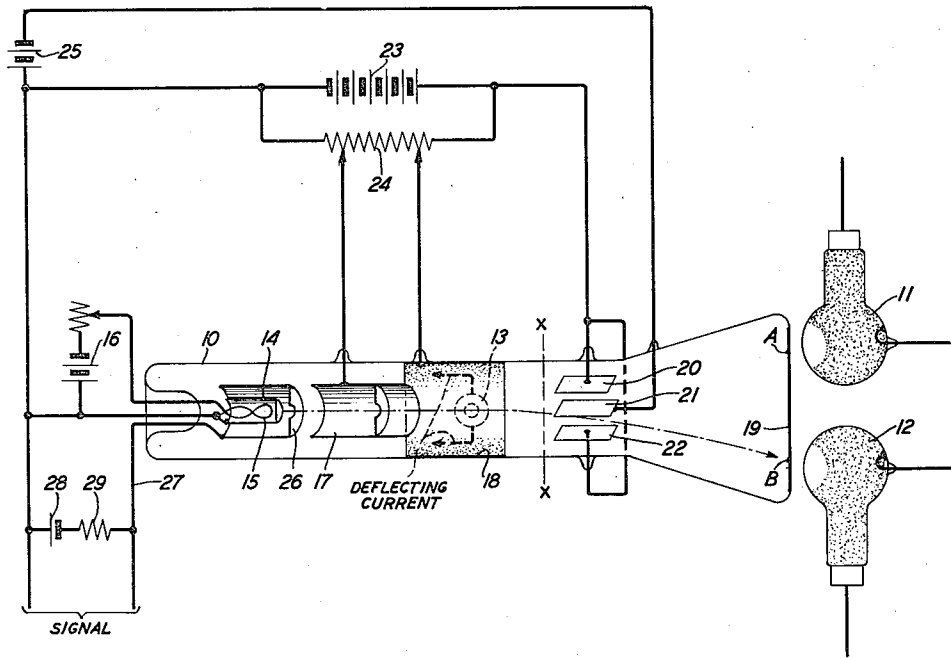
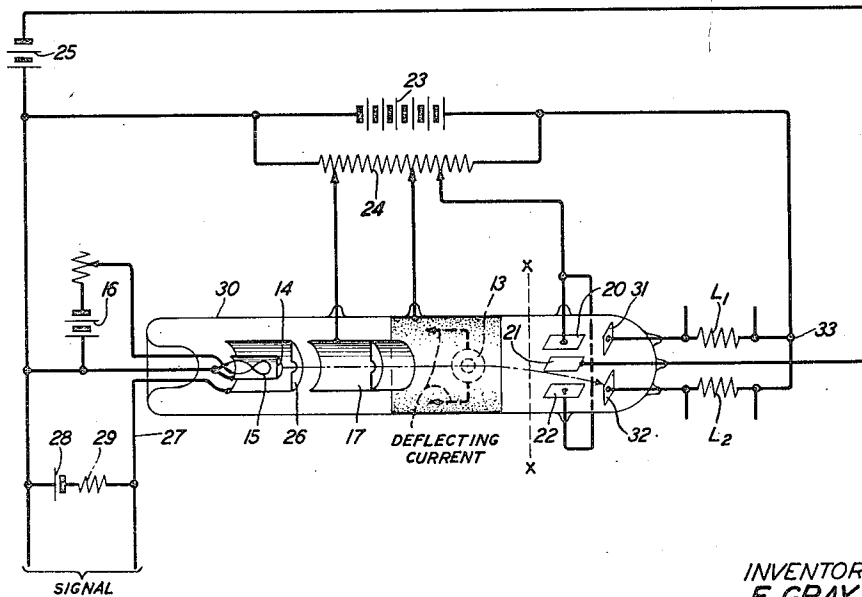


