Dec. 8, 1925. 1,565,151

W. G. HOUSKEEPER

ELECTRIC DISCHARGE DEVICE

Filed Dec. 27, 1919

Fig. 1.

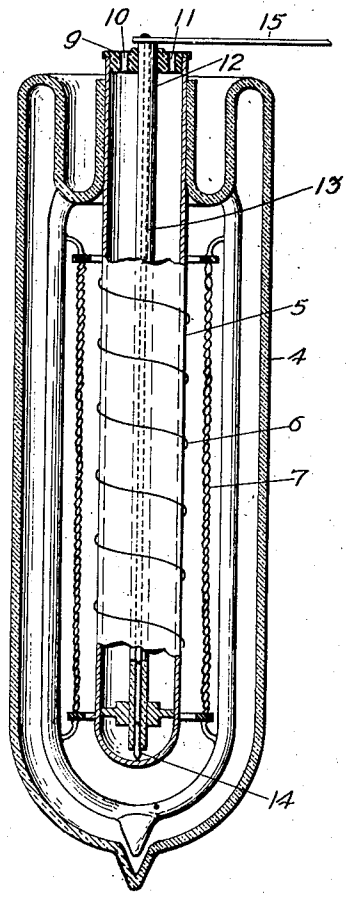
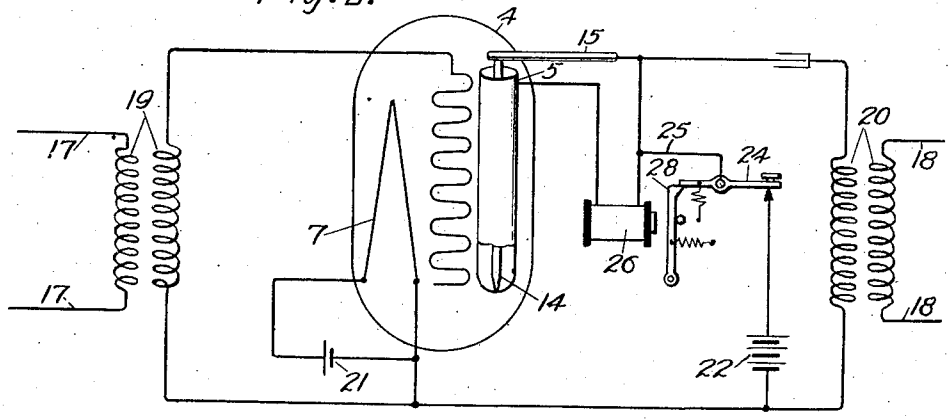



Fig. 2.




Inventor
William G. Houskeeper
by W. G. Beatty Att'y.

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# UNITED STATES PATENT OFFICE.

WILLIAM G. HOUSKEEPER, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

## ELECTRIC DISCHARGE DEVICE.

Application filed December 27, 1919. Serial No. 347,812.

*To all whom it may concern:*

Be it known that I, WILLIAM G. HOUSKEEPER, a citizen of the United States, residing at New York, county of New York, State of New York, have invented certain new and useful Improvements in Electric Discharge Devices, of which the following is a full, clear, concise, and exact description.

This invention relates to electric discharge devices and more particularly it relates to a circuit controlling device for vacuum tubes.

As is well known in the art, a thermionic device usually comprises an anode, a cathode and sometimes a control electrode or grid. In order to increase the amount of power such a device can handle, it has been hitherto proposed to cool the anode so as to prevent the anode from becoming excessively heated due to the electron-bombardment from the cathode. One way this may be accomplished is to make the anode cylindrical and to provide for the insertion of a cooling fluid, such as water, within the anode. With such an arrangement the possibility is always present that due to the evaporation of the cooling fluid or the temporary interruption of the fluid supply, the anode may become excessively heated to such a degree as to impair the operation of the tube, if not actually destroying it.

In accordance with this invention, means are actuated when the cooling system fails to operate whereby the temperature of the anode may be prevented from increasing beyond the permissible range. In the preferred form of this invention this is accomplished by providing automatic means for disconnecting the voltage supply of the tube when the temperature of the anode becomes excessive. This automatic means in the specific form hereinafter described, comprises a relay which is responsive to the thermal expansion of the anode for controlling the connections of the output circuit battery of the tube.

This invention will be better understood by reference to the following detailed description taken in connection with the accompanying drawings, in which Fig. 1 represents a thermionic device constructed according to this invention and Figure 2 represents the possible circuit connections for such a device.

