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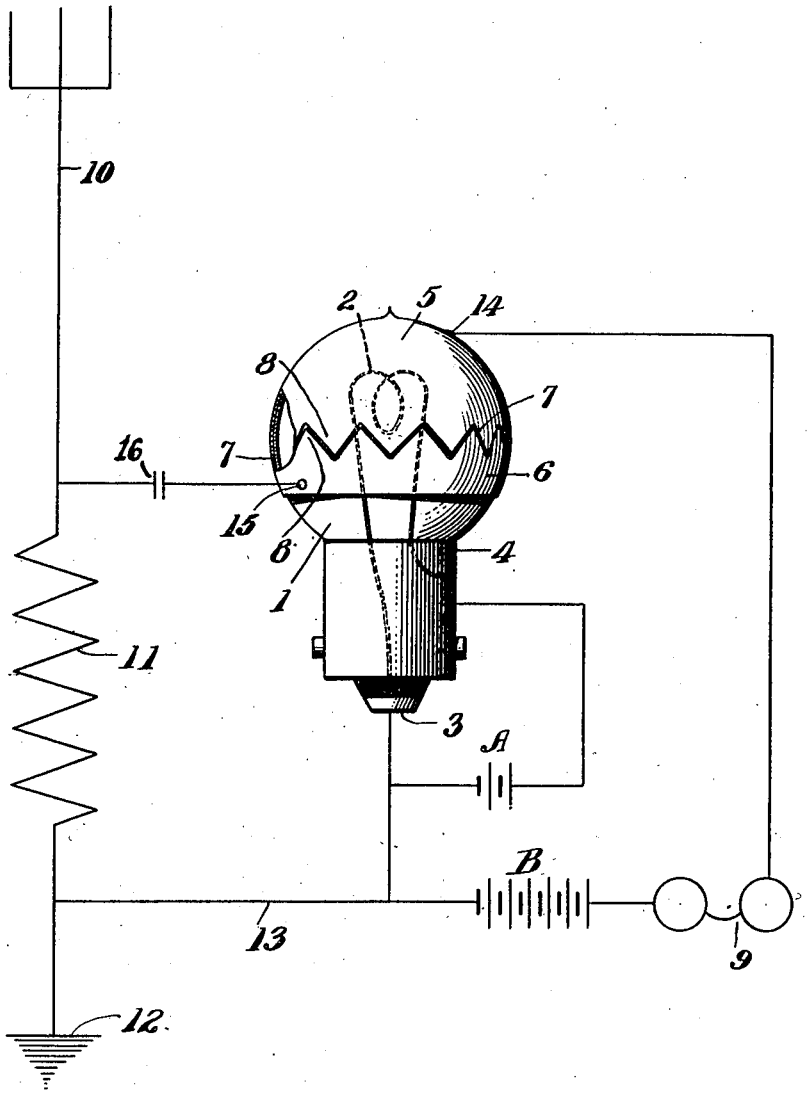
RADIO COMMUNICATION.

APPLICATION FILED MAR. 23, 1918.

1,291,641. Patented Jan. 14, 1919.



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RADIO COMMUNICATION.

1,291,641. Specification of Letters Patent. Patented Jan. 14, 1919.

Application filed March 23, 1918. Serial No. 224,115.

To all whom it may concern:

Be it known that I, HAROLD P. DONLE, a citizen of the United States of America, residing at Meriden, Connecticut, have invented a new and useful Radio Communication, of which the following is a specification.

My present invention has reference to an electron valve for radio telegraphy and telephony.

The so-called "valves" in use at the present time possess certain disadvantages, particularly in that they are quite delicate and fragile, are of expensive complicated construction and require especially trained skill for their manufacture. These valves moreover lack sensitiveness to a certain degree, being unable when used as "detectors" for instance to "pick up" some of the weaker signals.

The objects of my invention have been to overcome these disadvantages and to provide a valve structure which would be of rugged, substantial construction, simple and easy to manufacture, relatively inexpensive and possessed of the desired sensitiveness.

In the valves of the prior art the so-called "plate" and "grid" elements have been mounted within the evacuated vessel containing the filament and the operation of such valves has been dependent upon the effective resistance of the vacuum alone, the electron flow being from the heated filament through the evacuated space to the plate, under the control of the interposed grid.

