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SYSTEM FOR SUCCESSIVE AMPLIFICATION OF ENERGIES.

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1,303,579. Patented May 13, 1919.

Fig. 1.

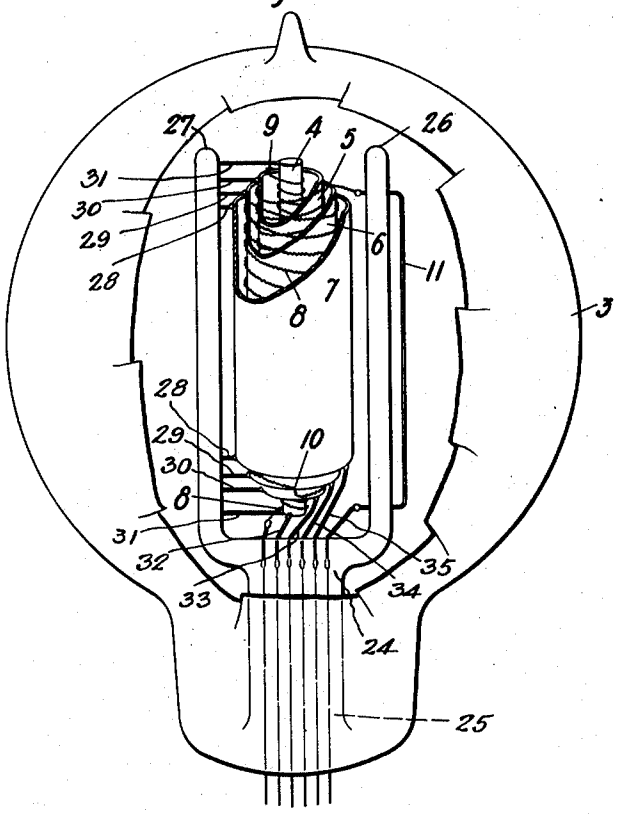
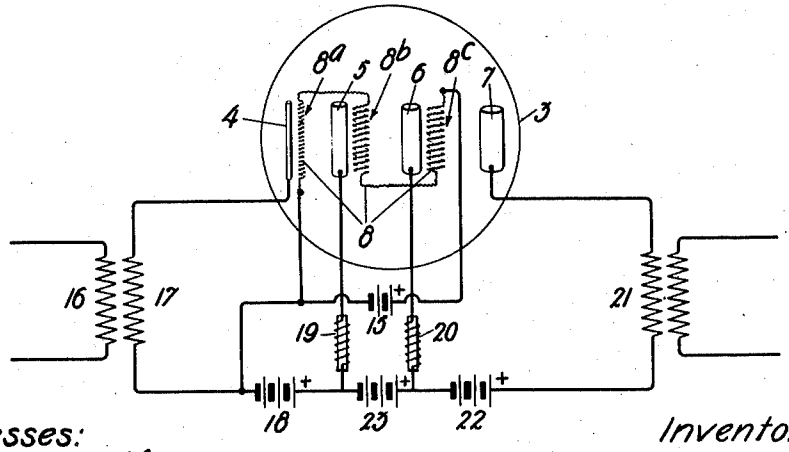


Fig. 2.



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UNITED STATES PATENT OFFICE.

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SYSTEM FOR SUCCESSIVE AMPLIFICATION OF ENERGIES.

1,303,579. Specification of Letters Patent. Patented May 13, 1919.

Application filed April 16, 1915. Serial No. 21,919.

To all whom it may concern:

Be it known that I, ALEXANDER McLEAN NICOLSON, a subject of the King of Great Britain, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Systems for Successive Amplification of Energies, of which the following is a full, clear, concise, and exact description.

This invention relates to systems for the successive amplification of energies and in particular to an adaptation of the audion principle to such a system. Its object is to provide a compact and economical arrangement whereby small energies may be put through successive stages of amplification and thus increased to any desired degree without the employment of intervening electromagnetic transformers.

In this invention, a plurality of input elements is employed, each being associated with a given section of a single cathode. The input is impressed between the first section of the cathode and its associated input element and serves to vary the discharge from said cathode section to another electrode which is maintained positive with respect to said cathode section. By inductively isolating it from the output circuit of the system, the electrode in question is made to function as an input element with reference to the second section of the cathode and, by virtue of the varying charge delivered to it from the first cathode section, is made to vary the discharge from the second cathode section to a second electrode maintained positive with respect to said section and which similarly may be made to serve the double function of an anode for said cathode section and an input element for a third section.

