

Dec. 10, 1929.

S. RUBEN

1,739,043

VACUUM TUBE RELAY

Filed Dec. 17, 1926

Fig. 1.

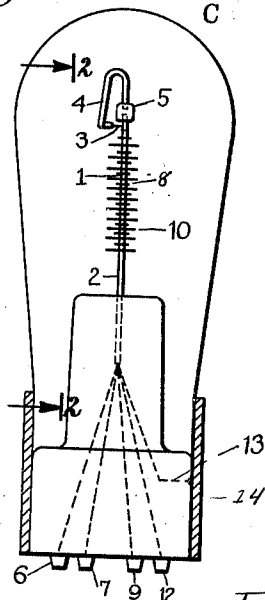


Fig. 2.

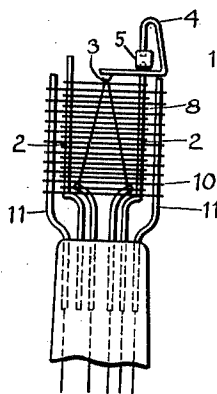


Fig. 3.

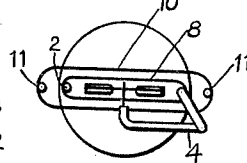


Fig. 5.

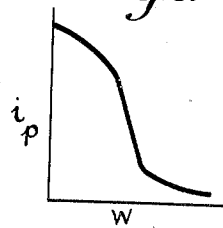
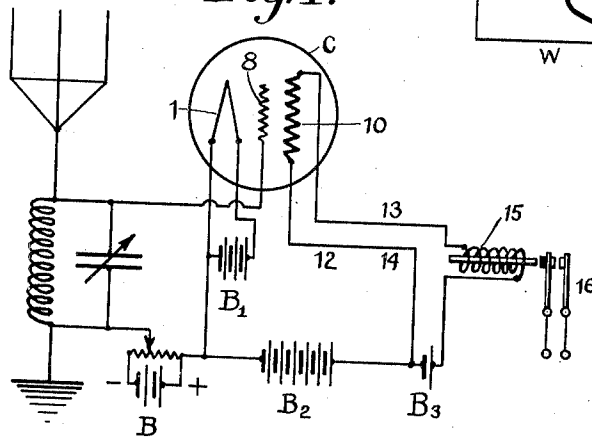


Fig. 4.



Inventor
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By his Attorney *W. L. Clapham*

UNITED STATES PATENT OFFICE

SAMUEL RUBEN, OF NEW YORK, N. Y., ASSIGNOR TO RUBEN PATENTS COMPANY, OF
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VACUUM-TUBE RELAY

Application filed December 17, 1926. Serial No. 155,541.

This invention relates to a vacuum tube relay; and more particularly it relates to an improved form of vacuum tube relay employing the electronic bombardment of an anode composed of a metal having a high positive coefficient of resistance, as controlled by electrical impulses impressed upon its grid circuit to vary the current discharge through a local circuit including the anode, by changing the electrical resistance of the anode connected also in the cathode anode circuit.

The object of the invention is to provide a relay sensitively responsive to grid potential changes to control current in a local circuit in which the anode is connected.

For certain uses the apparatus constitutes an improvement upon those relay devices described in my prior and copending applications bearing Serial Numbers 534,213; 551,678; 754,957 and 23,581, filed respectively February 4, 1922; April 11, 1922; December 10, 1924 and April 16, 1925.

The apparatus constructed according to the terms of my invention employs the kinetic energy of the electronic discharge upon the anode as varied by incremental values by grid potential changes to control the electrical resistance of and the current discharge through a local circuit in which is connected the anode having a high positive thermal coefficient of resistance. For the anode element, I employ iron, preferably a thin wire or strip, which for operation is heated to just below the critical temperature of 500° C. at which its electrical resistance coefficient rapidly increases to many times its initial value. Heat is applied by a normal current discharge through the local circuit and by electronic bombardment of the anode; when just below the critical point, by reducing the density of the electronic bombardment in very slight degree, the temperature and the resistance of the anode drop rapidly to a point at which the current flows more freely therethrough, and the response in increase of resistance and temperature is as prompt; it requires but an incremental variation of the bombardment which is secured by potential changes of the grid circuit. To assist in cool-

ing the anode, that element is blackened, the radiation factor being thereby greatly increased and, due to the small mass when the wire is at high temperatures, rapid radiation occurs.

For a better understanding of the principles of the invention, reference is made to the accompanying drawings of one embodiment thereof, in different views, and as connected in a radio receiving circuit.

Fig. 1 is an elevation of the relay; Fig. 2, a more detailed view of the relay elements, shown by plan view in Fig. 3. Fig. 4 shows a radio receiving circuit with a relay connected therein and Fig. 5, a graph of the relation between the wire temperature and current flow.

Referring more particularly to Fig. 1, C represents a glass envelop containing in its highly evacuated space filament 1, surrounded by grid 8, and outside of the grid black iron wire anode 10. Filament 1 having leads 6 and 7, is supported at 3 by wire 4, supported by glass bead 5 resting on one of the conducting wire rods 2 which carry grid 8, the lead from which is at 9. Anode 10 consists of an iron wire wound outside of the grid upon conducting rods 11, connected by leads 12 and 13 (the latter through conducting base 14) with the cathode-anode circuit and with the local circuit to be controlled.

