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AMPLIFYING RELAY SYSTEM

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7 Claims. (Cl. 179—171)

My invention relates broadly to electron tube systems and more particularly to an amplifying relay system.

This application is a division of my application Serial No. 690,907, filed September 25, 1933, now Patent Number 2,096,653, and entitled Electron tube system.

One of the objects of my invention is to provide an electron tube system operative to increase the amplitude of electrical currents in extremely large ratios.

Another object of my invention is to provide an electron tube system operative in conjunction with a balanced electrical circuit for effecting high amplification of feeble electrical currents for effecting the control of electrical circuits and wherein a large amplification factor per stage is obtainable.

Still another object of my invention is to provide an electrical control circuit in which a shaped beam of electrons is angularly deflected over a prearranged plate assembly connected in different electrical circuits and in which the plate assembly comprises elements, the effective plane areas of which are varied with respect to each other for effecting a division in output current in circuits electrically connected with the elements of the plate assembly.

A further object of my invention is to provide an electronic discharge device including a plate assembly formed by a multiplicity of target elements which are preformed with respect to each other, so that the effective plane area of one element decreases while the effective plane area of an adjacent element increases, whereby a division in output current is effected by sweeping of the plate assembly by an electron beam.

A still further object of my invention is to provide improved means for deflecting the path of an electron beam in an electronic discharge device above or below a central axis in accordance with the character of the input control current.

Still another object of my invention is to provide an improved electronic control system wherein improved magnetic means are employed for controlling the angular movement of an electronic beam over a preformed plate assembly.

A further object of my invention is to provide an improved electronic control system wherein improved electrostatic means are employed for controlling the angular movement of an electronic beam over a preformed plate assembly.

A still further object of my invention is to provide a balanced circuit arrangement wherein the output is taken from two complementary ele-

ments of a plate assembly in an electron discharge tube.

Other and further objects of my invention reside in the amplifying relay system described in the specification hereinafter following, and by reference to the accompanying drawing, in which:

Figure 1 is a schematic diagram of the tube structure of my invention and the balanced electrical circuit connected therewith; Fig. 2 is a longitudinal sectional view taken through the electron stream deflection type tube on line 2—2 of Fig. 1; Fig. 3 is a cross sectional view of the tube structure of my invention taken on line 3—3 of Fig. 1, showing in elevational view, the plate assembly; Fig. 4 illustrates the flange and core assembly employed with the coil shown in Fig. 6, showing the means of mounting the magnetic control means on opposite sides of the tube when a magnetic core structure is used; Fig. 5 shows one form of the formative anode having a rectangular aperture therein which serves to form the electron beam and direct it towards the plate assembly in the tube structure of my invention; Fig. 6 shows the coil used in the magnetic control means; Fig. 7 is a diagrammatic illustration of the electrostatic control means used in lieu of the magnetic control system; and Fig. 8 illustrates a modified form of plate anode assembly which may be employed instead of the arrangement shown in Fig. 3.

Referring to the drawing in detail, the amplifying relay system of my invention employs an electron tube comprising an envelope shown at 1, of suitable material, preferably of glass and exhausted to a high degree of vacuum or filled with a gas or vapor of a composition generally employed in the art; a cathode element at 2, with heating means shown as a filament at 3, and a source of potential at 4; a formative and directive anode shown at 5, acting to pass a beam of electrons indicated at 11, of rectangular cross section in an essentially central line with respect to the plate assembly shown at 8; and magnetic control elements at 7 and 7', shown externally of the envelope 1.

The plate assembly shown at 8 comprises four separate elements disposed as shown in Fig. 3. Two of the elements, shown at 9 and 10, are in the form of right triangles, and are mounted to form a rectangle along the diagonal of which is a gap bounded by each hypotenuse, as shown at 12. That is to say, the effective plane area of element 9 decreases while the effective plane area of element 10 increases in one direction, and the

effective plane area of element 10 decreases while the effective plane area of element 9 increases in the opposite direction. Adjacent the ends of the rectangle thus formed, and separated slightly therefrom, are the other two elements of the plate assembly, shown at 14 and 15, which are rectangular in shape. Elements numbered 14 and 15 are connected respectively to elements numbered 9 and 10 of the plate assembly; that is, the rectangular plate on one end is connected to the triangular plate whose adjacent portion is the apex of the triangle and not the base. This cross connection serves to equalize the electrostatic field when one set of plates becomes of higher potential than the other, the plate areas charged by the different potentials being substantially equal as regards any division thereof with respect to the middle of the plate assembly.