Referring to Figure 1, 4 is a vacuum tube having an anode 5, a control electrode 6 and a cathode 7. Anode 5 is shown cylindrical in form and the stopper 9 for the end of the anode is provided with openings 10 and 11 to permit the entrance and exit of a cooling fluid for the anode. Mounted within the cylindrical anode 5 is a rod 12, preferably of insulating material. Within rod 12 is a metallic rod 13 or other electrical conductor for connecting the metallic tip 14 to spring member 15. The action of spring member 15 is to keep tip 14 normally in contact with the lower end of anode 5. When, however, anode 5 tends to expand beyond its normal length, spring member 15 would still tend to maintain tip 14 in contact with anode 5 until spring member 15 rests on the stopper 9. Further expansion of anode 5 thereafter would disconnect the electrical connection between spring member 15 and the anode.

Figure 2 shows how electro-magnetic means may be made responsive to the breaking of the connection between tip 14 and anode 5 in order to render the tube inoperative until the anode has contracted to its normal length. In Figure 2 the vacuum tube 4 is shown connected for repeater action between lines 17, 17 and 18, 18. The input circuit of tube 4 is connected to line 17, 17 through a transformer 19. The output circuit of tube 4 is associated with line 18, 18 through a transformer 20. 21 is a source of voltage for supplying heating current to cathode 7. Battery 22 is a source of voltage for the output circuit of tube 4 and supplies potential between anode 5 and cathode 7 by the following circuit:

From cathode 7, battery 22, contact 24 of a circuit breaker, through conductor 25, spring member 15, and conductor 14 to anode 5 and through conductor 25 and solenoid 26 to anode 5.

The current may thus pass to the anode 5 from battery 22 either directly from contact 24 and spring member 15 to the anode, or through the trip coil 26 of the circuit breaker. Coil 26 should be so adjusted that when current is being supplied to anode 5 through both of the two circuit branches previously traced, the amount of current flowing through coil 26 is not sufficient to energize coil 26 so as to pull up its movable contact 28. Current to the anode will, therefore, be supplied through these two

paths as long as the cooling fluid for anode 5 maintains the anode 5 within the desired temperature range. As soon, however, as the cooling fluid fails to maintain this desired temperature for anode 5 due, for example, to the evaporation of the fluid or the interruption of the fluid supply, anode 5 will become heated due to the electron-bombardment from cathode 7. As a result of this heating, anode 5 will expand and break the connection between the conductor 14 and the anode so that all of the output current will now flow through solenoid 26. This increase in the circuit through solenoid 26 will energize it to pull up its movable contact 28, thereby breaking the connection between battery 22 and contact 24. The breaking of this connection disconnects battery 22 entirely from anode 5 and thereby renders the tube inoperative until the anode 5 has reached its normal temperature again. In the preferred form of this invention the movable contacts for solenoid 26 should be such as to prevent the automatic connection of battery 22 to anode 5 as soon as anode 5 has reached its normal temperature, that is, the circuit breaker for anode 5 should be so designed as to require some manual adjustment before the battery 22 is reconnected to the anode, since in most instances, the individual attention of the operator is required to determine and correct the failure of the cooling fluid to maintain the anode 5 within the desired temperature range. It follows, therefore, that the circuit arrangement above described will prevent the anode 5 from becoming heated to such a high temperature as to seriously impair the operation of the tube or actually destroy it.

In the preferred arrangement of this invention the adjustment of conductor 14 and spring member 15 should be such that spring member 15 comes in contact with stopper 9 when the maximum permissible temperature for anode 5 has been reached.

It is obvious that various modifications may be made in the form of the invention described above without departing in any wise from the spirit of this invention as defined in the appended claims.

What is claimed is:

1. In combination, a space current discharge device comprising an evacuated envelope containing a plurality of electrodes, said device being normally operative, and automatic means responsive to a condition of said device for rendering said device inoperative.

2. In combination, a space current discharge device comprising an evacuated envelope containing a plurality of electrodes, said device being normally operative, and automatic means responsive to the physical condition of said device for rendering said device inoperative.

3. In combination, an electric discharge device, an evacuated envelope containing a plurality of electrodes, and automatic means responsive to the thermal condition of one of said electrodes for changing the efficiency of said device.

4. In combination, a space current discharge device comprising an evacuated envelope containing a plurality of electrodes, and a solenoid responsive to the thermal condition of one of said electrodes for rendering said device inoperative.

5. In combination, a space current discharge device comprising an evacuated envelope containing an electrode, means for supplying energizing current to said device, and means operative when the thermal condition of said device is abnormally changed for reducing said energizing current substantially to zero.

6. In combination, an electric discharge device having a plurality of electrodes means for supplying space current to said device and electromagnetic means responsive to a condition of said device for reducing said space current to zero.

7. In combination, an electric discharge device having a plurality of electrodes, means for supplying voltage between two of said electrodes and electromagnetic means responsive to a condition of said device for reducing the efficiency of said supply means.

