July 3, 1928. 1,675,334

H. P. DONLE

ELECTRON DEVICE

Filed June 9, 1922 2 Sheets-Sheet 1

Fig. 1.

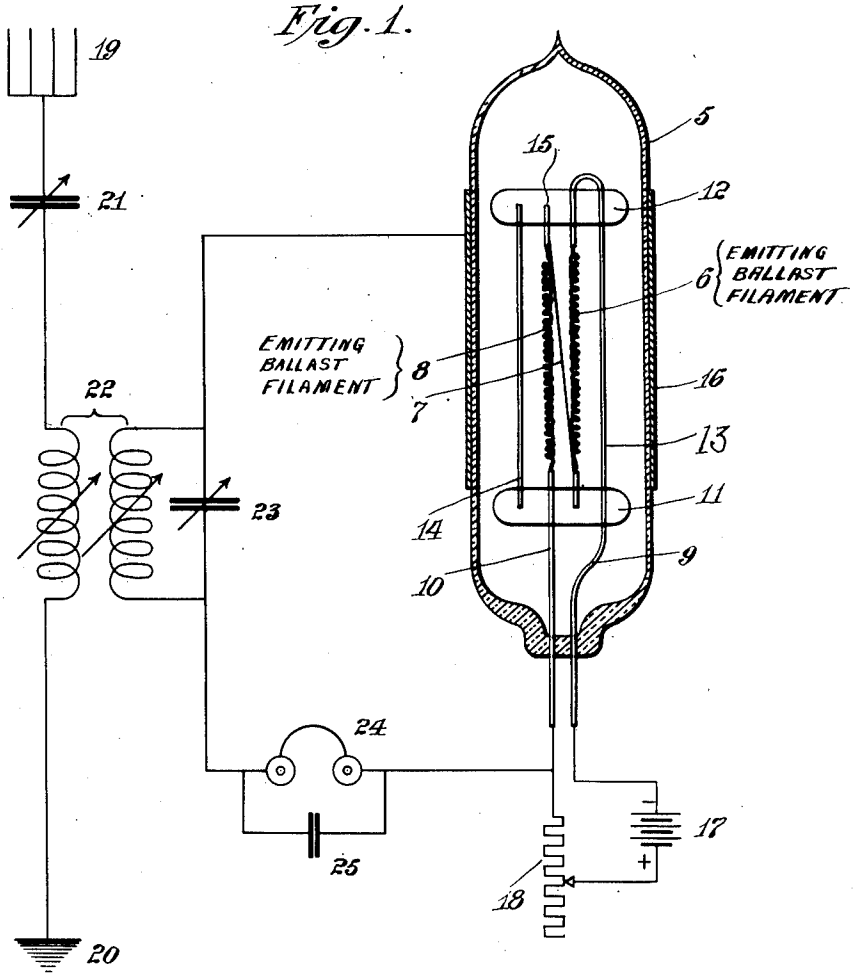

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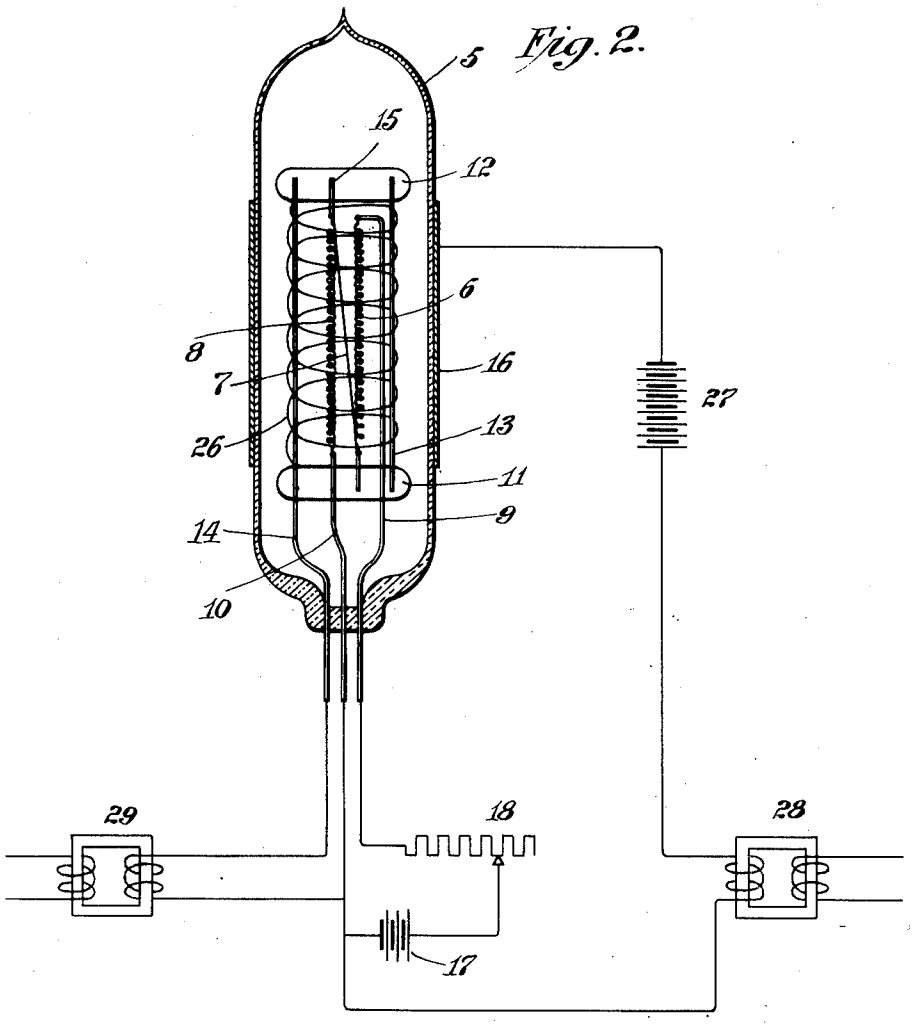
Fig. 2.