I have discovered that improved results are obtained by causing an electron discharge through the walls of the globe to conducting surfaces located outside the evacuated area and disposed in such relation that when the filament is lighted and made the negative terminal of a battery, a flow of electrons is released from the lighted filament which passes across the evacuated area through the warm walls of the globe to an externally located conductor which is made a positive terminal of the battery.

My invention accordingly resides in this combination including the globe with the heating filament therein and the externally disposed conducting elements arranged in electron-receptive relation to the filament within the globe and forming, one an electron target and the other, as I have termed it, an "electron deflector." These externally located conducting elements may be, and conveniently are, applied directly to and supported by the globe, being for instance, in the nature of separated metallic deposits made on the outer surface of the globe.

The external conducting elements while separated, I have found, should be relatively closely approached and I have further found that greater effectiveness is attained for some purposes by making the adjoining edges of said conducting elements in jagged or serrated conformation, this latter in effect increasing electron control by the bringing of the deflector "nearer" to the target, this by reason of the fact that the edges of the deflector are extended up between the edges of the target. This separation of these edges of the conducting elements may be however a straight line in cases where it is desirable to increase the resistance between deflector and target.

Other features of the invention will be made apparent as the specification proceeds.

In the accompanying drawing I have illustrated my invention embodied in one of its simplest, practical forms but would have it understood that the invention is susceptible of various modifications both as to the possible circuit arrangements and otherwise, without departure from the true spirit and scope of the invention.

The figure is a partly sectional view of a simple form of the electron valve with one arrangement of circuits for a radio receiving set.

The globe or tube which is designated 1, is indicated as an evacuated vessel of a material such as glass or quartz, which is normally non-conductive to electricity but which, I have found, when warmed, is conductive to, or at least, permits of an electron flow. Within said globe there is mounted a suitable heating filament 2. This globe may have an ordinary lamp base such as indicated, provided with terminals 3 and 4 for the filament.

The external conducting elements, in the present illustration are formed as separated sections of a coating or covering applied directly to the globe, one of said sections 5 constituting in effect a cap covering the end of the globe and the other section 6, constituting in effect a band about the middle portion of the globe. These two elements are of suitable conducting material such as silver or copper and may be applied to the globe in any suitable way, such as by elec-

tro-deposition. The end or cap portion 5, is it will be seen, of greater area than the band portion 6, and is for this reason better suited to form the plate, or as I have termed it, the "electron target," while the band or element of lesser conducting area, is suited to take the place of the grid and form, as I call it, the "electron deflector."

The two external conducting elements are shown as having their adjoining edges relatively closely approached but as having a clear insulating space 7 therebetween. The adjoining edges of the two elements furthermore, are indicated at 8 as of serrated or jagged outline, thus providing a zigzag intervening space between the two members. This in effect increases the areas of the two elements which are opposed to each other.

It is desirable that as many as possible of the electrons which control flow from the filament to the target shall be influenced by the deflector. In order that the deflector influence these electrons, its electrical field should be as close as possible to the target. The portion of the target not affected by the electrical field from the deflector will receive an uninterrupted flow of the electrons from the filament. As an amplifier, the action depends upon the volume of electron control. The deflector should therefore control as great a percentage of the electron flow as possible. This in effect is what is accomplished by the intermeshing or "overshadowing" of the target by the deflector.

In the particular instance illustrated, the valve is shown in use as a detector but it will be apparent to those skilled in the art that it is not limited to such a purpose, being adapted for instance for use also as an "amplifier" or as a "generator of sustained oscillations."

Referring now to said diagram, the heating filament is indicated as energized by a battery A, the electron target element 5 is shown as connected in a receiving circuit to the positive terminal of a battery B through a set of telephone receivers 9, and the electron deflector 8, is indicated connected through a small stopping condenser 16, with the antennæ or aerial 10 and with the inductance 11, said inductance being connected with the ground or counterpoise 12 and having a connection 13 with one side of the filament, this latter connection being common also to the negative terminal of the battery B.