The circuit shown in Figs. 1 and 2 comprises an input circuit consisting of the magnetic control coils 7 and 7' connected in parallel, and an output circuit consisting of connections at 16 and 17 from the plate assembly 8 to resistance elements at 18 and 19, respectively. The other terminals of resistance elements 18 and 19 are connected together and to the positive terminal of a source of direct current shown as a battery 20. The negative terminal of the battery at 20, is connected to the cathode through connection 21. The formative anode is energized from the positive terminal of a source of potential, shown as a battery 23, the negative terminal of which is connected to the cathode 2. As the input is conducted through the coils at 7 and 7', the electron beam is bent above or below the normal central position according to the character of the input energy. In varying above and below normal, the beam of electrons traverses an appreciable arc on the plate assembly 8. In the normal central position, equal portions of the beam fall on each of the triangular plates 9 and 10 of the plate assembly 8; but if the beam is bent upwards, more electrons fall on plate numbered 10 and fewer electrons fall on plate numbered 9; resulting in an increased current through the resistance at 19 and a decreased current through the resistance at 18. The changes of current result in changes in the potentials of the terminals at 24 and 25, raising the potential of the terminal at 24 and lowering the potential of the terminal at 25. Thus a wide variation of potential is possible. The output is taken from terminals 24 and 25. Impedances or transformers may also be employed in positions 18 and 19.

The formative and directive anode shown in perspective in Fig. 5, has a rectangular channel member shown at 6, projecting at 90° from the main plate structure at 5, which plate structure serves to shield the far end of the tube from all electrons emitted from the cathode at 2 except those electrons guided through the channel at 6.

Fig. 6 shows the coil employed in the magnetic control feature of my invention. The winding at 27 is supported by the circular form 28 having an opening at 29 of sufficient diameter to receive the core element shown at 30 of Fig. 4. The flange, shown at 31 in Fig. 4, on the core is shaped to produce a magnetic field of uniform intensity and of such shape as to embrace efficiently the electron beam. In Fig. 4 the magnetic yoke 22 is shown embracing the tube 1 and provided with removable pole tips 33, over which the cores 30 of magnetic control elements are mounted. The coils are of impedances congruant with the expected input and may be selectively varied in number and electrical values. To facilitate this interchangeability

of coils, the core pieces may be permanently attached to the exterior of the tube in position to control the electron beam, and selected coils interchangeably mounted thereon. The return magnetic circuit through yoke 22 insures maximum effectiveness of the magnetic control means.

Fig. 7 illustrates the electrostatic control means which may be employed in the system of my invention in cases where current sufficient to produce a magnetic field is lacking. The rectangular metal plates shown at 36 and 37 which constitute the electrostatic control means are supported within the tube envelope 1 in close proximity to the electron beam. The input is connected directly to the two elements of the electrostatic control means. The rest of the circuit is similar to that described in Fig. 1 or Fig. 2.

I may employ triangular shaped plates 59 and 60, as illustrated in Fig. 8, separated by a gap 61. The fact that the effective area of plate 59 decreases as the area of plate 60 increases, and vice versa, produces the required distribution of current through the electron stream.

In the magnetic control system, I have shown the control coils mounted upon a magnetic core, but I do not desire to have my invention limited to the use of magnetic cores, as I may provide the control coils with air cores thereby enabling the coils to readily function at high frequencies. Furthermore, it is not essential that the control coils be connected in parallel, as shown, for the coils may be disposed in series as well as in parallel. The structure of the tube of my invention is such, that the tube may function under control of currents of relatively large amplitude and the tube is not limited for operation under control of feeble currents. It is also advantageous in some forms of my invention, to employ a grid structure in lieu of the formative anode. Such a grid structure may control the electron stream more efficiently than is the case with the formative anode.

The voltage amplification possible with magnetic or electrostatic control of an electron beam far exceeds the amplification obtainable from any device yet made. The currents from the two plates produce voltages across two impedances. The one voltage goes up while the other goes down, thus producing large output voltages.