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UNITED STATES PATENT OFFICE.

HAROLD POTTER DONLE, OF MERIDEN, CONNECTICUT, ASSIGNOR, BY MESNE ASSIGNMENTS, TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE.

ELECTRON DEVICE.

Application filed June 9, 1922. Serial No. 566,969.

My invention relates particularly to a construction to be used for the conversion, modification, or amplification of alternating current power. One of the forms shown is designed for use as a detector, and the other as an amplifier, which may be used for radio signalling purposes and the like.

Expressed in its simplest terms, the invention contemplates a vacuum tube device in which the electron emitting filament is formed of a plurality of parts arranged in series, one part of which has a greater electron emitting power than another part which may serve not only as a supplemental emitting and heating element, but also as a ballasting coil, tending to keep the current in the circuit uniform. I have discovered that such a construction when applied for the purpose of detection or amplification, affords very desirable characteristics. The invention is especially applicable to a tube having an external anode in which the heat from the filament is utilized to increase the conductivity of the glass.

Figure 1 shows in longitudinal section a tube embodying the improvements of my invention connected as a detector in one form of circuit.

Fig. 2 shows a modified form of tube embodying my invention and arranged in a circuit for amplification of alternating currents.

In Fig. 1 the tube 5 may be of any suitable construction such as glass commonly employed in vacuum tube and lamp construction and evacuated to a high degree. The heating filament consists of a plurality of parts, for instance, three parts 6, 7, and 8 connected to each other serially in the order named. This filament may conveniently be supported by means of brackets 9 and 10 sealed in one end of the tube. For added security I may employ insulating buttons 11 and 12, for instance of glass. The brackets 9 and 10 are connected to the button 11, and the buttons 11 and 12 are connected for instance by means of supports 13 and 14, one of which may be integral with a bracket, as 9. The common connection on the filament parts 7 and 8 may be conveniently supported by a member 15 secured in the insulating button 12.

The anode 16 is preferably of suitable material mounted on the outside of the tube surrounding the control member.

The filament is heated from a battery 17, and the filament current may be adjusted by the rheostat 18.

Associated with the tube 5 there is provided the usual antenna 19 connected to ground 20 through a tuning condenser 21 and the primary of a radio frequency transformer 22. The secondary of this transformer is shown as having a secondary tuning condenser 23 connected across its terminals. Radio frequency voltages developed in the secondary of the transformer 22 are impressed on the anode 16 and the cathode 10 by way of the telephones 24 and by-pass condenser 25. The detector acts in the well known way to convert variations in the applied radio frequency currents to current variations of audible frequency which produce signal responses in the telephones 24.

The stepped, or, in effect, tapered, filament 6, 7, and 8 when heated to normal operating incandescence emits electrons throughout its length. In the form shown in Fig. 1 the total drop of potential across the filament terminals is distributed in three parts respectively across the portions 6, 7, and 8. I find it convenient to distribute the voltage drop equally over these three steps, so that if the total filament drop is 4½ volts, there will be a difference in potential of 1½ volts across each of the three steps. The central portion 7 I prefer to make of somewhat finer wire than the other portions, so that with the same current flowing through all, this central portion 7 will be heated to a somewhat higher temperature and consequently will emit, per unit length, somewhat more electrons than will any of the remaining parts. Thus I provide a substantial percentage of the total electron flow utilized in the device from a step in the cathode having a total difference of potential of as little as 1½ volts. However, my invention makes possible the effective utilization of the heat developed and the ballasting function exhibited by the steps of my cathode through which the balance of the cathode potential fall exists and I am thus enabled to secure the increased conductivity of the wall of the tube 5 supporting the external anode 16 in addition to a beneficial regulating effect. The outer steps of the cathode 6 and 8 may conveniently be coiled so as to concentrate their heating effects at the portions of the tube where they are most useful, and also so