My theory of operation of this set, briefly, is substantially as follows: When the filament is lighted by the source of current at A, the globe, which is of glass or other material normally non-conductive to electricity, becomes warmed and the electrons released from the incandescent filament act as carriers for the energy of the battery B from the target to the filament, enabling said battery to force a certain amount of current through the wall of the globe and across the intervening space to the filament. If a charge is now placed upon the electron deflector element 6 by means of rectified radio oscillations for instance, this rectification being due to the unilateral conductivity between the filament and electron deflector, the flow of electrons will be aided or retarded as the case may be, depending upon the polarity of the charge, and a very slight charge upon this conducting element 6 is sufficient to affect the flow of current through the other branch, which includes the receivers, to a large degree. The conducting element 6 thus acts, in effect, as a deflector and by its deflection of the electrons to a secondary path, serves to affect the receiving circuit and thus produce a true reproduction of the radio signals. The magnified effects obtained in the receiving circuit enable the detection of very weak signals and hence make the device much more sensitive, enabling the detection of such weak signals as would probably have been "lost" heretofore. It will be noted that the operation depends upon the electron flow through the warmed glass or other normally non-conducting wall of the globe and not simply upon the flow through an evacuated space, as heretofore. In other words, the efficiency of the device is not dependent solely upon the maintenance of a proper vacuum.

The electron discharge at the inside of the bulb may be considered, because of its unilateral conductivity, a polarizing conductor or polarizing medium. The electrode on the outside of the bulb which is of a material that does not polarize in contact with the glass constitutes what may be termed a non-polarizing layer or conductor. The controlling effect of the deflector, it will be evident from the foregoing, is to modify the current conveyed by the electron discharge.

The circuit conductors may be connected with the externally located conducting elements in any suitable way and in the present disclosure I have shown such conductors as simply soldered fast to the conducting elements, as indicated at 14 and 15.

I claim:

1. In apparatus of the character set forth, the combination of a body of solid material which though normally non-conductive to electric current becomes conductive to electron flow when warmed, a conductor on one side of said solid body, and means for creating an electron discharge through said solid body to said conductor.

2. In apparatus of the character set forth, the combination with a globe of a material which though normally non-conductive to electric current becomes conductive to electron flow when warmed, of a conductor on one side of said globe, and means for creat-

ing an electron discharge from the opposite side of the globe through the wall of the globe to said conductor.

3. The combination with a heated solid body of a material which though non-conductive to electric current at normal temperature becomes conductive to electron flow when heated, of a conductor at one side of said heated solid body, and means for creating an electron discharge through said heated solid body to said conductor.

4. In apparatus of the character set forth, the combination of a body of solid material non-conductive to electric current at normal temperature but conductive to electron flow when heated, a conductor at one side of said solid body, and means for heating and for producing an electron discharge through said solid body to said conductor.

5. In apparatus of the character set forth, the combination of a body of solid material non-conductive to electric current at normal temperature but conductive to electron flow when heated, a conductor in intimate contact with said solid body, and means for heating and for producing an electron discharge through said solid body to said conductor.

6. In combination with a body of heated glass-like material, a conductor in contact therewith, and means for producing an electron discharge through said heated glass-like body to said conductor.

7. In apparatus of the character set forth, the combination with a body of material having substantially the electrical characteristics of glass, a conductor having substantially the electrical characteristics of silver in contact with said body, and means for creating an electron discharge through said body to said conductor.

8. An electron valve comprising in combination a wall of material having substantially the electrical characteristics of glass, a conductor at one side of said wall an electron source at the opposite side of said wall, a source of electric current connected with the conductor, and electrical connections for enabling the electron discharge to establish flow of said current through said wall.

9. An electron valve comprising in combination a body of a material which though normally non-conductive to electric current becomes conductive to electron flow when warmed, a conductor on one side of said body, an electron source at the opposite side of said body, a source of electric current connected with the conductor, and electrical connections for enabling the electron discharge to establish flow of said current through said body.

10. An electron valve comprising in combination a wall of material having substantially the electrical characteristics of glass, a conductor at one side of said wall, a filament at the opposite side of said wall and a source of direct current connected with the conductor and with said filament.

11. An electron valve comprising a tube of a material which though non-conductive to electric current at normal temperature becomes conductive to electric current when heated, a filament in said tube, a conductor on the outside of said tube, and connections for enabling an electron discharge from the filament through the wall of the tube to said outside conductor.

12. An electron valve comprising a tube of material having substantially the electrical characteristics of glass, an electron source in said tube, a conductor on the outside of said tube and connections for producing an electron discharge from said source through the wall of the tube to said outside conductor.

