June 30, 1925.

1,543,872

S. RUBEN

VACUUM TUBE APPARATUS

Filed April 13, 1923

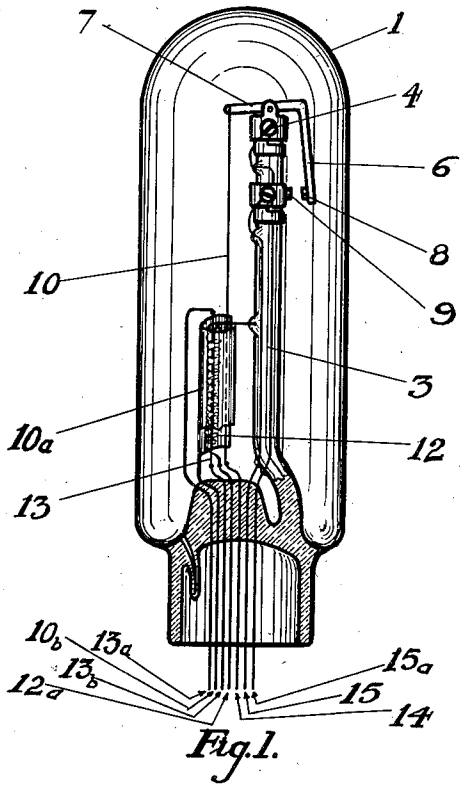


Fig.1.

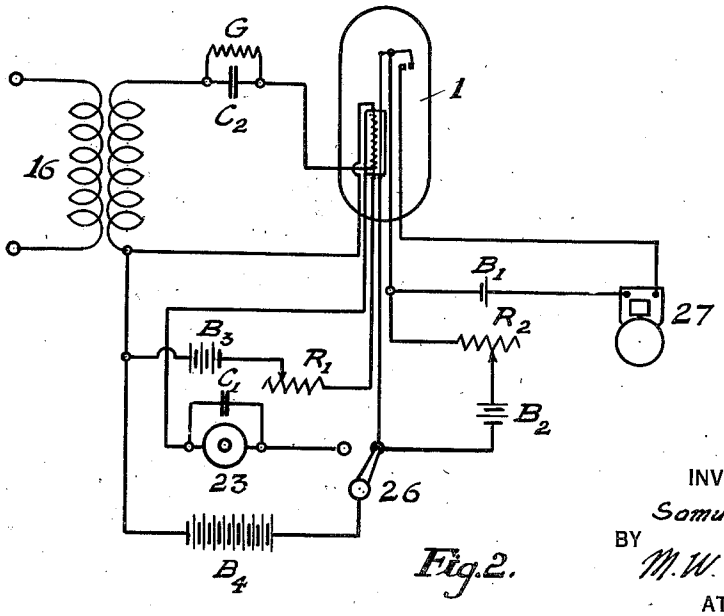


Fig.2.

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UNITED STATES PATENT OFFICE.

SAMUEL RUBEN, OF NEW YORK, N. Y.

VACUUM-TUBE APPARATUS.

Application filed April 13, 1923. Serial No. 631,938.

To all whom it may concern:

Be it known that I, SAMUEL RUBEN, citizen of the United States, and resident of New York city, in the county of New York and State of New York, have invented certain new and useful Vacuum-Tube Apparatus, of which the following is a specification.

This invention relates to a vacuum or electron tube apparatus; and it relates more particularly to apparatus of this general type in which advantage is taken of certain effects produced by electronic emission to accomplish the control of an electrical circuit in a predetermined manner, especially where this involves making and breaking such circuit by relay operation, and in which is provided, also a means for relaying audio frequency oscillations, impressed upon a receiving circuit, by an anode or plate element designed and arranged to meet the requirements of telephonic operation.

In such fields as radio control, signal recording, simultaneous telephonic and telegraphic operation, and control of electrical circuits of high current density and potential, and in other relations, it is commonly desirable to control the flow of current in a circuit in a predetermined manner, and to relay by the same apparatus audio frequency oscillations. In the apparatus of my invention I have combined in one vacuum tube, means for accomplishing both objects.

In my prior co-pending application, Serial Number, 551,778, filed April 12, 1922, I have disclosed and claimed an electron relay device in which the effects produced by electronic impact upon the plate or anode element of a cathode discharge are utilized for the purpose of controlling the flow of current in an external circuit, specifically by the movement of a thermo-expansive anode to operate a circuit make-and-break device. The present application is therefore a continuation in part of, and an addition to said prior co-pending application, in that it is upon a device in which, with the circuit control means disclosed in said prior application, is included in a vacuum tube, means for relaying audio frequency oscillations, more efficiently than by employing the thermo-expansive anode therefor.

One of the principal objects of my present invention is therefore, to provide in one vacuum tube, means by which both operations can be efficiently performed. In general then, the present invention involves the utilization in a vacuum tube apparatus of the effects produced by electronic impact upon a plate or anode element by the movement thereof, to control, by a make-and-break device, the current in an external circuit, and of the effect of the thermionic discharge from the same cathode upon another anode, for relaying audio frequency oscillations.

In an apparatus constructed according to my present invention, are employed a cathode, a thermo-expansive anode of restricted area, due to which the impedence of the thermionic gap is relatively large, a circuit make-and-break device, operable by the movement of the anode in response to variations of the thermionic discharge, and the circuit connection means for the various elements and, in addition, for telephonic impulse relaying, a stationary anode designed and arranged for a thermionic gap of relatively low impedence. The stationary anode is normally not connected in the receiving circuit, but means are provided by which, upon receipt of designated signals, it can be connected in circuit with a telephone receiver or used for amplification.