The invention resides further in the manner of arranging and mounting the electrodes within the evacuated envelop.

This invention will be more readily understood by reference to the accompanying drawing in which Figure 1 represents a device of the type in question with electrodes arranged for the successive energy amplifications and Fig. 2 shows diagrammatically a typical circuit arrangement for employing such device in a system for the amplification of telephonic and similar currents.

Referring in detail to Fig. 1, 3 is an evacuated vessel containing a group of concentrically arranged cylindrical electrodes 4, 5, 6 and 7. A filamentary cathode 8 is wound first about the outer surface of electrode 4, passing from electrode 4 to electrode 5 as at 9 and from electrode 5 to electrode 6 as at 10 and from electrode 6 to the leading-in wire 11. The electrodes 4, 5, 6 and 7 are preferably made of nickel, and in the case of 4, 5 and 6 the outer surface is oxidized so as to form a dielectric or insulating film between the cathode filament 8 and the electrode on which such filament is wound. The operation of the device in question as an amplifier of energies will be more clearly understood by reference to Fig. 2. In this figure 8_a is that section of the filament which is wound on electrode 4 and 8_b and 8_c are those sections which are wound on electrodes 5 and 6, respectively. The filament 8, as a whole, is heated to incandescence by a battery 15 and the input is impressed between this filament and the main input electrode 4 by means of the transformer secondary 17, the primary 16 of which is connected to the source of telephonic or other currents of varying frequency to be amplified. The electrode 5 which is maintained positive with respect to the cathode section 8_a by battery 18 serves as an anode with respect to this cathode section and with respect to the input electrode 4, and receives a varying charge by virtue of the variation in thermionic current flowing from the cathode section in question produced by the varying electromotive force of the input energy. The electrode 5, instead of being directly connected to the output circuit, as in former audion arrangements, is here inductively isolated therefrom by the impedance coil 19. The varying charge thus received by electrode 5 causes it to act as an input electrode for the cathode section 8_b by varying the thermionic current from said cathode section to its inclosing cylindrical electrode 6, which in turn is inductively isolated from the output circuit by impedance coil 20 and serves as an input electrode for the cathode section 8_c. The anode 7, associated with this cathode section 8_c is included in the output circuit which comprises transformer primary 21, batteries 22, 23 and 18 and cathode 8.

As shown in Fig. 1, the vacuum tube 3 contains the usual press 24, in which the lead wires to the various electrodes are mounted.

Arising from the tubular column 25, of which the press 24 is the termination, are the arbors 26 and 27. Mounted in the arbor 26 is the lead wire 11 by means of which electrical connection may be made with the filamentary electrode sections. Mounted on the arbor 27 are a plurality of laterally extending supporting connections 28, 29, 30 and 31 provided at both the top and the bottom of the cylindrical electrodes, these wires being connected at one end to these electrodes and at their other ends to the arbor 27. The wires 32, 33, 34 and 35 which form a continuation of the lead wires to which they are connected are relatively heavy as shown, and serve to assist in supporting and properly positioning the cylindrical electrodes.

It is important that in the arrangement shown the filament section 8_a be connected to the negative terminal of battery 15 and that section 8_c be connected to the positive terminal of the said battery. Thus, because of the potential drop in the filament 8 as a whole due to the flow of heating current through it, the section 8_a will be more negative with respect to electrode 5 than will section 8_b, and similarly, section 8_b will be more negative with respect to electrode 6 than will section 8_c.

In the particular arrangement depicted the input energy is subjected to three distinct stages of amplification by what is the equivalent of three distinct audion arrangements. The first of these arrangements comprises electrode 4 as an input electrode, filament section 8_a as cathode and electrode 5 as anode. The second comprises electrode 5 as input electrode, filament section 8_b as cathode and electrode 6 as anode, while the third comprises electrode 6 as input electrode, filament section 8_c as cathode and electrode 7 as the final anode and output electrode. The battery 23 makes anode 6 more positive than anode 5, while anode 7 is more positive than anode 6 by reason of battery 22. Each anode is thus more positive than the one preceding.

It is obvious that the system can be extended to include further stages of amplification as desired. An inspection of Fig. 2 will show that the total amplification may be obtained with only two more electrodes than the number of stages of amplification employed, whereas an equivalent amplification of energies by audions arranged in cascade formation will require at least three electrodes for each stage of amplification. The invention as thus seen provides an extremely compact and economical arrangement for the large amplification of energies.