Employed as amplifiers in line wire, radio or public address systems, the system of my invention is adaptable for response to high or low frequency alternating or pulsating current or steady direct currents, by the use of either the electrostatic or magnetic control means, as set forth in the foregoing specification.

Although I have described my invention in certain of its preferred embodiments, I desire that it be understood that my invention is not to be limited thereby, but may be modified in arrangement, and no limitations are intended other than are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. An amplification system comprising an electron tube device having a cathode, a directive anode, and a receptive anode assembly comprising a pair of triangularly shaped plates arranged adjacent each other in the same plane and a pair of rectangularly shaped plates oppositely disposed adjacent the triangularly shaped plates and in the same plane, the rectangular plates being connected respectively to the triangular plate of less adjacent area so that the electrostatic field

between said triangularly shaped plates is maintained substantially equalized, said cathode and said directive anode adapted to form a beam of electrons of substantially rectangular cross-section received by said anode assembly within a rectangular area along a diagonal of which extend the adjacent edges of said triangularly shaped plates, means for deflecting said electron beam; said triangular plates being so arranged with respect to each other that upon deflection of the electron beam the amounts of electrons received by said plates vary inversely, the total amount of electrons received by said plates being constant; and an output circuit connected with said plates.

2. An amplification system comprising an electron tube device having a cathode, a directive anode, and a receptive anode assembly comprising a pair of triangularly shaped plates arranged adjacent each other in the same plane and means for maintaining the electrostatic field equalized between said adjacent plates, said cathode and said directive anode adapted to form a beam of electrons of substantially rectangular cross-section received by said anode assembly within a rectangular area along a diagonal of which extend the adjacent edges of said triangularly shaped plates, means for deflecting said electron beam; said plates being so arranged with respect to each other that upon deflection of the electron beam the amounts of electrons received by said plates vary inversely, the total amount of electrons received by said plates being constant; and an output circuit connected with said plates.

3. An amplification system comprising an electron tube device having a cathode, a directive anode, and a receptive anode assembly comprising a pair of triangularly shaped plates arranged adjacent each other in the same plane and means for maintaining the electrostatic field equalized between said adjacent plates, an output circuit connected with said plates; said cathode and said directive anode adapted to produce a beam of electrons of substantially rectangular cross-section directed towards said receptive anode assembly, and means for deflecting said electron beam, said plates being so arranged with respect to the cross-section of said electron beam that current flows in said output circuit in accordance with the deflection of said beam by virtue of the differential properties of the adjacent

triangularly shaped plates of said anode assembly.

4. An amplification system as described in claim 3 wherein said means for deflecting said electron beam comprise electromagnetic devices mounted adjacent the normal path of said beam and energized by the impressed signal energy.

5. An amplification system as described in claim 3 wherein said means for deflecting said electron beam comprise electrostatic devices mounted adjacent the normal path of said beam and energized by the impressed signal energy.

6. An amplification system comprising an electron tube device having a cathode, a formative anode, and an electrostatically balanced plate anode assembly including separate pluralities of electrically connected plate elements interposed adjacent each other in the same plane, a pair of impedance devices, one of said impedance devices connected at one end to a plurality of said elements, the other of said impedance devices connected at one end to a second plurality of said elements, an output circuit fed from said impedance devices; a source of potential having the positive terminal thereof connected in common to the other ends of said impedance devices, and the negative terminal thereof connected to said cathode; a second source of potential having the positive terminal thereof connected to said formative anode, and the negative terminal thereof connected to said cathode; means for controlling the path of electrons emitted from said cathode, and input terminals connected to said means.

7. An amplification system comprising an electron tube device having a cathode, a formative anode, and an electrostatically balanced plate anode assembly including separate pluralities of electrically connected plate elements interposed adjacent each other in the same plane, an output circuit connected with the separate pluralities of plate elements, said cathode and said formative anode adapted to produce a beam of electrons of substantially rectangular cross-section directed towards said plate assembly, and means for deflecting said electron beam, said plate elements being so arranged with respect to the cross-section of said electron beam that current flows in said output circuit in accordance with the deflection of said beam.

WALTER SOLLER.