Feb. 24, 1948. J. B. MAGGIO 2,436,393

CATHODE RAY TUBE WITH DISCHARGE TO DEFLECTING PLATES

Filed Dec. 29, 1944 2 Sheets-Sheet 1

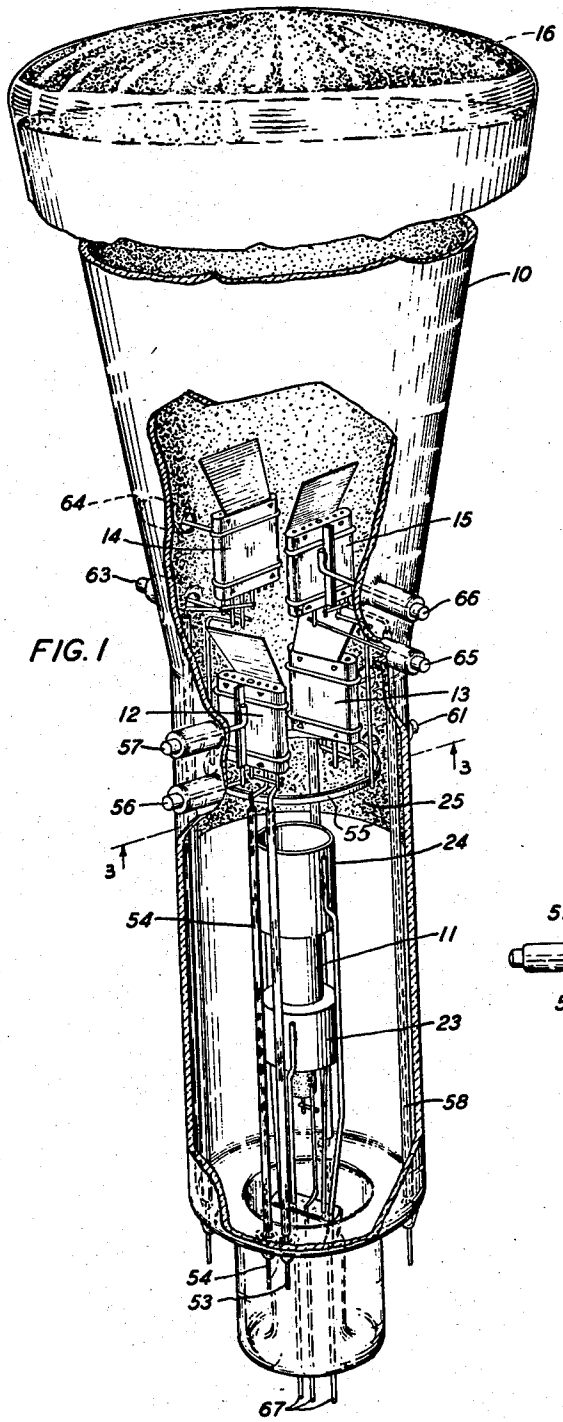

FIG. 1

FIG. 2

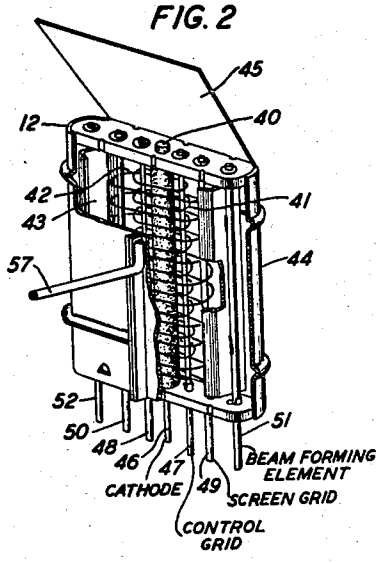

FIG. 3

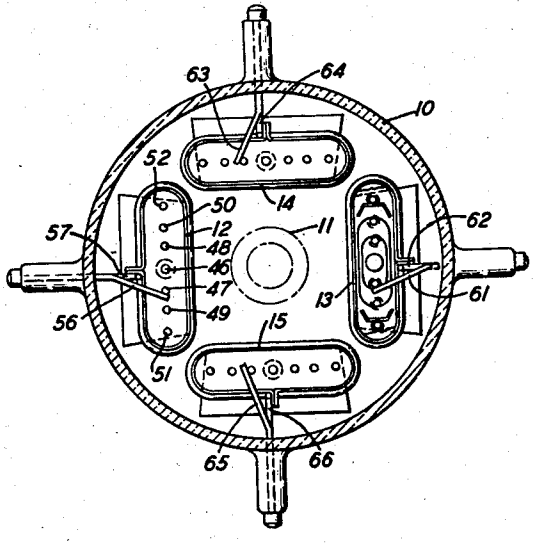

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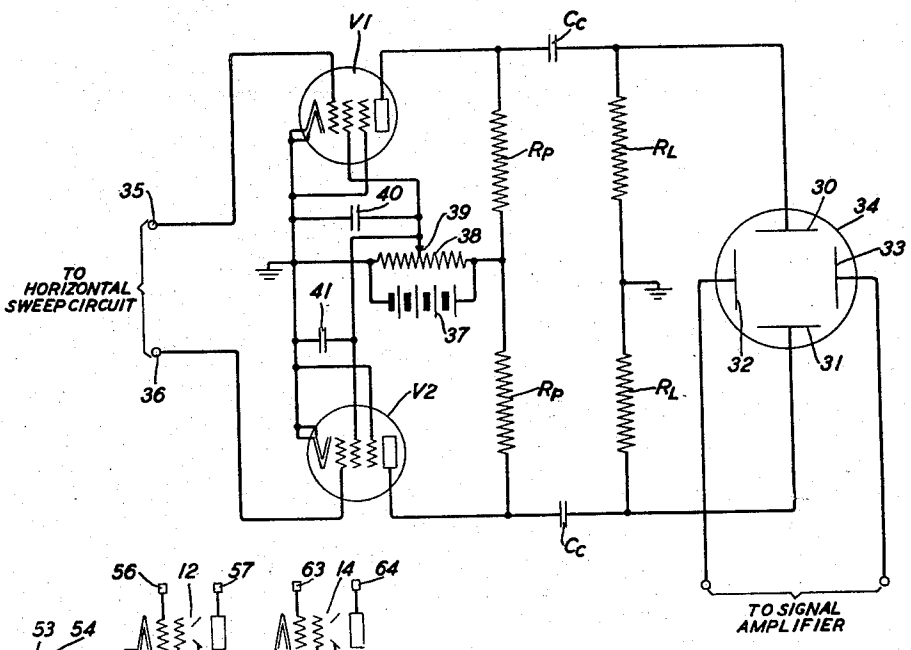
FIG. 4



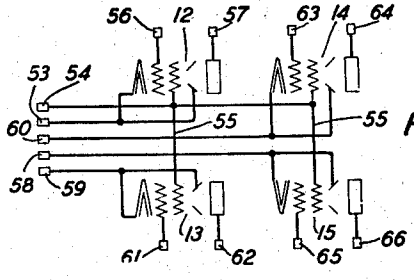
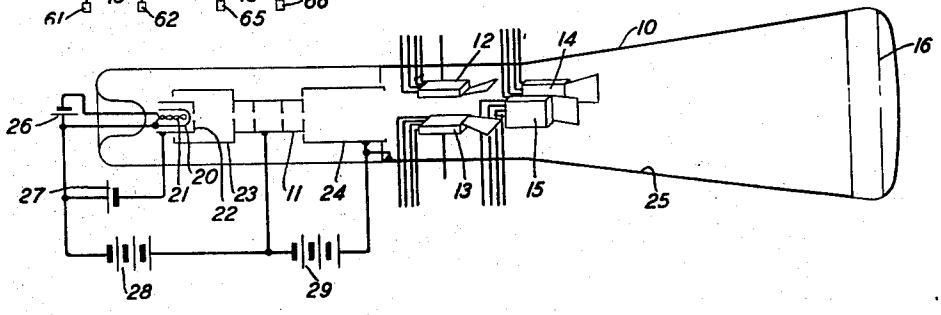


FIG. 6

FIG. 5



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2,436,393

CATHODE-RAY TUBE WITH DISCHARGE TO DEFLECTING PLATES

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Application December 29, 1944, Serial No. 570,287

7 Claims. (Cl. 315—2)

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This application relates to space current devices and more specifically to devices of this character in which a cathode beam is formed and deflected by elements within the device.

