Jan. 13, 1931. A. MAVROGENIS 1,789,186

ELECTRON DISCHARGE DEVICE

Filed Nov. 3, 1926

Fig. 1

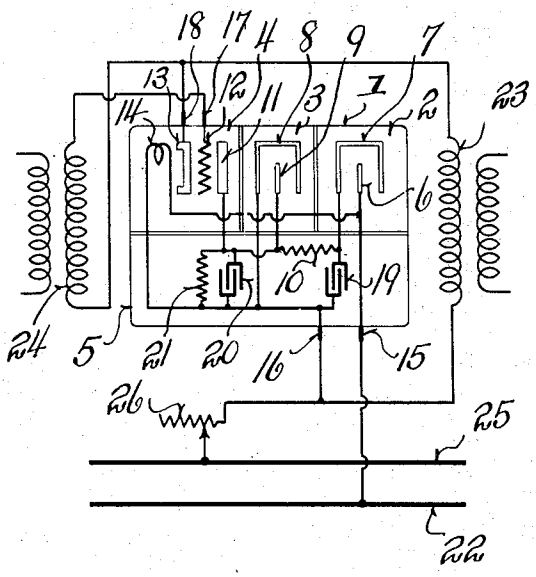
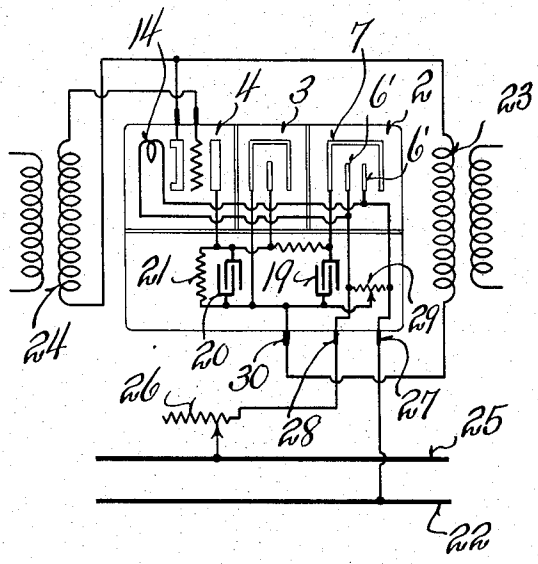


Fig. 2



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UNITED STATES PATENT OFFICE

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ELECTRON-DISCHARGE DEVICE

Application filed November 3, 1926. Serial No. 145,940.

This invention relates to electron discharge devices, and is particularly directed to an electron discharge device in which all of the parts may be energized from commercial alternating current mains.

Further objects are to provide a device of this nature which may be used in radio work as a detector or amplifier without the necessity of using either filament or plate batteries, and in which all hum or disturbance is eliminated.

This invention deals with the general type of electron discharge device, such as disclosed in my Patent No. 1,570,444, of January 19, 1926, for wireless apparatus; and as disclosed in my Patent No. 1,638,499, August 9, 1927, for electron discharge devices; and my copending application No. 78,877, filed January 2, 1926, for wireless receiving apparatus; and in my Patents, No. 1,616,914 of February 8, 1927, and No. 1,629,171, of May 17, 1927, for electron discharge devices.

In general, this invention has for its object the provision of a novel form of electron discharge device in which a rectifier, a voltage limiting or control device, and an audion are employed in the same vessel preferably, however, with the three essential elements divided out or separated from each other by the glass or other walls of the vessel, so that the conditions of gas pressure or vacuum obtaining in the several chambers, and also the character of the atmosphere or gas therein may be maintained distinct and separate to secure the best working of the several elements.

Further objects are to provide a unitary electron discharge device in which the rectifier and voltage limiting apparatus are more robust and mechanically stronger, and are not so liable to break in handling or shipping, or to burn out in use, as the pure electron emission apparatus consisting of a heated filament and associated parts.

Further objects are to provide an electron discharge device which may be very cheaply constructed, which is reliable in operation, and which may be used with the utmost facility.

Embodiments of the invention are shown in the accompanying drawings in which:—

Figure 1 is a diagrammatic view of one form of the invention;

Figure 2 is a diagrammatic view showing a further form of the invention corresponding to Figure 1, but showing an apparatus adapted for full rectification.