It will further be noted that the arrangement shown provides at each succeeding stage of amplification an input electrode and cathode area of larger size than at the preceding stage, and that thereby there is obtained at each stage an input capacity proportioned to the amount of energy to be amplified.

What is claimed is:

1. A thermionic device comprising a plurality of electrodes adapted to be supplied with current to provide a plurality of space current paths, and connections to said electrodes whereby one of them is adapted to operate as an input element for one of said paths and as an anode for another of said paths.

2. A plurality of thermionic energy amplifying units of the three electrode type combined in a system in which one of said electrodes serves as the control electrode of one of said units and the anode of another of said units.

3. A thermionic energy amplifying device comprising an evacuated vessel, a plurality of concentrically arranged cylindrical electrodes therein, a filamentary cathode successively wound upon said electrode and a cylindrical anode concentrically surrounding said electrodes.

4. In a system for the successive amplification of energies, a distributed cathode having a succession of thermionically active sections, an electrode adjacent each of said sections except the first, each electrode serving as an input electrode for the cathode section individual thereto and as an anode for the next preceding cathode section.

5. In a system for the successive amplification of energies a thermionically active cathode having a plurality of serially connected sections, an input element adjacent the first of said sections, an electrode adjacent each of the other of said sections, each of said electrodes serving as an input electrode for the cathode section individual thereto and as an anode for the preceding cathode section, and an anode opposite the last of said cathode sections.

6. The combination with an evacuated vessel, of a plurality of concentric electrodes therein adapted to function simultaneously as anodes.

7. The combination with a vacuum tube, of a plurality of concentric electrodes therein, the inner of said electrodes having the greater effective length, and a supporting arm attached laterally to the inner of said electrodes.

8. The combination with a vacuum tube, of a plurality of concentric electrodes therein, the inner of said electrodes having the greatest effective length, the other of said electrodes having lengths progressively smaller, and a supporting arm attached laterally to each of the inner ones of said electrodes.

9. A thermionic device comprising a plurality of extended cathode surfaces, one of which surrounds another, and means for

heating said surfaces to cause them to emit electrons.

10. A thermionic device comprising a plurality of extended cathode surfaces, one of which surrounds another and means for heating one of said surfaces to cause it to emit electrons.

11. A thermionic device comprising a plurality of helical electrode sections, one of which surrounds another.

12. An audion containing an anode, a cathode, means for energizing said cathode to cause it to emit electrons and an auxiliary electrode, said cathode surrounding said anode and said auxiliary electrode.

13. An evacuated vessel containing a cathode, means for energizing said cathode to cause it to emit electrons, and a plurality of other electrodes surrounded by said cathode.

14. An evacuated vessel comprising a hollow cylindrical anode, a filamentary electrode surrounding said anode, an auxiliary electrode between said filamentary electrode and said anode, and means for energizing one of said electrodes to cause it to emit electrons.

15. A thermionic device comprising a plurality of concentric helical electrodes, and an anode surrounding said electrodes.

16. A thermionic device comprising a helical filamentary cathode, an anode surrounding said cathode, a press, and a supporting connection from said press to said anode, said supporting connection being located outside of said anode.

17. A thermionic device comprising a plurality of concentric cylindrical electrode surfaces, a press and supporting connections from said electrodes to said press and located outside of said electrodes.

18. A thermionic device comprising a control electrode, an anode surrounding said electrode, a cathode extending laterally beyond the center of said anode, a press, and a supporting connection from said press to said anode and located outside of said anode.

19. A thermionic device comprising a control electrode, an anode surrounding said control electrode, and a cathode within said control electrode and symmetrically disposed about an axis of said anode.

20. A thermionic device comprising a cathode, an anode surrounding said cathode, a control electrode between said cathode and said anode, a single press within said tube, and supporting connections for said electrodes extending beyond said press.

21. A thermionic device comprising a control electrode, a cathode, an anode surrounding said control electrode and cathode, a press through which electrical connection to said electrode is adapted to be made, and means outside of said cathode for supporting said electrodes.

22. A thermionic device comprising an evacuated vessel, a press, a control electrode, an anode surrounding said control electrode, a cathode within said control electrode and extending laterally beyond the longitudinal axis of said anode, and supporting connections between said electrodes and said press.

