June 19, 1923. 1,459,412

A. McL. NICOLSON

THERMIONIC TRANSLATING DEVICE

Original Filed April 16, 1915

Fig. 1

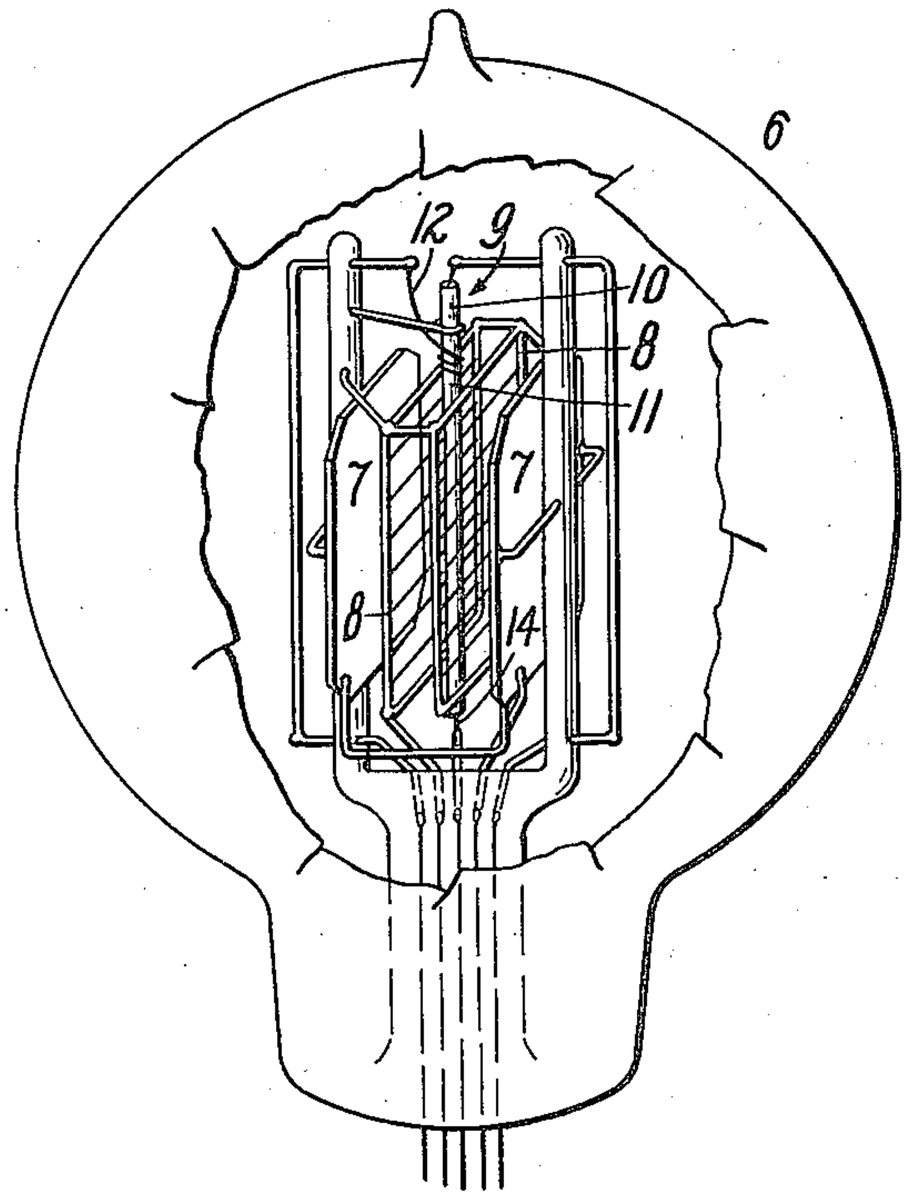


Fig 2

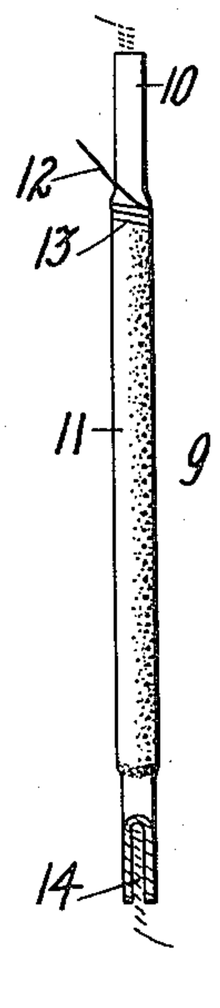


Fig. 3

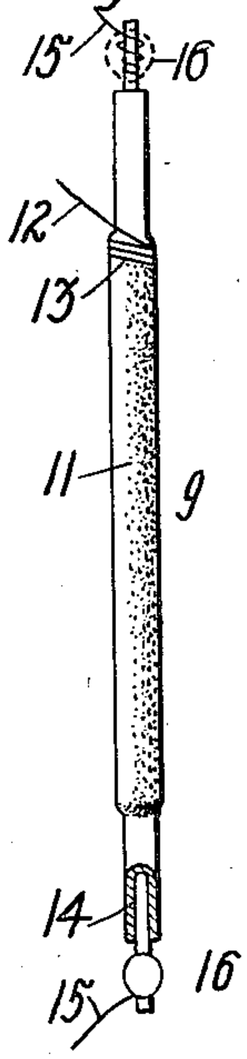


Fig. 4

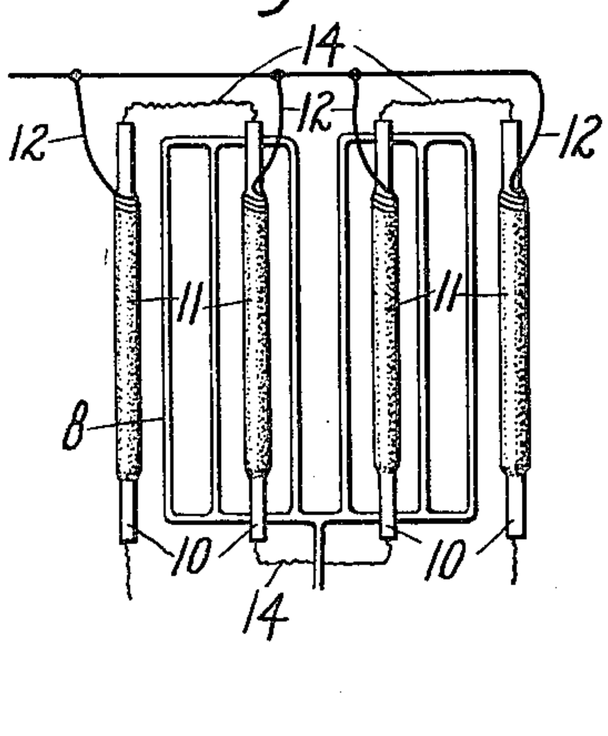
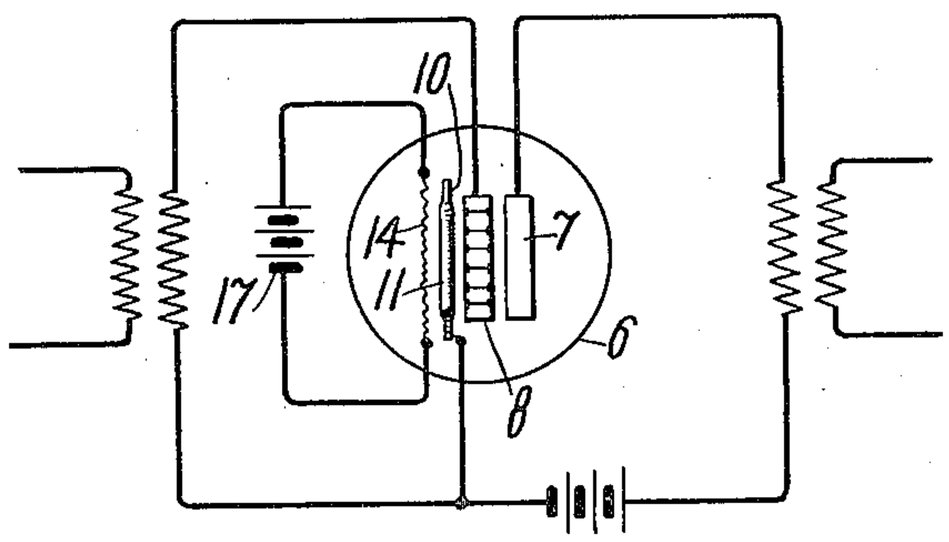


Fig. 5



Inventor
Alexander McLean Nicolson
by W. E. Beatty. Att'y

Patented June 19, 1923. 1,459,412

UNITED STATES PATENT OFFICE.

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

THERMIONIC TRANSLATING DEVICE.

Continuation of application Serial No. 21,918, filed April 16, 1915. This application filed September 10, 1919. Serial No. 322,944.

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 Thermionic Translating Devices, of which the following is a full, clear, concise, and exact description.

This invention relates to thermionic translating devices and more particularly to a form of cathode element for use in such devices, and its object is to produce a large energy output therefrom.