The demand frequently arises, such as, for example, for the observances of sharp pulses, for a cathode ray tube in which the deflecting frequencies are of the order of 100 megacycles. A limiting factor in the use of cathode ray tubes at these high deflecting frequencies is found to be the total capacity of the output circuit of the amplifiers to which the deflecting means are connected and of the deflecting means themselves. The present invention relates to the enlargement of the deflecting frequency range of cathode ray devices by decreasing this total capacity.

It is an object of this invention to provide a novel cathode ray tube suitable for use at deflecting frequencies of the order of 100 megacycles.

It is another object of this invention to provide a novel cathode ray tube in which the over-all capacity of the amplifiers driving the deflecting means and of the deflecting means themselves is greatly reduced.

In accordance with one embodiment of the invention chosen for illustrative purposes, there is provided a cathode ray tube in which the plates or anodes of the final stage of the output amplifier and the electrostatic deflecting plates of a cathode ray tube are combined in one structure. This has the effect of reducing the over-all total capacity of amplifier devices and deflecting plates by approximately one half. Thus, associated with each of the four deflecting plates in the tube is an amplifying device such as the electrode elements of a beam power tube (preferably the envelope of each beam power tube is omitted so that the "atmosphere" of the cathode ray tube surrounds the electrode elements of the amplifying device). Each element of each amplifying device is preferably attached to a separate lead so that connections thereto can be made outside the cathode ray tube. Small high frequency bypassing condensers for the screen grid can be incorporated within the envelope, if desired. The electrode structures of the amplifying devices used can be essentially of standard construction with the exception of the plates which are preferably extended along their inner faces in order to give a greater deflection.

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

Fig. 1 is a perspective view, with portions broken away, of a cathode ray tube in accordance with this invention;

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Fig. 2 is an enlarged perspective view of one of the composite deflecting structures, comprising the electrode elements of an amplifying device and a deflecting plate, utilized in the tube of Fig. 1;

Fig. 3 is a cross-sectional view taken through the tube of Fig. 1 in a plane drawn through line 3—3 and looking in the direction of the arrows;

Fig. 4 shows a prior art circuit arrangement of deflecting plates of a cathode ray tube and amplifiers external thereto to which the plates are connected;

Fig. 5 is a schematic diagram of the tube shown in Fig. 1; and

Fig. 6 is a schematic circuit diagram of the amplifiers in the tube of Fig. 1;

Referring more specifically to the drawings, Fig. 1 shows, by way of example for purposes of illustration, a cathode ray tube embodying an evacuated container 10 enclosing an electron gun 11, four composite structures 12, 13, 14 and 15 each embodying an amplifying device and an electrostatic deflecting plate, and a fluorescent target or screen 16. As shown in Fig. 5, which is a schematic diagram of the cathode ray tube of this invention, the electron gun 11 comprises a cathode 20, a cathode heater 21, a modulating or control element 22, a first anode 23 and a second anode comprising a cylindrical member 24 and a conducting coating 25 on the inner walls of the envelope 10. A suitable source 26, which may be either alternating or direct, provides current for the heater 21 while a biasing source 27 places the modulating or control electrode 22 at a suitable negative potential with respect to the cathode 20. The first anode 23 is placed at a positive potential with respect to the cathode 20 by means of the direct source 28 while the second anode 24, 25 is placed at a positive potential with respect to the anode 23 by means of the source of direct potential 29. The shapes and spacings of the various members 20 to 25, inclusive, and their relative potentials are so chosen that a beam of electrons strikes the target 16 to form a small spot thereon, which beam can be deflected in a direction having both horizontal and vertical components by means of the composite electrode structures 12, 13, 14 and 15.