FIG. 2



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FIG. 3

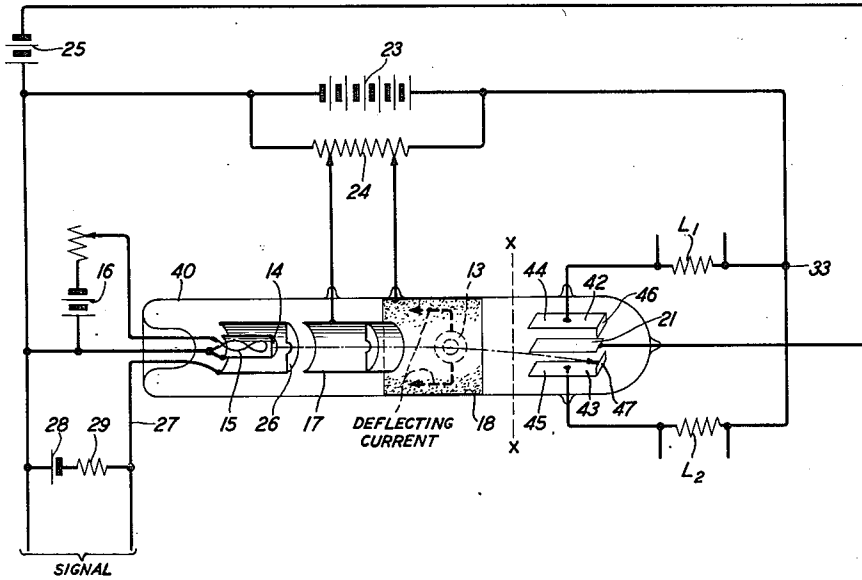
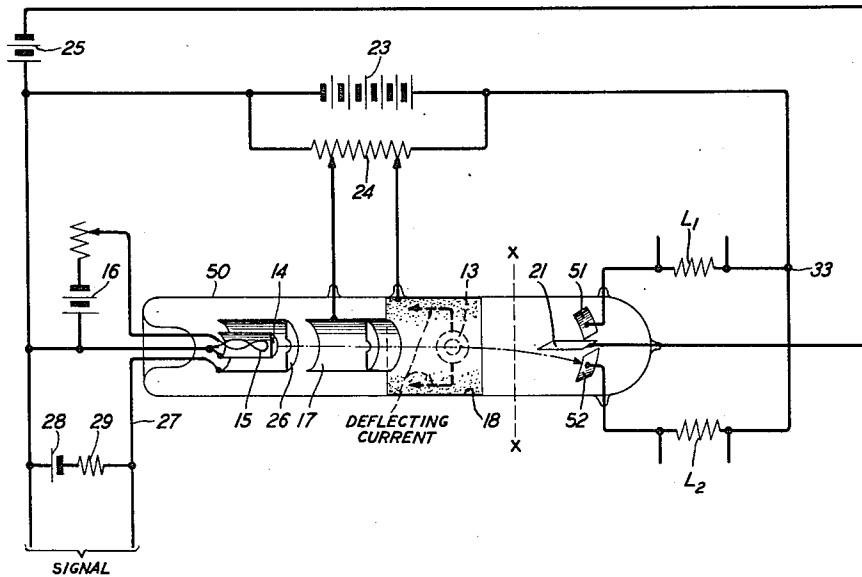


FIG. 4



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ELECTRONIC SWITCHING DEVICE

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16 Claims. (Cl. 250—27)

This invention relates to electron discharge devices and more specifically to devices of this character which are used as electronic switching or distributing devices.

5 It is an object of this invention to provide a cathode ray tube in which only a relatively small amount of energy is required to deflect the electron beam by a relatively large amount.

10 It is another object of this invention to provide novel means for suppressing the flow of cross currents in an electronic switching or distributing tube, these currents arising from the flow of secondary electrons emitted from the target.

15 It is a further object of this invention to provide a cathode ray tube in which there is a sharp line of demarkation between the paths of the electron beam to each of a pair of beam receiving electrodes.

20 In accordance with this invention, a cathode ray tube is provided which comprises an electron gun for forming a beam of electrons, a target or screen, means for setting up a field to deflect the beam, and additional means for setting up a second field to subsequently deflect the beam in the same plane as the first deflection, these two means for setting up fields cooperating to produce a snap switch action; that is, a small initial deflection will cause a large deflection of the beam in the plane of the target or screen.