13. An electron valve comprising a glass tube, a filament in said tube, a conductor on the outside of said tube, and connections for producing an electron discharge from said filament through the wall of the tube to said outside conductor.

14. An electron valve comprising a tube, an electron source in said tube, a conductor on the outside of said tube, connections for producing an electron discharge from said source through the wall of the tube to said outside conductor, and a controller disposed in electron receptive relation to said source and arranged to modify the electron discharge to the conductor.

15. An electron valve comprising in combination a tube, a conductor on the outside of said tube, means for producing an electron discharge from inside the tube through the wall of the tube to said outside conductor, and means for modifying the electron discharge to said conductor.

16. An electron valve comprising in combination a tube, a conductor on the outside of said tube, means for producing an electron discharge from inside the tube through the wall of the tube to said outside conductor, and means for modifying the electron discharge to said conductor, said latter means consisting of a second conductor on the outside of the tube separated from the first conductor but disposed in electron receptive relation to the electron source.

17. An electron valve comprising a body of a solid material which though non-conductive to electric current becomes conductive to electron flow when heated, a conductor at one side of said body, means for heating and for creating an electron discharge through said solid body to said conductor, and means for modifying the electron discharge to said conductor.

18. An electron valve comprising a globe, separated conducting surfaces on the outside of said globe, and means for creating an electron discharge through the wall of

said globe to said separated conducting surfaces.

19. In an electron valve, a globe, separated conducting surfaces on the outside of said globe, a receiving instrument connected with one of said conducting surfaces, an aerial connected with the other of said conducting surfaces, and means for creating an electron discharge from inside the globe through the wall of the same to said outside conducting surfaces.

20. In an electron valve, a body of a solid material which though normally non-conductive to electric current becomes conductive to electron flow when heated, separated conducting surfaces on one side of said body, a receiving instrument connected with one of said conducting surfaces, an aerial connected with the other of said conducting surfaces, and means for heating and for forcing an electron discharge through said solid body to said separated conducting surfaces.

21. In an electron valve, a body of a solid material which though normally non-conductive to electric current becomes conductive to electron flow when heated, a conductor on one side of said body, means for heating and for forcing an electron discharge through said solid body to said conductor, and means for modifying the electron discharge to said conductor comprising a second conductor in the path of electron discharge.

22. An electron valve, comprising a bulb and an anode outside said bulb.

23. In an electron valve, a globe, separated conducting surfaces on the outside of said globe, and having closely approached opposed zig-zag edges, an electron source within the globe and means for providing an electron discharge from said source through the wall of the globe to said conducting surfaces.

24. An electron valve comprising in combination, an electron emitting element, an anode element in electron receptive relation thereto and a body of glass-like material interposed between said electron emitting element and anode element.

25. In an electron valve, an evacuated tube of a material having substantially the electrical characteristics of glass, a filament within said tube, a conductor on the outside of said tube, a receiving circuit connected with said conductor, a controller for modifying the electron discharge to said conductor, and an aerial circuit connected to said controller.

26. In an electron valve, a globe, a cap of electrically conductive material applied to said globe, a filament within the globe, and means for enabling an electron discharge from said filament through the wall of the globe to said cap.

27. In an electron valve, a globe, a cap of electrically conductive material applied to said globe, a filament within the globe, means for enabling an electron discharge from said filament through the wall of the globe to said cap, a band encircling the globe in close proximity to but separated from the cap, and means for charging said band to modify the electron discharge to the cap.

28. In an electron valve, a globe, a conductor encircling said globe, means for creating an electron discharge from inside the globe through the wall of the globe to said encircling conductor, and a controller disposed in the electron path and arranged to modify the electron discharge to said conductor.

29. In apparatus of the character set forth, the combination with a body of solid material which though normally non-conductive to electric current becomes conductive to electron flow when warmed, of a conductor on one side of said body, means for creating an electron discharge through said solid body to said conductor, and means for modifying the electron discharge to said conductor.

30. In apparatus of the character set forth, the combination with a body of solid material which though normally non-conductive to electric current becomes conductive to electron flow when warmed, of a conductor on one side of said body, means for creating an electron discharge through said solid body to said conductor, and a second conductor disposed in the path of electron flow for modifying the electron flow to the first conductor.

