Aug. 7, 1923. 1,464,104

A. McL. NICOLSON

SELECTIVE APPARATUS FOR SIGNALING CIRCUITS

Filed July 26, 1917

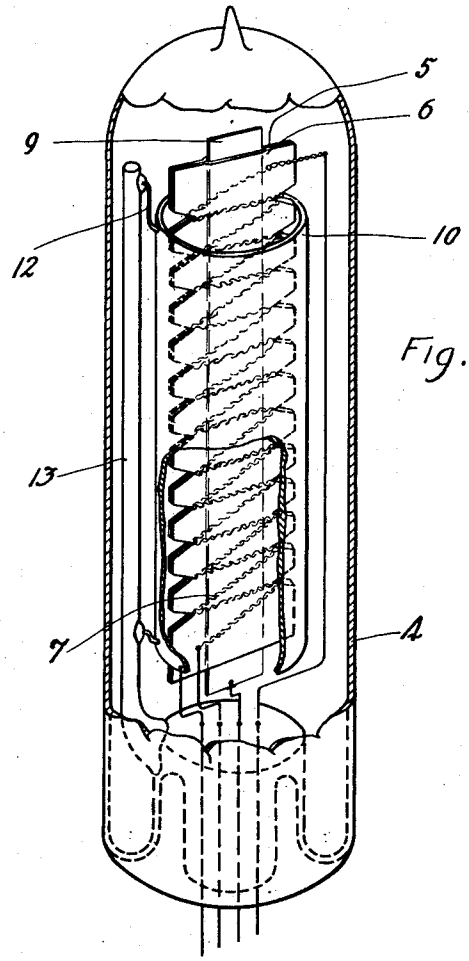

Fig. 1.

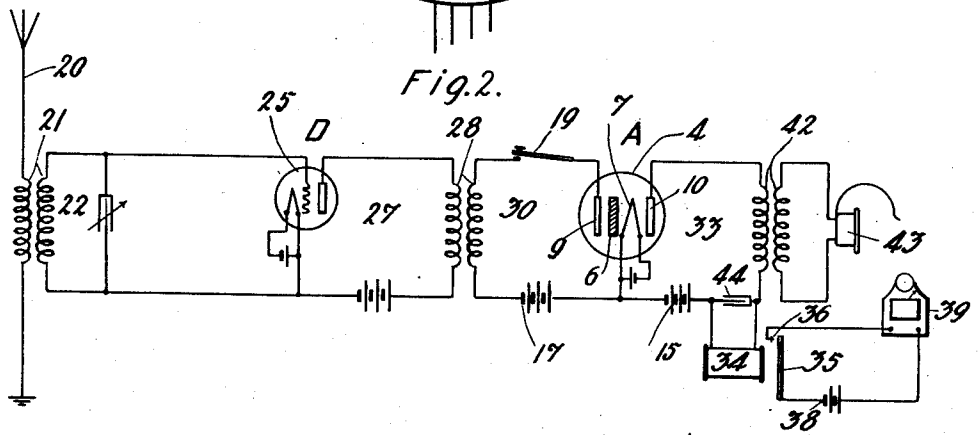

Fig. 2.

Inventor:
Alexander. M. Nicolson
by J. G. Roberts
Atty

Patented Aug. 7, 1923. 1,464,104

UNITED STATES PATENT OFFICE.

ALEXANDER McLEAN NICOLSON, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SELECTIVE APPARATUS FOR SIGNALING CIRCUITS.

Application filed July 26, 1917. Serial No. 182,993.

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 Selective Apparatus for Signaling Circuits, of which the following is a full, clear, concise, and exact description.

This invention relates to selective apparatus for signaling circuits, an object being to provide a vacuum tube capable of functioning as an annunciator, more specifically capable of functioning both as an annunciator and as a repeater.

In accordance with this invention it has been found that a vacuum tube of the well-known audion type may be made to function both as an annunciator to indicate that signals are being received and as a repeater of those signals.