as to confine the electron emission from these portions of the filament to the part of the tube directly adjacent the anode. Since these outer steps 6 and 8 are not heated to as high a temperature as the central step 7, they act as ballast resistances, or in other words, they show a tendency to permit for a given voltage decrease, greater current flow through the entire stepped cathode than would be possible with the use of a simple filament circuit of straight line temperature coefficient characteristics. Thus, it is not necessary to rely upon the rheostat 18 for adjustment of cathode temperature to the extent which has been the case heretofore in vacuum tubes using simple filaments.

In Fig. 2 I have shown a similar stepped filament having three parts applied to an electron device especially adapted for amplification of alternating currents. The filament, anode, tube, heating battery, and rheostat are marked with reference numerals as in the case of Fig. 1. There is provided additionally a control member 26 which may conveniently be wound upon the supports 13 and 14, the latter being continued through the base of the tube 5 so as to provide electrical connection to this supplementary control electrode. There is also shown in Fig. 2, a battery 27 connected between the cathode and the anode 16, its circuit passing through the primary of an output transformer 28. Associated with the control electrode 26 is the secondary circuit of an input transformer 29.

Electrical variations applied to the primary of the input transformer 29 produce in the secondary thereof corresponding voltages which are impressed upon the control member 26. The potential variations of this electrode cause corresponding but augmented or amplified fluctuations in the current from battery 27 passing through the tube 5 from anode 16 and the primary of output transformer 28. The secondary of the output transformer may be connected to any device, such as a telephone receiver or loud speaker which will serve to reproduce these augmented or amplified variations. It will be understood that the reproducing device may alternately be connected directly in circuit with the battery 27 in place of the primary of the output transformer 28.

I consider that a more or less ideal uniformity of action is attained with a small cathode having a small difference of potential between its terminals. There are, however, practical limitations in the construction of such a device. My invention makes it possible to secure great uniformity of electron emission, and at the same time produce sufficient heat to satisfactorily operate an external anode device without overheating any portion of the filamentary cathode. By the use of my new construction, I am able to increase the gauge of the wire used in a substantial part of the filament and thus to prolong its life without sacrificing any important operating characteristic of the tube. Moreover, since the larger part of the electron stream is secured from the central step of the cathode over which there is a small drop of potential, my construction is particularly valuable in electron devices operating on relatively low anode voltages.

I claim:

1. An electron device construction comprising an evacuated tube, a heating filament within the tube comprising two portions connected in series but arranged alongside of each other, one portion being straight and the other being in the form of a coil and operating at a lower temperature than the straight portion and constituting a ballasting member, an anode and a third electrode.

2. An electron device comprising an evacuated tube, a heating filament therein consisting of three serially connected parts arranged alongside of each other, the central part being of such a size as to materially exceed the emissive power of the lateral parts, and an anode outside said tube.

3. An electron device construction comprising an evacuated tube, a heating filament within the tube comprising two portions connected in series but arranged alongside of each other both portions being capable of electronic emission but one portion being in the form of a heating coil operating at a lower temperature than the other and constituting a ballasting member, the other member being outside of the coil, an anode and a third electrode.

4. An electron device comprising an evacuated tube, a heating filament therein consisting of three serially connected parts arranged alongside of each other, the central part being of such a size as to materially exceed the emissive power of the lateral parts, the lateral parts being in the form of heating coils, and an anode.

5. An amplifier construction comprising an evacuated tube, a heating filament within the tube comprising two portions connected in series but arranged alongside of each other both portions being capable of electronic emission, but one portion operating at a lower temperature than the other and constituting a ballasting member, an anode, said other portion being connected outside of said one portion, and a control member interposed in the path of electronic emission.

6. An electron device comprising a tube containing a filament consisting of two heating coils and an interposed more intensely emitting section in series therewith, and an anode.

7. An electron device comprising an evac-

uated tube, a filamentary cathode therein having a main portion and a ballasting coil alongside thereof and connected in series therewith and of substantially the same length but heavier gage of wire, an anode and a third electrode.

8. An electron device comprising an evacuated tube, a filamentary cathode therein having a main emitting portion and a supplemental emitting and ballasting coil portion alongside thereof but of larger diameter wire and in series therewith, and an anode arranged in electron receiving relation with respect to both portions, the resistance of the ballasting coil portion being at least as great as that of the main portion.

HAROLD POTTER DONLE.