

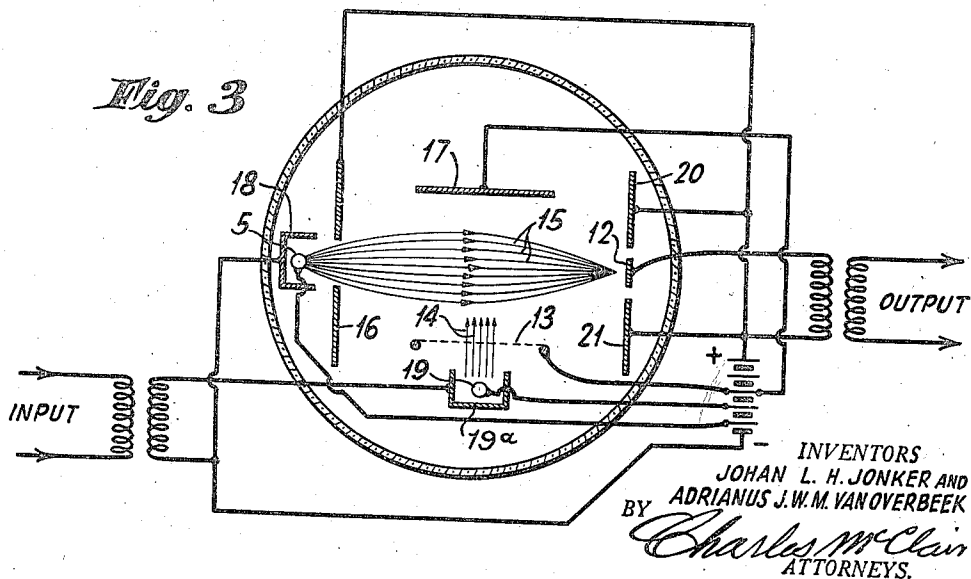
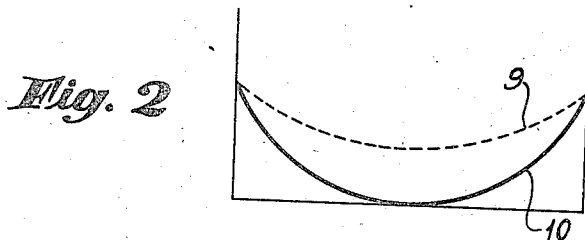
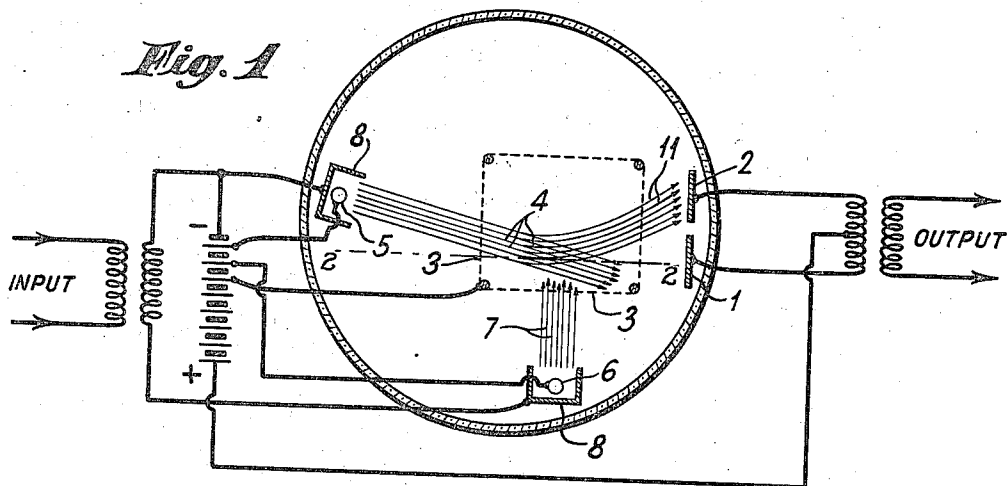
Jan. 28, 1941.