As is well known in the art, an evacuated vessel of the audion type may comprise three electrodes, a filament, an anode, and a grid or auxiliary electrode. In one form of this invention, in addition to these electrodes, is provided a dielectric plate between the auxiliary electrode and the filament, whereby space current between the filament and the plate is made independent of the static potential or of slow changes of the potential of the auxiliary electrode, but is dependent upon the potential of said electrode, due to voltages of a higher frequency. Any element or combination of elements capable of performing the function of the dielectric plate may, of course, be substituted therefor. Such a tube is, therefore, particularly adapted for a system for the reception of signals, since the tube may be employed both as a repeater or detector of the incoming signals, and also for example, as an annunciator to energize a relay for ringing a bell.

Although this vacuum tube annunciator will hereinafter be described in connection with a receiving station for a high frequency signaling system, it is to be understood that it may also be employed for all other purposes to which an annunciator may be applied.

For the setting of the tube for the annunciator action, the potential of the grid is made just below the critical value for no space current, i. e., the space current is substantially zero. An incoming positive impulse of any frequency which would, for instance, be a component part of an incoming signal wave impressed upon the grid, will start the space current. The space current persists even after the incoming waves cease. The current which is thereby established in the output circuit may be employed to energize a relay for ringing a bell or to energize any other apparatus desired. The same tube, moreover, when the space current has been established may be employed as an amplifier or detector of the incoming signal oscillations, as for rapidly varying oscillations the operation of the tube has been found to be substantially the same as if the dielectric plate were absent. By rapidly varying oscillations is meant, with a tube constructed substantially as shown in the drawings, oscillations having a frequency of about one quarter of a cycle per second, or more, a frequency less than this being rather uncommon.

A tube of this kind also possesses many advantages over the types of tubes now known in the art in regard to ease of construction and to a possible close spacing of the electrodes. Hitherto considerable skill has been required to manufacture a tube having its electrodes supported rigidly enough for them to maintain their proper space relations under all working conditions. However, in the above described form of the tube, the construction may be such that the above mentioned difficulty does not occur, since the cathode or the auxiliary electrode or both may be supported by the dielectric which in turn may be supported by the anode or plate electrode. This tube may therefore be readily employed as an amplifier or detector, as its action for alternating currents of speech frequency or for a higher frequency may be the same as such a tube in which the dielectric is omitted.

For the better understanding of this invention, reference is made to the following detailed description taken in connection with the accompanying drawing, in which Fig. 1 shows in detail the construction of a tube in accordance with this invention; and Fig. 2 shows how this tube may be employed as a combined annunciator and amplifier in a radio receiving system.

Fig. 1 shows in perspective a tube with certain parts torn away in order that its construction may be more readily under-

stood. In the evacuated vessel 4 are two sheets 5 and 6 of a dielectric, such as mica, around which is wound the filament 7. These dielectric sheets have serrated edges so that the turns of the filament may be supported, and the desired distance between turns be maintained. Between these two sheets, and insulated from the filament by said sheets, is the auxiliary electrode 9, shown in the form of a long metallic strip. The anode 10 is shown in the form of a metallic cylinder surrounding the two other electrodes and the dielectric sheets. This cylinder is supported by the arm 12 of the glass standard 13. The dielectric sheets, the auxiliary electrode and the filament, however, are shown to be supported by the anode, due to the fact that the width of the dielectric sheets is slightly greater than the inner diameter of the cylinder, so that they are firmly held therein.

Fig. 2 illustrates a receiving system for high frequency signaling having in conjunction therewith a vacuum tube annunciator 4 of the general form shown in Fig. 1. Assume that the potential of the source of voltage 15 is sufficient to establish a space current between the anode 10 and the filament 7. If, now, the negative potential of the source of voltage 17 is numerically greater than the critical value for no space current, then, on closing the key 19, the negative voltage applied to the grid will reduce the space current to zero. The tube 4 is then ready to act both as an amplifier and as an annunciator for the signals received by the antenna 20. Assuming that these signals consist of high or radio frequency oscillations, modulated by low or telephone frequency signals, the oscillations received by transformer 21 will be impressed upon the circuit 22, tuned to the frequency of the carrier wave oscillations. The oscillations in this tuned circuit are then impressed upon the input terminals of a detector 25. The detected currents in the output circuit 27, by transformer 28, may then be impressed upon the input circuit 30 of the tube 4. These detected currents impressed on the auxiliary electrode will make it more positive than the critical value for no space current, thereby allowing the current to flow. After the space current has been started in such a manner by impressing positive impulses upon the grid, it has been found that the current rises to approximately its full value for zero potential of the grid, and thereafter persists and remains independent of the value of the static potential of the grid. The current, however, may be controlled by the impulses resulting from the detection of the incoming signals so that the tube may function as an amplifier of these impulses.