One way of increasing the energy output of a thermionic translating device, such, for example, as an audion, is to increase the active area of its cathode member. Where the cathode is in the form of a filament and is heated by a flow of current therethrough, the two ends of the filament will be at different potentials by virtue of this current flow and the resistance of the filament. When, as is customarily the case, the anode or plate element is made positive with respect to the filament by means of some external electromotive force, it is seen that there will be a greater difference of potential between the negative end of the filament and the anode, than between the positive end of the filament and the anode. There is, within certain limits, a direct relation between the output of an audion and the potential applied between the anode and cathode. It follows that other parts of the filament being at a higher potential than the negative terminal with respect to the anode, will not be working at maximum efficiency, the greatest inefficiency occurring at the positive end of the filament. In other words, the space current between the anode and the filament will be unsymmetrically distributed. While this unsymmetrical distribution is not of great importance where short filaments are used, it becomes of serious importance when the length of the filament is increased to give a greater active area for the purpose of increasing the energy output of the tube.

This invention provides a thermionically active cathode which, while affording a large active area, will be devoid of the property of presenting a drop of potential between its terminals. It is in fact an equipotential cathode, that is, a cathode all parts of whose active surface can be maintained at the same potential. Thus, an even distribution of space current over the cathode surface is permitted, and the cathode as a whole may be worked at its maximum efficiency. This result is obtained by divorcing the heating agent from that which produces the thermionic activity.

This application is a continuation of application Serial No. 21,918, filed April 16, 1915.

This invention will be more clearly understood by reference to the accompanying drawings, in which Fig. 1 represents a thermionic translating device of the audion type incorporating the cathode of this invention; Fig. 2 shows more in detail the construction of the cathode element; Fig. 3 shows the cathode element with an alternative form of heating element; Fig. 4 shows how a plurality of such cathodes may be heated by a single heating element; and Fig. 5 shows diagrammatically the connection of the various elements of an audion such as that of Fig. 1 in a typical circuit arrangement for the amplification of telephonic or outer currents.

In Fig. 1, 6 is a highly evacuated vessel or glass bulb. Within the bulb 6 are supported in a suitable manner the two anode plates 7—7, the grid or input members 8—8 and the cathode 9. The cathode 9 comprises a tube 10 of quartz or other material having dielectric and high heat-resisting characteristics. The other surface of tube 10 is coated with a layer of thermionically active material 11. This surface is prepared by first coating the tube with platinum tetrachloride and baking, thus forming a platinum deposit which is made sufficiently thick to prevent other than an inappreciable drop in potential when the surface is made to carry a large thermionic current. The platinum surface so formed is coated with a suitable mixture of thermionically active preparations such, for example, as a mixture of the oxides of strontium and barium. A connecting wire 12 may conveniently be attached to this coating by wrapping its end around the coating 11 as at 13, covering the joint so formed with platinum tetrachloride and baking.

Within the tube 10 is a heating element 14 which, as shown in Fig. 2, is composed of

a spiral of platinum wire, or, as shown in Fig. 3, composed of a rod of carbon closely fitting the bore of the tube. In case the carbon rod is used, electric connection may be made thereto by wrapping the end of a platinum connecting wire 15 about the end of the rod and covering the joint thus formed by a layer of clamp mixture 16 such as is used in incandescent lamp manufacture, for attaching the metal leading-in wires to the carbon filament. The heating element 14 is customarily brought to incandescence by battery 17 as in Fig. 5, and its function is to incandesce the layer 11 by radiation, thus making this layer thermionically active. Where a greater active surface is desired, it has been found possible to heat a number of equi-potential cathode surfaces 11 by a single heating element 14, as illustrated in Fig. 4.

The functioning of the equi-potential cathode surface 11 in an audion is identical with that of the filamentary cathode well known in the art, the only differences being as stated above and as illustrated in Fig. 5, that all parts of the cathode surface 11 are at the same potential with respect to the anode 7. In Fig. 5, for the sake of convenience in illustration, the heating member 14 is shown as outside of the tube 10. While it has been found preferable to locate this heating member inside of a tubular cathode arrangement, as above described, it is to be understood that this specific arrangement is by no means essential and that any arrangement wherein an equi-potential cathode surface is heated by an element electrically distinct therefrom is within the scope of this invention. It is also apparent that the exciter which renders the cathode active need not be in the form of a heater as shown herein, but may also be an electrode from which a stream of electrons is emitted for the purpose of bombarding the cathode to render the same active, as shown in applicant's Patent No. 1,210,678.

What is claimed is:

1. In a thermionic translating device, means for producing a thermionic discharge therethrough substantially independent of gas ionization, said means comprising a solid equipotential cathode surface and a heat radiating body in close proximity to said surface.

2. A thermionic translating device comprising an evacuated vessel containing a solid equipotential cathode surface of thermionically active material, and means within said vessel adjacent said surface and out of electrical contact therewith for heating said surface.

3. A thermionic translating device comprising an equipotential cathode comprising a dielectric support coated with thermionically active material, a resistance element in close proximity to said cathode and means for heating said element.

4. A thermionic translating device comprising an insulating tube, a coating of thermionically active material on the outside of said tube, and a heating element within said tube.