J. L. H. JONKER ET AL
ELECTRON DISCHARGE DEVICE

2,229,752

Filed July 30, 1938

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

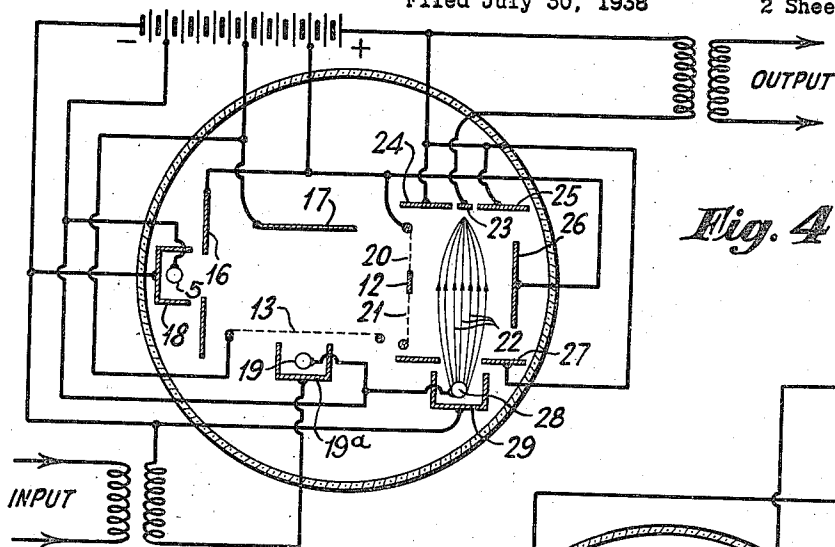


Fig. 5

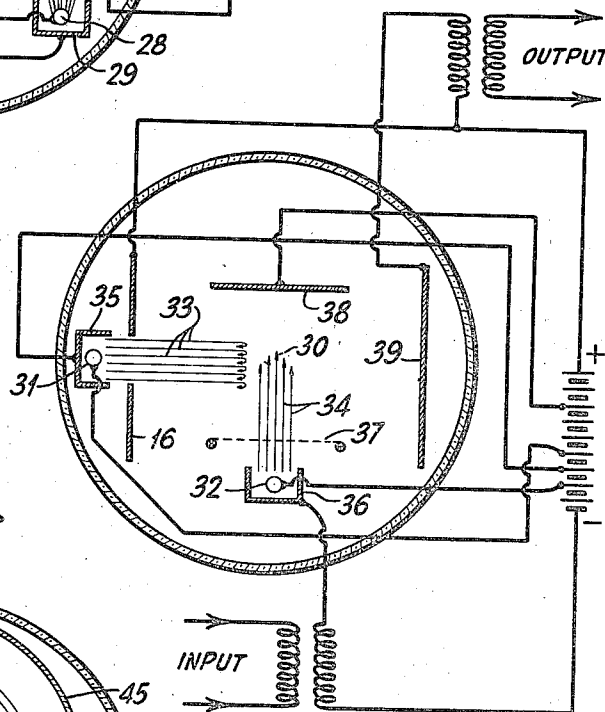
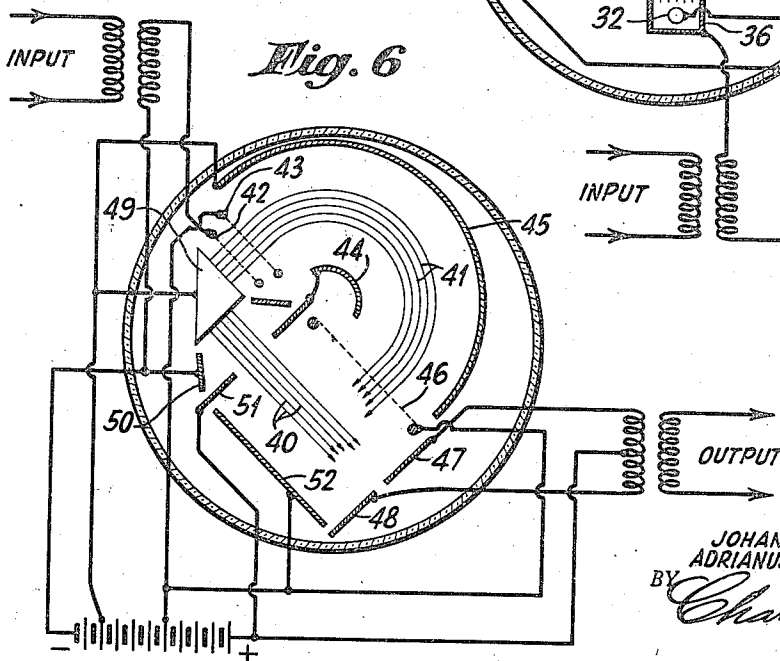


Fig. 6



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2,229,752

ELECTRON DISCHARGE DEVICE

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Application July 30, 1938, Serial No. 222,174
In Germany August 3, 1937

4 Claims. (Cl. 250—27.5)

This invention relates to an electron discharge tube wherein the electrons are united to form two or more beams which intersect each other. In the use of such tubes, which have been suggested and in which the electron beams intersect each other, a certain interference of these beams may occur in the discharge space.