30 In one embodiment of this invention there is provided a cathode ray tube comprising an electron gun for generating and accelerating a beam of electrons and for focussing this beam into a spot on a fluorescent screen, a pair of magnetic deflection coils to which deflecting signals are applied, and three parallel plates within the tube between the plane including the axes of the deflecting coils and the plane of the fluorescent screen which plates lie in planes which are parallel to the axis of the tube. The plane of the central one of these plates preferably contains the axis of the tube and the two outside plates are parallel to the central plate and on opposite sides thereof. A positive potential is applied to each of the outside plates with respect to that of the inside or central plate. On the outside of the cathode ray tube and adjacent to two separated parts of the fluorescent screen are two photocells which are preferably connected to respective external circuits. The beam is deflected by signal currents flowing through the magnetic deflection coils and this small deflection is increased when the electrons pass between the axially extending central plate and one or the other of the two outside plates parallel thereto

depending on the direction of the initial deflection. As a result of the positive potential on the outside plates a greatly enhanced deflection is produced and the electrons strike the fluorescent screen in two widely separated spots. These fluorescent spots have very little motion. The beam is simply switched from one spot to the other very quickly. The center plate is placed at the same potential as the cathode or else slightly negative with respect thereto. In the intermediate or rest position of the beam, it acts as a sharp knife edge to divide the beam into two parts with no loss of electrons to the edge. To avoid distortion of the beam, the potentials of the deflecting electrodes are balanced with respect to the potential of an accelerating anode. The action of this device can be compared to that of a snap switch in which a small starting force, corresponding to a small deflection signal in this case, causes an enlarged movement of the switching member (the beam).

As a modification of the arrangement disclosed above, the fluorescent screen and the plurality of photocells are replaced by a pair of anodes whose potentials are balanced with respect to that of an accelerating anode. In this arrangement resistances are connected to the target anodes and the common terminal of these resistances is connected to the outside members of the deflection enhancing plates through a source of potential, the electrode plates being positively polarized with respect to the outside deflection enhancing plates. The external resistances are each connected in an appropriate output circuit, and the tube functions to switch from one circuit to the other in a quick inertialess way with a very small applied deflecting signal.

In a modification of the device described in the preceding paragraph, the outside members of the set of plates to enhance the deflection and the two anodes are combined into a pair of unitary structures. The external resistances are connected to these structures and the common terminal connected through a suitable source of potential to the last accelerating anode which preferably comprises a coating on the inside walls of the tube.

In a further modification, the unitary structures are made slightly curved, the tube and circuits being otherwise as disclosed in the arrangement in the preceding paragraph.

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

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

Fig. 2 shows a modification of the device shown in Fig. 1;

Fig. 3 shows a modification of the device shown in Fig. 2; and

Fig. 4 shows a modification of the device shown in Fig. 3.

Referring more particularly to the drawings, Fig. 1 shows a cathode ray arrangement which can be used for switching between a plurality of circuits. The arrangement comprises a cathode ray tube 10 and a pair of photoelectric devices 11 and 12 adjacent the large end of the tube 10. Also associated with the cathode ray tube 10 are deflecting coils 13 to which are applied deflecting signals to cause the beam generated in the cathode ray tube 10 to be deflected.

The cathode ray tube 10 comprises a cathode 14 which is heated by a suitable heater element 15 supplied with current from a direct current source 16, a first accelerating anode 17, a second accelerating anode 18 which preferably comprises a coating of aquadag on the inside walls of the tube 10, a fluorescent screen 19 and three parallel plates 20, 21 and 22 located between the accelerating anode 17 and the fluorescent screen 19. The middle plate 21 is preferably located on the axis of the tube and also on the plane including the axis of the deflecting coils 13. The outside plates 20 and 22 are placed a short distance on either side the plate 21 and parallel thereto. The first accelerating anode 17 is placed at a potential which is positive with respect to that of the cathode 14 by means of a source of direct current potential 23 and a potentiometer 24. The second accelerating anode 18 is placed at a potential which is positive with respect to that of the first accelerating anode 17, the relative potentials and spacing of the accelerating anodes with respect to the cathode being so chosen that an electron lens system is formed which focusses the electrons generated by the cathode 14 into a narrow beam of electrons. The outside deflection enhancing plates 20 and 22 are placed at a positive potential with respect to that of the second accelerating anode 18 and also with respect to that of the center plate 21 which is placed at a potential which is negative with respect to that of the cathode 14 by means of a source of potential 25.