In Fig. 4, B is a battery for regulating the grid potential, B₁ a heat source for filament 1, B₂ a potential control for the cathode anode circuit, B₃ a heating source for the anode. At 15 and 16 respectively are a coil having a movable armature and a contact make and break device actuated by the movement of the armature of coil 15. Fig. 5 is a graph of the relationship between the current discharge and temperature.

When filament 1 is heated to incandescence by battery B₁ at 6 volts, and a plate potential of 150 volts applied from battery B₂, there is a discharge of electrons from the cathode to the black wire anode 10. With the bombardment of anode 10 by the electron stream, the anode temperature rises beyond that at which the anode is normally maintained by a current discharge through the local circuit

from battery B₂; when its temperature reaches about 500° C. the anode resistance is about 10 times its normal room temperature value, thereby causing a large reduction of current flow through that circuit. The normal plate resistance included in the local circuit at 20° C. is 40 ohms. When the filament is heated, due to the radiation effect, it increases to 48 ohms; but with an electron bombardment of 10 milliamperes at 150 volts plate potential, the plate resistance is 400 ohms.

By applying a negative potential to the grid, the density of the impacting electron stream is reduced, thereby permitting the anode to cool by heat radiation, its resistance to drop and higher current to flow through the circuit. Superposing a potential on the grid circuit, as obtained from an inductance by a transformer or the like, the density of the electron stream is raised, the temperature and the resistance of the anode increased and the current flow through the local circuit greatly reduced. Assuming the contacts of the device 16 to be closed normally by the pressure of the armature of coil 15, as the current through that coil is varied in response to electronic bombardment variations, the armature moves within the field, opening and closing the contacts of 16 and thereby regulating the circuit of which it is a member.

Any device controlled by this anode local circuit may be adjusted to operate by a closed or an open circuit.

For operation upon certain circuits, as a submarine cable, I prefer a bridge circuit included in the local circuit, the anode comprising one arm of the bridge circuit. As the input in a cable circuit is varied in polarity according to whether a dot or a dash of the telegraphic code is being sent, the resistance of the anode increases or decreases and unbalances the bridge circuit and causes the operation of the siphon recorder.

What I claim is:

1. Vacuum tube apparatus comprising, in combination, an electron emission element constituting a cathode, a cooperating anode having a positive thermal coefficient of resistance and being responsive to variations of electron impact, means for substantially increasing the responsiveness by heating the anode to a critical temperature, a modulating element interposed between the cathode and anode, and translating means connected in the local circuit connecting the cathode and anode.

2. Vacuum tube apparatus comprising, in combination, an electron emission element constituting a cathode, a cooperating anode having a surface composed of a material having a positive thermal coefficient of resistance and being responsive to variations of electron impact, means for substantially increasing

the responsiveness by heating the anode to a critical temperature, a modulating element interposed between the cathode and anode, and translating means connected in the local circuit connecting the cathode and anode.

3. The combination, within a vacuum tube, with an electron emission element, of a cooperating anode separated therefrom by a conductive gap, and having a surface composed of a material having a positive thermal coefficient of resistance and being responsive to variations of electron impact, means for substantially increasing the responsiveness by heating the anode to a critical temperature, and means for varying the electron stream flowing between the emission element and the anode.

4. A thermionic amplifying device of the type described, comprising within its vacuum space, means for producing an electron stream, a grid, a grid circuit for controlling the electron stream, and an anode element in an external circuit with the cathode and composed of a material having a positive thermal coefficient of resistance, and means for producing therein relatively high power electrical variations in response to relatively low power current variations in the grid circuit by heating the anode to a critical temperature.

5. A thermionic emission device of the type described comprising an electron emitting cathode, a cooperating anode having a surface composed of a material which has a relatively high electrical resistance at about 500° C. and which is sensitively responsive to electron impact above said temperature, the anode element being connected with the cathode in a local circuit, and with a source of current supply for heating the anode in another local circuit.

6. Vacuum tube apparatus comprising, in combination, an electron emitting cathode, an anode composed of iron, and connected in a local circuit with the cathode, a modulating element interposed between the cathode and the anode, another local circuit in which the anode and a current supply are included, and translating means connected in the local circuit and arranged to be affected by resistance variations in the anode.

7. Vacuum tube apparatus comprising, in combination, an electron emitting cathode, an anode connected by a local circuit with the cathode and having a surface composed of iron, a modulating element interposed between the cathode and the anode, another local circuit in which the anode and a current supply are included, and translating means connected in the second mentioned local circuit and arranged to be affected by resistance variations in the anode.

8. The combination, with an electron emitting cathode, of a wire anode separated therefrom by a conductive gap and connected therewith in an external circuit, the anode

surface being composed of iron, and means for varying the electron stream flowing between the cathode and anode, the anode being also connected in another external circuit with a source of current supply.

5 9. The combination with an electron emitting cathode, of an anode separated from the cathode by a conductive gap and connected with the cathode by an external circuit, and
10 having a surface composed of a metal having a positive thermal coefficient of resistance, and means for varying the electron stream between the cathode and anode, the anode being also connected in another external circuit with a source of current supply.

15 In testimony whereof, SAMUEL RUBEN has signed his name to this specification, this 23rd day of November, 1926.

SAMUEL RUBEN.

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