Referring to Figure 1, it will be seen that the apparatus comprises a glass or similar vessel 1 which is provided with three distinct and separate compartments or chambers 2, 3, and 4, and also which is provided with a neck portion 5, the neck portion being preferably open to the air and providing a storage space for the condensers and resistances hereinafter mentioned. Each of the compartments, 2, 3, and 4, is, as stated, distinct and separate and is completely walled off from the rest of the apparatus by the glass walls of the vessel, as indicated diagrammatically in the drawings.

Within the compartment 2 a rectifier is employed in which a relatively small cylindrical anode 6 is located centrally within a relatively large tubular or cylindrical electrode 7. Preferably, the compartment 2 contains a rarefied atmosphere of a gas of the helium group or else a mixture of such gases with the pressure such as to maintain a gaseous discharge between the electrodes 6 and 7. The electrodes may be made of any suitable metal with the cathode, however, preferably formed of a metal of the alkali group.

The next compartment 3 contains a similar arrangement of electrodes and gaseous atmosphere, the cathode 8 and the anode 9 of this apparatus constituting a voltage limiting device or in effect a bypassing device, as will appear hereinafter as the description proceeds. The anode 9 of the last described device is connected to the cathode 8 of the rectifier by means of a resistance 10.

The next compartment 4 contains an audion which consists of a plate 11, a grid 12, an equipotential cathode 13, and a filament 14.

Four prongs extend out of the apparatus, as indicated at 15, 16, 17, and 18. Preferably, these prongs extend out of the base of the apparatus, although for convenience of illustration they have been otherwise

shown in Figure 1. It is to be understood, however, that they may extend out of any portion of the apparatus.

Within the hollow neck 5 which is surrounded by the base of the apparatus in the usual manner, the resistance 10 is located together with a storage condenser 19, a bypass condenser 20, and a bypass resistance 21.

The anode 6 of the rectifier is connected to the prong 15 and from thence to one of the city mains 22. The cathode of the rectifier is connected to one end of the resistance 10, and to one side of the storage condenser 19. The other side of the storage condenser is connected to the prong 16. Further, it is to be noted that the two ends of the filament are connected to the anode 6 and the prong 16 and to the prong 16 and the other side of the storage condenser 19. The cathode 8 of the bypassing or voltage limiting apparatus is connected to the prong 16 and consequently to one side of the condenser 19. The anode 9 of such apparatus is, as stated, connected to one end of the resistance 10. It is also connected to the anode or plate 11 of the audion and to one side of the bypass condenser 20. The other side of the condenser 20 is connected to the prong 16. The condenser 20 is shunted by means of the resistance 21, such resistance preferably having a relatively high value.

It is to be noted that the audion cathode 13 is connected to the prong 18 and from thence to the primary 23 of a transformer or other translating or output device, the other side of this primary being connected to the prong 16. In effect, therefore, it is apparent that the condenser 20 and resistance 21 bridges the audion and forms a bypass around the audion. Further, it will be noted that the cathode 13 is connected to one side of the input apparatus or secondary 24 of a transformer, the other side of such transformer being connected through the prong 17 to the grid 12.

The prong 16 is connected to the other main 25 through a variable resistance 26 so that the voltage supplied the apparatus as well as the filament may be simultaneously controlled. The several compartments 2, 3, and 4 have their gaseous contents so constituted and of such rarefication as required for the several devices. The compartments 2 and 3 have been previously described and it is to be noted that the compartment 4 which contains the audion may have an extremely low pressure so that a pure electron emission is secured from the heated cathode 13 or else this apparatus may constitute in effect a gas tube of the well known type.

The materials of the electrodes 8 and 9 of the apparatus in the compartment 3 and the gases and pressure therein are so chosen that the device has a voltage-current characteristic which has a substantial portion thereof parallel to the current axis, whereby a relatively great change in current flow may occur through the apparatus without appreciably altering the voltage between its terminals. Consequently, when the rectifier supplies pulsating unidirectional current and charges the storage condenser 19, such condenser discharges through the resistance 10 across which a voltage drop occurs. However, the apparatus in the vessel 3 constitutes in effect means for securing a constant difference of potential between the end of the resistance 10 which is connected to the anode 9 and the prong 16 as it bypasses any excess current. In other words, a constant difference of potential is maintained between the audion anode 11 and the prong 16 which is connected through the output primary 23 to the cathode 13 of the audion.