Before explaining the construction of each of the elements 12, 13, 14 and 15, reference is made to Fig. 4 which shows a prior art circuit arrangement of deflecting plates 30, 31, 32 and 33 of a cathode ray tube 34 to which are applied ampli-

fied signals. By way of example a saw-toothed potential wave is applied to the input terminals 35 and 36 which are connected to the output terminals of a sweep circuit suitable for producing a wave for horizontal deflection of the beam, for example. As an example of a suitable circuit, reference is made to the application of B. M. Oliver, Serial No. 561,410, filed November 1, 1944. The output of the horizontal sweep circuit, which is balanced with respect to a fixed potential such as ground, is applied to two amplifier tubes V1 and V2 each comprising an anode, cathode, control grid, screen grid and suppressor grid. The cathodes of the two tubes are connected together and to each suppressor grid. Each anode is connected to the positive terminal of a source 37 through an anode resistor R_P. Connected across the source 37 is a potentiometer resistor 38 to an inner terminal 39 of which are connected the two screen grids. By-pass condensers 40 and 41 are connected between the screen grids and the cathode. The anodes of the two tubes V1 and V2 are connected to the horizontal deflecting plates 30 and 31, respectively, through equal coupling condensers C_C. Connected across the deflecting plates 30 and 31 are two resistors R_L the common terminal of which is connected to ground or to another suitable fixed potential. In an arrangement such as that shown in Fig. 4, the capacity of the coupling condensers C_C, that of the resistors R_P and R_L, and that of the deflecting plates 30 and 31 as well as of the wiring between these members all contribute to the total capacity at the output of the amplifier formed by the tubes V1 and V2. Thus the top frequency of the amplifier is limited. Since the band of frequencies contained in a linear saw-toothed wave with a very short return time, such as that produced by the circuit described in the above-mentioned Oliver application, is very high, the effect of this total capacity may be to round off the sharp edges and to increase the return time. Moreover, if the signal, a representation of which is to be observed on the screen of the tube and which signal is applied to the plates 32 and 33, contains high frequencies of the order of megacycles or higher, the total capacity of the coupling circuit connected to these plates and of the plates themselves limits the band width of the amplifier and hence may distort the presentation of the signal.

In accordance with the present invention, the functions of each of the amplifier tubes V1 and V2 and of its corresponding deflecting plate are combined in a single structure. Similarly, the functions of an output amplifier tube for the vertical signals and one of the deflecting plates 32 and 33 are combined in a single structure. One such composite structure, such as the device 12, is shown in perspective in Fig. 2. The device 12 comprises, by way of example, the electrode structure (without the container) of a beam power tube, such as the well-known 6L6 for example, although it is to be understood that any suitable amplifier electrode structure, such as that of common triode, tetrode, pentode or even higher element tubes, can be combined, in the manner shown in Fig. 2, with a deflecting plate in a way which will now be described. The device shown in Fig. 2 comprises a cathode 40, a control grid 41, a screen grid 42, beam-forming elements 43, and an anode member 44. The inner surface of the anode member 44 is extended and, if desired, bent or otherwise directed outwardly to form a long deflecting plate 45 capable of a large deflection. It will, of course, be understood that in cases where the deflection required is not great the portion 45 need not be bent outwardly and if a small deflection per unit deflecting voltage is all that is required, the portion 45 can be entirely omitted. Terminal 46 is connected to the cathode, terminals 47 and 48 are connected to the control grid, terminals 49 and 50 are connected to the screen grid, and terminals 51 and 52 are connected to the beam-forming elements. In practice, the terminals 48 and 50 are not used since one terminal for each of the control and screen grids is sufficient. The terminal 52 is connected (by means not shown) to the terminal 51 so that both of these are placed at the same potential. Connections to the terminals 46, 47, 49 and 51 can be brought out through the envelope of the tube by any suitable means. By way of example, in the arrangement of Fig. 1 the cathode terminal 46 is connected to a connector 53 which is brought out at the base of the tube and is also connected to the terminals 51 and 52. The terminal 49 of the screen grid is connected to the connector 54 which is brought out through the base. The connector 54 is also connected to a conducting ring 55 to which the screen grids of all of the elements 12, 13, 14 and 15 are connected. The control grid terminal 47 is connected to a connector 56 which is brought out through the side of the tube while the anode terminal 57 is also brought out through the side of the tube.