5. A thermionic translating device comprising a cathode comprising insulating material, and an electrically conducting thermionically active coating thereon.

6. A thermionic translating device, comprising an electric conductor, insulating material thereon, and an electrically conducting thermionically active coating on said insulating material.

7. A thermionic translating device comprising an anode, a thermionically active solid cathode surface, all parts of said surface being at the same potential with respect to said anode, means electrically distinct from said cathode surface for heating said surface, and an electrode for controlling the discharge between said cathode and said anode.

8. In a thermionic translating device, means for producing a thermionic discharge therethrough substantially independent of gas ionization, said means comprising a solid cathode surface and a heating element in close proximity to and insulated from said surface, whereby said surface is maintained thermionically active.

9. A thermionic translating device comprising a highly evacuated envelope, a solid equi-potential cathode surface therein, means within said envelope adjacent said surface and out of electrical contact therewith for maintaining a state of thermionic activity in said cathode.

10. A thermionic translating device comprising a highly evacuated envelope, a solid equi-potential cathode surface therein, and a heating element within said envelope adjacent said surface for rendering said surface thermionically active.

11. A thermionic translating device comprising a solid cathode and a heating element adjacent thereto but out of electrical contact therewith, said heating element comprising substantially the only means for rendering said cathode thermionically active, said cathode and heating element being enclosed in an evacuated space.

12. An audion comprising a solid cathode, a heater adjacent said cathode, and within said audion, and means for supplying current for rendering said cathode thermionically active, said means being adapted to send current only through said heater in contradistinction to being adapted to send current through both said heater and said cathode.

13. A thermionic repeater comprising an evacuated vessel, means for supplying to

said vessel alternating currents to be repeated, said vessel containing a solid cathode, an anode, and a control electrode, said cathode adapted to be rendered thermionically active, an exciter adjacent said cathode, and means for heating said exciter and thereby rendering said cathode active.

14. A thermionic amplifier comprising an evacuated vessel, a circuit adapted to supply to said vessel the alternating currents to be amplified, said vessel containing a solid cathode and anode, said cathode adapted to be rendered thermionically active, an exciter within said vessel adjacent said cathode, and means for rendering said cathode active by an emanation from said exciter.

15. A device of the audion type having a thermionic cathode comprising a platinized quartz member.

16. A device of the audion type having a thermionic cathode comprising insulating material, platinum thereon, and a coating of thermionically active material on said platinum.

17. A thermionic repeater of alternating currents comprising an evacuated vessel containing a solid cathode and anode; a filament within said vessel adapted to be heated to render said cathode thermionically active, and means for supplying to said vessel the alternating currents to be repeated.

18. A thermionic repeater comprising an evacuated vessel containing a cathode, an anode, and a controlling electrode, and independent means within said vessel for exciting said cathode to render the same thermionically active.

19. The combination with a highly evacuated tube and its separated anode and solid cathode for producing the main discharge through said tube, of means within said tube for raising the temperature of said cathode to incandescence, and means for passing current through said means simultaneously with said main discharge.

20. The combination with a solid cathode, of a conductor disposed in proximity to said cathode, means for heating said conductor, whereby by an emanation from said conductor said cathode is raised to a temperature for changing the conductivity of the vacuum tube, and a highly evacuated tube enclosing said cathode and said conductor.

21. The combination with a vacuum tube and its separated anode and solid cathode for producing the main discharge through said tube, of means spaced from said cathode for heating said cathode, and means for passing current through said means simultaneously with said main discharge, said main discharge comprising a space current carried principally by electrons emitted from said cathode in response to said heating means.

22. An electron discharge device comprising a highly evacuated vessel, main discharge electrodes of solid form therein, and continuously operating auxiliary heating means within said vessel for maintaining one of said electrodes at a relatively high temperature by transfer of heat thereto.

23. An electrical translating device comprising an evacuated vessel, an anode, a thermionic cathode surface, means for maintaining all parts of said surface at substantially uniform potential with respect to said anode, and an electrode for controlling the discharge between said cathode and said anode.

24. An electrical translating device comprising an evacuated vessel, an anode, a thermionic cathode surface, means for maintaining all parts of said surface at substantially uniform potential with respect to said anode, said potential being such that the discharge between said cathode and said anode is substantially independent of gas ionization.

25. An electrical translating device comprising an anode, an equi-potential thermionic cathode surface, means for heating said surface, and metallic connections from a plurality of separated points on said surface to said anode.

26. A thermionic translating device comprising a cathode surface, an electric heater, and heat conducting means connecting said surface and said heater, said means being a non-conductor of electricity.

27. A composite cathode for electron discharge devices comprising an electrical conductor serving as a heater and a metallic member serving as an electron emitter mounted thereon.

In witness whereof, I hereunto subscribe my name this 28th day of August, A. D. 1919.

ALEXANDER McL. NICOLSON.