The intensity of the beam may, if desired, be controlled by means of a modulating or control cylinder 26 located between the cathode 14 and the first accelerating anode 17 and to which are applied signals by means of an input circuit 27. Deflecting signals which may be sine waves or waves of nonsinusoidal shape may be applied to the deflecting coils 13 to deflect the beam from one side of the plate 21 to the other or, in other words, from between the plates 20 and 21 to between the plates 21 and 22, and vice versa, in accordance with the deflecting signals applied to the coils 13 by means of a suitable circuit (not shown).

The operation of the device shown in Fig. 1 is as follows: A stream of electrons is generated by the cathode 14, accelerated by the anodes 17 and 18 and focussed into a beam by the action of the electron lens system comprising the cathode and the anodes 17 and 18. The intensity of this beam is controlled by the application of a modulating signal from the circuit 27 between the cathode 14 and the modulating or control element 26, this element being suitably biased by

means of the battery 28 and the high resistance 29 in the input circuit 27. This beam is given an initial deflection by means of deflecting signals from a suitable circuit (not shown) flowing through the deflecting coils 13 which signals may be of relatively small magnitude. This small initial deflection is enhanced in the electron paths between the central plate 21 and either of the outside plates 20 or 22 depending on which direction the beam is deflected by the current flowing through the coils 13. As the outside plates 20 and 22 have a positive potential with respect to the middle plate 21, the beam, once it passes between the proper pair of plates (the proper pair, of course, being determined, by the direction the beam is deflected by the deflection signal flowing through the coils 13), acquires a larger deflection as it passes between the plates. The plate 21 acts as a sharp knife edge to divide the beam into two parts when there is no initial deflection of the beam. In this condition the beam is divided into two parts which strike the fluorescent screen 19 at widely separated points. When there are signals flowing in the coils 13, the beam will strike point A on the fluorescent screen or point B thereon, these two points being respectively adjacent photoelectric cells 11 and 12. The photoelectric cells 11 and 12 are each connected in a work circuit and the entire device operates to switch from one circuit to the other rapidly and without inertia. In some cases, it may not be desirable to have the beam modulated by the signals in the input circuit 27, and the device may be used only for switching rather than for switching and control as in the preferred arrangement. Due to the deflection enhancing plates 20, 21 and 22, only a relatively small signal in the coils 13 is required to produce a deflection between widely separated points on the fluorescent screen 19 thus making it possible to properly space the cells and at the same time use very small signals to cause the deflection of the beam.

Fig. 2 shows a cathode ray device which is a modification of the device described above in connection with Fig. 1. In this device, metallic electrode plates are used as pick-up devices rather than the photoelectric cells 11 and 12 of Fig. 1. In the tube 30 shown in Fig. 2, all portions to the left of the line XX are preferably the same as those portions to the left of the line XX in Fig. 1. The electrode plates 31 and 32 are respectively in the path of the beam as it emerges from between the plates 20 and 21 and between the plates 21 and 22. These plates 31 and 32 are connected to a common terminal 33 which is connected to the source of potential 23. The middle deflecting plate 21 is connected to the negative terminal of the source of potential 25 and the two outside plates 20 and 22 are connected to the potentiometer 24 at a point which makes them positive with respect to the cathode and with respect to the middle plate 21 but negative with respect to the common terminal 33 of the output circuits L1 and L2. In operation, the beam after being deflected by the current in the coils 13 has its deflection enhanced as it passes between the plates 20 and 21 or between the plates 21 and 22 and is then directed to the corresponding electrode plate 31 or 32 because of the potential applied thereto. If the signals flowing through the coils 13 are continuously varying in sign, the electrode plates 31 and 32 are alternately contacted by the electron beam to alternately energize the work circuits L1 and L2. In all other respects

generating a beam of electrons, means for deflecting said beam, and means comprising three parallel plate-electrode members for enhancing the deflection caused by the deflecting means.