Broadly, the invention involves the use of a vacuum tube having an anode or plate element delicately responsive to temperature variations produced by impact of the cathode discharge thereupon, the impedance of the gap between those elements being relatively large, the expansion and contraction of said anode serving to actuate a non-arcing current make-and-break device, included in an external electrical circuit to be controlled or affected, and an anode or plate element of sufficient surface and so spaced as to allow a relatively low discharge gap impedance, to relay more efficiently audio frequency oscillations impressed upon the circuit of the thermionic discharge modulating element of the vacuum tube apparatus.

To accelerate the thermo-expansive anode response to variations in electron bombardment, means are provided for maintaining the normal anode temperature at a point higher than that of the surrounding atmosphere, so that the radiation is initially high. This is accomplished by the discharge of energy through the anode by a local circuit, independent of the emission bombardment of the cathode. The normal temperature

of that anode is raised to about 600 deg. C. and, as the speed of the anode response is controlled by its thermal radiation power, the speed may be expressed by $p=k\varepsilon at^4$, k being the radiation constant, ε its thermal emissivity which has a maximum value when the anode has the radiation power of a black body, a the area and t the temperature. The area is made as large as possible by the use of a strip anode and ε is increased by blackening the anode surface.

By adjusting this temperature, the speed of response is controlled, so that it may be made unresponsive to signals at radio frequency of the same wave length, but of shorter duration than that of the calling signal.

For relaying audio frequency oscillations an anode of wide area exposed to the cathode discharge is arranged to partially surround that element, over its full length, as far as possible.

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

Fig. 1 is a vertical sectional view of a vacuum or electron tube constructed in accordance with the invention.

Fig. 2 is a circuit diagram illustrating a practical application of the novel vacuum tube in a relaying system permitting simultaneous and separate utilization of the call signal circuit and of that of the second anode.

Referring more particularly to Fig. 1, 1 represents a highly evacuated container of glass or other suitable material. Projecting within the tube is a glass stem, 3, in which are conducting members 15 and 15^a constituting leads to the external circuit to be controlled by operation of contact 8, on arm 6, moving towards or away from stationary contact 9, by the expansion and contraction of anode 10, responsive to electron impact thereon from cathode 13, as controlled by the potential grid 12. At 10^a is a second anode, the gap between which and cathode 13, partially surrounded thereby, is narrowly spaced. Leads 10^b, 12^a, 13^a—13^b and 14 connect respectively with anode 10^a, grid 12, cathode 13 and anode 10, the heating current for which is supplied through leads 14 and 15^a.

Referring to Fig. 2, 16 represents a radio circuit tuning device, 23 a telephone receiver, 26 a switch, 27 a bell or other signal device in the external circuit to be controlled. In the receiving circuit G and C_2 are respectively a grid leak and a condenser. C_1 is a condenser in the telephone circuit; B_1 B_2, B_3, B_4 are the sources of energy for the various circuits shown, and R_1 and R_2 variable resistances.

In operation, as signals are received and indicated by the external circuit in which bell 27 is connected, as fully set forth in my said prior co-pending application, by means of the expansion and contraction of anode 10, in response to variations in impact of thermionic discharge upon it, controlled by changes of potential of grid 12, the tuning device being employed to select the desired signal impulse, if used for radio or carrier wave purposes, the telephone circuit can be closed by switch 26, in which a potential is established between cathode 13 and anode 10^a, when audio frequency oscillations can be therein indicated or amplified as by the present known means.

What I claim is:

1. The combination, with a vacuum discharge device having a cathode and a plurality of anode or plate elements, located in a vacuous space, and separate external circuits connecting said cathode with either of said elements, of another circuit which includes a gap located in said vacuous space and arranged to be closed and opened by the expansion and contraction respectively, of one of said anode elements.

2. In combination, with an electron emission element, and a plurality of anode or plate elements cooperating therewith, said elements being located in a vacuous space, of a circuit, including, one of said anode elements, and means for relaying thereby audio frequency oscillations, and of another circuit, including circuit-making-and-breaking means located in said vacuous space and operable by the action of electron discharge upon another of said anode elements to make or break said second circuit.

3. The combination, with an electron emission element and a plurality of anode elements, separated therefrom, said elements being located in a vacuous space, of a circuit, including contact means associated with and operable by movement of one of said anode elements to make or break said circuit, and of means for relaying audio frequency oscillations, said means employing another of said anode elements.

4. In combination, with an electron emission element a plurality of anode elements, separated therefrom, said elements being located in a vacuous space, and a modulating device operable to vary the electron stream between said emission element and said anode elements, of circuit-making-and-breaking means mechanically connected to one of said anode elements for actuation by movement of the latter and of means for relaying audio frequency oscillations by the employment of another of said anode elements.

5. The combination, with an electron emission element and a plurality of anode elements, separated therefrom, said elements

being located in a vacuous space, of an electrical circuit, including contact means located within said space and associated with and operable by movement of one of said anode elements to make or break said circuit, and of means for relaying oscillations of higher frequencies, said means employing another of said anode elements.

6. The combination, with an electron emission element, a plurality of anode elements, separated therefrom, said elements being located in a vacuous space, and a modulating device operable to vary the electron stream between said emission element and said anode elements, of circuit-making-and-breaking means located within said vacuous space and mechanically connected to one of said anode elements for actuation by movement of the latter and of means for relaying oscillations of higher frequencies by the employment of another of said anode elements.

Signed at New York city in the county of New York and State of New York this 24 day of March A. D. 1923.

SAMUEL RUBEN.