The space current established in the output circuit 33 by the incoming signals may be employed to energize a relay 34, whereby contact is made between the arm 35 and the point 36, thereby closing the circuit containing the battery 38 and the bell 39. The ringing of this bell is, therefore, an indication that signals are being received by the antenna.

The output circuit also contains the detected currents which have been amplified by the tube in a manner now well known in the art. These amplified oscillations may be impressed by the transformer 42 upon other amplifiers or, as shown, may be impressed upon a suitable receiver 43.

As relay 34 presents a path of high impedance for the amplifying currents in the output circuit, a low impedance path containing the condenser 44 is shunted around the relay.

In order to sensitize the annunicator for another call, the space current should be brought to zero again. This may be accomplished by opening the key 19 for a small interval of time, and then closing it.

With regard to the operation of the device, while the space current is flowing, the dielectric sheet or sheets pick up positive charges of such amount as to shield the filament from the charge on the grid. The thermionic current is thus made independent of the potential between the filament and the input electrode. When, however, the input circuit is opened for an interval of time sufficient to allow these charges to leak to or from the dielectric and the filament, then, on closing the circuit again, the input electrode will be brought to a negative potential greater than that required to give no space current, and the current is reduced substantially to zero before the compensating charges have time to collect on the dielectric. But, as soon as the grid is momentarily made more positive than the critical value, then the space current will start to flow again, and the dielectric will acquire positive charges sufficient to compensate for the static potential between the filament and grid.

This statement as to the action of the device is the most plausible which can at present be given, but it is not intended in any manner to limit the invention, which is defined in the appended claims.

What is claimed is:

1. A vacuum tube device having at times substantially zero space current, and means responsive to impressed alternating current waves to establish the space current.

2. In combination, an incoming line, a vacuum tube having an anode, a cathode and a control electrode, circuit connections between said line and said control electrode and said cathode, and means for causing said tube to change its amplifying proper-

ties when acted upon by slowly varying potentials from said line while maintaining fixed said circuit connections.

3. Means for modifying the space current of a vacuum electric device having a current control element therein, said means comprising a shield for said current control element.

4. The combination of a vacuum tube device normally inoperative to repeat alternating currents, and means responsive to alternating currents to render said tube operative.

5. The combination with a device through which electric current flows between spaced circuit terminals, of means for producing a substantial modification of the current through said device comprising a dielectric element adjacent to one of the circuit terminals within the device.

6. In combination, an evacuated vessel comprising an anode, a cathode, and a control electrode, and self supporting shielding means between said control electrode and said cathode for causing slow changes in the potential of said electrode to produce a sudden rise of current in said vessel.

7. The combination with a vacuum tube discharge device which is quantitatively responsive to high frequency potential variations, of means associated with said device for changing such responsiveness from quantitative in nature to qualitative when the potential variations are of relatively low frequency.

8. The combination with an electric discharge device having circuit terminals therein separated by a solid dielectric element, of a plurality of translating devices selectively operated by said discharge device.

9. The combination with means for producing electric disturbances of different characteristics, of an electric discharge device subjected to said disturbances and means within said device for causing said device to respond selectively thereto, the character of the response being different for each of a plurality of the differently characterized disturbances.

10. The combination with means for producing electric disturbances of different characteristics, of an electric discharge device subjected to said disturbances and responding selectively thereto, and means for rendering useful at will any one or more of said selective responses.

11. The combination with means for producing electric disturbances of different characteristics, of a vacuum electric device subjected to said disturbances and responding selectively thereto, and means for rendering useful at will any one or more of said selective responses.

12. An evacuated vessel and an electrode therein comprising a filament wound around a self-supporting dielectric sheet.

13. An electric discharge device comprising an evacuated vessel containing an anode, a cathode, and a control electrode, means connected with said vessel for supporting one of said electrodes, a member of insulating material supported by said last mentioned electrode, said other two electrodes being supported by said member.

