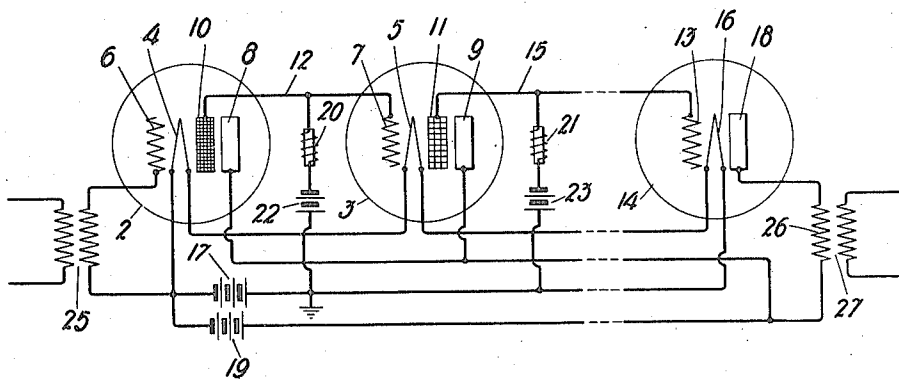


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 SYSTEM FOR THE SUCCESSIVE AMPLIFICATION OF ENERGIES.
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UNITED STATES PATENT OFFICE.

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SYSTEM FOR THE SUCCESSIVE AMPLIFICATION OF ENERGIES.

1,255,211.

Specification of Letters Patent.

Patented Feb. 5, 1918.

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To all whom it may concern:

Be it known that I, ALEXANDER McLEAN NICOLSON, a subject of the King of Great Britain, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Systems for the Successive Amplification of Energies, of which the following is a full, clear, concise, and exact description.

This invention relates to systems for the successive amplification of energies, and more particularly to an improved organization of electrodes employing the thermionic principle, whereby telephonic or other currents to be repeated or detected are put through successive stages of amplification without the employment of intermediate electromagnetic transformers. Its object is to simplify and to increase the efficiency of such an energy amplification.

The type of thermionic repeater or detector best known in the art is that in which a heated cathode is inclosed in a highly evacuated vessel with an anode which is maintained positive with respect to the cathode by an external source of electromotive force. The flow of current between the anode and cathode, which results by virtue of this source, and the thermionic emissions of the cathode, may be varied by altering the potential between the cathode and a third or input electrode. This idea is made use of in the telephone art and allied arts by employing such a device in a circuit whereby the currents which it is desired to amplify are made to vary the potential between the cathode and the input element, thus inducing a corresponding variation in the much greater space current flowing between the anode and cathode.

In devices of this sort it has been found that a fourth electrode element or space element, as it will hereinafter be termed, if located between the cathode and anode in the path of the thermionic current, will acquire a charge from such current, and that under certain conditions this charge will vary as a function of the instantaneous value of the space current. If such a space element

is in the form of a large and obstructing plate directly between the cathode and anode, it will effectively cut off the flow of thermionic current to the anode, provided the inclosing vessel is sufficiently evacuated to prevent the formation of blue haze.

It has furthermore been found that such an obstructing space element will function as a carrier of current provided that means are associated with it for discharging it.

This invention employs the principle just outlined in a system in which small energies to be amplified are impressed between the input and cathode elements of a thermionic repeater and are thereby amplified in accordance with the well-known principle of operation of such a device. Simultaneously with this amplification a fourth or space element located in the path of the thermionic current delivers to the input element of a second amplifying arrangement a varying charge having a frequency characteristic corresponding to that of the original input wave. This varying charge serves to vary the space current flowing in this second amplifier arrangement. Similarly, a space element located in the path of the second thermionic stream acts to control the current flow in a third thermionic amplifier. The process may be continued through other stages of amplification by other thermionic amplifiers, the final amplifier of the set being connected to the output circuit in the customary manner.

The invention will be more clearly understood by reference to the accompanying drawing which shows an arrangement for producing the effect above described. In the drawing, 2 and 3 are thermionic amplifiers having the customary heated filaments 4 and 5, input or grid electrodes 6 and 7, anodes 8 and 9 and, in addition to these, the fourth or space elements 10 and 11. The space elements 10 and 11 are preferably in a form of a grid or mesh, and are located between the cathodes 4 and 5 and anodes 8 and 9 as shown. For best effect the space elements 10 and 11 should present a degree of obstruction to the thermionic stream, de-

pending upon their location in the series. In other words, the space element 10 should present the maximum obstruction, the space element 11 should present a smaller degree of obstruction, and any subsequent amplifiers of the type of 2 and 3 should have space elements of consecutively decreasing obstruction.