8. In combination, a space current discharge device comprising a plurality of electrodes, said device being normally operative, and means operating when the thermal condition of said device is abnormally changed for rendering said device inoperative.

9. In combination, a vacuum tube, a cooling system for said tube employing a circulating fluid, and means actuated when the circulation of the fluid is interrupted for rendering said tube inoperative.

10. In combination, two lines, a vacuum tube repeater between said lines for normally repeating currents between said lines and electromagnetic means responsive to said repeater for preventing currents from one of said lines from being impressed on the other of said lines.

11. In combination, a vacuum tube comprising a plurality of electrodes, an electromagnetic means responsive to a change in a position of one of said electrodes for rendering said device inoperative.

12. In combination, a vacuum tube having a plurality of electrodes, an outgoing line associated therewith, and automatic means responsive to the temperature of one of said electrodes for changing the character of the currents impressed on said outgoing line by said tube.

13. In combination, a vacuum tube having an anode, a cathode, and a control electrode, and a solenoid responsive to the tempera-

ture of said anode for rendering said tube inoperative.

14. In combination, a vacuum tube having a cathode, a control electrode, and a cylindrical anode, a contact normally in electrical connection with a portion of said anode and electromagnetic means responsive to the breaking of said connection for reducing the efficiency of said tube.

15. In combination, a vacuum tube having a cathode, a control electrode and a cylindrical anode, said anode being closed at one end, a source of voltage and an electrical conductor in contact with the closed end of said anode for supplying voltage to said anode from said source.

16. In combination, a vacuum tube having an anode, a cathode and a control electrode, a contact normally electrically connected to said anode, a source of voltage, circuit connections for supplying voltage from said source between said cathode and anode through said contact, means for breaking the electrical connection between said contact and said anode in response to an increase in temperature of said anode, and electromagnetic means responsive to the breaking of said connection for disconnecting said battery from said tube.

17. In combination, a vacuum tube, cooling means for said tube, and electro-responsive means actuated when said cooling means fails to operate.

18. In combination, a vacuum tube, a cooling system for said tube, and electro-responsive means actuated when said cooling system becomes defective.

19. In combination, a vacuum tube, means for cooling a portion of said tube, and means actuated when said cooling means becomes defective to render said tube inoperative.

20. In combination, a vacuum tube comprising a plurality of electrodes, means for cooling one of said electrodes, and electro-responsive means actuated when said cooling means becomes defective to change the efficiency of said tube.

21. In combination, a vacuum tube having a hollow electrode, means providing for the passage of a cooling fluid within said electrode, and electro-responsive means actuated when the cooling fluid fails to flow.

22. In combination, a vacuum tube having a plurality of electrodes, a source of voltage, connections from said source to said tube, means for causing a cooling fluid stream to contact with a portion of one of said electrodes, and means actuated when said fluid fails to flow for disconnecting said source from said tube.

23. In combination, an electric discharge device having a plurality of electrodes, a contact closing device comprising a thermal expansion element controlled by a condition of said device, and electro-responsive means controlled by said element.

24. In combination, an electric discharge device having a plurality of electrodes, a thermal expansion element controlled by a condition of said device, and electro-responsive means controlled by said element to render said tube inoperative.

25. In combination, a space current discharge device having a plurality of electrodes, electro-responsive means for rendering said device inoperative, and a movable member, the position of which is changed when a condition of said device is changed for controlling said means.

26. In combination, a vacuum tube, means for cooling said tube, and thermal means actuated when said cooling means fails for rendering said tube inoperative.

27. An electron discharge device comprising an envelope, cathode, anode and control electrodes therein and a contact operable in response to temperature changes in one of said electrodes.

28. An electron discharge device comprising an envelope, cathode, anode and control electrodes therein, and a contact operable in response to temperature changes in said anode.

29. An electron discharge device comprising an anode, a cathode, a control electrode, and an electric circuit controlled by movable means responsive to the expansion of one of said electrodes.

30. An electron discharge device comprising an anode, a cathode, a control electrode, and an electrical contact operated by the expansion of one of said electrodes.

31. An electron discharge device comprising an anode, a cathode, a control electrode, and a circuit closing member supported by one of said electrodes.

32. An electric discharge device comprising an anode, a cathode, a control electrode, and a movable circuit closing member supported by said anode, and spring means for holding said member in a desired position.

33. An electric discharge device comprising an anode, a cathode, and means for closing an electric circuit when said anode is in one position and for opening an electric circuit when said anode is in a second position.

34. In combination, a vacuum tube having a cathode, a control electrode and a cylindrical anode, said anode being closed at one end, a source of voltage and an electrical conductor in contact within the closed end of said anode for supplying voltage to said anode from said source.

In witness whereof, I hereunto subscribe my name this 23rd day of December, A. D. 1919.

WILLIAM G. HOUSKEEPER.