April 22, 1930. S. RUBEN 1,755,796

ELECTRON TUBE APPARATUS

Filed Dec. 10, 1924

Fig.1.

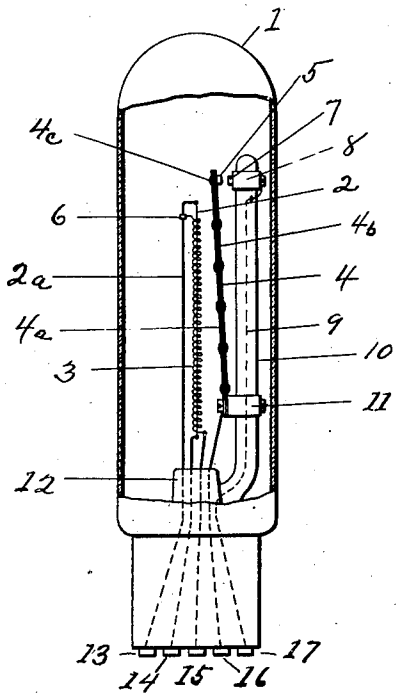
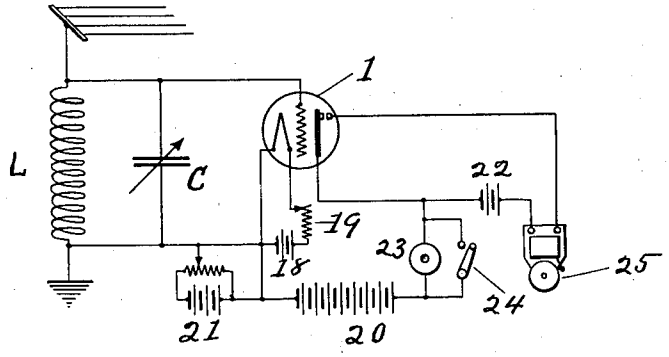


Fig.2.



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UNITED STATES PATENT OFFICE

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ELECTRON-TUBE APPARATUS

Application filed December 10, 1924. Serial No. 754,957.

This invention relates to vacuum or electron tube apparatus; and more particularly, it relates to apparatus of this type which utilizes the kinetic energy of the electron stream from the emission element to effect the movement of a thermosensitive bimetallic expansion anode element.

The invention comprises an improvement over those described in my prior and copending application filed in the United States Patent Office, February 4, 1922, April 11, 1922, and April 13, 1923, bearing serial numbers respectively, 534,213, 551,678 and 631,938, upon various forms of vacuum tube relays, operating by the kinetic energy of the electron stream bombarding the anode element of the tube. The object of the invention is to provide a vacuum tube relay sensitively responsive to the electron stream bombardment from the emission element, more sturdy in construction than those of my said prior inventions and less susceptible to anode movement by the vibration of the tube apparatus.

By the movement of the bimetallic expansion anode, in response to temperature changes thereof, due to variations in the electron bombardment of the anode by the filament emission under the control of electrical impulses impressed upon the grid circuit, an external circuit is closed or opened. That circuit is external to the cathode-anode circuit and, due to the high vacuum, the current density and potential of the external circuit can be very high.

The anode is preferably composed of a strip of tungsten and a strip of aluminum magnesium alloy, which latter has a very high coefficient of expansion.

The principles of the invention can best be further explained in connection with a certain illustrative embodiment thereof, shown in the accompanying drawings, in which,

Fig. 1 is a vertical section through an electron tube constructed in accordance with the invention; and Fig. 2 is a circuit diagram illustrating a practical application of the novel tube as a relay in a system for receiving and indicating radio signals. In Fig. 1, 1 is an evacuated container of glass or other suitable material, most desirably exhausted to a degree at which substantially a pure electron discharge is obtained. At 2 is an incandescible filament, supported by conducting rod 2_a, and at 3 is a modulating element or grid, also supported by rod 2_a, but insulated from it by glass bead 6. The various leads are brought to the exterior of the tube through sealing stem 12. At 4 is the anode or plate element of the bimetallic expansion type, of an aluminum-magnesium alloy strip, 4_a and tungsten strip 4_b, held together by rivets 4_c. The anode is held firmly at one end by nickel ferrule 11, and is of such character and arrangement as to be delicately responsive to temperature changes thereof. Carried on the other end of the anode is tungsten contact point 5, opposite to and contacting with stationary contact point 7, with which it can be brought into contact, thereby closing the external circuit, the elements of which are anode 4 and wire 9, leads of which are 16 and 17. The fixed contact point 7 is held in place by nickel ferrule 8, which also supports conducting wire 9 of the external circuit, passing through glass support 10. At 13 and 14 are the filament leads and at 15 is the grid lead.