The object of our invention is to provide such a tube in which one beam is accurately controlled by the space charge of another beam without undesirable interference of the beams.

In accordance with our invention an electron discharge tube in which the electrons are united to form two or more beams which intersect each other is provided with a grid-shaped electrode having a positive potential and positioned between at least one of the cathodes and a point of intersection of the beams, the various electrodes in the tube receiving such voltages that a virtual cathode appears at or in the immediate vicinity of the point or points of intersection of the electron beams.

We have found that although the use of a tube having a plurality of electron beams intersecting each other, without additional means, involves a certain interference, suitable control of one of the beams by means of the space charge of another beam is possible only when care is taken to cause a dense space charge or virtual cathode to appear at about the point of intersection of the beams. In this way the beams may be so adjusted with respect to each other that a characteristic curve having the desired form can be obtained. An important field of application of the present invention is to mixing tubes particularly where one beam is controlled by an oscillator frequency and another beam by the incoming frequency. Another field is in obtaining a very strong amplification by using several systems one behind the other, as will be set forth hereinafter with regard to the drawings.

In order to obtain a sufficient space charge at the point of intersection of the electron beam at least one grid having a positive potential is, according to the invention, provided between the cathode or cathodes and this point of intersection, and it has been found to be advantageous for the distribution of field that there be no insulating members such as the glass wall of the tube or the like in the vicinity of the point of intersection of the electron beams.

Although it is very simple and easy to use a separate cathode for each electron beam, and these separate cathodes may, if desired, have different potentials, a common cathode may also

be used for two or more electron beams, with which cathode the stream of electrons is divided by splitting up and deflection into a plurality of beams to be controlled separately. It is also possible to use either a separate anode for each system of beams or a common anode for all of the systems.

The invention will be more clearly understood by reference to the accompanying drawings representing diagrammatically and by way of example, several embodiments thereof.

In the accompanying drawings Figure 1 shows in section a deflection type tube; Figure 2 is a curve showing potential variation along the plane indicated by the section line; Figures 3 and 4 are modified forms of deflection tubes; Figure 5 is another form of tube in which one beam controls a second beam; and Figure 6 is a sectional view of a deflection type tube with two beams from one cathode.

Figure 1 shows a deflection type beam tube in which 1 and 2 are output anodes side by side which are in the path of and may be struck by a stream of electrons 4 issuing from a main cathode 5 in the form of a concentrated main beam. The electron beam 4 is deflected and controlled by another electron beam 7 issuing from another or auxiliary cathode 6. The electrons from both cathodes pass through a tubular or cage-like grid electrode 3 having a positive potential and constituting an auxiliary anode to which the discharge from the auxiliary cathode 6 flows, and the two beams intersect and influence each other in the space inside this grid electrode. Beam forming electrodes 8 having a low potential may be mounted behind and partially surround the cathodes 5 and 6 to concentrate the electron discharges into beams. Figure 2 shows by the curve 9 the variation of space potential along the plane or section 2—2 of the tube shown in Figure 1. When an electronic stream or beam 7 is directed from cathode 6 into the space inside the grid electrode 3 the potential along the plane 2—2 may vary according to the curve 10, so that the electrons deviate and impinge on the anode 2, as diagrammatically represented in Figure 1 by the beam 11. In this way deflection through a separate stream or beam of electrons is obtained.

Other control methods for influencing of the path so as to vary the distribution of current may be used, as shown, for example in Figure 3, in which the controlled or main stream or beam 15 of electrons is focused on a main output anode 12 by means of an electron optical system con-

sisting of a negative electrode 13, a positive electrode 16, an auxiliary anode consisting of two spaced members or concentrating electrodes 13 and 17 one of which, such as 13, is grid-like, and the other is a sheet-like member, both electrodes being maintained positive with reference to the auxiliary cathode 19. When an electronic stream 14 from the cathode 19, concentrated into a beam forming electrode 19^a behind the cathode, is directed through the grid electrode 13 into the space between 13 and 17 the electron optical system is disturbed, the main beam 15 is deflected and the greatest part of the controlled electronic stream passes to the auxiliary output anodes or electrodes 20 and 21 mounted on opposite sides of the main output anode 12.