As indicated in the drawing, the space element 10 is connected to the input electrode 7 by means of a wire 12. Similarly the space element 11 is connected to the input electrode 13 of the next amplifier 14 in the series through a wire 15. The cathodes 4, 5 and 16 are heated in series by battery 17, while the anodes 8, 9 and 18 are maintained positive with respect to their respective cathodes by means of battery 19. Inductances 20 and 21 are introduced respectively between wires 12 and 15 and ground to prevent the accumulation of a charge on the electrodes 10, 7, 11 and 13. Also batteries 22 and 23 may be employed to give the electrodes 10, 7, 11 and 13 a definite potential if desired. The final amplifier of the series need not have a space electrode but may be of the customary 3-electrode type.

In operation the telephone or other currents to be amplified are impressed by means of transformer 25 between the input electrode 6 and the cathodes 4, 5 and 16. The variation in the potential between input electrode 6 and cathode 4, which results from the variation in the telephonic current, causes the customary variation in the space current flowing between cathode 4 and anode 8 and, in accordance with the principle above discussed, causes a varying charge to be delivered to the space element 10. This varying charge is delivered over the wire 12 to the input electrode 7 of the amplifier 3, and serves therein to vary the space current flowing from cathode 5 to the anode 9. By virtue of this variation in space current a similar variable charge is induced on the space element 11 and delivered over wire 15 to the input electrode 13 of the amplifier 14, and serves to produce therein a greatly amplified variation in the space current flowing between the cathode 16 and the anode 18, in circuit with which is the winding 26 of the output transformer 27.

The amplifiers 2, 3 and 14 may, as indicated in the drawing, be inclosed in separate evacuated vessels, or they may conveniently be inclosed in a single vessel without in any way interfering with the operation of the device.

What is claimed is:

1. A thermionic translating device comprising an evacuated vessel containing an input electrode, a cathode, an anode and a fourth electrode between said cathode and anode, means for establishing a space cur-

rent between said cathode and anode, and means for maintaining said fourth electrode at a negative potential with respect to said cathode.

2. An electrical system comprising an evacuated vessel containing an input electrode, a cathode, an anode and a fourth electrode between said cathode and anode, means for establishing a space current between said cathode and anode, and means responsive to the potential of said fourth electrode.

3. In a system for the successive amplification of energies, a succession of thermionic repeaters each having an input electrode, an anode, a cathode for producing a thermionic discharge to said anode, and a fourth electrode in the path of said discharge and partially shielding said anode therefrom, the said fourth electrodes of said succession of repeaters presenting successively decreasing shielding effects to their respective anodes.

4. In a system for the successive amplification of energies, a succession of thermionic repeaters each having an anode, a cathode, an input electrode and a fourth electrode, said fourth electrode of one repeater being connected to the input electrode of the next succeeding repeater.

5. An electrical system comprising an evacuated vessel containing an input electrode, a cathode, an anode and a fourth electrode between said cathode and anode, means for establishing a space current between said cathode and anode, an outgoing line, and means for impressing the variations in potential of said fourth electrode upon said line.

6. An electrical system comprising an evacuated vessel containing an input electrode, a cathode, an anode and a fourth electrode between said cathode and anode, means for establishing a space current between said cathode and anode, a second evacuated vessel, comprising an electrode, and means for impressing the potential of said fourth electrode upon the electrode of said vessel.

7. An electrical system comprising an evacuated vessel containing an input electrode, a cathode, an anode and a fourth electrode, a second evacuated vessel containing an input electrode and means for impressing the potential of said fourth electrode upon the input electrode of said second vessel.

8. An electrical system comprising an evacuated vessel containing an input electrode, a cathode, an anode and a fourth electrode, a second evacuated vessel containing an input electrode, said fourth electrode and the input electrode of said second vessel being electrically connected with each other.

9. A thermionic translating device comprising an evacuated vessel containing an input electrode, a cathode, an anode and a

fourth electrode, means for establishing current between said cathode and anode and means for preventing an accumulation of electrical charges upon said fourth electrode.

- 5 10. A thermionic translating device comprising an evacuated vessel containing an input electrode, a cathode, an anode and a

fourth electrode, said fourth electrode being grounded, whereby an accumulation of electrical charges upon said fourth electrode is 10 prevented.

In witness whereof, I hereunto subscribe my name this 4th day of June A. D., 1915.

ALEXANDER McLEAN NICOLSON.