14. In an evacuated vessel, an anode, means for supporting said anode, a dielectric supported by said anode, and a filament and an auxiliary electrode supported by said dielectric.

15. In an evacuated vessel, a hollow electrode, a dielectric sheet within said electrode, the width of said sheet being slightly greater than an inner dimension of said electrode whereby the dielectric sheet is supported by said electrode.

16. In an evacuated vessel, a hollow electrode, a dielectric sheet within said electrode, the width of said sheet being slightly greater than an inner dimension of said electrode whereby the dielectric sheet is supported by said electrode, and an electrode supported by said dielectric.

17. In an evacuated vessel, a hollow anode, a dielectric sheet within said electrode, the width of said sheet being slightly greater than an inner dimension of said electrode whereby the dielectric sheet is supported by said electrode, and a filament and an auxiliary electrode supported by said dielectric.

18. In an evacuated vessel, an anode, a cathode and an auxiliary electrode, means for establishing a space current between said anode and cathode, and means whereby said space current is made independent of slow changes in the potential of said auxiliary electrode.

19. In an evacuated vessel, an anode, a cathode, means for establishing a thermionic discharge from said cathode, an auxiliary electrode adjacent said cathode, and means whereby the discharge from said cathode is made independent of slow changes in the potential of said auxiliary electrode.

20. In an evacuated vessel, an anode, a cathode, means for establishing a thermionic discharge from said cathode, an auxiliary electrode adjacent said cathode, means whereby the discharge from said cathode is made independent of slow changes in the potential of said auxiliary electrode but is caused to fluctuate with more rapidly alternating potentials of said auxiliary electrode.

21. An electric discharge device comprising a highly evacuated envelope, said envelope containing an anode, a cathode and a cold electrode, a solid dielectric substantially dividing the space between said cathode and said cold electrode, and an external connection for each of said electrodes.

22. In an evacuated vessel, an anode, a filamentary cathode, a cold electrode, and a

solid dielectric completely separating said cathode from said cold electrode.

23. In an evacuated vessel, an anode, a cathode of thermionically active material, an auxiliary electrode, and a dielectric sheet between said cathode and said auxiliary electrode adapted to shield said cathode from slow changes in the potential of said auxiliary electrode.

24. An annunciator comprising an evacuated vessel, said vessel having an input circuit and an output circuit, a source of voltage in said input circuit, a source of voltage and a relay in said output circuit, and means for rendering the current in said output circuit independent of slow changes of the voltage in said input circuit.

25. An annunciator comprising an evacuated vessel, said vessel containing an anode, a cathode and an auxiliary electrode, a relay and a source of voltage connected between said anode and cathode, and means for rendering the space current between said cathode and anode independent of the static potential of said auxiliary electrode.

26. In an evacuated vessel, an anode, a cathode and an auxiliary electrode, means for establishing a space current between said cathode and anode, a source of potential for said auxiliary electrode of a value more negative than the critical value for no space current, means for making the value of the potential of said source more positive than the critical value, whereby the space current may be established, and means interposed between said auxiliary electrode and said cathode whereby said space current will continue to flow after said last-mentioned means ceases to act.

27. In an evacuated vessel, an electrode, insulating material supported by said electrode, and a plurality of other electrodes supported by said insulating material.

28. A vacuum tube of the audion type comprising a plate electrode, insulating material supported thereby, and a plurality of other electrodes supported by said insulating material.

29. A space current device comprising a plate anode, and a plurality of other electrodes insulatingly supported thereby.

30. A vacuum tube device comprising a control electrode, a cathode and an anode, two of said electrodes being insulatingly supported by the other electrode.

31. An audion comprising a hollow electrode, a plurality of sheets of insulating material supported thereby, a control electrode surrounded by said sheets, and a filamentary electrode surrounding said sheets.

32. A vacuum tube device comprising a cathode, an anode and a control electrode, means for supplying a space current between said cathode and anode, means for supplying a potential to said control electrode, said potential having such a value that said space current is substantially zero, and means responsive to alternating currents to establish the space current.

33. The method of operating a vacuum tube which comprises establishing a space current therein in response to received alternating current waves.