To further explain the operation of the voltage limiting device and the associated parts, attention is called to the fact that the storage condenser 19 furnishes pulsating unidirectional current through the resistance 10 to the voltage limiting device, such condenser having its other side connected to the prong 16. The voltage limiting device is so constructed that it has a portion of its voltage-current characteristic substantially parallel to the current axis so that after a predetermined point is reached, any further increase in voltage produces a large current flow through the voltage limiting device. The voltage limiting device is bypassed or shunted across the resistance 21 and consequently it furnishes a parallel path to the resistance 21. Any increase in voltage across the condenser merely produces an increased current flow through the voltage limiting device which bypasses this increase in current and thus does not allow current to increase through the resistance 21. Thus, at the critical voltage, the ionization starts in the voltage limiting device and thus short circuits the excess current and maintains a constant current through the resistance 21. The potential difference between the ends of the resistance 21 is therefore constant. One end of the resistance is connected to the anode 11 of the audion and the other end of the resistance is connected through the prong 16 and the primary 23 of the output circuit to the cathode 13 of the audion. Thus a substantially constant voltage is impressed upon the audion and the audion is permitted to function in its usual capacity. The condenser 20 and resistance 21 furnishes a bypass around the audion to take care of any variations that may occur due to variations in the signals received by the audion and consequently variations in the demand made upon the apparatus.

The apparatus illustrated in Figure 2 is substantially the same as that described in Figure 1, except that full rectification is pro-

vided. The three compartments 2, 3, and 4 are arranged as previously described. However, two anodes 6′ are provided which cooperate with the cathode 7 of the rectifier. Further, the ends of the filament 14 are connected to these two anodes and such anodes are connected to the prongs 27 and 28, such prongs being in turn connected to the city mains 22 and 25 through a variable resistance 26. The anodes 6′ of the rectifier are bridged by a relatively high resistance 29 and the center point of this resistance is connected to a fifth prong 30, such prong being connected to one end of the secondary 23 of the output transformer. Further, the bypass resistance 21 and bypass condenser 20 and storage condenser 19 each have one end connected to this prong 30 and to the neutral or center point of the resistance 29. Otherwise the connections are the same as those previously described.

In this form of the invention, it is apparent that the storage condenser may be relatively smaller than that previously described as full rectification is secured and consequently the condenser is charged twice during each cycle.

It will be seen that this invention discloses a novel form of electron discharge device in which three distinct compartments may be employed for the three main elements of the device and in which the selection of gas and pressure for each compartment may be individually made.

Further, it is to be noted that in the two forms of the invention shown in Figures 1 and 2, a constant voltage apparatus is employed for maintaining constant voltage at the audion plate.

It will be seen further that the apparatus is very sturdy and is not liable to burning out, particularly with regard to the rectifier and voltage limiting device. Further, these devices are relatively simple and consequently the apparatus may be very cheaply constructed.

It will be seen that an ionic rectifier has been provided which is very sturdy in construction and not subject to burning out. It is to be understood that by the term "ionic" rectifier is meant any type of rectifier in which the principal agents carrying the current between the electrodes are ions either produced by collision or else already in existence in the gaseous atmosphere of the compartment.

Further, it is to be noted that the invention is not to be limited to any particular type of voltage limiting device as regards the controlling elements, the nature of pressure of the gas, or other features of this type.

Further, it is to be noted that the term "audion" is intended to cover either a detector, an amplifier, a pure electron emission device for radio reception, or a gas or vapor tube.

Although the invention has been described in considerable detail, such description is intended as illustrative rather than limiting as the invention may be variously embodied and as the scope of such invention is to be determined as claimed.