A cathode and a beam-forming element of the composite structure 15 are connected to a connector 58 which is brought out at the base of the tube while similar connectors 59 and 60 (see Fig. 6) are provided for the cathode and beam-forming elements of the composite structures 13 and 14, respectively. Connectors 61 and 62, corresponding to the members 56 and 57, are provided for the control grid and anode respectively of the composite structure 13. Similarly, connectors 63 and 64 are provided for the composite structure 14 and connectors 65 and 66 are provided for the composite structure 15. A schematic diagram of the connections 53 to 66, inclusive, is shown in Fig. 6, while the arrangement of the members 12, 13, 14 and 15 is shown in Fig. 3 which is a cross-sectional view taken in a plane drawn through the line 3—3 and looking upward. The connections to the electrode elements of the electron gun 11 can be brought out of the base as indicated by the connectors 67 in Fig. 1. For simplicity in the drawings, the connections for the cathode heaters have not been shown. In actual practice, these connections are also brought outside the tube.

Small high frequency by-passing condensers, corresponding to the condensers 40 and 41 of Fig. 4, can be incorporated within the envelope 10 if desired. For simplicity in the drawing these have not been shown as separate elements but each of these condensers can, if desired, comprise the capacity between the leads to each cathode and its corresponding screen grid.

Various changes can be made in the arrangement described above without departing from the spirit of the invention. For example, all of the conductors can be brought out from the tube through the base or all through the sides or divided between the sides and the base in any desired manner. For extremely high frequency application it is advisable to bring the cathode connections (as well as those to the control grid and anode) out the side of the tube inasmuch

as the length from cathode to base would introduce a prohibitive amount of inductance. If desired, all of the cathode connections can be brought out to a single pin on the base or at the side but as cathode feedback is usually employed in such circuits to improve the linearity, each cathode has been shown in the drawing as connected to a separate base pin.

It will be readily apparent that by combining the plates of the output amplifier and the deflection plates of the cathode ray tube itself the over-all capacity is about halved because of the elimination of each C_C and R_L and the wiring associated with these elements. Each composite structure still requires an R_P. The approximate halving of the over-all capacity produces a consequent doubling of the practical frequency range of the deflecting signals which can be applied to the tube.

What is claimed is:

1. In a space current device, means for amplifying signal energy, said means including a cathode, an anode and a control element for controlling a discharge between said cathode and anode to thereby vary the potential of said anode with respect to a fixed potential, means for generating a beam of charge particles and for directing it in a path which passes near but does not touch said anode, whereby said beam is given a deflection which varies with the said variation in potential of said anode, and means upon which said electrons impinge after they pass said anode.

2. In a cathode ray device, means for generating a beam of electrons, and means comprising a pair of electrostatic deflecting plates for deflecting said beams, each of said plates having a cathode and a control member associated therewith to form a repeating device for signals applied between said cathode and control member.

3. In a cathode ray device, means for generating a beam of electrons and a plurality of beam-deflecting structures entirely contained within said device, each of said structures comprising an anode which serves as an electrostatic deflecting plate, a cathode and a control element.

4. A cathode ray device comprising an evacuated vessel containing means for generating a beam of electrons and a plurality of beam-deflecting structures mounted in the evacuated space within said container, each of said structures comprising an anode which serves as an electrostatic deflecting plate for said beam, a cathode and an element for controlling the amplitude of the electronic current between the cathode and anode of the structure.

5. In a cathode ray device, means for generating a beam of electrons, a plurality of beam-deflecting structures entirely contained within said device, each of said structures comprising an anode which serves as an electrostatic deflecting plate, a cathode and a control element, each said plate member having an extension which is directed away from the path of the beam when the beam is undeflected.

6. In a cathode ray device, means for generating a beam of electrons, a plurality of beam-deflecting structures entirely contained within said device, each of said structures comprising an anode which serves as an electrostatic deflecting plate, a cathode, an element for controlling the amplitude of space current between said cathode and said anode, and means for making connection to said anode, cathode and control element through the envelope of said device adjacent said deflecting structures.

7. A cathode ray device comprising an evacuated vessel, a main cathode and at least two auxiliary cathodes mounted in the evacuated space within said vessel, anode means within said space cooperating with said main cathode to form a beam of electrons, two electrostatic beam-deflecting plate-like elements each mounted between the path of said beam and a cooperating one of said auxiliary cathodes so that the elements have corresponding faces adjacent to, and on opposite sides of, said beam path, each of said auxiliary cathodes being very close to the deflecting element lying on the same side of said beam path compared with the distance to said main cathode, and two control electrodes mounted in the evacuated space adjacent said deflecting elements, respectively, for controlling the amplitude of flow of electrons to the latter from the respective auxiliary cathodes.

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