Fig. 3 shows a modification of the device shown in Fig. 2, all portions of the tube 40 to the left of line XX in this figure being similar to the corresponding portions of tubes 10 and 30 to the left of line XX in Figs. 1 and 2. In this modification the outside deflecting plates 20 and 22 and the electrode plates 31 and 32 are combined into unitary electrode structures 42 and 43. The electrode structures 42 and 43 are connected to the work circuits L1 and L2, the common terminal 33 of which is connected to the source of potential 23, the middle electrode 21 being connected to the negative side of the source 25 as in the preceding arrangement. Conductors 42 and 43 comprise plates 44 and 45, which are parallel to the center plate 21 and on opposite sides thereof, with ends 46 and 47 which are turned in towards the center plate 21 so that they are at approximately right angles thereto. The ends 46 and 47 simulate the electrode plates 31 and 32 of Fig. 2, although it will be noted that they are placed at the same potential as the plates 44 and 45 inasmuch as they are unitary parts of the same metallic structure, rather than being at different potentials as in the case of the device 30 of Fig. 2. The features of the cathode ray tube 40 and the method of operation thereof are otherwise similar to the cathode ray device 30 described above in connection with Fig. 2.

Fig. 4 shows a cathode ray device 50 which is a modification of the device 40 shown in Fig. 3. The portion of the device 50 to the left of the line XX is preferably similar to the portion of the devices 10, 30 and 40 to the left of the line XX in Figs. 1, 2 and 3. The composite structures 42 and 43 of Fig. 3 are replaced by curved anode plates 51 and 52. Between the plates 51 and 52 is the central plate 21 extending out in front of the plates 51 and 52 and serving to divide the beam in a manner similar to the corresponding plate 21 in the three preceding figures. Plates 51 and 52 are connected to output circuits L1 and L2, the common terminal 33 of which circuit is connected to the source of potential 23.

The plate 21 cooperates with the plates 51 and 52 to give a greatly enhanced deflection, the plate 21 giving a sharp line of division to the two parts of the beam. Due to the fact that the electrode plate 21 extends out in front of the plates 51 and 52 and is also placed at a negative potential with respect to the potential of these plates because of its connection to the negative pole of battery 25, it will serve to prevent the flow of secondary electrons between the plates 51 and 52. The plate 21 in Figs. 2 and 3 also serves to prevent the flow of secondary electrons between the target electrode plates due to the negative potential applied thereto with respect to the potential of the target electrode. The device in Fig. 4 has the advantage over those in the preceding arrangement in that it is relatively simpler to construct than the others.

While deflecting coils have been described as the preferred arrangement for producing the initial deflection, it is, of course, to be understood that electrostatic deflecting plates may be used as well.

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

What is claimed is:

1. A cathode ray device comprising means for

generating a beam of electrons, means for deflecting said beam, and means comprising three parallel plate-electrode members for enhancing the deflection caused by the deflecting means.

2. The method of producing a large deflection of a beam in a cathode ray tube with relatively small signals comprising the steps of generating a beam of electrons in said tube, causing a small deflection of said beam by relatively small signals, causing said beam to pass between a pair of plates which are placed at different potentials to increase the deflection in the direction of the original deflection, and then allowing said beam to strike beam utilizing means remote from said pair of plates.

3. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, and means separate from said deflecting means for enhancing the deflection caused by said first-mentioned means, said last-mentioned means comprising a flat electrode member located in a plane which contains the axis of the tube and two curved metallic targets one of which is located on each side of said electrode member.

4. The method of distributing the energy of a cathode beam to widely separated portions of a target structure in succession which comprises applying a stationary deflecting field of continuously increasing strength to said beam in a direction to tend to sweep said beam along a path between said portions, and subjecting said beam to an additional field in the region between said deflecting field and said target structure to cause said beam in its sweep to impinge first upon one of said portions, and then to abruptly change its direction so as to reach the other of said portions without reaching a region between said portions which the beam would reach if it were swept under the influence of said first-mentioned field alone.