I claim:

1. A unitary electron discharge device including an hermetically sealed vessel having three distinct chambers, an audion having a plate, an equipotential cathode, a controlling element interposed between said cathode and plate, and a heater for heating said cathode, said audion being mounted within one of said chambers, an ionic rectifier having a plate and a cathode for supplying current to the plate of said audion and mounted within one of said chambers, said last mentioned chamber having an inert gas therein, a voltage limiting device for controlling the voltage supplied the plate of said audion and having a cold cathode and an anode and mounted within the remaining chamber of said vessel, said last mentioned chamber having an inert gas therein, a conductor located within said vessel and connecting one end of said heater with the anode of said rectifier, a resistance cooperating with said voltage limiting device and interposed between said rectifier and said voltage limiting device, a storage condenser cooperating with said rectifier and having one terminal connected to the cathode of said rectifier and having the other terminal connected to the cathode of said voltage limiting device and to the other terminal of said heater.

2. A unitary electron discharge device including an hermetically sealed vessel having three distinct chambers, a full wave ionic rectifier provided with a pair of anodes, and a cathode enclosed within one of said chambers, a voltage limiting device provided with an anode and a cathode enclosed within a second chamber, a rare inert gas in said first and second chambers, the anode of the voltage limiting device being connected to the cathode of said rectifier, an audion enclosed within the third chamber of said vessel and having an anode, an equipotential cathode, an interposed grid, and a heater for said cathode, the plate of said audion being connected to the anode of said voltage limiting device, a resistance bridged around the ends of said heater, a conductor connecting the cathode of said voltage limiting device with the neutral of said resistance, and a condenser bridged around said voltage limiting device.

3. A unitary electron discharge device comprising an hermetically sealed vessel having three distinct chambers enclosing respectively an ionic rectifier, a voltage limiting device, and an audion, said rectifier having a cathode and a pair of anodes, said voltage limiting device having a cathode and an anode connected to the cathode of said rectifier, said audion having a heater, a cathode, a con-

trolling element, and a plate connected to the anode of said voltage limiting device, a resistance inserted in the circuit of said voltage limiting device and cooperating therewith, a second resistance bridged around the terminals of said heater and the anodes of said rectifier, a storage condenser connected between the cathode of said rectifier and the neutral point of said last mentioned resistance, a third resistance and a second condenser bridged around said audion, said unitary device having five prongs, two of the prongs being connected to the terminals of the heater and the anodes of the rectifier, a third and fourth prong connected respectively to the cathode and the controlling element of said audion, whereby the controlling element and cathode of said audion may be connected to an input circuit, and the cathode of the audion connected through an output circuit to the said neutral point, and a fifth prong connected to one terminal of each of said condensers and to a terminal of said third resistance.

4. A unitary electron discharge device including an hermetically sealed vessel, an audion, a rectifier and a control device enclosed within such vessel, a condenser cooperating with said rectifier and said control device, a second condenser bridged around said audion, said condensers being associated with said vessel as a unitary structure, and said vessel carrying conductors connecting said rectifier, control device and the plate of the audion, whereby the plate is supplied from said rectifier, said audion having a cathode and a heater therefor and a controlling element, connections leading from said heater, terminal connections extending from said device and adapted for connection to supply mains and input and output circuits, said connections being such that the voltage difference between the terminals of said heater is at least equal to the voltage difference between the plate and the cathode of said audion.

5. A unitary electron discharge device including a vessel, an audion having an anode and a cathode and an interposed grid, a rectifier for supplying current to said audion, both said rectifier and said audion being enclosed within said vessel, means for maintaining a constant potential difference between the cathode and anode of said audion, said means including a voltage limiting device bridged around said audion and enclosed within said vessel, said voltage limiting device having a pair of electrodes, one of said electrodes being connected to said rectifier and to said audion anode.

6. A unitary electron discharge device comprising an hermetically sealed vessel, a rectifier having an anode and a cathode, smoothing means including a storage condenser supplied from said rectifier, a voltage limiting device bridged around said storage condenser, said voltage limiting device and said rectifier being enclosed within said vessel, said voltage limiting device having two electrodes, one of said electrodes being connected to said rectifier and to one side of said condenser, the other electrode of said voltage limiting device being connected to the other side of said condenser.

In testimony that I claim the foregoing I have hereunto set my hand at Milwaukee, in the county of Milwaukee and State of Wisconsin.

ARISTOTE MAVROGENIS.