34. The method of operating a vacuum tube which comprises changing the space current from zero to a finite value in response to received alternating current waves.

35. A vacuum tube device comprising means for supplying an electron stream, controlling means for said stream, a source of voltage for normally making the potential of said controlling means of sufficient value to reduce said electron stream substantially to zero, and means for changing at times the effectiveness of said source while maintaining the connections of said source.

36. A signaling system comprising a vacuum tube device having normally zero space current, and means responsive to alternating current waves to establish the space current whereby said tube is maintained responsive to subsequently received waves.

37. A high frequency receiving system, comprising a high frequency receiving conductor, means for receiving the high frequency signals from said conductor and translating them into low frequency signals, said means comprising a vacuum tube device having substantially zero space current when no high frequency waves are received, and means responsive to an impressed high frequency wave to establish said space current.

38. A vacuum tube device comprising a cathode, an anode and a control electrode, means for supplying a space current between said cathode and anode, and means for reducing said space current substantially to zero when no waves are being received by said device and for establishing said space current upon the receipt of waves, said space current persisting in the absence of received waves.

39. A vacuum tube device comprising a cathode, an anode and a control electrode, means for supplying a space current between said cathode and anode, means for supplying a substantially constant potential to said control electrode, said potential having such a value that said space current is substantially zero, and means responsive to alternating currents to establish the space current.

40. A space current device comprising a control electrode, means tending to supply a space current for said device, means tending to prevent said space current from being supplied, said means being so related that said space current is substantially zero, and means for varying the effectiveness of one

of said first two-mentioned means in response to received waves while maintaining the electrical connections for said last-mentioned means.

41. The method of operating a vacuum tube device having a control electrode and a space current, which comprises providing for said control electrode a potential of sufficient value to reduce said space current substantially to zero, and varying the effectiveness of the potential of said control electrode while maintaining fixed the circuit connections of said control electrode whereby said spaced current is established.

42. The method of operating a vacuum tube device having a control electrode and a space current, which comprises providing for said control electrode a constant potential of sufficient value to reduce said space current substantially to zero, and superposing on said potential alternating current waves whereby said space current is established.

43. The method of operating a vacuum tube device having a control electrode and a space current which comprises providing for said control electrode a constant potential of sufficient value to reduce said space current substantially to zero and superposing on said potential alternating current waves, whereby said space current is established, and persists after said electrical waves are no longer received.

44. An electron discharge device comprising a cathode, an anode and a control electrode, a continuous conducting circuit connecting said cathode and anode, said circuit including a source of current, and means responsive to alternating current waves for varying the effectiveness of said control electrode.

45. The combination with a vessel, of an anode, a cathode, a control element within said vessel, and self-supporting means for shielding said cathode from slow changes in the potential of said control element.

46. A thermionic device comprising a cylindrical anode, a cathode within said anode, a cold electrode, and a solid dielectric completely separating said cathode from said cold electrode.

47. An electric discharge device comprising an anode, insulating material supported by said anode, a filament and an auxiliary electrode supported by said insulating material and a containing vessel surrounding said electrodes.

48. An electric discharge device comprising an electrode, insulating material supported thereby, a plurality of other electrodes supported by said insulating material and a containing vessel for said electrodes.

49. A vacuum tube comprising an evacuated envelope containing an anode, a cathode, and a grid, said grid being supported by said anode.

50. A vacuum tube comprising an evacuated envelope containing an anode, a cathode, and another electrode, one of said electrodes being a grid, said cathode being supported by said anode.

51. A vacuum tube comprising an evacuated envelope containing an anode, a cathode, and a grid, said cathode being supported by said anode.

52. A vacuum tube comprising an evacuated envelope containing therein an anode, a cathode, and a grid, said grid being insulatingly supported by said anode.

53. A space current device comprising an anode and a plurality of other electrodes supported thereby.

54. A vacuum tube device comprising a control electrode, a cathode and an anode, two of said electrodes being supported by the other electrode.

55. A vacuum tube comprising an evacuated envelope, containing therein an anode, a filamentary cathode, and a grid, and means for supporting said grid through the intermediary of said anode.

In witness whereof, I hereunto subscribe my name this 21st day of July A. D., 1917.

ALEXANDER McLEAN NICOLSON.