Amplification can be obtained by repeating several times the action illustrated in Figure 3 since, by a suitable choice of the shape and dimensions of the electrodes and of the potentials applied, the electronic stream 14 may be much weaker than the current which, as a result of its influence, reaches the auxiliary output anodes 20 and 21. As illustrated in Figure 4, the current which passes the main anode 12 through grid-like auxiliary anodes 20 and 21 modifies the effect of the electron optical system which controls a third main beam 22, so that a very small primary control current 14 is sufficient for controlling a large tertiary current. In the tube shown in Figure 4 the parts corresponding to those shown in Figure 3 are denoted by the same references. The tertiary electronic current 22 may strike a main anode 23, and auxiliary output anodes 24 and 25, and is further influenced by the sheet electrode 26 and the diaphragm 27, both of which are at positive potential with reference to the cathodes. The cathode system consists of a cathode 28 surrounded by a beam forming electrode 29. Of course, the number of these units may be chosen at will so that very strong amplification is possible.

The amplification may be obtained by a modification of the electron optical system, as in Figure 3; by deflection, according to Figure 1, or by completely reversing or returning the electronic stream by the action of the space charge. Figure 5 shows a modification in which the operation, as appears from this figure, depends on returning the beam by the space charge 30 at the intersection of the beams. The tube illustrated in Figure 5 comprises two cathodes 31 and 32 from which emerge the beams 33 and 34. The cathodes are surrounded by electrodes 35 and 36 at a negative potential. Furthermore, the tube comprises a positive grid-like anode 37, a positive sheet electrode 38 and an output anode 39. By the choice of the voltages such a space charge 30 appears that the electrons of the beam 33 turn back and may return to the electrode 16.

The different electronic streams need not issue from different cathodes, since, as shown in Figure 6, the tube may be so made that the main electronic stream 40 is controlled by the electron beam 41 and the latter is controlled by a control grid 42. The suction grid or apertured auxiliary anode 43 sucks the electrons into the semi-annular passage between the curved sheet electrodes 44 and 45, of which the electrode 44 has a positive potential and the electrode 45 a negative potential, so that the electrons may gain access along curved paths through a positive grid electrode or auxiliary apertured anode 46 to the path of the electronic stream 40 and cause deflection, in which case the electronic stream 40 may reach

one of the main or output anodes 47 or 48, or by concentration variation, as in Figure 3. The two beams issue from a cathode 49, from which beam 40 is obtained by a system consisting of a negative electrode 50, a positive electrode 51, the apertured electrode 46, and the sheet auxiliary anode or positive electrode 52.

We claim:

1. An electron discharge amplifier comprising a first cathode, first anode, means for forming the discharge from said cathode to said anode into an electron beam, a second cathode, means for forming the discharge from said second cathode into a second beam intersecting the first beam, a grid-like electrode between said second cathode and the intersection of said beams, a third cathode, a final output anode, means for forming the discharge from said third cathode to said final anode into a third beam along a path near said first anode and transverse to the path of said first beam.

2. An electron discharge device comprising a pair of output anodes mounted side by side, means comprising a main cathode for producing a concentrated main electron beam to said output anodes, an auxiliary cathode, an auxiliary sheet anode member on the side of the path of said main beam opposite said auxiliary cathode, means for producing a second concentrated electron beam from said auxiliary cathode to said sheet member directed across the path of said main electron beam and parallel to the plane of said main output anodes, and a grid-like anode member extending across the path of said second electron beam between said auxiliary cathode and the intersection of said electron beams for producing at the intersection of said beams and between said auxiliary anode members a space charge sufficient to deflect said main beam from one of said output anodes toward the other.

3. An electron discharge device comprising an output anode, a main cathode, means for concentrating the discharge from said main cathode to said output anode into a main beam, an auxiliary cathode, an auxiliary anode comprising two spaced members on opposite sides of the path of said main beam, one of said members being apertured and positioned between said auxiliary cathode and the path of said main beam, and means for concentrating the electron discharge from said auxiliary cathode through said apertured member of said auxiliary anode into a beam which intersects said main beam to produce between said members and in the vicinity of the intersection of said beams a space charge sufficient to control said main beam.

4. An electron discharge device comprising an output anode, a main cathode, means for concentrating the discharge from said main cathode to said output anode into a main electron beam, an auxiliary cathode on one side of the path of said main beam, and an auxiliary anode comprising a sheet member on the opposite side of the path of said main beam from said auxiliary cathode and an apertured auxiliary anode member in registry with said sheet member and between said auxiliary cathode and the path of said main beam, and means for forming the discharge from said auxiliary cathode into an electron beam directed through said apertured auxiliary anode to intersect said main beam between said anode members.

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