23. A three stage thermionic amplifier comprising not more than seven electrodes.

24. A multi-stage thermionic amplifier comprising less than six electrodes, a plurality of which are anodes, and a metallic connection comprising a source of direct current between each anode and a cathode.

25. A thermionic system comprising a plurality of audion elements each comprising a cathode, an anode and a control electrode, a plurality of said anodes being concentrically arranged.

26. A multi-stage amplifier comprising a plurality of audion elements each comprising cathode, anode and control electrodes, one of said electrodes for one of said elements being positioned and connected to serve as another of said electrodes for another of said elements.

27. A multi-stage amplifier comprising more than two audion elements each comprising cathode, anode and control electrodes, a plurality of said electrodes being connected and positioned to operate as anodes for certain audion elements and also as control electrodes for other audion elements.

28. A thermionic amplifier comprising a plurality of electrodes, a circuit for energizing said electrodes comprising three sources of direct current similarly connected in series, and connections from said sources to said electrodes.

29. A thermionic amplifier comprising a plurality of anodes, a circuit for energizing said anodes comprising a plurality of sources of direct current similarly connected in series, and a reactive lead from said circuit to each of said anodes.

30. A thermionic amplifier comprising a plurality of anodes, a circuit for energizing said anodes comprising a plurality of sources of current connected in series, and a connection from a point between adjacent sources to one of said anodes, said connection comprising an impedance device.

31. A thermionic amplifier comprising a plurality of anodes, a circuit for energizing said anodes comprising a plurality of sources of current connected in series, and a connection from a point between adjacent sources to one of said anodes, said connection comprising a choke coil.

32. A thermionic device comprising a cathode to be heated, and a plurality of anodes associated therewith providing a plurality of sets of electron paths, an anode for one of said sets of paths being positioned and connected to serve as the control electrode for another of said sets of paths.

33. A thermionic device comprising electrodes providing simultaneously a plurality of concentric sets of electron paths.

34. A thermionic device comprising cathode and anode surfaces providing simultaneously a plurality of concentric sets of electron paths.

35. A thermionic device comprising cathode, anode and control electrode surfaces providing a plurality of concentric sets of electron paths.

36. A thermionic device comprising concentric electrodes providing more than two concentric sets of electron paths.

37. In a thermionic amplifier comprising a cathode and a series of anodes, means for maintaining each successive anode after the first more positive than the one next preceding.

38. A thermionic amplifier comprising a plurality of anodes, and means for maintaining one of said anodes more positive than another one.

39. A thermionic amplifier comprising an evacuated vessel, a plurality of anodes therein, and means for maintaining one of said anodes more positive than another one.

40. A thermionic amplifier comprising a plurality of anodes, and a source of direct current connected between two of said anodes for maintaining one of said anodes at a different potential from another one.

41. A thermionic device comprising an evacuated vessel, a plurality of electrodes therein, a source of direct current for energizing said electrodes, a connection from the positive terminal and from the negative terminal of said source to said electrodes, a choke coil in each of said connections, and means for supplying to said device the alternating impulses to be repeated.

42. A thermionic device comprising anode, cathode and control electrodes, means for supplying alternating impulses to said control electrode, a source of direct current for energizing said electrodes, a connection from each terminal of said source to one of said electrodes, and a choke coil in each of said connections.

43. A thermionic device comprising means for simultaneously producing a plurality of concentric sets of electron streams, means for controlling one of said streams, and means responsive to an effect produced by one of said streams.

44. A thermionic amplifier comprising means for simultaneously producing a plurality of concentric sets of electron streams, said means comprising cathode and anode surfaces for each stream.

45. A thermionic amplifier comprising means for producing a plurality of concentric sets of electron streams, said means comprising cathode, anode and control electrode surfaces for each stream.

46. A thermionic device comprising a plurality of concentric anodes, a cathode surface between two of said anodes, and means for heating said cathode to cause it to emit electrons.

47. A thermionic device comprising a plurality of concentric anodes, a cathode surface between two of said anodes, and a cathode surface surrounded by both of said anodes.

48. A thermionic device comprising a plurality of concentric anodes, a cathode surface between two of said anodes, a cathode surface surrounded by both of said anodes, and means for heating said cathode surfaces to cause them to emit electrons.

In witness whereof, I hereunto subscribe my name this 14th day of April, A. D. 1915.

ALEXANDER McLEAN NICOLSON.