5. A cathode ray device comprising means including a cathode for generating a beam of electrons, a target structure, beam deflecting means for building up a continuously increasing field tending to sweep said beam between two widely separated portions of said target structure, and means between said deflecting means and said target structure for modifying the sweep of said beam to cause it to impinge upon said portions in succession, said sweep modifying means causing said beam abruptly to change its direction within the zone where if it were under the influence of said first-mentioned beam deflecting means alone it would pass to and sweep with a relatively slow motion within the region between said portions, said change of direction preventing said beam from reaching said region.

6. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, and means separate from said deflecting means for enhancing the deflection caused by said deflecting means and serving as a divided target for said beam, said deflection enhancing means comprising a pair of parallel plates with the ends thereof farthest remote from the beam generating means turned in toward the axis of the device, and a third plate located between and parallel to the other plates, which third plate is placed at a negative potential with respect to the other plates.

7. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, means comprising three parallel plate-electrode members for enhancing the

deflection caused by the deflecting means, and a pair of target plates adapted to be impinged by said beam after it has passed between the inner plate and one or the other of the outer plates.

8. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, means comprising three parallel plate-electrode members for enhancing the deflection caused by the deflecting means, and a pair of target plates adapted to be impinged by said beam after it has passed between the inner plate and one or the other of the outer plates, the center one of the three electrode plates being placed at a negative potential with respect to that of the two outside plate-electrode members.

9. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, means comprising three parallel plate-electrode members for enhancing the deflection caused by the deflecting means, and a target for said beam, said target being located on the side of said deflection enhancing means remote from said means for generating said beam of electrons.

10. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, means comprising three parallel plate-electrode members for enhancing the deflection caused by the deflecting means, means for placing the center one of the three electrode plates at a negative potential with respect to that of the two outside plate-electrode members, and a target for said beam, said target being located on the side of said deflection enhancing means remote from said means for generating said beam of electrons.

11. The method of producing a large deflection of a beam in a cathode ray tube with relatively small signals comprising the steps of generating a beam of electrons in said tube, causing a small deflection of said beam by relatively small signals, causing said beam to pass between a central plate and either one or the other of two outside plates which outside plates are placed at positive potentials with respect to said central plate in order to increase the deflection in the direction of the original deflection of the beam, and then allowing said beam to strike a beam utilizing means remote from said pair of plates.

12. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, means comprising three parallel plate-electrode members for enhancing the deflection caused by the deflecting means, and a

target area for said beam, said area being located within a plane which is substantially perpendicular to the planes of the three parallel plate-electrode members.

13. The combination with means for generating a beam of electrons, of beam deflecting means for building up a continuously increasing field tending to sweep said beam from one region to a widely separated region, and means between said deflecting means and said regions for modifying the sweep of said beam to cause it to pass to said regions in succession, said sweep modifying means causing said beam abruptly to change its direction within the zone where if it were under the influence of said first-mentioned beam deflecting means alone it would pass to and sweep with a relatively slow motion in the space between said separated regions, said abrupt change of direction being such as to prevent said beam from passing into said space.

14. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, and means comprising three parallel plate-electrode members for enhancing the deflection caused by the deflecting means, the center one of the three plate-electrode members being placed at a negative potential with respect to that of the two outside plate-electrode members.

15. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, and means separate from said deflecting means for enhancing the deflection caused by said first-mentioned means, said last-mentioned means comprising a flat electrode member located in a plane which contains the axis of the tube, and two curved metallic targets one of which is located on each side of said electrode member, said curved plates being placed at a positive potential with respect to that of the beam generating means and the flat electrode being placed at a negative potential with respect to that of the beam generating means.

16. A cathode ray device comprising means for generating a beam of electrons, means for deflecting said beam, and means separate from said deflecting means for enhancing the deflection caused by said first-mentioned means, said last-mentioned means comprising a flat electrode member located in a plane which contains the axis of the tube and two curved metallic targets one of which is located on each side of said electrode member, and means for modulating said beam of electrons in accordance with signals.

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