Referring particularly to Fig. 2, in the receiving circuit, are connected inductance L and condenser C, comprising elements for selectively tuning the device to respond, by the movement of the expansive anode 4, to received impulses of the desired wave length. At 21 is a potentiometer for applying a negative potential to the grid for regulating the contact spacing to a normal or fixed degree and to control the rectification characteristics of the device. At 18 is the filament heating battery, the current supply being regulated by resistance 19. At 20 is the accelerating electron potential for supplying potential energy for anode bombarding. A telephone receiver 23, is placed in the circuit for use if the device is to be used as an ordinary vacuum tube. Battery 22 is employed when the device operates bell 25. At 24 is a switch for use in connection with telephone receiver 23.

The normal position of the anode may be

such that the external circuit is closed at the contact points, according to the degree to which its copper plate element is normally expanded by the emission from the filament under the influence of its current supply and the applied potential of the grid. If the normal position of the contact is for the open circuit, it is closed by the incoming impulses when the grid potential is normally regulated as positive to overcome the negative bias potential applied to the grid.

To operate the device from a normal position of an open circuit at the contact points, the filament is heated to an emission temperature by battery 18, the electron stream under the influence of the potential of battery 20, bombarding and heating the bimetallic anode which, because of the wide difference of the thermal expansion coefficients of aluminum alloy and tungsten, causes the anode to expand or incline towards the fixed contact point 7, to a degree determined by the bombardment permitted. By the application of the negative grid bias potential by means of the potentiometer, 21 the density of the bombarding stream is reduced until it is just insufficient to permit the contacts to close; and when the grid adds, through the input potential of the incoming radio signals, the increment necessary to increase the electron stream and consequent temperature of the anode sufficiently to close the contacts, the external circuit is closed; the contact points being separated as and with the grid potential changes.

As shown, if so desired, the telephone receiver, 23 can be connected by switch, 24, and the tube used as an ordinary vacuum tube. This relay is operable in various electric circuits, such as regenerative circuits, and in combination with other devices.

By supporting the anode at both ends, one end being rigidly held, and mounting the movable contact between the supports thereon, the device is made little subject to the effects of vibration of the tube.

What I claim is:

1. A vacuum discharge device having in a space therein, evacuated to a pressure at which substantially no positive ionization can occur, an electron emission element, an electron stream control element and an anode element composed of a thermosensitive bimetallic expansion element, and a plurality of contact elements, one of which is adapted to open and close an electric circuit, by its movement, actuated by variations of the electronic bombardment of said anode element in response to variations of potential applied to said control element.

2. A vacuum discharge device having in a space therein, evacuated to a pressure at which substantially no positive ionization can occur, an electron emission element, an electron discharge control element and an anode element composed of a thermosensitive expansible couple, and means for opening and closing an electric circuit by the movement of said anode element.

3. A vacuum discharge device, evacuated to a pressure at which substantially no positive ionization can occur, housing a cathode, an electron stream control element and an anode, said anode comprising a bimetallic expansion element composed of an aluminum alloy member and a tungsten member, and a switch located in said vacuous space to close and open a circuit by variations of electron bombardment upon the anode.

4. The combination with an electron emission element and a cooperating anode element, said anode element comprising a bimetallic expansion couple, separated from the emission element and an electron stream control element, said elements being located in an envelope within a vacuous space in which substantially no positive ionization can occur, of a circuit-making-and-breaking means located in said vacuous space and operable by the action of an electronic discharge upon said anode element.

5. The combination within a container, evacuated to a pressure at which substantially no positive ionization can occur, of a cathode, a cooperating bimetallic expansion anode and an electron stream control element and cooperating contacts, said electrodes, control element and contacts being located within said evacuated space, one of said contacts being mounted upon, and operable to close and open an external circuit by variations of an electronic bombardment of said anode, due to changes of potential applied to said control element.

Signed at New York, in the county of New York and State of New York, this 8th day of December A. D. 1924.

SAMUEL RUBEN.