31. In an electron valve, a body of solid material having substantially the electrical characteristics of glass, a conductor at one side of said body, an electron source at the opposite side of said body, and a source of direct current connected with the conductor and with said electron source.

32. In an electron valve, a body having substantially the electrical characteristics of glass, separated conducting surfaces on one side of said body, and means for creating an electron discharge through said body to said separated conducting surfaces.

33. In an electron valve, a body of a material having substantially the electrical characteristics of glass, separated conducting surfaces on one side of said body, a receiving instrument connected with one of said conducting surfaces, an aerial connected with the other of said conducting surfaces, and means for creating an electron discharge through the body to said separated conducting surfaces.

34. In an electron valve, a tube of electrically non-conductive material, an electron source within said tube, an electron target

on the outside of said tube and in electron receptive relation to the source through the wall of the tube, and electrical connections common to said target and to said electron source.

35. In an electron valve, a tube of electrically non-conductive material, an electron source within said tube, an electron target on the outside of said tube and in electron receptive relation to the source through the wall of the tube, electrical connections common to said target and to said electron source, and an electron deflector on the outside of the tube but separated from the electron target and disposed in electron receptive relation to the source through the wall of the tube.

36. In an electron valve, a tube of electrically non-conductive material, an electron source within said tube, an electron target on the outside of said tube and in electron receptive relation to the source through the wall of the tube, electrical connections common to said target and to said electron source, and an electron deflector disposed in electron receptive relation to the source, but separated from the target.

37. An electron valve, comprising a cathode element and an anode element in electron receptive relation thereto and a body of glass-like material interposed between said two elements.

38. The process of creating an electron flow through a solid body which is non-conductive to electric current at normal temperature, which consists in heating the same to render it conductive to electron flow, and subjecting said solid body while thus heated to an electron discharge.

39. The process of producing an electron discharge, comprising heating a globe of normally non-conductive material to render the same conductive to electron flow and creating an electron discharge through the wall of said globe while the same is heated.

40. The process of producing an electron discharge through a solid body which is normally non-conductive to electric current, which comprises heating said body to render the same conductive to electron flow, and imposing a current charge on one side of said heated body while subjecting the other side of said body to an electron discharge.

41. The herein disclosed process of producing and modifying an electron discharge, comprising heating and projecting an electron discharge through a body of glass-like material to a conductor and deflecting a portion of said electron discharge to thereby modify the effective electron flow to said conductor.

42. The herein disclosed thermionic receiving process comprising heating and projecting an electron discharge through a body of glass-like material to a receiving circuit, and impressing varying charges on a second conductor to vary the electron flow and thereby vary the effect on the receiving circuit.

43. The method of producing a flow of direct current through a body of heated glass which consists in impressing a charge of direct current on one side of the glass while discharging an electron flow against the opposite side of said glass.

44. In an electron valve, a globe, a filament within said globe, separated conducting areas on the outer surface of said globe, a lighting circuit of which the filament forms a part and circuits including said separated externally located conducting areas and having a common connection with the lighting circuit.

45. In combination, a globe of electrically non-conducting material, a filament within said globe, separated conducting elements outside said globe but in electron conducting relation to the filament within the globe, a lighting circuit for the filament, and circuits for the separated external conducting elements connected with the filament circuit.

46. An electron valve, comprising in combination, an electron emitting element, an anode element in electron receptive relation thereto, a body of glass-like material interposed between said electron emitting element and anode element and an electron controlling member separated from the anode element and disposed in electron controlling relation to the electron emitting element.

47. In an electron valve, a globe, an electron emitting element therein, an anode conductor outside the globe and external circuit connection for enabling the conduction of electrical energy from the electron emitting element through the wall of the globe to the external anode aforesaid.

48. An electron valve, comprising a closed vessel, an anode outside the vessel, a polarizing conductor inside the vessel and an electron controlling member separated from the anode but disposed in electron receptive relation to the polarizing conductor.

49. An electron valve, comprising a closed vessel having a polarizing medium at one of its surfaces and a non-polarizing layer at its other surface, and means for varying the effect of the polarizing medium.

50. The herein disclosed process, comprising producing a polarizing medium at one surface of a layer of glass-like material having a non-polarizing conductor in contact with the opposite surface thereof and varying said polarizing medium to vary the effect on the non-polarizing conductor.

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